# Reef Check Australia

## Townsville Region
## Season Summary Report 2019-2020

REEF CHECK AUSTRALIA

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Project activities were conducted on the traditional lands of the Indigenous groups throughout the Townsville region including the Wulgurukaba, Bindal and Manbarra People of the Townsville & Palm Island regions. We acknowledge the Traditional Custodians of the land and their Elders past, present and emerging.

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# 1. Project Introduction

Reef Check Australia's (RCA) monitoring program helps to provide an early warning system for changes in the health of surveyed coral habitats. Annual surveys provide long-term data sets that can reveal important patterns over time. Quantitative data is collected in relation to substrate cover, as well as abundance of key invertebrate species, and at some locations, target fish species. RCA also monitors natural and anthropogenic impacts that affect coral habitats. The Great Barrier Reef (GBR) project was first implemented in 2001, and numerous sites have been regularly monitored since.

A summary of the findings for surveys conducted around Townsville in the central region of the Great Barrier Reef during the 2019-2020 financial year are presented in this report. Teams of trained volunteers monitored a total of 22 sites across 11 different reefs. These sites included both new and existing survey sites ranging from Inshore reefs of Magnetic Island and the Palm Island Group to the offshore reefs of John Brewer & Lodestone Reef.

For a full summary of methods and findings for the entire GBR region over the same period see the Reef Check Australia Great Barrier Reef Season Summary Report 2019-2020 (Link). This includes data collection methods.

# 2. Monitoring Sites

Reef Check Australia monitoring sites around Townsville in the central region of the Great Barrier Reef for the reporting period range from Palm Island and Magnetic Island to offshore Townsville. (Figure 1 and Table 1). RCA collects data in varied reef habitats, both within protected and non-protected marine park areas for contrast and comparison. Overall across the GBR during the 2019-20 financial year RCA completed 70 surveys at 48 sites, 46 at existing reef sites and 2 new sites. In the Townsville region RCA completed 35 surveys at 22 sites. Some sites were surveyed twice in this reporting period.

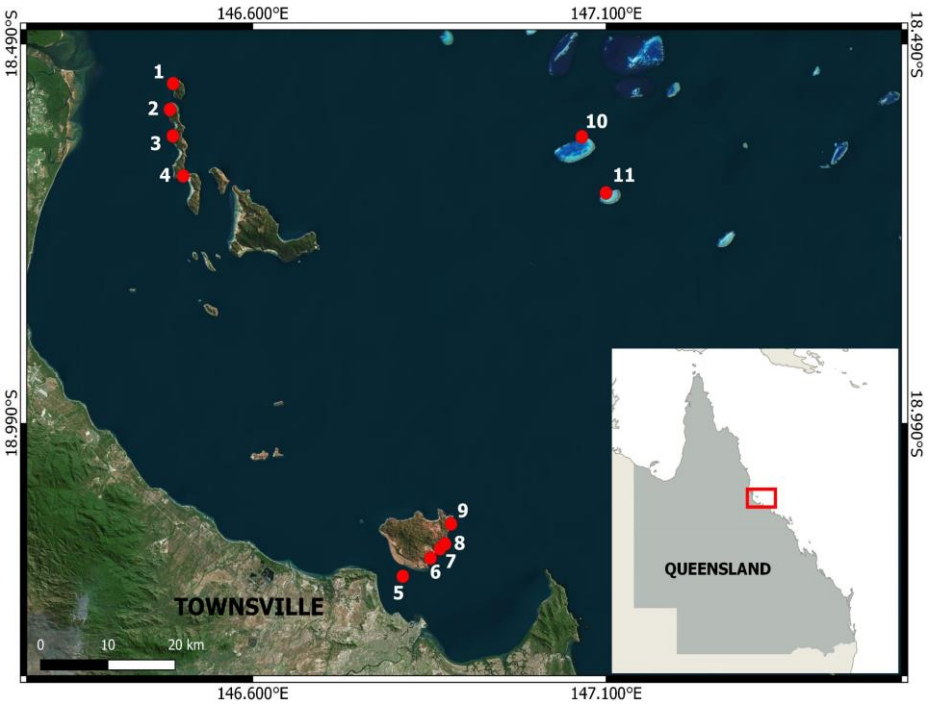



*Figure 1: Map of Townsville and Palm Island region survey sites.*

*Table 1: Site Information as indicated in Figure 1*

| Map ID | Region | Location | Reef | # of Sites | # of Surveys |
|---|---|---|---|---|---|
| 1 | Palm Island Reefs | Fantome Island | Juno Bay | 2 | 4 |
| 2 | Palm Island Reefs | Orpheus Island | Cattle Bay | 2 | 4 |
| 3 | Palm Island Reefs | Orpheus Island | Pioneer Bay | 2 | 4 |
| 4 | Palm Island Reefs | Pelorus Island | Pelorus Island | 2 | 4 |
| 5 | Townsville | John Brewer Reef | John Brewer Reef | 2 | 3 |
| 6 | Townsville | Lodestone Reef | Lodestone Reef | 2 | 4 |
| 7 | Townsville | Magnetic Island Reefs | Magnetic Island - Alma Bay | 2 | 2 |
| 8 | Townsville | Magnetic Island Reefs | Magnetic Island - Geoffrey Bay | 2 | 2 |
| 9 | Townsville | Magnetic Island Reefs | Magnetic Island - Nelly Bay | 2 | 4 |
| 10 | Townsville | Magnetic Island Reefs | Magnetic Island - Florence Bay | 2 | 2 |
| 11 | Townsville | Magnetic Island Reefs | Middle Reef | 2 | 2 |
| | **TOTAL** | **6 Locations** | **11 Reefs** | **22** | **35** |

# 3. Summary of Findings

## 3.1. Coral Cover

In the Townsville Region, from the 35 surveys completed across 22 sites, live coral cover (LCC) was recorded at an average of 38.1% across all sites, times and locations. This consisted of 31.6% hard coral and 6.5% soft coral (Table 2). LCC varied from a maximum of 65% at John Brewer Reef, offshore from Townsville, and 58.4% on the fringing reefs of Magnetic Island at Geoffrey Bay to a minimum observation of 17.2% at Lodestone Reef, Offshore Townsville and 18.4% at Nelly Bay on Magnetic Island.

Maximum hard coral cover was recorded at John Brewer Reef (58.8%, n=3) while the lowest recording of hard coral cover was at nearby Lodestone Reef (12.5%, n=4) demonstrating the effects of recent COTS outbreaks. Soft coral cover was prominent at two sites in the Palm Island Group; Pelorus Island (25.8%) & Orpheus Island, Cattle Bay (21.9%).

*Figure 2: Plate corals proliferate on reef flats on offshore reefs across the GBR (left) while minor bleaching affects branching corals on the reef slope at John Brewer Reef (right)*

## 3.2. Invertebrate Abundance

Invertebrate surveys were conducted across all sites, 35 surveys in total (Table 2). Giant clams were the most abundant indicator invertebrate recorded with a total of 7333 individuals recorded on 23 (or 66%) of surveys with a mean abundance of 166 individuals. 7314 individual clams were recorded in the Palm Island Group which was surveyed twice in the reporting period. Other indicator invertebrates such as sea cucumbers and long spined sea urchins (*Echinothrix* spp and *Diadema* spp.) were less commonly observed (Table 2).

Across 35 surveys a total of 8 crown of thorn sea stars (COTs) were observed at 1 of the 11 reefs surveyed (John Brewer Reef). For more information about COT outbreaks visit https://www.aims.gov.au/docs/research/biodiversity-ecology/threats/cots.html

*Table 2: Site summary – Mean benthos/substrate, invertebrates, and impacts indicators across all 11 locations at 22 sites in the Townsville region.*

| | | | Substrate (Mean) | | | | Invertebrates (Mean) | | | | | | | Impacts (Mean) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location =11 | Sites = 22 | Hard Coral Coverage (%) | Soft Coral Coverage (%) | Algae (%) | Silt (%) | Edible Sea Cucumbers (#) | Giant Clam (#) | Triton (#) | Trochus (#) | Drupella Snail (#) | Anemone (#) | Banded Coral Shrimp (#) | Drupella Scar | Unknown Scar # | COTS Scar # | Coral Damage # | Coral Disease # | Coral Bleaching % Population | Coral Bleaching % Colony | Marine Debris # |
| 1 | Fantome Island (Juno Bay) | 2 | 33.4 | 0.0 | 0.5 | 0.5 | 0 | 954 | 0 | 0 | 1 | 0.8 | 0 | 0.8 | 0.8 | 0.0 | 2.8 | 0.8 | 2.8 | 25.4 | 0.0 |
| 2 | Orpheus Island (Cattle Bay) | 2 | 33.1 | 21.9 | 0.6 | 0.0 | 0 | 266 | 0 | 0 | 6 | 1 | 0 | 3.5 | 0.0 | 0.0 | 2.5 | 0.3 | 5.9 | 62.6 | 0.0 |
| 3 | Orpheus Island (Pioneer Bay) | 2 | 30.8 | 10.8 | 0.9 | 0.0 | 0 | 590 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0.3 | 0.0 | 0.8 | 0.0 | 14.0 | 44.7 | 0.0 |
| 4 | Pelorus Island | 2 | 17.5 | 25.8 | 0.5 | 0.0 | 0 | 18 | 0 | 0 | 0 | 1 | 0 | 0.5 | 0.5 | 0.0 | 8.8 | 0.0 | 11.1 | 62.0 | 0.8 |
| 5 | John Brewer Reef | 2 | 58.8 | 6.3 | 10.2 | 0.0 | 5 | 2 | 0 | 0 | 5 | 3 | 0 | 3.0 | 9.7 | 4.3 | 11.7 | 2.7 | 14.1 | 37.6 | 2.0 |
| 6 | Lodestone Reef | 2 | 12.5 | 4.7 | 13.0 | 0.0 | 1 | 3 | 0 | 0 | 6 | 5 | 0 | 3.3 | 1.3 | 0.0 | 1.8 | 0.5 | 25.4 | 47.0 | 0.0 |
| 7 | Magnetic Island - Alma Bay | 2 | 29.4 | 1.9 | 34.7 | 0.3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0.0 | 6.5 | 0.0 | 3.0 | 0.5 | 0.5 | 2.6 | 0.0 |

| | | | Substrate (Mean) | | | | Invertebrates (Mean) | | | | | | | Impacts (Mean) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location =11 | Sites = 22 | Hard Coral Coverage (%) | Soft Coral Coverage (%) | Algae (%) | Silt (%) | Edible Sea Cucumbers (#) | Giant Clam (#) | Triton (#) | Trochus (#) | Drupella Snail (#) | Anemone (#) | Banded Coral Shrimp (#) | Drupella Scar | Unknown Scar # | COTS Scar # | Coral Damage # | Coral Disease # | Coral Bleaching % Population | Coral Bleaching % Colony | Marine Debris # |
| 8 | Magnetic Island - Geoffrey Bay | 2 | 58.4 | 0.0 | 40.6 | 0.3 | 0 | 1 | 0 | 0 | 24 | 0 | 0 | 0.0 | 0.0 | 0.0 | 13.0 | 3.0 | 0.9 | 29.6 | 0.0 |
| 9 | Magnetic Island - Nelly Bay | 2 | 18.3 | 0.2 | 66.3 | 0.3 | 0 | 0 | 0 | 1 | 26 | 0 | 0 | 9.8 | 5.8 | 0.0 | 4.8 | 5.3 | 0.9 | 9.0 | 0.5 |
| 10 | Magnetic Island - Florence Bay | 2 | 20.9 | 0.6 | 35.3 | 0.6 | 0 | 0 | 0 | 0 | 4 | 0 | 2 | 2.0 | 0.0 | 0.0 | 1.5 | 0.0 | 11.4 | 74.5 | 0.0 |
| 11 | Magnetic Island - Middle Reef | 2 | 34.4 | 0.0 | 41.6 | 12.8 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0.0 | 0.0 | 0.0 | 9.5 | 0.0 | 4.0 | 71.3 | 1.0 |
| | **Mean** | | 31.6 | 6.5 | 22.2 | 1.4 | 0.5 | 166 | 0 | 0.1 | 6.8 | 0.2 | 0.1 | 2.1 | 2.2 | 0.4 | 5.4 | 1.0 | 8.3 | 42.4 | 0.4 |

## 3.3. Reef Health Impacts

Impact surveys were performed at all sites surveyed (Tables 2 and 3 and Figure 3). Coral bleaching was observed during 34 out of 35 surveys (97%) (Table 3). However, population level bleaching was not substantial across surveyed sites, with an average of 8.3% of the population affected.

Coral disease was recorded during 10 of the 35 surveys completed (28.57%) (Table 3), with an average abundance of 1.03 incidences per 400m² survey area. Many sightings appeared to be white syndrome and to a lesser extent black band disease.

*Drupella* spp. (coral-eating snails) were recorded on 21 out of 35 surveys (60%), but in fairly low abundance (average of 6.8 per 400m$^2$ on all transects). Drupella scarring was recorded on 17 of 35 surveys (49%) with an average abundance of 2.46 per 400m$^2$.

Coral scarring from unknown causes was commonly recorded on impact surveys (13 of 35 surveys or 37%) which ranged from just one scar to as many as 10 per 400m$^2$. The majority of surveys reported hard coral damage (28 of 35 or 80%). The number of recorded incidents per site varied from only one, to as many as 16 per 400m$^2$. Rubbish was not commonly reported on surveys. Marine debris was reported on 6 of 35 surveys (17%) with low incidences between 1-2 items observed.

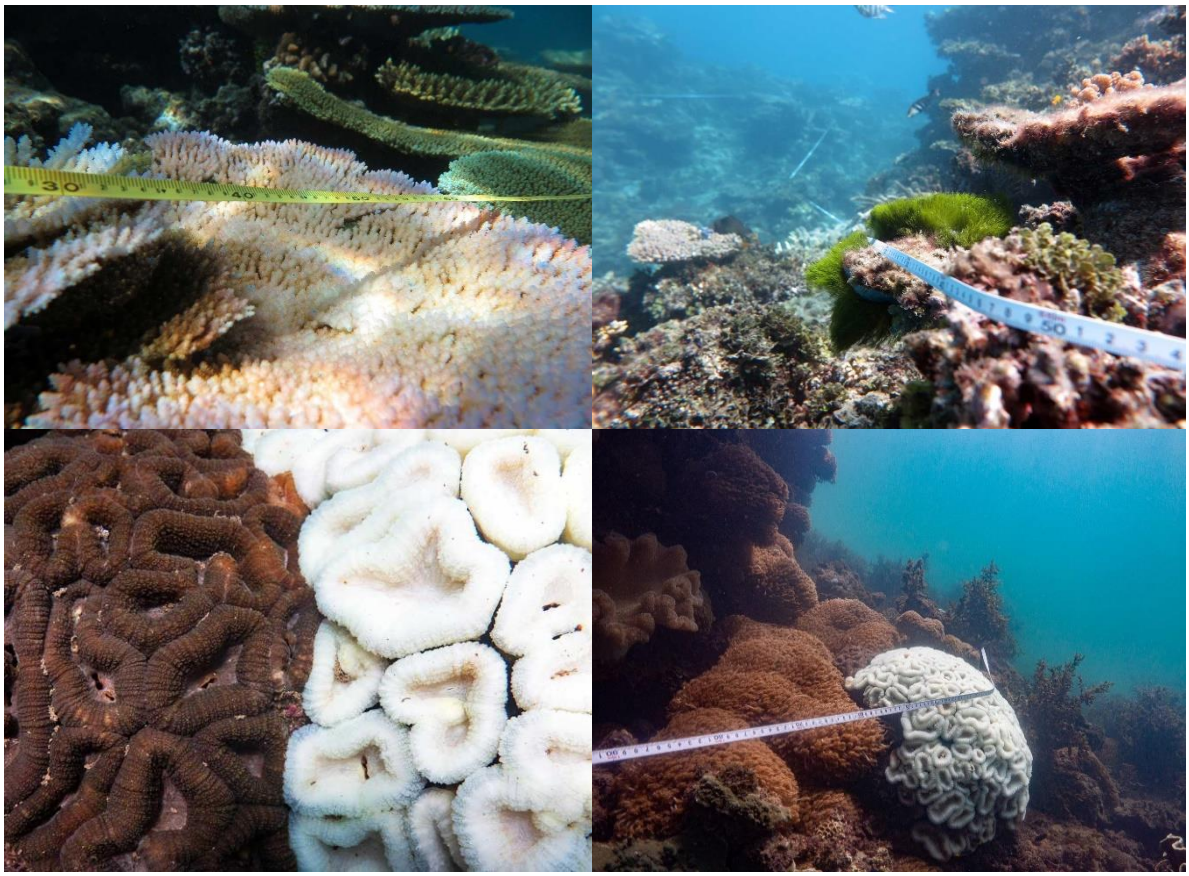


*Figure 3: Examples of impacts across Reef Check survey sites illustrating bleaching at John Brewer Reef (top left), coral damage from COTS at Lodestone Reef (top right), variable bleaching at Florence Bay, Magnetic Island (bottom left and right).*

*Table 3: The percent of RCA survey sites in the Townsville region with recorded impacts (of a total of 22 sites), and the average abundance of impacts recorded from 2019-2020*

| Impacts | % of sites with impact | Average abundance (per400m$^2$) |
|---|---|---|
| **Coral Bleaching** | 97.14 | 9.04 |
| **Coral Damage** | 80 | 4.97 |
| **Coral Disease** | 28.57 | 1.03 |
| ***Drupella* Scars** | 48.57 | 2.46 |
| **Marine Debris** | 17.14 | 0.37 |
| **CoTS Scars** | 5.71 | 0.37 |
| **CoTS** | 10 | 0.4 |
| **Unknown scars** | 37.14 | 2.17 |

# 4. Townsville Region

As North Queensland's largest regional city, Townsville has a unique connection with the reef. The city hosts the Australian Institute of Marine Science and James Cook University as well as the headquarters for the Great Barrier Reef Marine Park Authority. The Aboriginal Traditional Owners, the Wulgurukaba people, the 'canoe people', have strong connections with Magnetic Island (Yunbenun) and its surroundings representing significant cultural heritage.

Although reef tourists are not as numerous as the Cairns and Whitsunday regions, visitors are drawn to the accessible fringing reefs of Magnetic Island only 8km away, the Palm Island Group reefs including Orpheus, Pelorus and Fantome islands and the spectacular outer reefs including Lodestone and John Brewer. Surveys were initially established in 2005 at Magnetic Island and the Palm Island Group (Figure 4) and in 2017, partnerships with local tourism operators allowed the commencement of surveys on the outer reefs. During the 2019 -20 season, surveyors completed surveys on a total of 22 sites across 11 reefs.

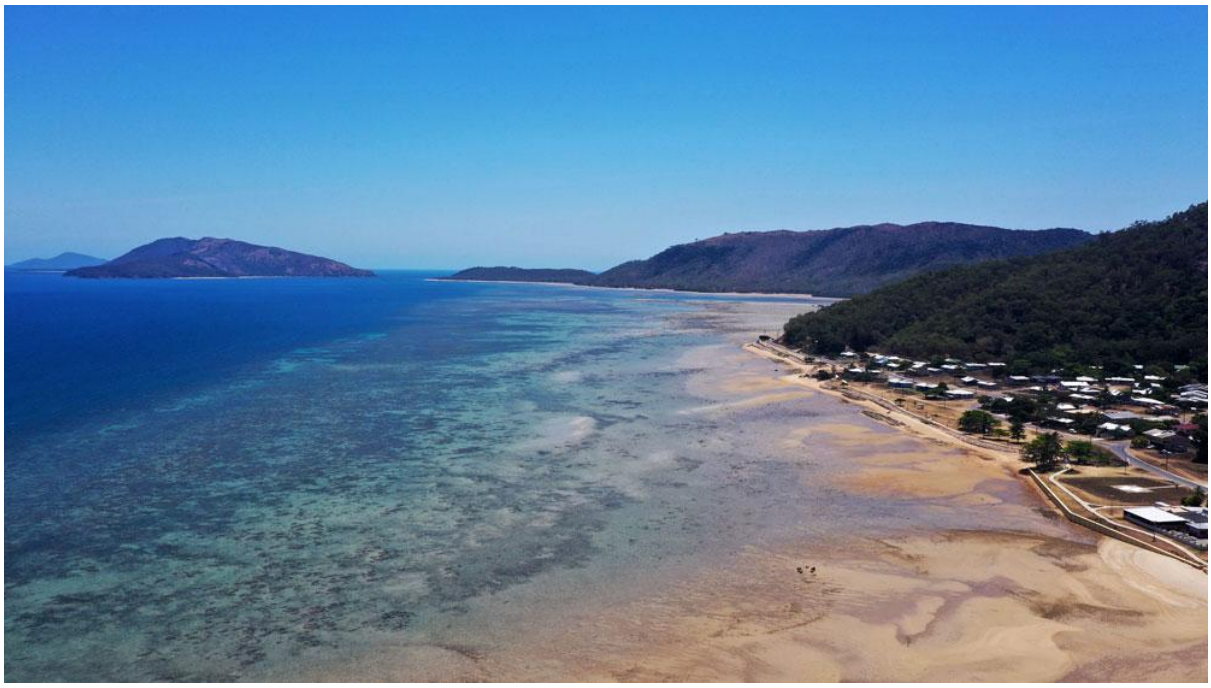


*Figure 4: Palm Island and town near multiple survey sites in the Palm Island Group.*

## 4.1. Palm Island Reefs - Cattle Bay

**Site Description**

Orpheus (Goolboddi) Island is situated 110km north of Townsville and is approximately 25km off Ingham. The Traditional Owners of Orpheus Island are the Manbarra people. Orpheus island is approximately 12km long, consisting of sandy beaches and rocky headlands (Queensland Government 2020). The James Cook University Research Station is located on the island; however camping is also permitted for visitors at particular sites, and luxury accommodation is also available.

There are two RCA survey sites located at Cattle Bay, which is situated on the north-west side of the island. The two transect lines are concurrent, both lying on the edge of the fringing reef at a 2m depth (Figure 5). Cattle Bay lies within a Marine National Park Zone (green zone), where activities are restricted. Boating, diving and photography, and traditional use of marine resources are allowed, and a permit is required for activities including shipping, tourism and research.

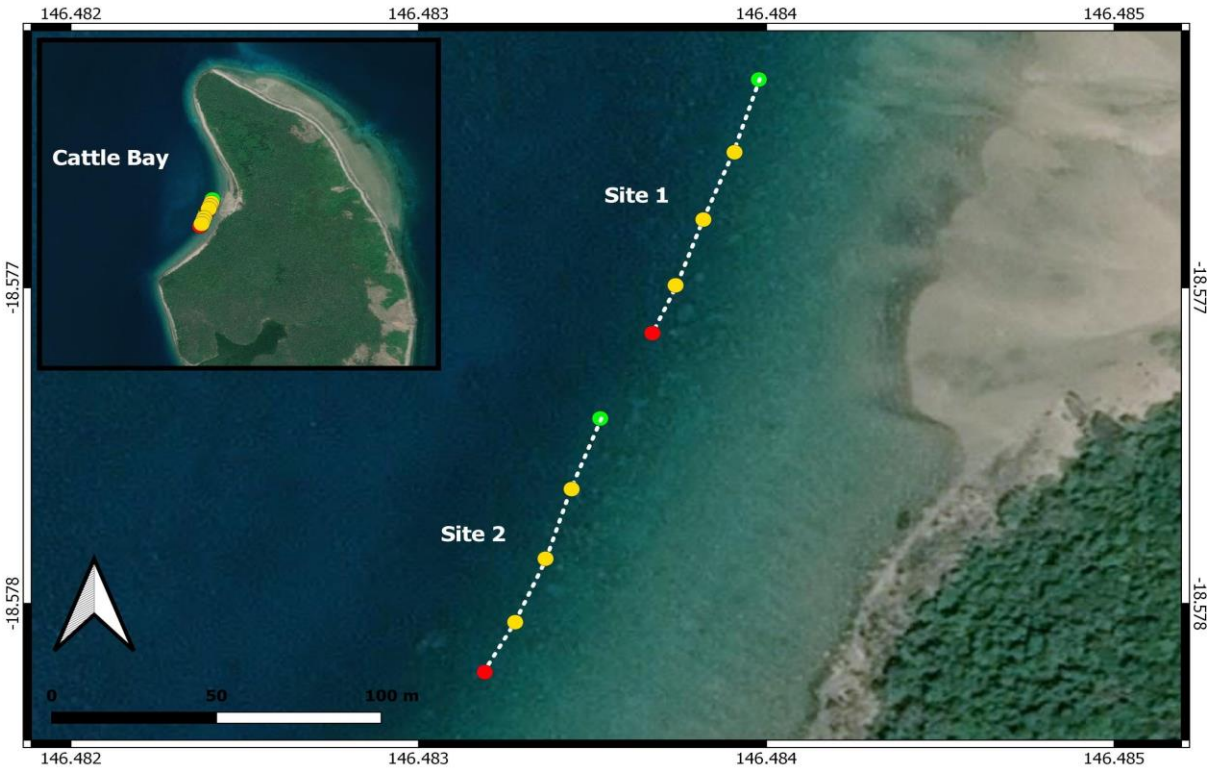



*Figure 5: Map showing survey sites 1 and 2 in Cattle Bay, Orpheus Island.*

**Substrate Survey**

Live coral cover (LCC) from 2020 surveys at Cattle Bay was 53.75%, consisting primarily of hard corals (28.44%), followed by soft corals (23.75%) with a lower incidence of bleached coral (1.57%) (Figure 6). Considering overall substrate cover, LCC was the largest contributor, followed by coral rock (29.06%), and then coral rubble (10.63%). There was limited coverage by sand/silt (1.56%), nutrient indicator algae (NIA) (0.63%), recently killed coral (0.63%) and other substrates (3.75%).

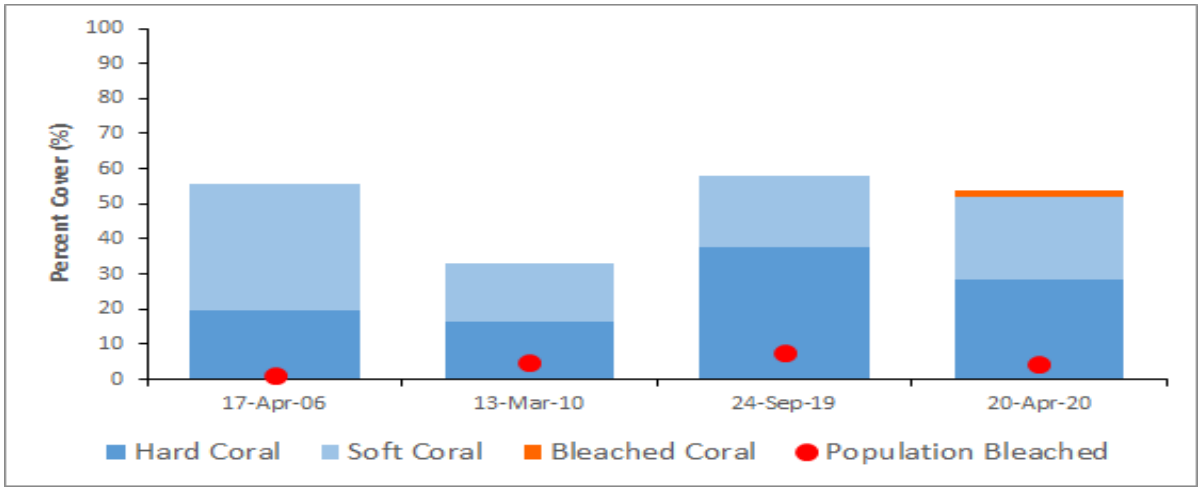



*Figure 6: Long-term percent cover of hard and soft corals and bleached corals by survey year at Cattle Bay, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

Looking at longer term trends, LCC has remained the main contributor to substrate coverage over the 2006, 2010, 2019 and 2020 survey periods (Figure 7). The 2010 data shows a significant increase in substrate coverage by rubble to 28.75% from 0% in 2006, while there is also a decrease in LCC from 2006 (55.62%) to 2010 (33.13%). However, LCC returns to a higher percentage for 2019 (57.81%) and 2020 (53.75%). There is consistently little contribution and fluctuation of recently killed corals and nutrient indicator algae (NIA) over time (Figure 21).

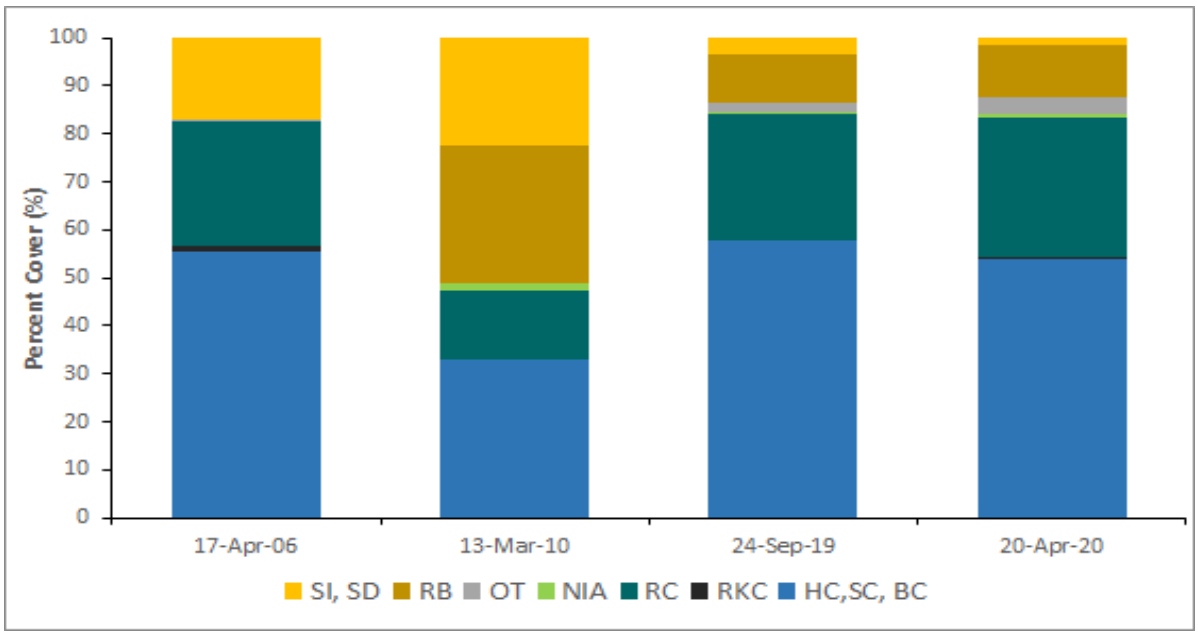



*Figure 7: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Cattle Bay, Palm Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

In 2020, coral rock is the biggest contributor to overall benthic cover (29.06%), followed by hard corals (28.44%), and then soft corals (23.75%) (Figure 7). Of the hard corals, the dominant morphology type was branching corals (17%), followed by massive (9%) and then encrusting (2%).

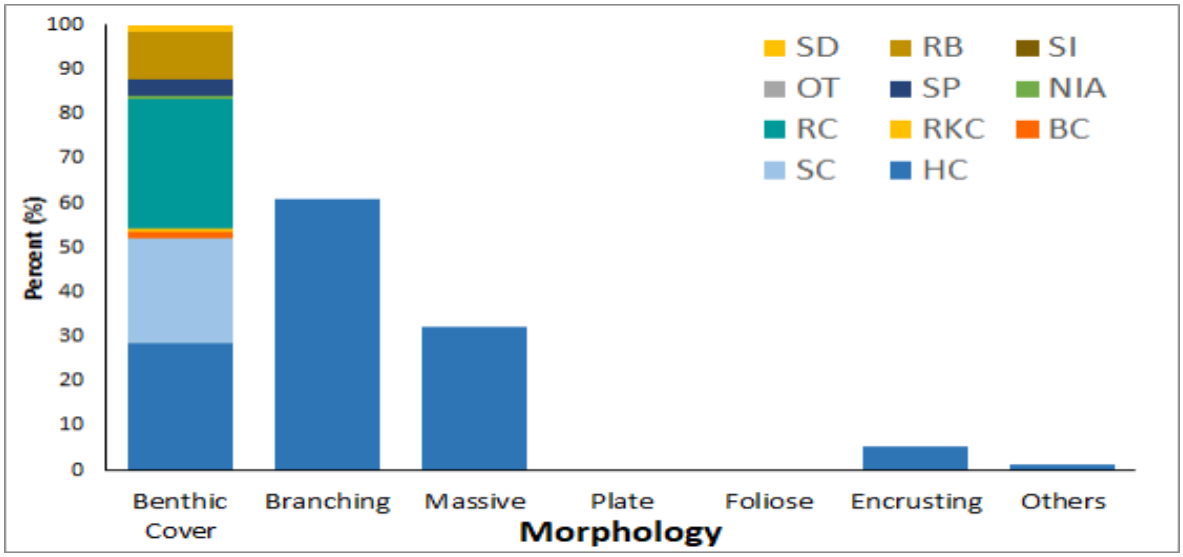



*Figure 8: Percent cover of different benthic categories and dominant hard coral morphologies at Cattle Bay, Palm Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

The key invertebrate observed at Cattle Bay over the 2019/2020 survey period was giant clams, a total of 492 in 2019 and 573 in 2020 (Table 2, Image 9). No other key invertebrates were observed in 2019, however in 2020, 23 drupella snails, three anemones and one trochus, were counted. There was no evidence of COTS or drupella scarring, nor coral disease observed in 2019, and only two cases of coral damage. In 2020, 14 drupella scars were observed as well as eight incidents of coral damage and one of coral disease.

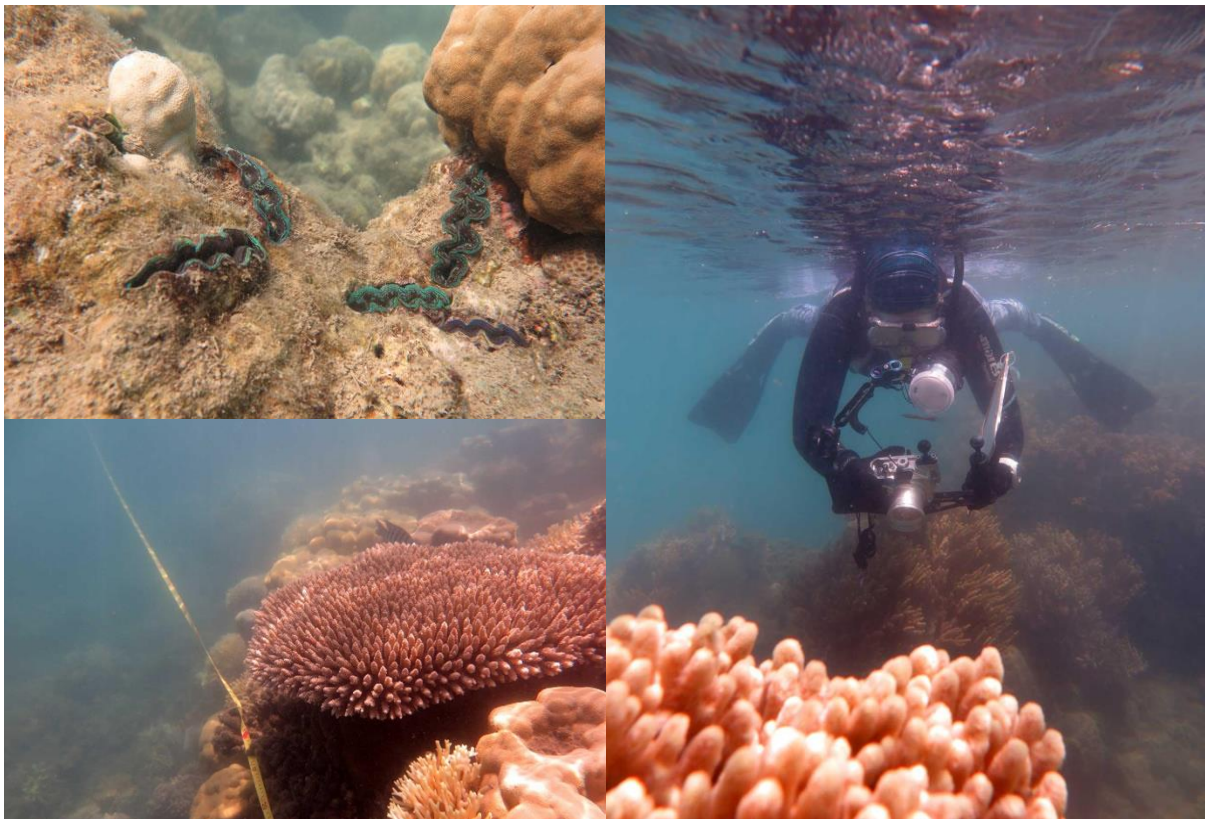


*Figure 9: Giant clams (Tridacna* sp.*) embedded into the reef rock (top left) transect line and reefscape (bottom left) and snorkel surveyor collecting images (right).*

## 4.2. Palm Island Reefs - Pioneer Bay

**Site Description**

Pioneer Bay located on the leeward side of Orpheus Island is generally sheltered from the weather and consists of a mangrove habitat which extends out to a reef flat, reef crest and reef slope. It is home to James Cook University's Orpheus Island Research Station often used as a base for RCA survey activities (Figure 10). RCA has two sites in the shallow reef flat at Pioneer Bay accessible from the popular snorkelling point near the shore.

*Figure 10: James Cook University's (JCU) Orpheus Island Research Station located adjacent to survey location in Pioneer Bay and base for some of RCA's survey activities.*

These sites are in approximately 2-3 metres of water extending on the northern and southern side of the channel to the research station and can be conducted via snorkelling (Figure 11). These two sites were first surveyed in 2006 and in the 2019-2020 survey season, RCA had the opportunity to revisit the area and conduct surveys again.

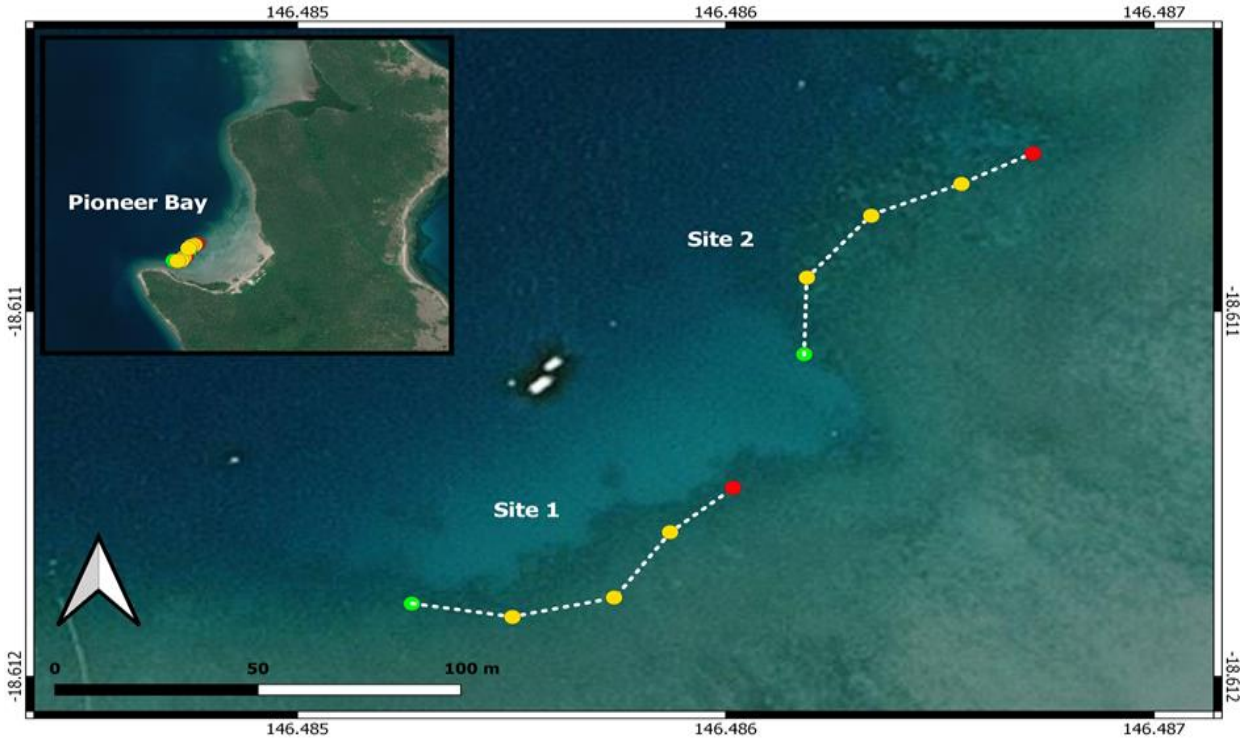



*Figure 11: Map showing survey sites 1 and 2 in Pioneer Bay, Orpheus Island.*

**Substrate Survey**

Live coral cover (LCC) was observed at 39.38% in 2019 and 46.56% in 2020 which is a reduction since 2006 (55.63%). This is mostly made up of an increase in hard coral (19.7% in 2006 to 34.4% in 2020) and a reduction in soft coral (36% in 2006 to just over 10% in 2020) (Figure 12). There also higher incidents of bleaching populations of coral colonies in 2019 (8.9%) and 2020 (19.13%) compared to 2006 (1.4%) which is consistent with reports of some areas experiencing varying levels of a third mass bleaching in the Great Barrier Reef (AIMS, 2020).

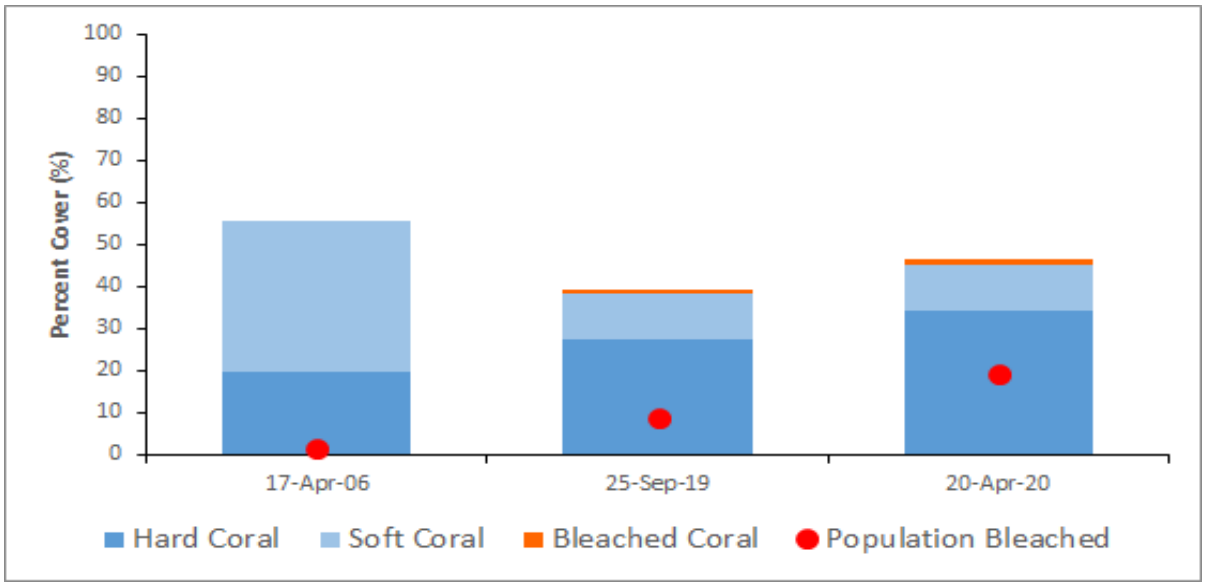



*Figure 12: Long-term percent cover of hard and soft corals and bleached corals by survey year at Pioneer Bay, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

Substrate cover at these sites is consistently dominated by live coral (46.5% in latest survey) and rock (44.4% in latest survey) with some silt, sand, rubble and low levels of nutrient indicator algae (NIA) recorded in 2020 (Figure 13). This site has not been surveyed since 2006, in which live coral cover made up 55% of the substrate.

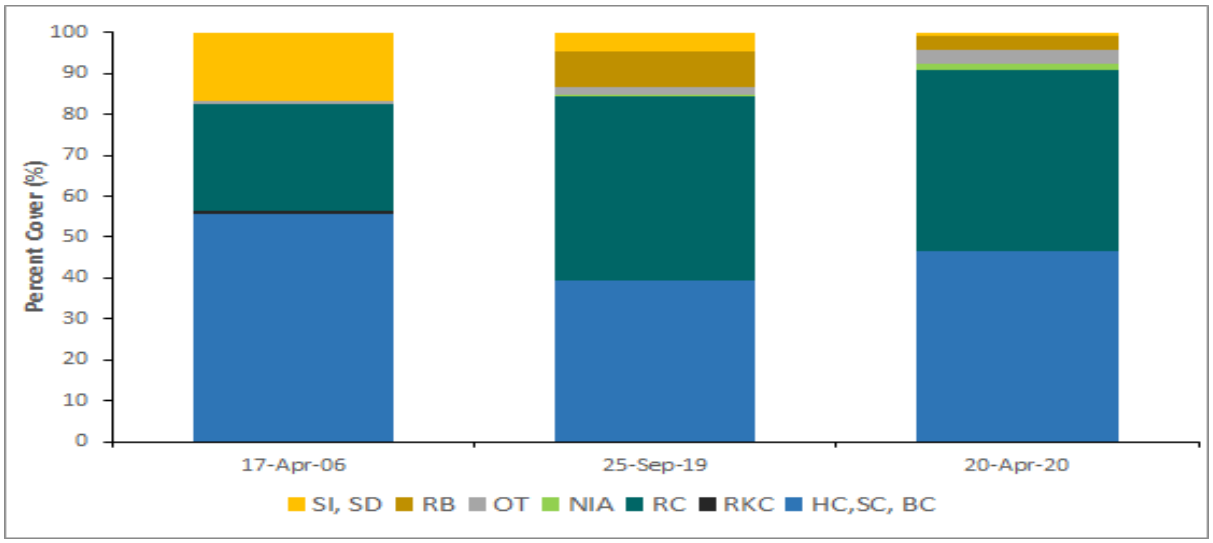



*Figure 13: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Pioneer Bay, Palm Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

Benthos at Pioneer Bay in 2020 was dominated by rock (44%), hard coral (34.37%) and soft coral (10.63%). The most dominant hard coral morphology was massive (72%), followed by branching (24%) with foliose and encrusting observed as well (Figure 14).

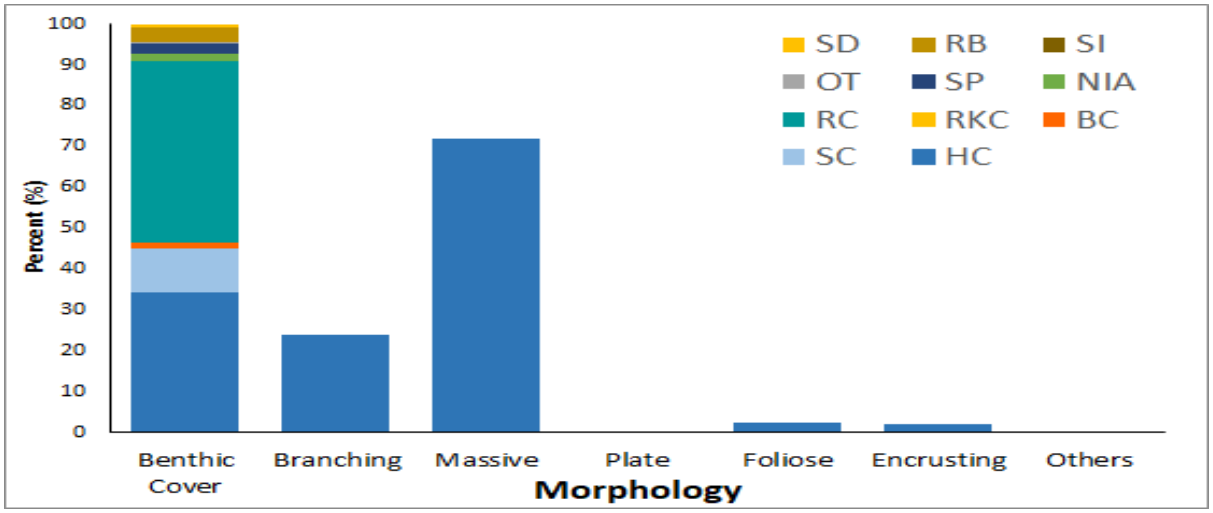



*Figure 14: Percent cover of different benthic categories and dominant hard coral morphologies at Pioneer Bay, Palm Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

Like the Cattle Bay site at Orpheus Island, the Pioneer Bay reef flat sites are dominated by various species of giant clam. Site 1 and Site 2 combined was represented by a total of 836 counts of giant clam in 2019 along both transects and in 2020, there was a total of 1525 counts. Other invertebrates observed were two coral eating drupella snails in 2019 and three in 2020. One anemone was observed along the transect line in 2019 at Site 1. Low levels of impacts were observed; two counts of scarring

from Drupella snail in 2019, one count of unknown scarring, two counts of coral damage in 2019 and one count in 2020.

## 4.3. Palm Island Reefs - Pelorus Island

**Site Description**

Pelorus Island is a small, northernmost island in the Palm Island group and the most easily accessible by boat (Figure 15). It is often frequented by recreational and tourist boat operators who depart from the popular boat ramp in Lucinda. More adventurous travellers can camp on the island without a permit but must carry all equipment, food and water with them. Being located close to shore, visibility is often restricted but on calm days, snorkelers and divers can enjoy the island's beautiful fringing reefs with colourful branching corals and complex reef topography. Due to its popularity, coral damage is often observed in Pelorus Bay.

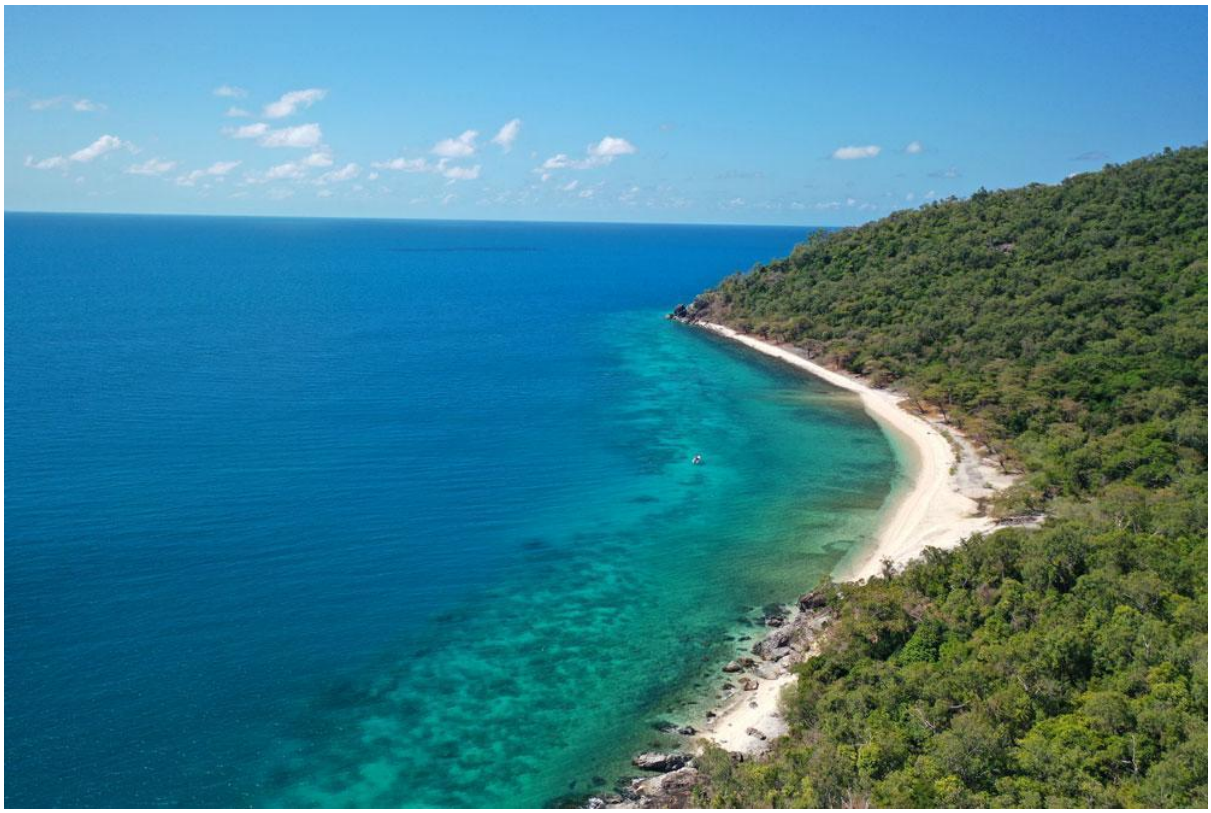


*Figure 15: Overview of Pelorus Island's west coast and location of survey sites.*

Reef Check Australia has surveyed two north-western sites on Pelorus Island five times since 2005. Both sites run north to south, parallel to the beach in the shallow reef flat (Queensland Government 2020a) (Figure 16). The dominant coral species belongs to the genus *Porites*, which tends to be resistant to bleaching, which may explain why coral cover has remained consistently high at the Reef Check sites.

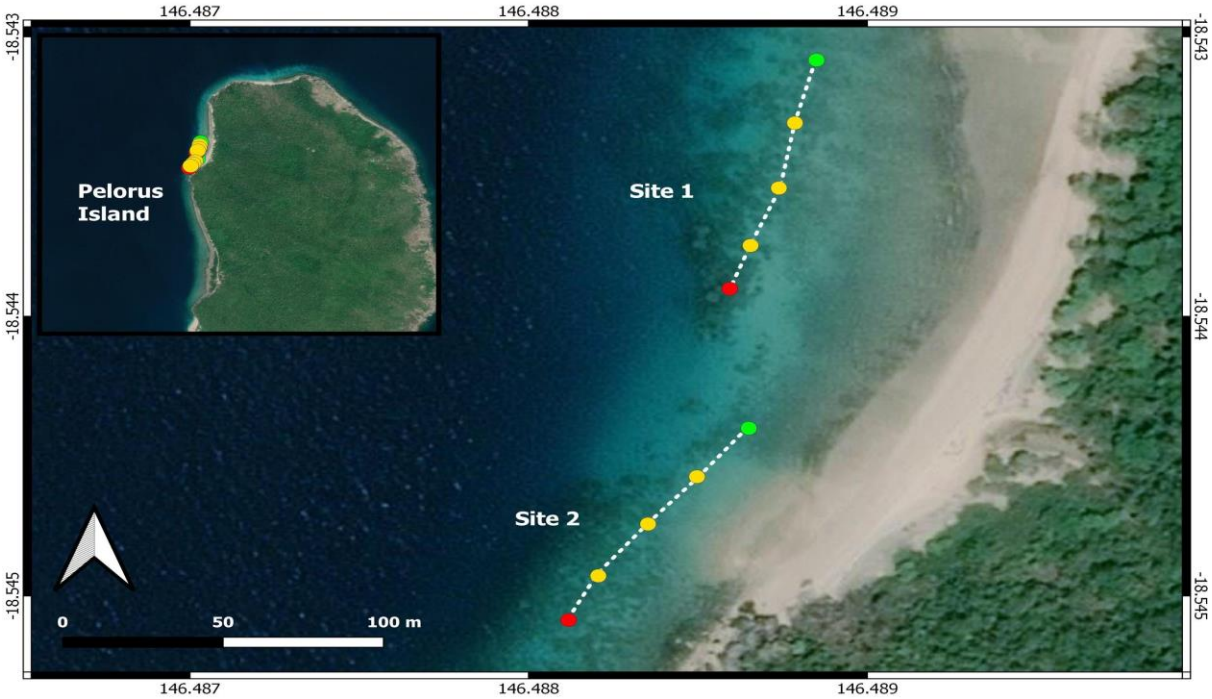



*Figure 16: Map showing survey sites 1 and 2 on Pelorus Island.*

**Substrate Survey**

Long-term coral cover has remained consistently at around 50% since 2005 with the exception of 34% in September 2019 but increased to 54% in 2020. Soft coral cover has exceeded hard coral cover since April 2006 at the survey sites (Figure 17).

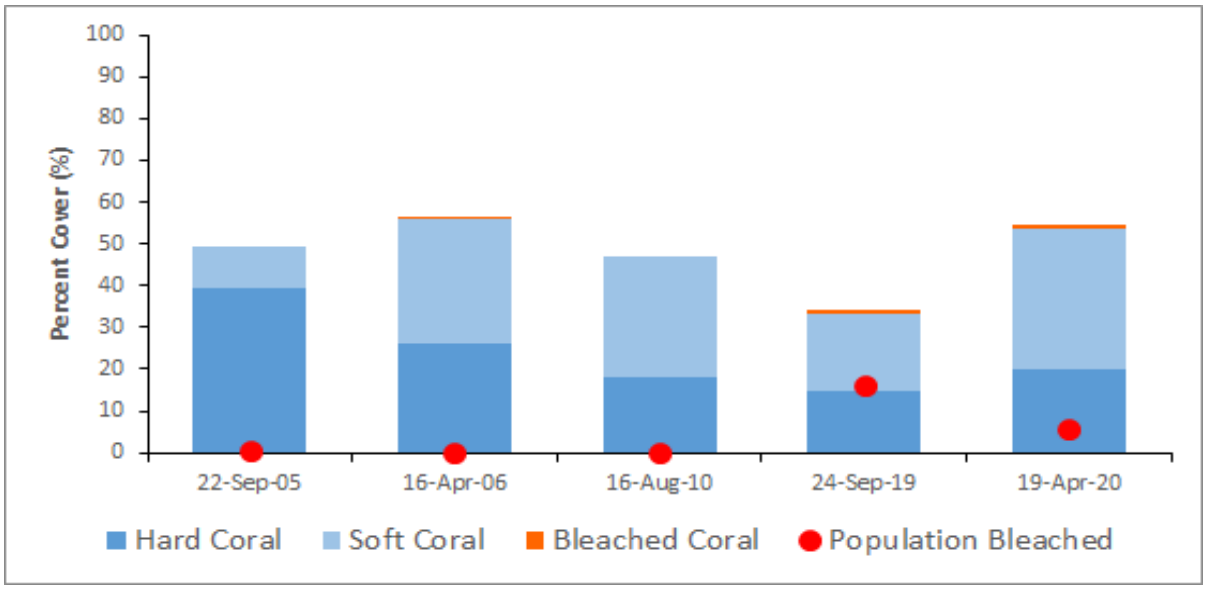



*Figure 17: Long-term percent cover of hard and soft corals and bleached corals by survey year at Pelorus Island, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

Long-term substrate cover has been fairly consistent throughout the five surveys conducted from 2005 to 2020. LCC has consistently been the dominant benthic category at Pelorus followed by rock (RC) (20%-40%), silt (SI)/Sand (SD)(1%-18%) and rubble (RB) (4%-17%). Surprisingly, nutrient indicator algae (NIA) is low (5% in 2005 and 0% in 2020) despite the site's proximity to the coast and agricultural operations (Figure 18).

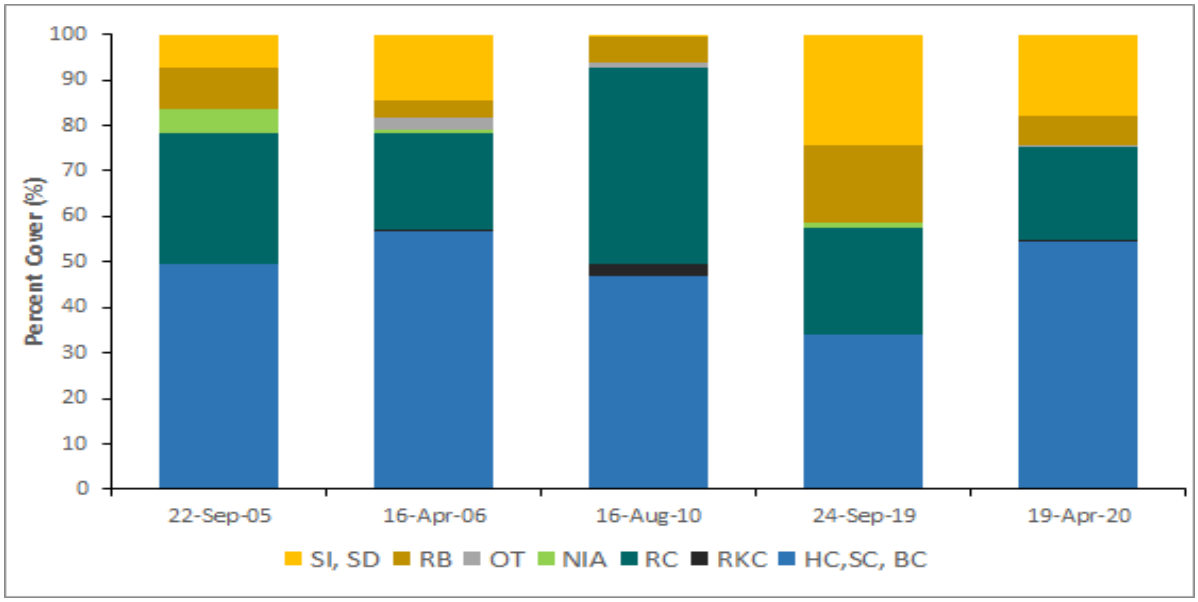



*Figure 18: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Pelorus Island, Palm Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

In April 2020, coral cover was high at 54% compared with 34% in September 2019. Dominant HC morphologies were branching (57.8%) and massive (29.5%) with minor contributions from encrusting (8%) and foliose (2.2%). Soft corals represented 34% of coral cover. Other non-coral substrates present at the sites in 2020 included RC (21%), SI/SD (18%), RB (7%) and less than 1% recently killed coral (RKC) and other (OT) (Figure 19).

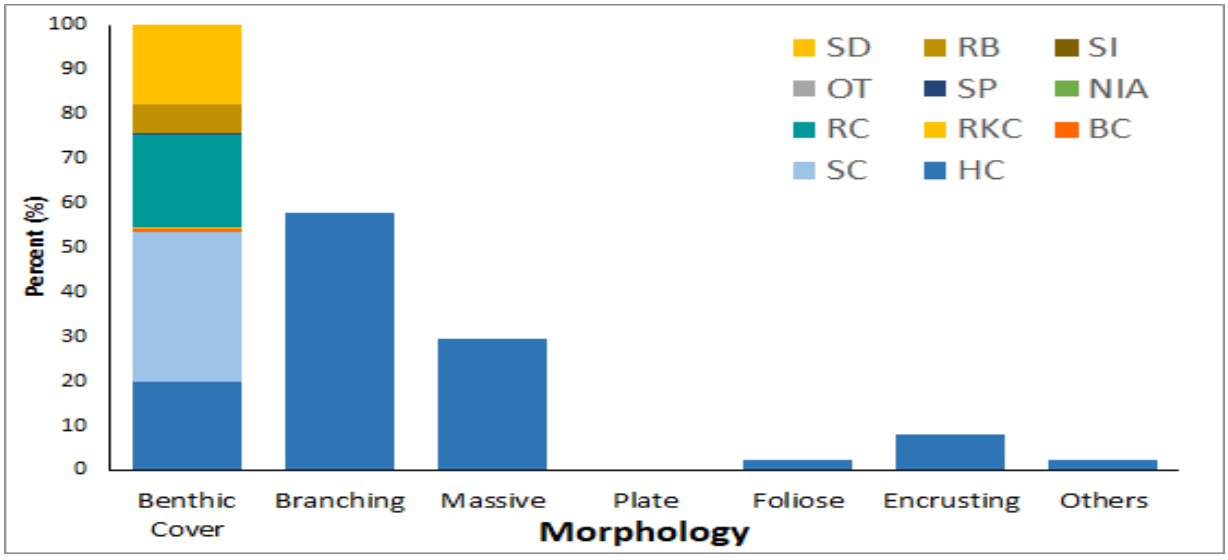
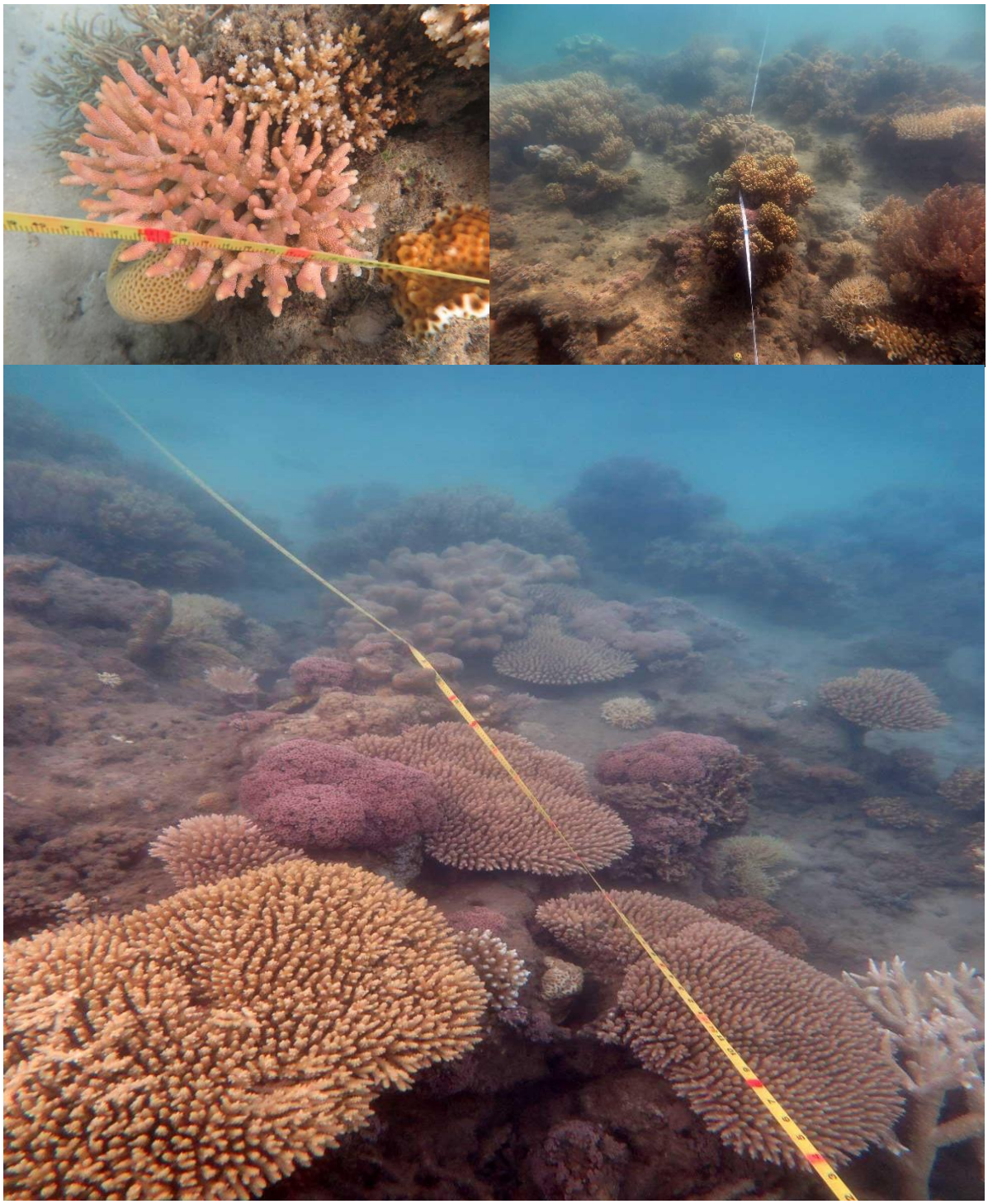



*Figure 19: Percent cover of different benthic categories and dominant hard coral morphologies at Pelorus Island, Palm Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

The most common invertebrate present in the 2020 surveys of Pelorus Island were giant clams. The number of giant clams observed in 2020 (28) is much lower than the number observed in 2019 (43). Other invertebrates present at the survey sites included anemones (3), and a single Drupella snail. Impacts present at the survey sites included coral damage (20 colonies), some bleaching (6% of coral colonies), marine debris (1), Drupella scars (2) and unknown scars (2). Of the bleached colonies present, an average of 36% of the tissue was bleached.



## 4.4. Palm Island Reefs - Fantome Island

**Site Description**

Fantome Island (Eumili) is located north of Townsville, approximately 22km off the coast of Ingham (QPWS 2020). The Traditional Owners of Fantome Island are the Manbarra people. Fantome Island is a heritage-listed former leper colony, and the former site of the Lock Hospital and Lazaret. The Fantome Island Lock Hospital (1928-45) and Lazaret (1939-73) were used as facilities to treat non-European patients and demonstrate past control and discrimination suffered by Aboriginal, Torres Strait Islander and South Pacific Islander people. Fantome Island is no longer inhabited.

There are two RCA survey sites located at Juno Bay, which is situated on the North-west side of the island. The two transect lines are concurrent, both lying on the edge of the fringing reef at a 2m depth (Figure 20). Juno Bay lies within a habitat protection zone (blue) where recreational fishing is permitted (with restrictions). Trawling is not permitted, and a permit is required for activities including research, tourism, and harvest fishing.

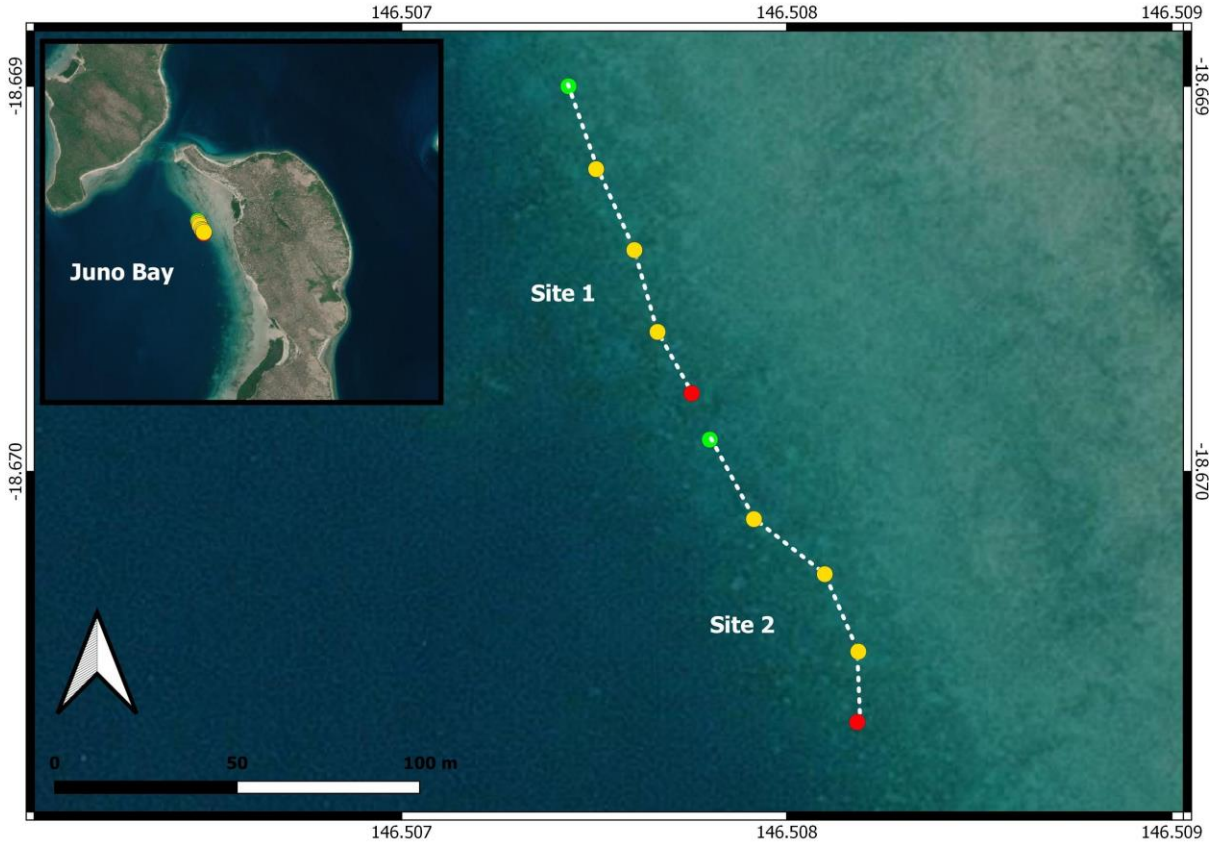



*Figure 20. Map showing survey sites 1 and 2 in Fantome Island.*

**Substrate Survey**

Cumulative live coral cover (LCC) following the most recent 2020 surveys was 37.81% at Juno Bay. No soft corals were observed, with coral cover primarily consisting of hard corals (36.56%) and minimal bleached corals (1.25%) (Figure 21). Overall, substrate cover was dominated by LCC, followed by coral rock (34.38%) and silt/sand (22.19%) (Figure 21).

***Long-term Substrate Trend***

Considering longer term trends, there is an observable increase in LCC from 18.75% in 2006 to 37.81% in 2020. In contrast, sand/silt cover has decreased from 2006 to 2020 (from 48.44% to 22.19%) (Figure 37). Dominant substrate cover has remained consistent from 2005-2020, with live coral, coral rock and silt/sand being the three main contributors over this period. However, the contribution of coral rubble was significantly higher in 2005 (11.56%) compared to the following years (Figure 37). There is limited contribution to substrate cover from nutrient indicator algae (NIA), recently killed corals, and other life-forms, as well as little fluctuation in percentage cover of these substrate types, across the 2005-2020 period (Figure 22).

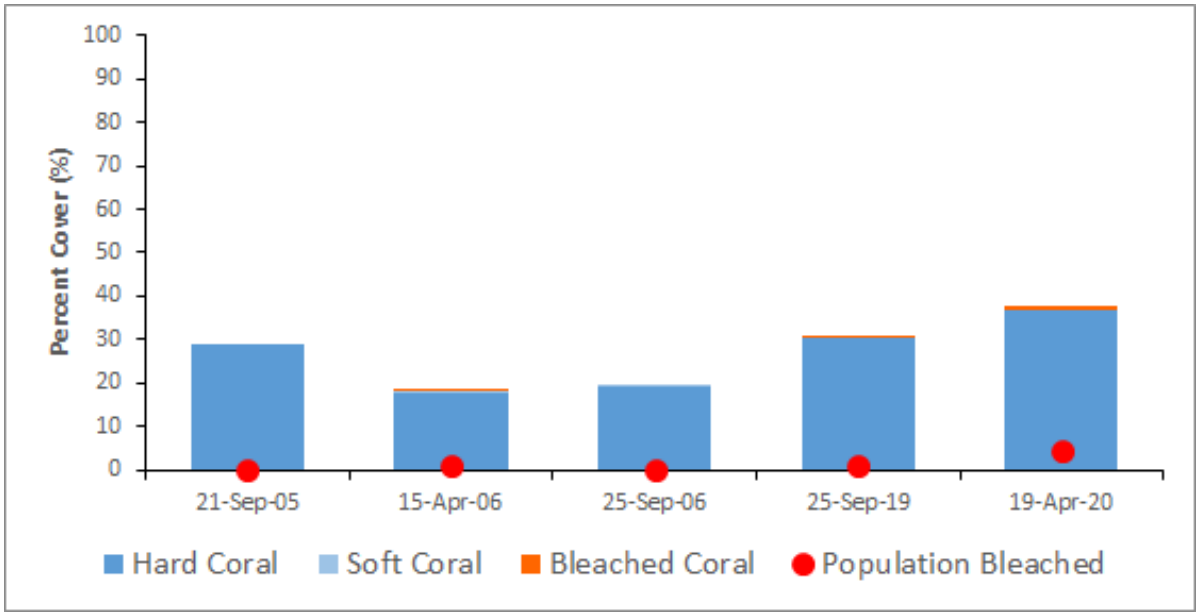



*Figure 21. Long-term percent cover of hard and soft corals and bleached corals by survey year at Fantome Island, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

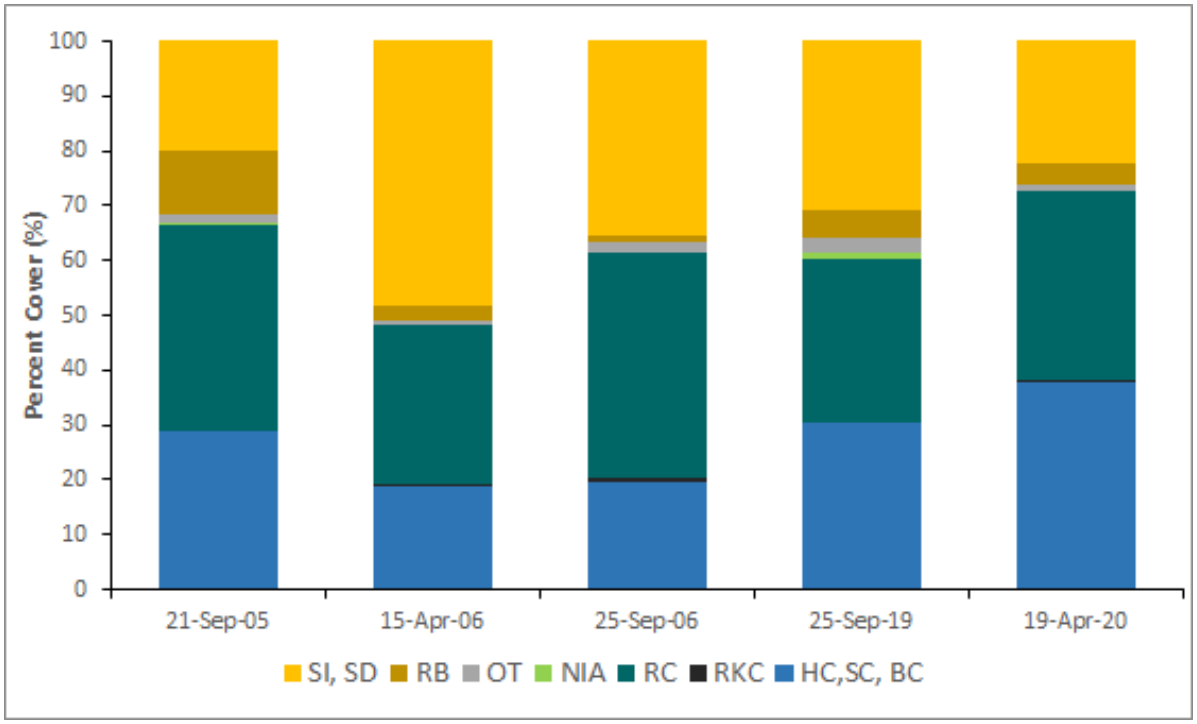



*Figure 22. Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Fantome Island, Palm Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

Overall benthic cover is dominated by hard corals (36.56%) (Figure 38). The dominant morphology of these hard corals is massive (79.49%), followed by branching (12.82%), with foliose and encrusting observed as well (Figure 23.).

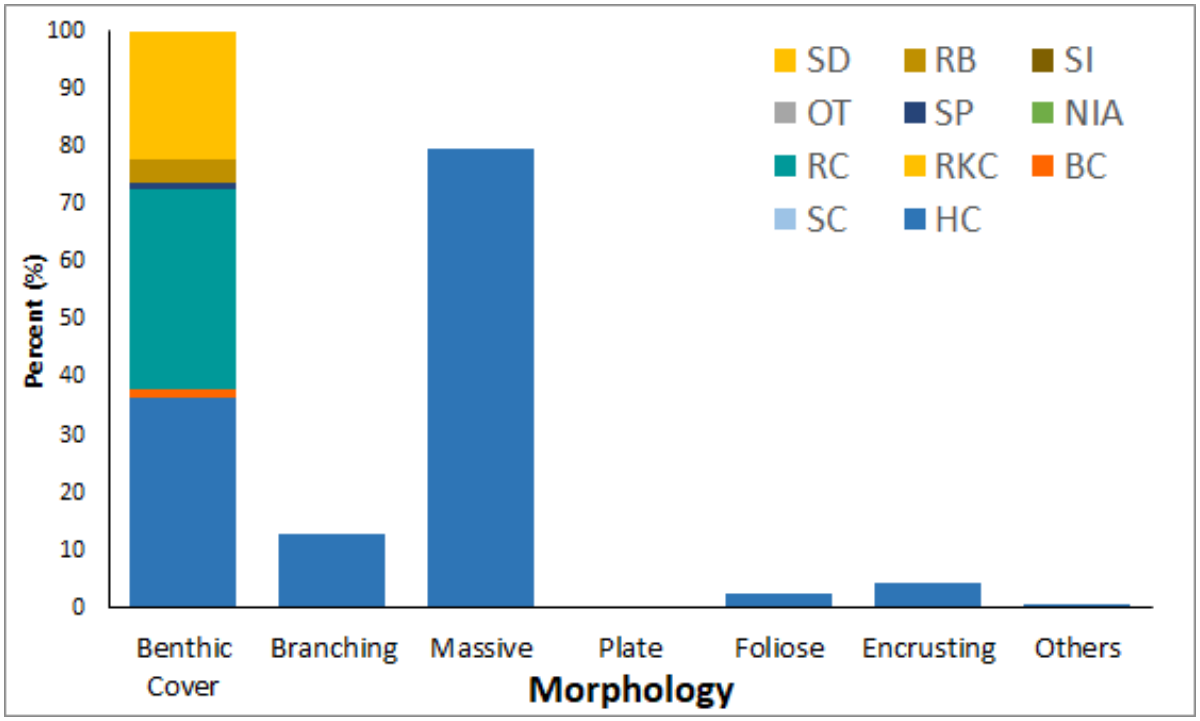



*Figure 23. Percent cover of different benthic categories and dominant hard coral morphologies at Fantome Island, Palm Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

Over the 2019 survey period, 1187 giant clams were observed at Juno Bay, increasing to 2630 in 2020. In 2019, no other key invertebrates were observed, however a loss of anemones was recorded. In 2020, other key invertebrates observed were drupella snails (2) and one anemone (Table 2). Bleaching incidence in 2019 was 1.125%, increasing to 4.5% in 2020. Other than bleaching, coral damage was observed on six occasions in 2019 and five in 2020 (Table 3). Three incidences of drupella scarring were observed in 2019, and three scars from an unknown source in 2020, no COTS scars were observed. Coral disease was only observed on one occasion in 2020, and four previously diseased corals recovered in 2019 (Figure 24).

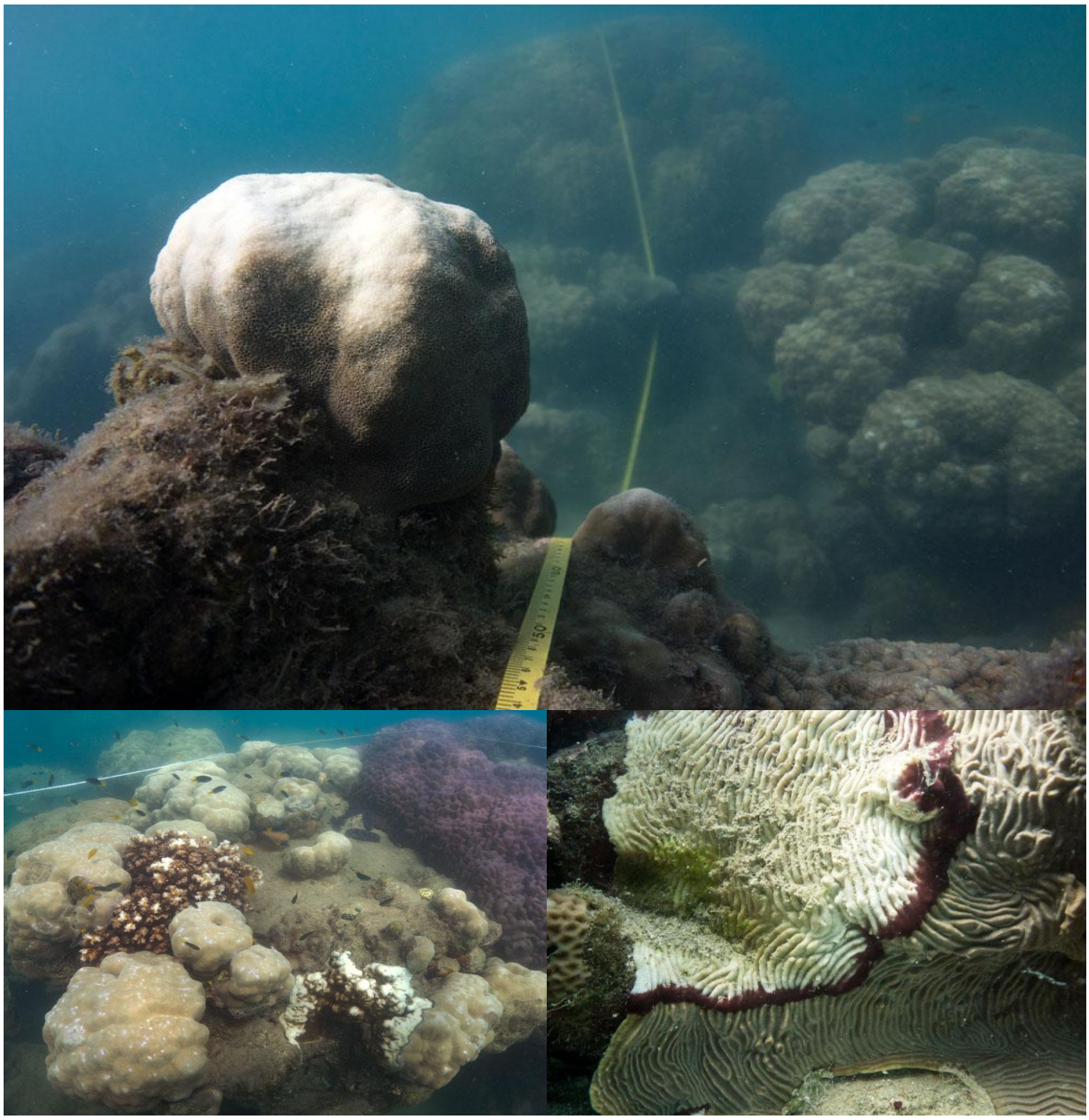


*Figure 24: Transect and large Porities* sp. *bommies (top), coral damage of bushy colonies (bottom left) and black band disease (bottom right).*

## 4.5. Magnetic Island - Nelly Bay

**Site Description**

Nelly Bay is located on the south-east side of Magnetic Island. The bay is approximately 2.4km long, spanning from the Magnetic Island Ferry Terminal in the north to Hawkings Point in the south. Magnetic Island or *Yunbenun* has significant cultural and spiritual importance to the Aboriginal Traditional Owners, the Wulgurukaba people. The town of Nelly Bay has a population of 1,196 and a highly used marina, several shops, a school and residences (Australian Bureau of Statistics 2020). Nelly Bay is in a habitat protection zone, which allows fishing, however trawling is not permitted.

There are two back-to-back RCA survey sites located approximately 100m offshore, adjacent to the popular Base Backpackers (Figure 25). Site 1 is 4m deep and Site 2 rises from a depth of 4m to finish around 2m. Both sites can be very shallow on a low tide. Recent surveys have shown the sites to be algal dominated by both nutrient indicator algae and sargassum macroalgae. The sites have been surveyed 17 times since 2003, with the most recent survey conducted in June 2020.

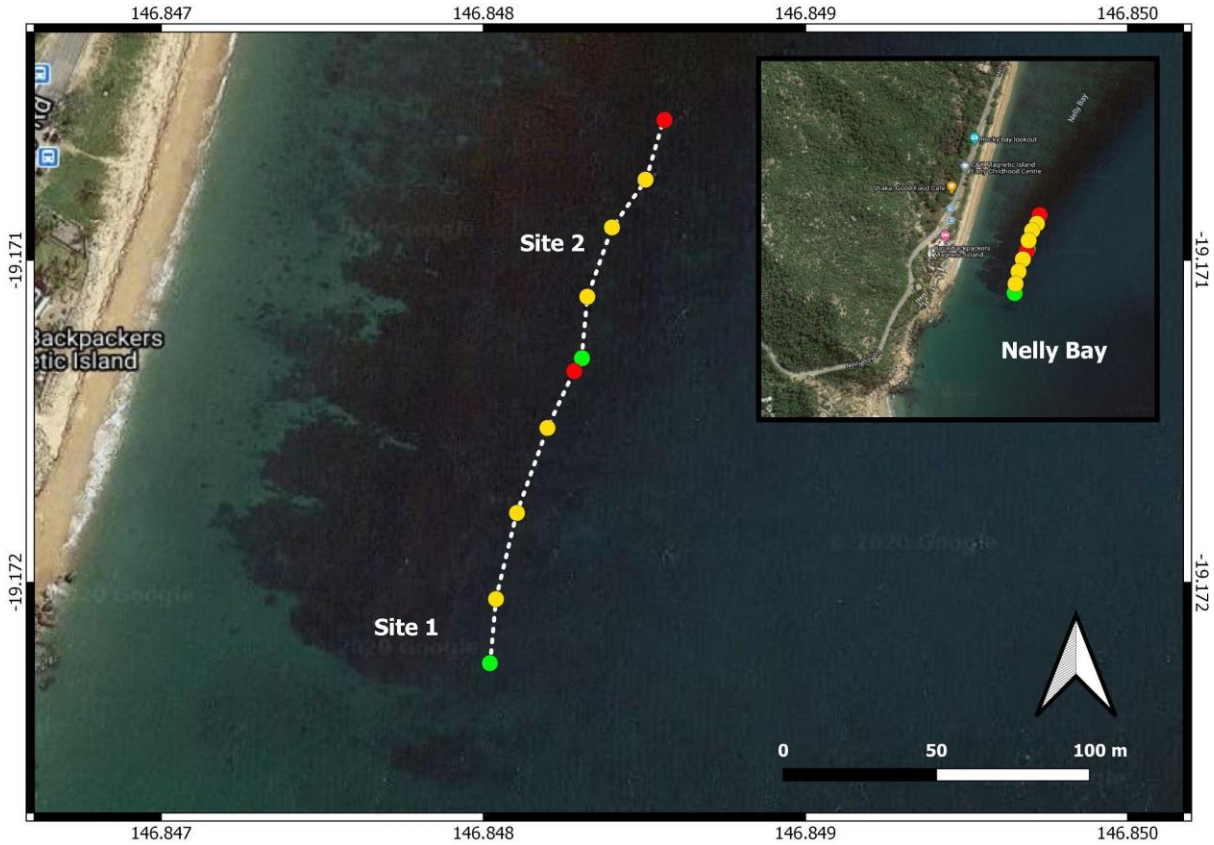



*Figure 25: Map showing survey sites 1 and 2 in Nelly Bay, Magnetic Island.*

**Substrate Survey**

LCC has been relatively consistent since October 2012, with percentages during this period ranging from 11.25% (2017) to 25% (2016) (Figure 26). The highest abundance of coral cover at 77% was observed in 2007, though by 2012 this had reduced to 16%. The most recent survey determined the coral cover in Nelly Bay to be 23%. The percentage of bleached coral since 2003 has remained below 5% of the population, with the most recent survey recording approximately 1% of the population as bleached (Figure 26).

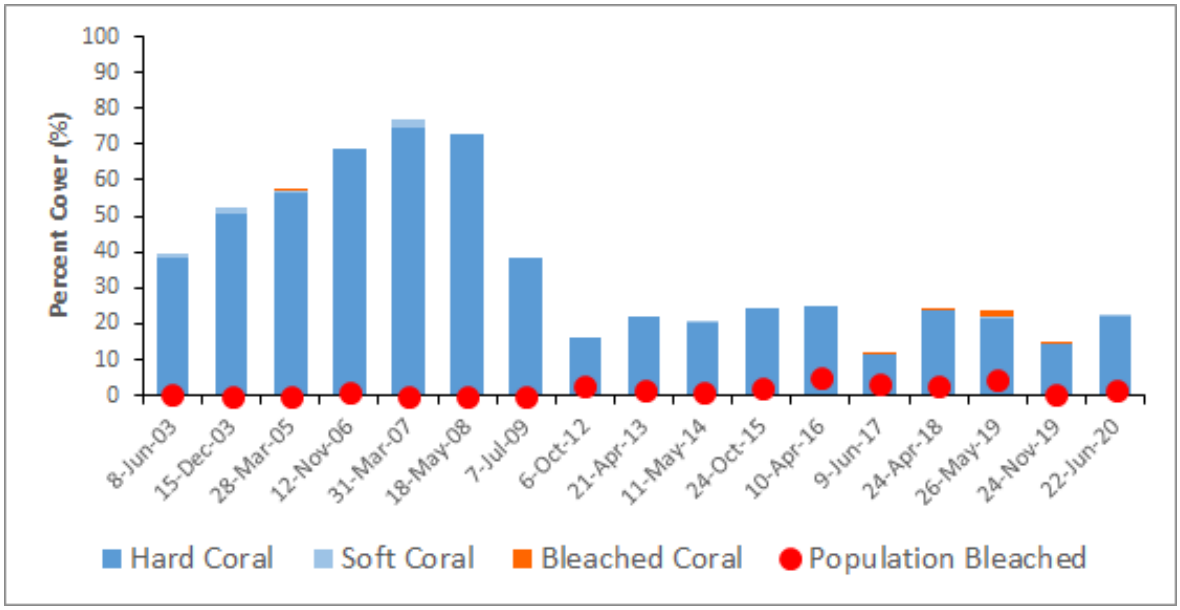



*Figure 26: Long-term percent cover of hard and soft corals and bleached corals by survey year at Nelly Bay, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

The greatest fluctuations in substrate cover since 2012 have been between nutrient indicator algae (NIA) and rock (Figure 27). Prior to 2012, the dominant substrate cover observed was hard coral. Since 2012, seven out of 10 surveys have shown rock dominant substrates, two surveys showed NIA dominance, and 2017 showed similar levels of both rock and NIA.

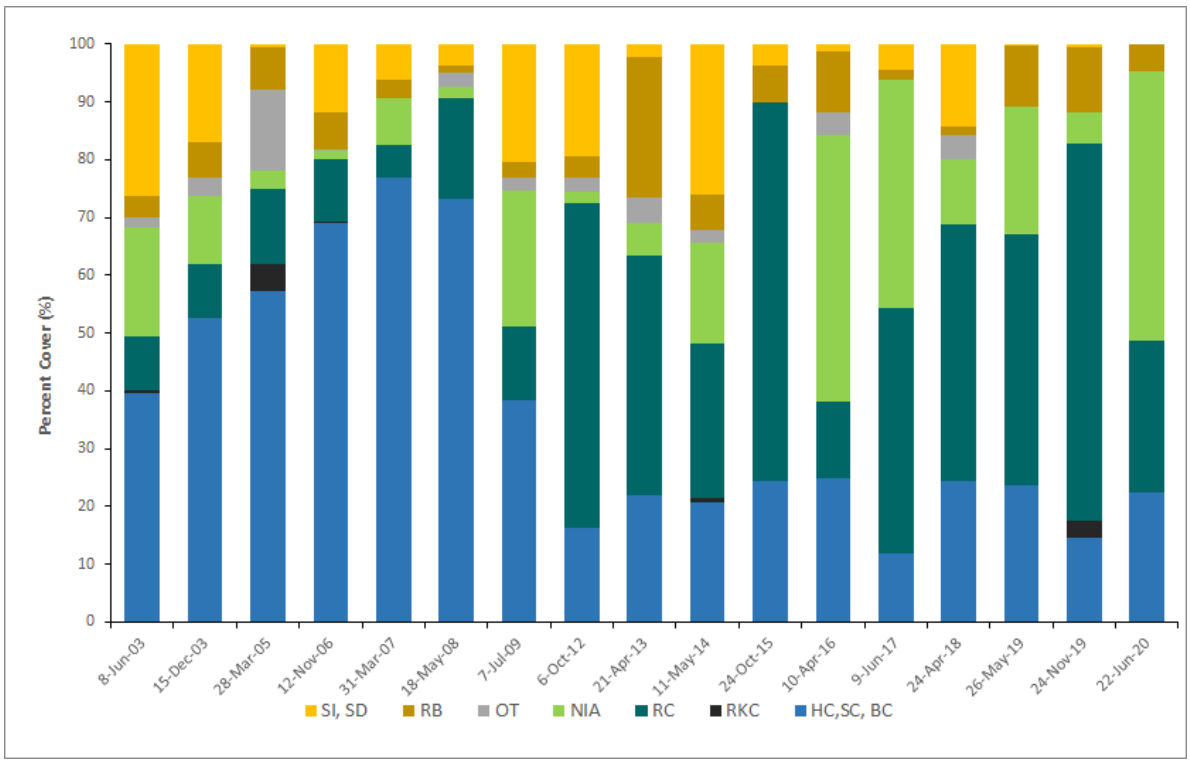



*Figure 27: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Nelly Bay, Magnetic Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

During the most recent June 2020 survey the dominant substrate cover identified was nutrient indicator algae (47%), followed by rock (26%), hard coral (22%) and rubble (5%). The observed hard coral consisted predominantly of foliose morphology (61%), though encrusting (27%), branching (7%), massive (3%) and plate (3%) morphologies were also recorded at Nelly Bay during the 2020 RCA surveys (Figure 27 & 28).

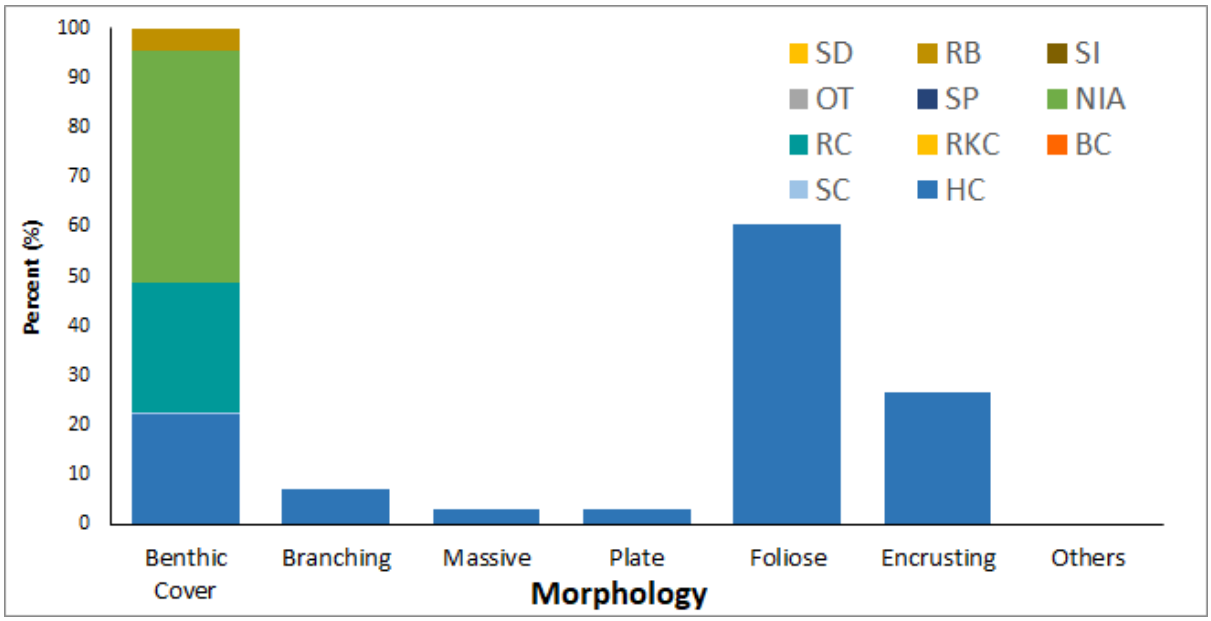



*Figure 28: Per cent cover of different benthic categories and dominant hard coral morphologies at Nelly Bay, Magnetic Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

During the 2019 and 2020 surveys, an average of 26 drupella snails and one trochus snail were observed per survey (Table 2). No other key invertebrates were observed. A site average of 9.8 drupella scars, 5.8 unknown scars, zero COTS scars, 4.8 instances of other coral damage, 5.3 cases of coral disease and less than one piece of debris were recorded during RCA surveys in both 2019 and 2020. Observed coral bleaching of the population in 2019 and 2020 was 0.9%, with an average colony bleaching of 9%.

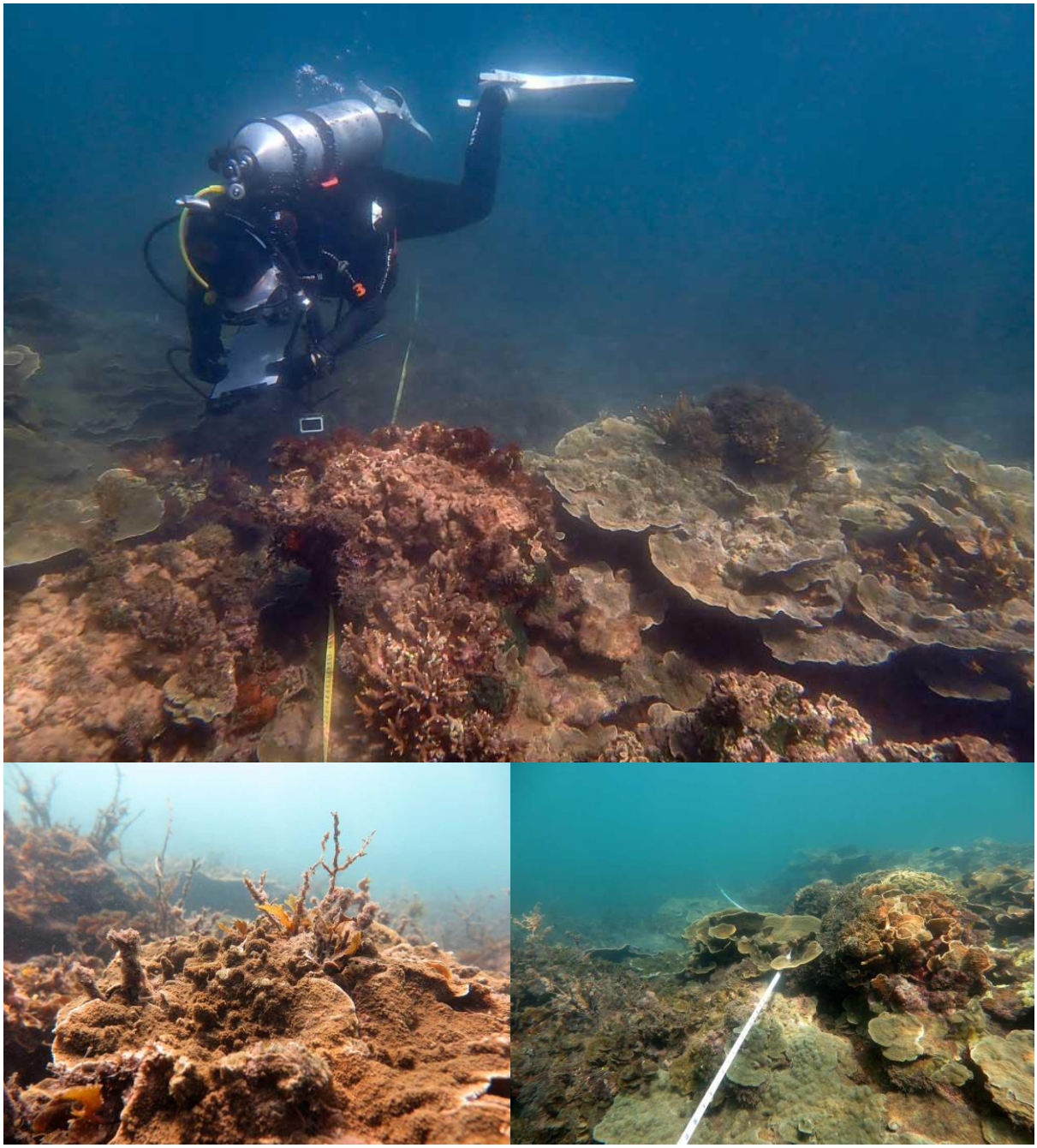


*Figure 29: Diver conducting survey at Nelly Bay (top), Montipora* spp*. coral and Sargasssum* sp*. algae at Nelly Bay (bottom left) and reefscape at Nelly Bay (bottom right).*

## 4.6. Magnetic Island - Alma Bay

*Figure 30: Alma Bay, Magnetic Island*

**Site Description**

Alma Bay is a small bay protected from fishing activities and is located on the exposed side of the island, just north of Nelly Bay (Figure 30 & 31). It is commonly used recreationally by beach goers and locals.

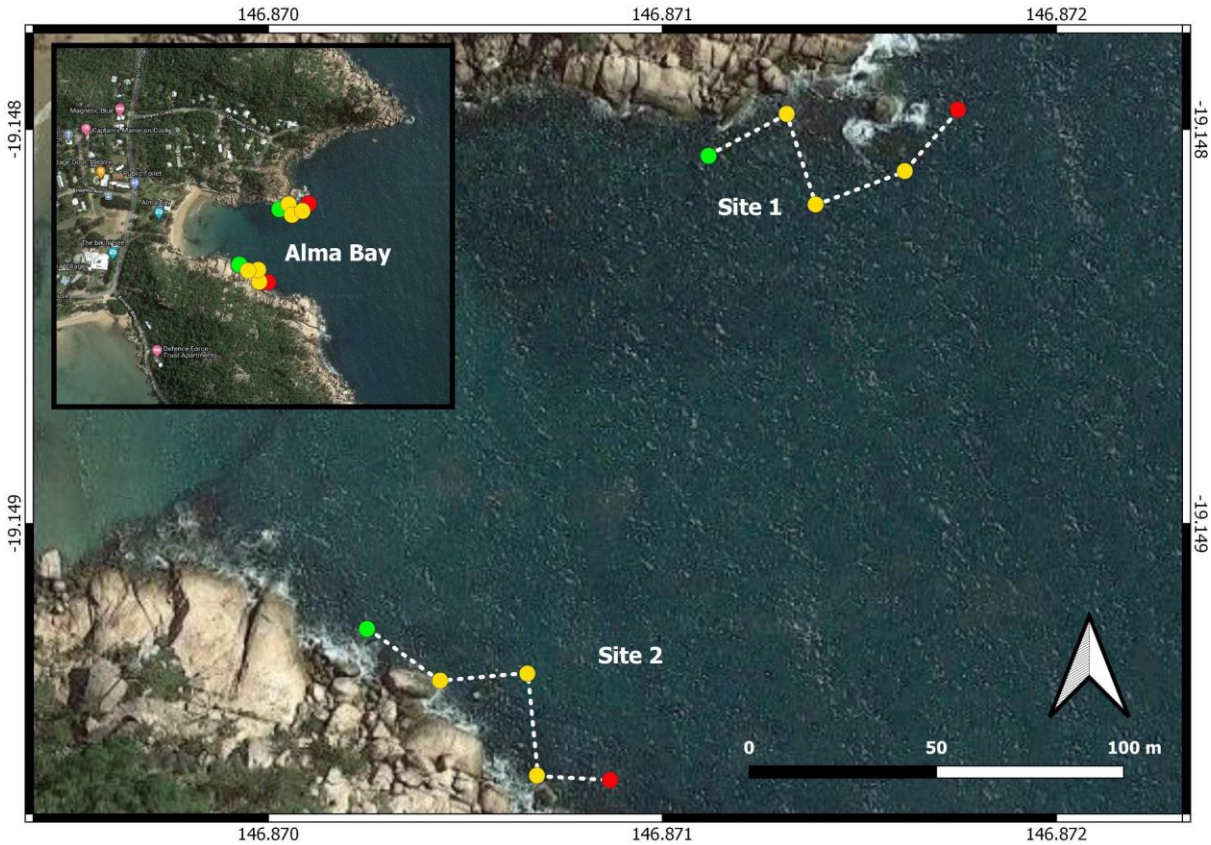



*Figure 31: Map showing survey sites 1 and 2 at Alma Bay, Magnetic Island.*

There are two RCA survey locations within Alma Bay, one on each side of the bay within the fringing reefs alongside the rocks (Figure 31). Site 1 is situated approximately 150m from shore along the northern side, and Site 2 is located approximately 100m from shore on the southern side of the bay. These sites are dominated by rock and hard corals and have a depth between 4-8m. These two sites have been surveyed nine times since the first survey here in 2005.

**Substrate Survey**

Live coral cover (LCC) has remained relatively consistent since 2005, with cover ranging from 15-35.5%, although an anomaly was seen in June 2008 with 65.5% LCC. Soft coral cover has remained low (below 3.2%), with LCC primarily consisting of hard coral. Throughout the 2005-2019 period, bleached coral was only recorded on the substrate survey in two years, 2016 and 2019, with 0.6% and 0.3% bleached coral respectively (Figure 32).

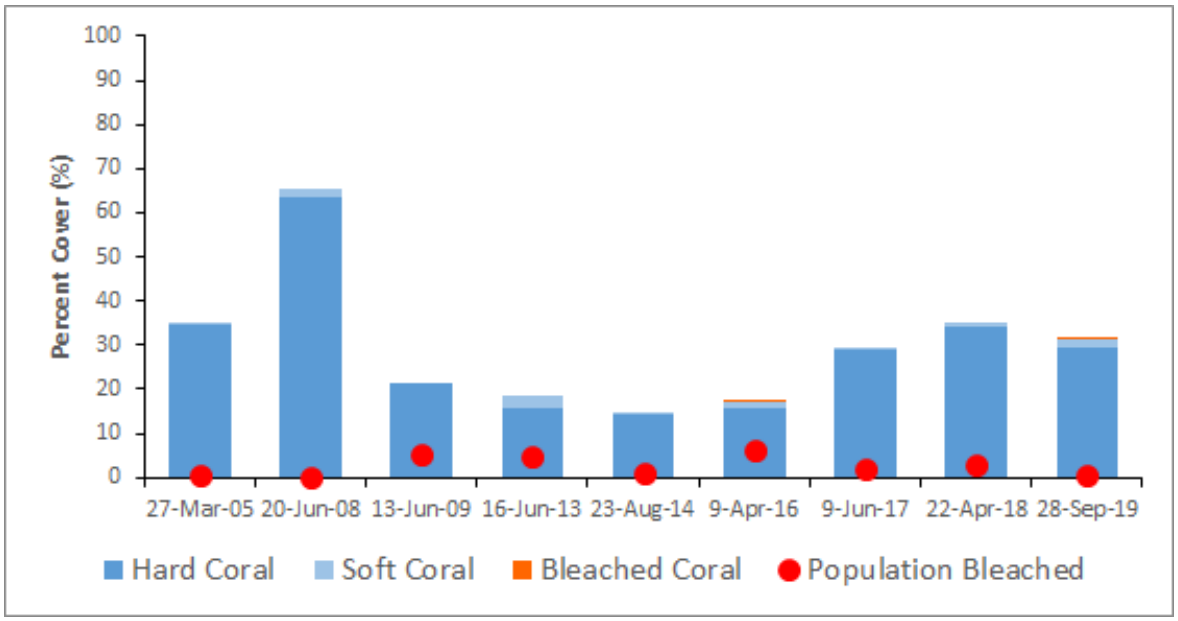



*Figure 32: Long-term per cent cover of hard and soft corals and bleached corals by survey year at Alma Bay, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

The benthic substrate composition has fluctuated since surveys began in Alma Bay in 2005, with no obvious trends over time (Figure 33). The sites have primarily been dominated by live coral and rock, although in 2014 sediment/sand was dominant, accounting for 35% of benthic cover. The greatest fluctuations can be seen in nutrient indicator algae (NIA) cover, ranging from 0% in 2008 to 32.5% in 2016 (Figure 33).

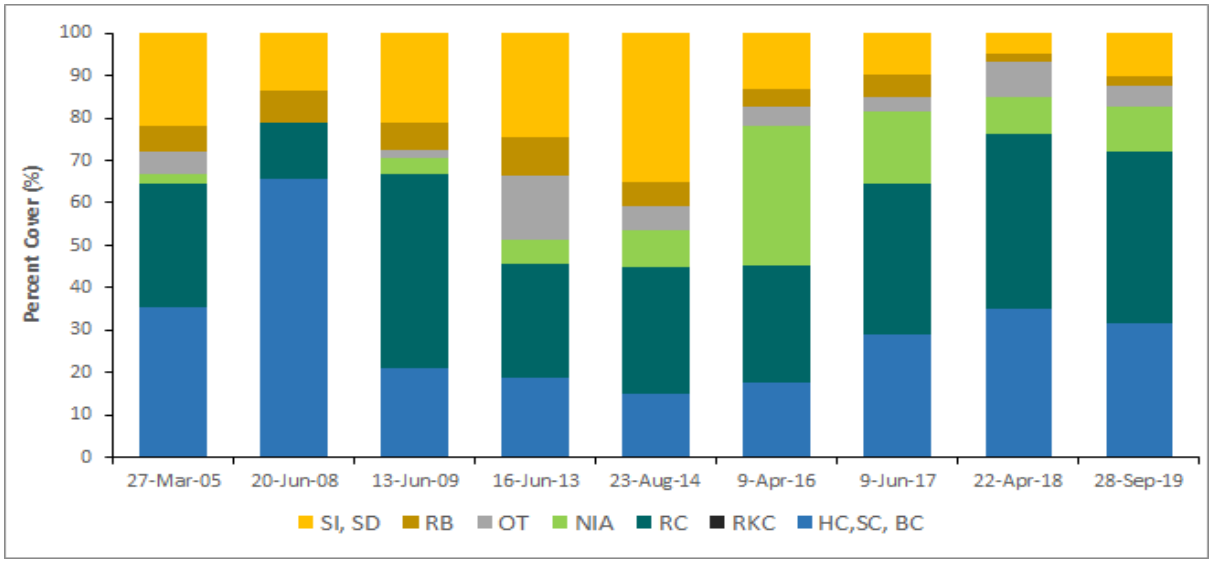



*Figure 33: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Alma Bay, Magnetic Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

The most recent survey in September 2019 found the benthic substrate of the sites to be dominated by rock (40.6%) and hard coral (29.4) (Figure 48). The remainder of the benthos consisted of NIA (10.6%), silt/sand (10%), other benthic organisms (4.7%) and rubble (2.5%). Hard corals were dominated by foliose (52.1%) and encrusting (34%) morphologies (Figure 34).

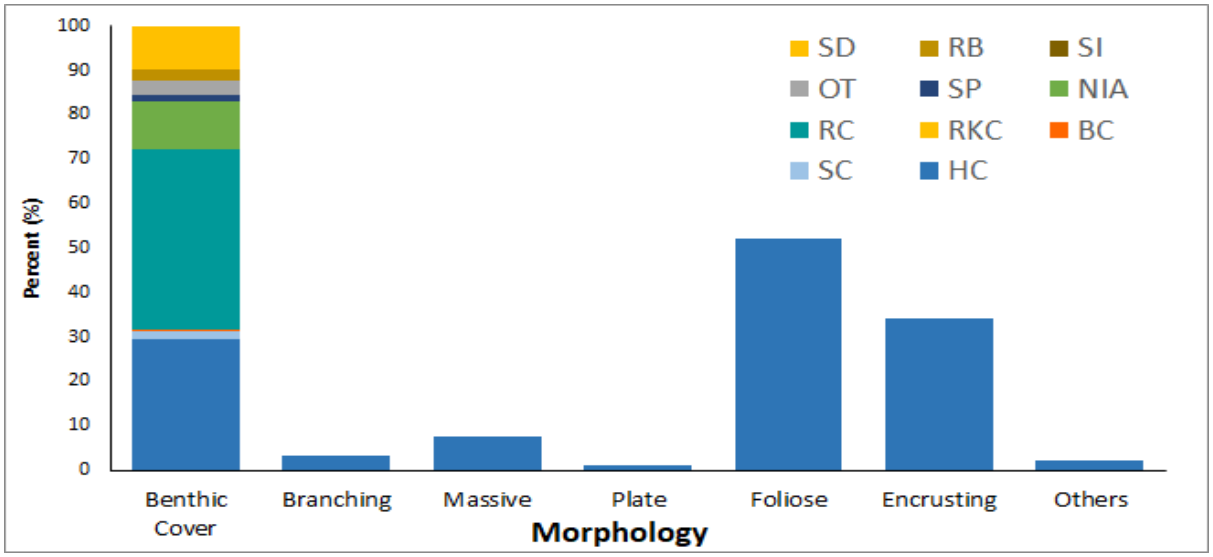



*Figure 34: Percentage cover of different benthic categories and dominant hard coral morphologies at Alma Bay, Magnetic Island Reef Check Australia Monitoring site.*

**Invertebrates and Impacts**

In the September 2019 surveys of Alma Bay, the only key invertebrate recorded at these sites was one drupella snail (Table 3). The occurrence of impacts at these sites were also low, with an average of 6.5 unknown scars, three incidences of coral damage and 0.5 of coral disease per site. No drupella snail scars, COTS scars or marine debris were observed. Bleaching was also low, with bleached coral populations 0.5%, with on average 2.6% of the colonies bleached, however silt cover was considered to be medium.

## 4.7. Magnetic Island - Middle Reef

**Site Description**

Middle Reef is located 6km off the coast of Townsville, in the middle of a channel between the mainland and Magnetic Island. This location provides shelter to the reef, which does not experience ocean swell and minimum wind-driven waves. Ross River is the closest river, located 7km south of the reef and significant flows of freshwater occur only during extremely heavy rains. Magnetic Island (Yunbenun) and its surroundings represent significant cultural heritage to the Aboriginal Traditional Owners, the Wulgurukaba people, who have lived on the island and the nearby mainland for thousands of years.

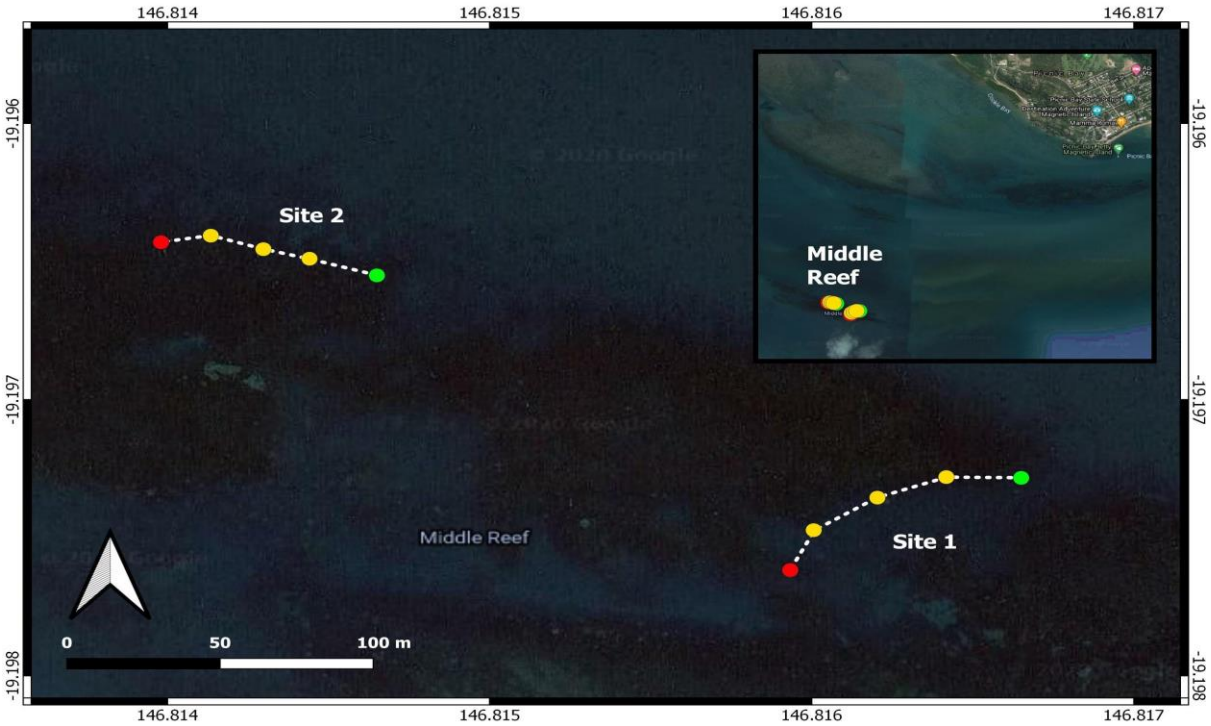



*Figure 35: Map showing survey sites 1 and 2 in Middle Reef, Magnetic Island.*

Middle Reef consists of two RCA survey locations in two different sites on the seaward side of the fringing reef (Figure 35). The reef is surrounded by shallow waters between 2-5m in depth. Site 1 faces south towards the southernmost point of the reef and crosses a predominant field of algae with presence of silt and hard coral cover. Site 2 faces Magnetic Island and crosses the middle part of the reef. It primarily consists of hard coral (mostly foliose) and algae. Middle Reef has been surveyed 10 times since 2005.

**Substrate Survey**

Live coral cover (LCC) for 2020 (35%) was relatively similar to those values before the lowest percentage in 2014, however percentages after 2014 have not reached 50% of coral cover. In 2020, there was a slight increase in bleaching in the coral population (up to 4%) compared to 1% in 2017-2018 (Figure 36).

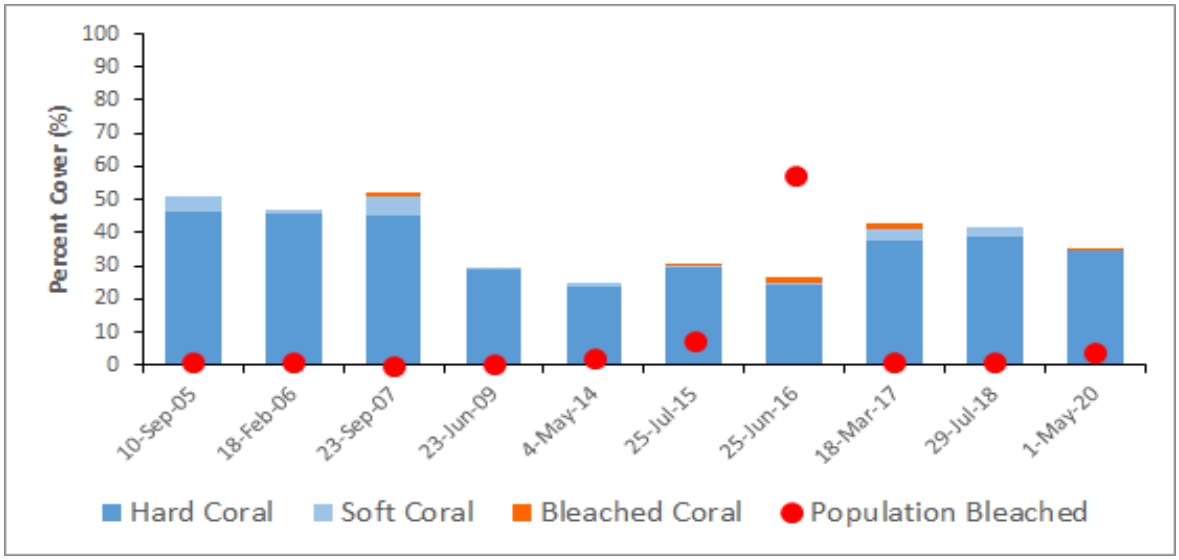



*Figure 36: Long-term percent cover of hard and soft corals and bleached corals by survey year at Middle Reef, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

The percentage of coral cover, (HC, SC and BC) observed has declined marginally over the last three years (35% in 2020) from a LCC high of 50% in 2006. This site demonstrates a level of variability over the time surveyed however it has maintained a LCC over 25% throughout the entire survey period. The percentage of Nutrient Indicator Algae (NIA) (39% in 2020) stayed relatively consistent since 2014, however the values of NIA were relatively lower (<11%) in years before 2014. The percentage of rock (RC) has decreased after 2014 with only 10% observed in 2020. This may suggest that NIA is occupying the stable substrate faster than corals over the last 6 years, however, is not yet affecting coral mortality as coral cover was observed to be stable and with similar amounts before and after 2014. The percentage of Silt and Sand have remained lower than 38% over time with only 13% in 2020 (Figure 37).

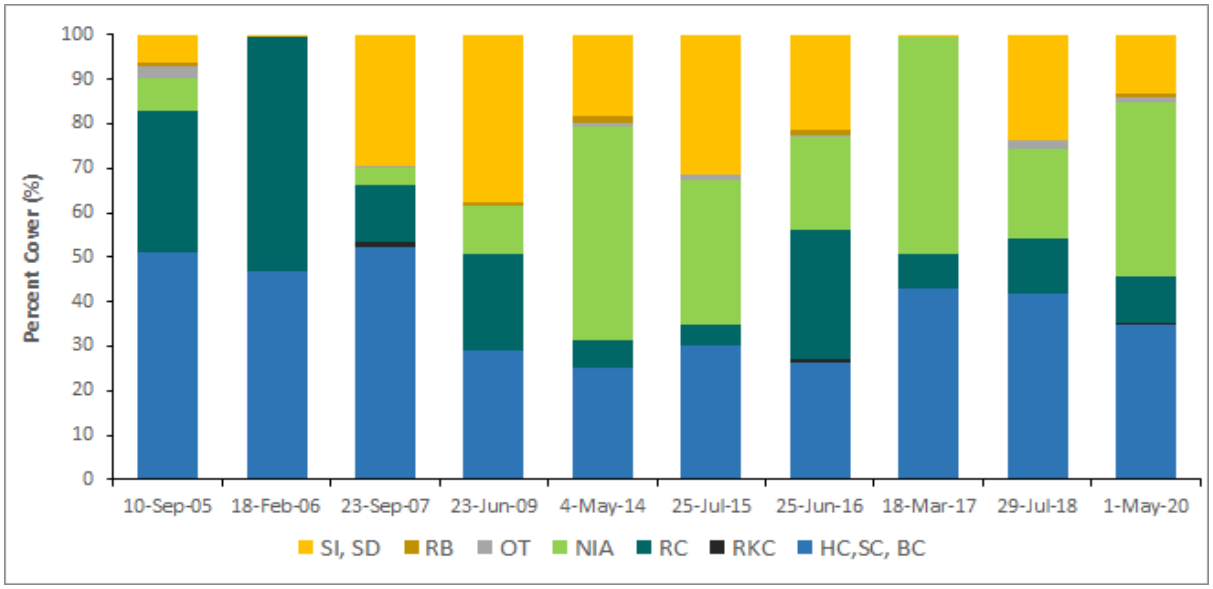



*Figure 37: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Middle Reef, Magnetic Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

The benthic cover of Middle Reef in 2020 was mainly represented by Hard Coral (35%) and Nutrient Indicator Algae (39%) followed by Rock (10%) and Silt (13%). The morphology of the surveyed hard corals was observed with a good biodiversity, where foliose represented about 52% followed by encrusting (32%), branching (9%), massive (5%) and other (2%) (Figure 37 and 38).

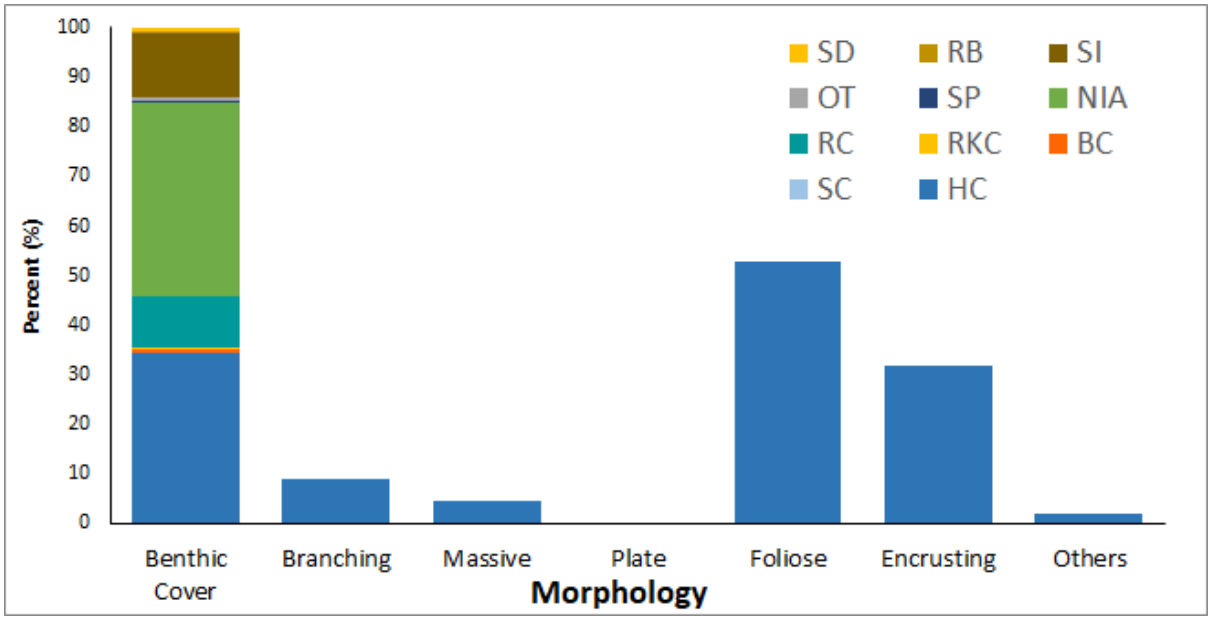



*Figure 38: Percentage cover of different benthic categories and dominant hard coral morphologies at Middle Reef Magnetic Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

There was a significant lack of invertebrates on this reef. The only invertebrates observed during surveys were drupella snails with only five counted in the transect. Coral colonies were observed with a high percentage of bleaching (71%) (Table 3). However in terms of the population of the reef, bleaching only represented about 4% of coral cover, suggesting a healthy state of corals in 2020. Damage of corals was only observed in 10 individuals and marine debris was minimal. Silt levels however were high and may compromise recruitment substrate for corals.

*Figure 39: Hard corals at Middle Reef.*

## 4.8. Magnetic Island - Florence Bay

**Site Description**

Florence Bay is located in the north-east corner of Magnetic Island with a fringing reef covering half of the sand flats on the northern side of the bay and along the shoreline in the south. This protected bay is predominately sheltered from strong winds and generally experiences clear waters

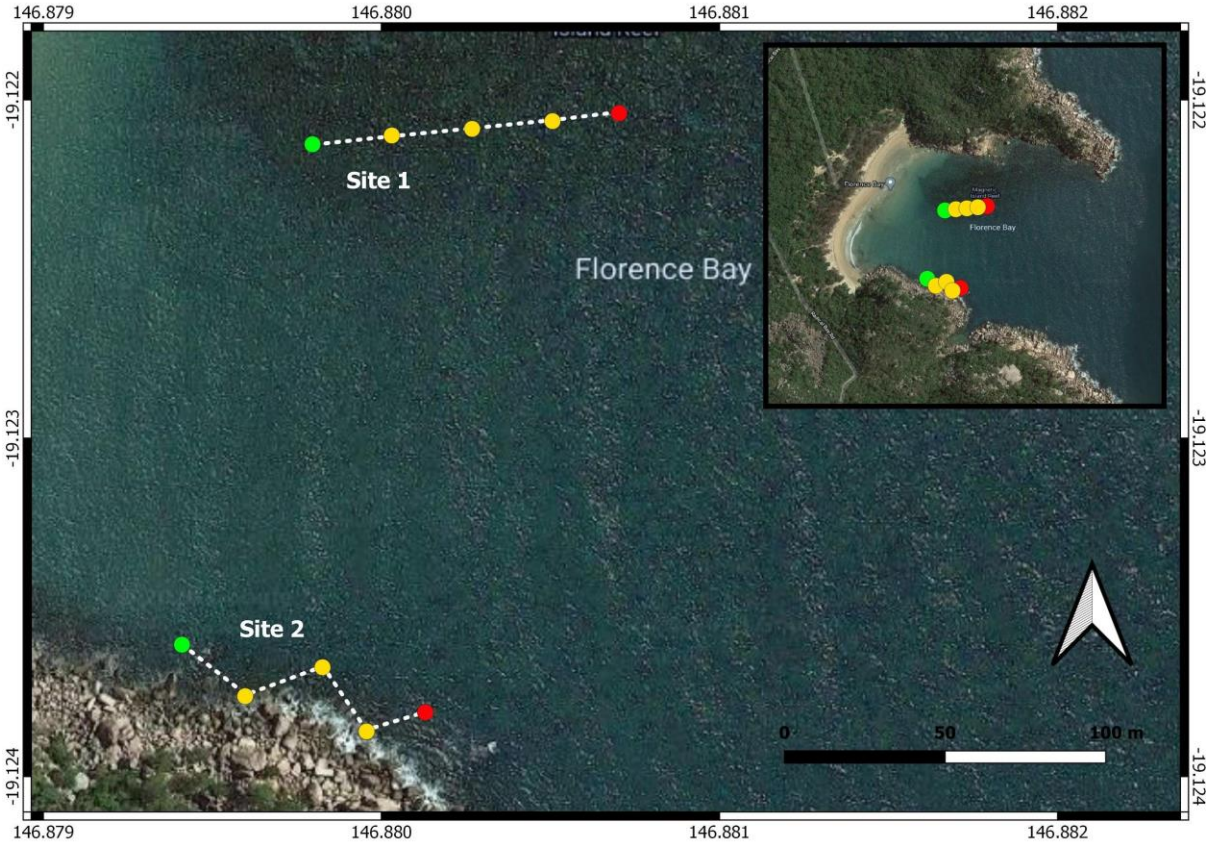



*Figure 40: Map showing survey sites 1 and 2 in Florence Bay, Magnetic Island.*

Florence Bay consists of two RCA survey locations on the seaward side of the fringing reefs (Figure 40). Shallow waters of about 3-15m surround the reef with some areas exposed at low tide. Site 1 crosses a predominant field of algae with a lower presence of hard corals and macroalgae. Site 2 along the shoreline, crosses a predominant field of algae and hard coral with a lower presence of silt and soft coral. The reef at Florence Bay has been surveyed nine times since 2006.

**Substrate Survey**

Coral cover was observed to decrease from 35% in 2018 to 24% in 2020. Percentages of coral cover were the lowest from 2014 to 2016 (24%) with previous years obtaining a percentage of about 38%. Since 2016, the coral population has not bleached more than 6% until 2020 where coral bleached 11%. Those are similar levels to the bleaching that occurred in 2015 (13%). Figure 41 illustrates the surveyed coral cover as well as bleaching populations overtime since 2006.

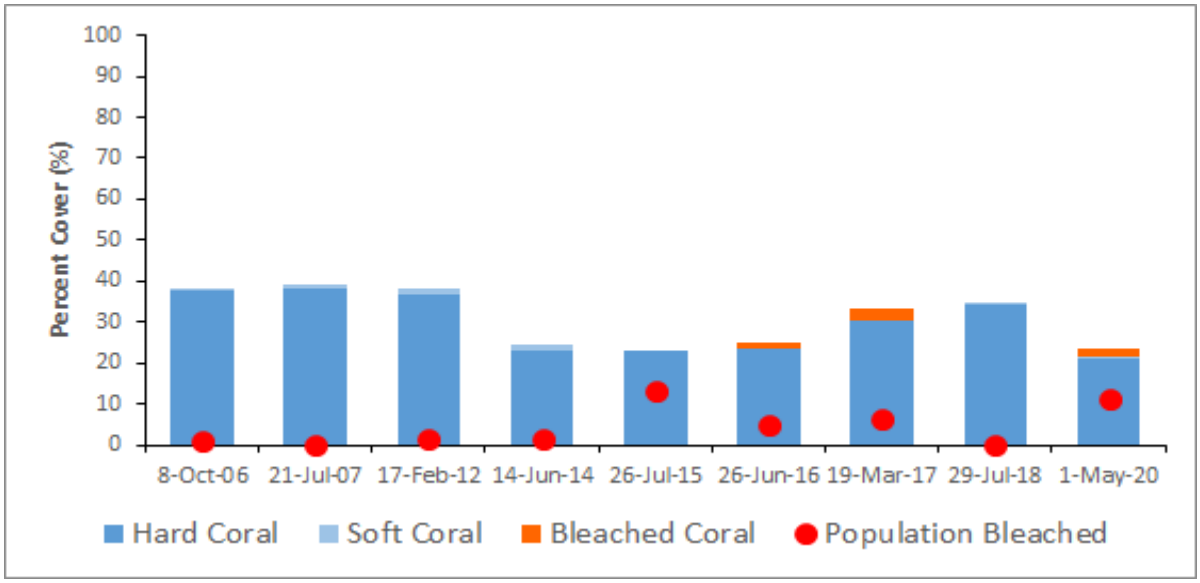



*Figure 41: Long-term percent cover of hard and soft corals and bleached corals by survey year at Florence Bay Reef, Magnetic Island Reef Check Australia monitoring sites. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

The percentage of LCC observed decreased from 35% in 2018 to 24% in 2020. The substrate category 'rock' has been relatively stable since 2012 to 2020 regularly observed between 40 to 46%. The year of 2018 was an exception to this trend as the percentage of rock cover was half of the observed value (21%) with higher amounts of SD (23%) and NIA(18%). NIA has varied throughout the surveyed period ranging from as low as 1% (2014) to as high as 18% (2018) but often between 10-14%. The amount of rubble increased substantially from 2018 (2%) to 2020 (23%) (Figure 42).

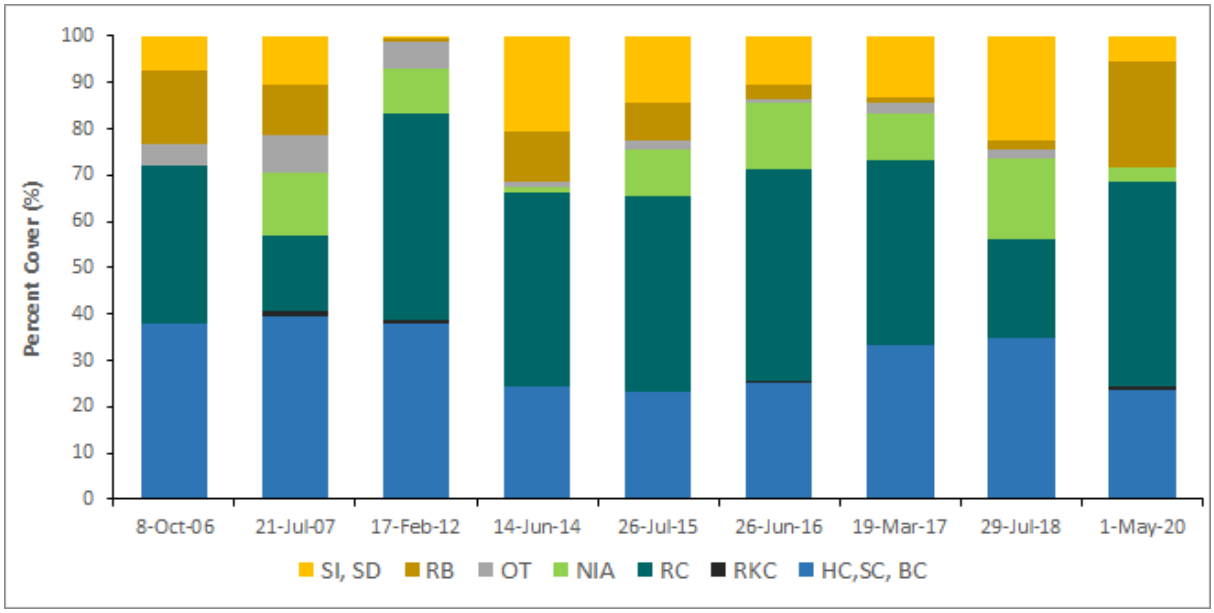



*Figure 42: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Florence Bay Reef, Magnetic Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

The benthic cover of Florence Bay reef in 2020 was mainly represented by RC (44%) and in lower percentages RB (23%) and HC (21%). NIA (3%) and SI/SD (6%) also represented a minimum percentage of the benthic cover. The morphology of the surveyed HC was observed to have good biodiversity,

where encrusting corals represented about 43%, followed by foliose (30%), massive (12%), branching (6%), plate (4%) and other (4%). Figure 43 illustrates a further breakdown of the benthic cover and the characteristic morphology percentages of hard corals at Florence Bay reef.

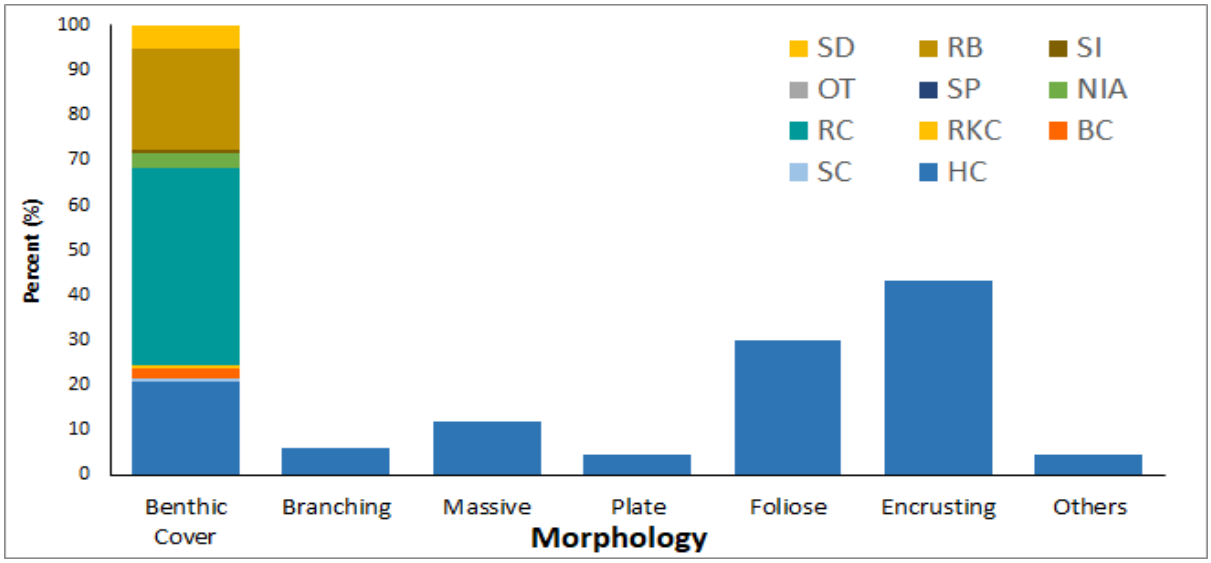



*Figure 43: Percent cover of different benthic categories and dominant hard coral morphologies at Florence Bay Reef, Magnetic Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

There was a lack of invertebrates on this reef. The only invertebrates observed during surveys were drupella snails (7) and banded coral shrimp (3). Coral colonies were observed with a high percentage of bleaching (75%) (Table 3). However in terms of population of the reef, bleaching only represented about 11% of the coral cover, suggesting the good state of corals in 2020. Damage of corals and drupella scars were only observed in three and four individuals respectively. No marine debris was observed during the surveys of 2020. The silt level of the reef was low meaning that Silt does not affect the percentage of hard substrate for corals. Overall, this indicates that corals at Florence Bay reef do not suffer significantly from impacts such as scars, damage, disease, bleaching, marine debris and levels of silt (Figure 44).

*Figure 44: Variable coral bleaching under the transect line (top) and bleached corals (bottom)*

## 4.9. Magnetic Island - Geoffrey Bay

**Site Description**

Geoffrey Bay is a popular location for tourists both on land and in the water and is a designated green zone (Figure 45 & 46). It's home to one of Magnetic Island's most popular snorkel trails, the Moltke Shipwreck, and the curious rock wallabies. Geoffrey Bay is a long beach located on the eastern side of the island, nestled between Nelly Bay to the west and Alma Bay to the east. Although fishing is not allowed within the bay, it is regularly accessed by recreational boat owners. Snorkelers and divers access the bay from the northern side of the beach or by driving down an old jetty road to access the water from an old boat ramp adjacent to where tourists can be found at dusk and dawn to feed the rock wallabies. Due to its popularity as a tourist destination, impacts such as coral damage are often observed. Magnetic Island's survey sites 4 and 5 are located in Geoffrey Bay between approximately 1-5m depth (Figure 45 & 46). Site 4 runs parallel to the beach and Site 5 follows the popular Geoffrey Bay snorkel trail.

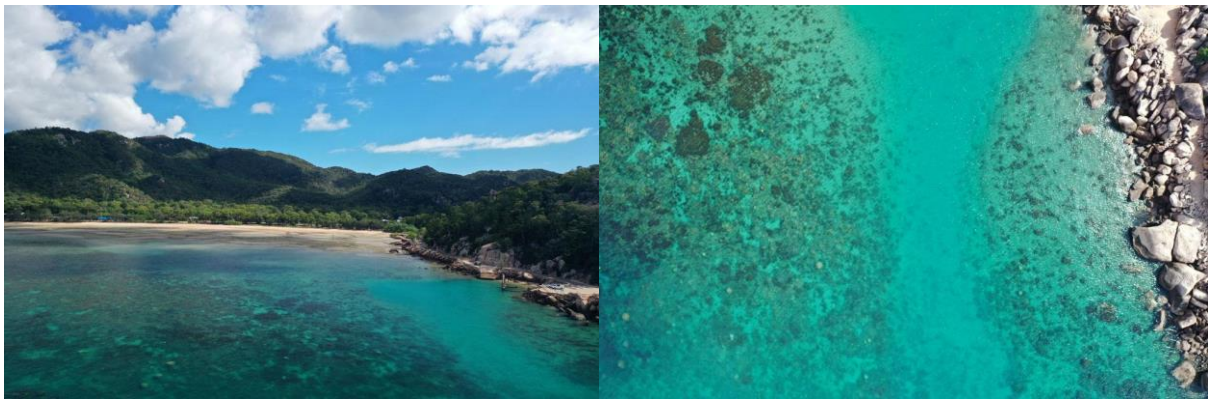


*Figure 45: Geoffrey Bay (left) with aerial view of site 5 (right) along the snorkel trail at Geoffrey Bay.*

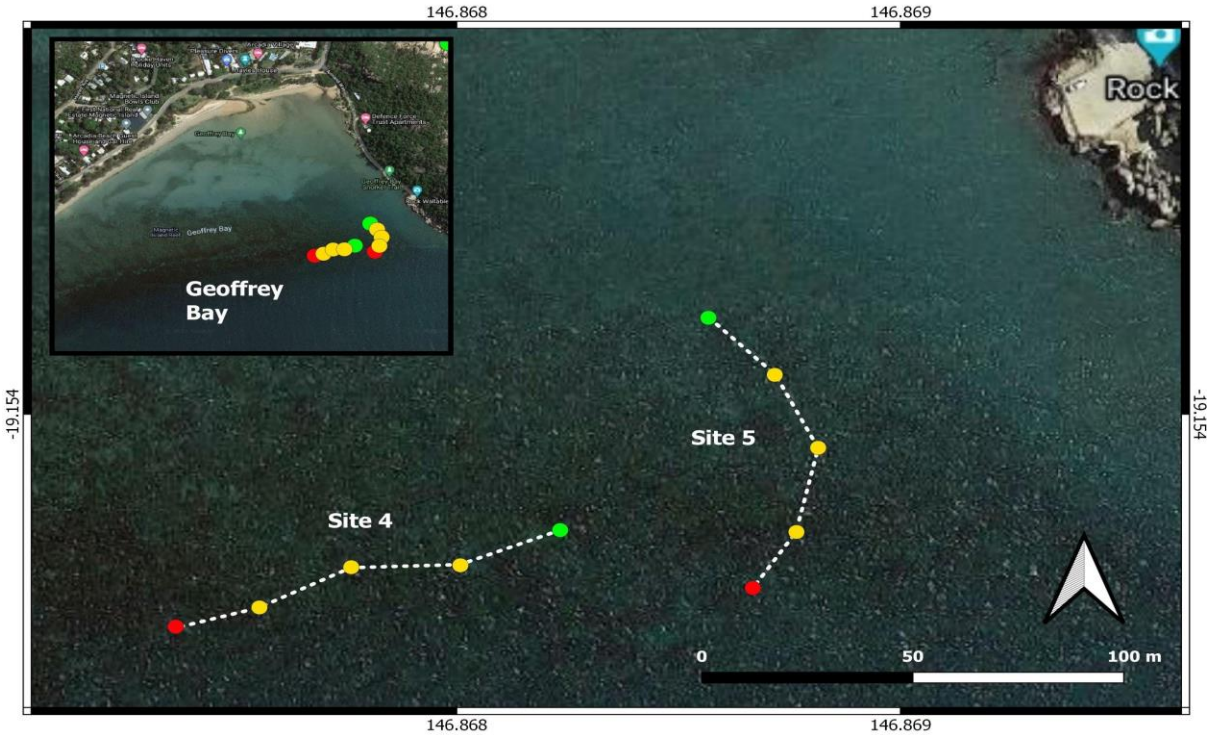



*Figure 46: Map showing survey sites 1 and 2 in Geoffrey Bay, Magnetic Island.*

**Substrate Survey**

LCC at Geoffrey Bay since the initial Reef Check survey in 2016, has been consistently high (44-58%) compared to other survey sites around Magnetic Island (Figure 47 and 48).

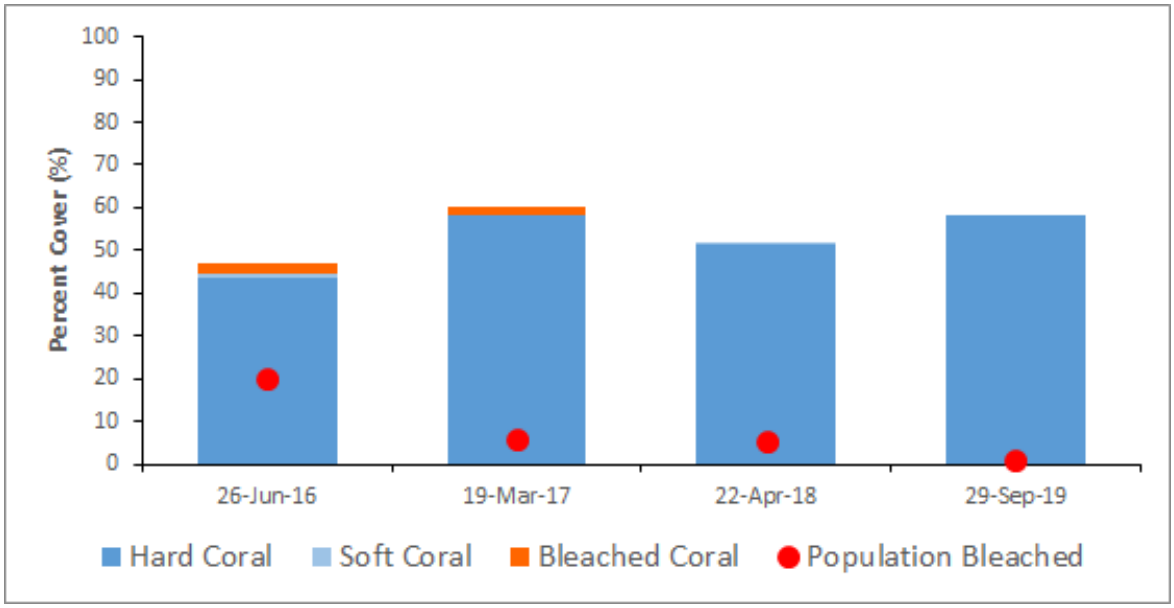



*Figure 47: Long-term percent cover of hard and soft corals and bleached corals by survey year at Geoffrey Bay, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

Since 2017, rock has been the second highest benthic substrate category represented at these sites and in 2019, rock cover increased from 16% to 24% of the surveyed transects (Figure 48). Nutrient indicator algae (NIA) and silt (SI) have fluctuated up and down each year Geoffrey Bay has been surveyed. In 2018, NIA was 13% of substrate cover and this dropped to 4% in 2019. Silt increased from 2016-2017 values to 13% in 2018 but dropped to 7% in 2019. Rubble and sand have consistently been the least represented benthic substrates at these sites since Reef Check Australia included the Geoffrey Bay sites in the survey.

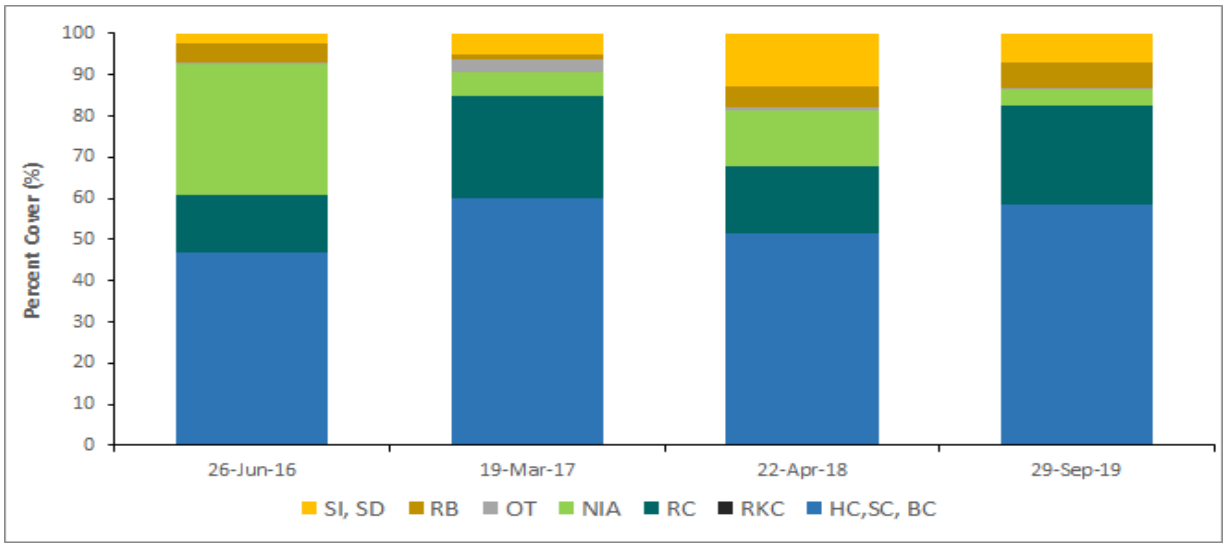



*Figure 48: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Geoffrey Bay, Magnetic Island Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

Geoffrey Bay was last surveyed in September 2019. In the most recent survey, hard coral cover (HC) dominated (58%) followed by RC (24%), SI/SD (7%), NIA (4%) and OT (<1%). The hard corals were represented by encrusting corals (49%), foliose corals (35%), branching corals (11%), some massive bommies (1%), other coral morphologies (4%) and small plate corals (0.5%) (Figure 49 and 50). Soft coral was absent from these survey sites.

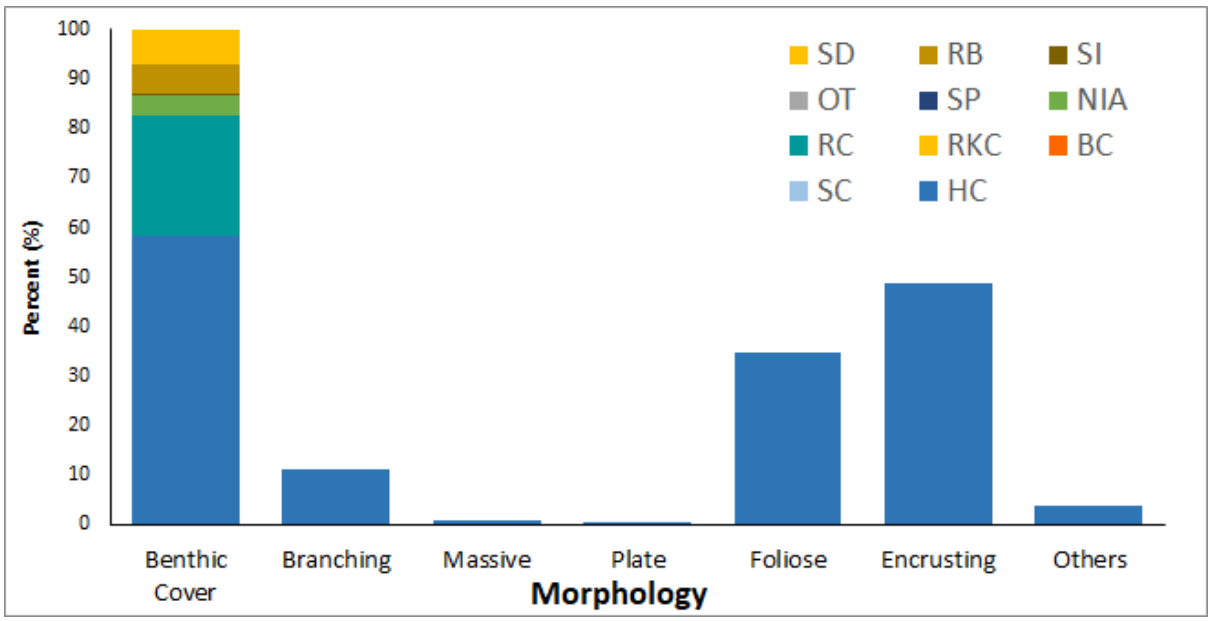



*Figure 49: Percent cover of different benthic categories and dominant hard coral morphologies at Geoffrey Bay, Magnetic Island Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

During the most recent invertebrates survey in September 2019, 48 drupella snails were recorded. Impacts included coral damage (26 colonies), coral disease (6 colonies), and coral bleaching (1%) (Table 3). Of the 1% of coral colonies that were bleached, 30% of each colony exhibited bleaching on average. There were no observed COTS scars or marine debris. It is important to note that large, massive corals in Geoffrey Bay are known to have severely bleached after experiencing thermal stress in February 2020. Reef Check was unable to conduct surveys at the sites in Geoffrey Bay in 2020 but it can be assumed that impacts may have changed in the past year.

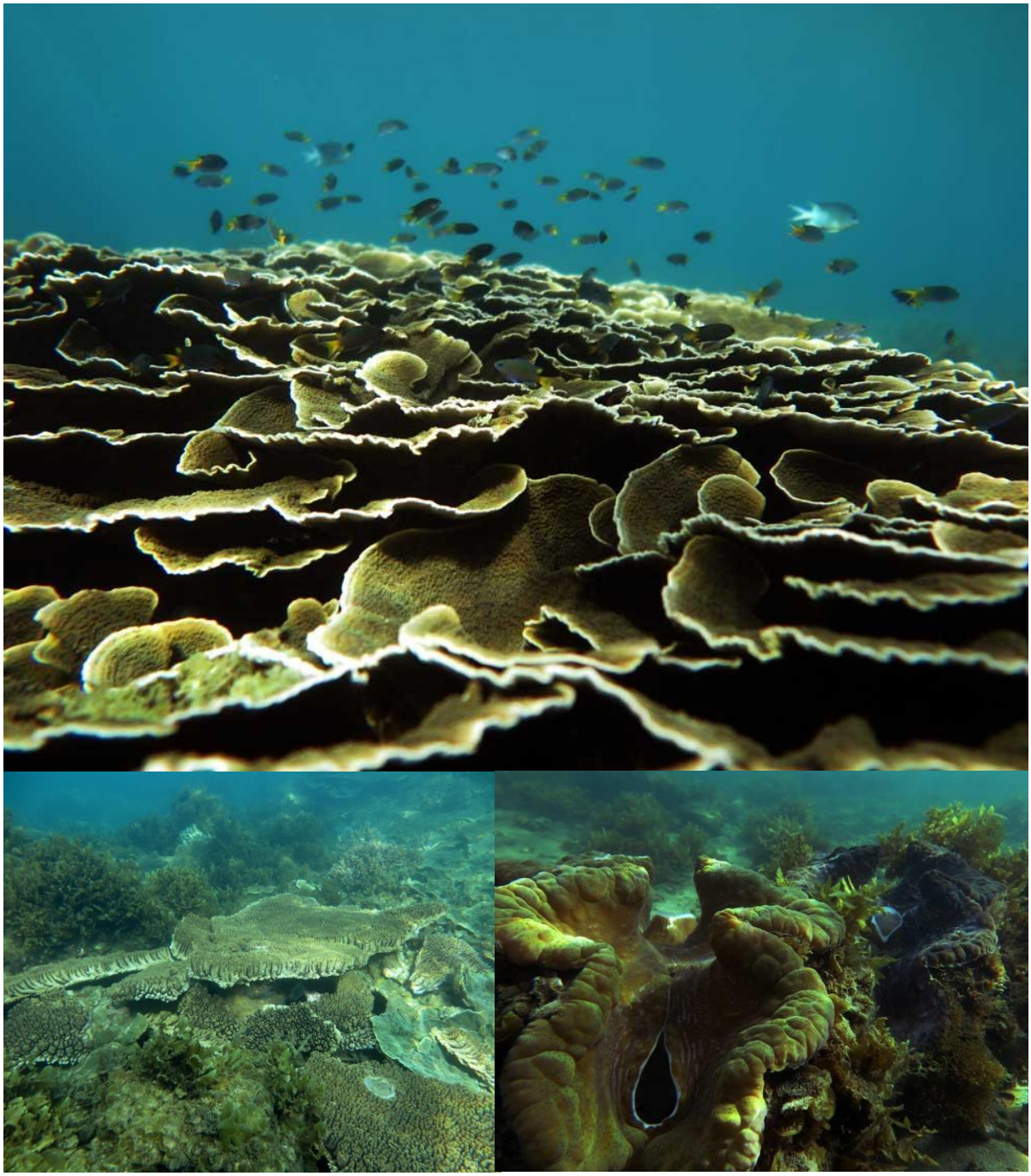


*Figure 50: Large foliose Montipora* sp*. colony (top), broken tabulate Acropora* sp*. colony (bottom left) and large giant clams (Tridacna* sp.*) on the snorkel trail at Geoffrey Bay (bottom left).*

## 4.10. John Brewer Reef

*Figure 51: Aerial view of John Brewer Reef RCA survey location.*

**Site Description**

John Brewer Reef is located 74km off the coast of Townsville (Figure 51 & 52). It has been recovering from severe COTS outbreaks and since 2020, zero COTS sightings have been recorded (AIMS, 2020). It is frequented by a few tourism operators from Townsville but otherwise remains a less popular tourism destination in the Great Barrier Reef. In 2019, the installation of the Museum of Underwater Art (MOUA) increased visitors to the reef, allowing Reef Check to include an additional survey site in 2020. While this reef has only been surveyed for the last three years, the installation of MOUA has made this site more prominent and accessible, and as a result more regular RCA surveys will be conducted in the future.

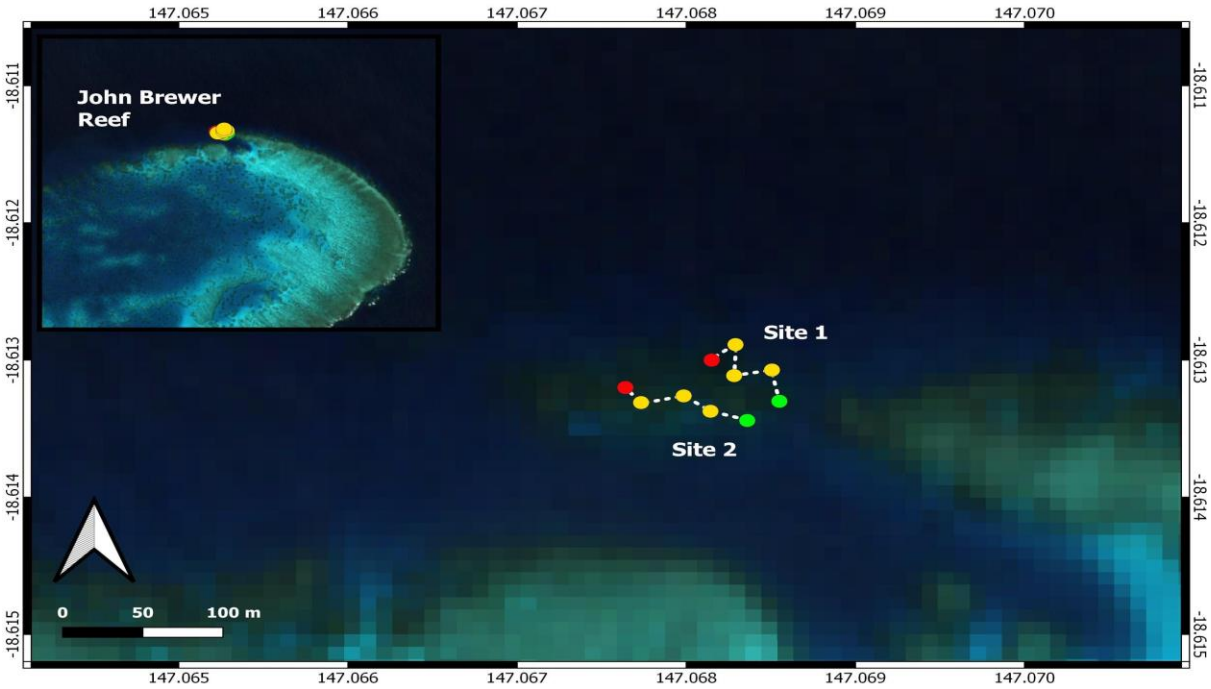



*Figure 52: Map showing survey sites 1 and 2 in John Brewer Reef.*

**Substrate Survey**

Overall, John Brewer Reef has maintained a high-level of coral cover throughout the entire survey period. Between the first two surveys, the coral cover slightly fluctuated between 50% and 60% (See Figure 53 and 54). Variations are expected as transect placement varies marginally from time to time. In 2020, the installation of Site 2 dramatically increased the collective live coral cover observations meaning the real change between 2019 and 2020 is not substantial. Hard coral cover at site 1 was a mean of 43% (n=2) while site 2 demonstrated a coral cover of 68% (n=1). While a small amount of bleaching was present in 2020, John Brewer Reef has not had the survey history to accurately conclude bleaching does not occur regularly. More accurate conclusions will be drawn as more surveys are undertaken in the area.

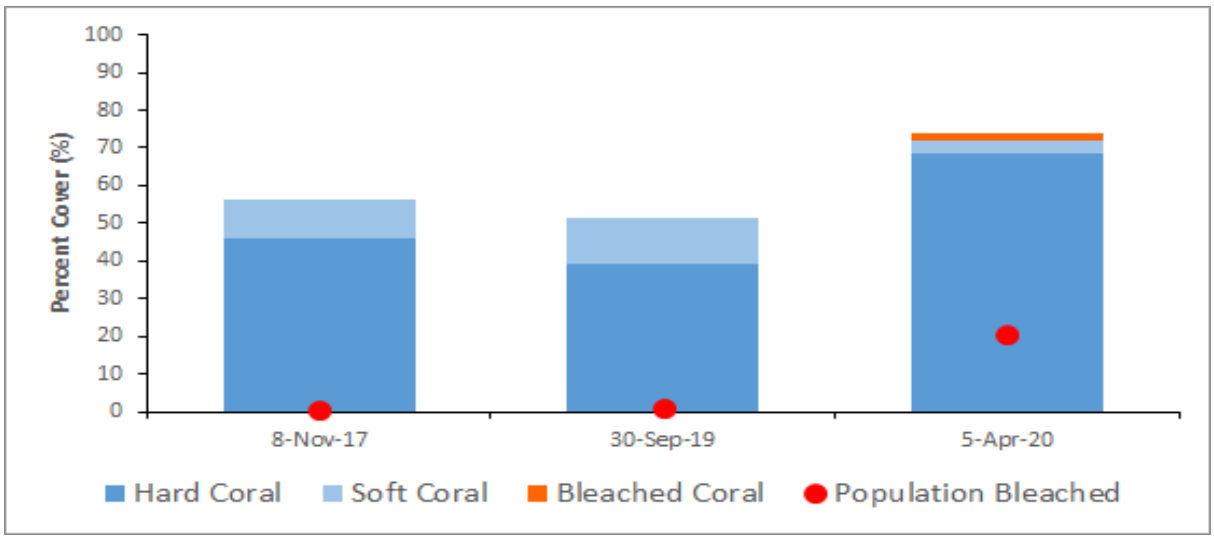



*Figure 53: Long-term per cent cover of hard and soft corals and bleached corals by survey year at John Brewer Reef, Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

The long-term substrate cover of John Brewer Reef shows a trend that matches that of a recovering reef. Surveys in 2017 show significant amounts of recently killed coral (RKC) and nutrient indicator algae (NIA) (Figure 54). As this survey took place a year after the bleaching event of 2016 and John Brewer has been recovering from a severe COTS outbreak, it is plausible to see these signs of stress on the reef. In 2019, the reduction of RKC and NIA indicates the reef is in good condition. As noted, the addition of a second survey site (Site 2) on the reef flat with a LCC of 68% increased the average coral cover at this site. An interesting note is that the most recent survey is the first done in summer and is the first time bleaching and RKC has been observed since 2017.

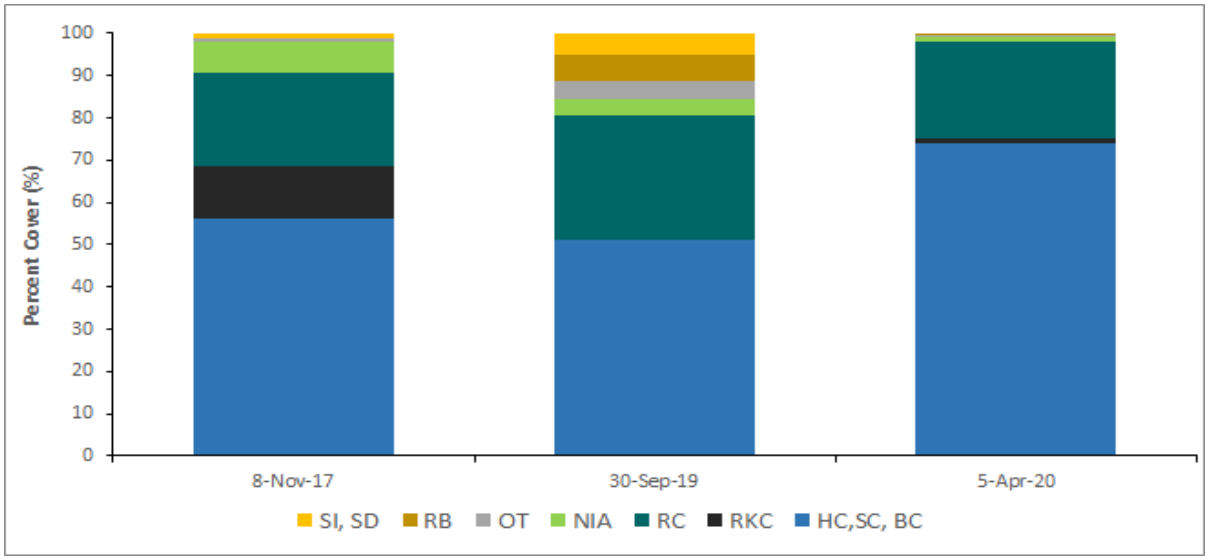



*Figure 54: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at John Brewer Reef, Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

Benthic cover was dominated by LCC (74%) and rock 23% (Figure 55). Recently killed coral (RKC) represented 1.25% while all other categories recorded less than 1%. The hard corals were represented by plate coral and branching corals with some massive bommies and encrusting forms (Figure 55 and 56).

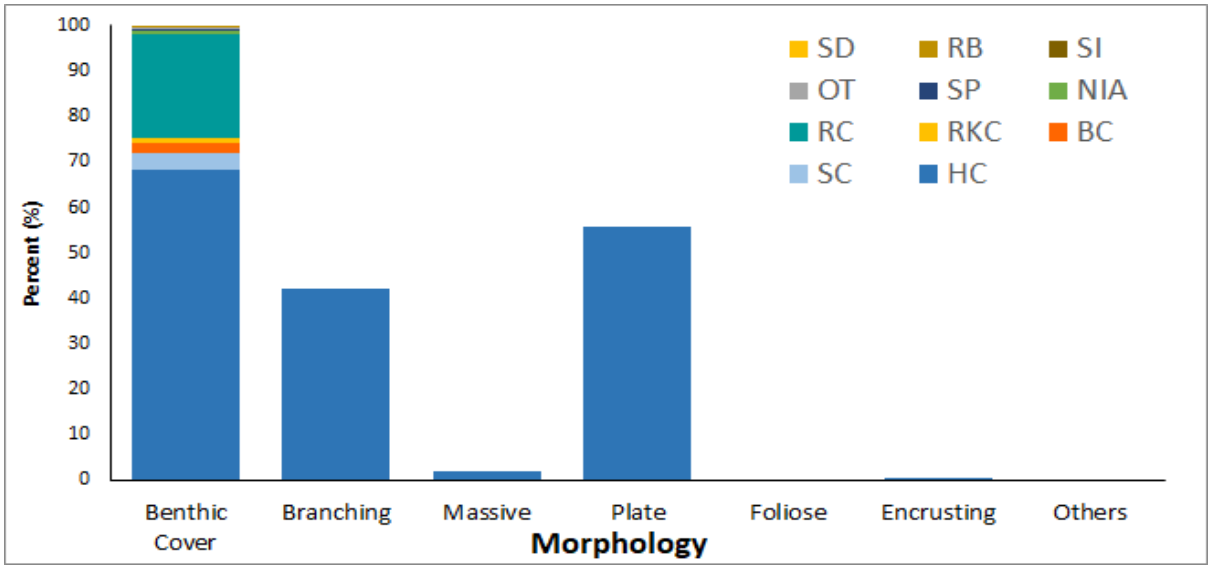



*Figure 55: Percent cover of different benthic categories and dominant hard coral morphologies at John Brewer Reef, Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

Combining data from the most recent surveys of both sites, indicates that John Brewer, while low in numbers, has a variety of invertebrates. Records of COTS, sea cucumbers, giant clams and anemones all appeared with frequencies less than 10 (Table 3). An interesting note is that drupella snails appeared most frequent with 16 sightings. Monitoring of this data point should continue as John Brewer Reef has a history with coral predation outbreaks.

Impacts were minimal in 2020. While there was a significant number of coral scarring (37) and coral damage (23), there were no cases of coral disease, a small percentage of bleaching (20%) and four pieces of marine debris. It is also worth noting that John Brewer is one of the only locations to have no silt observed.

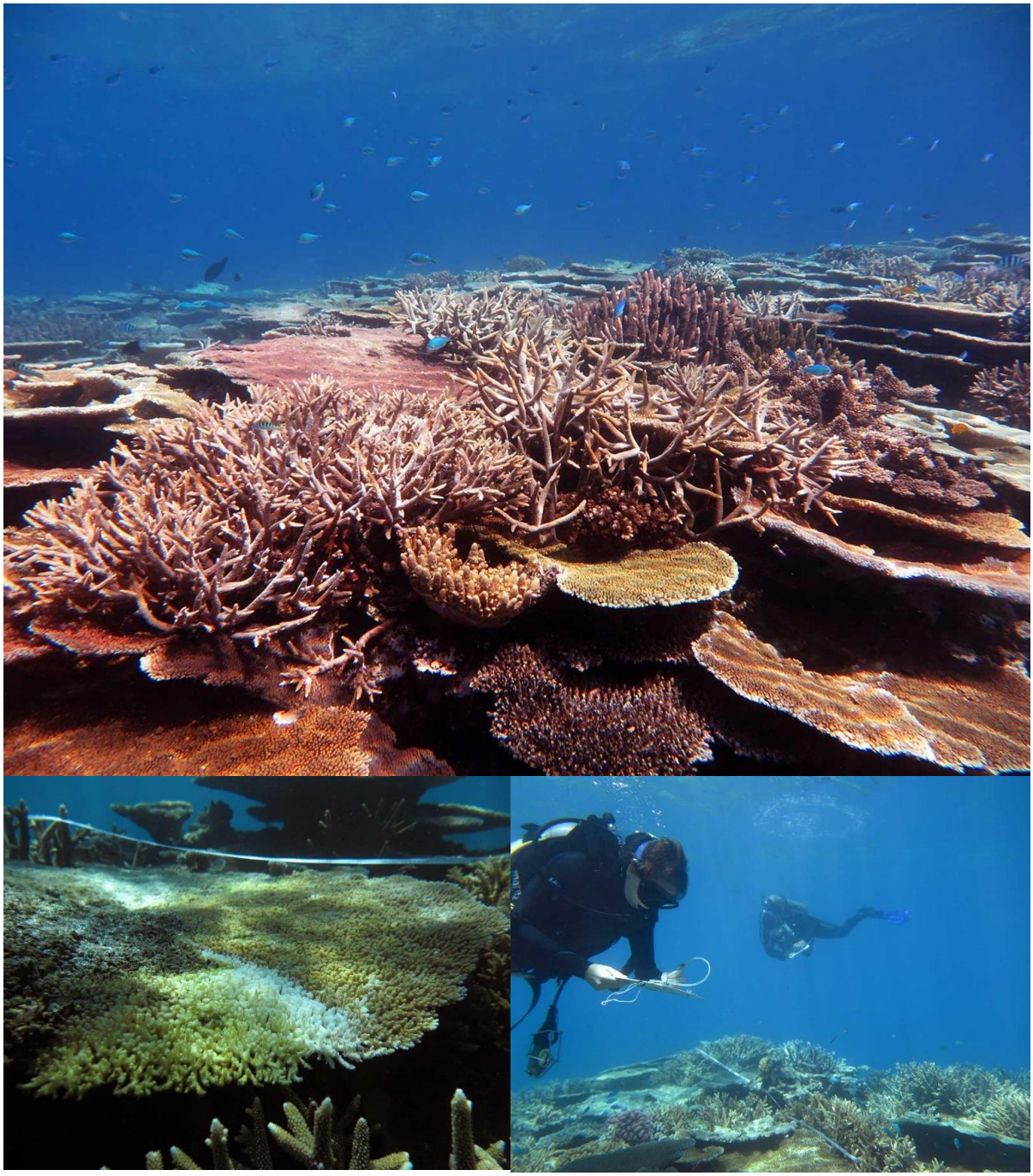


*Figure 56: Hard coral cover with a variety of branching and plating corals (top) coral disease on a plate Acropora* sp*. coral (bottom left) and divers completing RCA surveys (bottom right).*

## 4.11. Lodestone Reef

**Site Description**

Located 7 km off of the coast, Lodestone reef is a popular midshelf reef frequented by dive and snorkel operators from the Townsville region. The shallow reef flat (1-3m) makes it easily accessible to snorkelers and consists of colourful branching and tabulate *Acropora* spp., anemone fish and a diversity of colourful reef fish. Though possible to dive deeper in some areas of the reef (up to 25 m), the most abundant and vibrant fish activity and coral cover is found in the shallows.

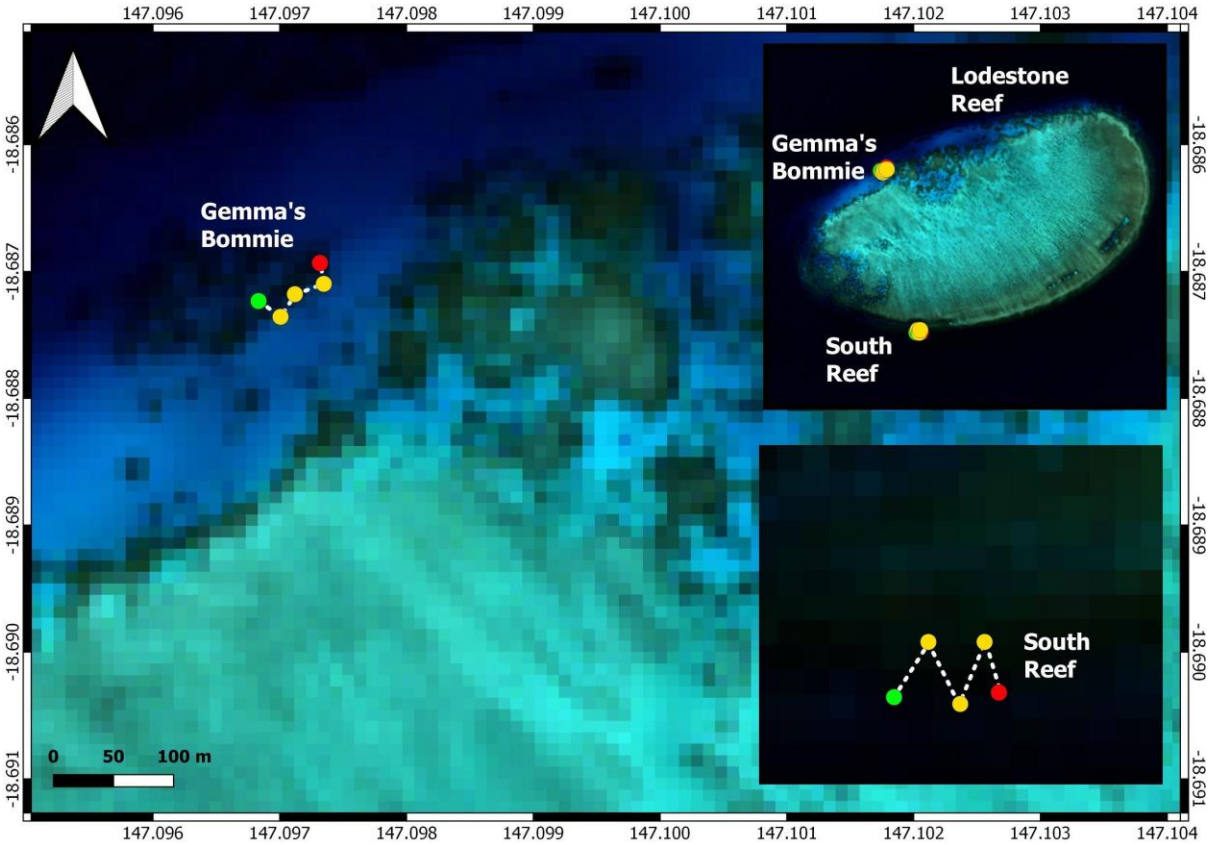



*Figure 57: Map showing survey sites 1 and 2 at Lodestone Reef.*

Reef Check has two survey sites at Lodestone Reef. One site is situated on the north-western reef flat (Gemma's Bommie) and the other site is in the south-western reef flat (South Reef) (Figure 57). Reef Check Australia has surveyed these sites four times since July 2017 with the most recent survey in April 2020.

**Substrate Survey**

Coral cover (HC, SC and BC) varied from 40% to 58% when first surveyed in July and November of 2017. Reef Check next surveyed Lodestone Reef in 2019 where coral cover dropped to 20%. When most recently surveyed in April 2020, coral cover decreased slightly to 16% with a marked increase in the population that bleached (Figure 58). Soft-coral (SC) has consistently comprised 3%-6% of the coral cover observed at this site.

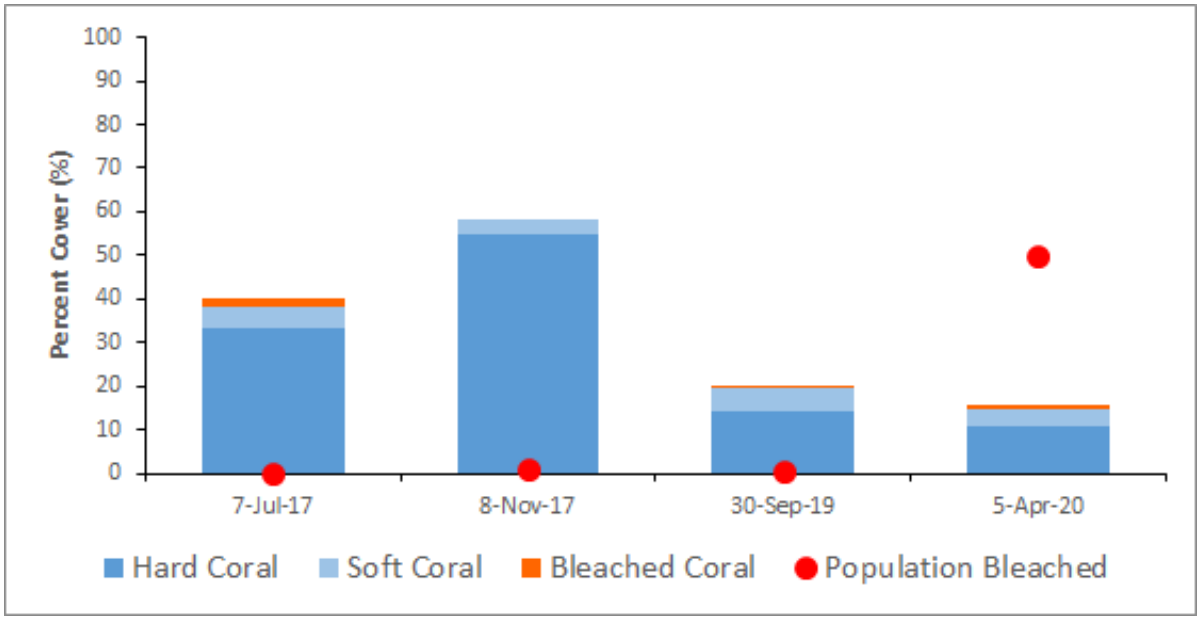



*Figure 58: Long-term percent cover of hard and soft corals and bleached corals by survey year at Lodestone Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.*

***Long-term Substrate Trend***

In 2017, corals (HC and SC) made up the dominant substrate category followed by rock (RC) and nutrient-indicator algae (NIA). In 2017, recently-killed coral (RKC) was 7% in July and 15% in November. Surveys carried out in 2019 and 2020 report no recently killed coral, but a dramatic decrease in coral cover and an increase in rock (RC), making up around 50% of the substrate at these sites (Figure 59).

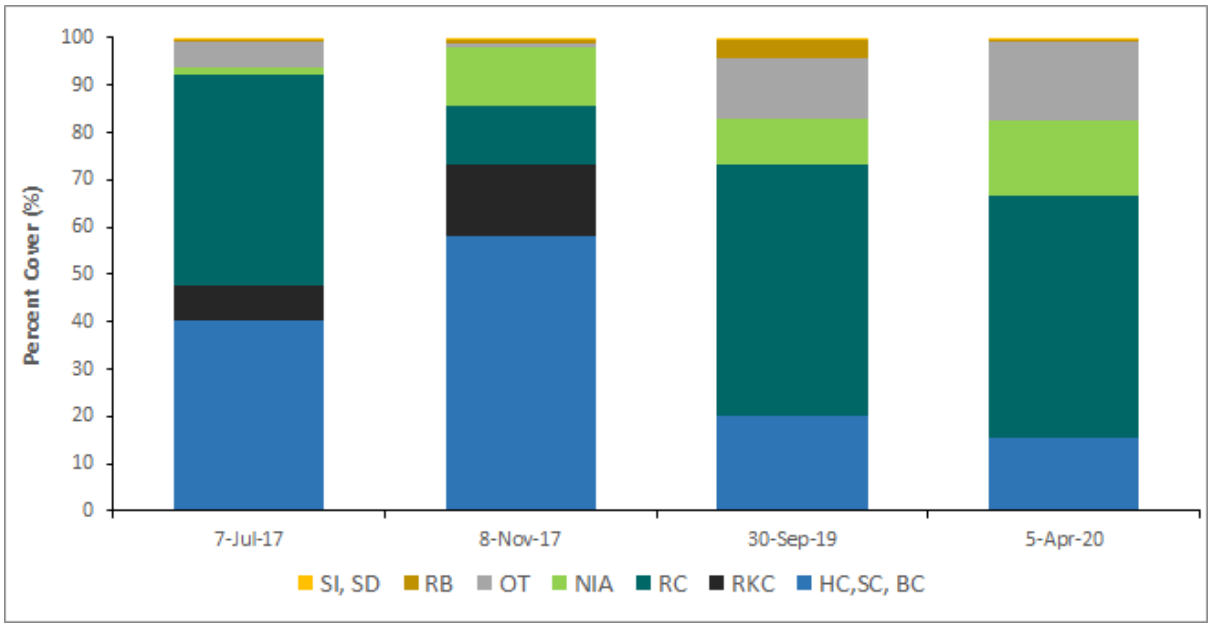



*Figure 59: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Lodestone Reef Check Australia monitoring site.*

***2020 Survey Benthic Cover and Dominant Morphology***

The 2020 substrate surveys found rock to be the most dominant benthic substrate at 50%. After rock, 'other' substrate categories (16%) were the next dominant, followed by NIA and coral (16%) and RB, SI/SD categories each represented less than 1% of the survey sites (Figure 60). HC and SC was only slightly higher at Gemma's Bommie (12% and 4%) compared to South Reef (10% and 3%). Branching coral dominated, followed by massive, encrusting and foliose (Figure 60 and 61).

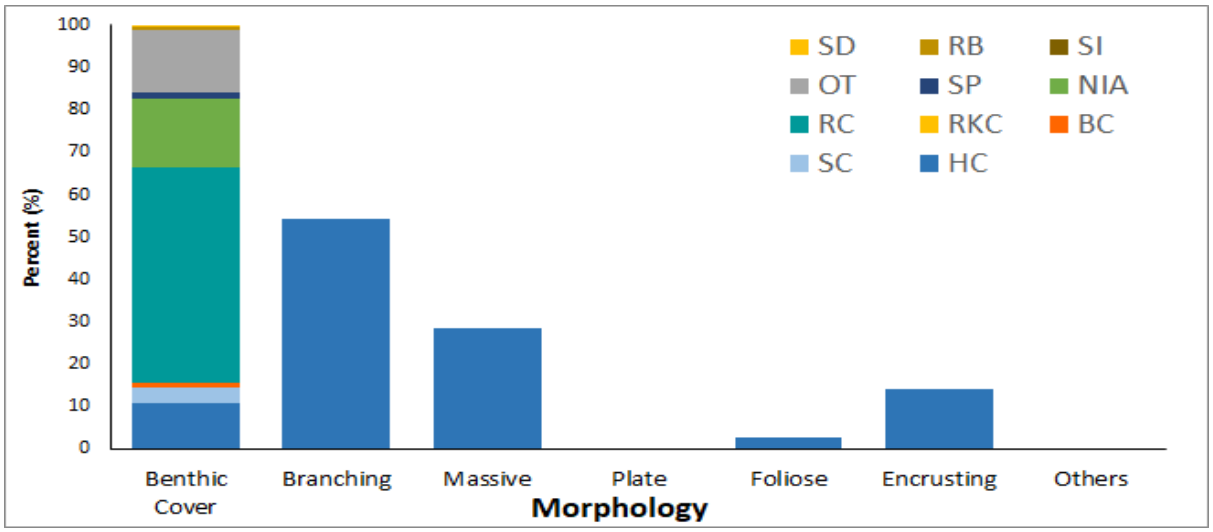



*Figure 60: Percent cover of different benthic categories and dominant hard coral morphologies at Lodestone Reef Check Australia monitoring site.*

**Invertebrates and Impacts**

At Gemma's Bommie, an abundance of anemones (19), some drupella (4), giant clams (5) and an edible sea cucumber were represented within the transect (Table 3). At South Reef, the invertebrate transect found drupella (7), giant clams (2) and a trochus. Bleached corals represented 42.5% of colonies at Gemma's Bommie and 57.5% at South Reef. Of the colonies bleached, an average of 66% at Gemma's Bommie and 64% at South Reef showed bleached tissue. The previous survey in 2019 found less than 1% of colonies bleached at each of Lodestone's sites. At South Reef, five coral colonies were damaged. The only other impacts observed were three drupella scars at South Reef; four drupella scars and one unknown scar at Gemma's Bommie.

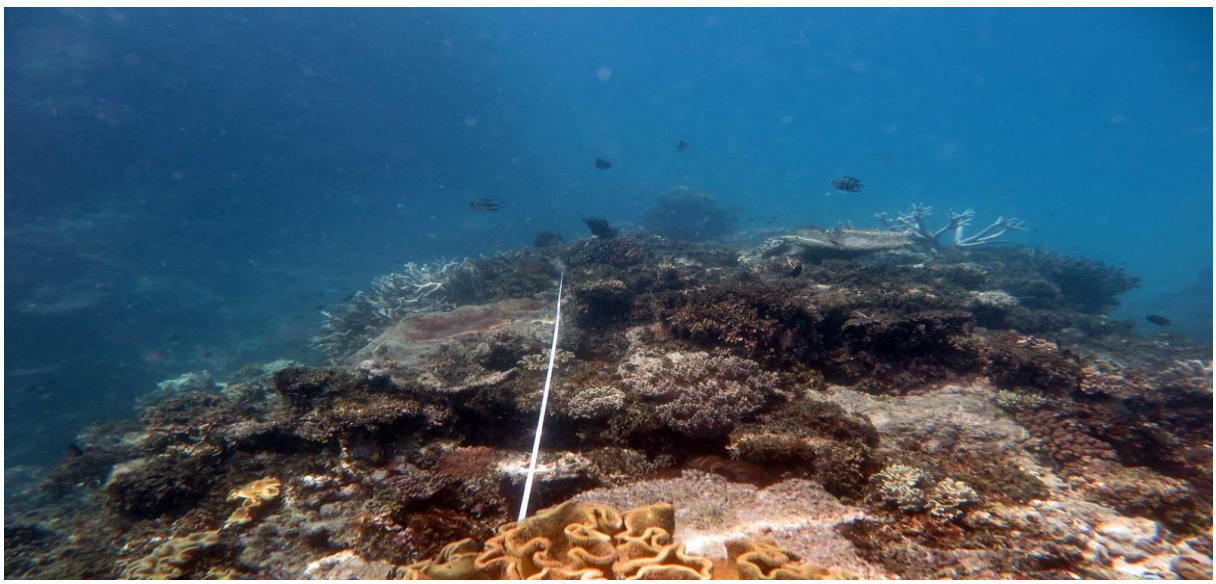


*Figure 61: Reefscape at Gemma's Bommie, Lodestone Reef showing large amounts of reef rock.*

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