UNIVERSITY of TASMANIA

IMAS

Institute for Marine and Antarctic Studies

Illustrated Scoring Guide: Rapid visual assessment of reef ecosystems for nutrient enrichment in Tasmania

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1 Introduction

This guide has been developed to assist in the completion of rapid visual assessment (RVA) surveys; a method used to detect change in ecosystem function due to nutrient enrichment on temperate reef environments.

This method was originally developed by IMAS with the intent of being used to assess change in temperate reef environments where impacts from finfish aquaculture operations were a possibility. Since the development of this method, it has been applied to a range of different management scenarios across multiple aquaculture industries including finfish, shellfish and seaweeds (Ross et al. 2021, White et al. 2022, McAnaney et al. 2024, White et al. 2025b). The method provides a robust and consistent technique for scaling the effects of nutrient enrichment and thus functions as a tool to examine both spatial and temporal patterns of nutrient stimulus in marine systems.

This method was largely developed and validated against data collected using pre-existing, more detailed biodiversity assessments (Edgar & Barrett 1999, Oh et al. 2015). However, RVA surveys take a more functional-based approach to ensure the effects of nutrient enrichment were targeted, while being simple enough to be applied by a wide range of operators (Ross et al. 2021). RVA surveys were designed specifically for shallow (approximately 5 m depth), inshore reefs that are dominated by macroalgae. For reef habitats that do not fit this description, such as deeper reefs, intertidal or shallow sub-tidal zones or mixed substrate communities, modification to the methods will be necessary.

This RVA method encompasses fifteen functional parameters as a proxy for reef health, with ten of these being broad structural parameters associated with ecosystem function and five relating solely to a nutrient enrichment response (Table 1). Data is analysed to provide information on shifts in ecosystem function from a natural to an enriched state. Individual or multiple parameters can provide an indication of a loss of resilience or functional response to nutrient enrichment.

This guide has been developed to help ensure consistency over time and between operators. It provides detailed information on each of the parameters and the considerations for collecting robust and consistent data for each survey. An example scorecard is also provided in Appendix A.

Table 1: Summary of all functional parameters and their purpose within the RVA surveys (reproduced from White et al. 2022).

Functional Parameter		Expected response to increased nutrient enrichment	Reference
Broad Structural Conditions	**Total canopy algae cover (including breakdown by species)**	Decline	Connell et al. (2008), Eriksson et al. (2002), Benedetti-Cecchi et al. (2001)
	Sub-canopy brown algae cover	Dependent on canopy response	
	Sub-canopy green algae cover	Potential increase due to increased nutrient availability	Oh et al. (2015), Nelson et al. (2008)
	Sub-canopy red algae cover	Potential increase due to higher sedimentation in water column. Overall increase in red+green:brown algae ratio expected in enhanced nutrient conditions	Stuart-Smith et al. (2008)
	Turfing algae cover	Increase	Connell et al. (2008), Eriksson et al. (2002), Benedetti-Cecchi et al. (2001)
	Pink encrusting algae cover	Potential decline and replacement by turfing or opportunistic algae, if canopy is lost	Burkepile and Hay (2006)
	Red encrusting algae cover	Could decline as per pink encrusting, or increase due to changes in predation pressure or light conditions	Burkepile and Hay (2006)
	Sessile filter feeders	Likely to increase under mild organic enrichment and decrease under major organic enrichment	Strano et al. (2020) Huang et al. (2011)
	Encrusting & epibiotic fauna	Potential increases with increases in opportunistic algae cover likely	Russell and Connell (2005), Burkepile and Hay (2006), Haugland et al. (2021)

Functional Parameter		Expected response to increased nutrient enrichment	Reference
Enrichment response	**Epiphytic algae cover**	Increase	Oh et al. (2015), Fowles et al. (2018a)
	Filamentous algae cover	Increase	Oh et al. (2015), Lavery and McComb (1991)
	Opportunistic green algae cover	Increase	Oh et al. (2015), Nelson et al. (2008), Fowles et al. (2018a)
	Opportunistic red algae cover	Increase	White et al. (2022), Ross et al. (2021)
	"Dust" on algae	Increase (a reflection of sedimentation)	Anecdotal

This document is intended as a reference to guide divers in making decisions when identifying each parameter successfully and scoring percentages. It aims to provide realistic images of each habitat type and where possible, provide visual examples of different percentage scores for each parameter. It also addresses some of the frequently asked questions associated with the method. Although the ecological significance of each RVA parameter is briefly introduced in this guide, further background information on the ecological responses of temperate reef communities to nutrient enrichment from aquaculture can be found in Volume 3 ('Ecological effects of finfish aquaculture on shallow temperate reef ecosystems') of the 'Aquaculture Environment Review Series' (White et al. 2025a). Additional information on monitoring reefs for the effects of finfish aquaculture can also be found in the "Guide to the Environmental Monitoring and Assessment for Finfish Aquaculture" (Ross et al. 2025).

2 Rapid visual assessment surveys

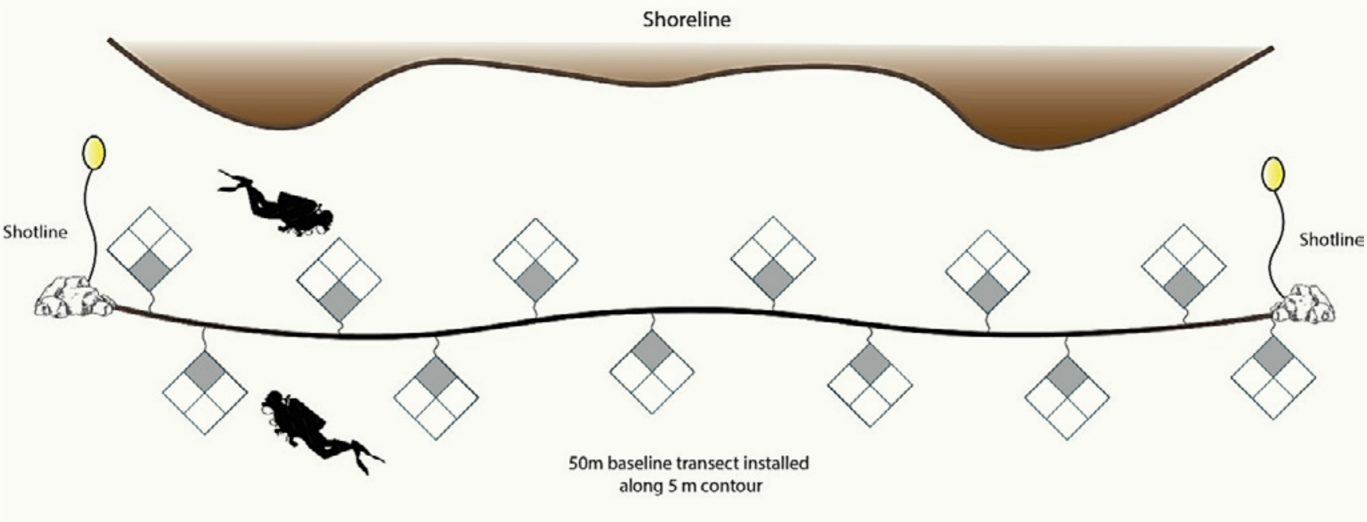
2.1 Site selection

The site requirement for an RVA survey is 50 m of continuous hard substrate (i.e. reef) at any given location (Figure 1). The method is not designed to assess mixed-substrate and large sand patches along the transect line can confound the data.

To limit variability in the data, particularly at sites that have a steep profile and/or are subject to an exposure gradient, a fixed 50 m transect line should be established to ensure repeatability of the surveys and accuracy of the data over time.

This transect is generally fixed by installing eyebolts into the substrate at either end and attaching a sub-surface float to each eyebolt. GPS coordinates for the start and end of the transect should be recorded so that the transect can be easily located for subsequent surveys. Ideally, the 50 m transect should follow the 5 m depth contour, or as close to this as possible.

Figure 1: Diagram showing the site layout of an RVA transect and an example placement of quadrats



2.2 Survey procedure

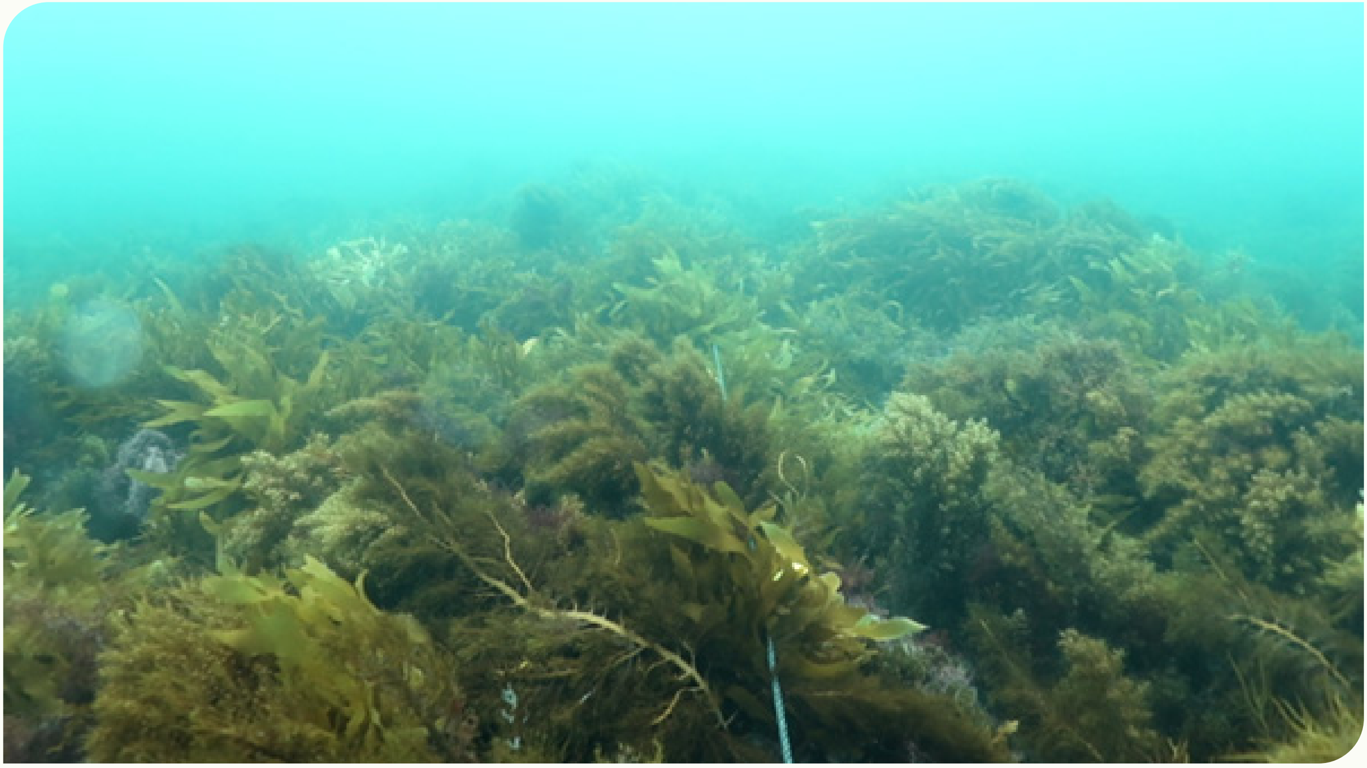
When approaching the site to commence a survey, two shot lines should be deployed at either end of the transect, based on recorded GPS coordinates. Two divers should enter the water at the “0 m” (start) shot line and commence searching for the eyebolt and float. Once this is located, the transect line should be clipped off onto the eyebolt. One diver can return to the surface and navigate towards the 50 m (end) shot line, while the second diver reels out the transect line underwater. Once the 50 m eyebolt has been located, the transect line should be clipped off and tensioned so that the line is taut across its length. The two divers then swim back along the transect to the 0 m mark, with one of the divers filming the transect line for archival purposes. When filming along the transect line, the video frame should comprise approximately two thirds reef substrate/canopy and one third water column (Figure 2).

Across each site, twelve 1 m^2 quadrats are scored from the tensioned transect line. These quadrats are divided into four 0.25 m^2 sub-quadrats, to assist with scoring accuracy. The quadrats are attached to a 1.5 m rope that is clipped onto the transect line, with the quadrat line running perpendicular to the main transect line (Figure 1). This is to increase the survey area, incorporating a higher level of in-site variation into the study design. Placement of these quadrats can be haphazard (i.e. one approximately every 5 m) or fully random (i.e. determined by a random number generator).

Once random or haphazard sampling has been decided on for a particular region, this form of sampling should continue for future survey events. Quadrats should alternate between either side of the quadrat line, so the effects of any site-specific depth gradients are evened out across the transect. Each quadrat should be photographed prior to scoring. When photographing quadrats, photos should be taken from directly above the quadrat and as close to the substrate as possible while still encompassing the entire quadrat frame. Along with a photograph of the entire quadrat frame, a photo should be taken of the 0.25 m^2 sub-quadrat closest to the transect line, as substrate parameters are only scored within this sub-quadrat. Photographs are archived and often used in the QA/QC of data prior to analysis.

During the survey, divers should record the visibility, along with any notable site conditions that may inform the data or assist with site maintenance e.g. any significant visual changes from previous surveys, the presence of damaged or missing eyebolts or sub-surface floats, or where quadrat placement had to be altered due to site conditions. These should be compiled into the metadata and noted prior to the data analysis or subsequent surveys.

Figure 2: Still image captured from a video taken along the RVA transect, showing an appropriate field of view



2.3 Diver calibration

To ensure that scoring is consistent between divers, a calibration or "diver QA/QC" procedure is run across the scoring of the first two quadrats between the two divers surveying the site. This ensures that divers are scoring parameters in the same way at each site, helps to correct for “diver-drift” and highlights any small issues regarding interpretation of parameters as they arise. This process ensures that any “diver-effect” is mitigated within subsequent datasets.

For this process, two divers score the first two quadrats side-by-side. Once the first quadrat is scored, the divers compare scorecards underwater. Any parameter that has >10% variation between divers is rescored or discussed until an agreement is reached between divers. During method development, it was found that the normal margin for error between two experienced, well-trained divers was ≤10% (Ross et al. 2021).

The QA/QC process ensures that diver-to-diver difference remains within this ≤10% margin and that data remains comparable, regardless of who has surveyed the site. This process is then repeated for the second quadrat, where there has usually been a marked improvement in variability between divers. Once the QA/QC process is complete, the two divers leapfrog each other along the transect line until all 12 quadrats are scored.

When scoring parameters that are present in extremely low abundance (i.e. <5% cover), a score of 1% represents that the species/parameter is present but at a very low abundance, while a score of 2% represents that the species/parameter is present, at a slightly higher abundance. Abundances higher than this should be recorded at 5% increments.

3 Scoring RVA parameters

The following section outlines how to score each of the individual parameters within an RVA survey. This section aims to ensure that parameters are scored consistently between divers and surveys.

An example layout of an RVA scorecard can be found in Appendix A, with a word version of the scorecard also available for downloading from the Aquaculture Environment website.[1]

A summary table of how to score each of the parameters can be found at the end of this section (Table 2) along with a visual guide of representative images of each of the parameters across a range of environments (Appendix C). This includes canopy, sub-canopy, epiphytic, filamentous and opportunistic algae at a range of abundances, along with key substrate characterisations.

3.1 Macroalgae canopy cover

The macroalgae canopy is one of the most important components of an inshore rocky reef assemblage, maintaining ecosystem function, providing three-dimensional structure and supporting a wide range of biodiversity (Smale et al. 2013, Teagle et al. 2017). The abundance of the macroalgae canopy will play a large role in shaping subsequent functional parameters (Ross et al. 2021). Given the importance of this parameter, it is one of the few metrics that is scored to species level within the RVA surveys. The species of macroalgae dominating the canopy also provides valuable information on environmental conditions, with most species having a defined range within a wave exposure gradient (Edgar 1984, Hill et al. 2010), along with differing sensitivities to nutrients and/or siltation in the water column (Kawamata et al. 2012, Fowles et al. 2018b).

In south-east Tasmania, macroalgae canopy tends to be dominated by either *Phyllospora comosa* or *Ecklonia radiata* across the D'Entrecasteaux Channel and Storm Bay. *Lessonia corrugata* is also a common species in more exposed areas within Storm Bay, along with *Durvillaea potatorum*.

Macrocystis pyrifera is also present, and sometimes dominant, at sites within this region, particularly where an obvious source of nutrients is present. In more sheltered locations, *Cystophora* spp. and *Sargassum* spp. are likely to dominate the canopy. Diverse assemblages of *Cystophora* and *Sargassum* can form a large component of the canopy along the north coast of Tasmania. *Undaria pinnatifida is* also present in certain locations, such as the Derwent, northern D'Entrecasteaux Channel or Mercury Passage.

Some considerations for scoring macroalgae canopy include:

- Where possible, ensure that quadrat placement has not altered (i.e. flattened) the canopy cover.
  - If a holdfast is present outside the quadrat, then the laminar of that plant may need to be moved outside of the quadrat.
  - If a holdfast is present inside the quadrat, then the laminar of that plant may need to be moved inside the quadrat.

1 https://aquacultureenvironmentteam.org.au

- Use the four 0.25 m^2 sub-quadrats to aid estimations of canopy abundance.
- The sum of all species should be equal to the total canopy cover.
- If a definitive identification can't be reached for a species of *Cystophora* or *Sargassum*, then these can be scored at the genus level. Photographs should be taken of the laminar and the holdfast of the algae to potentially enable later species identification.
- For species that have a tall canopy height (e.g. *Macrocystis pyrifera* or *Phyllospora comosa*), canopy cover should be estimated by viewing the quadrat from as high as required, to incorporate as much of the canopy as possible. In these cases, the photograph taken of the quadrat may not necessarily be representative of the true canopy cover and this should be noted in the scorecard.

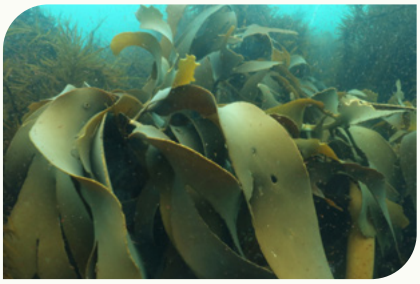
In habitats with a high abundance of *Cystophora* spp. or *Sargassum* spp., the distinction between the canopy and the brown sub-canopy macroalgae becomes difficult to delineate. To ensure consistency of data collection, the following guidelines have been established:

- Where only the basal *Sargassum* is present, it should be included as sub-canopy brown rather than canopy.
- *Cystophora* species can be recorded as either canopy or sub-canopy depending on the way it functions:
  - *Cystophora* that tends to lie prostrate on the substrate (e.g. *Cystophora platylobium* or *Cystophora moniliformis*) should be recorded as sub-canopy.
  - Upright species (e.g. *Cystophora retroflexa*) tend to function more as canopy and should be recorded accordingly.

Smaller *Ecklonia* or *Phyllospora* individuals should be recorded as canopy as the separation between juvenile and adult plants is not always distinct for these species.

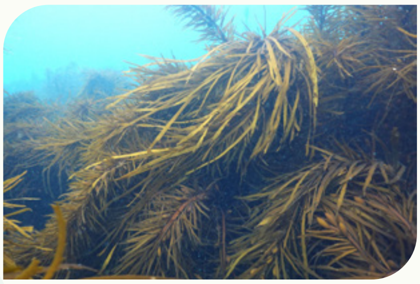
Figure 3: Macroalgae canopy cover recorded during RVA surveys

a) *Ecklonia radiata*

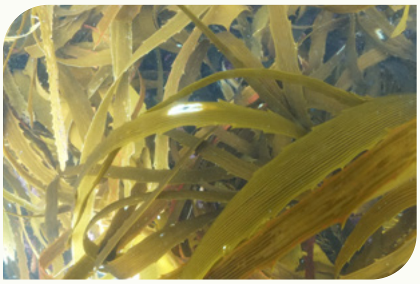


c) *Durvillaea potatorum*

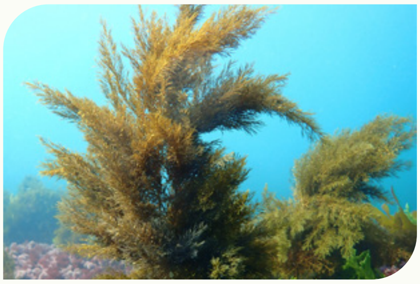
e) *Sargassum fallax* sp.



b) *Phyllospora comosa*



d) *Lessonia corrugata*



f) *Cystophora retroflexa*

3.2 Sub-canopy brown, green & red algae

Canopy cover has been observed to be a driver of sub-canopy algae community characteristics in several regions within southern Tasmania, interacting with factors such as light attenuation, physical abrasion and nutrient cycling (Schiel 2011, Tait et al. 2014, Shelamoff et al. 2019). On a broad functional level, brown, green and red sub-canopy communities appear to respond differently to changes in canopy composition, and are also sensitive to other factors like wave exposure and nutrient availability (White et al. 2021a, White et al. 2022, White et al. 2025b). Red algae are the most diverse algal taxonomic group, with approximately 800 species known from southern Australia (Edgar 2012).

During RVAs, sub-canopy algae is classified as algae ≥2 cm in height that grows on the substrate and forms an understorey to the canopy algae. Any algae ≤2 cm in height should be recorded as turfing algae. Brown, green and red sub-canopy algae are scored as separate parameters. When scoring sub-canopy algae, the total percentage cover is reflected at the functional level (i.e. total percentage cover of browns, greens, reds), rather than at the species level.

While the identity of the dominant sub-canopy brown and green species are noted on the scoresheet, it is not necessary to assign percentage cover to the sub-canopy species observed. The dominant species of brown and green algae included on the scoresheet are not used in subsequent data analysis, but provide good background information on the general reef community that can help inform interpretation of data. Common sub-canopy brown algae species in Tasmania include *Acrocarpia paniculata*, *Carpoglossum confluens*, *Halopteris paniculata*, *Perithalia caudata* and *Zonaria* spp. Common sub-canopy green algae taxa include species of the genus *Caulerpa*, *Codium fragile* and *Chaetomorpha coliformis*.

The total percentage cover of all red sub-canopy algae species is also recorded, but dominant species does not need to be noted. This is due to the diversity and the complexity of red algae species identification, with the overall aim of keeping the RVA method as simple as possible.

Scoring sub-canopy algae often requires physically moving the canopy algae out of the way to enable a clearer view of the understorey and substrate. Sometimes, opportunistic species (see below section), such as *Ulva* spp. and *Asparagopsis armata*, can grow on the substrate and so should be recorded as both sub-canopy algae and opportunistic algae.

3.3 Epiphytic algae

Epiphytic algae refers to algae growing on the surface of other algae species, and has been shown to respond positively to nutrient enrichment from finfish aquaculture (Oh et al. 2015, Haugland et al. 2021). Epiphytic algae can be present in a number of morphological types (e.g. foliose, sheet-like/membranous, filamentous), all of which are incorporated into the epiphytic algae score. When scoring epiphytic algae it is important to be mindful that other RVA parameters such as filamentous algae, or opportunistic green and red algae may also be growing epiphytically. These should all be incorporated into the overall epiphytic algae score, and scored under both categories if necessary. When scoring the percentage cover of epiphytic algae within a quadrat, the total percentage area of the entire quadrat covered by epiphytic algae should be recorded, rather than the percentage of kelp/algae covered by epiphytic algae.

When assessing epiphytic algae, the final score should reflect the percentage cover of all epiphytic algae found on both canopy, sub-canopy and turfing algae on a single plane across the quadrat.

Some epiphytic algae can be easily mistaken for sub-canopy algae (e.g. the epiphytic red algae *Hypnea ramentacea*, which attaches itself to other algae via small hooks and can grow in dense clumps). As a result, care must be taken to determine whether the algae is growing on the substrate or the surface of another alga.

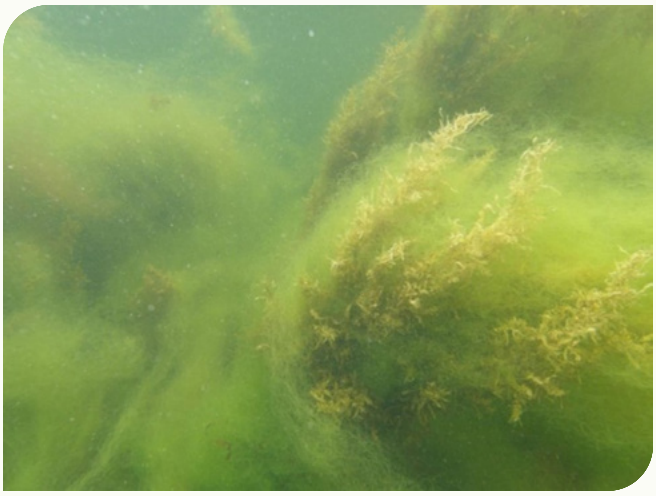
It is important that only algae growing on the surface of another plant is classed as epiphytic and subsequently scored in this category.

3.4 Filamentous algae

Filamentous algae has been shown to occur in elevated densities in sheltered waters exposed to nutrient enrichment (Oh et al. 2015, White et al. 2021b, Cherry 2022). Filamentous algae has no obvious structure and is very fine and delicate (Figure 4). The total percentage cover of filamentous algae should be scored across the entire quadrat. This includes filamentous algae growing both epiphytically (on canopy, sub-canopy or turfing algae) or on substrate. Note that the epiphytic component of the filamentous algae should also be included in the epiphytic algae score. Filamentous algae may also overlap with turfing algae when it is growing on the substrate and is ≤2 cm in height.

Cyanobacteria has been found in some locations around Tasmania. Its presence should be noted in the comments section for the site, but percentage cover included in the overall filamentous algae category for now.

Figure 4: An example of dense filamentous algae growing epiphytically



3.5 Opportunistic red & green algae

Opportunistic (also known as "nuisance") algae are characterised as ephemeral, delicate, rapidly colonising species known to exhibit fast growth in the presence of high nutrient levels (Littler & Littler 1980, Oh et al. 2015). In Tasmania, higher abundances of opportunistic algae have been recorded at sites closer to finfish aquaculture relative to control sites (Oh et al. 2015, White et al. 2022).

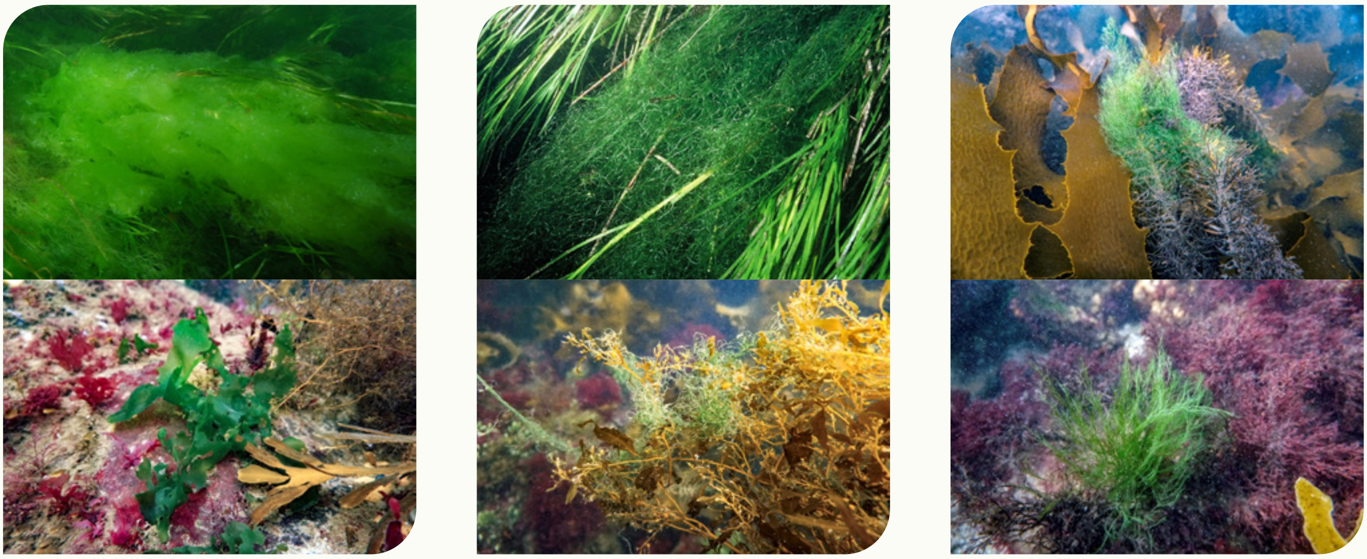
During RVA surveys, the percentage cover of all green and red opportunistic algae species should be recorded across the entire quadrat. Green and red opportunistic algae are scored as two separate functional categories. Opportunistic algae can grow either epiphytically or on the substrate (epiphytic component should also be scored as epiphytic algae, while substrate component should also be scored as sub-canopy algae).

Green algae species considered opportunistic in Tasmania are shown in Figure 5 and include:

- *Ulva* spp. (Figure 5a-b): Can rapidly respond to favourable nutrient conditions in exposed and sheltered locations
- *Chaetomorpha billardierii:* Often occurs in more sheltered locations exposed to elevated nutrient concentrations (Figure 5c-d)
- *Cladophora feredayi:* when growing as larger branching individuals (Figure 5e-f)

If several species of opportunistic green algae are present within the same quadrat, the separate percentage covers of each species should be recorded, rather than the overall cover of all species combined.

Figure 5: Opportunistic green algae species recorded during RVA surveys



a-b) *Ulva* spp.

c-d) *Chaetomorpha billardierii*

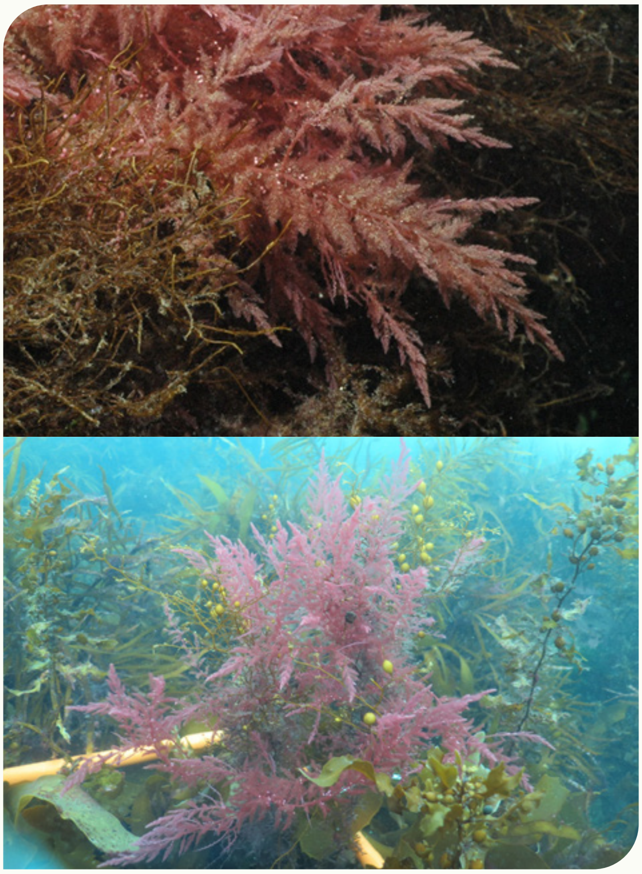
e-f) *Cladophora feredayi* (growing in adult branching form)

Green algae species **NOT** considered opportunistic include:

- *Cladophora feredayi:* smaller individual strands or tufts measuring <2 cm in height should be recorded as turfing algae instead
- *Chaetomorpha coliformis*

Asparagopsis armata (Figure 6) is the sole opportunistic red algae species recorded as part of RVA surveys in Tasmania. The total percentage cover of *Asparagopsis armata*, growing either epiphytically or on the substrate, should be recorded.

Figure 6: Asparagopsis armata, the sole opportunistic red algae species recorded during RVA surveys in Tasmania



As knowledge of ecology of local red algae species continues to grow it is possible that other easily identifiable species might also be incorporated into the survey as "opportunistic red" (e.g. *Grateloupia turuturu*). While these additional species are not formally incorporated into the survey method at this point in time, it is recommended a note is made when other species of red algae known to respond to nutrient elevation are present in the environment.

3.6 Substrate parameters

Substrate parameters are only scored in the 0.25 m^2 sub-quadrat located closest to the main transect line. The following substrate parameters are scored for abundance as percentage cover:

- Percentage cover of both pink and red encrusting coralline algae
- Percentage cover of sessile filter feeders
- Percentage cover of the various colours (red/brown/green) of turfing algae

Note that the percentage cover of benthic sessile filter feeders is a total of all organisms that fall within this functional category, including sponges, ascidians, bryozoans and octocorals. Where possible the dominant type of sessile filter feeders should also be recorded for site characterisation, but each individual taxa does not need to have percentage cover assigned.

The dominant substrate type present is also recorded. This information is unlikely to be used in a formal data analysis, but can provide useful information for interpretation of data. Note that any of the parameters scored for percentage cover can also be listed as the dominant substrate type. Examples of common substrate types are listed below.

Note that the scoring of the dominant substrate type can be considered optional if divers are pressed for bottom time, as long as the percentage cover of encrusting algae, sessile benthic filter feeders and turfing algae are recorded, as outlined above.

The following descriptors apply to the various categories of sessile filter feeder and substrate types:

Ascidians

Ascidians that can be growing erect (e.g. Pyura spp.) or encrusting (e.g. Botrylloides) or a combination of the two on the substrate.

Bare rock (barrens)

Bedrock/boulders is the dominant substrate type and there is a visible presence of medium-high abundance of urchins.

Bare rock (non-barrens)

Bedrock/boulders is the dominant substrate type but there is no visible presence of medium-high abundance of urchins.

Biogenic matrix

Fine, often colourless (or grey or beige) 'fuzz' growing on substrate.

Bryozoans

Bryozoans that can be growing erect or encrusting, and in both hard and soft forms.

***Caulerpa* spp. rhizomes**

Often present when *Caulerpa* spp. is the dominant sub-canopy green algae species.

Cobble

Substrate comprises rocks generally 6-25 cm in diameter.

Encrusting coralline algae

Encrusting coralline algae: Present as red or pink encrusting algae, or a combination of both.

Encrusting octocoral

Often present as the octocoral species, *Erythropodium hicksoni*. Surface appearance may be smooth if polyps are retracted and fuzzy if polyps are extended. Often grey or beige in colour.

Mussels

Dense beds formed by individuals of the family *Mytilidae*. Are often encrusted by other species e.g. sponge or algae.

Peyssonnelia/Sonderopelta

Substrate dominated by the laminate red algae species *Peyssonnelia novaehollandiae* or *Sonderopelta coriacea*, which are often difficult to distinguish from one another.

Sand

Fine or coarse sediments with grain size of <2 mm, may include shell fragments.

Shell

Biogenic gravel substrate composed of shell fragments that are generally >2 mm in size.

Silt

Unconsolidated substrate with very fine muddy or silty appearance and no visible grain structure.

Sponge

Sponge that is growing erect or encrusting (or a mixture of the two) on substrate.

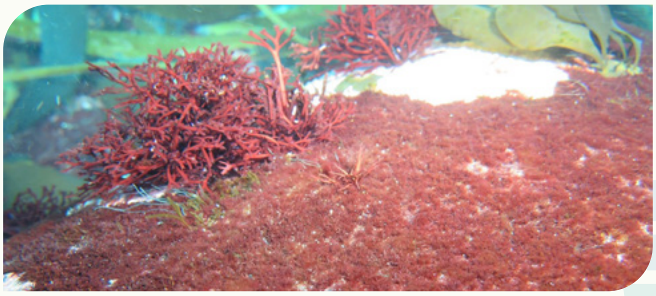
Turfing algae

Algae ≤2 cm in height that does not contain a build-up of sand or sediment, which can be determined by running fingers over the turf (Figure 6); algae may be filamentous in nature and can also be recorded as filamentous algae.

Turfing algae/sand/sediment matrix

Algae ≤2 cm in height that contains a build-up of sand or sediment (can be determined by running fingers over the turf) and is present more as a matrix (or 'fuzz') rather than individual plants or blades.

Figure 7: An example of red turfing algae, growing ≤2 cm in height



3.7 Major mobile invertebrates

The total abundance of feather stars (*Cenolia* spp., Figure 8) within the entire quadrat should be estimated using the following categories:

- None (N): no individuals
- Low (L): 1 or 2 individuals
- Medium (M): approximately 5 individuals
- High (H): >10 individuals

In addition, the total number and identity of the most abundant major mobile invertebrate species (excluding *Cenolia* spp.) within the quadrat should be recorded. Common major mobile invertebrate species/groups include sea urchins, sea stars, large gastropods (generally >2 cm in length), abalone, rock lobster, nudibranchs and crabs (e.g. *Plagusia chabrus*). Invertebrates measuring <2 cm in length are generally not recorded. When species identification is uncertain, the invertebrate should be photographed for later identification.

Where sea urchins are present, the number and species should always be recorded, even if they are not the most dominant mobile invertebrate within the quadrat.

Given their cryptic nature, any cracks or crevices should also be checked for the presence of feather stars and major mobile invertebrates.

Figure 8: Examples of commonly observed mobile invertebrates

a) Blacklip abalone (*Haliotis rubra*)

b) Shortspined sea urchin (*Heliocidaris erythrogramma*)

c) Longspined sea urchin (*Centrostephanus rodgersii*)

d) Biscuit star (*Tosia* sp.)

3.8 ‘Dust’ and epibiotic fauna

Levels of dust and epibiotic fauna are categorical variables that are scored to provide proxy measurements of the overall health of the macroalgae canopy.

‘Dust’ refers to flocculant material, generally comprised of bacteria, marine snow and particulate matter, including sediment. It is a reflection of how much particulate matter has settled on the surface of the canopy algae and is used as a proxy for sedimentation. In general, higher water column productivity leaders to greater levels of dust accumulation on canopy algae. Levels of dust can be determined by gently shaking the laminar to see how much particulate matter is dislodged. The different categories for dust are none (N), low (L), medium (M) and high (H).

This parameter is often best scored at the same time as the overall canopy cover before the canopy is moved and any settled particles are dislodged.

Similarly, levels of epibiotic fauna growing on the surface of the canopy algae are generally a reflection of water column productivity of the general area. Most epibiotic fauna are filter feeders and commonly include bryozoa, hydroids, sponge, and the encrusting tube worm *Galeolaria caespitosa* (see Figure 9). Epibiotic fauna are recorded as either none (N), low (L), medium (M) or high (H). A combined score of all epibiotic species/groups present should be recorded, rather than trying to separate individual taxa.

Figure 9: Examples of epibiotic fauna growing on brown algae

a) hydroids, pink encrusting coralline algae (and epiphytic red algae)

b) hydroids (and epiphytic red algae)

c) bryozoan

Table 2: RVA diver scoring requirements

Purpose	Functional parameter	Diver scoring requirements	Quadrat area
Broad structural	Total canopy cover	Score the total percentage cover of the macroalgal canopy. Record each of the canopy species present along with the percentage cover of each species.	1m x 1m
	Sub canopy cover (brown, green, red)	Score the percentage cover of all sub-canopy brown macroalgae and note the major species present	1m x 1m
		Score the percentage cover of all sub-canopy green macroalgae and note the major species present	1m x 1m
		Score the percentage cover of all sub-canopy red macroalgae	1m x 1m
	Substrate	Record the dominant substrate type present	0.5m x 0.5m
	Pink encrusting algae cover & red encrusting algae cover	Score the percentage cover of pink and red encrusting coralline algae (as separate parameters).	0.5m x 0.5m
	Sessile filter feeders	Score the percentage cover of benthic sessile filter feeders and record the dominant type.	0.5m x 0.5m
	Turfing algae cover	Score the percentage cover of each major colour (red, green and brown) of turfing algae (algae that is ≤ 2 cm in height) present.	0.5m x 0.5m
Enrichment response	Epiphytic algae cover	Score the percentage cover of all epiphytic algae	1m x 1m
	Filamentous algae cover	Score the percentage cover of all filamentous algae	1m x 1m
	Opportunistic green algae cover	Score the combined percentage cover of *Ulva*, *Chaetomorpha billardierii* and *Cladophora feredayi* (adult only)	1m x 1m
	Opportunistic red algae cover	Score the percentage cover of *Asparagopsis armata*	1m x 1m
	'Dust' on algae	Record dust (flocculant material) on canopy species (categorical).	1m x 1m
Additional information	Encrusting and epibiotic fauna	Record encrusting species on canopy species (categorical).	1m x 1m
	Major mobile invertebrates	Estimate the number of featherstars present (categorical).	1m x 1m
		Identify and count the number of the most abundant mobile invertebrates present	1m x 1m

4 Data checking

Data checking is a vital part of the data collection process. Robust data checking routines should be in place to ensure reliability of data

Following data collection, scorecards from the field should be scanned and filed, and photographs of quadrats and sub-quadrats should be uploaded, organised, labelled and filed. Data should be entered into a custom-built Excel spreadsheet which includes taxa/category codes for the various species/types of algae, substrate and major mobile invertebrates. This is available to download from the Aquaculture Environment team website.

Data QA/QC involves verifying any uncertain scores and species identities with the relevant data collector and cross-checking all data against the scorecards once entered. From there, data can be manipulated and analysed to examine spatial and temporal variation across parameters, depending on the research question of interest.

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Appendix A

RVA scorecard

The following is a standard IMAS RVA scorecard. The first page provides a framework for consistently scoring all major RVA parameters. Note that the Site, Date, Diver and Depth should all be recorded for metainformation. The Site Comments line at the bottom of the page allows for the diver to note anything of interest about the site that might impact either directly on the data, or the interpretation thereof.

The second page provides the diver with an underwater "cheat sheet" that can provide information or clarification underwater throughout the actual scoring process. If clear dive slates are used, then this information can be available to the diver at all times.

SITE: **DATE:** **DIVER:** **DEPTH:** **PROJECT NO:**

Circle Quadrat #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Total % canopy												
Canopy sp 1 **/** Canopy sp 2 %												
Canopy sp 3 **/**Canopy sp 4 %												
% Sub-canopy brown + major spp.												
% Sub-canopy green + major spp.												
% Sub-canopy red												
% Epiphytic algae												
% Filamentous algae												
% Ulva / Chaeto / Clado (adult only)												
% Asparagopsis												
Substrate characterisation												
% UALCC & type Pink vs. Red	P R	P R	P R	P R	P R	P R	P R	P R	P R	P R	P R	P R
% Sessile filter feeder												
% Turfing algae (<2cm)												
Feather stars (N/L/M/H)												
MMI spp. and #												
Dust on algae (N/L/M/H)												
Enc. spp. on algae (N/L/M/H)												

SITE COMMENTS:

ASSESSED IN ENTIRE 1m x 1m quadrat. **PHOTOGRAPH ENTIRE QUADRAT FROM DIRECTLY ABOVE**

% Canopy brown: Assessed from above, total area of quadrat covered by brown canopy species

% Major canopy species: Assessed from above, % of total area. Alter scoresheet for site. Common species include:

- *Phyllospora comosa* (Pcom) (Crayweed)
- *Ecklonia radiata* (Era) (Common kelp)
- *Lessonia corrugata* (Lcor) (Strapweed)
- *Macrocystis pyrifera* (Mpy) (Giant kelp)
- *Sargassum fallax, vestitum* or *verruculosum* (Sfal, Sves, Sver)
- *Durvillaea potatorum* (Dpo) (Bull kelp)

ASSESSED IN ENTIRE 1m x 1m quadrat

% Sub-canopy brown: Assessed from below the canopy, area of quadrat covered by sub-canopy brown algae. Common species (if known) include:

- *Acrocarpia paniculata* (Apan)
- *Carpoglossum confluens* (Ccon)
- *Cystophora platylobium* (Cpla)
- *Xiphophora gladiata* (Xgl)
- *Perithalia caudata* (Pcau)
- *Zonaria* spp. (Zon)
- *Lobophora* spp. (Lob)

% Sub-canopy green: Assessed from below the canopy, area of quadrat covered by sub-canopy green algae. Common species (if known) include:

- *Caulerpa brownii* (Cbrow), *flexilis* (Cfle), *trifaria* (Ctrifa), *geminata* (Cgem), *scalpelliformis* (Csc), *hodgkinsoniae* (Chod)
- *Codium fragile* (Cfra), *pomoides* (Cpom)
- *Chaetomorpha coliformis* (Ccol)

% Sub-canopy red: Assessed from below the canopy, area of quadrat covered by sub-canopy red algae.

% Epiphytic algae on kelp: Area of quadrat with epiphytic algae

% Filamentous algae: Area of quadrat covered by filamentous algae

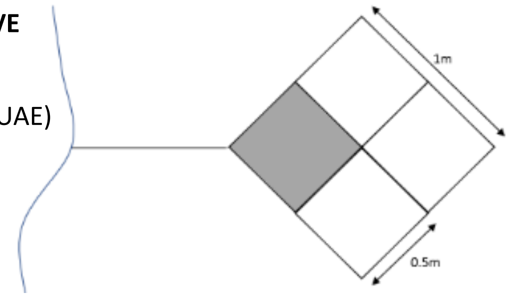
% Nuisance green: area covered by *Ulva / Chaetomorpha billardierii / Cladophora feredayi (adult only)*

% Nuisance red: area covered by *Asparagopsis armata*

ALL SUBSTRATE PARAMETERS TO BE ASSESSED IN THE <u>NEAR 0.5 x 0.5 m quarter</u>. **PHOTOGRAPH ¼ QUADRAT FROM DIRECTLY ABOVE**

Substrate characterisation - Categories include:

- encrusting coralline algae (UALCC)
- red encrusting algae *Peyssonnelia* (PEYE)
- *Sonderopelta/Peyssonnelia* (SOPE)
- turfing algae (UALT), turfing algae/sand/sediment matrix (TSS)
- encrusting sponge (USEN)
- sponge (USP)
- ascidians (UAS), encrusting ascidians (UAE)
- sand (SAND)
- cobble (COBB)



% Encrusting flora (UALCC) & type: Pink rock vs red rock.

% Sessile filter feeders: % sessile filter feeds. May include sponge, ascidian, bryozoan, octocorals (note dominant type)

% Turfing algae: Algae on substrate <2 cm in height. Assessed from above and given % score for <u>each</u> colour present (red, green, brown).

ASSESSED IN ENTIRE 1m x 1m quadrat

Feather stars: N= 0, L= 1 or 2, M= ~5, H= 10+

Major mobile invertebrate (MMI): ID & # of most abundant large mobile invertebrate(s) in quadrat

Dust on algae: Is it present on canopy species?

Encrusting species on algae: Is it present on canopy species

Appendix B

Common species/categories recorded during RVA surveys and their corresponding taxa codes

Canopy algae

Species	Code
Phyllospora comosa	PCOM
Ecklonia radiata	ERA
Lessonia corrugata	LCOR
Durvillaea potatorum	DPO
Macrocystis pyrifera	MPY
Sargassum spp.	SAR
Sargassum fallax	SFAL
Sargassum vestitum	SVES
Sargassum verruculosum	SVER

Sub-canopy green algae

Species	Code
Caulerpa spp.	CAUL
Caulerpa brownii	CBROW
Caulerpa flexilis	CFLE
Caulerpa trifaria	CTRIFA
Caulerpa geminata	CGEM
Caulerpa scalpelliformis	CSC
Caulerpa hodgkinsonaiae	CHOD
Codium fragile	CFRA
Codium pomoides	CPOM
Chaetomorpha billardierii	CBIL
Chaetomorpha coliformis	CCOL
Cladophora feredayi	CFE

Sub-canopy brown algae

Species	Code
Acrocarpia paniculata	APAN
Carpoglossum confluens	CCON
Cystophora spp.	CYS
Cystophora platylobium	CPLA
Cystophora moniliformis	CMON
Halopteris paniculata	HPA
Perithalia caudata	PCAU
Zonaria spp.	ZON
Lobophora spp.	LOB
Xiphophora gladiata	XGL

Substrate

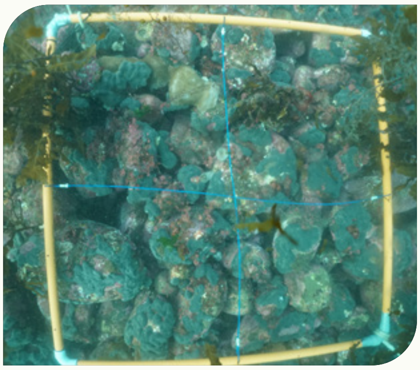
Category	Code
Biogenic matrix	BGM
Bare rock (barrens)	BRB
Bare rock (non-barrens)	BRN
Caulerpa spp. rhizomes	CAULR
Cobble	COBB
Encrusting octocoral	EHI
Mussels	MUSS
Sand	SAND
Shell	SHEL
Silt	SILT
Sonderopelta/Peyssonnelia	SOPE
Turf/sand/sediment matrix	TSS
Turfing algae	UALT
Encrusting coralline algae	UALCC
Unidentified sponge (encrusting)	USEN
Unidentified sponges	USP

Appendix C

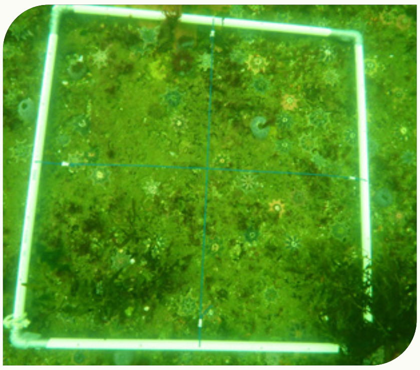
Representative images of RVA parameters at different abundances

Canopy algae

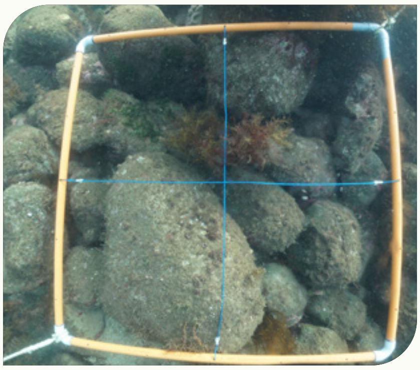
0-10%



Port Arthur, 0m East, Winter 2022, 5% canopy (*Cystophora* sp.)

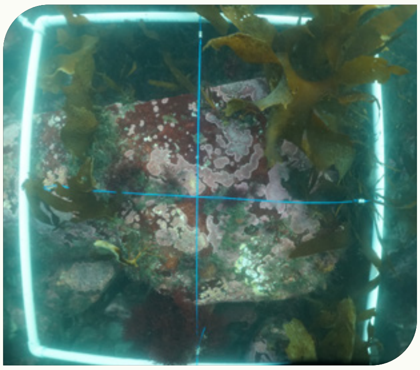


Storm Bay, Iron Pot, Winter 2023, 0% canopy

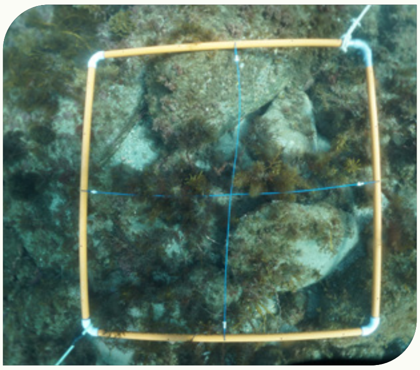


Mercury Passage, MPIR2, Winter 2022, 5% canopy (*Cystophora* sp.)

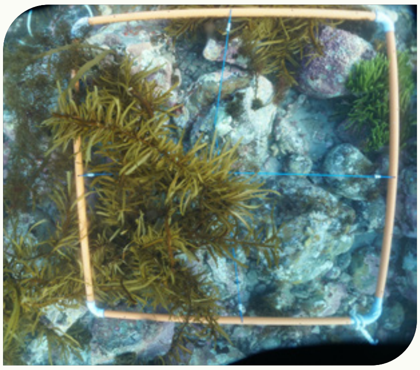
10-20%



Port Arthur, 400m South, Winter 2022, 15% canopy (10% *Ecklonia radiata*, 5% *Phyllospora comosa*)



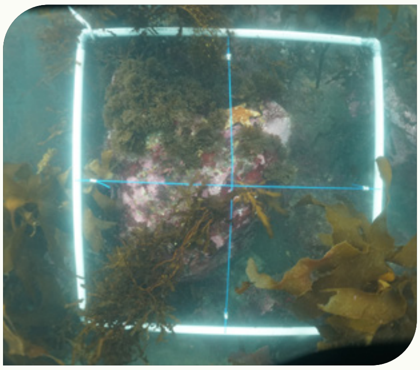
Mercury Passage, EB, Winter 2022, 20% canopy (15% *Caulocystis cephalornithos*, 5% *Sargassum* sp.)



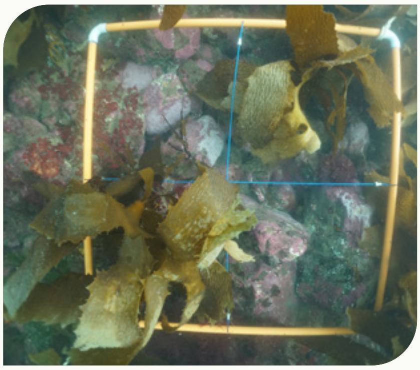
Mercury Passage, Earlham, Winter 2022, 15% canopy (*Phyllospora comosa*)

Canopy algae

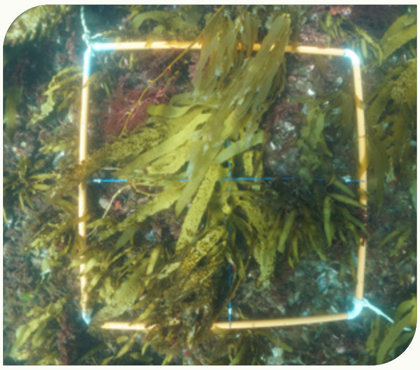
20-30%



Port Arthur, 1km East, Winter 2022, 30% canopy (15% *Sargassum* sp., 10% *Ecklonia radiata*, 5% *Cystophora* sp.)

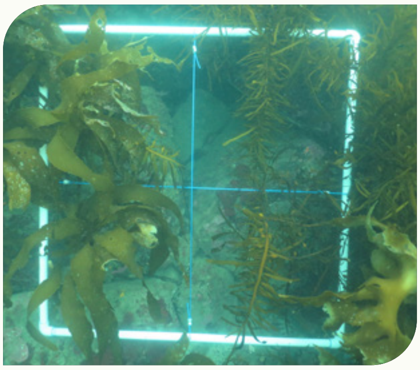


Mercury Passage, Freestone, Winter 2022, 30% canopy (*Ecklonia radiata*)

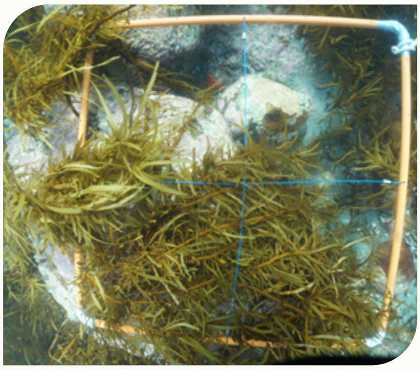


Storm Bay, Iron Pot, Summer 2022, 30% canopy (20% *Ecklonia radiata*, 10% *Macrocystis pyrifera*)

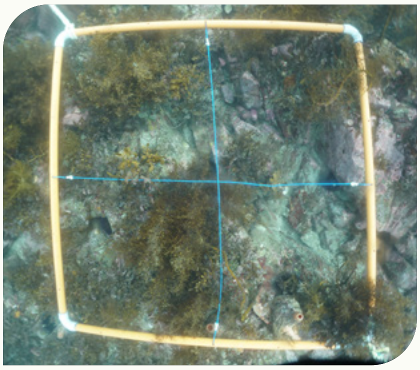
30-40%



Fortescue Bay, Canoe Bay, Winter 2022, 32% canopy (20% *Ecklonia radiata*, 10% *Phyllospora comosa*, 2% *Cystophora* sp.)

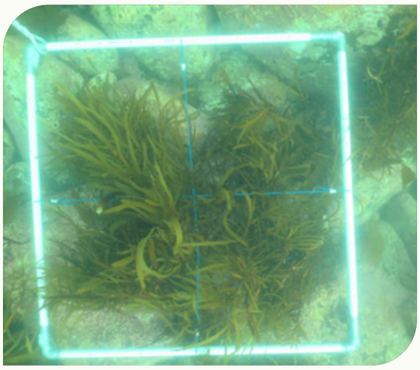


Mercury Passage, Earlham, Winter 2022, 40% canopy (*Phyllospora comosa*)

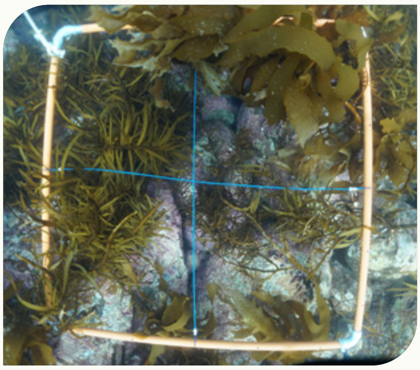


Mercury Passage, MPIR2, Winter 2022, 35% canopy (30% *Sargassum* sp., 5% *Cystophora* sp.)

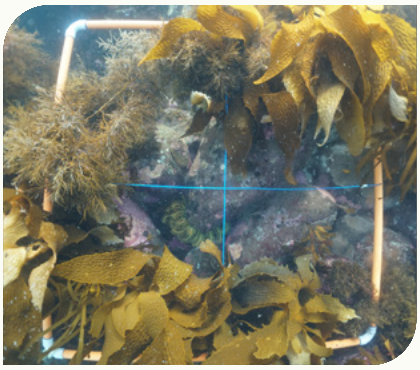
40-50%



Mercury Passage, EB, Summer 2022, 50% canopy (*Phyllospora comosa*)



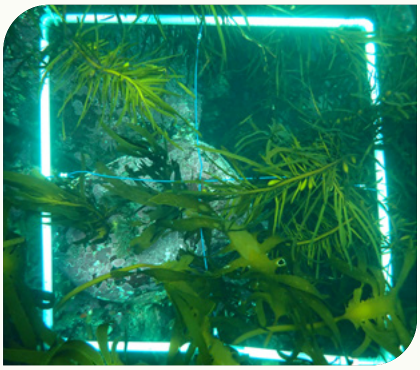
Mercury Passage, EB, Winter 2022, 50% canopy (30% *Phyllospora comosa*, 20% *Ecklonia radiata*)



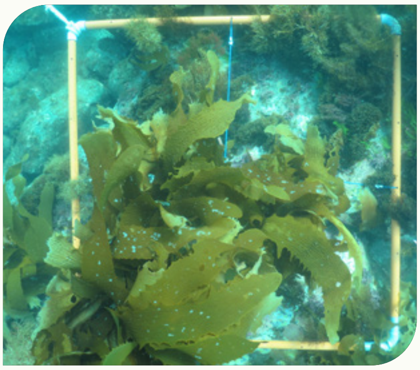
Mercury Passage, MPIR2, Winter 2022, 50% canopy (40% *Ecklonia radiata*, 10% *Cystophora* sp.)

Canopy algae

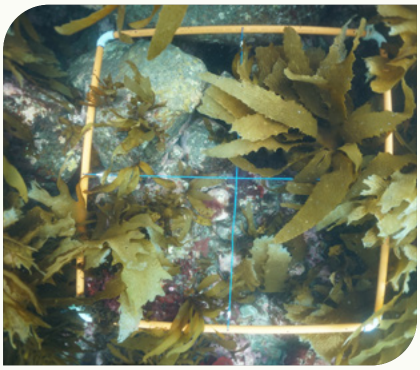
50-60%



Storm Bay, Cape Queen Elizabeth, Winter 2023, 60% canopy (30% *Phyllospora comosa*, 30% *Ecklonia radiata*)

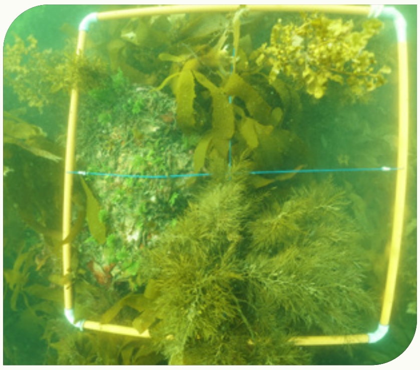


Mercury Passage, EB, Winter 2022, 55% canopy (40% *Ecklonia radiata*, 10% *Sargassum* sp., 5% *Cystophora* sp.)

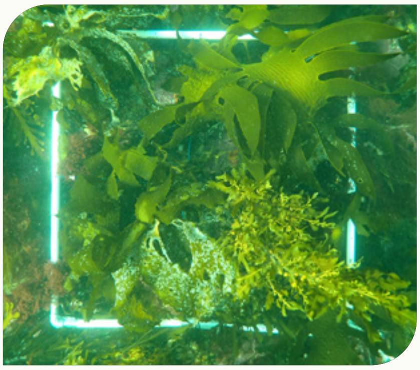


Fortescue Bay, Fortescue West, Summer 2022, 60% canopy (40% *Ecklonia radiata*, 20% *Phyllospora comosa*)

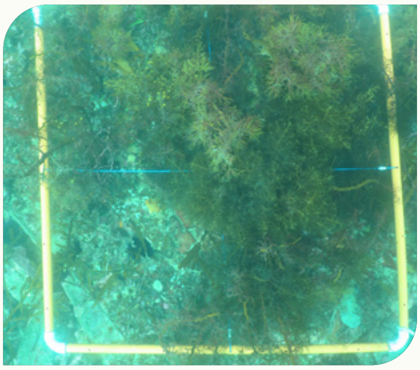
60-70%



Mercury Passage, Darlington North, Winter 2022, 70% canopy (40% *Ecklonia radiata*, 25% *Cystophora* sp., 5% *Sargassum* sp.)

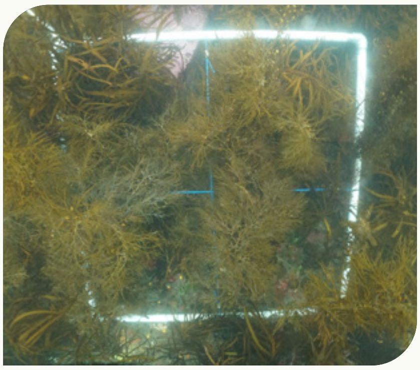


Storm Bay, Apex Point, Winter 2023, 65% canopy (50% *Ecklonia radiata*, 15% *Sargassum* sp., 5% *Macrocystis pyrifera*)



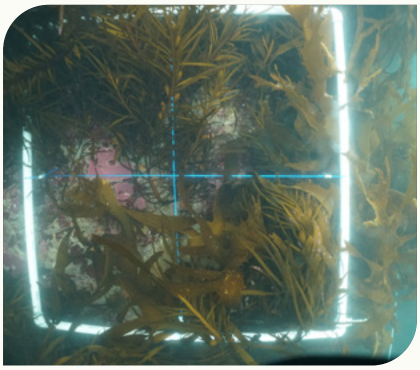
Mercury Passage, MPIR6, Winter 2022, 65% canopy (50% *Cystophora* sp., 15% *Sargassum* sp.)

70-80%



Port Arthur, 1km South, Winter 2022, 75% canopy (40% *Cystophora* sp., 30% *Phyllospora comosa*, 5% *Sargassum* sp.)

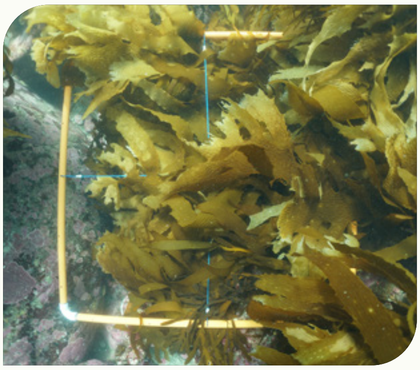
Mercury Passage, EB, Summer 2021, 75% canopy (*Ecklonia radiata*)



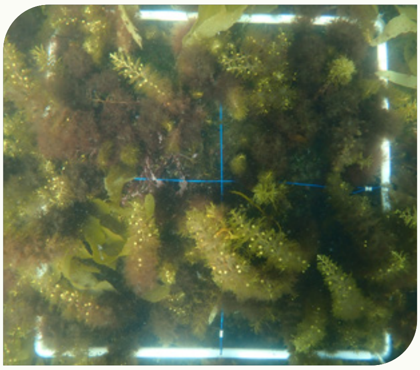
Port Arthur, Golf Course, Winter 2022, 80% canopy (50% *Phyllospora comosa*, 30% *Ecklonia radiata*)

Canopy algae

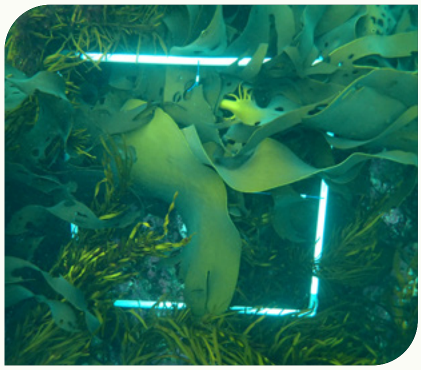
80-90%



Fortescue Bay, Fortescue West, Summer 2022, 90% canopy (85% *Ecklonia radiata*, 5% *Phyllospora comosa*)

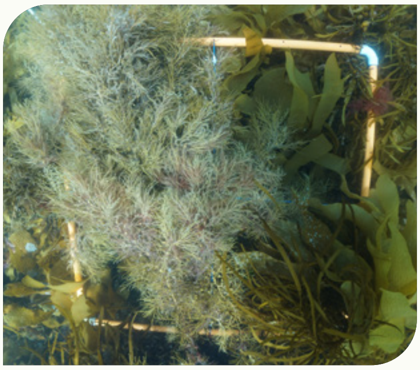


Storm Bay, Lobster Point, Summer 2023, 80% canopy (70% *Sargassum* sp., 5% *Ecklonia radiata*, 5% *Cystophora* sp.)

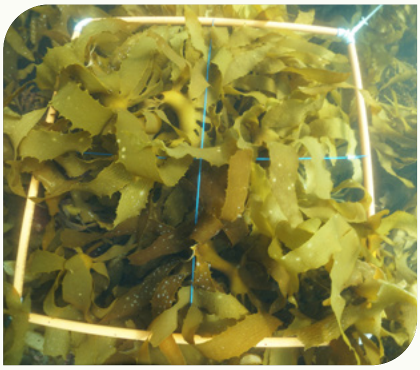


Storm Bay, Variety Bay North, Winter 2023, 90% canopy (50% *Phyllospora comosa*, 40% *Durvillaea potatorum*)

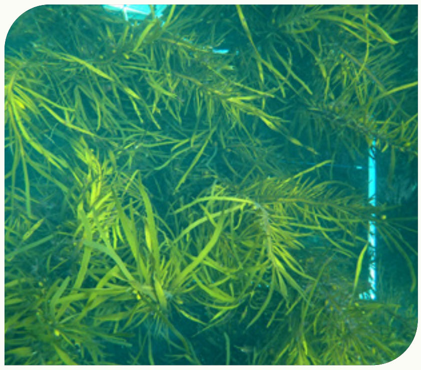
90-100%



Port Arthur, 400m East, Summer 2022, 100% canopy (70% *Cystophora* sp., 20% *Ecklonia radiata*, 10% *Phyllospora comosa*)



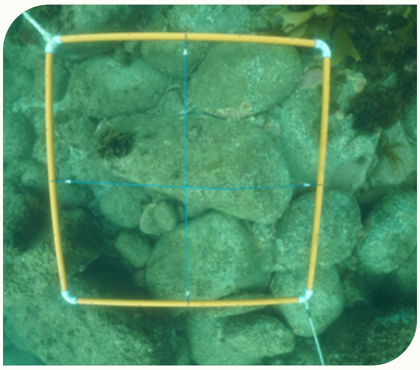
Fortescue Bay, Canoe Bay, Summer 2022, 100% canopy (*Ecklonia radiata*)



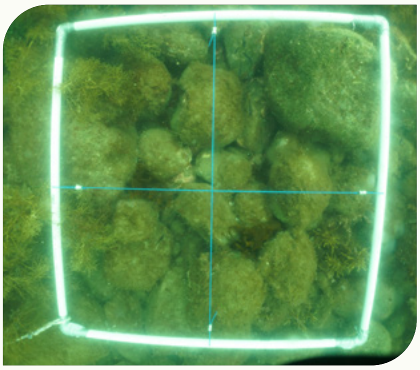
Storm Bay, Cape Queen Elizabeth, Winter 2023, 95% canopy (*Phyllospora comosa*)

Sub-canopy brown algae

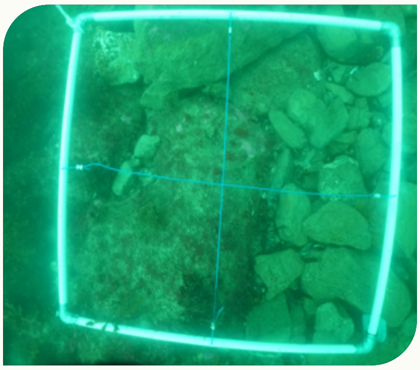
0-10%



Storm Bay, Yellow Bluff 2, Winter 2022, 5% cover (*Zonaria* sp.)

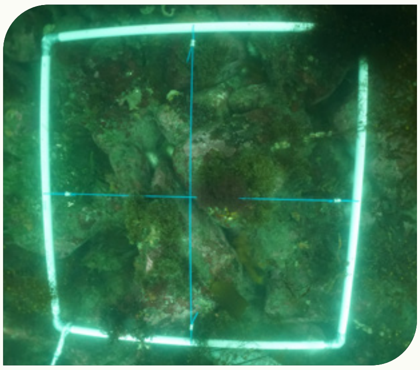


Mercury Passage, MPIR2, Summer 2022, 5% cover (*Acrocarpia paniculata*)

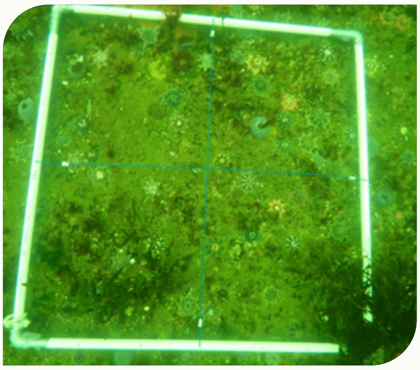


Mercury Passage, MPIR2, Winter 2022, 5% canopy (*Cystophora* sp.)

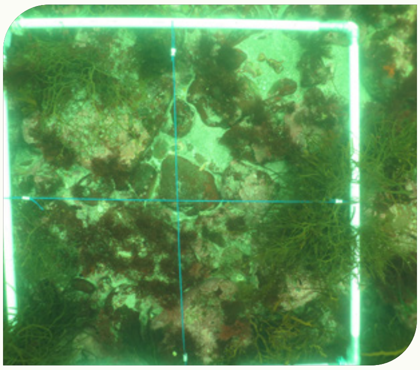
10-20%



Port Arthur, 1km South, Winter 2022, 15% cover (*Zonaria* sp.)

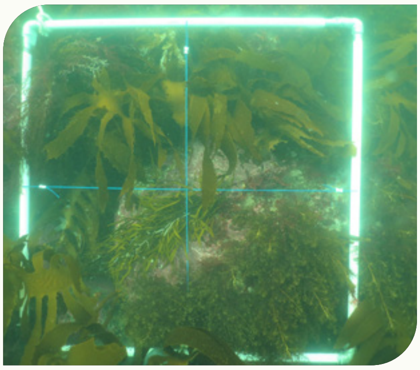


Storm Bay, Iron Pot, Winter 2023, 15% cover (*Sargassum* sp.)

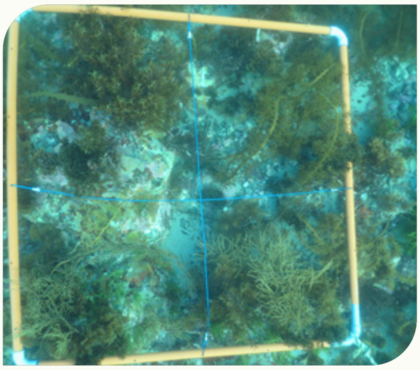


Storm Bay, Crooked Billet Bay, Winter 2023, 20% cover (*Xiphophora gladiata*)

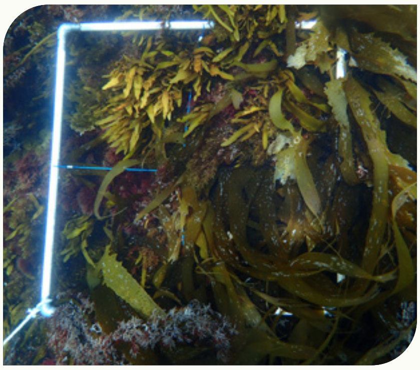
20-30%



Storm Bay, Bull Bay North, Winter 2023, 30% cover (*Acrocarpia paniculata*)



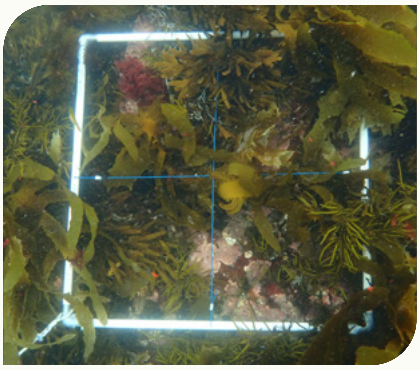
Mercury Passage, Earlham, Winter 2022, 30% cover (*Acrocarpia paniculata*)



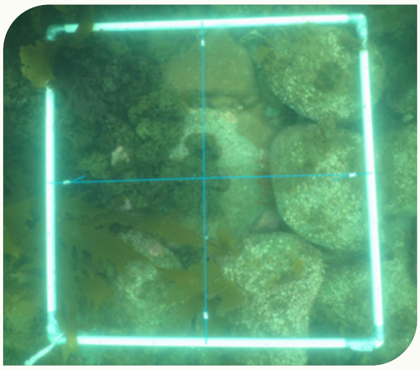
Storm Bay, Yellow Bluff 2, Summer 2023, 25% cover (*Acrocarpia paniculata*)

Sub-canopy brown algae

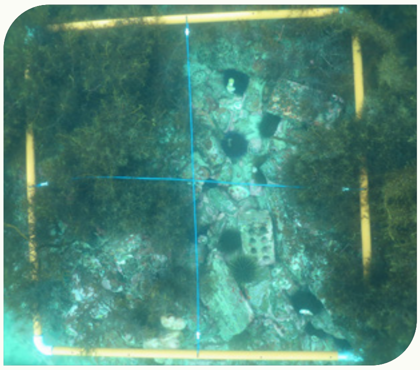
30-40%



Storm Bay, Bull Bay North, Summer 2023, 40% cover (*Cystophora platylobium*)

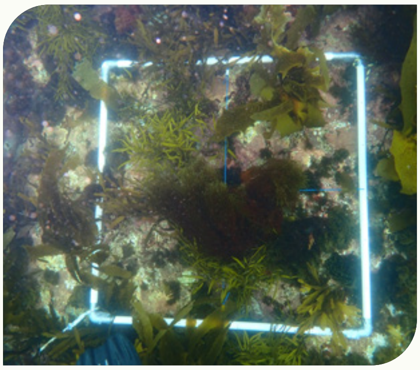


Mercury Passage, EB, Summer 2022, 35% cover (*Zonaria* sp.)

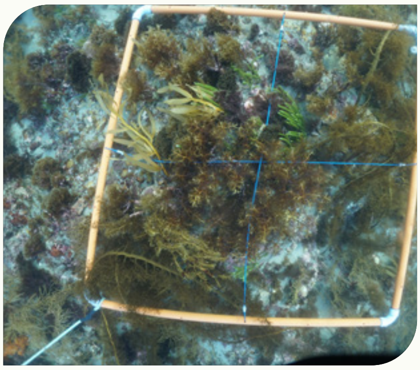


Mercury Passage, MPIR6, Winter 2022, 40% cover (*Acrocarpia paniculata*)

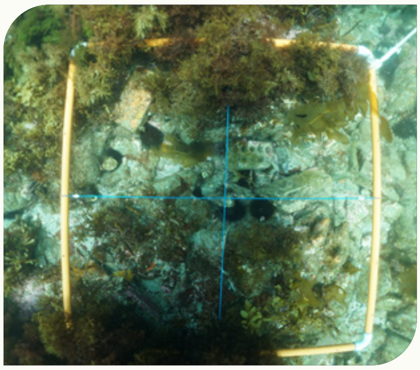
40-50%



Storm Bay, Bull Bay North, Summer 2023, 50% cover (*Cystophora platylobium*)

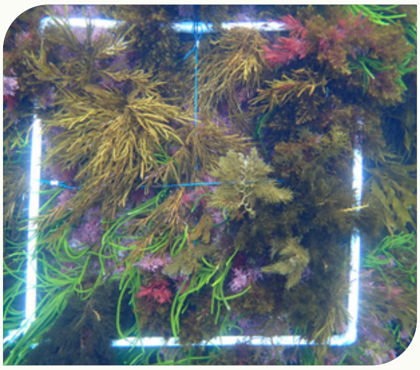


Mercury Passage, Earlham, Winter 2022, 50% cover (*Zonaria* sp.)

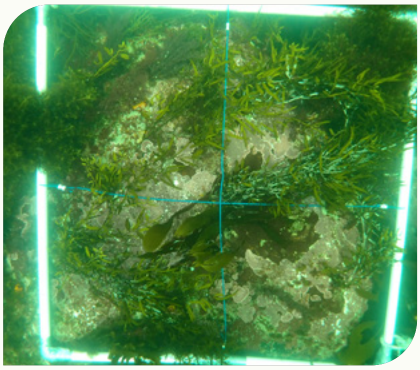


Mercury Passage, MPIR6, Spring 2021, 50% cover (*Acrocarpia paniculata*)

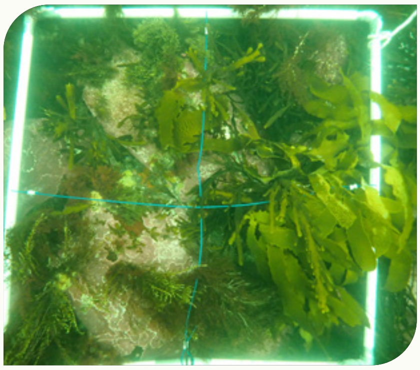
50-60%



Flinders Island, Badger Island, Winter 2023, 55% cover (*Seirococcus axillaris*)



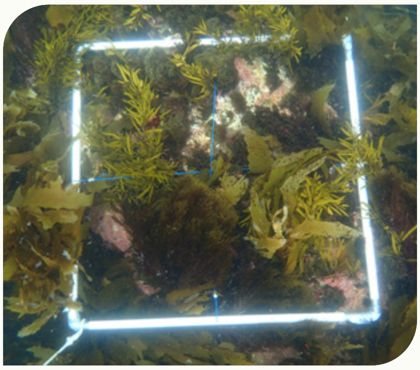
Storm Bay, Bull Bay North, Winter 2023, 55% cover (*Acrocarpia paniculata*)



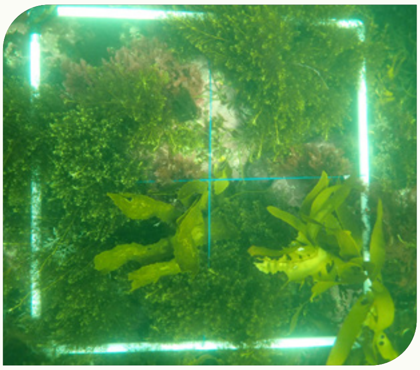
Storm Bay, North-West Betsey, Winter 2023, 60% cover (*Perithalia caudata*)

Sub-canopy brown algae

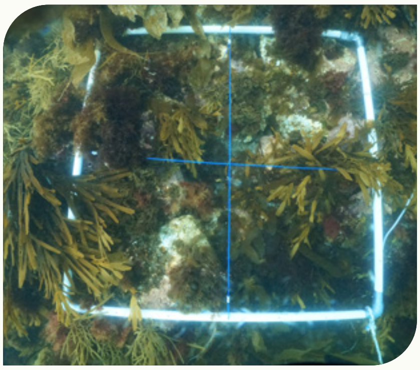
60-70%



Storm Bay, Bull Bay North, Summer 2023, 70% cover (*Zonaria* sp.)

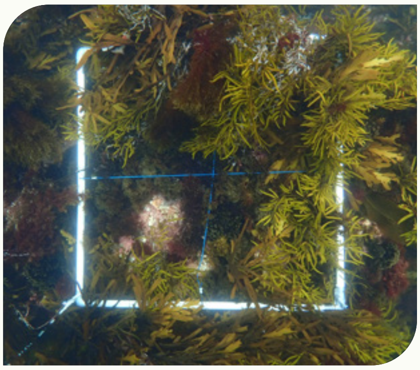


Storm Bay, North-East Betsey, Winter 2023, 70% cover (*Acrocarpia paniculata*)

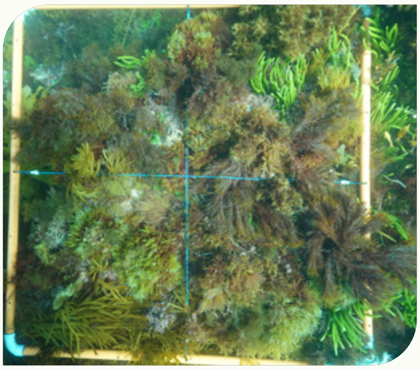


Storm Bay, Yellow Bluff 1, Summer 2023, 65% cover (*Carpoglossum confluens*)

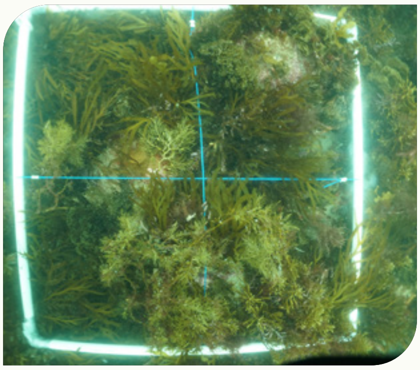
70-80%



Storm Bay, Bull Bay North, Summer 2023, 80% (*Cystophora platylobium*)



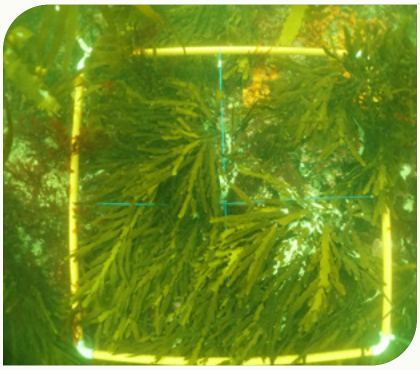
Flinders Island, Badger Island, Summer 2024, 80% cover (*Perithalia caudata*)



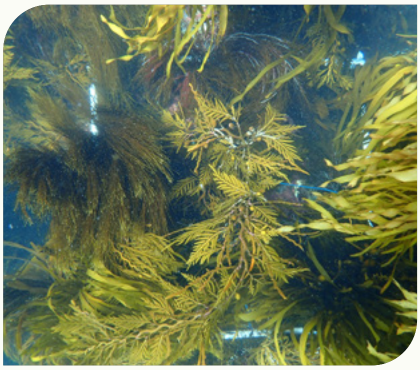
Mercury Passage, MPIR3, Summer 2022, 75% cover (*Seirococcus axillaris*)

Sub-canopy brown algae

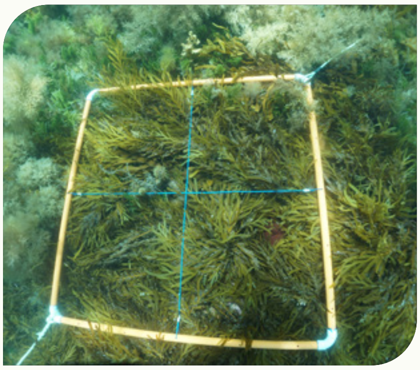
80-90%



Storm Bay, Iron Pot, Winter 2021, 85% cover (*Carpoglossum confluens*)

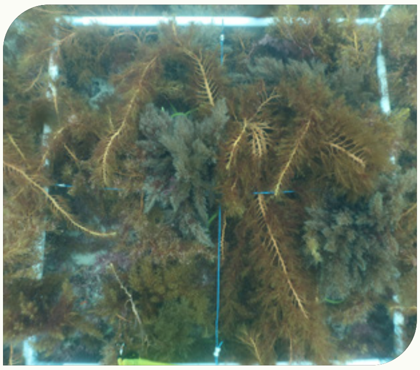


Storm Bay, Mount Zion, Summer 2023, 85% cover (*Perithalia caudata*)

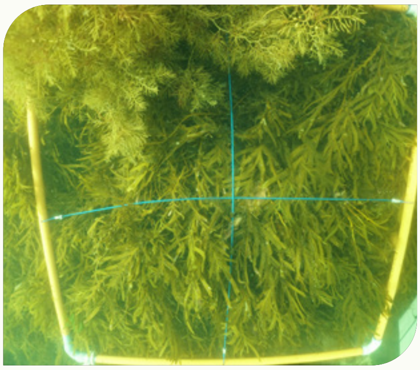


Mercury Passage, Painted Cliffs, Summer 2021, 90% cover (*Seirococcus axillaris*)

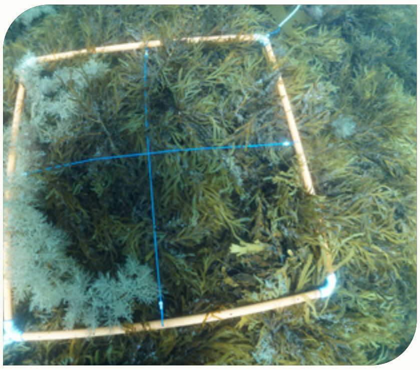
90-100%



Stanley, Robbins Island, Winter 2024, 95% cover (*Cystophora moniliformis*)



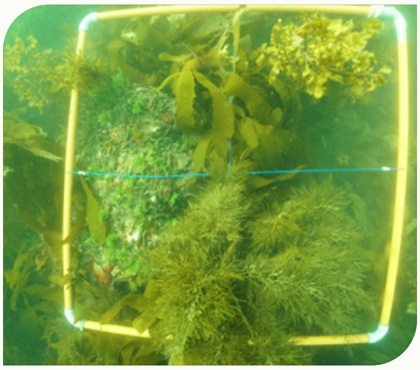
Mercury Passage, Painted Cliffs, Winter 2022, 95% cover (*Seirococcus axillaris*)



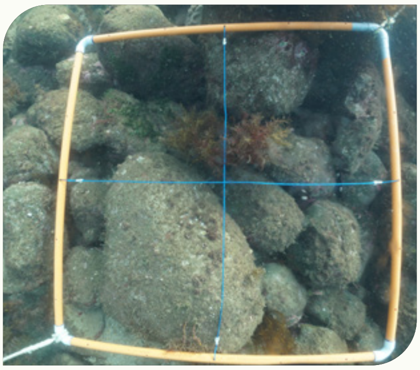
Mercury Passage, Painted Cliffs, Summer 2021, 95% cover (*Seirococcus axillaris*)

Sub-canopy green algae

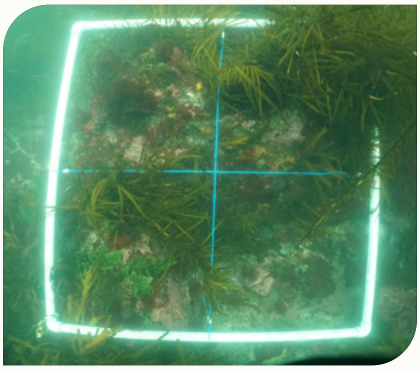
0-10%



Mercury Passage, Darlington North, Winter 2022, 10% cover (*Caulerpa flexilis*)

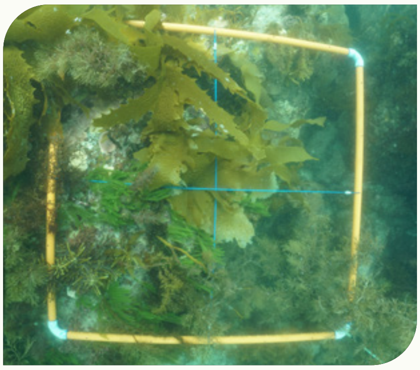


Mercury Passage, MPIR2, Winter 2022, 10% cover (*Caulerpa geminata*; top left sub-quadrat)

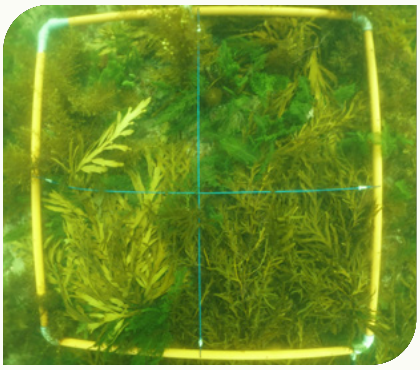


Port Arthur, Safety Cove, Winter 2022, 10% cover (*Caulerpa flexilis*)

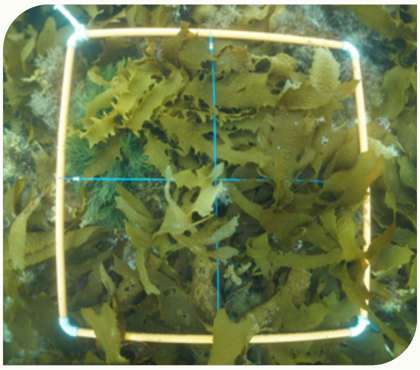
10-20%



Mercury Passage, EB, Summer 2021, 15% cover (*Caulerpa trifaria*)

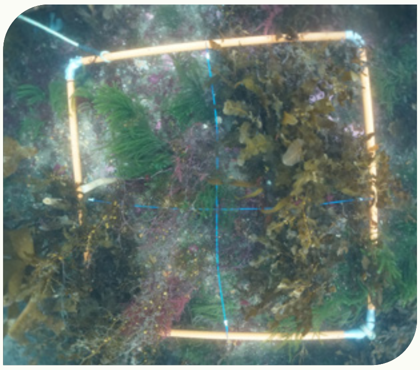


Mercury Passage, Painted Cliffs, Winter 2022, 20% cover (*Caulerpa flexilis*)

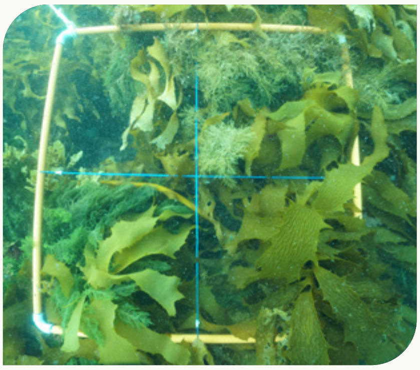


Mercury Passage, Return Point, Summer 2021, 15% cover (*Caulerpa flexilis*)

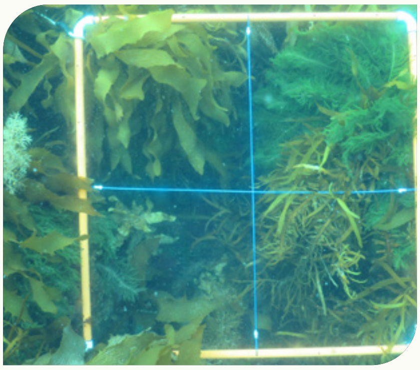
20-30%



Port Arthur, 0m North, Winter 2022, 25% cover (*Caulerpa brownii*)



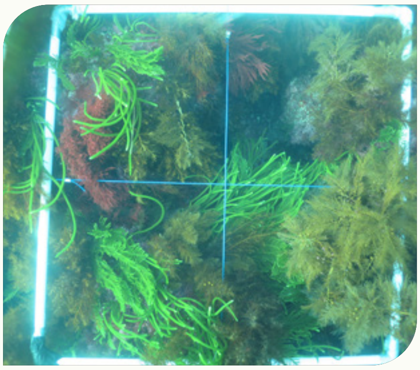
Mercury Passage, Ile du Nord, Summer 2021, 30% cover (*Caulerpa flexilis*)



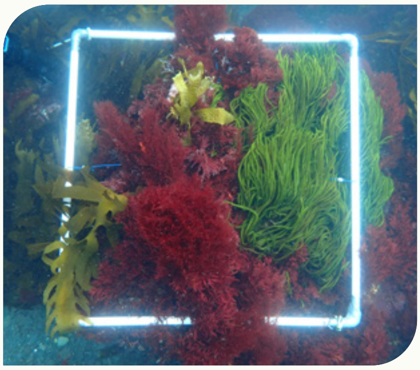
Mercury Passage, Ile du Nord, Summer 2021, 30% cover (*Caulerpa flexilis*)

Sub-canopy green algae

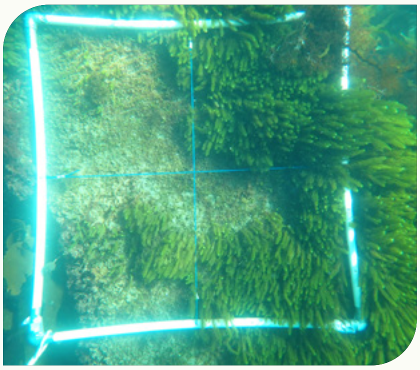
30-40%



Flinders Island, Badger Island, Winter 2023, 35% cover (*Caulerpa brownii*)

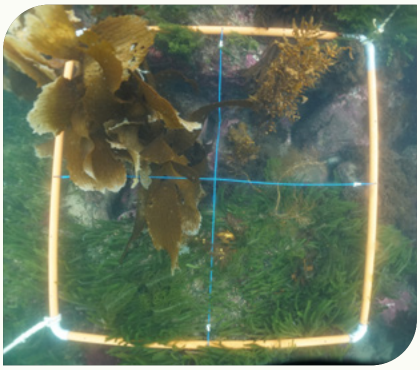


Storm Bay, North Head, Summer 2023, 35% cover (*Caulerpa trifaria*)

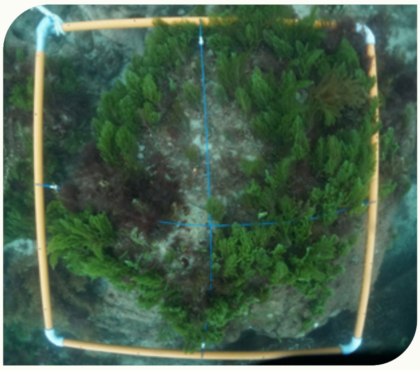


Storm Bay, South-East Betsey, Summer 2023, 35% cover (*Caulerpa longifolia*)

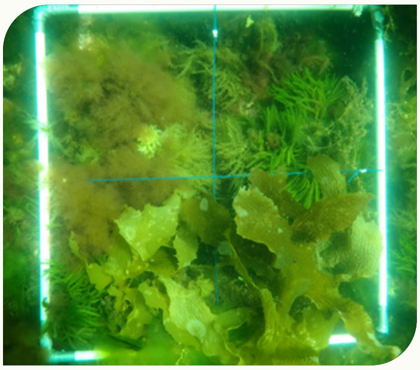
40-50%



Mercury Passage, Freestone, Winter 2022, 50% cover (*Caulerpa trifaria*)

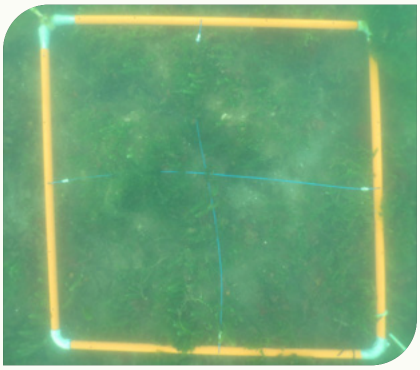


Mercury Passage, Orford 1, Winter 2022, 50% cover (*Caulerpa flexilis*)

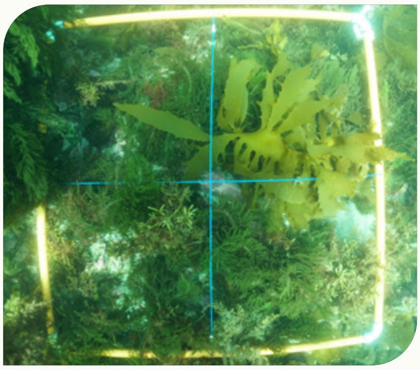


D'Entrecasteaux Channel, Huon Island, Summer 2024, 50% cover (*Caulerpa trifaria*)

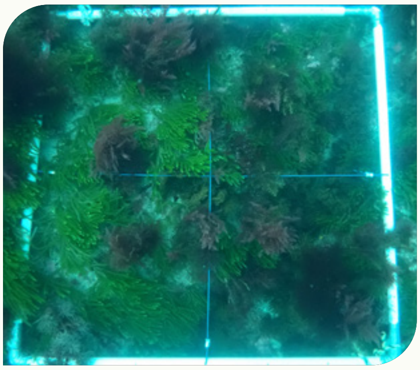
50-60%



Port Arthur, 1km North, Winter 2022, 60% cover (*Caulerpa trifaria*)



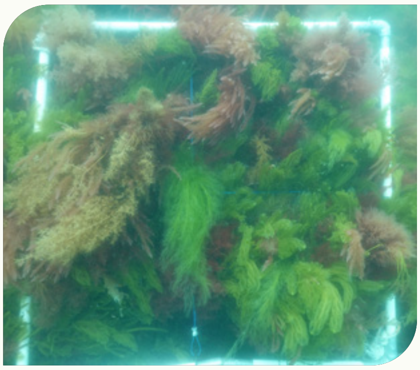
Mercury Passage, MPIR6, Spring 2021, 60% cover (*Caulerpa flexilis*)



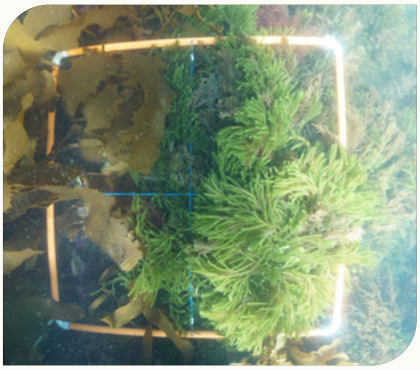
Coles Bay, Fleurieu Point, Winter 2023, 55% cover (*Caulerpa flexilis*)

Sub-canopy green algae

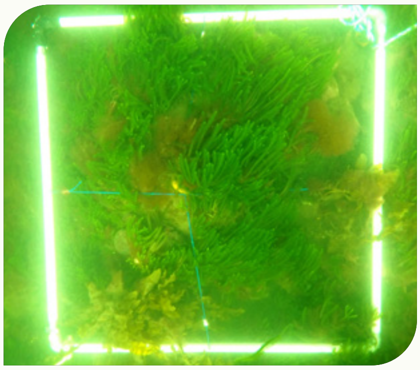
60-70%



Coles Bay, Fleurieu Point, Spring 2023, 70% cover (*Caulerpa flexilis*)

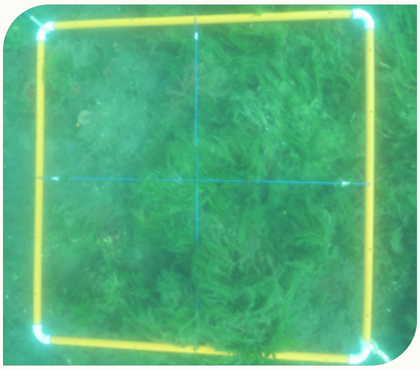


Mercury Passage, Freestone, Spring 2021, 65% cover (*Caulerpa trifaria*)

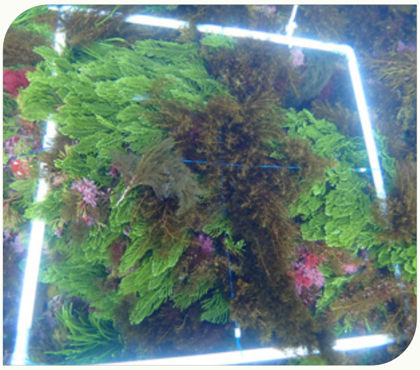


D'Entrecasteaux Channel, Great Taylors Bay, Spring 2023, 70% cover (*Caulerpa trifaria*)

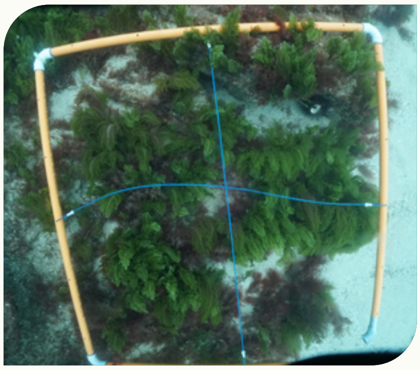
70-80%



Port Arthur, 400m North, Summer 2022, 75% cover (*Caulerpa trifaria*)



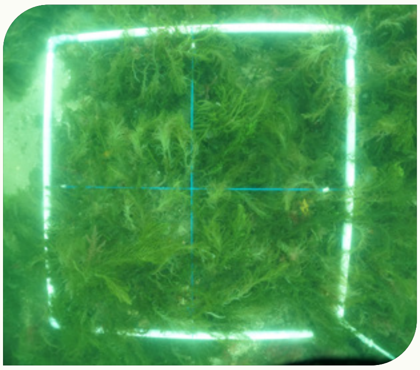
Flinders Island, Badger Island, Winter 2023, 75% cover (*Caulerpa flexilis*)



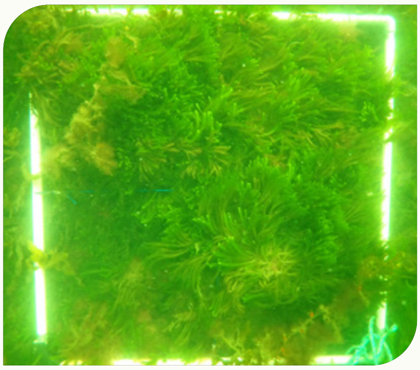
Mercury Passage, Orford 1, Winter 2022, 75% cover (*Caulerpa flexilis*)

Sub-canopy green algae

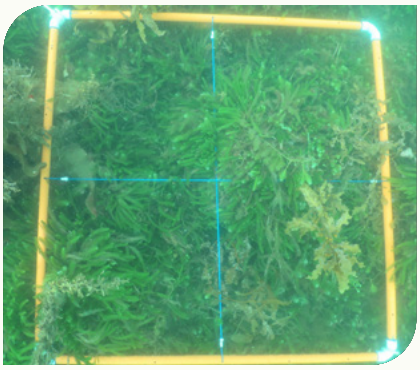
80-90%



Mercury Passage, Freestone, Summer 2022, 90% cover (*Caulerpa flexilis*)

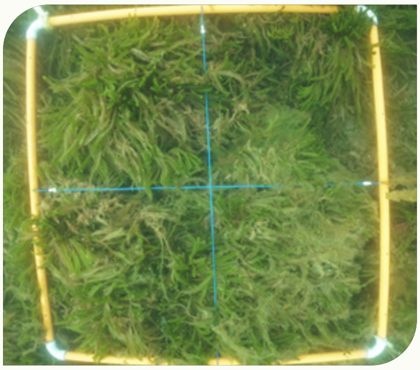


D'Entrecasteaux Channel, Great Taylors Bay, Spring 2023, 90% cover (*Caulerpa flexilis*)

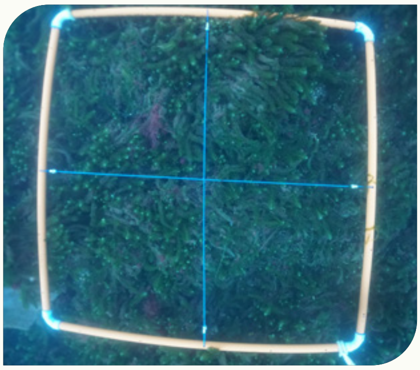


Port Arthur, 400m North, Summer 2021, 90% cover (*Caulerpa longifolia*)

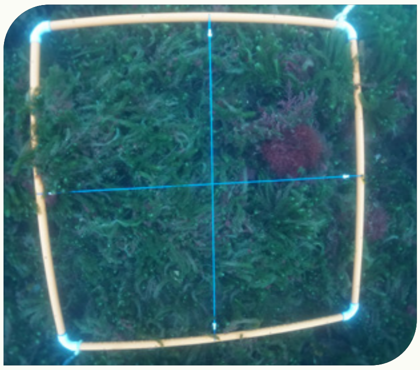
90-100%



Port Arthur, 400m North, Summer 2022, 100% cover (*Caulerpa trifaria*)



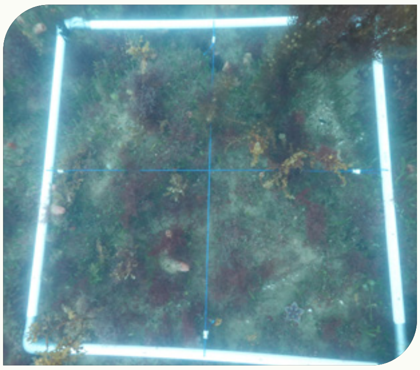
Port Arthur, 1km North, Winter 2021, 95% cover (*Caulerpa longifolia*)



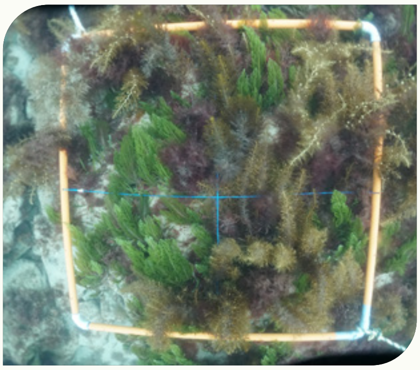
Port Arthur, 1km North, Winter 2021, 95% cover (*Caulerpa longifolia*)

Sub-canopy red algae

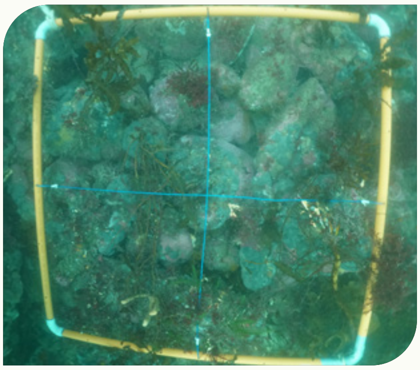
0-10%



Coles Bay, Esplanade, Winter 2024, 10% cover

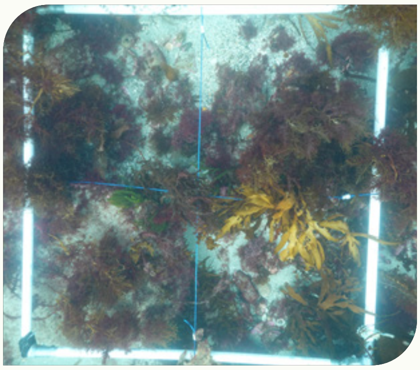


Mercury Passage, Orford 1, Winter 2022, 10% cover

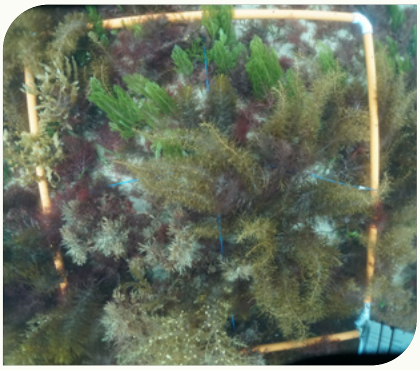


Port Arthur, 0m East, Winter 2022, 5% cover

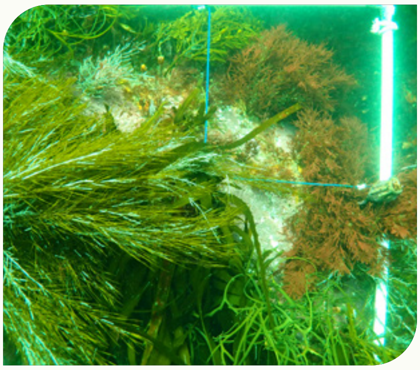
10-20%



Coles Bay, Gleaners Reef, Winter 2024, 15% cover

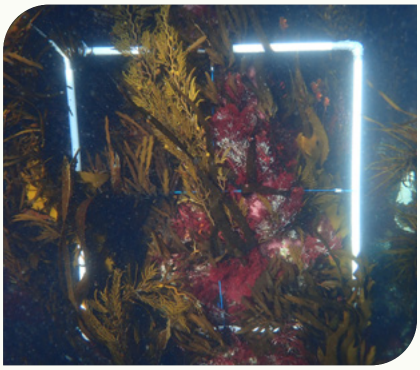


Mercury Passage, Orford 1, Winter 2022, 20% cover

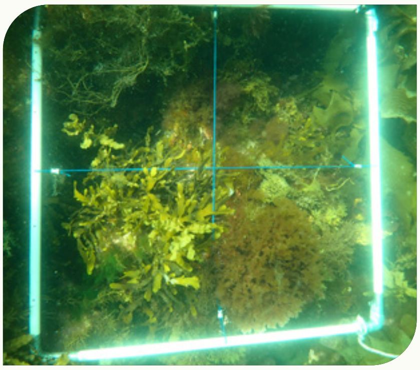


Storm Bay, Outer Wedge, Winter 2023, 20% cover

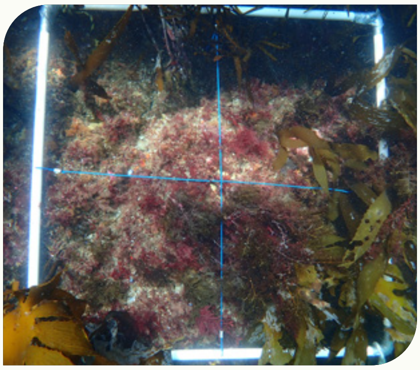
20-30%



Storm Bay, Black Jack Bight, Summer 2023, 30% cover



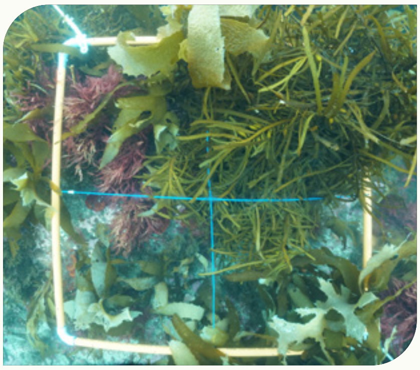
D'Entrecasteaux Channel, Huon Island, Summer 2024, 25% cover



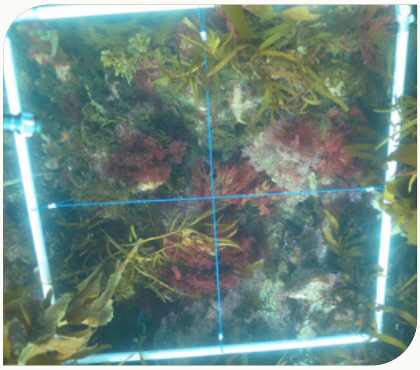
Storm Bay, Yellow Bluff 2, Summer 2023, 30% cover

Sub-canopy red algae

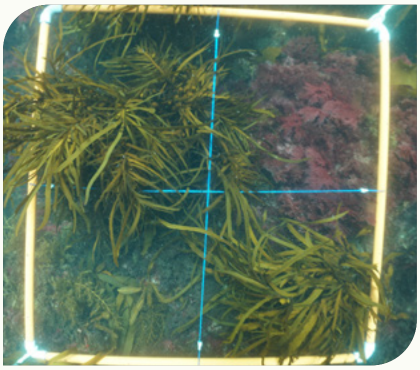
30-40%



Mercury Passage, Green Bluff, Winter 2022, 40% cover

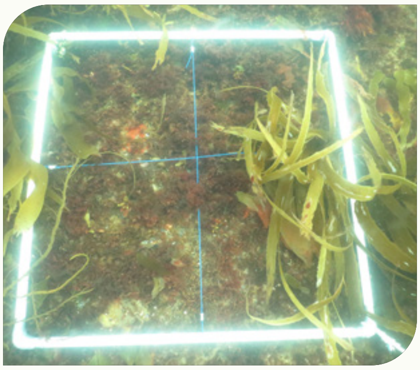


Coles Bay, Gleaners Reef, Winter 2023, 40% cover

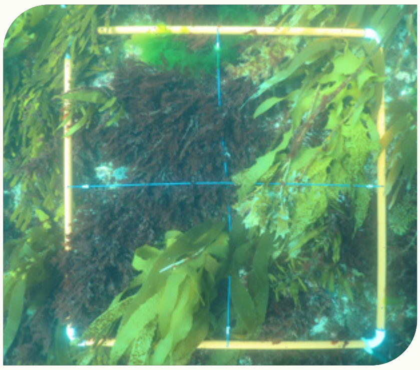


Mercury Passage, MPIR1, Spring 2021, 35% cover

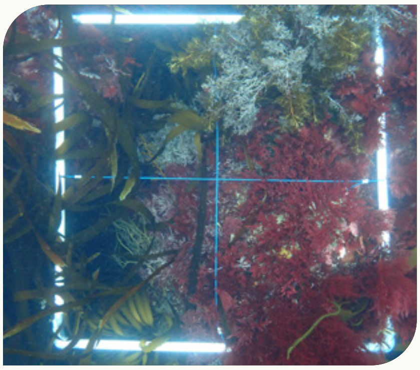
40-50%



Storm Bay, Black Jack Reef, Summer 2023, 50% cover

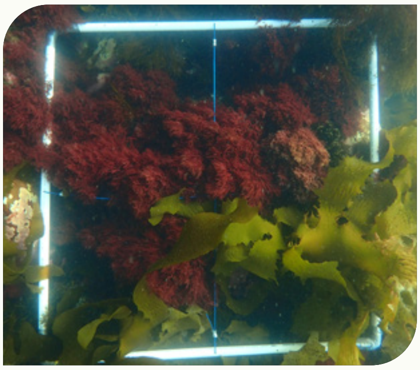


Storm Bay, Iron Pot, Summer 2022, 50% cover

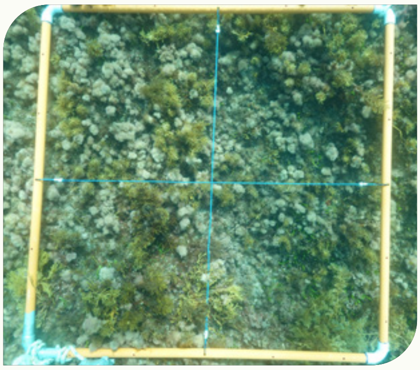


Storm Bay, North Head, Summer 2023, 50% cover

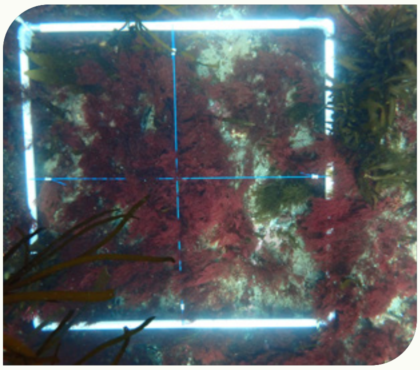
50-60%



Storm Bay, Apex Point, Summer 2023, 60% cover



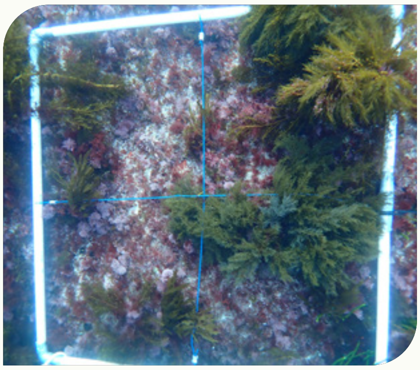
Flinders Island, Badger Island, Summer 2024, 60% cover



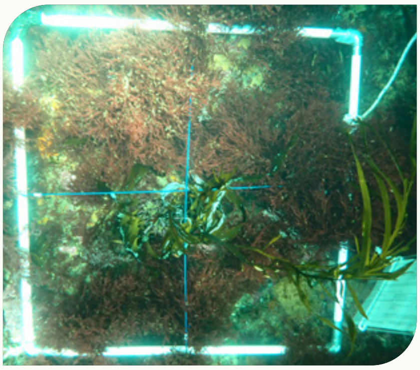
Storm Bay, Black Jack Bight, Summer 2023, 60% cover

Sub-canopy red algae

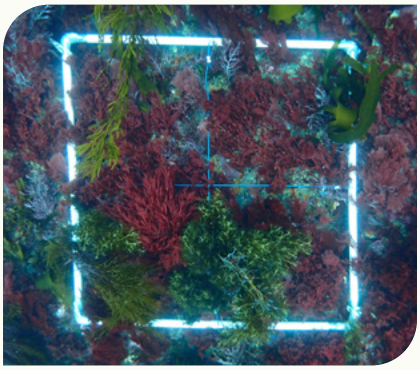
60-70%



Flinders Island, Badger Island, Winter 2023, 70% cover

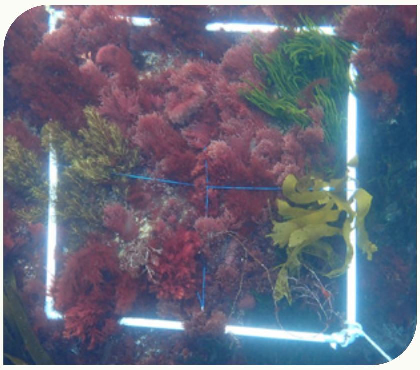


Storm Bay, Curio Bay, Winter 2023, 70% cover

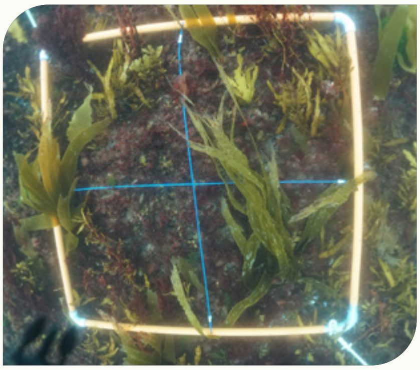


Storm Bay, Outside Wedge, Summer 2023, 70% cover

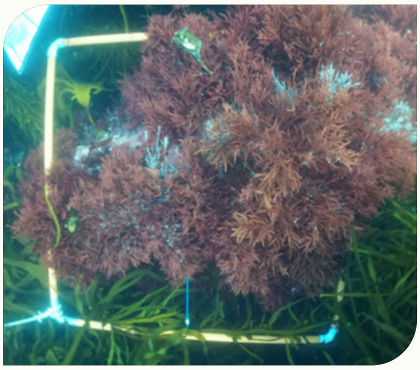
70-80%



Storm Bay, North Head, Summer 2023, 75% cover



Storm Bay, Black Jack Reef, Summer 2022, 80% cover



Storm Bay, Curio Bay, Summer 2022, 80% cover

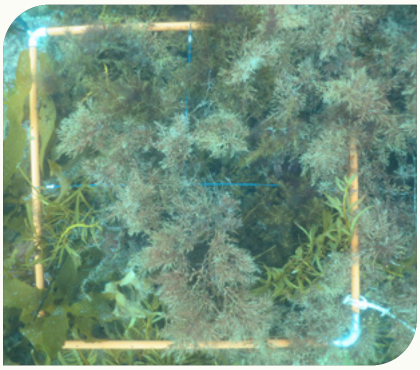
Note: no quadrats scored >80% sub-canopy red algae cover during IMAS RVA surveys.

Epiphytic algae

0-10%

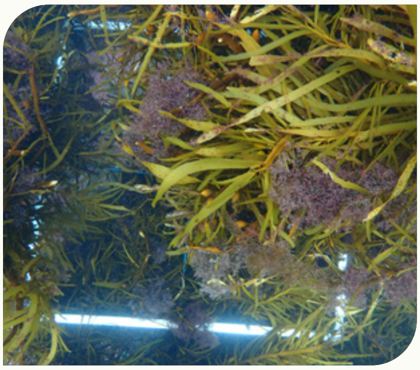
Storm Bay, North-West Betsey, Summer 2023, 10% epiphyte cover

Mercury Passage, Point Leseuer, Winter 2022, 10% epiphyte cover

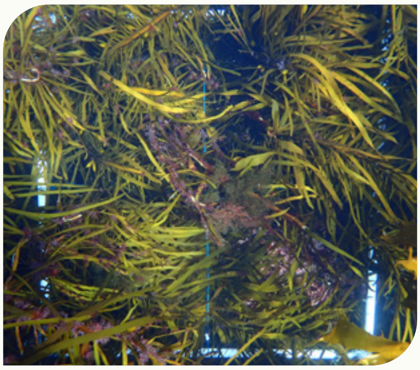


Mercury Passage, Return Point, Winter 2022, 10% epiphyte cover

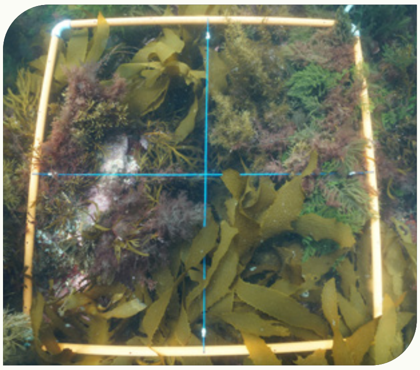
10-20%



Storm Bay, Adventure Bay, Summer 2023, 20% epiphyte cover

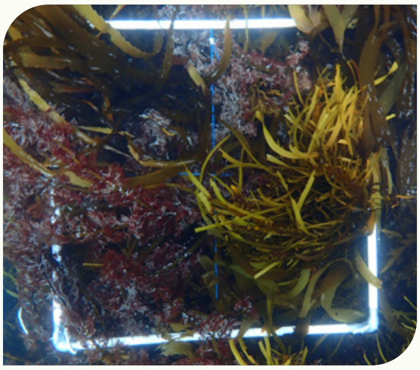


Storm Bay, Cape Queen Elizabeth, Summer 2023, 15% epiphyte cover

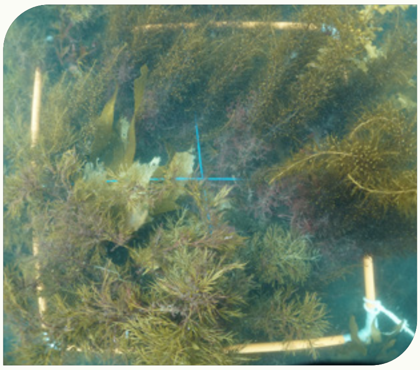


Mercury Passage, MPIR3, Spring 2021, 20% epiphyte cover

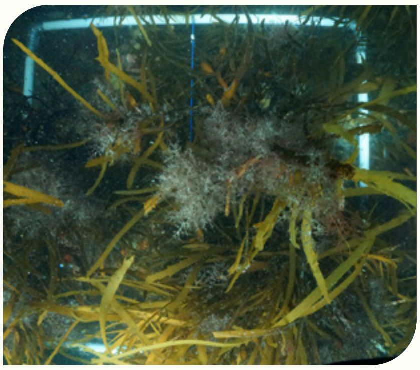
20-30%



Storm Bay, Yellow Bluff 2, Summer 2023, 30% epiphyte cover



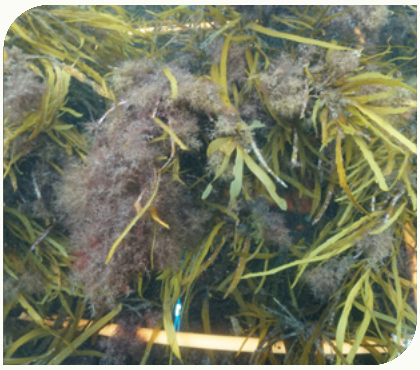
Mercury Passage, MPIR3, Winter 2022, 30% epiphyte cover



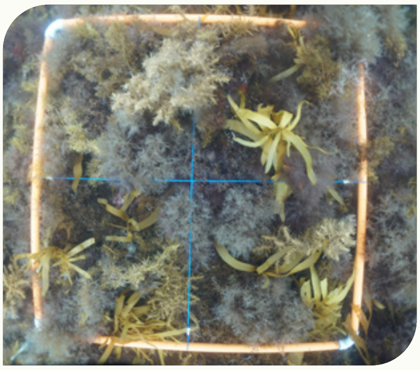
Mercury Passage, Point Leseuer, Summer 2022, 30% epiphyte cover

Epiphytic algae

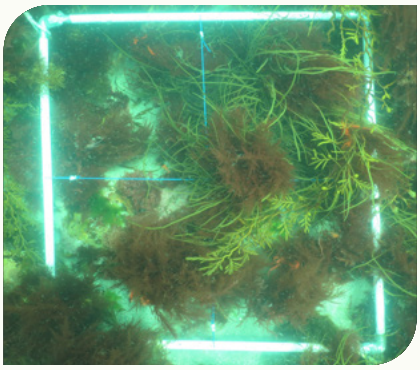
30-40%



Mercury Passage, Point Leseuer, Summer 2021, 40% epiphyte cover

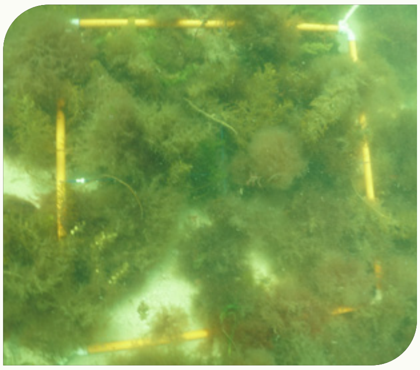


Mercury Passage, Return Point, Summer 2021, 40% epiphyte cover

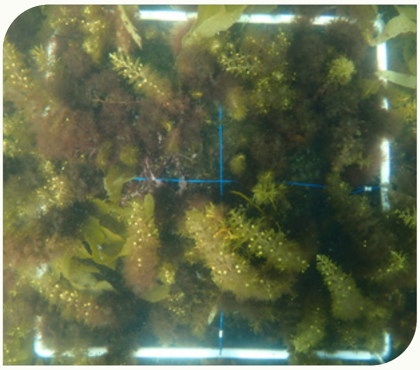


Storm Bay, Crooked Billet Bay, Summer 2023, 35% epiphyte cover

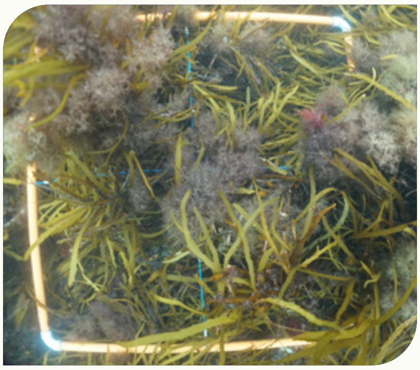
40-50%



Mercury Passage, Orford 1, Summer 2021, 50% epiphyte cover

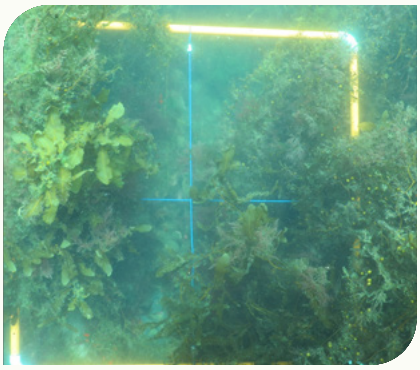


Storm Bay, Lobster Point, Summer 2023, 50% epiphyte cover

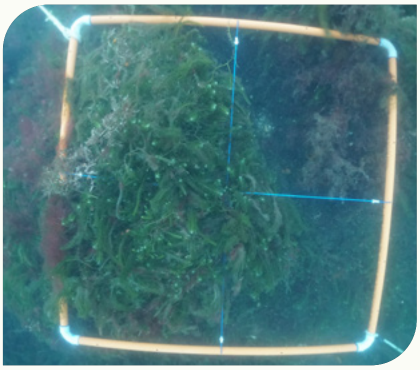


Mercury Passage, Point Leseuer, Summer 2021, 50% epiphyte cover

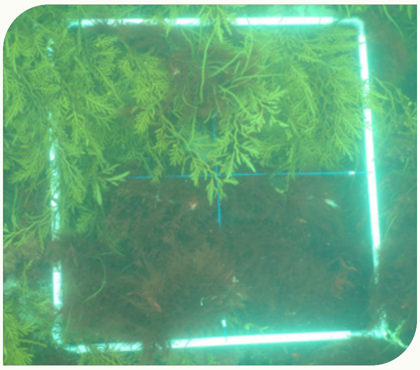
50-60%



Port Arthur, 0m North, Summer 2022, 60% epiphyte cover



Port Arthur, 1km North, Winter 2021, 60% epiphyte cover

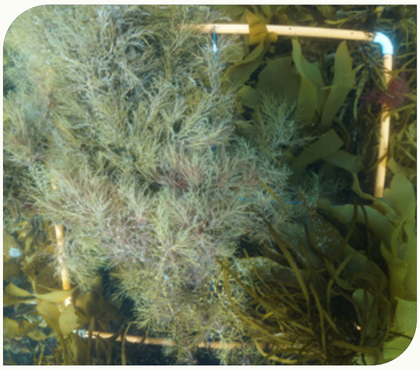


Storm Bay, Crooked Billet Bay, Summer 2023, 60% epiphyte cover

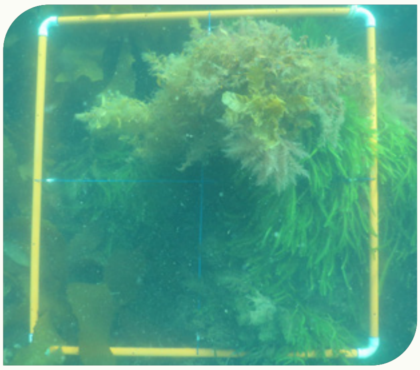
Note: quadrats with >60% epiphytic algae cover comprised filamentous algae, and so have been included in that category instead.

Filamentous algae

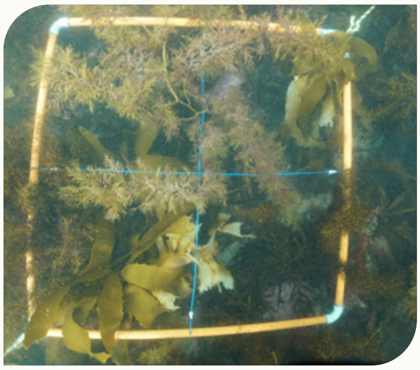
0-10%



Port Arthur, 400m East, Summer 2022, 10% filamentous algae cover

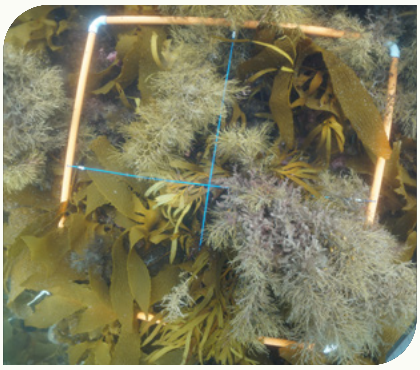


Mercury Passage, Freestone, Spring 2021, 10% filamentous algae cover

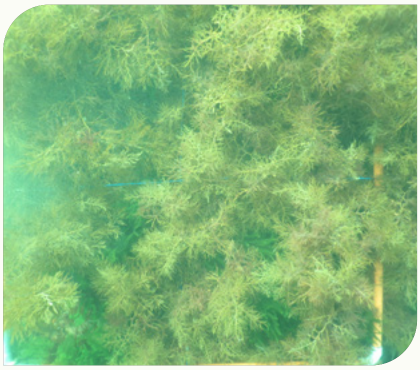


Mercury Passage, MPIR3, Winter 2022, 10% filamentous algae cover

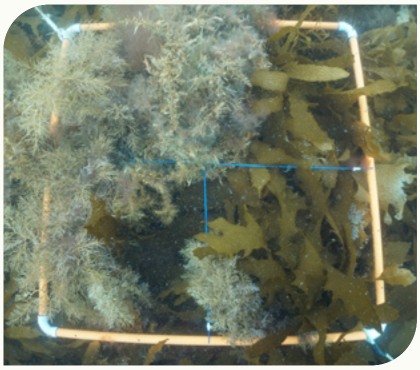
10-20%



Mercury Passage, MPIR2, Summer 2021, 20% filamentous algae cover

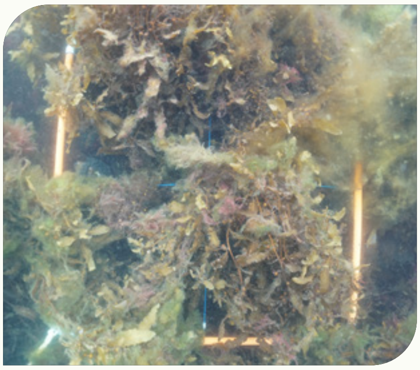


Mercury Passage, Painted Cliffs, Winter 2022, 20% filamentous algae cover

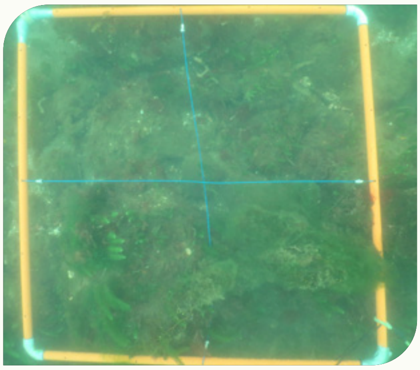


Mercury Passage, Return Point, Summer 2021, 15% filamentous algae cover

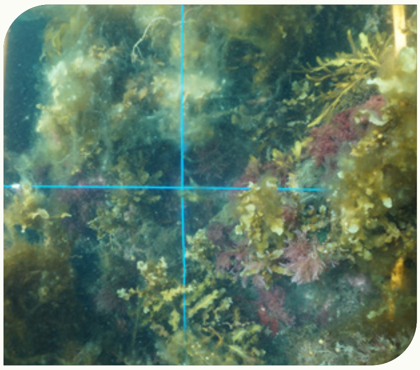
20-30%



Port Arthur, 0m East, Summer 2022, 30% filamentous algae cover



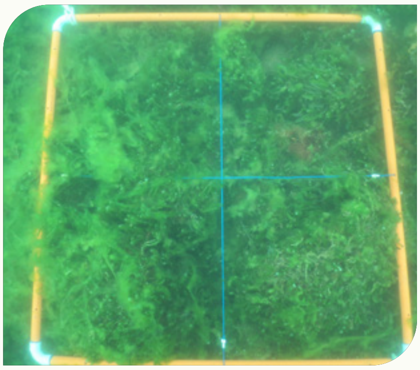
Port Arthur, 1km North, Winter 2022, 25% filamentous algae cover



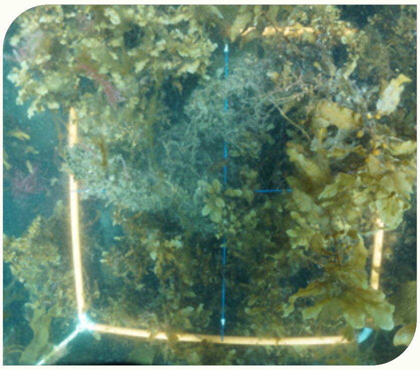
Port Arthur, 1km East, Summer 2022, 30% filamentous algae

Filamentous algae

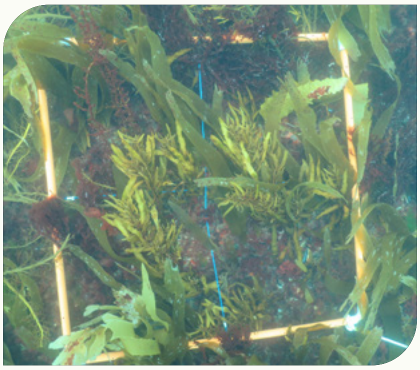
30-40%



Port Arthur, 1km North, Summer 2021, 40% filamentous algae cover

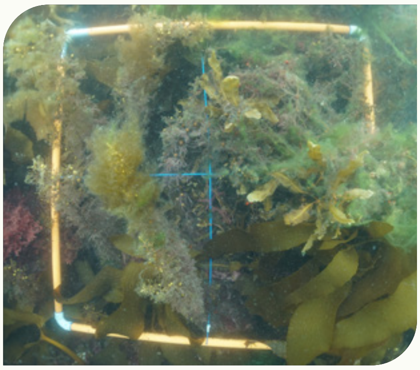


Port Arthur, 1km East, Summer 2022, 35% filamentous algae cover

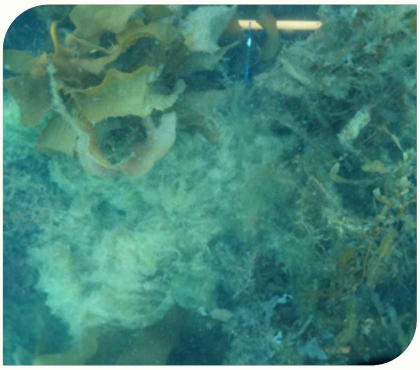


Storm Bay, Black Jack Reef, Summer 2022, 40% filamentous algae cover

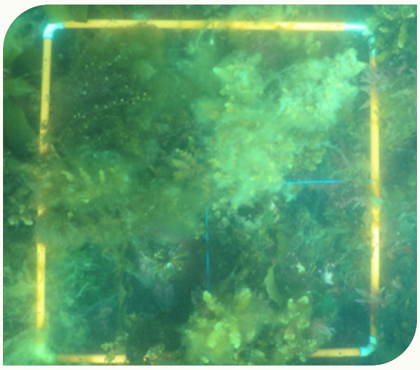
40-50%



Port Arthur, 0m East, Summer 2022, 50% filamentous algae cover

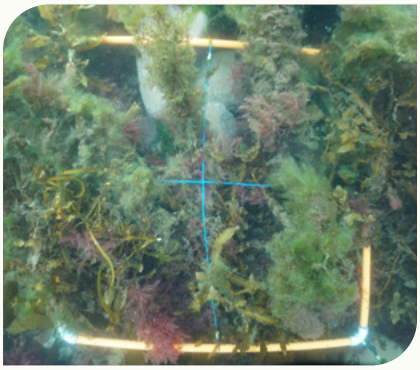


Port Arthur, 0m South, Summer 2022, 50% filamentous algae cover

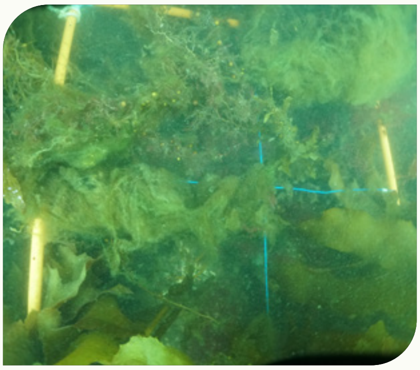


Port Arthur, 1km East, Summer 2022, 50% filamentous algae cover

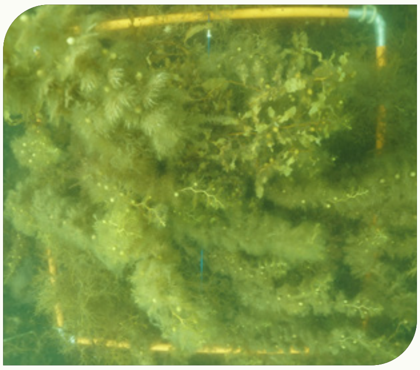
50-60%



Port Arthur, 0m East, Summer 2022, 55% filamentous algae cover



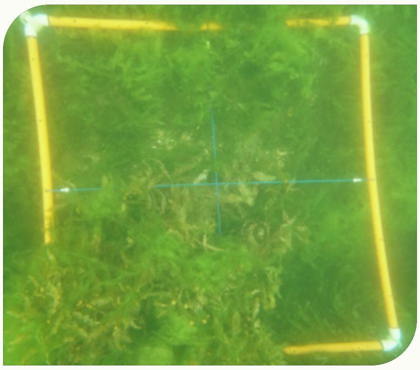
Port Arthur, 0m South, Summer 2022, 60% filamentous algae cover



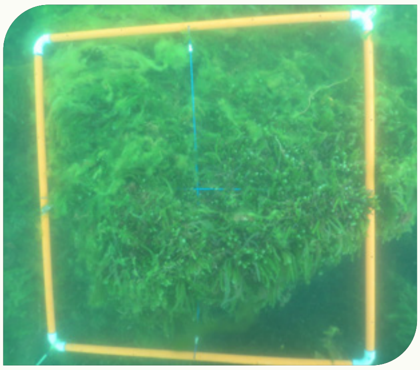
Port Arthur, 400m West, Summer 2022, 60% filamentous algae cover

Filamentous algae

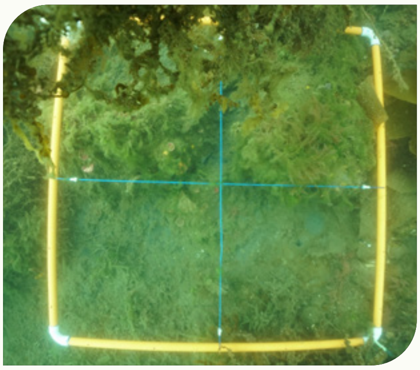
60-70%



Port Arthur, 1km North, Summer 2021, 65% filamentous algae cover



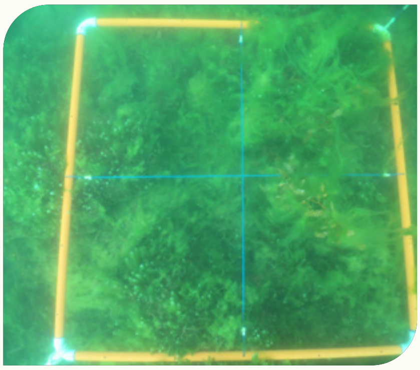
Port Arthur, 1km North, Summer 2021, 70% filamentous algae cover



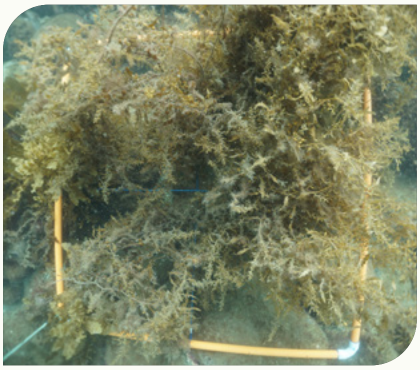
Port Arthur, 400m North, Summer 2022, 70% filamentous algae cover

70-80%

Port Arthur, 0m East, Summer 2022, 80% filamentous algae cover

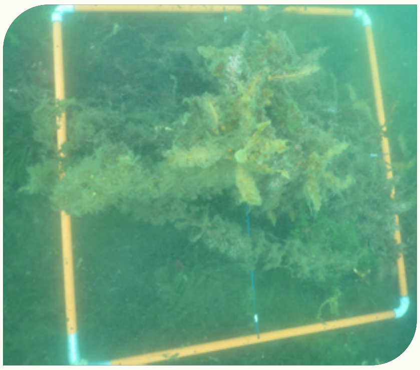


Port Arthur, 1km North, Summer 2021, 75% filamentous algae cover

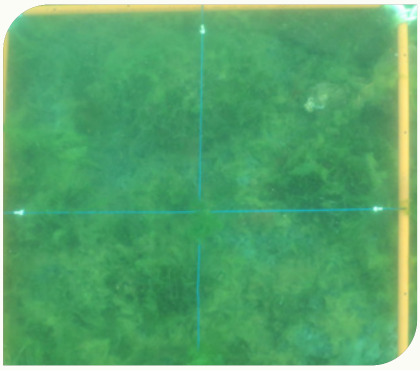


Mercury Passage, MPIR2, Summer 2021, 80% filamentous algae cover

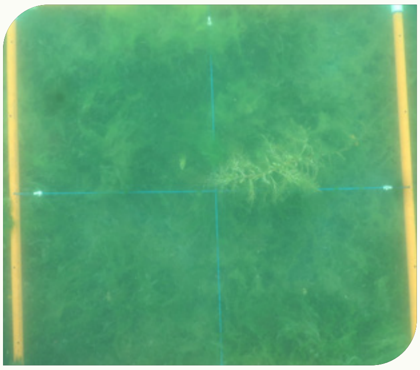
80-90%



Port Arthur, 400m North, Summer 2022, 90% filamentous algae cover



Port Arthur, 1km North, Summer 2022, 90% filamentous algae cover

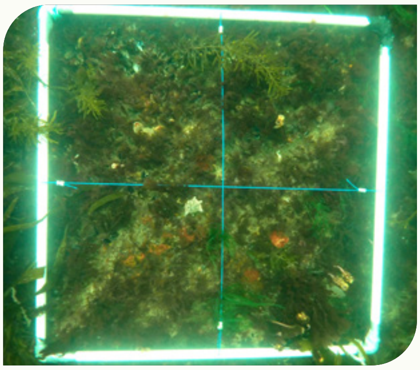


Port Arthur, 1km North, Summer 2022, 90% filamentous algae

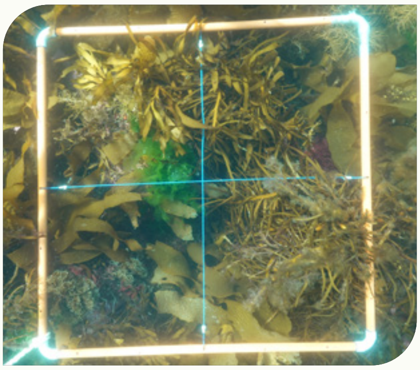
Note: no quadrats scored >90% filamentous algae cover during IMAS RVA surveys.

Opportunistic green algae

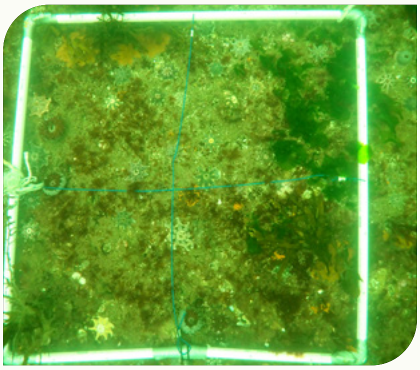
0-10%



Storm Bay, Black Jack Reef, Winter 2023, 10% cover (*Cladophora feredayi*)

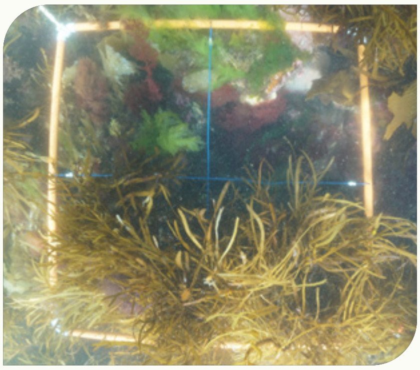


Port Arthur, Evendons Point, Summer 2024, 10% cover (*Ulva* sp.)

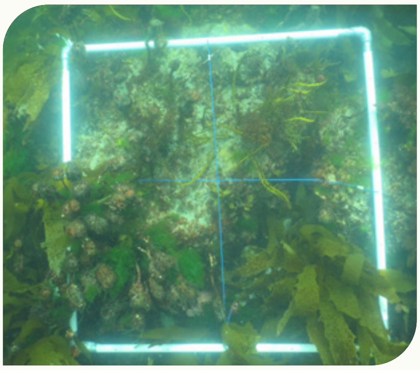


Storm Bay, Iron Pot, Winter 2023, 10% cover (*Ulva* sp.)

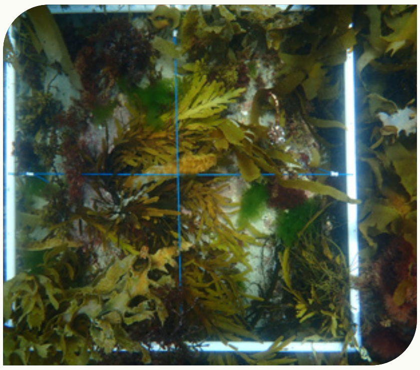
10-20%



Port Arthur, 1km South, Summer 2022, 20% cover (*Ulva* sp.)



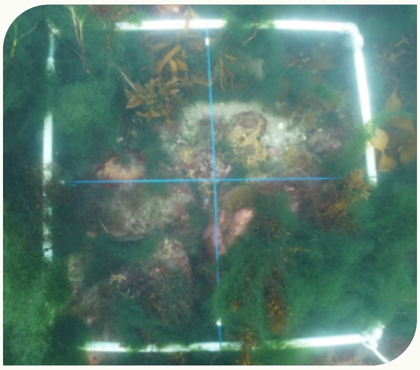
Storm Bay, Low Point North, Summer 2023, 15% cover (*Ulva* sp.)



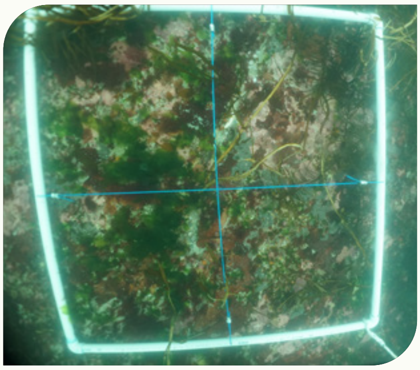
Storm Bay, Low Point North, Summer 2023, 15% cover (*Ulva* sp.)

Opportunistic green algae

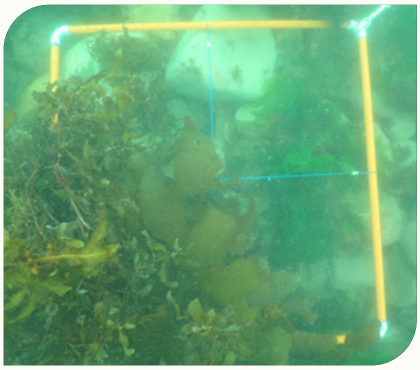
20-30%



Port Arthur, Safety Cove, Winter 2023, 30% cover (*Chaetomorpha billardierii*)

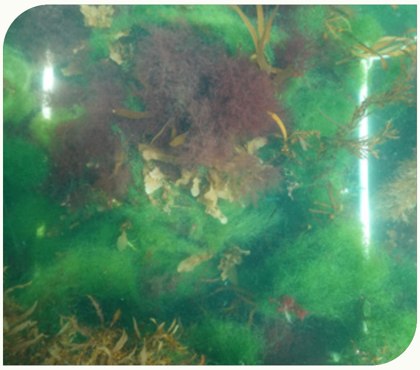


Port Arthur, Safety Cove, Winter 2022, 25% cover (*Ulva* sp.)

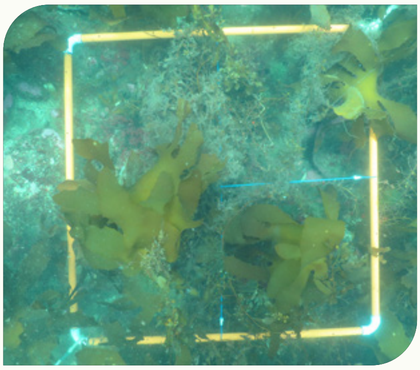


Port Arthur, 0m East, Summer 2021, 25% cover (*Ulva* sp.)

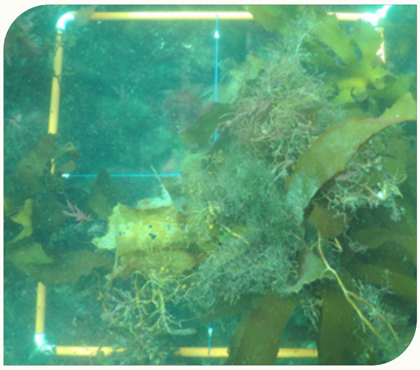
30-40%



Port Arthur, Safety Cove, Spring 2023, 40% cover (*Chaetomorpha billardierii*)



Port Arthur, 0m South, Summer 2021, 32% cover (30% *Chaetomorpha billardierii*, 2% *Ulva* sp.)

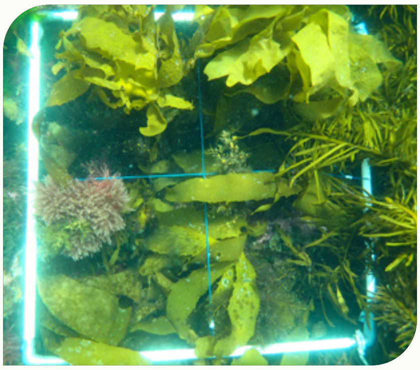


Port Arthur, 0m South, Summer 2021, 40% cover (30% *Chaetomorpha billardierii*, 10% *Ulva* sp.)

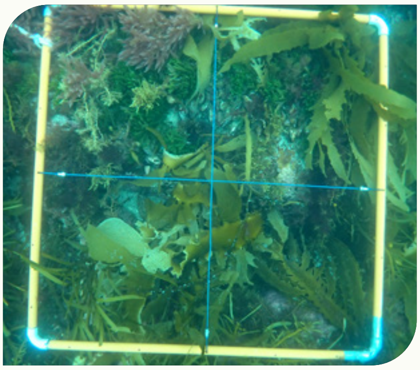
Note: no quadrats scored >40% opportunistic green algae cover during IMAS RVA surveys.

Opportunistic red algae

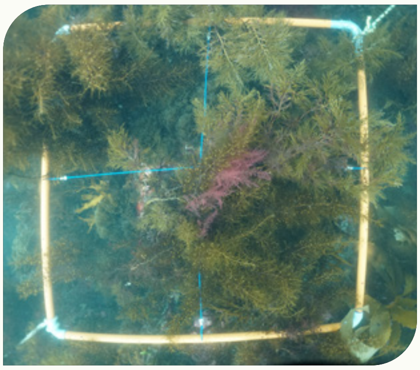
0-10%



Port Arthur, Evendons Point, Summer 2024, 10% *Asparagopsis* cover

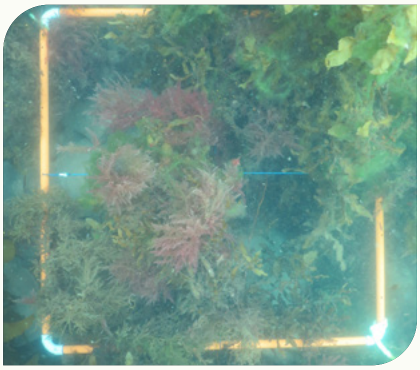


Coles Bay, Fleurieu Point, Summer 2024, 10% *Asparagopsis* cover

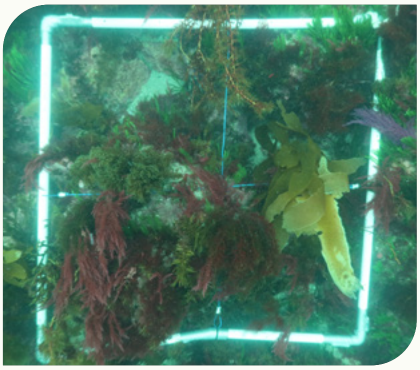


Mercury Passage, MPIR3, Winter 2022, 10% *Asparagopsis* cover

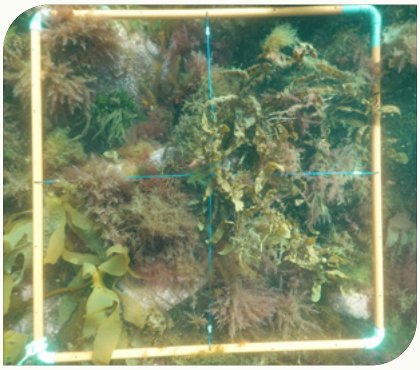
10-20%



Port Arthur, 0m East, Summer 2022, 15% *Asparagopsis* cover

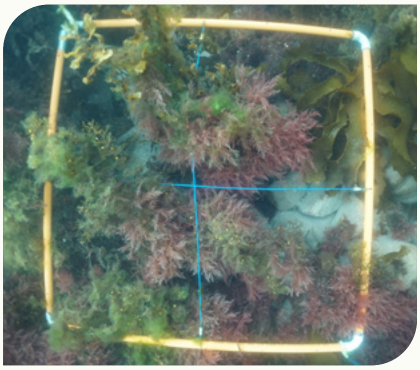


Coles Bay, Fleurieu Point, Winter 2024, 20% *Asparagopsis* cover

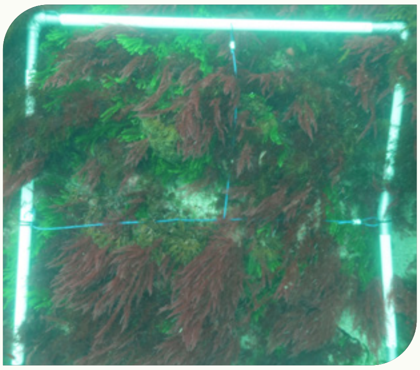


D'Entrecasteaux Channel, Huon Island, Summer 2024, 20% *Asparagopsis* cover

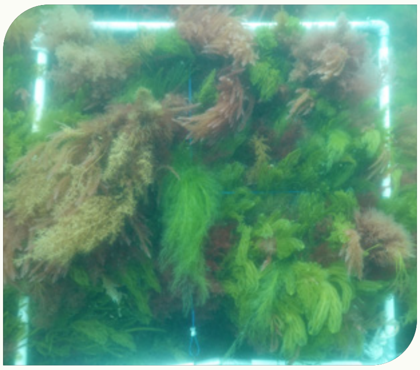
20-30%



Port Arthur, 0m East, Summer 2022, 30% *Asparagopsis* cover



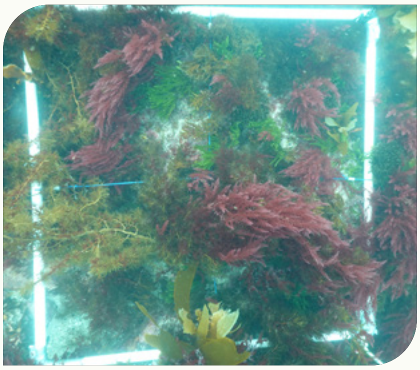
Coles Bay, Fleurieu Point, Winter 2024, 25% *Asparagopsis* cover



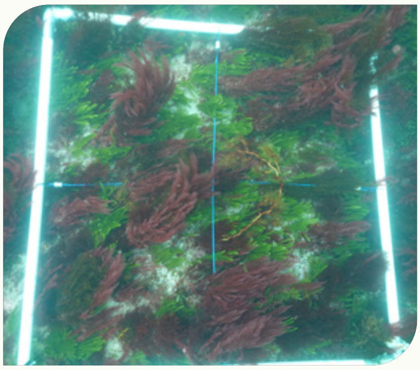
Coles Bay, Fleurieu Point, Spring 2023, 30% *Asparagopsis* cover

Opportunistic red algae

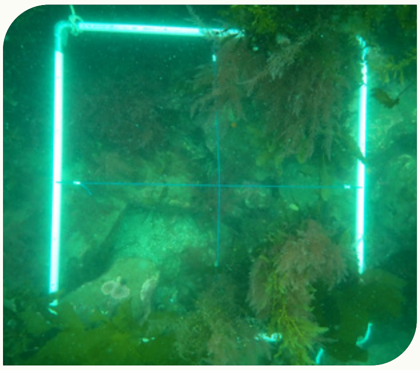
30-40%



Coles Bay, Fleurieu Point, Winter 2024, 37% *Asparagopsis* cover

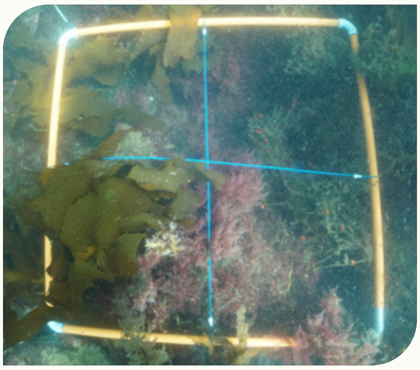


Coles Bay, Fleurieu Point, Winter 2024, 36% *Asparagopsis* cover

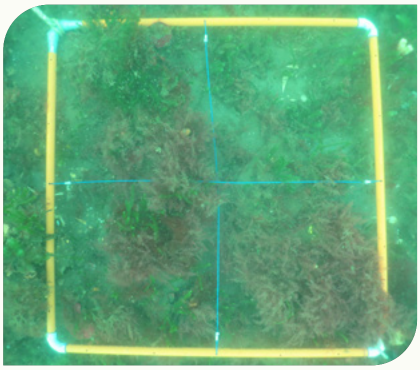


Port Arthur, Isle of the Dead, Spring 2023, 35% *Asparagopsis* cover

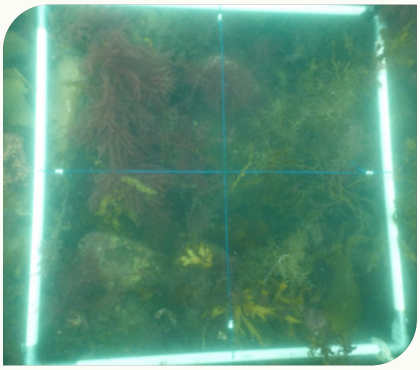
40-50%



Port Arthur, 0m North, Summer 2022, 45% *Asparagopsis* cover



Port Arthur, 400m North, Winter 2022, 45% *Asparagopsis* cover

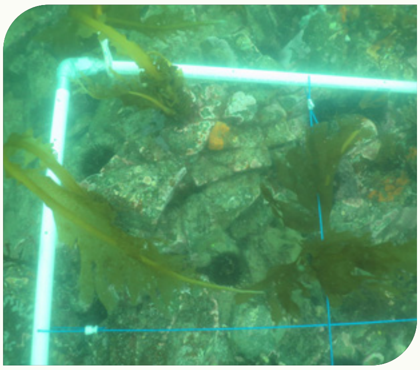


D'Entrecasteaux Channel, Huon Island, Autumn 2024, 42% *Asparagopsis* cover

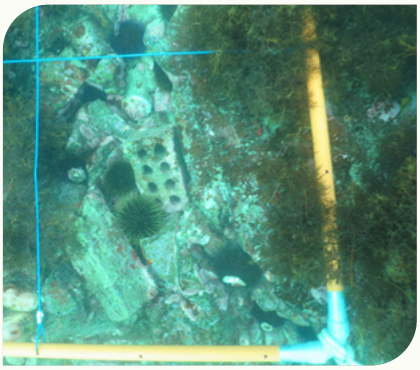
Note: no quadrats scored >50% opportunistic red algae cover during IMAS RVA surveys.

Substrate characterisation

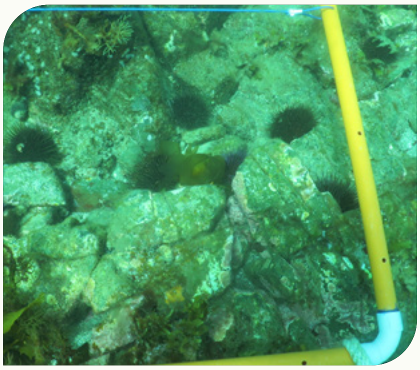
Bare rock (barrens)



Mercury Passage, MPIR6, Summer 2022

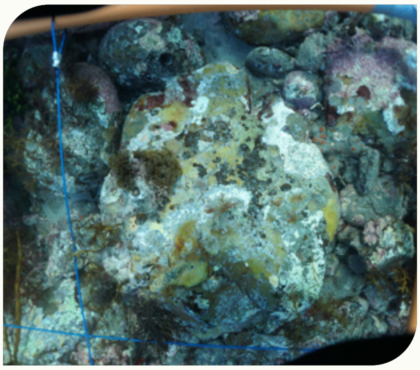


Mercury Passage, MPIR6, Winter 2022

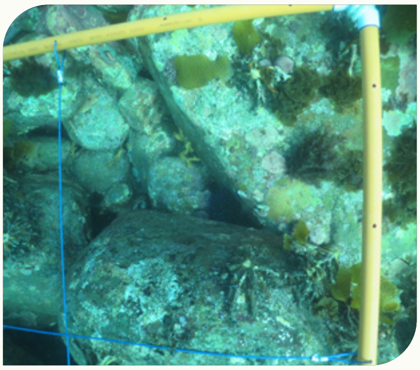


Mercury Passage, MPIR6, Spring 2021

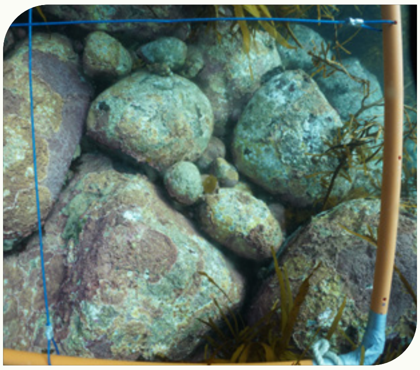
Bare rock (non-barrens)



Mercury Passage, Earlham, Winter 2022

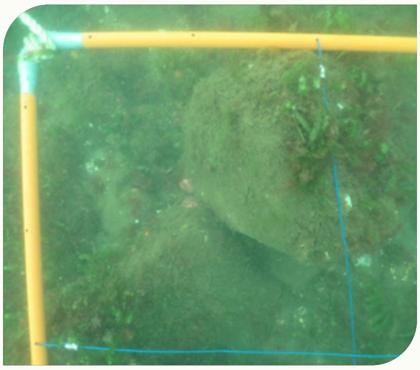


Mercury Passage, EB, Winter 2022

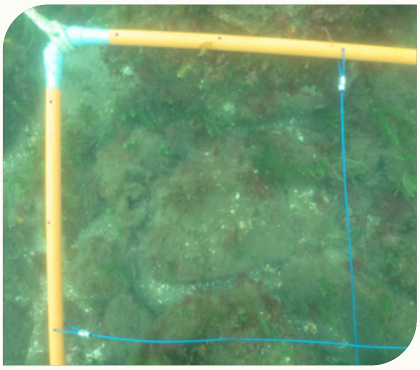


Mercury Passage, EB, Winter 2022

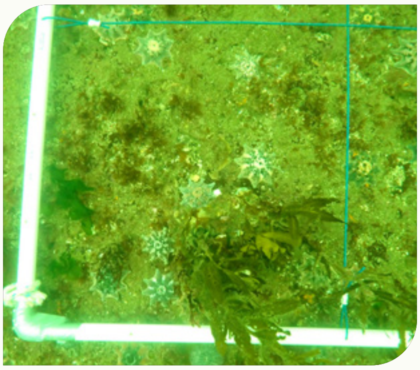
Biogenic matrix



Port Arthur, 1km North, Winter 2022



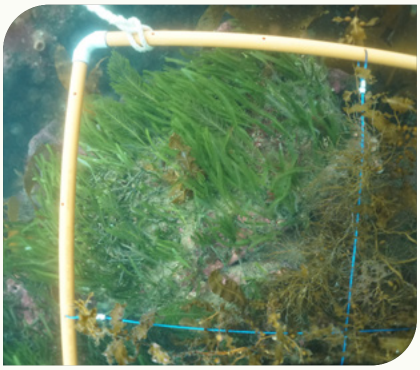
Port Arthur, 1km North, Winter 2022



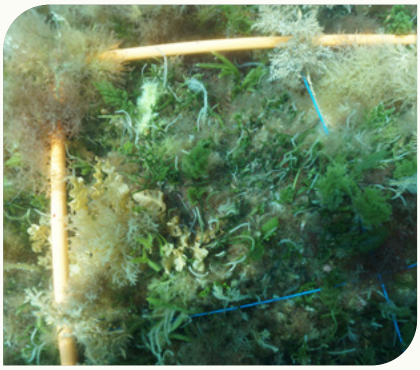
Storm Bay, Iron Pot, Winter 2023

Substrate characterisation

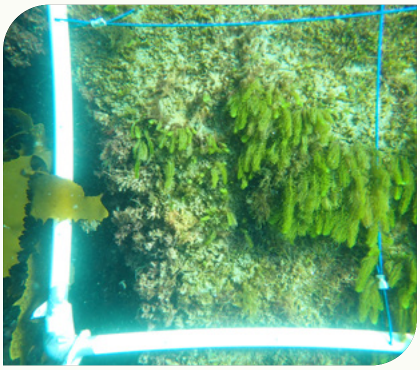
Caulerpa rhizomes



Mercury Passage, Freestone, Winter 2022

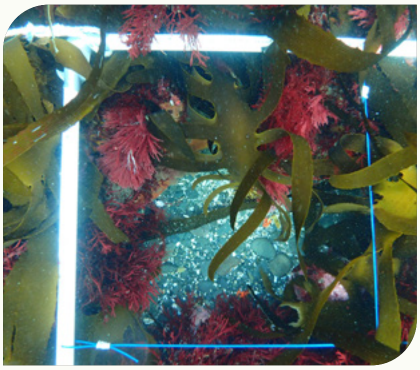


Mercury Passage, Painted Cliffs, Summer 2021

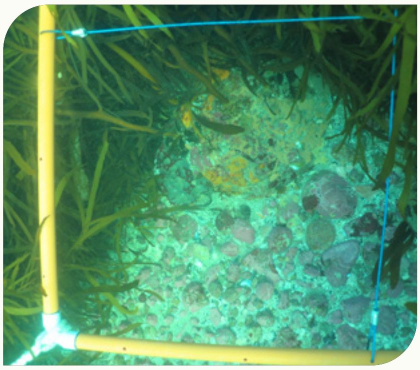


Storm Bay, South-East Betsey, Summer 2023

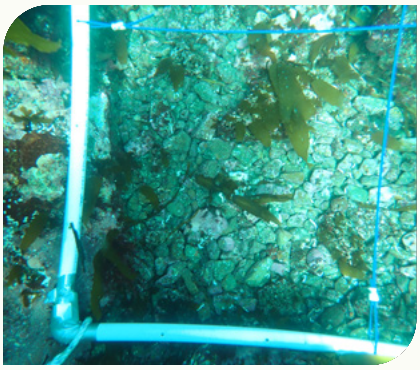
Cobble



Storm Bay, North Head, Summer 2023

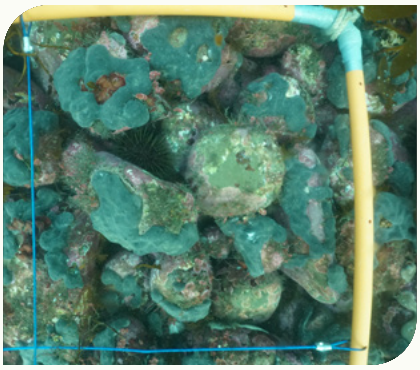


Mercury Passage, Point Leseuer, Winter 2022

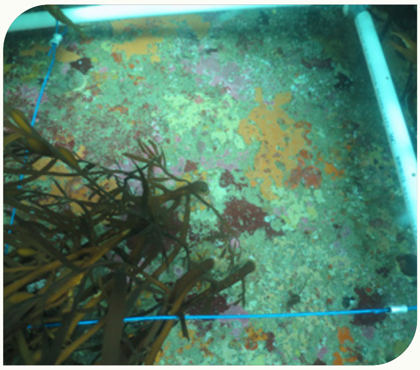


Storm Bay, Variety Bay North, Summer 2023

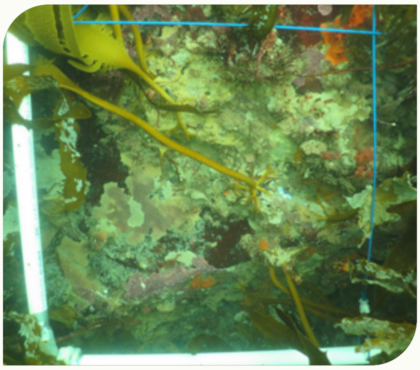
Encrusting sponge



Port Arthur, 0m East, Winter 2022



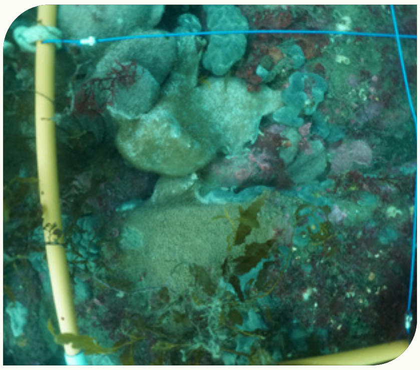
Storm Bay, Adventure Bay, Summer 2023



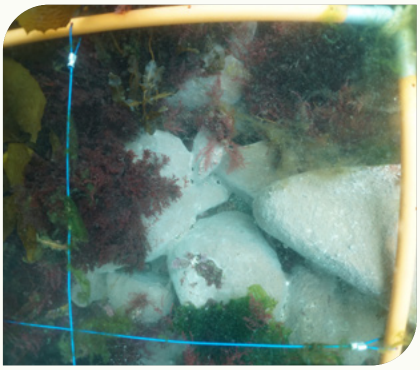
Storm Bay, Low Point North, Winter 2023

Substrate characterisation

Encrusting octocoral



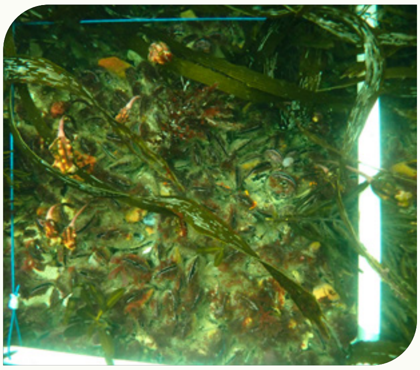
Port Arthur, 0m East, Winter 2022



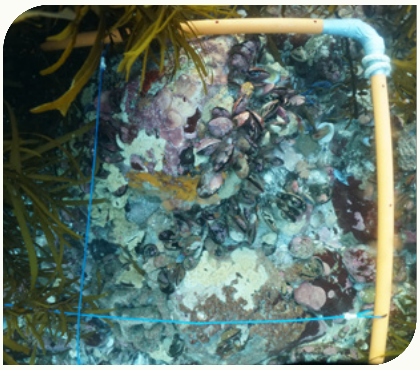
Port Arthur, 0m East, Summer 2022

Port Arthur, 400m West, Winter 2022

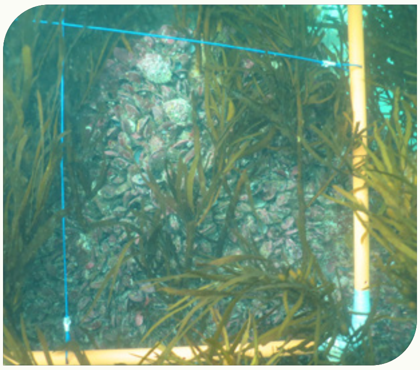
Mussels



Storm Bay, Black Jack Reef, Winter 2023

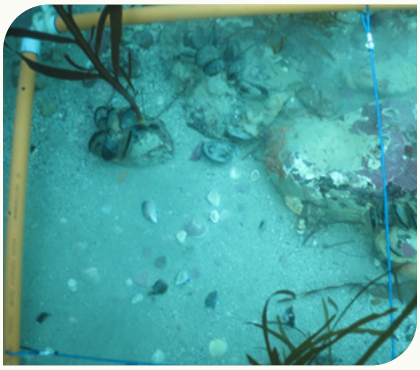


Mercury Passage, Lachlan Island, Winter 2022

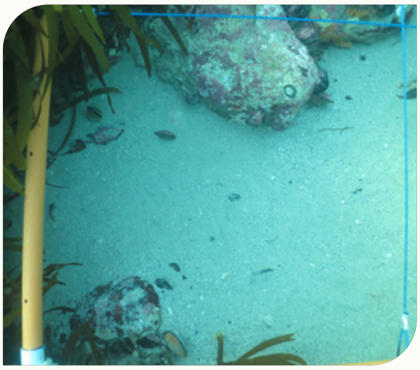


Mercury Passage, MPIR1, Winter 2022

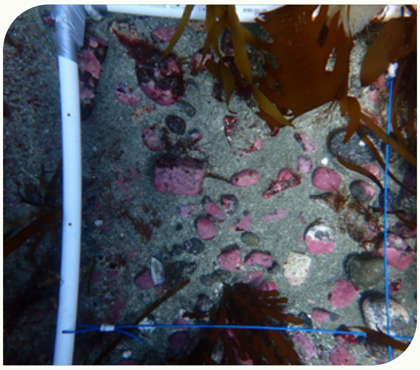
Sand



Mercury Passage, Lachlan Island, Winter 2022



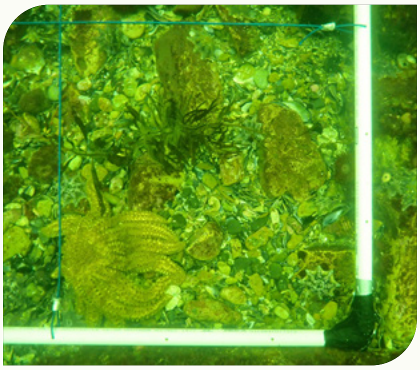
Mercury Passage, Lachlan Island, Winter 2022



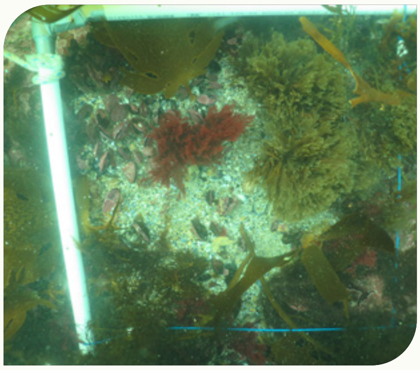
Storm Bay, Trumpeter Bay South, Summer 2023

Substrate characterisation

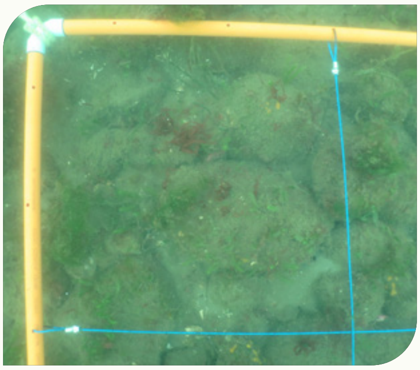
Shell

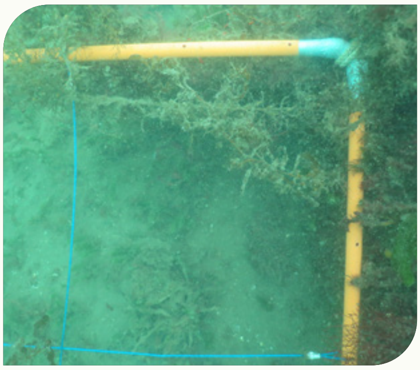

Storm Bay, Iron Pot, Winter 2023

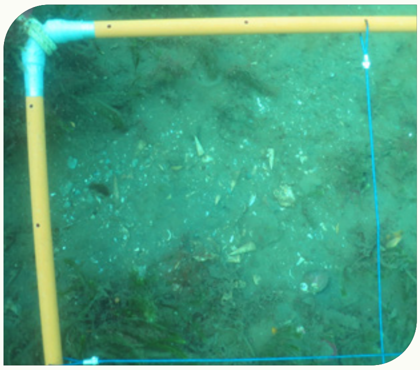

Storm Bay, Iron Pot, Summer 2023


Storm Bay, Yellow Bluff 1, Winter 2023

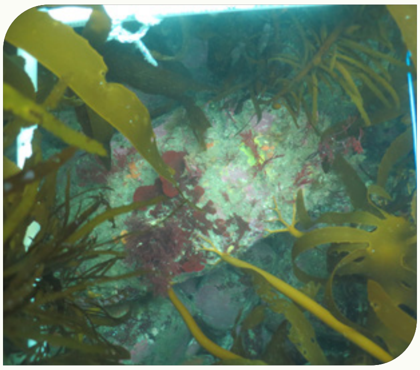
Silt


Port Arthur, 1km North, Winter 2022

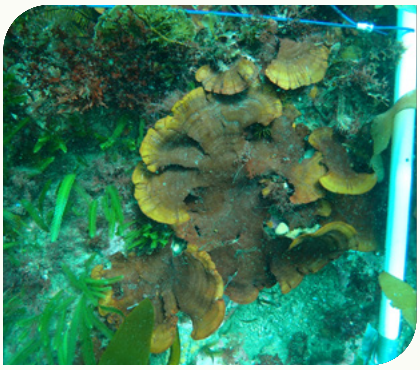

Port Arthur, 400m North, Winter 2022


Port Arthur, 400m North, Winter 2022

Sonderopelta/Peyssonnelia

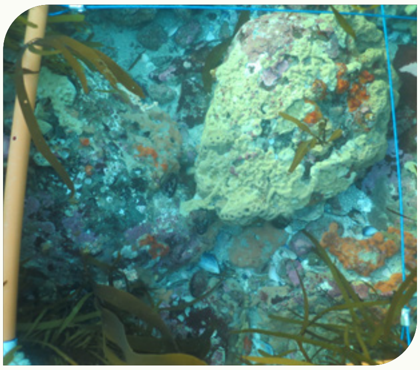

Fortescue Bay, Canoe Bay, Winter 2022


Coles Bay, Gleaners Reef, Summer 2024

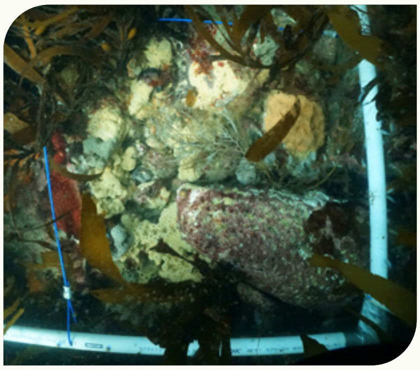

Port Arthur, Isle of the Dead, Spring 2024

Substrate characterisation

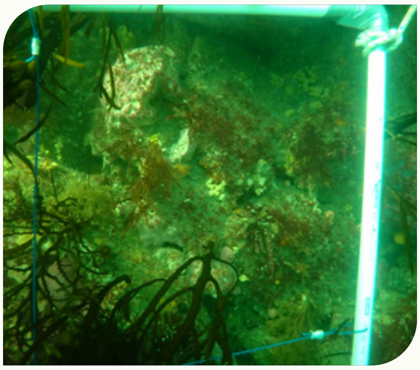
Sponge



Mercury Passage, Lachlan Island, Winter 2022

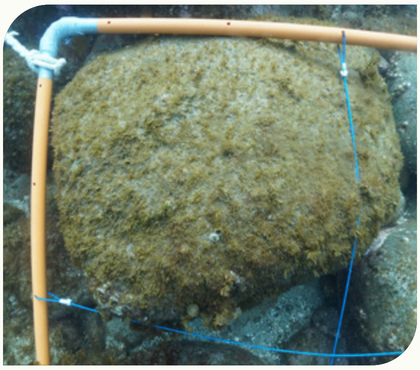


Mercury Passage, Point Leseuer, Summer 2022



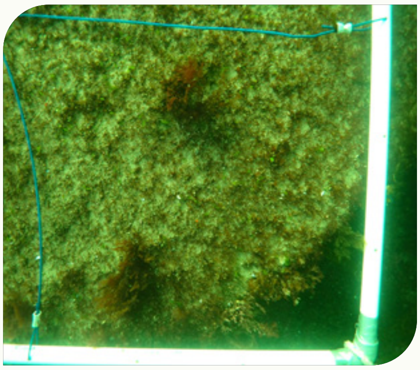
Storm Bay, Black Jack Bight, Winter 2023

Turf/sand/sediment matrix



Mercury Passage, EB, Winter 2022

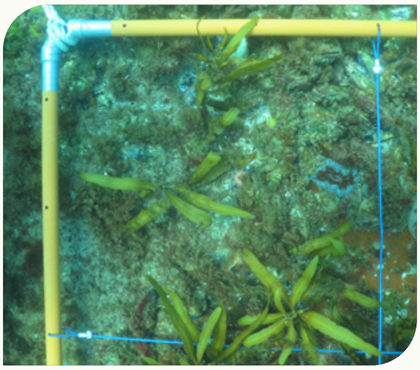
Mercury Passage, MPIR2, Winter 2022



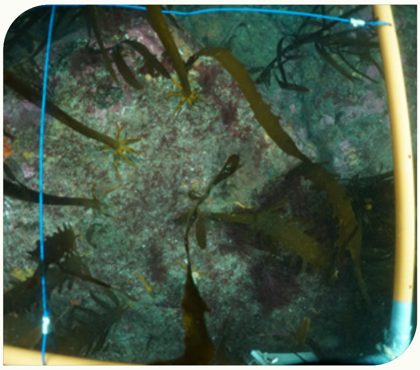
Storm Bay, South-East Betsey, Winter 2023

Substrate characterisation

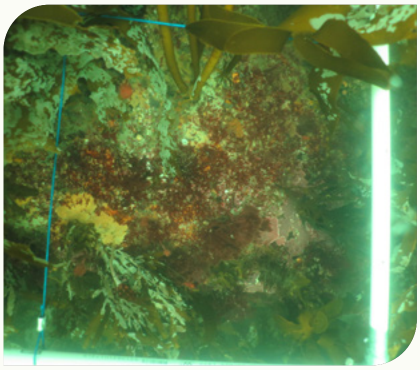
Turfing algae



Storm Bay, Iron Pot, Summer 2022

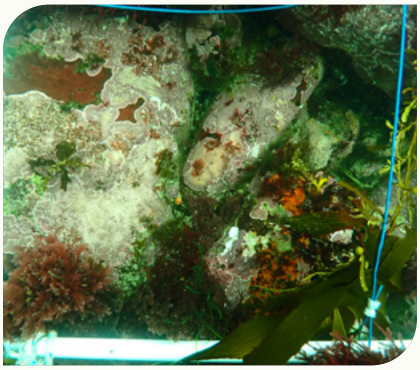


Mercury Passage, MPIR1, Winter 2022

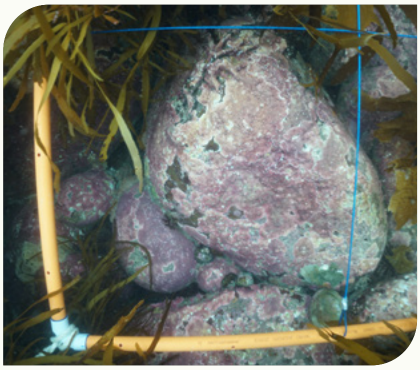


Storm Bay, One Tree North, Winter 2023

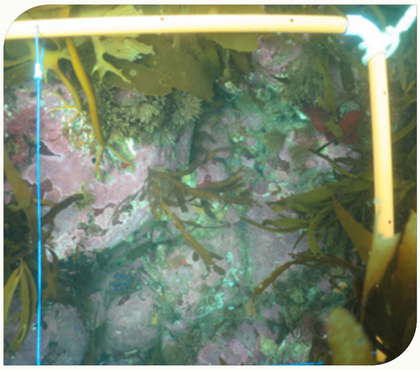
Encrusting coralline algae



Storm Bay, Crooked Billet Bay, Winter 2023



Storm Bay, Yellow Bluff 1, Winter 2023



Mercury Passage, MPIR2, Winter 2022

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