

Reef Check Australia

Great Barrier Reef Season Summary Report 2019-2020



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Great Barrier
Reef Foundation

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 in the GBR during the 2019-2020 financial year are presented in this report. Teams of trained volunteers monitored a total of 48 sites across 21 different reefs. These sites included both new and existing survey sites ranging from Heron Island in the southern GBR, to the northern inner reef near Port Douglas.

The GBR Marine Park spans a total of 344,400 km² and covers approximately two thirds of the coast of Queensland (Fernandes et al., 2005, GBRMPA, 2019). It includes the outer reefs that exist along the edge of the continental shelf, as well as the fringing reefs that occur close to the coast of the mainland and islands. In addition to the reefs, the park also protects other marine habitats adjacent to the reefs, such as seagrass, mangroves, soft substrate, and mudflats. In 2004, a new reserve network was implemented by the Great Barrier Reef Marine Protection Authority (GBRMPA), which resulted in 33% of the GBR Marine Park protected by no take zones (Fernandes et al., 2005). These areas are important as they prohibit any harvest of marine organisms and may act as a refuge to targeted species.



Figure 1: Survey materials ready for use by underwater surveyors. This image shows an RCA data sheet and a complimentary citizen science monitoring program tool, the Coralwatch Coral Health Chart.

Over the preceding four years the Great Barrier Reef has endured several threats including multiple mass coral bleaching events (Hughes 2017, 2018) and the Whitsundays region was severely impacted by ex-tropical Cyclone Debbie, in March of 2017. Other major threats to the Great Barrier Reef include outbreaks of crown of thorns sea star (COTs) and coral disease (De'ath et al., 2012). Coastal development and agriculture have also been found to have negative impacts on the Reef. The large scale of agriculture

that covers much of the Queensland coast is a cause of excess nitrogen and phosphorus runoff through soils, fertilizers, and pesticides (GBRMPA, 2019, De'ath et al., 2012). Cumulatively, these threats are causing declines in reef health.

Survey Methods

Surveys are typically conducted between three and eight metres below lowest astronomical tide (LAT) utilising SCUBA. However, some survey sites are monitored by shallow water snorkelling and reef walking. GPS and detailed maps are used to ensure that each site is surveyed within the same location every year and at a consistent depth (± 1 m). Transect tapes are used to perform four 20 metre replicates, with five metres between each replicate (Figure 2). Teams of three to five trained volunteers are used to conduct full surveys that monitor indicator fish and invertebrate abundance, and changes in substrate. In addition, reef impacts such as abundance of coral scars, bleaching, disease, and marine debris are recorded.

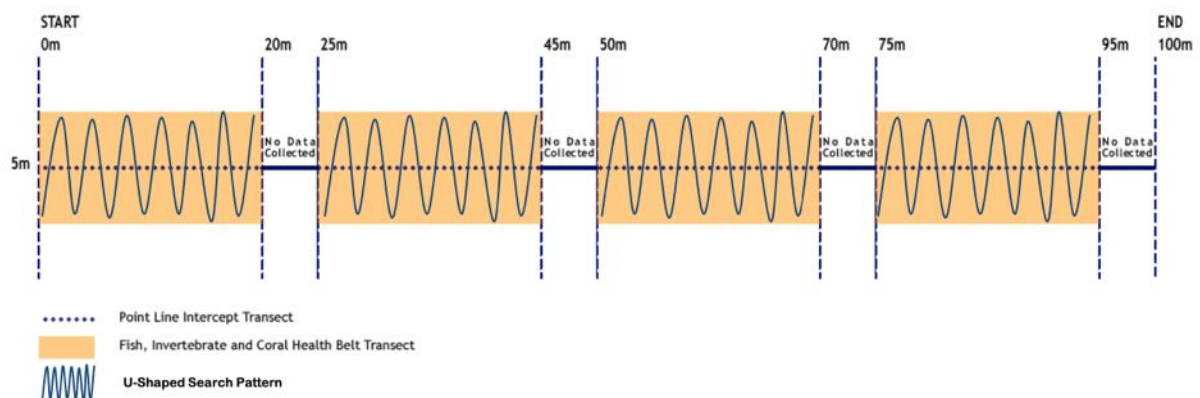


Figure 2: Reef Check Australia surveys consist of four 20 metre replicates with 5 metre gaps between each replicate.

To monitor substrate changes, volunteers perform point intercept transects (PIT) to record the substrate under the transect tape every half metre using underwater data sheets (Figure 1). Reef Check Australia categories include 10 general Reef Check categories and 15 Australia specific subcategories. Seasonal Macroalgae abundance is also recorded separately on substrate surveys (Table 1).

Table 1: Substrate categories and codes utilised for Reef Check Australia surveys

Reef Check Basic Categories	Reef Check Australia Categories
HARD CORALS Growth Forms	HCBR: Branching Hard Coral
	HCF: Foliose Hard Coral
	HCM: Massive Hard Coral
	HCE: Encrusting Hard Coral
	HCP: Plate Hard Coral
	HC: gathers all other growth forms (digitate, columnar, etc)
	HCB: Bleached Hard Coral
SOFT CORALS	SCL: Leathery Soft Coral
	SCZ: Zoanthids
	SC: Other Soft Coral (tree or flower shaped)
	SCB: Bleach Soft Coral
RECENTLY KILLED CORAL	RKCTA: Recently killed coral covered with turf algae
	RKCNIA: Recently killed coral covered with Nutrient Indicator Algae
	RKC: Recently killed coral (not covered with algae)
SPONGES	SPE: Encrusting sponge
	SP: All other sponges
OTHER	OT: All non-target life forms (ascidians, corallimorphs, etc)
MACROALGAE	MA: <i>Padina</i> , <i>Sargassum</i> , <i>Turbinaria</i> (and <i>Asparagopsis</i> in SEQ)
NUTRIENT INDICATOR ALGAE	NIA: All other algae forms
ROCK	RCTA: Rock covered with Turf Algae
	RCCA: Rock covered with Coralline Algae
	RC: Rock (not covered with algae)
SAND	SD: Coarse grain particulate matter
SILT	SI: Fine particulate matter
RUBBLE	RB: Un-consolidated substrate

A *belt* survey is used to monitor indicator invertebrate abundance and coral impacts. During these surveys, volunteers record any indicator invertebrate or impact within a 5-metre belt (2.5m on either side of the transect). Indicator invertebrates include: crown of thorns sea stars (COTS), *Drupella* snails, trochus shells, triton shells, giant clams, prickly greenfish sea cucumbers (*Stichopus chloronotus*), prickly redfish sea cucumbers (*Thelenota ananas*), collector urchins (*Tripneustes* spp.) long-spined sea urchins (*Diadema* and *Echinothrix* spp.), pencil urchins, lobsters, anemones, and banded coral shrimps. The impacts survey includes: coral bleaching (estimated percent of coral surface affected and coral population affected), coral damage (boat anchor, dynamite, or other), disease, COTS scars, *Drupella* scars, unknown scars, fishing line, and trash (fishing nets and general trash). Photos are taken to document each impact.

Fish surveys are conducted before the tape is laid. One volunteer moves slowly forward (approximately 10 minutes per 20 metres), recording all indicator fish that come within a 5 metre 'tunnel' in front of the volunteer. The tape is laid out behind the surveyor to ensure minimal disturbance during the fish survey. Indicator fish include barramundi cod, butterflyfish, coral trout, grouper, Queensland grouper, humphead wrasse, moray eel, bumphead parrotfish, other parrotfish, snapper and sweetlips. Fish surveys were not reported on in this report due to lack of coverage and consistency of the actual surveys completed.

2. Monitoring Sites

Reef Check Australia monitoring sites in the Great Barrier Reef for the reporting period range from Heron Island in the southern GBR to Port Douglas (Figure 3 and Table 2). RCA collects data in varied reef habitats, both within protected and non-protected marine park areas for contrast and comparison. During the 2019-20 GBR seasons RCA completed 70 surveys at 48 sites, 46 at existing reef sites and 2 new sites. Some sites were surveyed twice in this reporting period. For more information about GBRMPA zoning, visit <https://www.gbrmpa.gov.au/access-and-use/zoning>.

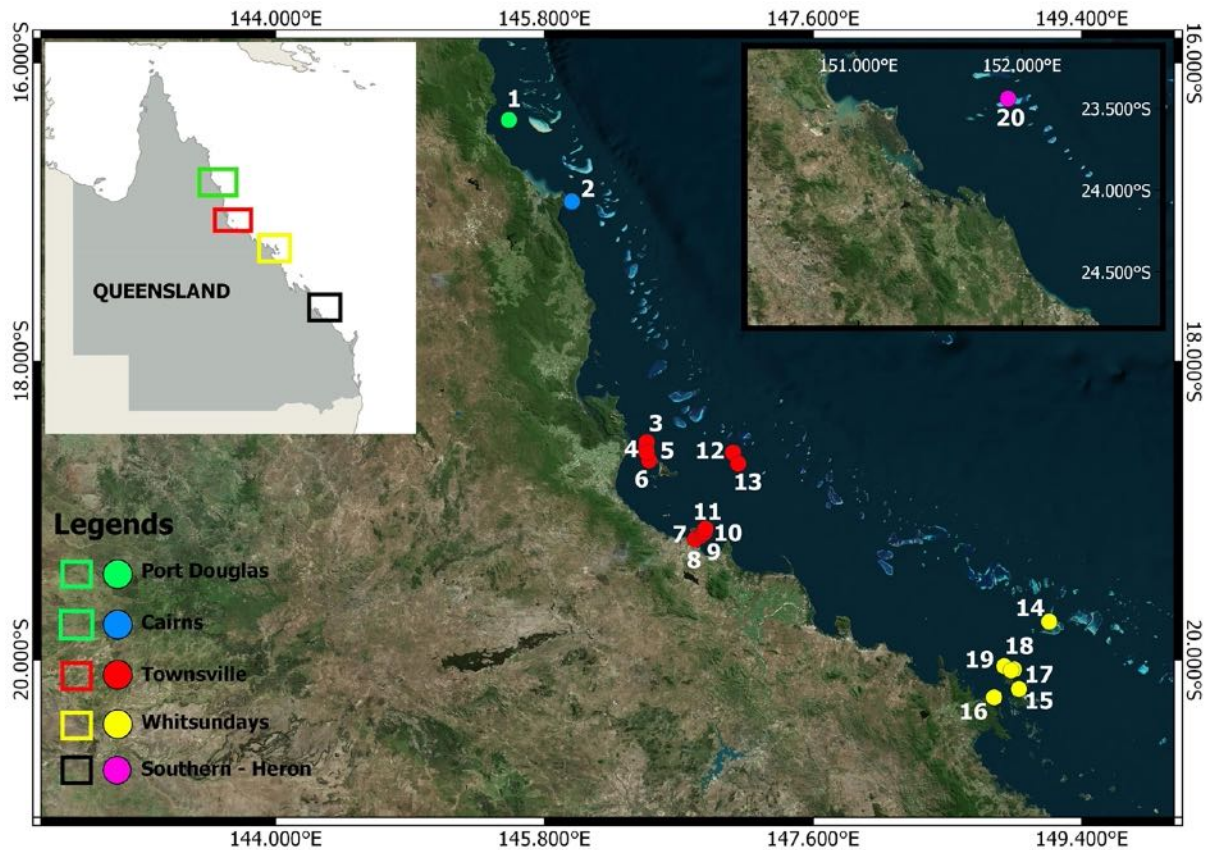


Figure 3: Map of North Queensland survey sites.

Table 2: Site Information as indicated in Figure 3

Map ID	Region	Location	Reef	Number of Sites
1	Port Douglas	Low Isles Reef	Low Isles	2
2	Cairns	Fitzroy Island	Fitzroy Island	1
3	Palm Island Reefs	Fantome Island	Juno Bay	2
4	Palm Island Reefs	Orpheus Island	Cattle Bay	2
5	Palm Island Reefs	Orpheus Island	Pioneer Bay	2
6	Palm Island Reefs	Pelorus Island	Pelorus Island	2
7	Townsville	John Brewer Reef	John Brewer Reef	2
8	Townsville	Lodestone Reef	Lodestone Reef	2
9	Townsville	Magnetic Island Reefs	Magnetic Island - Alma Bay	2
10	Townsville	Magnetic Island Reefs	Magnetic Island - Geoffrey Bay	2
11	Townsville	Magnetic Island Reefs	Magnetic Island - Nelly Bay	2
12	Townsville	Magnetic Island Reefs	Magnetic Island - Florence Bay	2
13	Townsville	Magnetic Island Reefs	Magnetic Island - Middle Reef	2
14	Whitsundays	Hayman Island Reefs	Hayman Island - Blue Pearl Bay	1
15	Whitsundays	Hook Island	Hook Island - Luncheon Bay	1
16	Whitsundays	Hook Island	Hook Island - Butterfly Bay	1
17	Whitsundays	Daydream Island	Daydream Island	2
18	Whitsundays	Whitsunday Island	Whitsunday Island - Peter's Bay	2
19	Whitsundays	Hardy Reef	Hardy Reef	2
20	Heron Island	Heron Reef	Heron Reef - Offshore	7
20	Heron Island	Heron Reef	Heron Reef - Inshore	7
	TOTAL	14 Locations	21 Reefs	48 Sites

3. Summary of Findings

3.1. Coral Cover

From the 70 surveys completed across 48 sites, live coral cover (LCC) was recorded at an average of 35.7% across all sites, times and locations (Table 3). This consisted of 28.2% hard coral and 7.4% soft coral (Table 3). LCC varied from a maximum of 65% at John Brewer Reef, offshore from Townsville, and 64.7% on the fringing reefs of Heron Island in the Southern GBR to a minimum observation of 2.5% at Daydream Island and 7.5% at Luncheon Bay in the Whitsunday Group. These sites in the Whitsundays have suffered greatly from the effects of ex-Tropical Cyclone Debbie.

Hard coral cover made up 28.2% of total LCC (Figure 4). Maximum hard coral cover was recorded at Heron Island in the Southern GBR (62%, n=7) while the lowest recording of hard coral cover was at Daydream Island (0.9%, n=2). Soft coral cover contributed 7.4% of total LCC and was prominent at two sites in the Palm Island Group; Pelorus Island (25.8%) & Orpheus Island, Cattle Bay (21.9%).

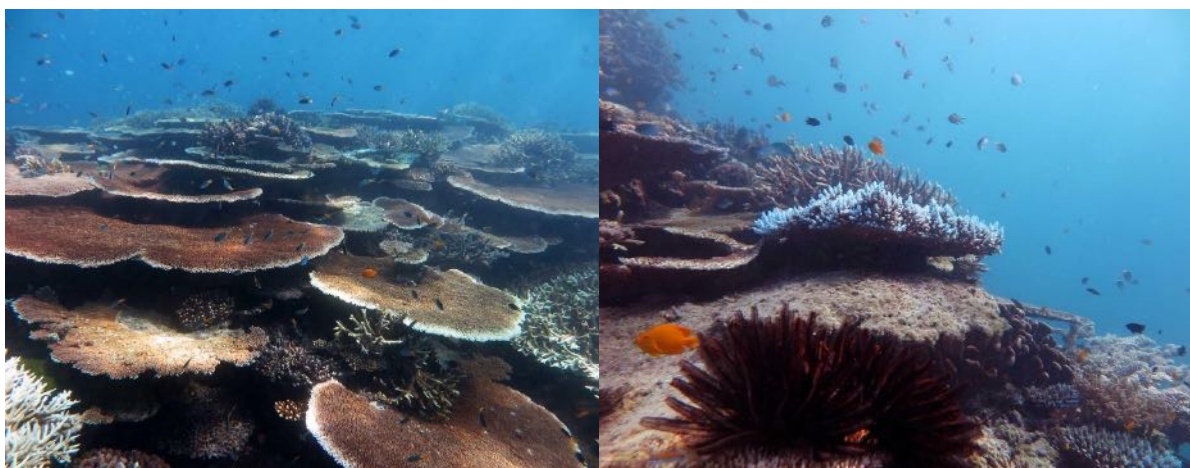


Figure 4: Plate corals proliferate on reef flats on offshore reefs across the GBR (left) while minor bleaching affects branching corals on the reef slope at John Brewer Reef (right)

3.2. Invertebrate Abundance

Invertebrate surveys were conducted across all sites, 70 surveys in total (Table 3). Giant clams were the most abundant indicator invertebrate recorded with a total of 7785 individuals recorded over 55 (or 79%) of surveys with a mean abundance of 111.2 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 (90) and long spined sea urchins (*Echinothrix* spp and *Diadema* spp.) were less commonly observed (Table 3).

A total of 15 crown of thorn sea stars (COTs) were recorded. Across 70 surveys COTS were only observed at 5 of the 21 reefs surveyed however COTS scars were observed during 17% of surveys.

For more information about COT outbreaks visit

<https://www.aims.gov.au/docs/research/biodiversity-ecology/threats/cots.html>

Table 3: Site summary – Mean benthos/substrate, invertebrates, and impacts indicators across all 21 locations at 48 sites in the GBR.

			Substrate (Mean)				Invertebrates (Mean)							Impacts (Mean)							
	Location =21	Sites = 48	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	Low Isles	2	34.8	9.2	1.5	0.8	0	25	0	0	2	0	0	2	3	1	2.3	0.3	1.4	11	0
2	Fitzroy Island	1	39.8	4.6	1.5	0.6	0	23	0	1	3	0	0	1	9	0	35	0	5.7	28	3
3	Fantome Island (Juno Bay)	2	33.4	0	0.5	0.5	0	954	0	0	1	-8	0	1	1	0	2.8	0.8	2.8	25	0
4	Orpheus Island (Cattle Bay)	2	33.1	21.9	0.6	0	0	266	0	0	6	1	0	4	0	0	2.5	0.3	5.9	63	0
5	Orpheus Island (Pioneer Bay)	2	30.8	10.8	0.9	0	0	590	0	0	1	0	0	1	0	0	0.8	0	14	45	0
6	Pelorus Island	2	17.5	25.8	0.5	0	0	18	0	0	0	1	0	1	1	0	8.8	0	11.1	62	1
7	John Brewer Reef	2	58.8	6.3	10.2	0	5	2	0	0	5	3	0	3	10	4	12	2.7	14.1	38	2
8	Lodestone Reef	2	12.5	4.7	13	0	1	3	0	0	6	5	0	3	1	0	1.8	0.5	25.4	47	0
9	Magnetic Island - Alma Bay	2	29.4	1.9	34.7	0.3	0	0	0	0	1	0	0	0	7	0	3	0.5	0.5	2.6	0
10	Magnetic Island - Geoffrey Bay	2	58.4	0	40.6	0.3	0	1	0	0	24	0	0	0	0	0	13	3	0.9	30	0
11	Magnetic Island - Nelly Bay	2	18.3	0.2	66.3	0.3	0	0	0	1	26	0	0	10	6	0	4.8	5.3	0.9	9	1
12	Magnetic Island - Florence Bay	2	20.9	0.6	35.3	0.6	0	0	0	0	4	0	2	2	0	0	1.5	0	11.4	75	0
13	Magnetic Island - Middle Reef	2	34.4	0	41.6	12.8	0	0	0	0	3	0	0	0	0	0	9.5	0	4	71	1
14	Hayman Island - Blue Pearl Bay	1	22.2	0	27.5	5.9	0	30	0	1	0	0	0	0	8	0	0.5	0	1.3	14	0

			Substrate (Mean)				Invertebrates (Mean)							Impacts (Mean)							
	Location =24	Sites = 48	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 #
15	Hook Island - Luncheon Bay	1	6.9	1	28.8	9.2	0	10	0	0	0	0	0	0	2	0	0.3	0	8.8	9.3	0
16	Hook Island - Butterfly Bay	1	20.9	15.6	0.9	7.5	0	41	0	0	3	0	0	1	0	0	4	0	18.8	30	0
17	Daydream Island	2	0.9	1.6	36.9	26.3	0	1	0	0	0	1	0	0	0	0	0	0	31.8	27	0
18	Whitsunday Island - Peter's Bay	2	10.9	35	1.3	0	0	15	0	0	2	1	0	1	0	0	1.5	0	12.9	67	1
19	Hardy Reef	2	34.8	14.4	0.8	0.2	0	12	0	1	0	4	0	0	4	0	6.3	4	25.9	33	0
20	Heron Reef - Offshore	7	62	2.8	0.8	0.1	1	3	0	0	1	1	0	1	9	2	8.9	13	0.9	25	1
21	Heron Reef - Inshore	7	12.1	0.1	12.9	0.3	10	5	0	0	0	1	0	0	3	0	0.3	1	16	18	0
	Mean		28.2	7.4	17	3.1	0.8	111.2	0	0.2	4	0.4	0.1	1	3	0	5.7	1.4	10.2	35	0

3.3. Reef Health Impacts

Impact surveys were performed at all sites surveyed (Tables 3 and 4 and Figure 5). Coral bleaching was observed at 62 out of 70 surveys (88.6%) (Table 4). However, population level bleaching was not substantial across surveyed sites, with an average of 10.2% of the population affected.

Coral disease was recorded during 21 of the 70 surveys completed (31.4%) (Table 4), with an average abundance of 2.2 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 30 out of 70 surveys (43%), but in fairly low abundance (average of 1.47 per 400m² on all transects). *Drupella* scarring was recorded on 28 of 70 surveys (40%) with an average abundance of 0.4 per 400m².

Coral scarring from unknown causes was commonly recorded on impact surveys (33 of 70 surveys or 47%) which ranged from just one scar to as many as 27 per 400m². The majority of surveys reported hard coral damage (53 of 70 or 76%). The number of recorded incidents per site varied from only one, to as many as 64 per 400m². Rubbish was not commonly reported on surveys. Marine debris was reported on 12 of 70 surveys (17%) with low incidences between 1-4 items observed.

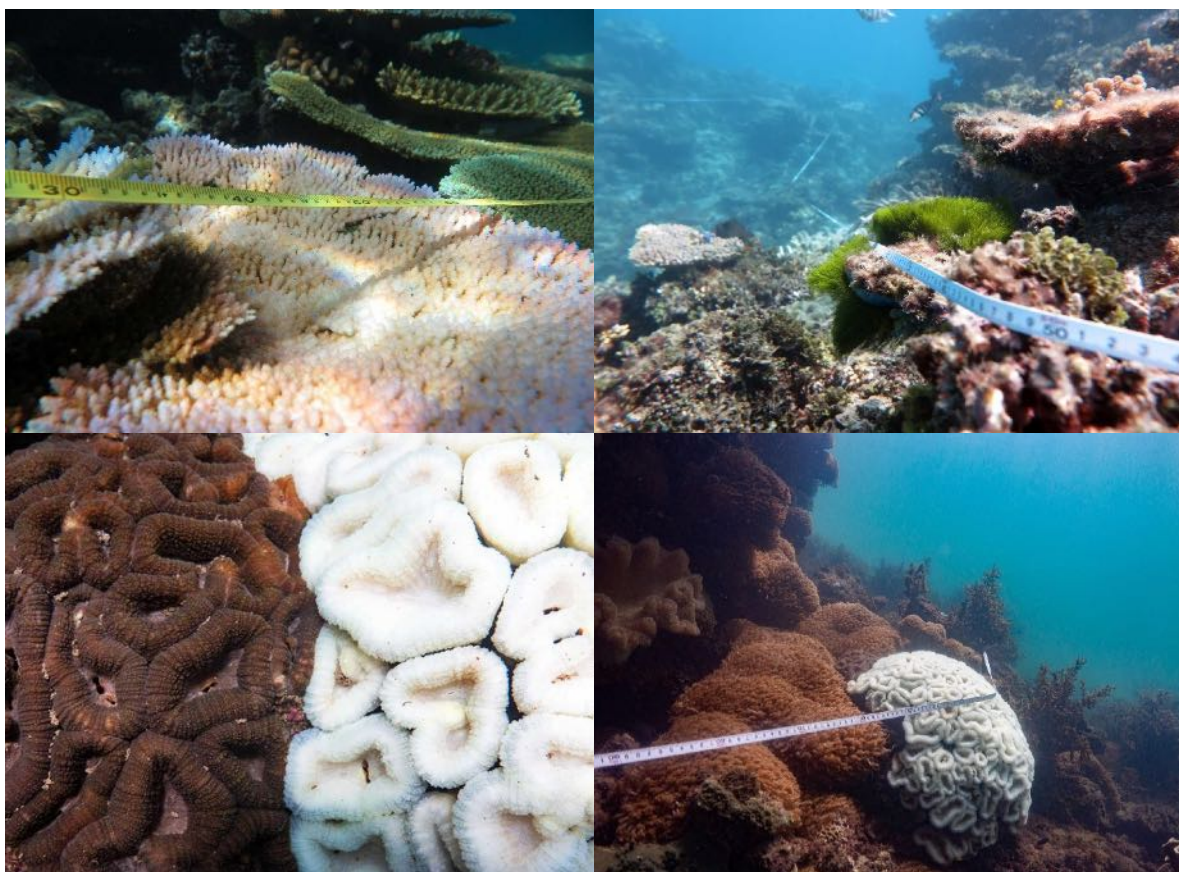


Figure 5: Examples of impacts across Reef Check survey sites illustrating bleaching at John Brewer Reef (top left), coral damage from COTS at Lodestone Reef (top right), variable bleaching at Florence Bay, Magnetic Island (bottom left and right).

Table 4: The percent of RCA survey sites with recorded impacts (of a total of 48 sites), and the average abundance of impacts recorded from 2019-2020

Impacts	% of sites with impact	Average abundance (per400m ²)
Coral Bleaching	88.6	10.21%
Coral Damage	75.7	5.5
Coral Disease	31.4	2.2
<i>Drupella</i> Scars	40	1.47
Marine Debris	17.14	0.44
CoTS Scars	7	0.4
CoTS	16.67%	0.63
Unknown scars	47.14	3.41

4. Cairns - Port Douglas

Cairns and Port Douglas are famous gateways for tourists to come and enjoy the Great Barrier Reef first-hand. The reefs are essential to local communities and the high numbers of visitors make these areas of high socio-economic value to the tourism industry.

Surveys have been conducted in various years, with the earliest sites established in 2002, and the latest in 2017. During the 2019-2020 survey season, Reef Check Australia volunteers visited three sites across two reefs in the Cairns (Fitzroy Island) and Port Douglas (Low Isles) region. The intention is to continue building on existing monitoring and revisit established sites at other offshore reefs in this region.

4.1. Low Isles Reef

Site Description

Situated 15km Northeast off the coast of Port Douglas, Low Isles reef surrounds two small coral cay islands. The two small islands, Low Island and Woody Island, are separate but share the common fringing reef (Figures 6 & 7) and are sheltered by the mangroves that make up Woody Island. Low Isles has important Indigenous cultural heritage connections for both the local KuKu Yalanji and Yirrganydji tribes.

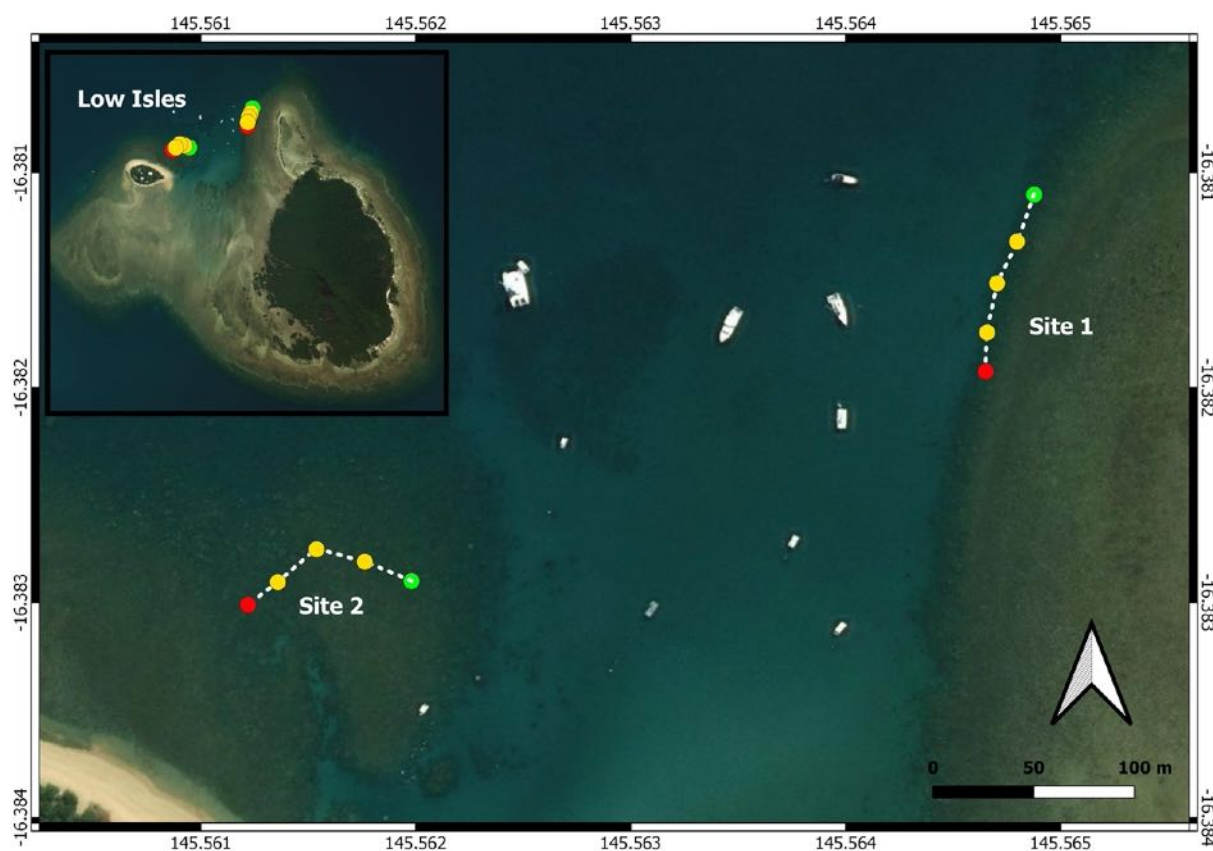


Figure 6: Map showing survey sites 1 and 2 at Port Douglas Low Isles Reef.



Figure 7: Low Isles Reef Site 1 location adjacent to Woody Island.

The two RCA survey locations at Low Isles are located in different coral reef habitats; one in the lagoon on the leeward side of the islands (Figure 6) and the other on the reef crest. Site 2 crosses the shallow (1-2m) lagoon/ reef flat to the north of Low Island consisting of soft coral (mostly *Sarcophyton* spp.) and robust *Acroporid* spp. Site 1 on the reef edge to the north-west of Woody Island crosses a field of *Porites* spp. bommies, interspersed with a diversity of branching and massive corals. Low Isles has been surveyed 14 times since 2002.

Substrate Survey

Live coral cover (LCC) was measured at 48.75% consisting of 41.9% hard coral and 7.8% soft coral (Figure 8).

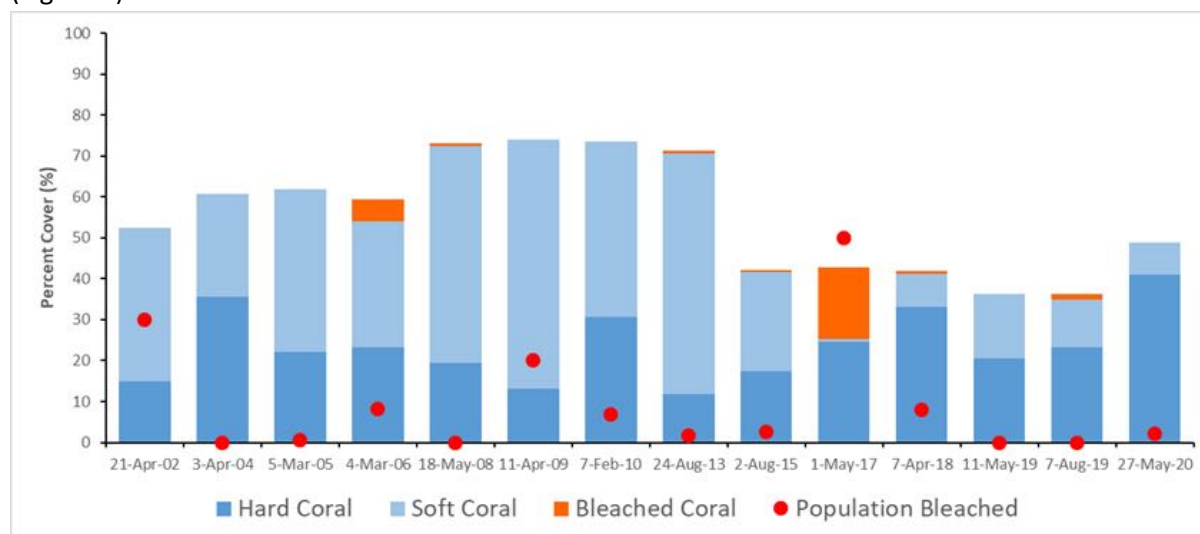


Figure 8: Long-term percent cover of hard and soft corals and bleached corals by survey year at Low Isles Reef, Port Douglas Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

LCC increased at Low Isles from 36.25% in 2019 following successive bleaching events (as illustrated in surveys conducted in 2017 where over 50% of the coral population bleached). LCC in 2020 whilst increasing on previous years represents a significantly lower LCC than highs (>70%) (assessed between 2008-2013) (Figure 9). This has been driven by significant reductions in soft coral. Hard coral cover has increased relative to soft coral in recent years although hard coral cover assessed by RCA is substantially higher than recently assessed by AIMS in 2019 at 24% using fixed transects and in 2020 using manta tow (AIMS, 2020). Soft coral mortality through successive bleaching events has reduced soft coral contribution to LCC from 24% in 2015 to its current level at less than 8%. Reef composition has been dominated over the years by live coral and rock with low contributions of nutrient indicator algae (NIA).

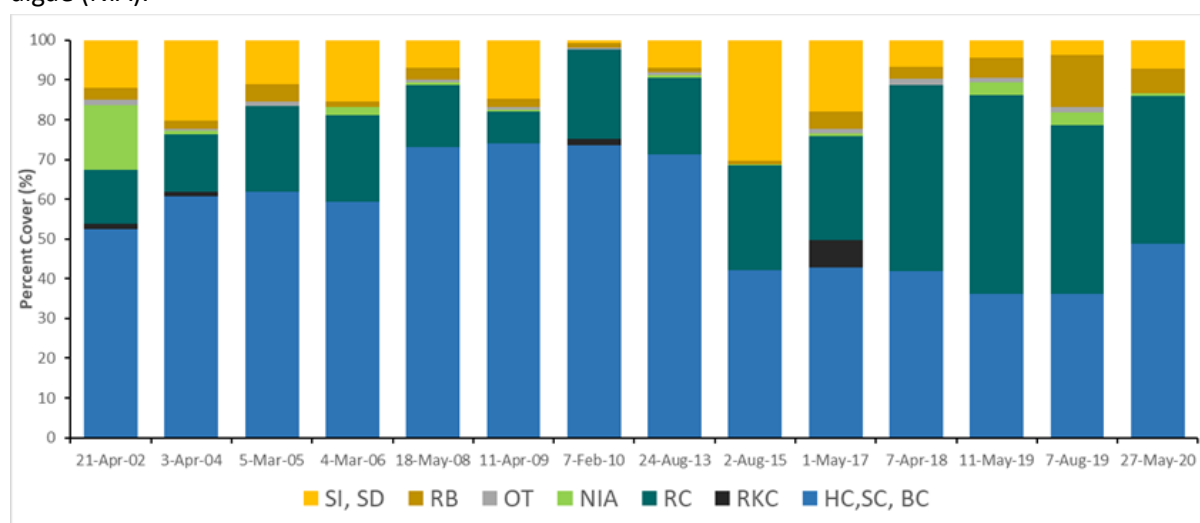


Figure 9: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Low Isles Reef, Port Douglas Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

Hard coral (41%) and rock (37%) dominated the benthic surveys at Low Isles in 2020. Soft coral (8%), rubble (6%) and sand/silt (7%) made up the other major benthic organisms greater than 5% (Figure 10). Hard corals were dominated by encrusting (29%), massive (27%) and branching (24%) morphologies.

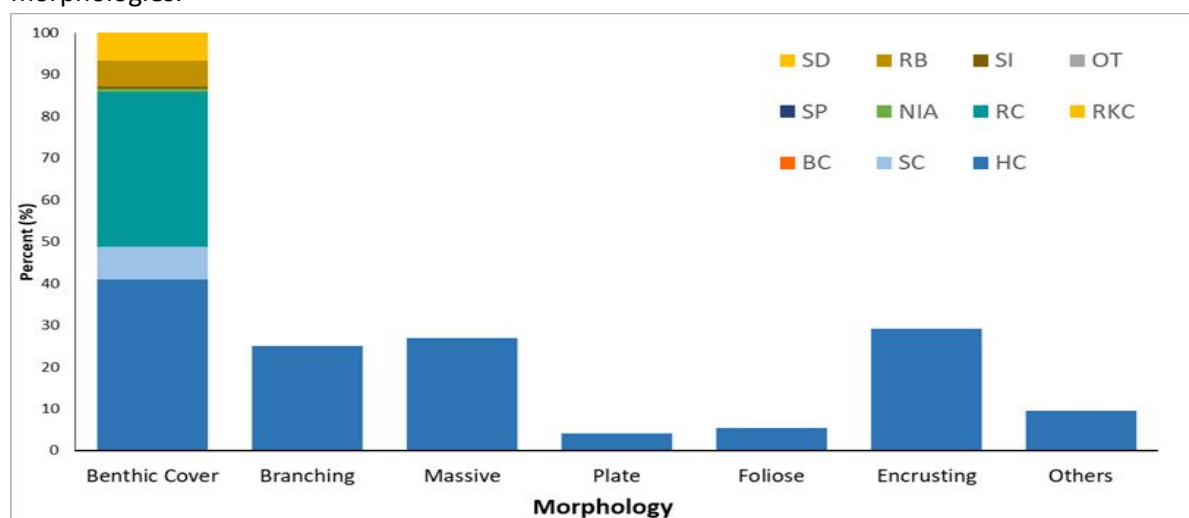


Figure 10: Percent cover of different benthic categories and dominant hard coral morphologies at Low Isles Reef, Port Douglas Reef Check Australia monitoring site.

Invertebrates and Impacts

Seventy-five giant clams (*Tridacna* spp.) were recorded during three surveys at Low Island with an average abundance of 25 per 400m². The sites were devoid of sea urchins and sea cucumbers with the only other invertebrates surveyed being *Drupella* spp. snails and *Drupella* snail scars (average of 2.0) observed on 2 of the 3 surveys. Coral bleaching was observed during surveys in May 2020 following warmer than average sea temperatures. The percentage of the population bleached was low (1.4%) while the percentage of the colony which bleached was also low (11.3%). Reported coral damage was a mean of 2.3 incidences across sites while unknown scars were observed an average of 2 times per site.

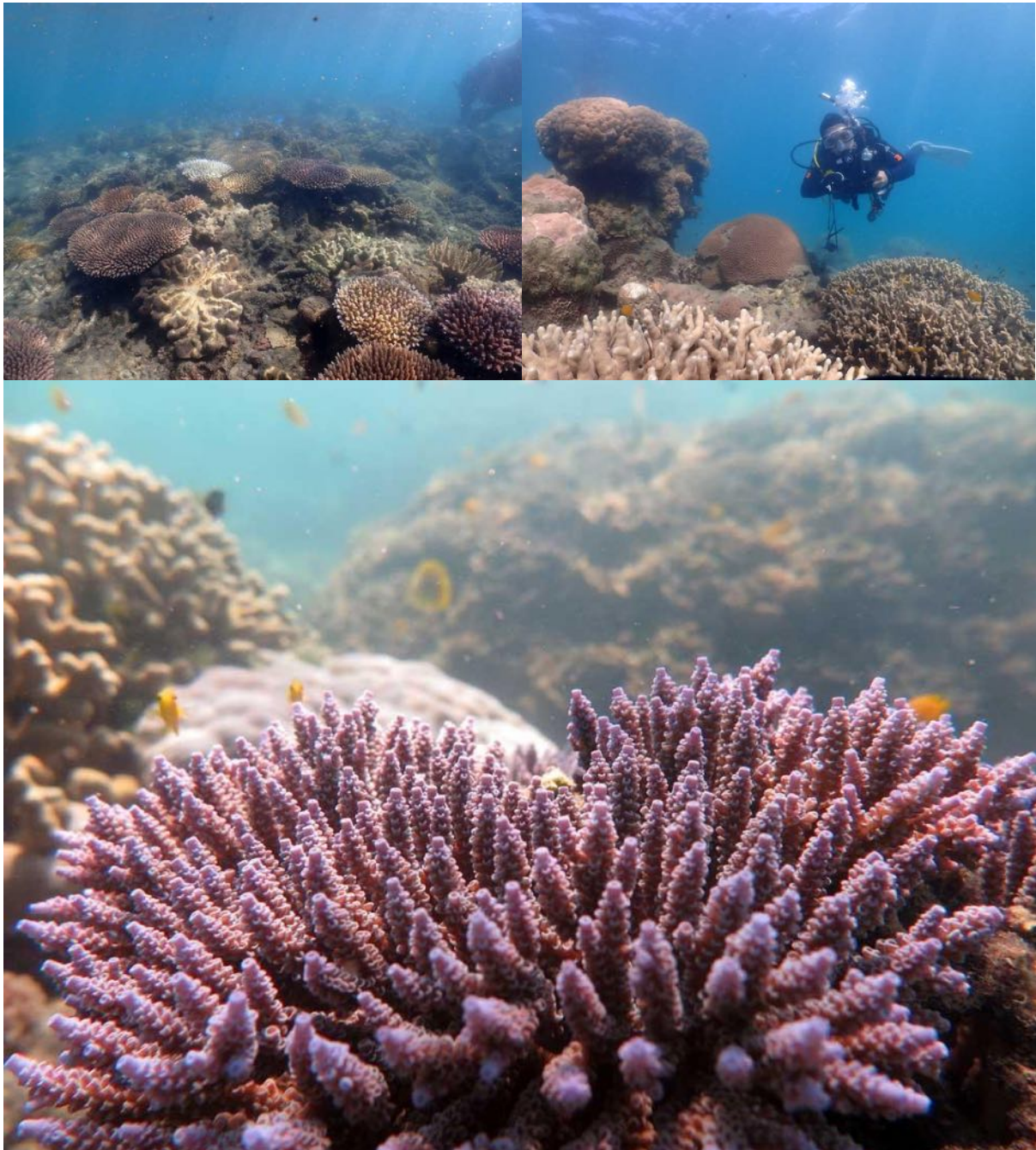


Figure 11: Images of Site 1 at Low Isles adjacent to Woody Reef (top left and bottom, and diver conducting surveys at Site 1 (top right).

4.2. Fitzroy Island

Site Description

Located almost 30km off Cairns, Fitzroy Island hosts a tropical rainforest and a fringing coral reef. It is home to the Fitzroy Island resort and is popular with the local community for many water-based activities (Figure 12).

A total of three sites were established in 2017 at Fitzroy Island, two of which were completed in the 2019 survey season. Both sites are located on the leeward side of the island and while they are generally quite sheltered by the weather, these sites suffer from high visitor traffic. “Spot X” is located alongside the rocky boulders in front of Foxy's café (Figure 12) and “White Rock” is located further north along the island (Figure 13).



Figure 12: Fitzroy Island looking south toward Spot X survey location.

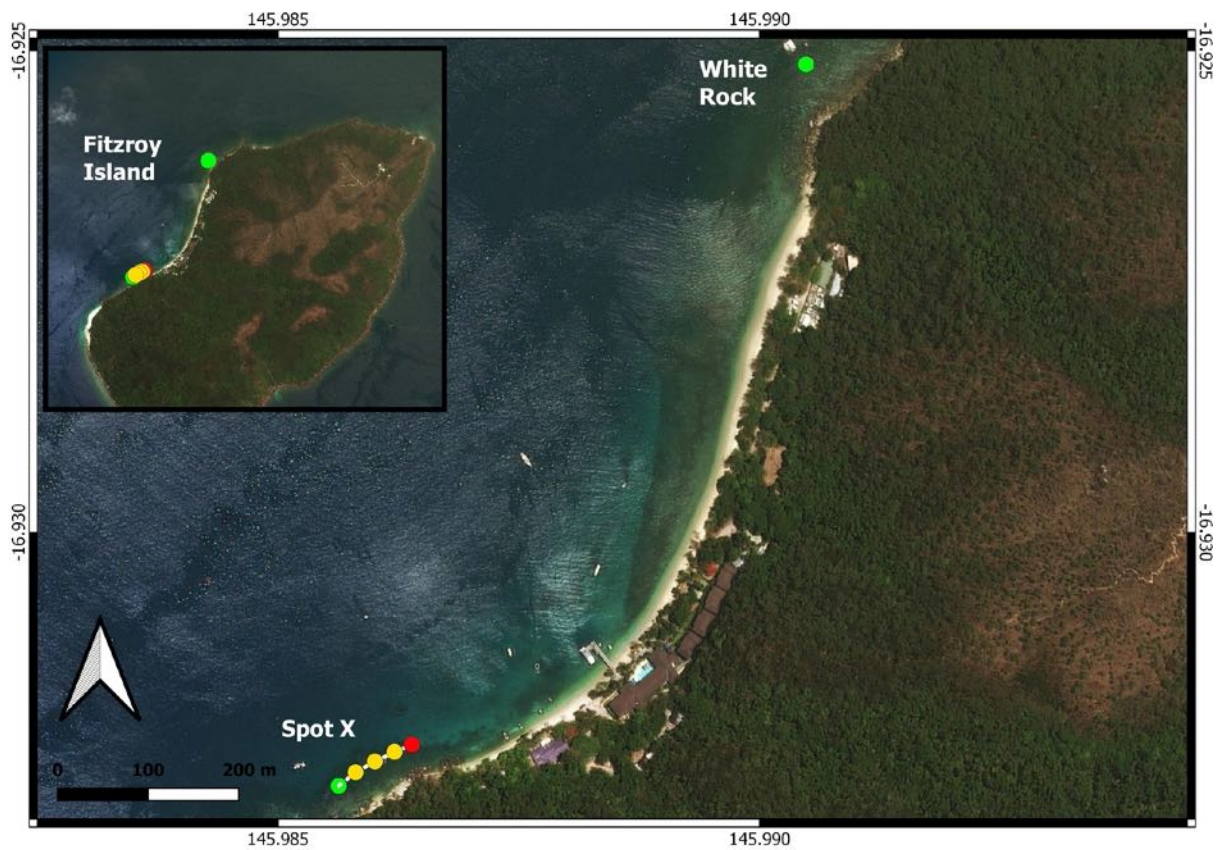


Figure 13: Map showing survey Spot X and White Rock sites in Fitzroy Island, Cairns.

Substrate Survey

Live coral cover (LCC) was measured at 55.01% consisting of 49.4% hard coral and 5.6% soft coral (Figure 14).

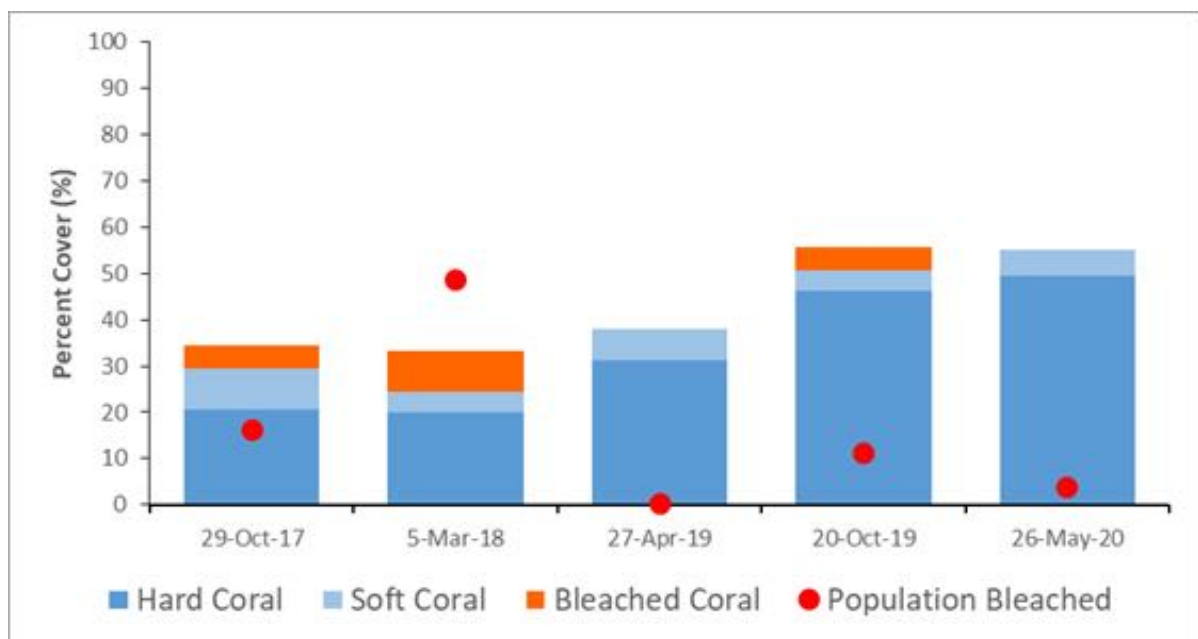


Figure 14: Long-term percent cover of hard and soft corals and bleached corals by survey year at Fitzroy Island, Cairns Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

LCC increased at Fitzroy Island from 2018 levels by over 17% in 2019/20 to 55%. This increase occurred despite unseasonal bleaching of 11.25% of the coral population in the first half survey period (October 2019). Since surveys began at the site in 2017, LCC in May 2020 is the highest on record (Figure 15).

Soft coral cover has increased relative to hard coral since October 2019. However, soft coral mortality through successive bleaching events has reduced an already low soft coral contribution to LCC from 8.75% in 2017 to 6% in 2020, compared with hard coral contribution to LCC which has increased from 20.63% in 2017 to close to 50% in 2020. Reef composition has been dominated by live coral and rock (although 'rock' has decreased by >30% since 2017) with an increase in rubble observed (19% in 2020). Contributions of nutrient indicator algae (NIA) remain low (1.25%).

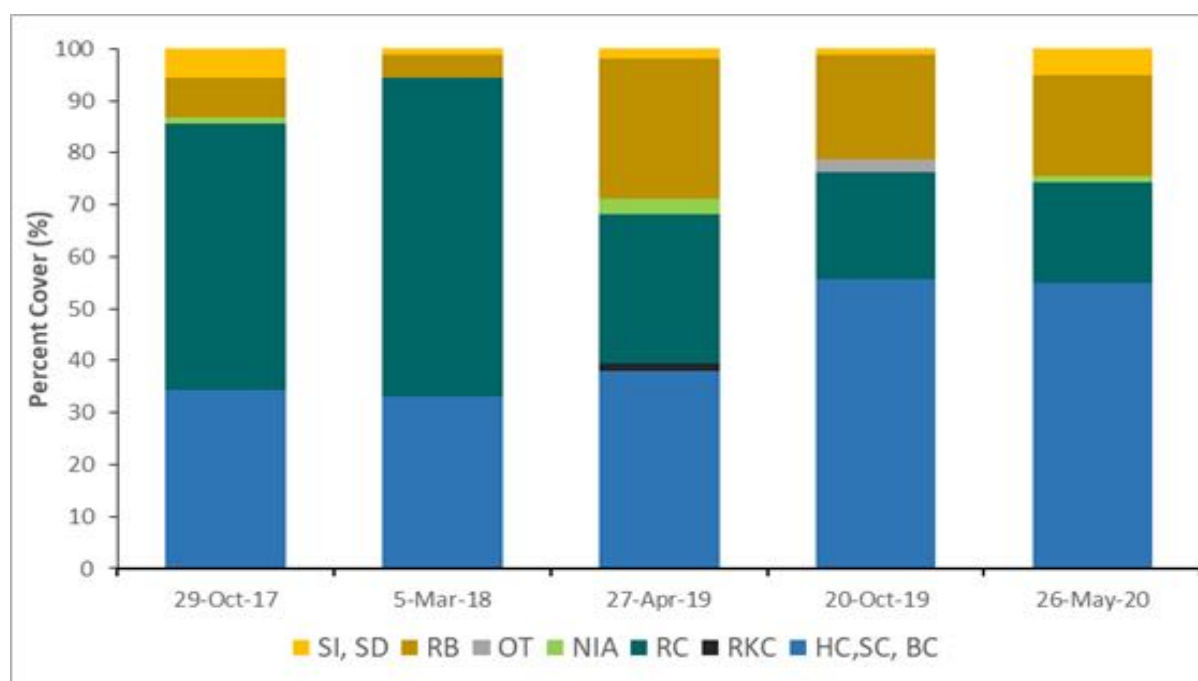


Figure 15: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Fitzroy Island, Cairns Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

Hard coral (49%), rock (19%) and rubble (19%) dominated the benthic surveys at Fitzroy Island in 2020. Soft coral (6%) made up the other major benthic organisms greater than 5% (Figure 15). Hard corals were dominated by branching (70%), massive (19%) and encrusting (5%) morphologies (Figures 16 and 17).

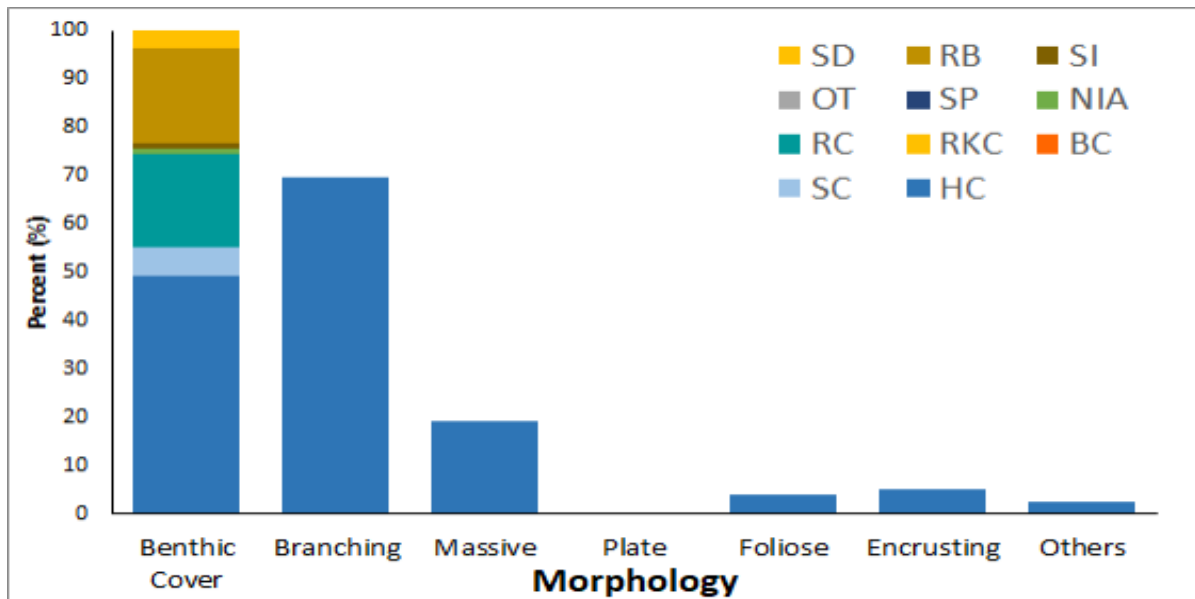


Figure 16: Percent cover of different benthic categories and dominant hard coral morphologies at Fitzroy Island Reef, Cairns Reef Check Australia monitoring site.

Invertebrates and Impacts

The most abundant invertebrate surveyed in 2020 at Fitzroy Island was the giant clam (21), with drupella snails (3) and crown of thorns starfish (2) also observed, along with scarring from both. The abundance of invertebrates at the site was much higher in 2019 with 49 giant clams, one triton, two trochus and six drupella snails recorded. Reported coral damage had decreased from 96 incidences in 2019 to just nine in 2020 and a reduced level of coral colonies (3.75%) exhibited bleaching.



Figure 17: Soft corals (top left), a variety of hard corals (top right) and the reefscape at Fitzroy Island Spot X.

5. 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 a 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 18) and in 2017, partnerships with local tourism operators allowed the commencement of surveys on the outer reefs. During the 2019 season, surveyors completed surveys on a total of 22 sites across 11 reefs.

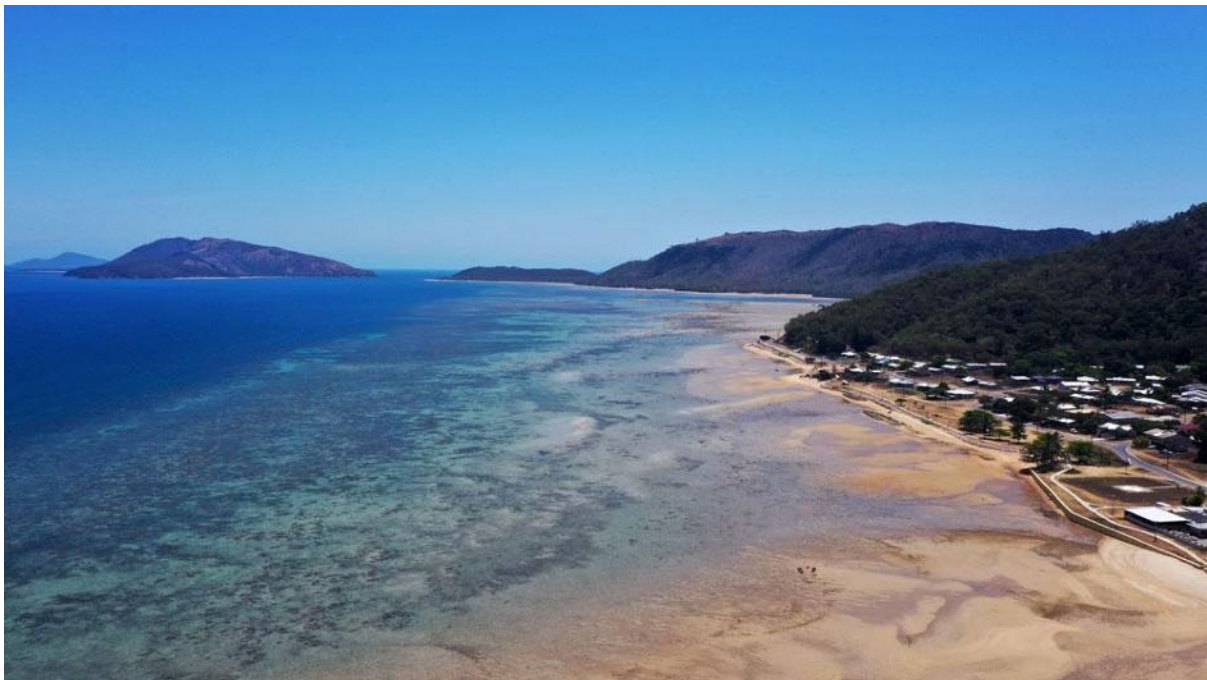


Figure 18: Palm Island and town near multiple survey sites in the Palm Island Group.

5.1. 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 19). 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.

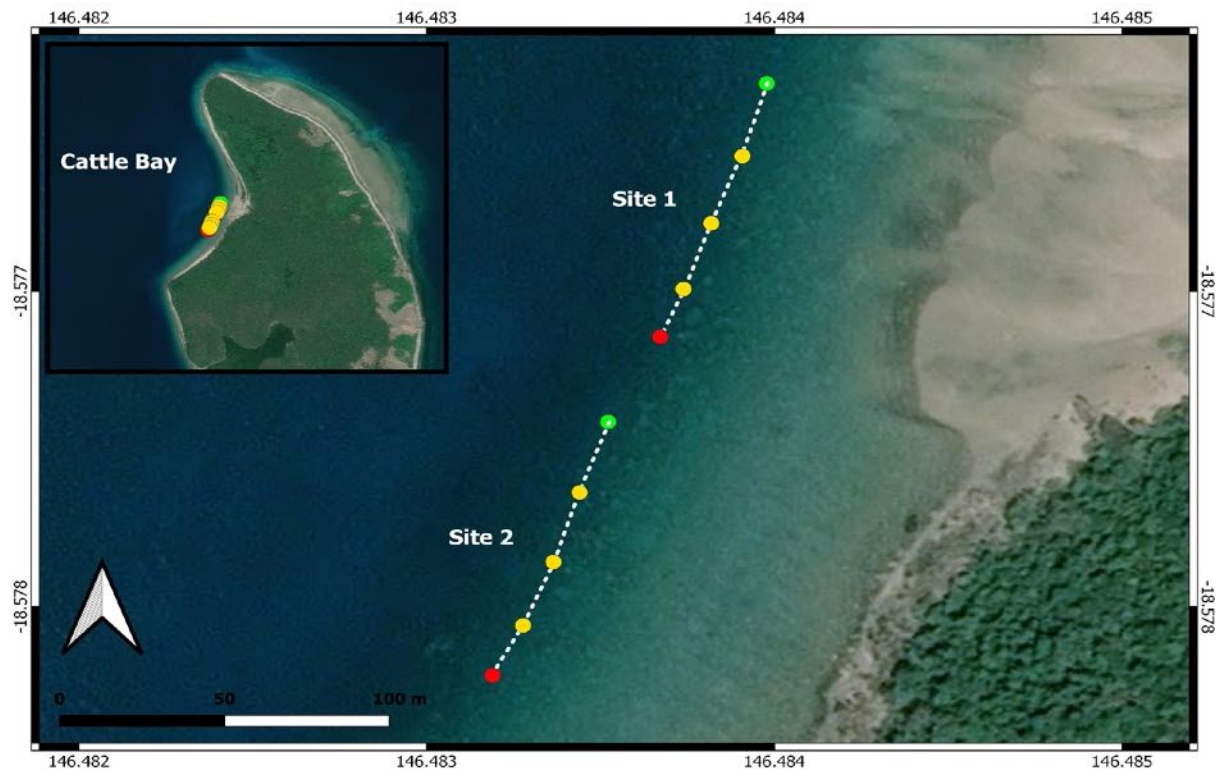


Figure 19: Map showing survey sites 1 and 2 in Cattle Bay, Orpheus Island.

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 20). 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%).

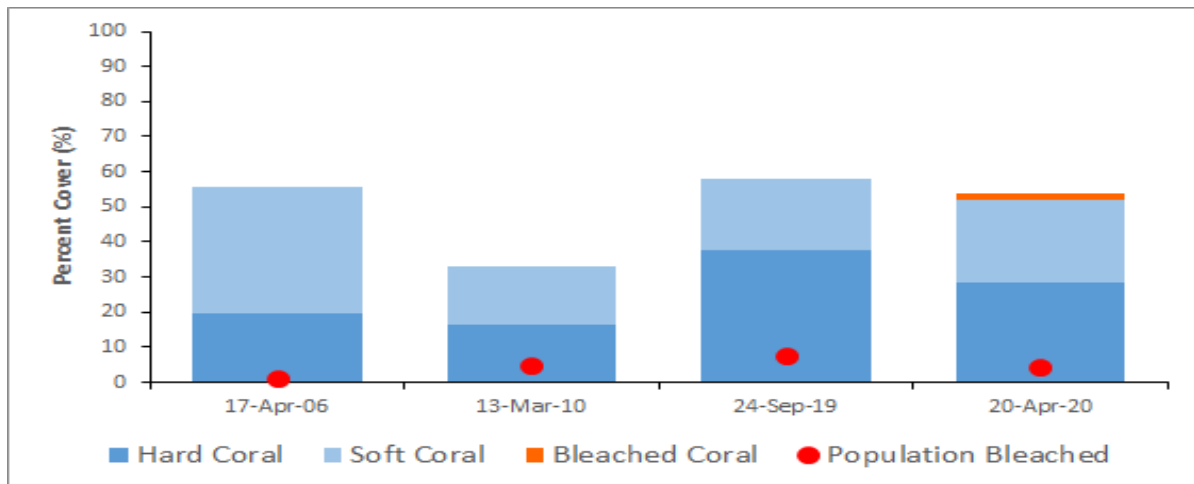


Figure 20: Long-term percent cover of hard and soft corals and bleached corals by survey year at Cattle Bay, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included 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 21). 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).

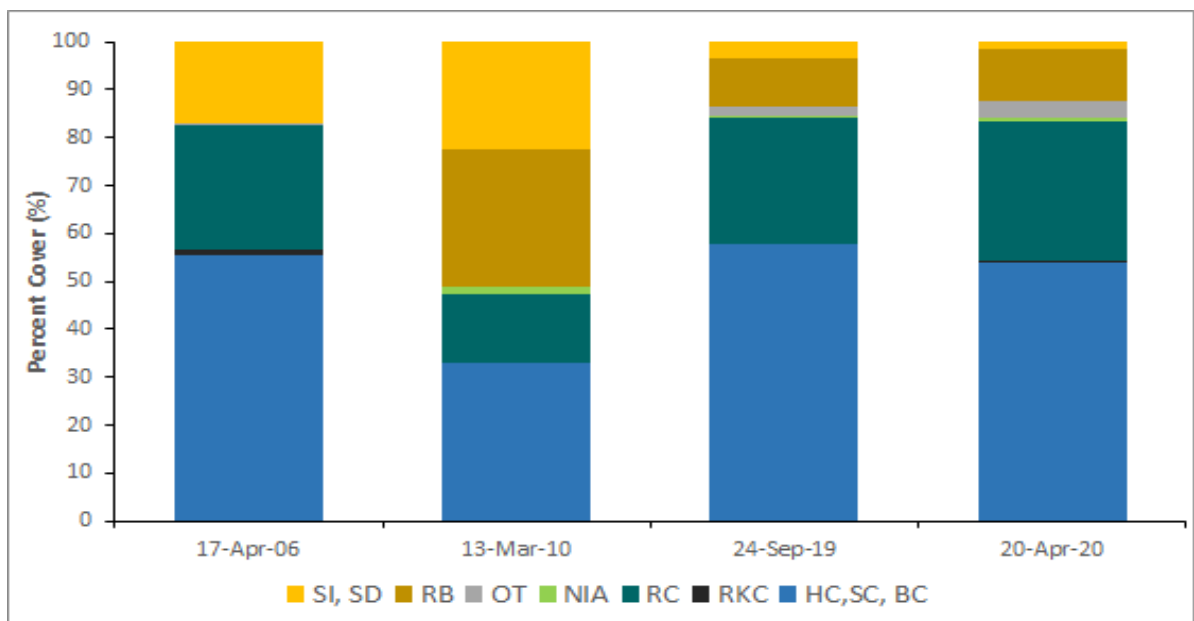


Figure 21: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Cattle Bay, Palm Island Reef Check Australia monitoring site.

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 22). Of the hard corals, the dominant morphology type was branching corals (17%), followed by massive (9%) and then encrusting (2%).

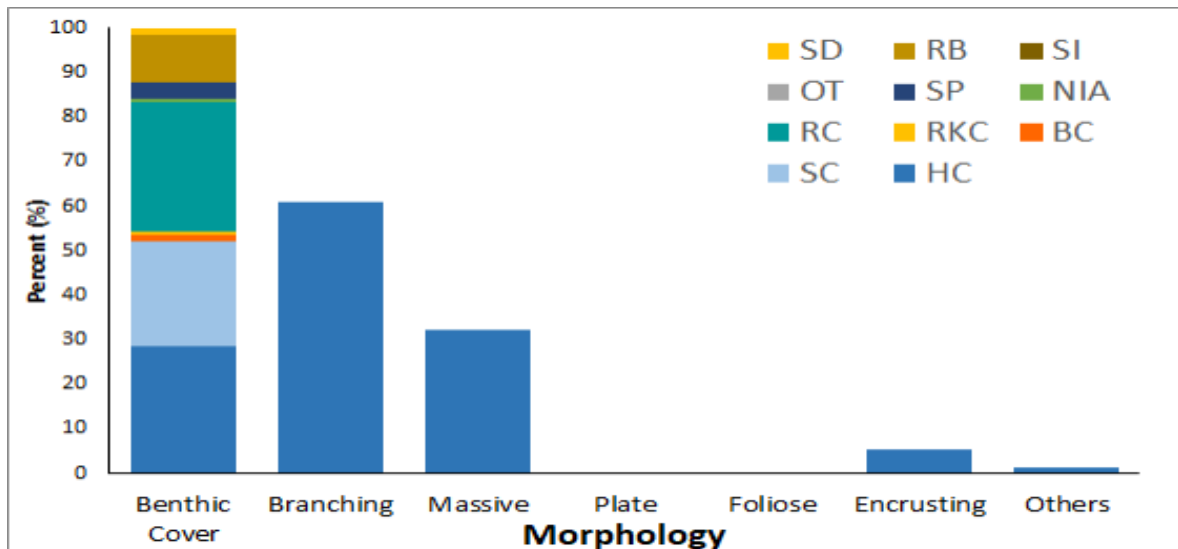


Figure 22: Percent cover of different benthic categories and dominant hard coral morphologies at Cattle Bay, Palm Island Reef Check Australia monitoring site.

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 3, Image 23). 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.

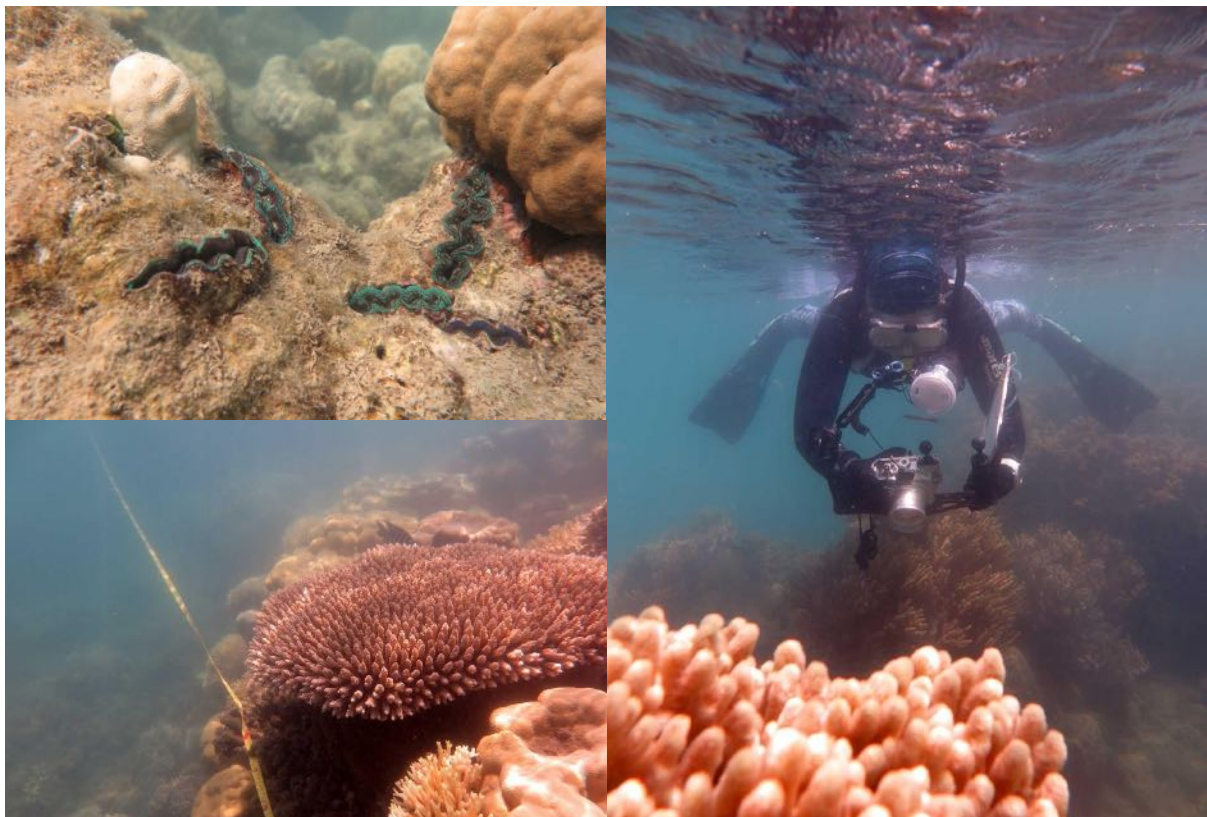


Figure 23: Giant clams (*Tridacna* sp.) embedded into the reef rock (top left) transect line and reefscape (bottom left) and snorkel surveyor collecting images (right).

5.2. 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 24). RCA has two sites in the shallow reef flat at Pioneer Bay accessible from the popular snorkelling point near the shore.



Figure 24: 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 25). 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.

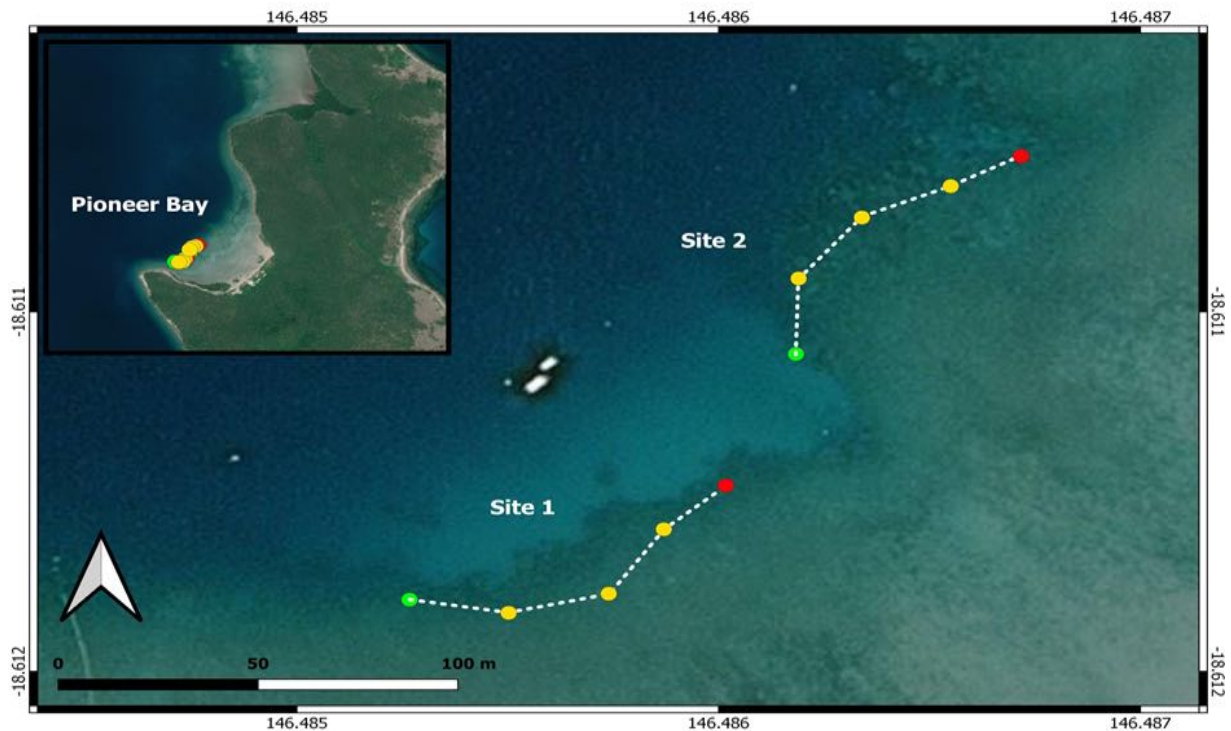


Figure 25: Map showing survey sites 1 and 2 in Pioneer Bay, Orpheus Island.

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 26). 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).

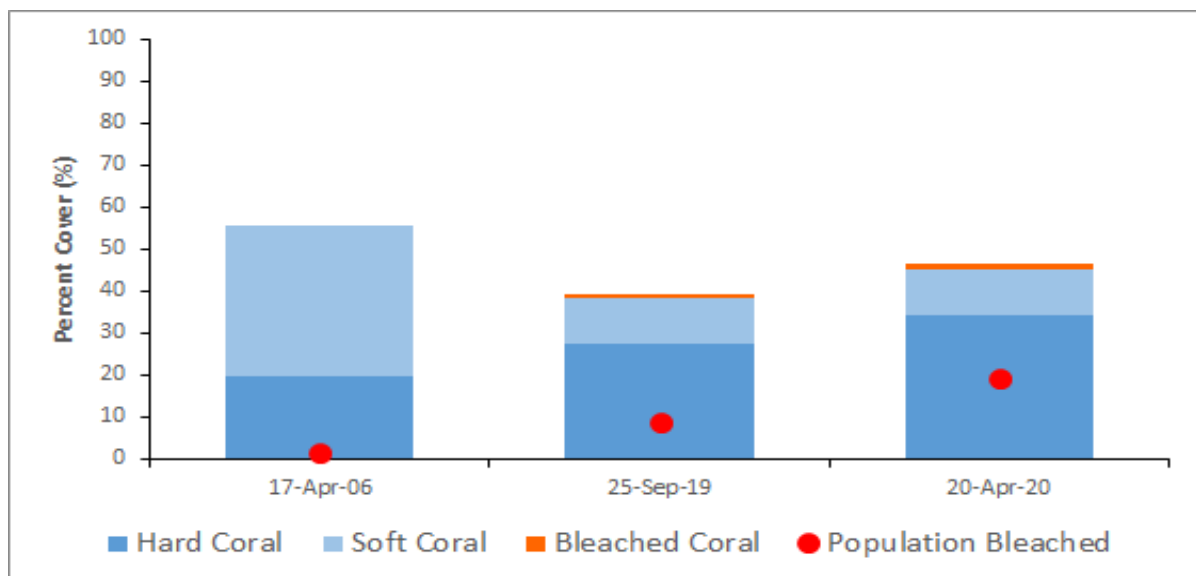


Figure 26: Long-term percent cover of hard and soft corals and bleached corals by survey year at Pioneer Bay, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included 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 27). This site has not been surveyed since 2006, in which live coral cover made up 55% of the substrate.

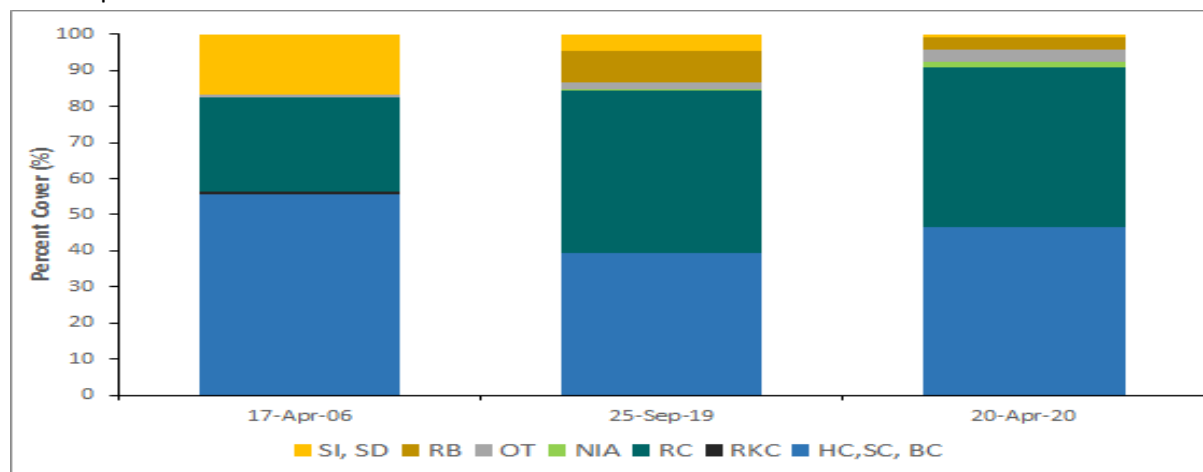


Figure 27: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Pioneer Bay, Palm Island Reef Check Australia monitoring site.

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 28).

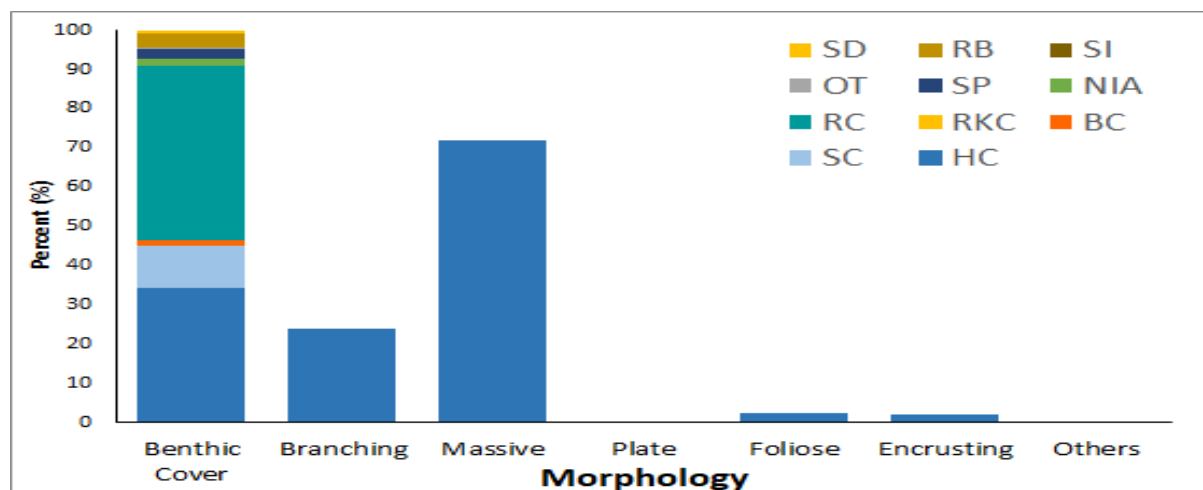


Figure 28: Percent cover of different benthic categories and dominant hard coral morphologies at Pioneer Bay, Palm Island Reef Check Australia monitoring site.

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.

5.3. 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 29). 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.

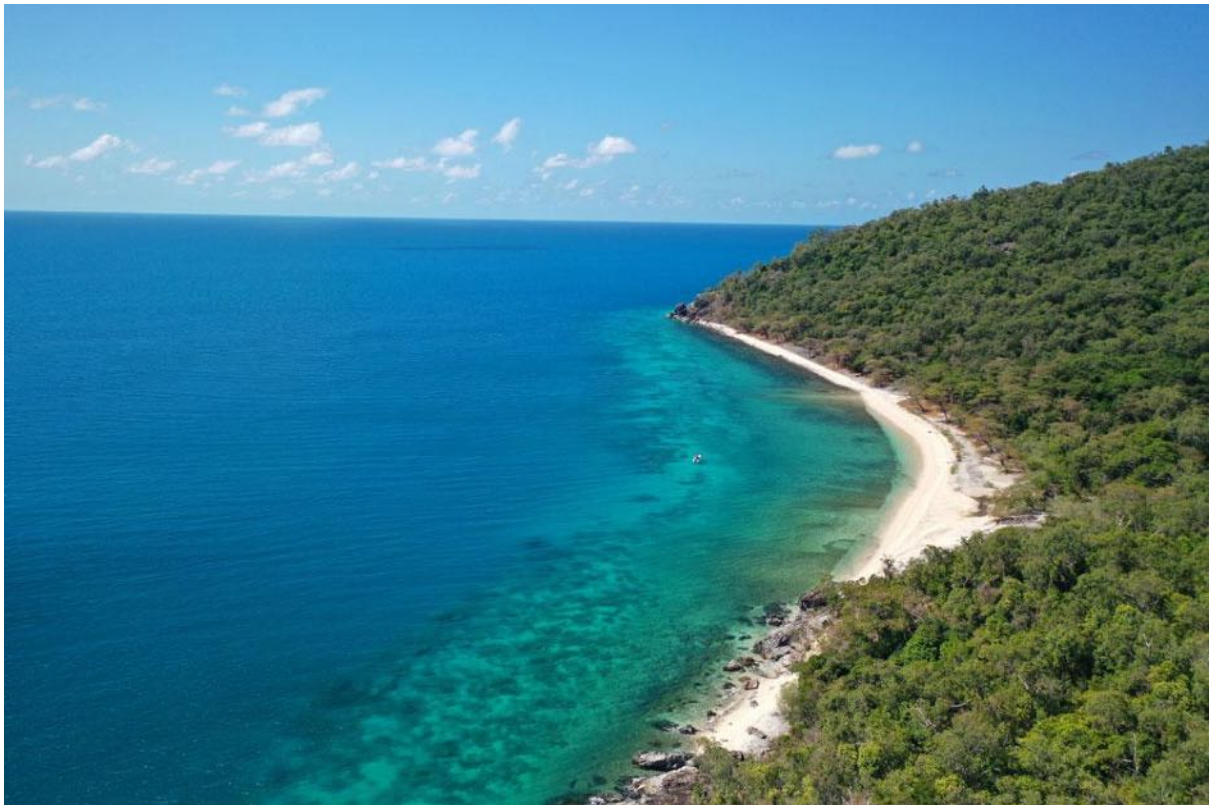


Figure 29: Overview of Pelorus Island's west coast and location of survey sites.

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 30). 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.

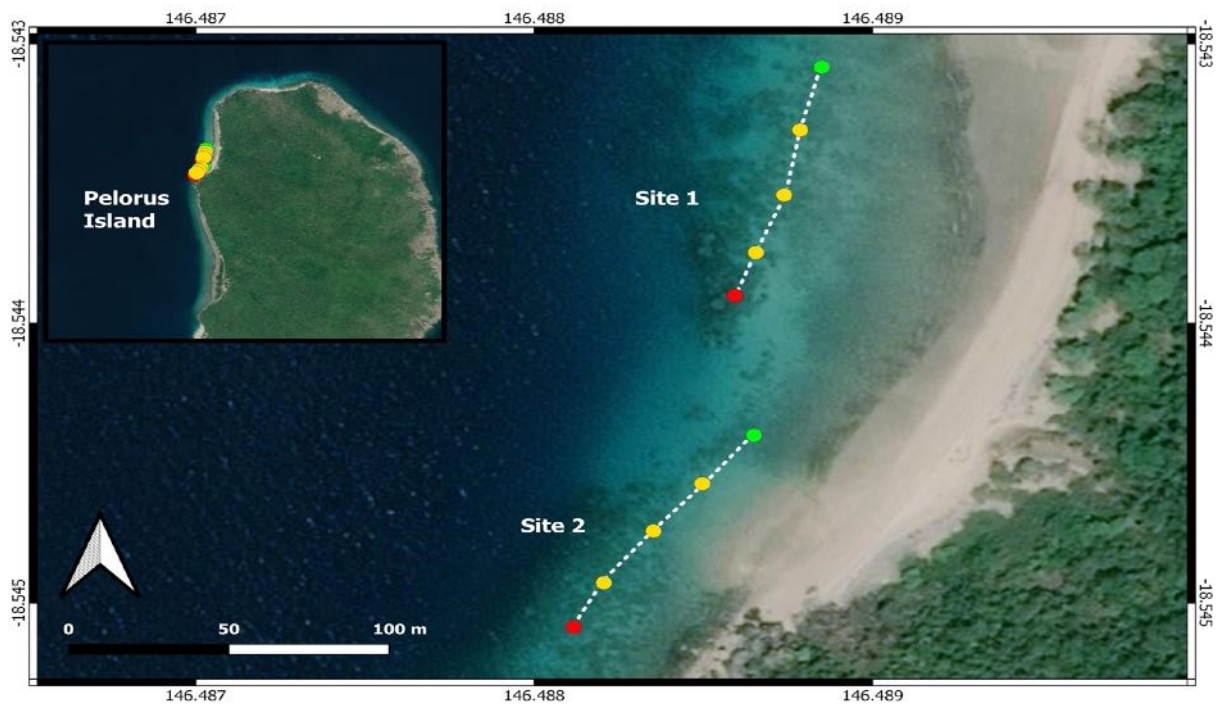


Figure 30: Map showing survey sites 1 and 2 on Pelorus Island.

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 31).

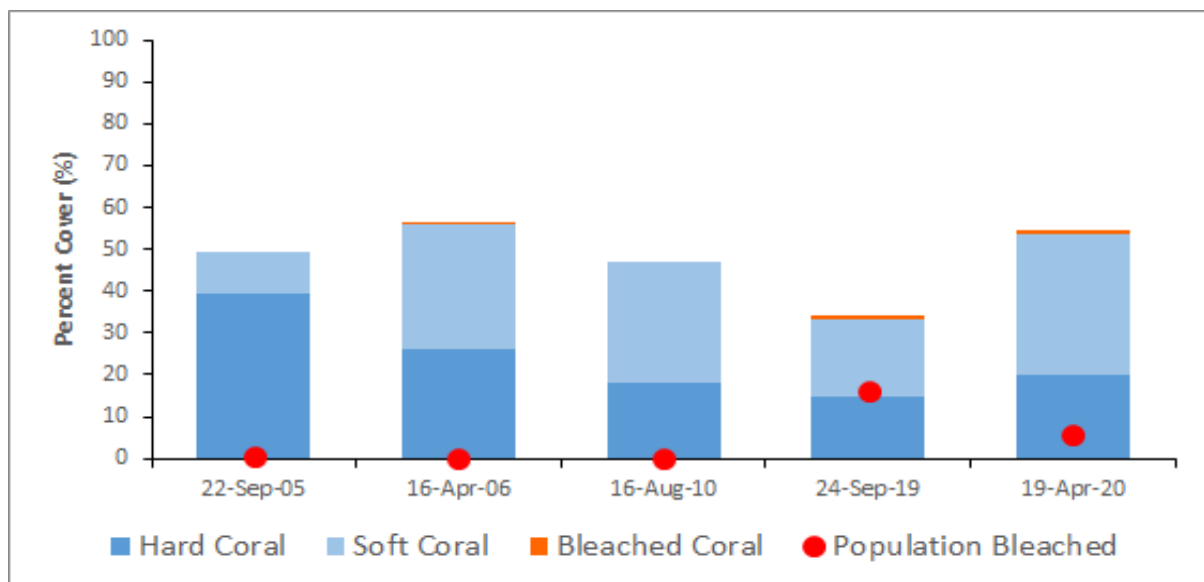


Figure 31: Long-term percent cover of hard and soft corals and bleached corals by survey year at Pelorus Island, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included 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 32).

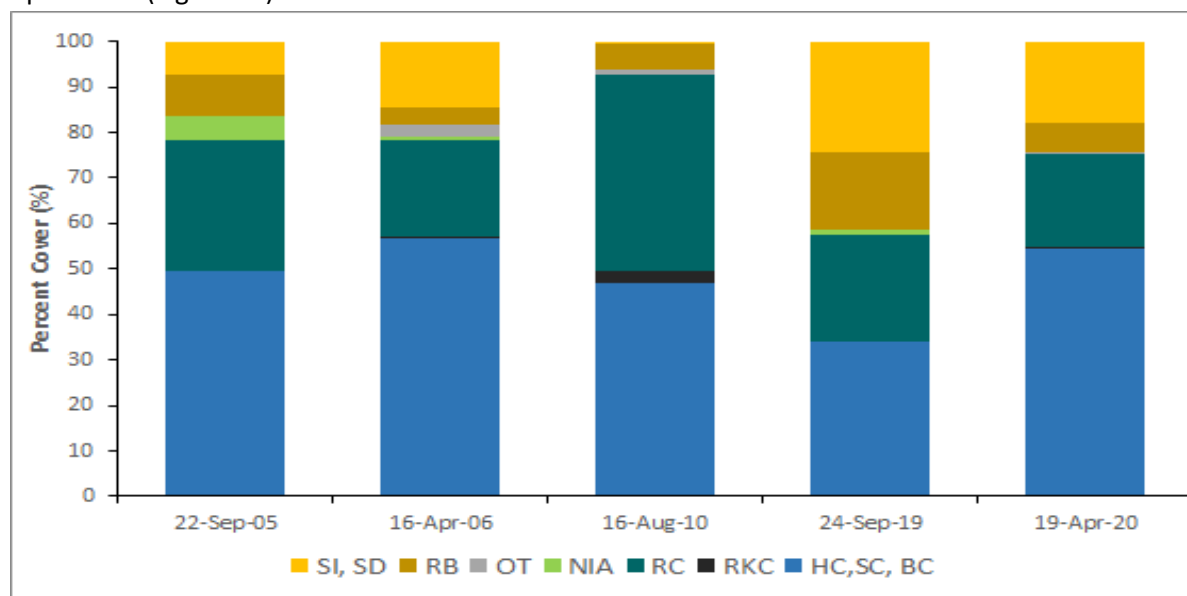


Figure 32: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Pelorus Island, Palm Island Reef Check Australia monitoring site.

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 33).

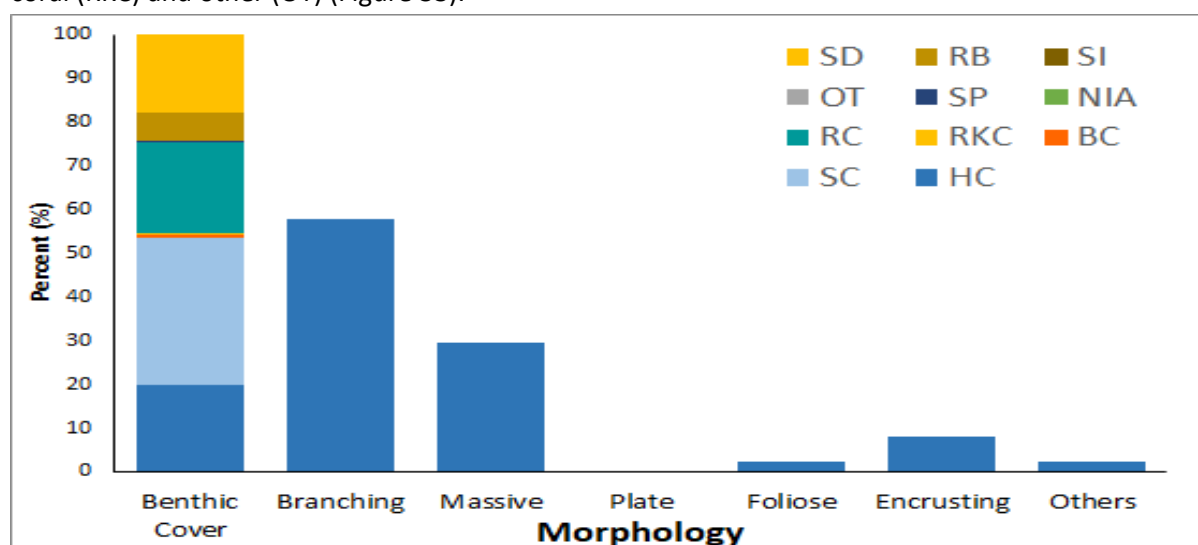


Figure 33: Percent cover of different benthic categories and dominant hard coral morphologies at Pelorus Island, Palm Island Reef Check Australia monitoring site.

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.

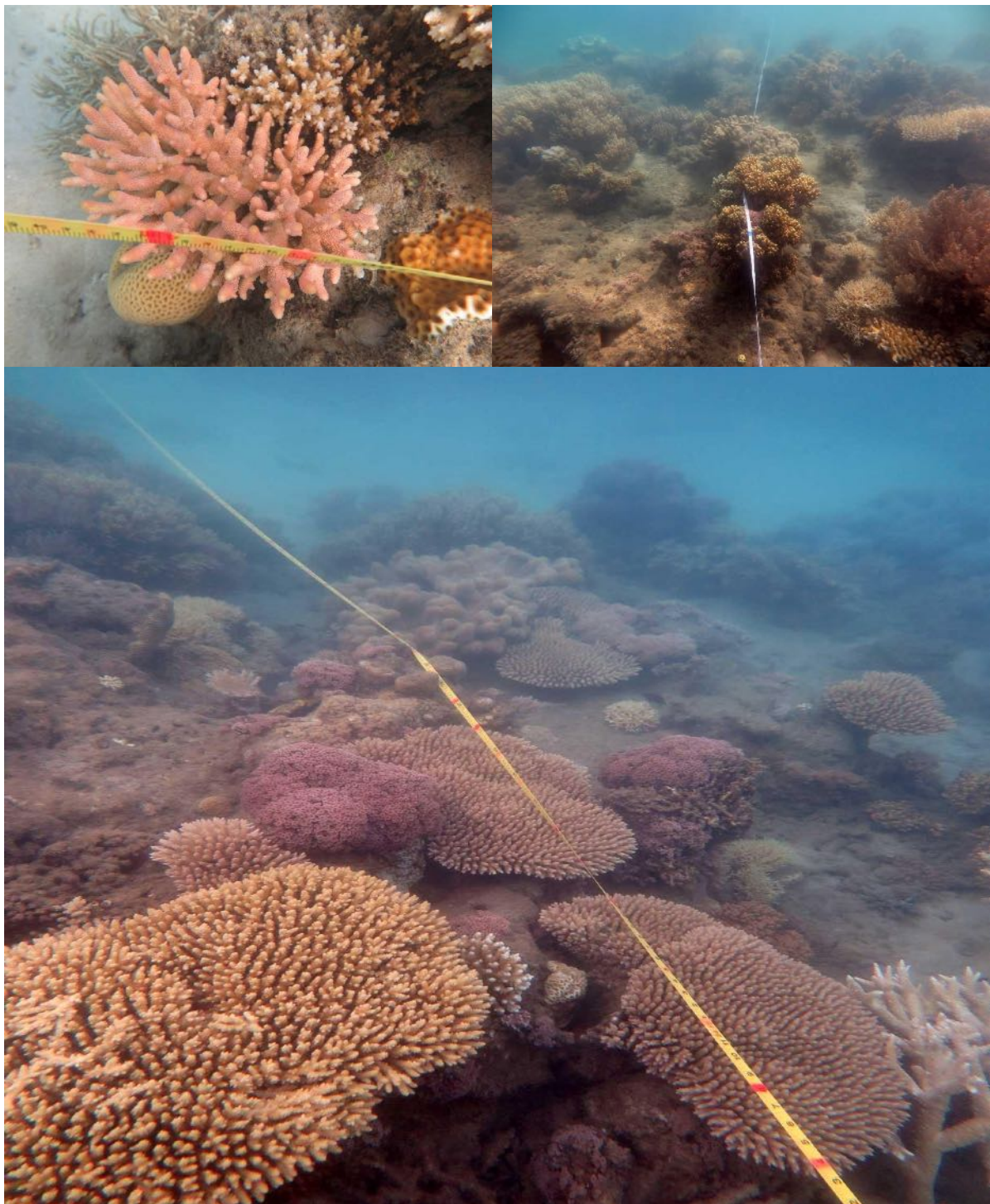


Figure 34: Transect line running across branching coral (top left), and over reef (top right) and reef dominated by plating and bushy hard corals (bottom)

5.4. 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 35). 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.

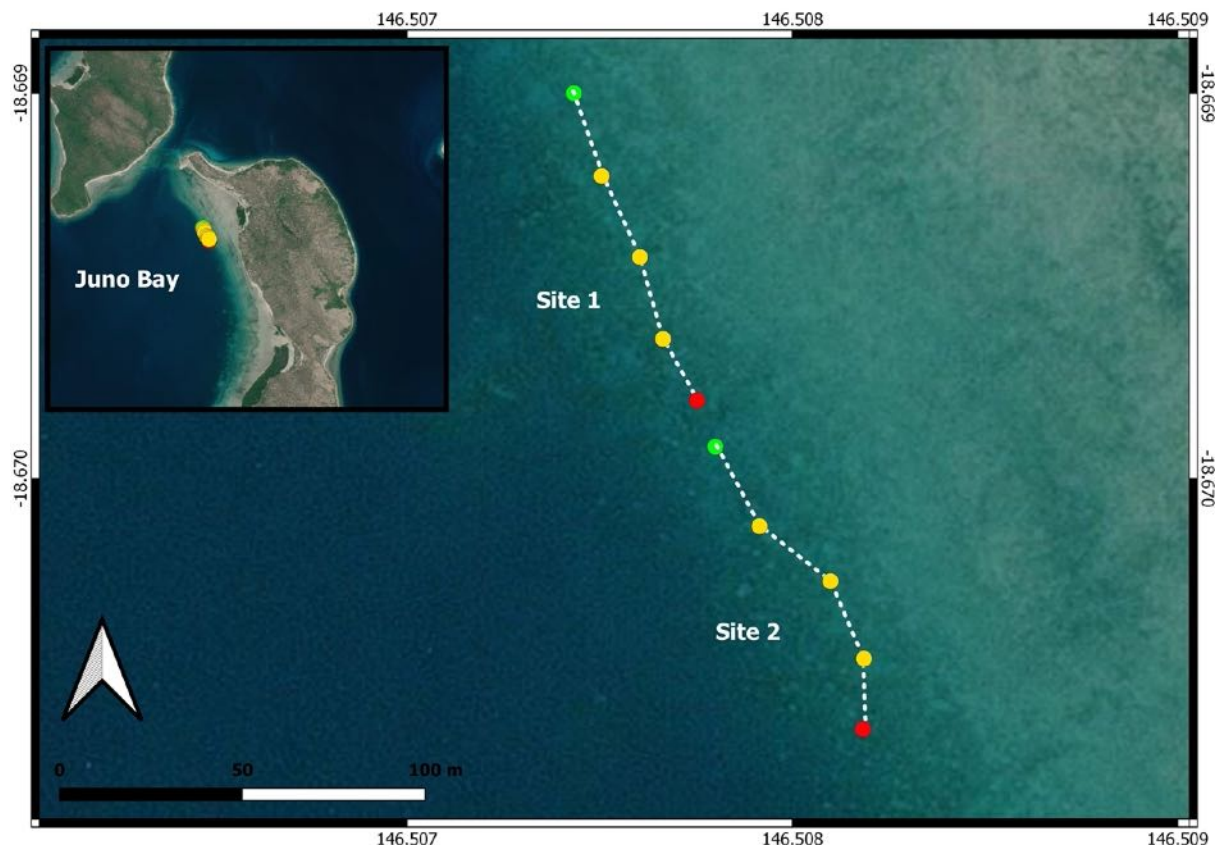


Figure 35. Map showing survey sites 1 and 2 in Fantome Island.

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 36). Overall, substrate cover was dominated by LCC, followed by coral rock (34.38%) and silt/sand (22.19%) (Figure 37).

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 37).

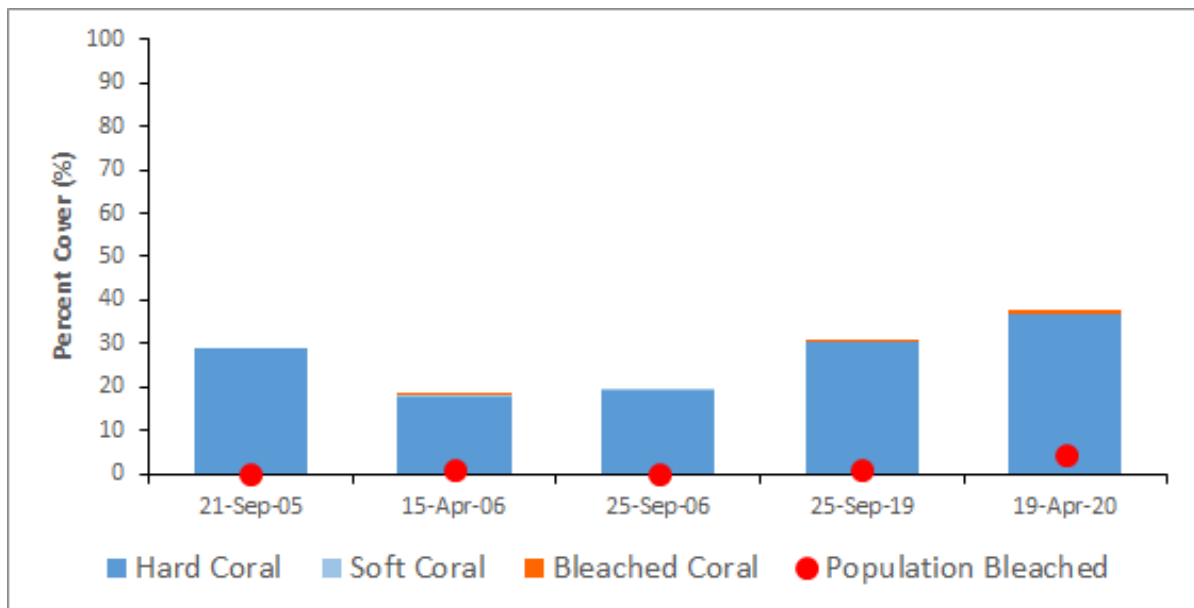


Figure 36. Long-term percent cover of hard and soft corals and bleached corals by survey year at Fantome Island, Palm Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included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

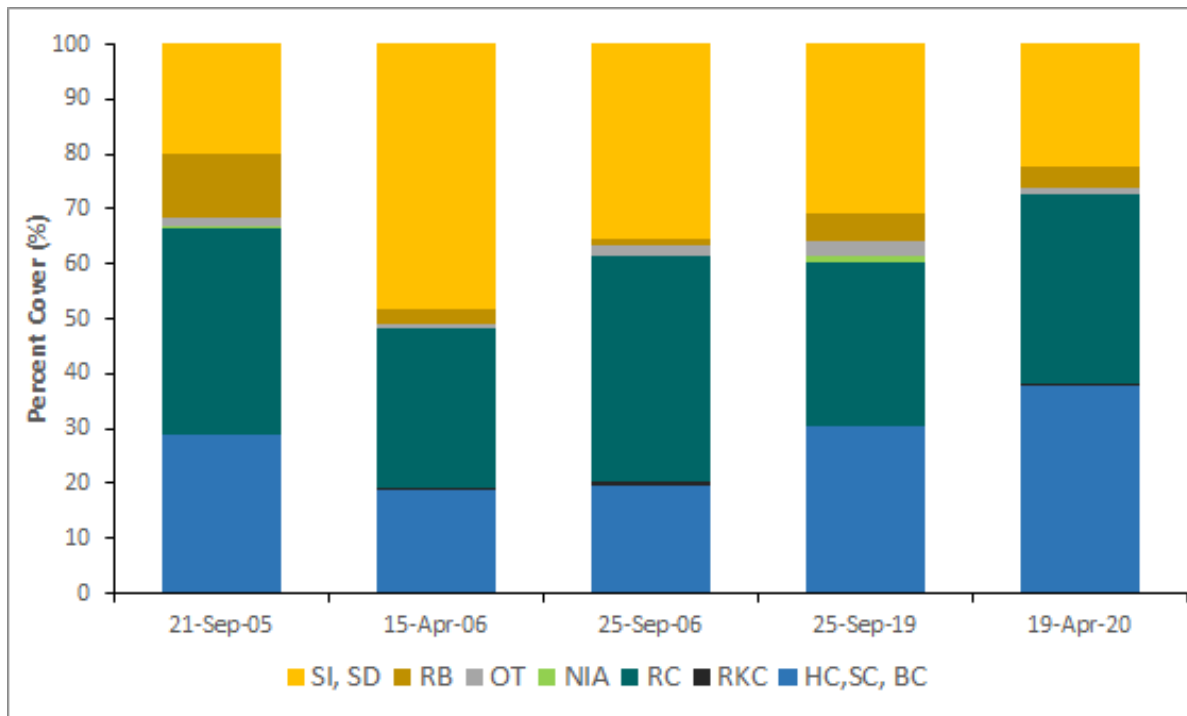


Figure 37. Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Fantome Island, Palm Island Reef Check Australia monitoring site.

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 38.).

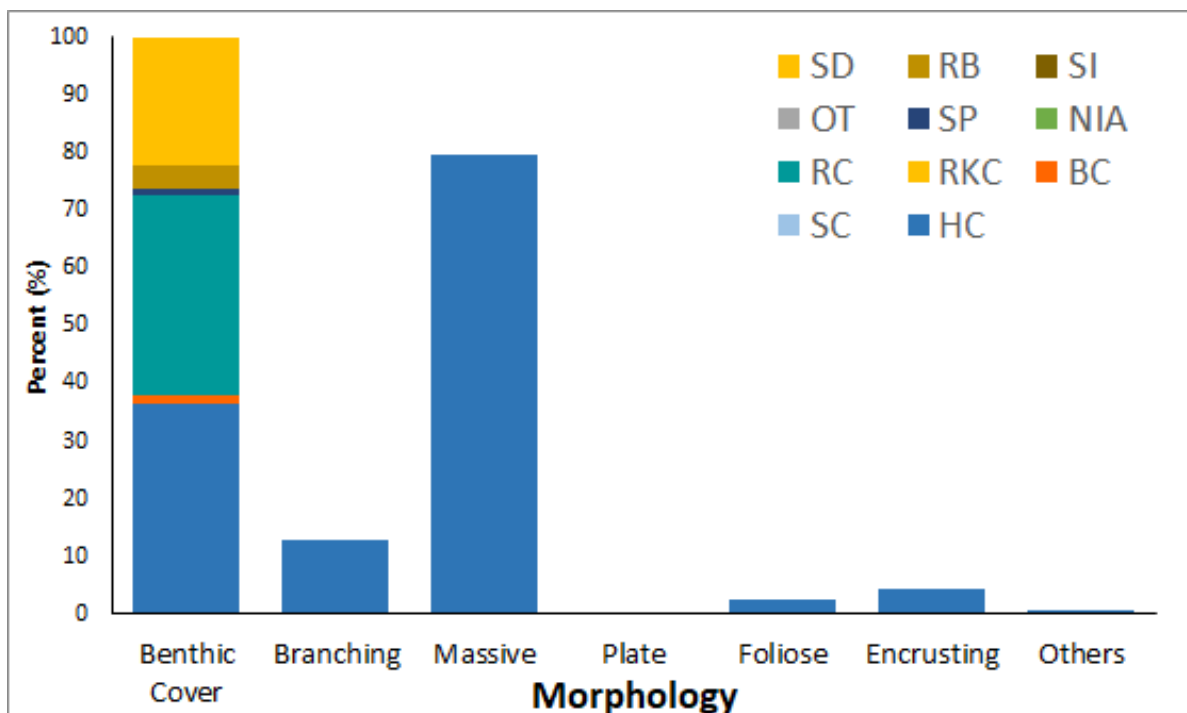


Figure 38. Percent cover of different benthic categories and dominant hard coral morphologies at Fantome Island, Palm Island Reef Check Australia monitoring site.

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 3). 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 39).

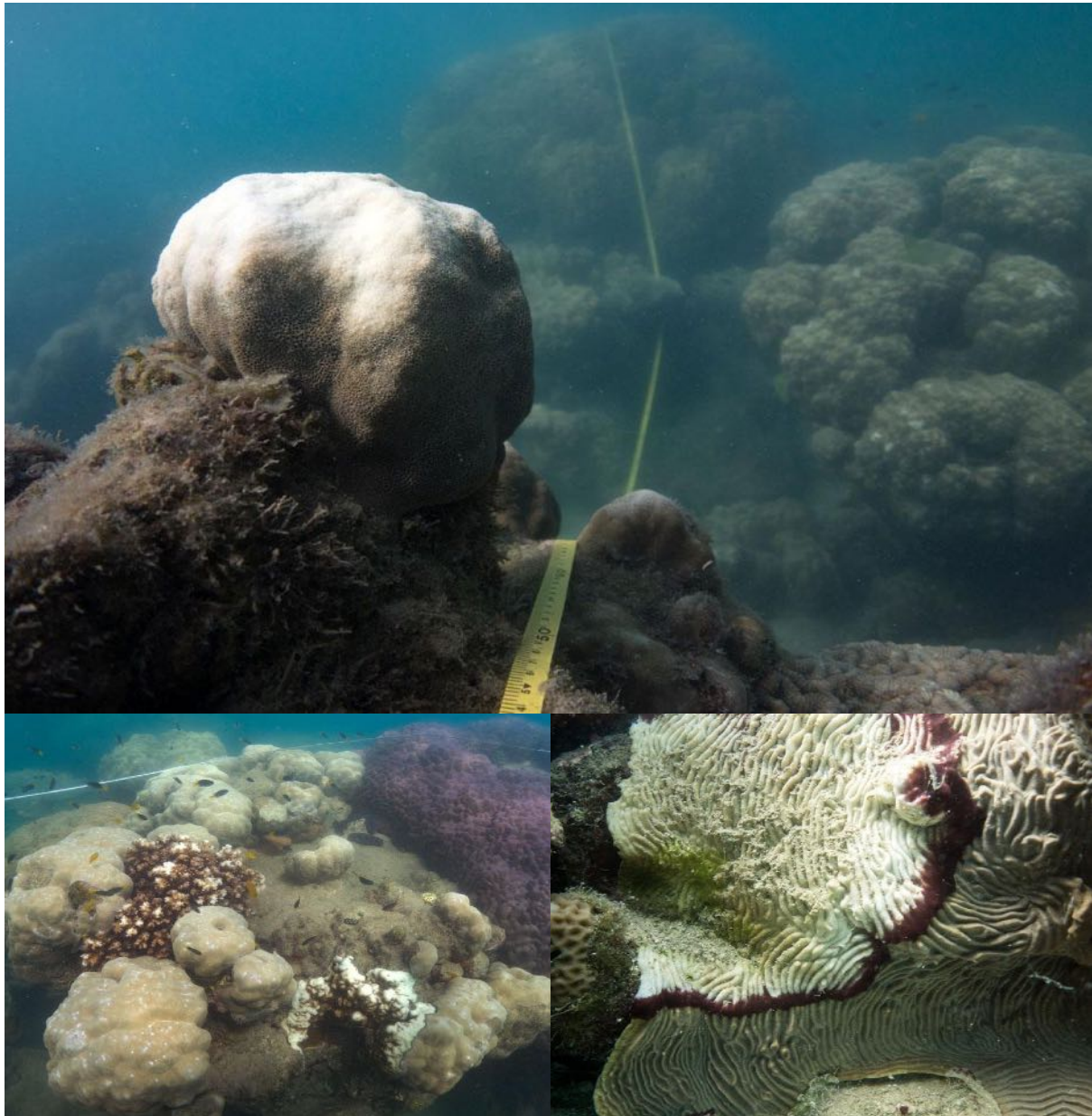


Figure 39: Transect and large *Porities* sp. bommies (top), coral damage of bushy colonies (bottom left) and black band disease (bottom right).

5.5. 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 40). 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.

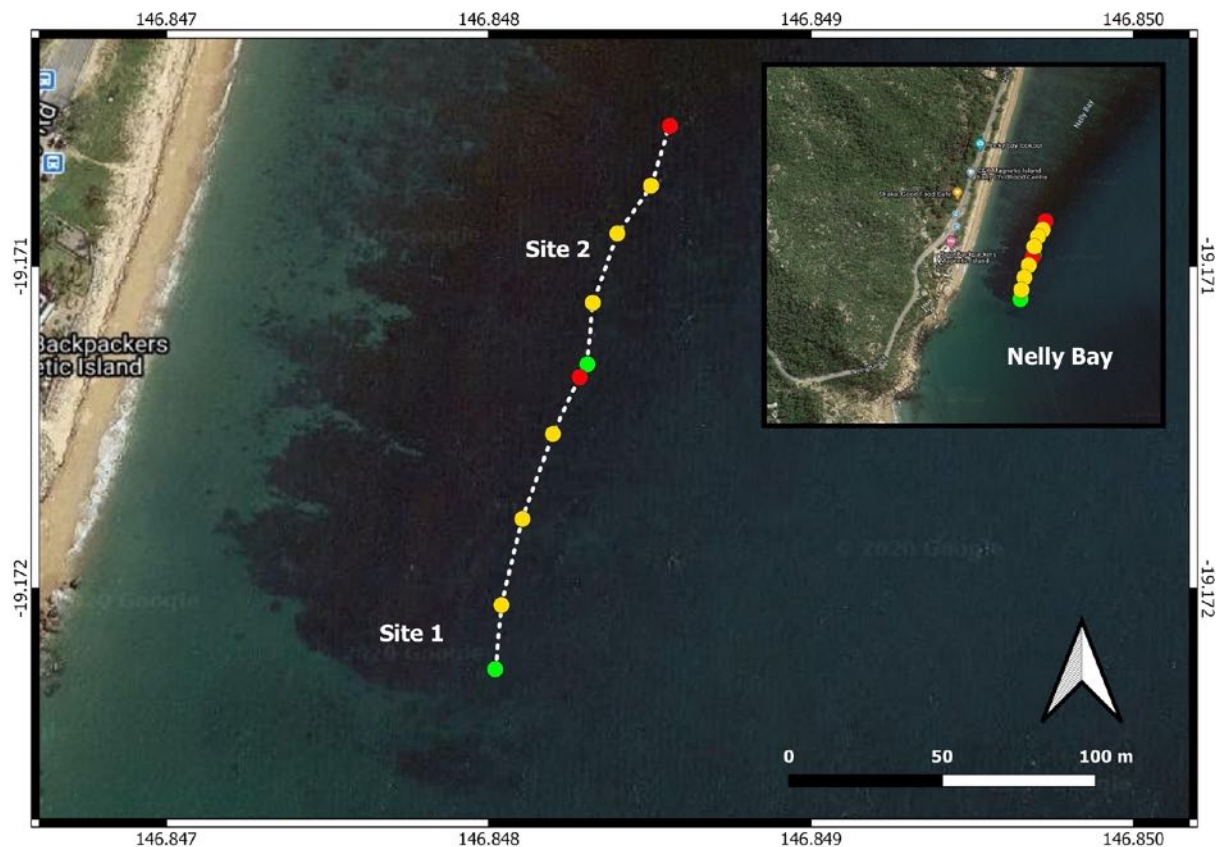


Figure 40: Map showing survey sites 1 and 2 in Nelly Bay, Magnetic Island.

Substrate Survey

LCC has been relatively consistent since October 2012, with percentages during this period ranging from 11.25% (2017) to 25% (2016) (Figure 41). 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 41).

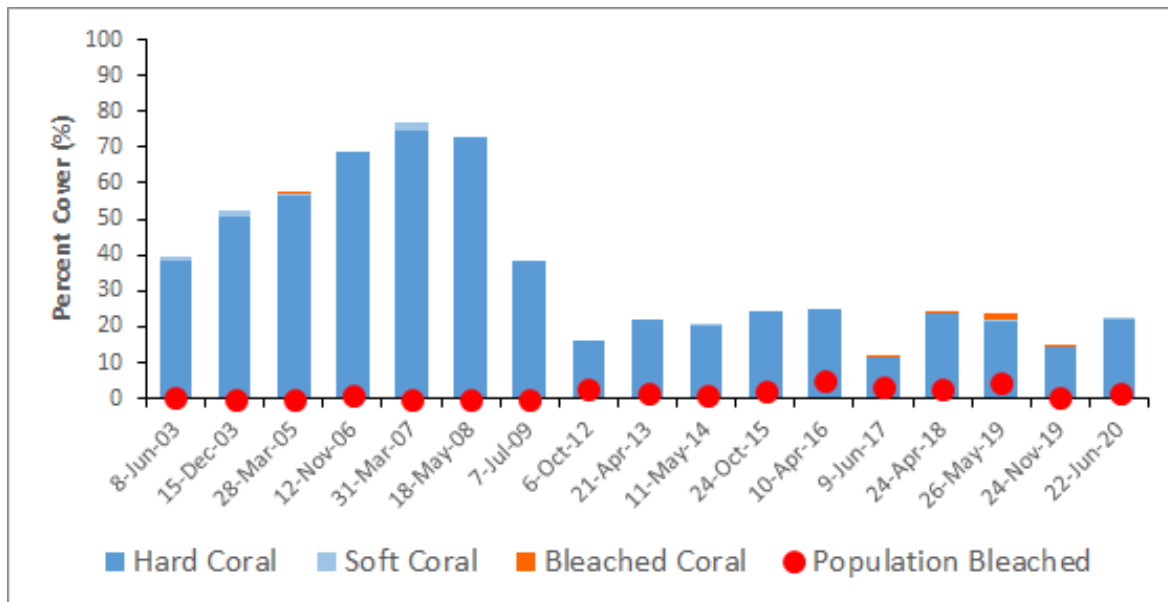


Figure 41: Long-term percent cover of hard and soft corals and bleached corals by survey year at Nelly Bay, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included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

Long-term Substrate Trend

The greatest fluctuations in substrate cover since 2012 have been between nutrient indicator algae (NIA) and rock (Figure 42). 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.

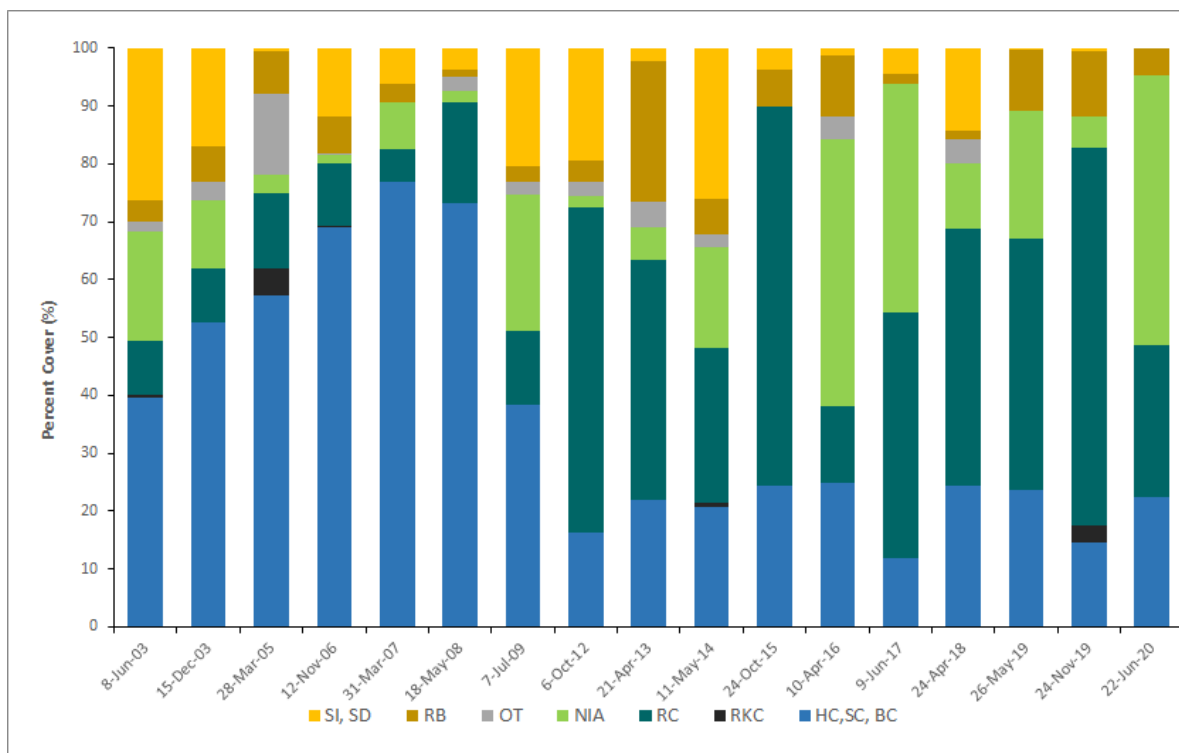


Figure 42: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Nelly Bay, Magnetic Island Reef Check Australia monitoring site.

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 43 & 44).

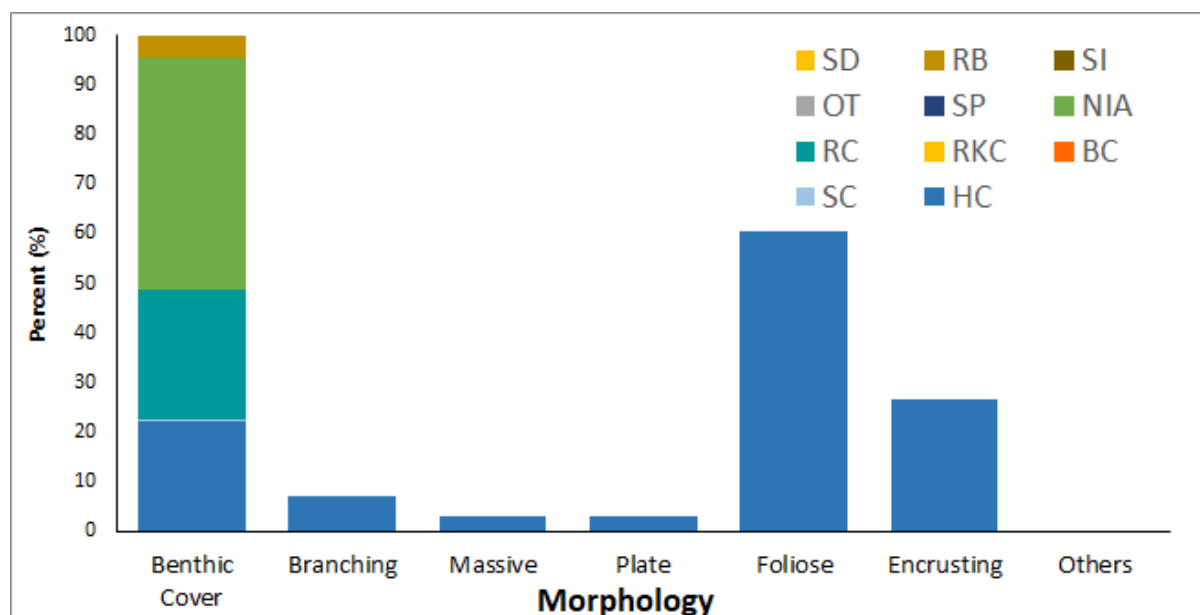


Figure 35: Per cent cover of different benthic categories and dominant hard coral morphologies at Nelly Bay, Magnetic Island Reef Check Australia monitoring site.

Invertebrates and Impacts

During the 2019 and 2020 surveys, an average of 26 drupella snails and one trochus snail were observed per survey (Table 3). 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%.

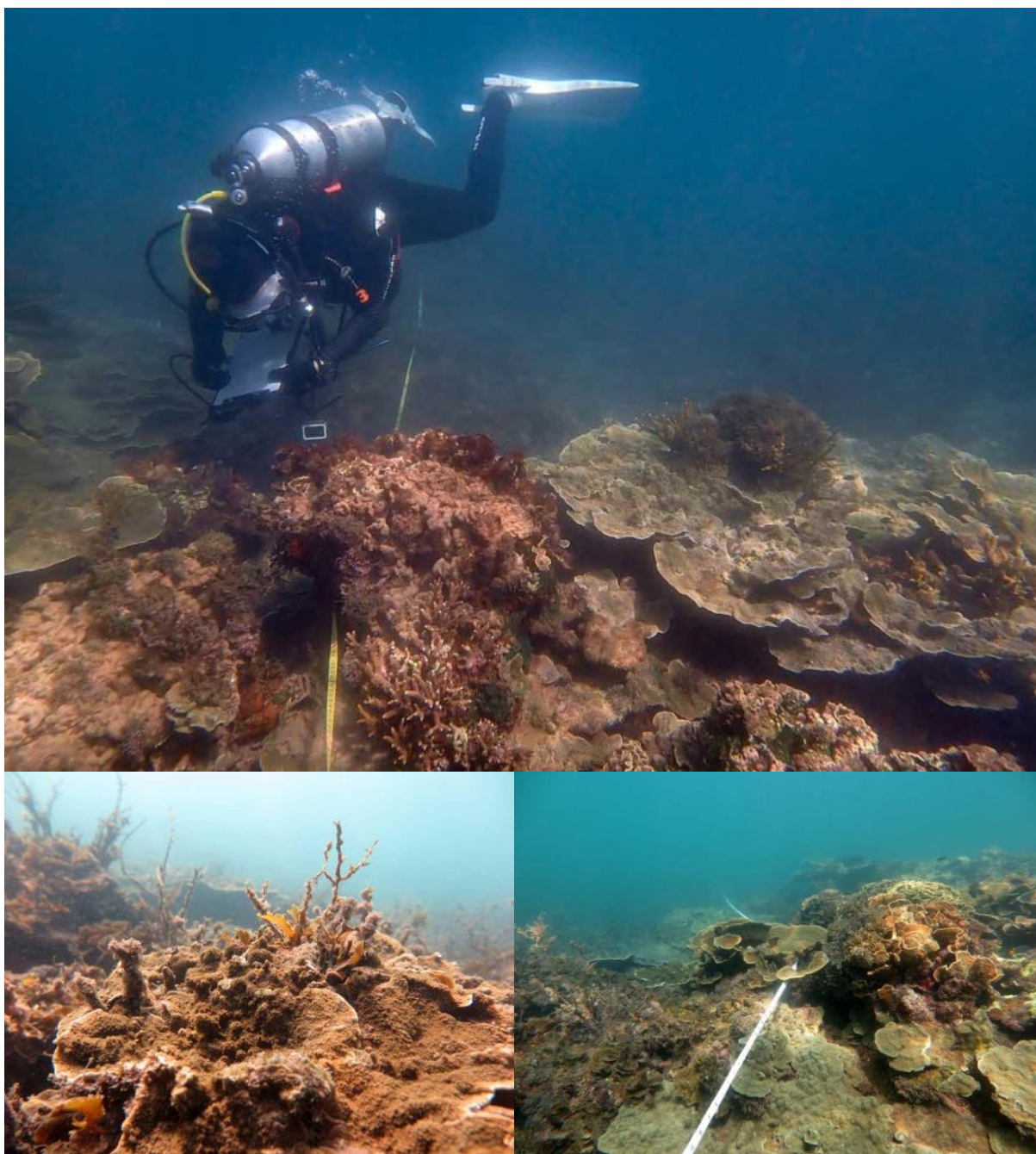


Figure 44: Diver conducting survey at Nelly Bay (top), Montipora spp. coral and Sargassum sp. algae at Nelly Bay (bottom left) and reefscape at Nelly Bay (bottom right).

5.6. Magnetic Island - Alma Bay



Figure 45: 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 45 & 46). It is commonly used recreationally by beach goers and locals.

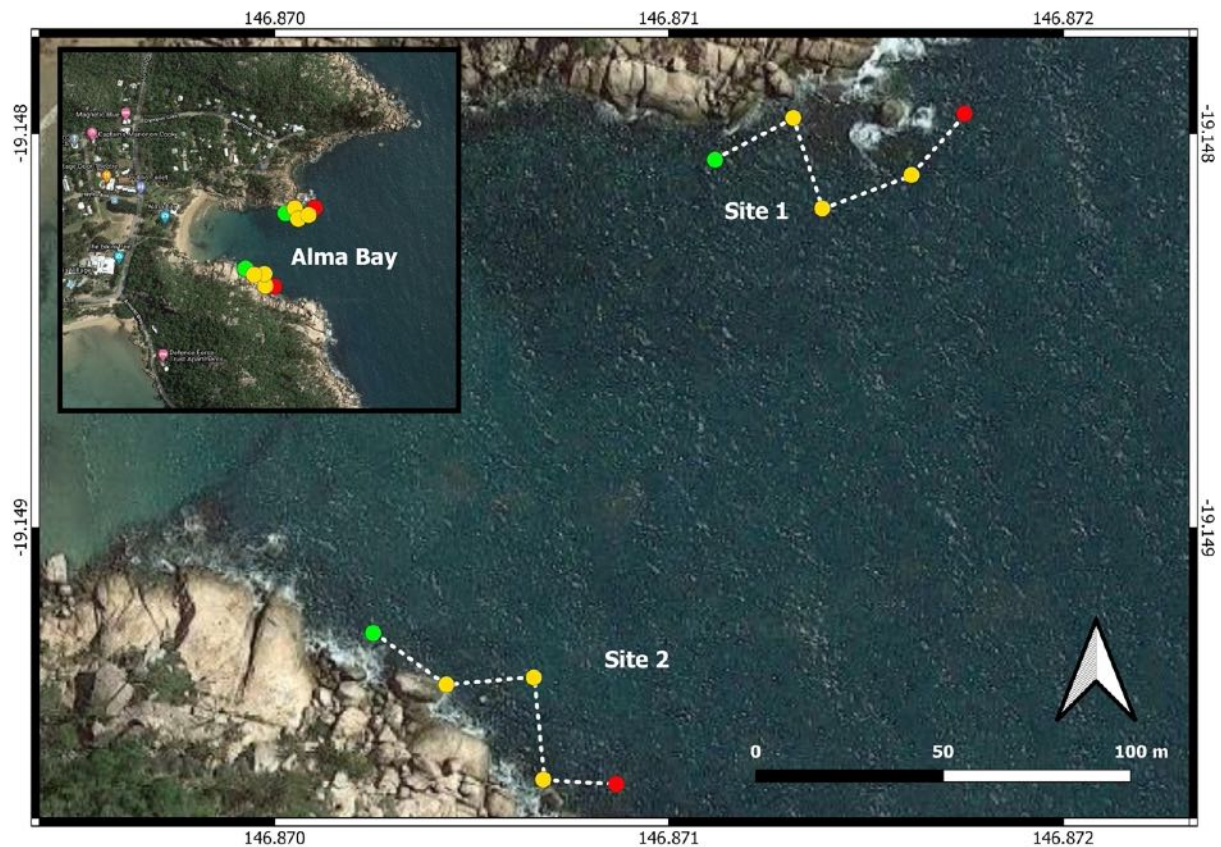


Figure 46: Map showing survey sites 1 and 2 at Alma Bay, Magnetic Island.

There are two RCA survey locations within Alma Bay, one on each side of the bay within the fringing reefs alongside the rocks (Figure 46). 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 47).

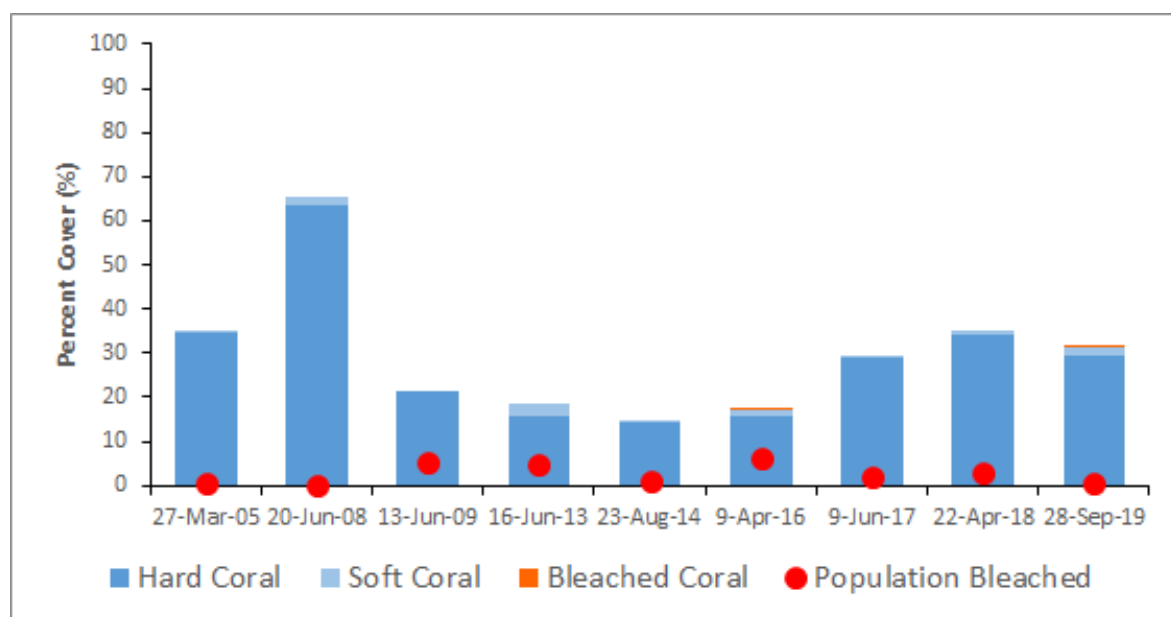


Figure 36: Long-term per cent cover of hard and soft corals and bleached corals by survey year at Alma Bay, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included 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 48). 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 48).

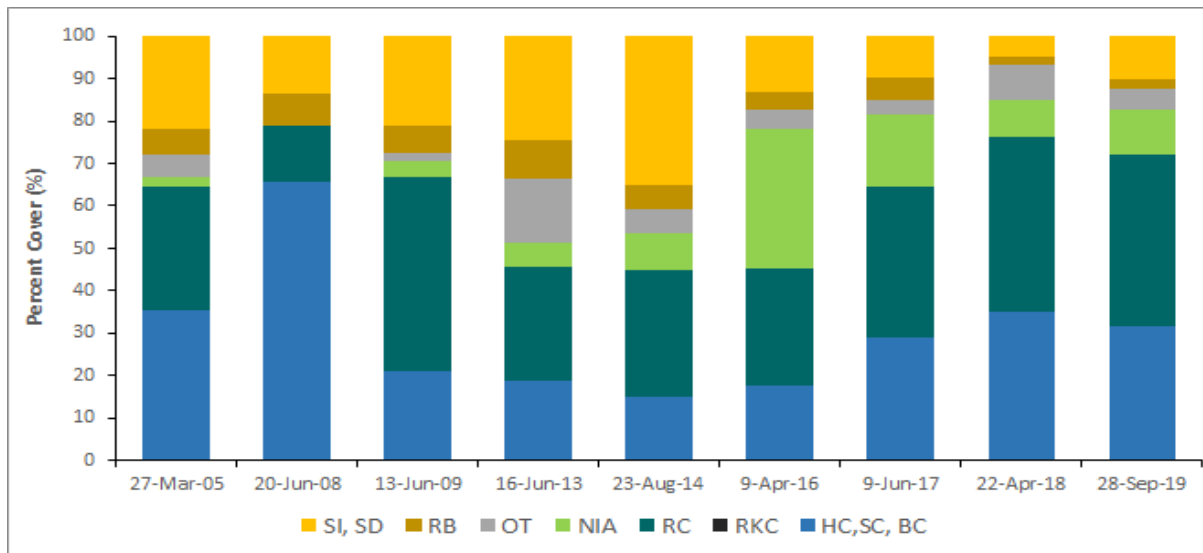


Figure 37: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Alma Bay, Magnetic Island Reef Check Australia monitoring site.

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 49).

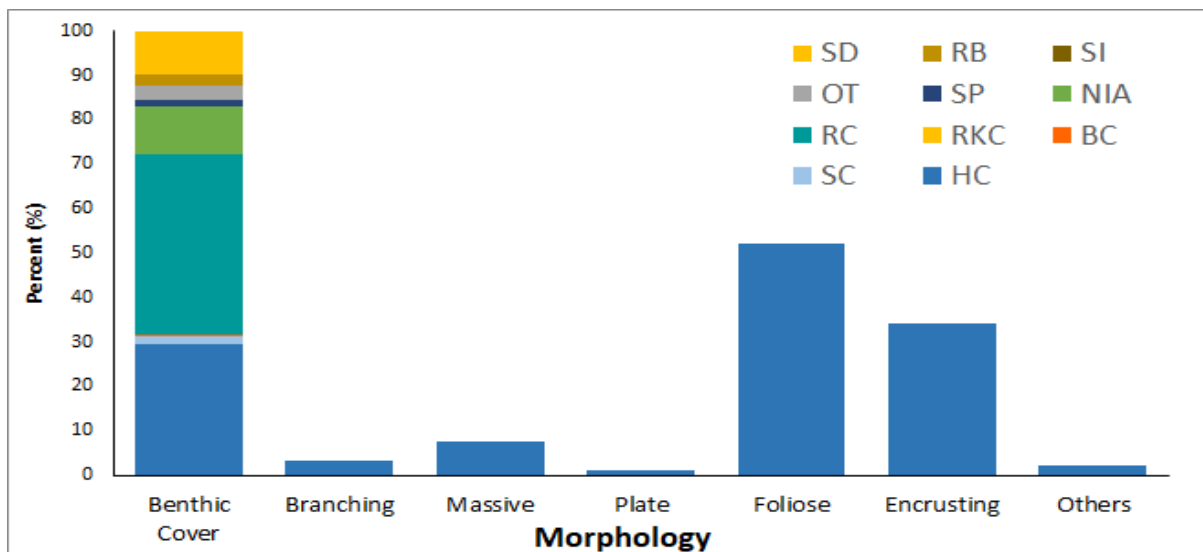


Figure 49: Percentage cover of different benthic categories and dominant hard coral morphologies at Alma Bay, Magnetic Island Reef Check Australia Monitoring site.

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.

5.7. 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.

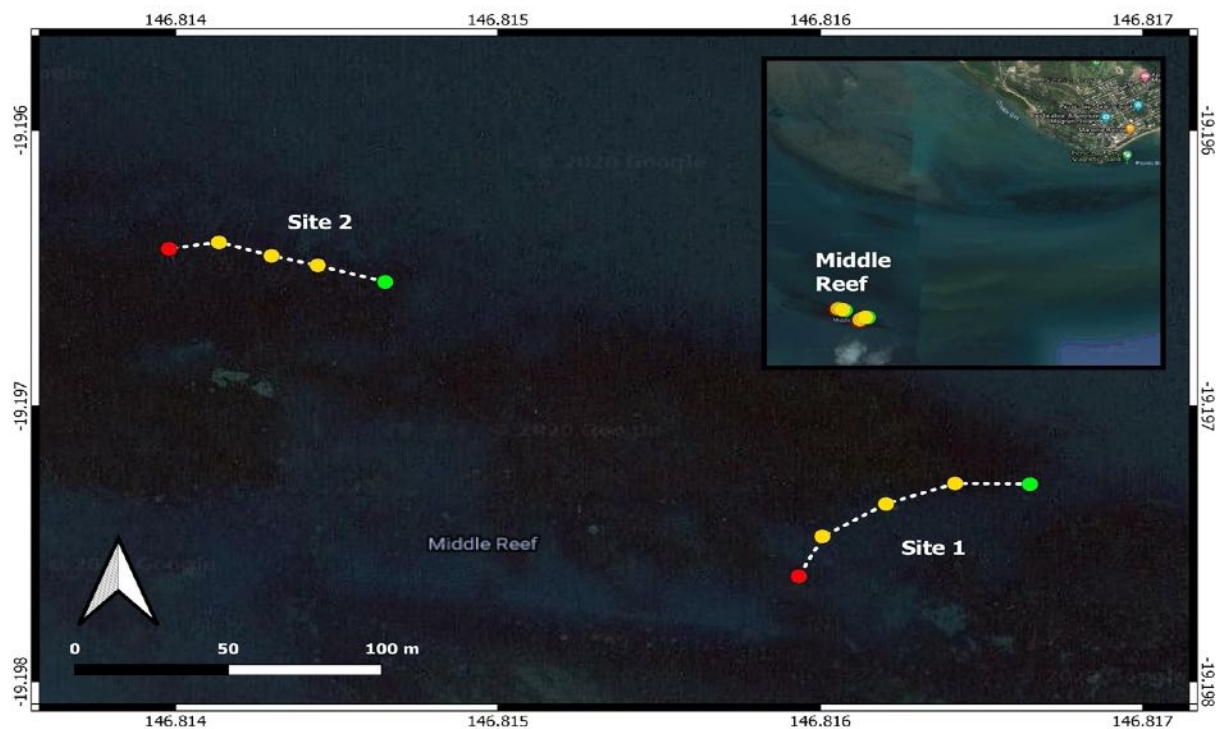


Figure 50: Map showing survey sites 1 and 2 in Middle Reef, Magnetic Island.

Middle Reef consists of two RCA survey locations in two different sites on the seaward side of the fringing reef (Figure 50). 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 51).

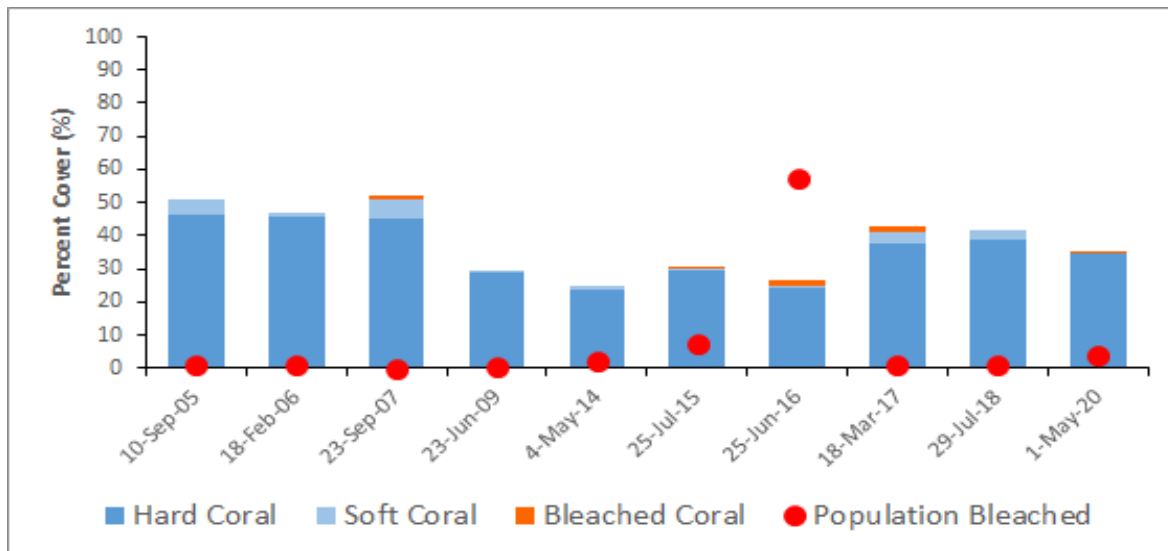


Figure 51: Long-term percent cover of hard and soft corals and bleached corals by survey year at Middle Reef, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included 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 52).

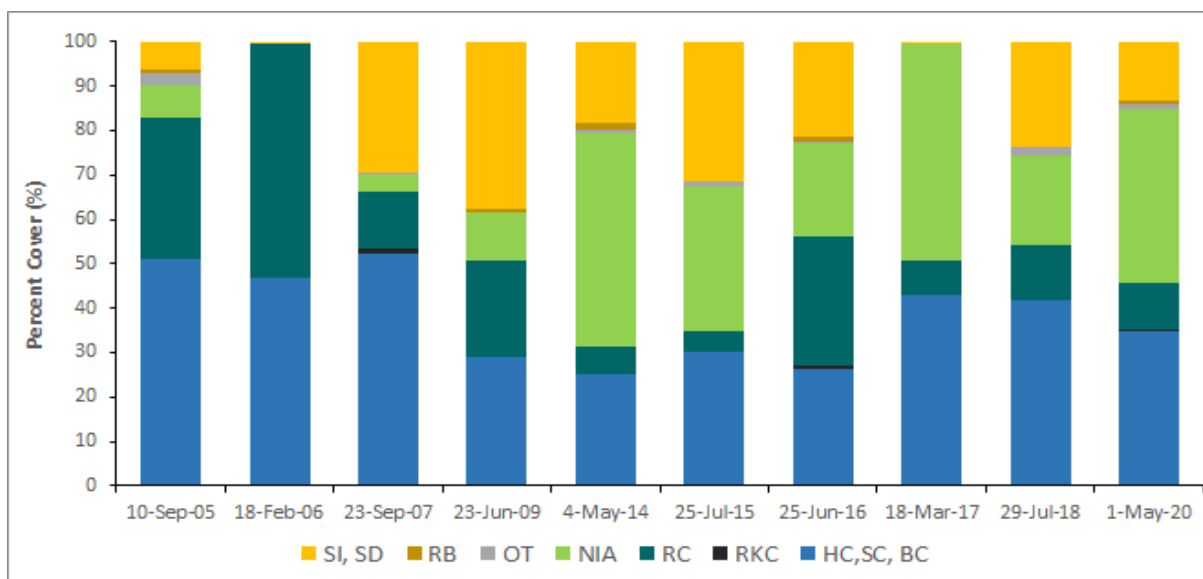


Figure 38: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Middle Reef, Magnetic Island Reef Check Australia monitoring site.

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 53 and 54).

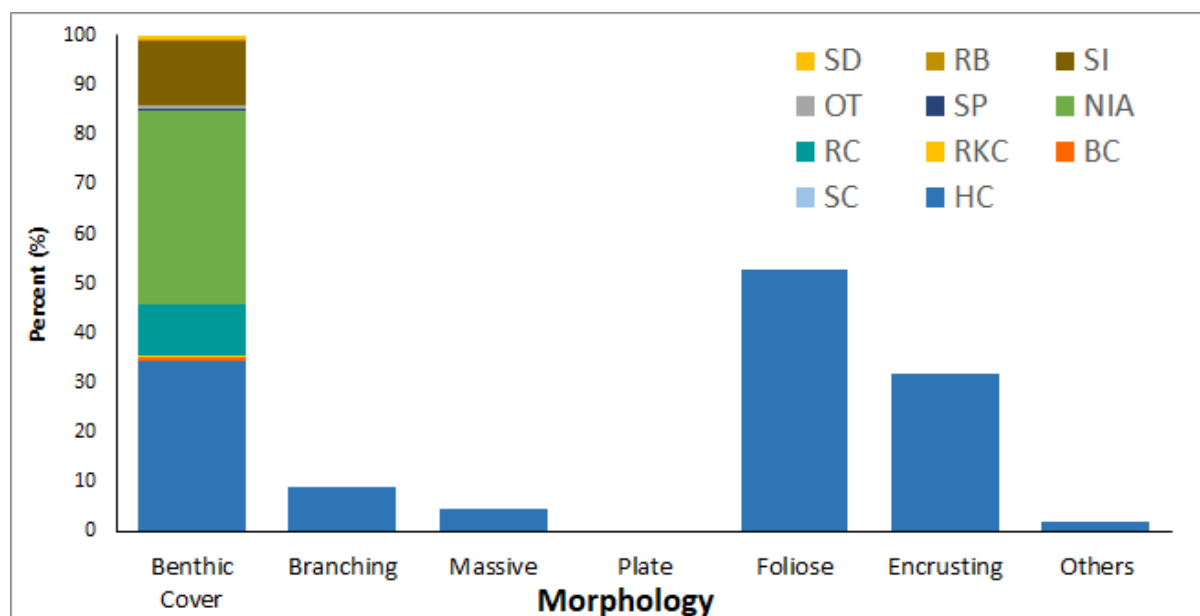


Figure 53: Percentage cover of different benthic categories and dominant hard coral morphologies at Middle Reef Magnetic Island Reef Check Australia monitoring site.

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: A variety of images showing the diversity of reefscape at Middle Reef. Plating *Montipora* sp. and branching *Acropora* sp. corals (top and bottom left) and large foliose *Turbinaria* sp. (bottom right).

5.8. 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

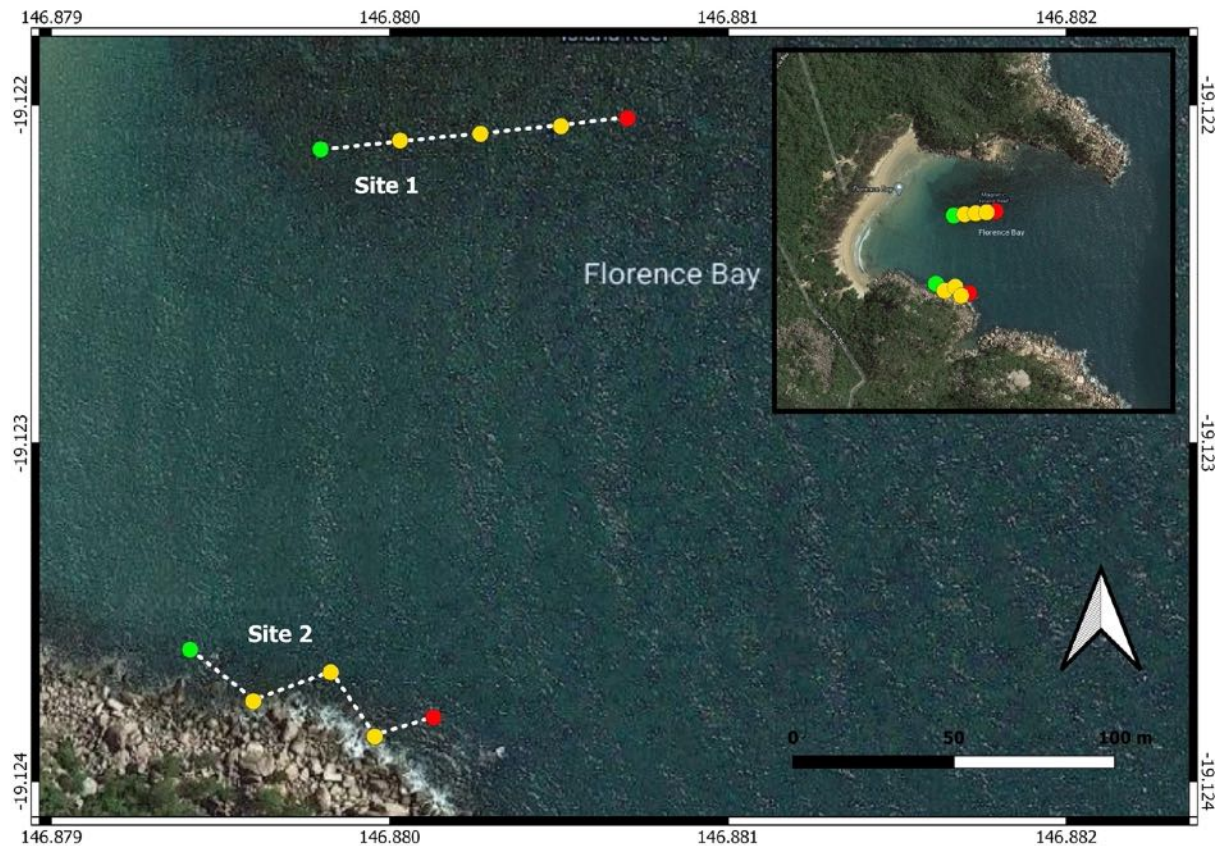


Figure 55: Map showing survey sites 1 and 2 in Florence Bay, Magnetic Island.

Florence Bay consists of two RCA survey locations on the seaward side of the fringing reefs (Figure 55). 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 56 illustrates the surveyed coral cover as well as bleaching populations overtime since 2006.

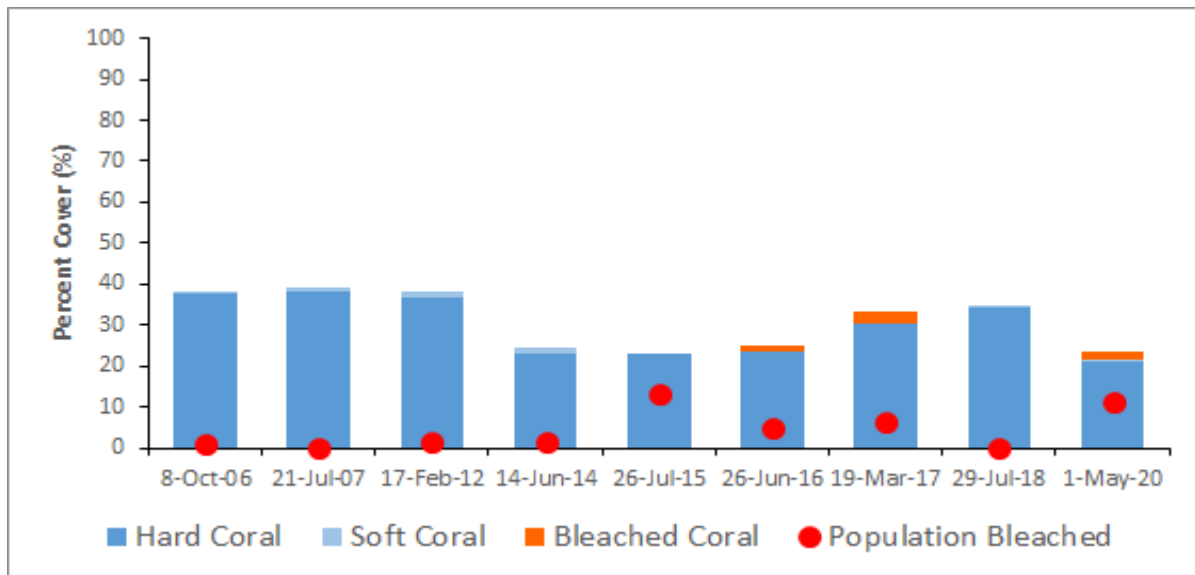


Figure 56: Long-term percent cover of hard and soft corals and bleached corals by survey year at Florence Bay Reef, Magnetic Island Reef Check Australia monitoring sites. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts 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 57).

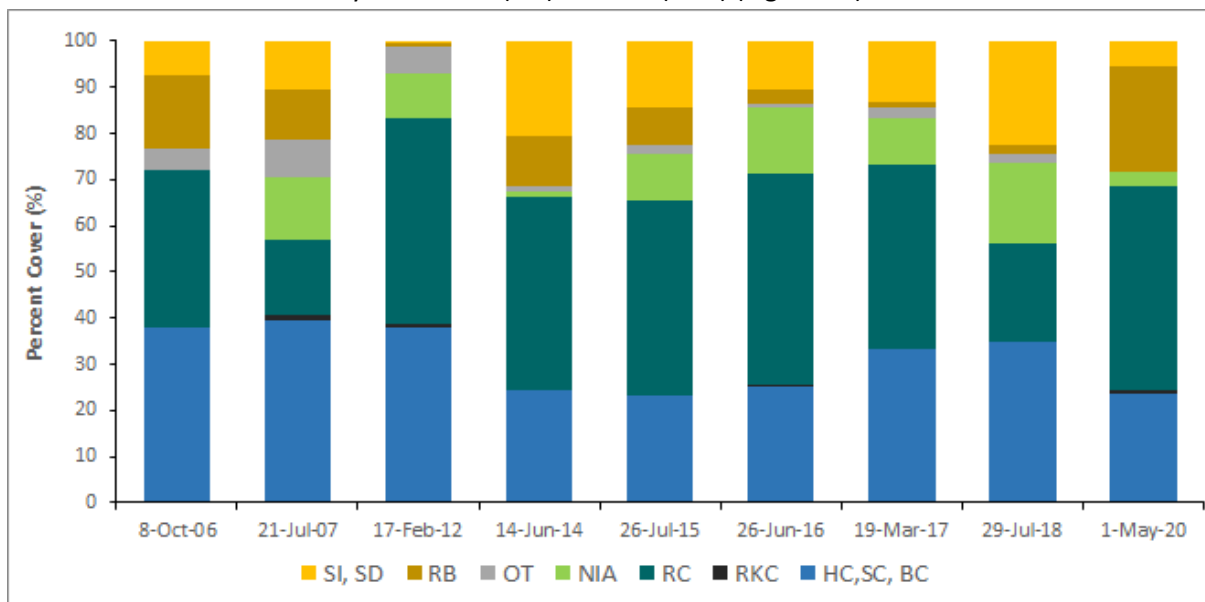


Figure 57: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Florence Bay Reef, Magnetic Island Reef Check Australia monitoring site.

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 58 illustrates a further breakdown of the benthic cover and the characteristic morphology percentages of hard corals at Florence Bay reef.

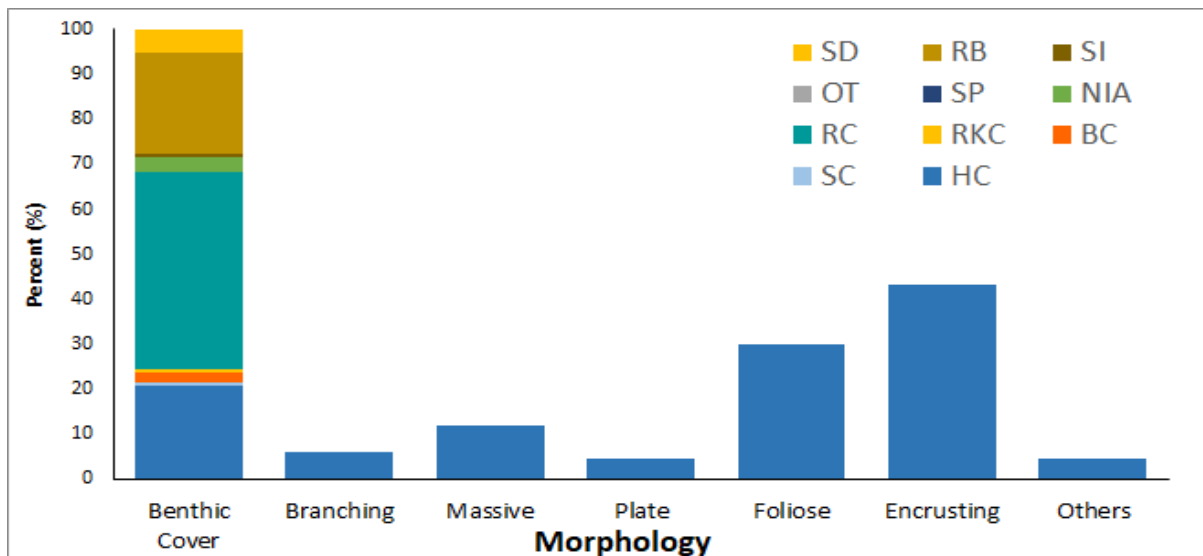


Figure 58: Percent cover of different benthic categories and dominant hard coral morphologies at Florence Bay Reef, Magnetic Island Reef Check Australia monitoring site.

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, Figure 59). 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.

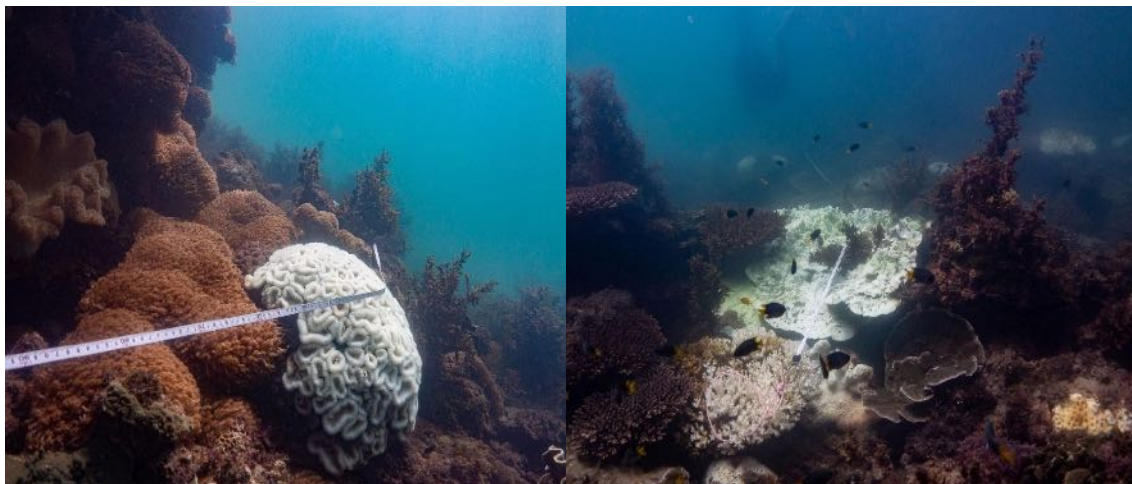


Figure 59: Variable coral bleaching under the transect line (top) and bleached corals (bottom)

5.9. 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 60). 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 61). Site 4 runs parallel to the beach and Site 5 follows the popular Geoffrey Bay snorkel trail.

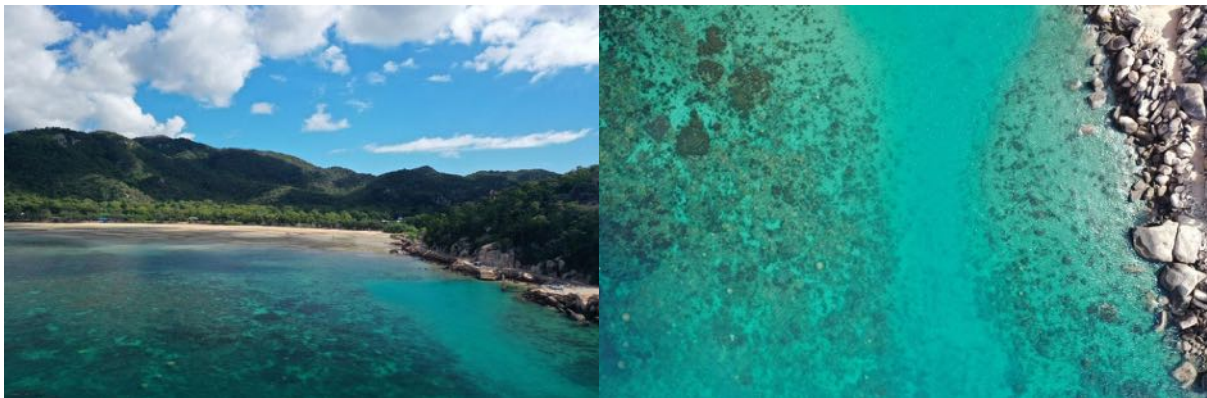


Figure 60: Geoffrey Bay (left) with aerial view of site 5 (right) along the snorkel trail at Geoffrey Bay.

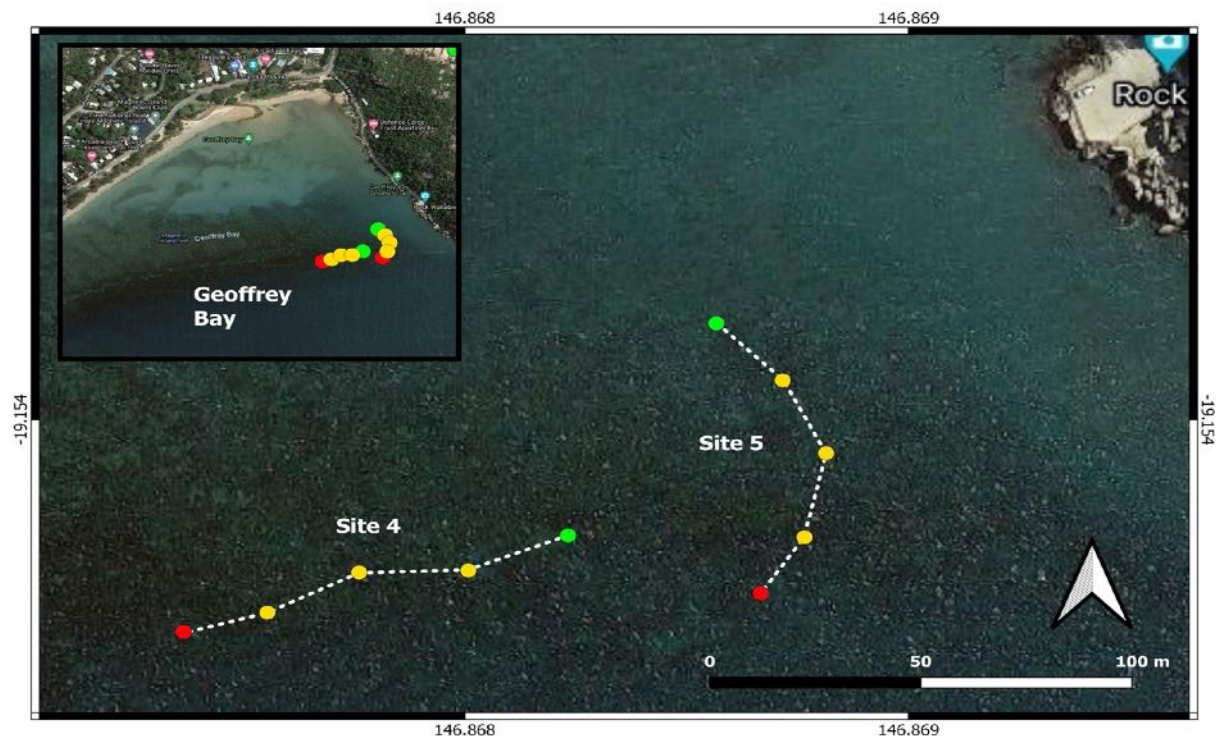


Figure 61: Map showing survey sites 1 and 2 in Geoffrey Bay, Magnetic Island.

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 62 and 63).

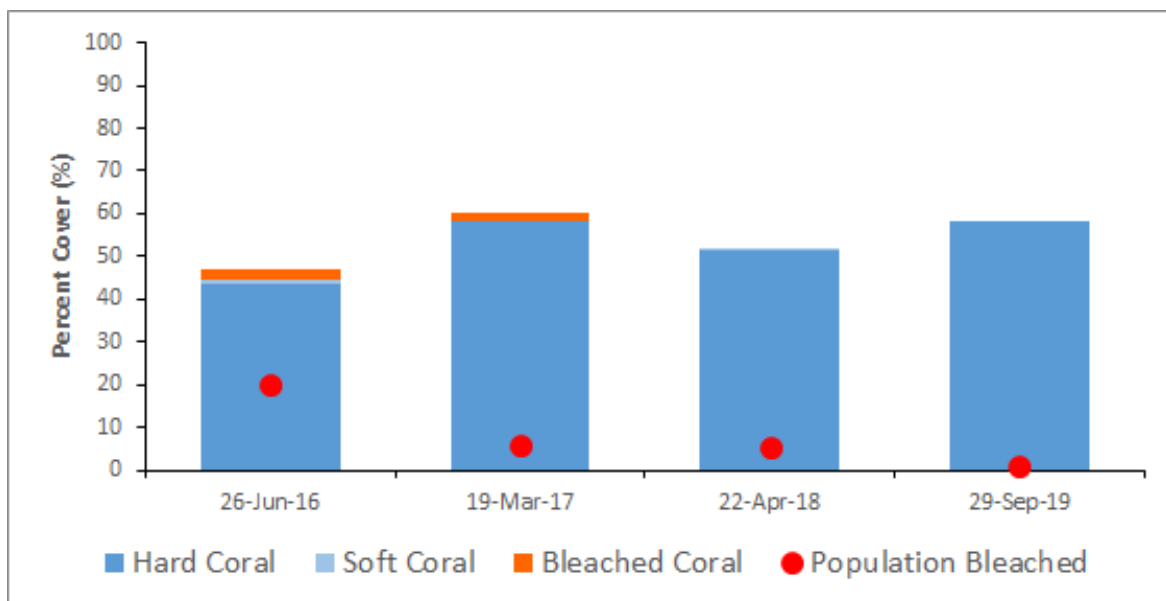


Figure 62: Long-term percent cover of hard and soft corals and bleached corals by survey year at Geoffrey Bay, Magnetic Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included 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 63). 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.

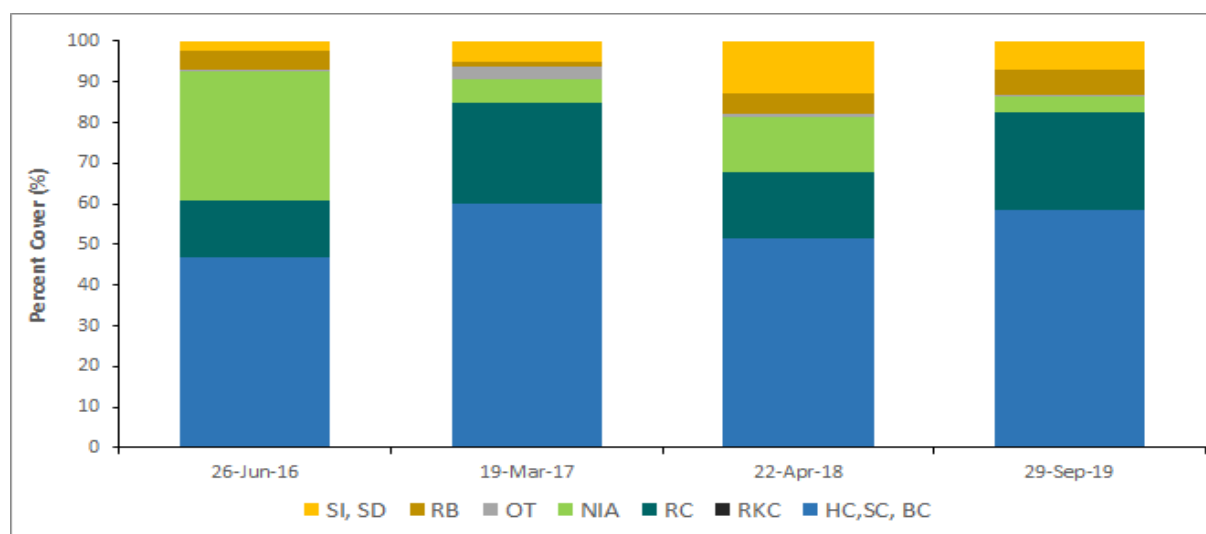


Figure 63: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Geoffrey Bay, Magnetic Island Reef Check Australia monitoring site.

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%). Soft coral was absent from these survey sites.

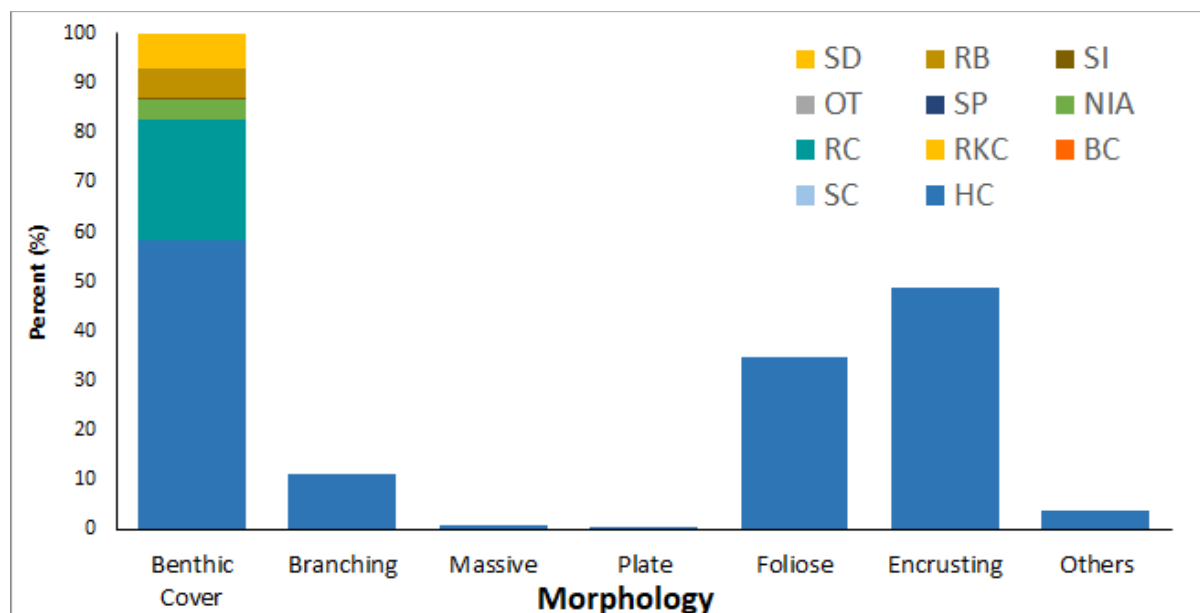


Figure 64: Percent cover of different benthic categories and dominant hard coral morphologies at Geoffrey Bay, Magnetic Island Reef Check Australia monitoring site.

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.

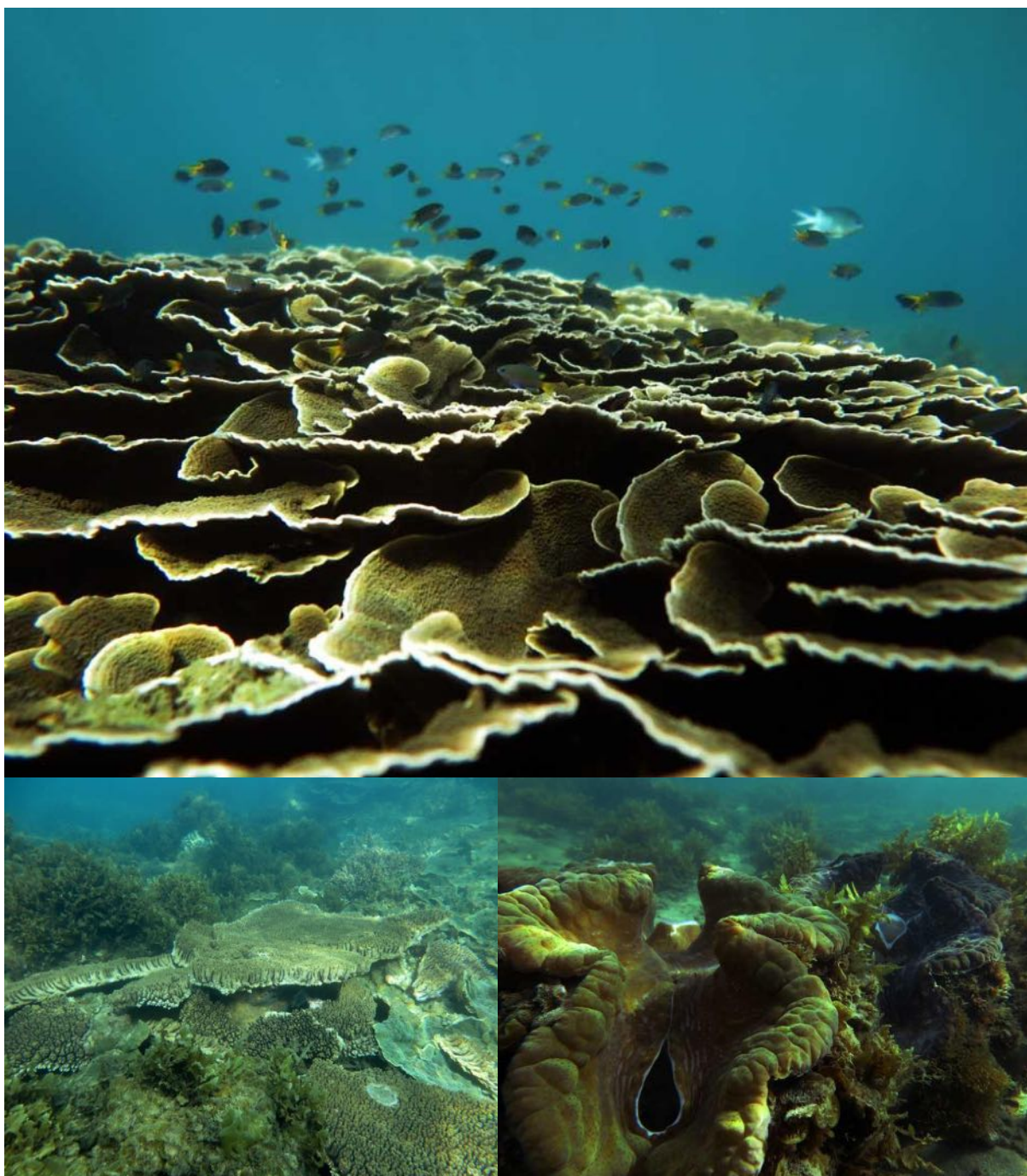


Figure 65: Large foliose *Montipora* sp. colony (top), broken tabulate *Acropora* sp. colony (bottom left) and large giant clams (*Tridacna* sp.) on the snorkel trail at Geoffrey Bay (bottom left).

5.10. John Brewer Reef



Figure 66: Aerial view of John Brewer Reef RCA survey location.

Site Description

John Brewer Reef is located 74km off the coast of Townsville (Figure 66 & 67). 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.

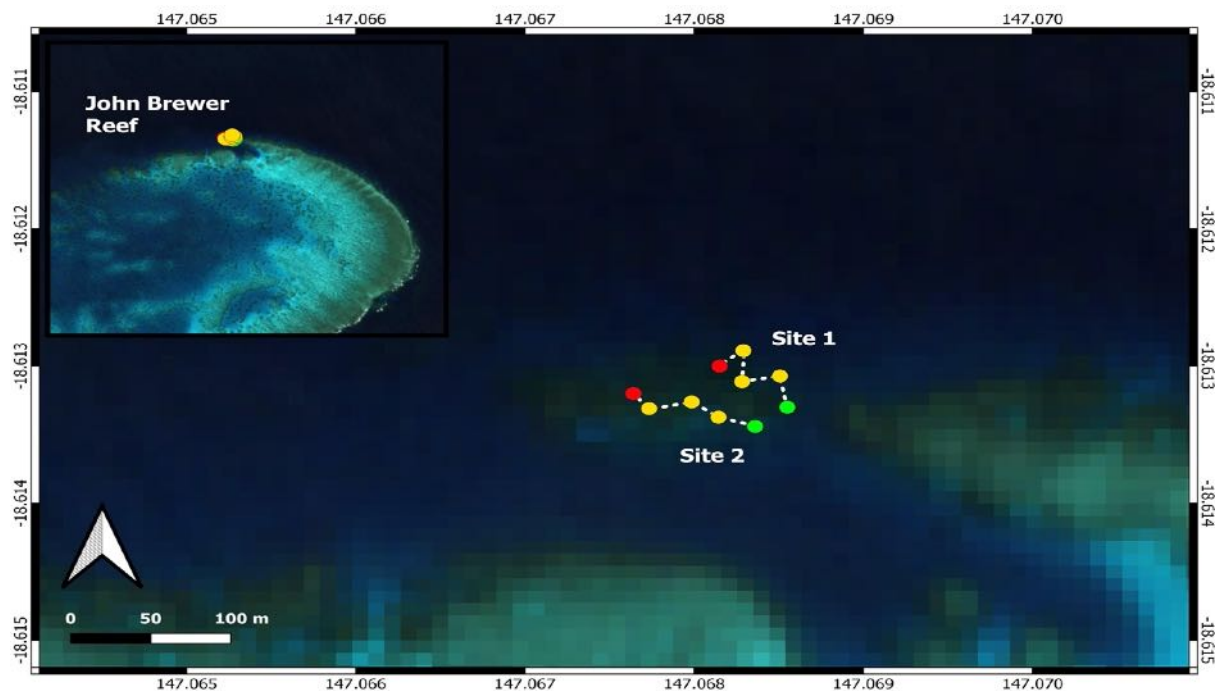


Figure 67: Map showing survey sites 1 and 2 in John Brewer Reef.

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 68 and 69). 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.

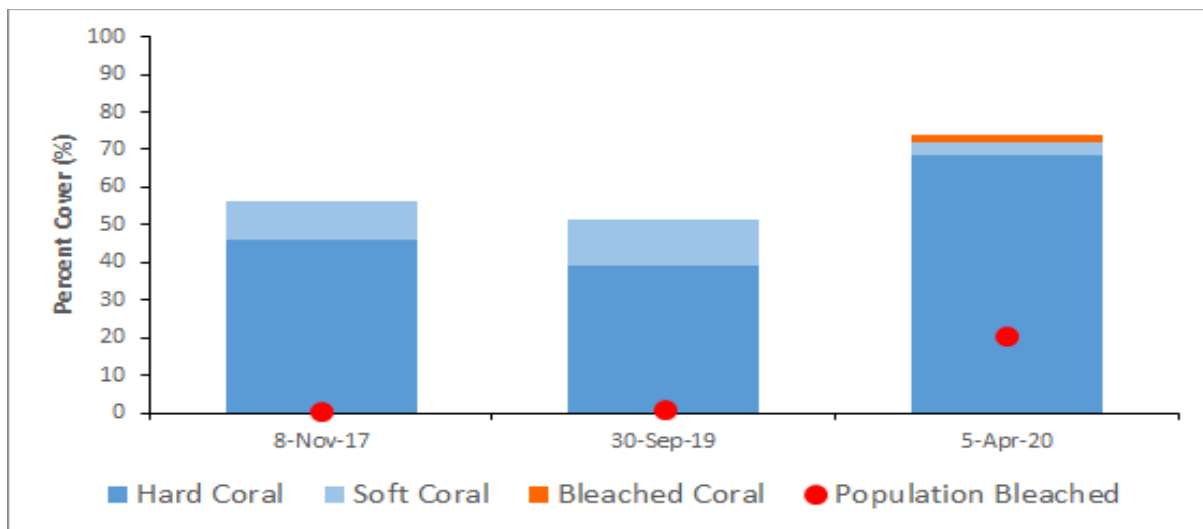


Figure 68: Long-term per cent cover of hard and soft corals and bleached corals by survey year at John Brewer Reef, Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where 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 69). 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.

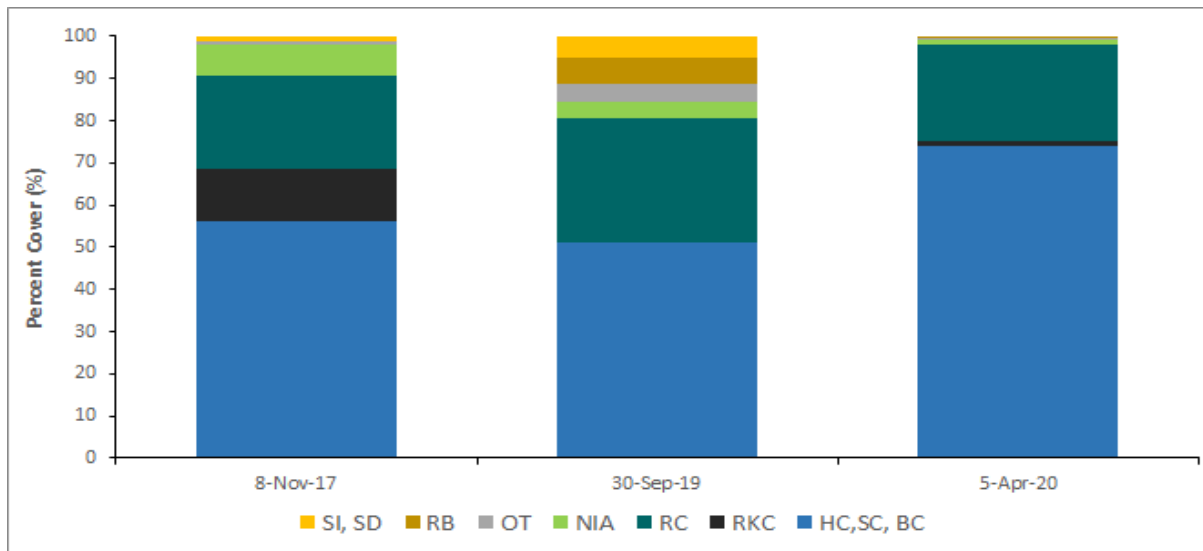


Figure 69: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at John Brewer Reef, Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

Benthic cover was dominated by LCC (74%) and rock 23% (Figure 65). 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 70 and 71).

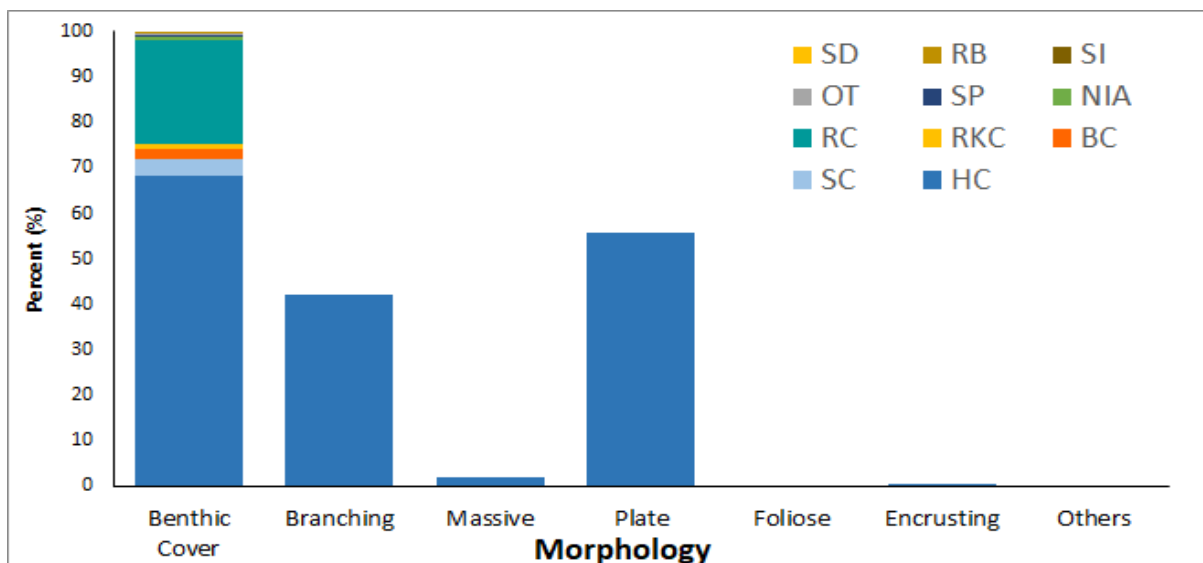


Figure 70: Percent cover of different benthic categories and dominant hard coral morphologies at John Brewer Reef, Reef Check Australia monitoring site.

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.

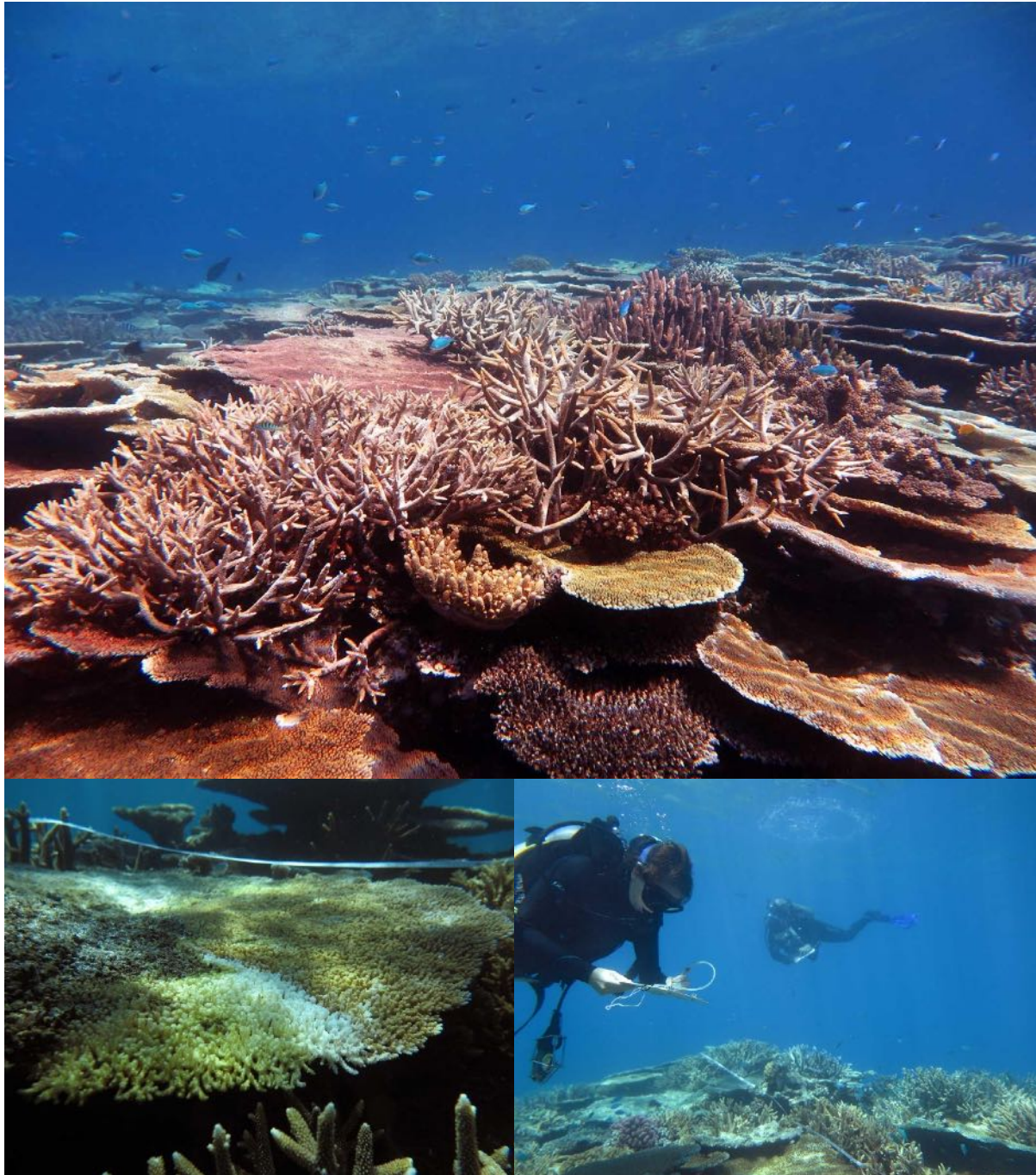


Figure 71: Hard coral cover with a variety of branching and plating corals (top) coral disease on a plate Acropora sp. coral (bottom left) and divers completing RCA surveys (bottom right).

5.11. 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.

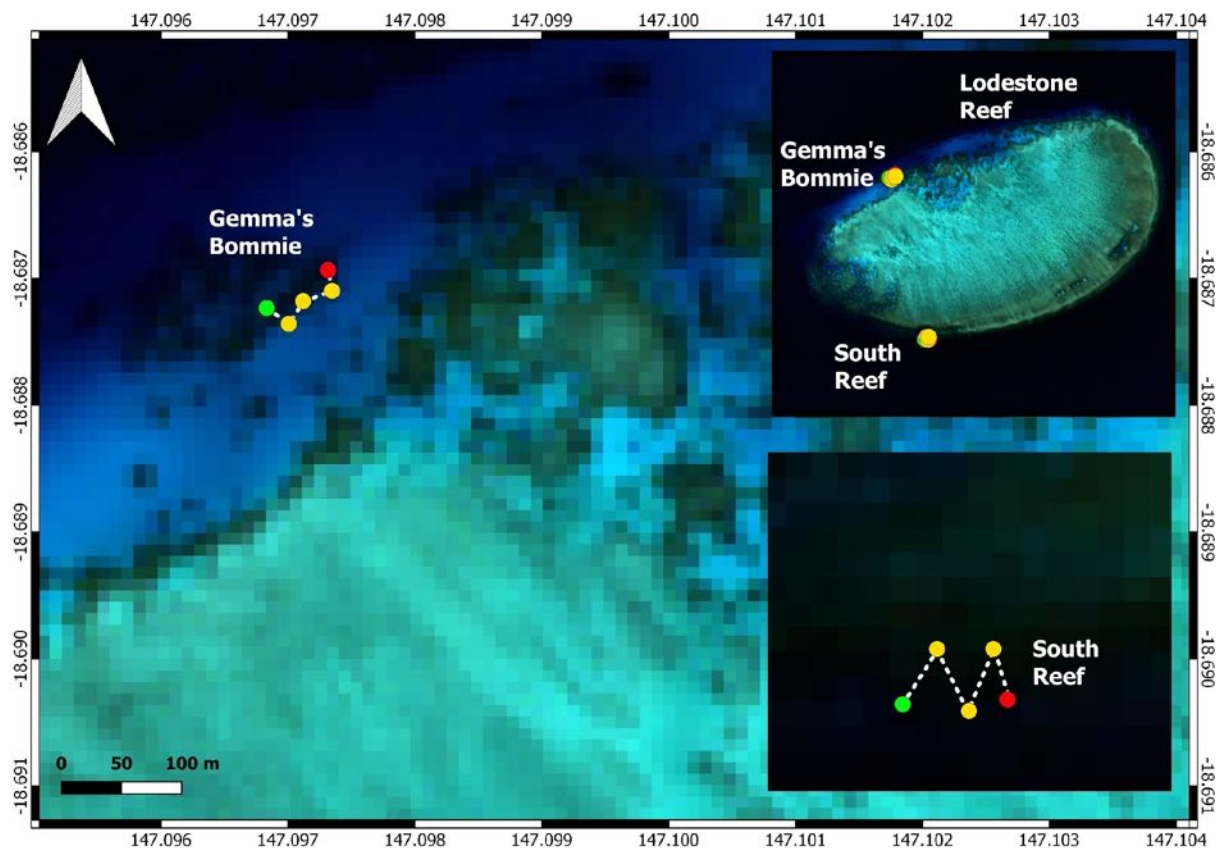


Figure 72: Map showing survey sites 1 and 2 at Lodestone Reef.

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 72). 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 73). Soft-coral (SC) has consistently comprised 3%-6% of the coral cover observed at this site.

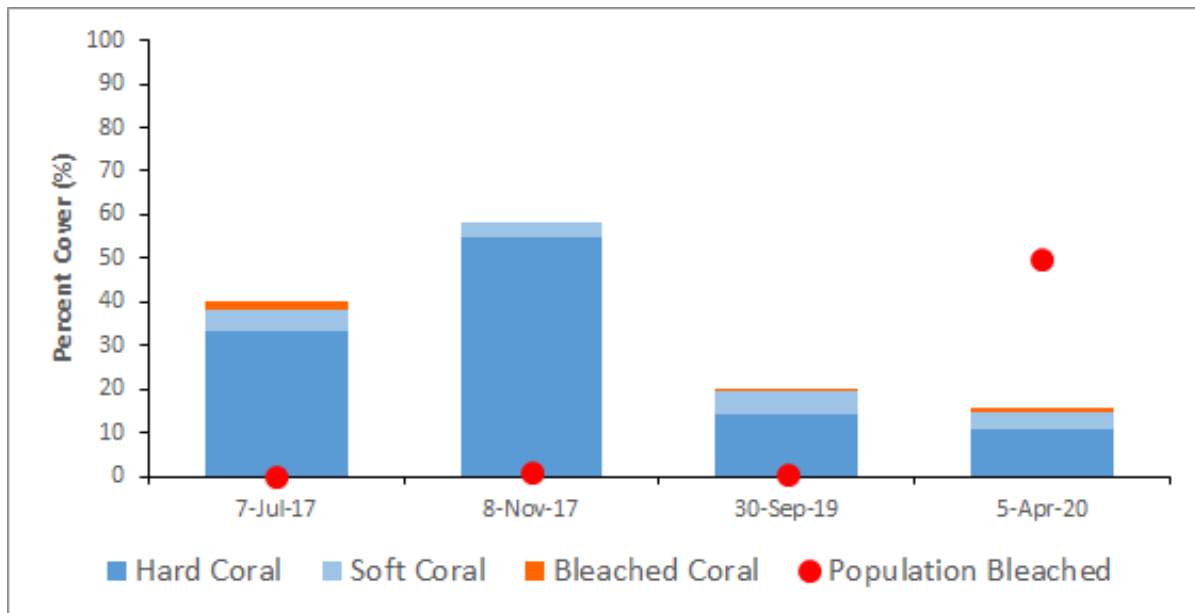


Figure 73: Long-term percent cover of hard and soft corals and bleached corals by survey year at Lodestone Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

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 74).

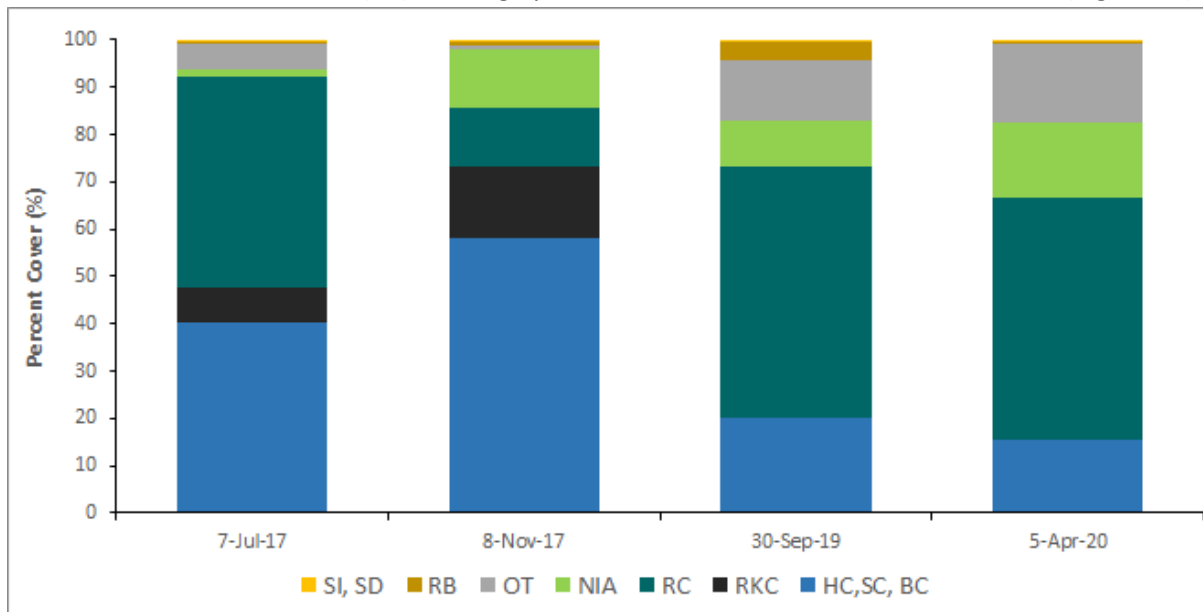


Figure 74: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Lodestone Reef Check Australia monitoring site.

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 75). 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 75 & 76).

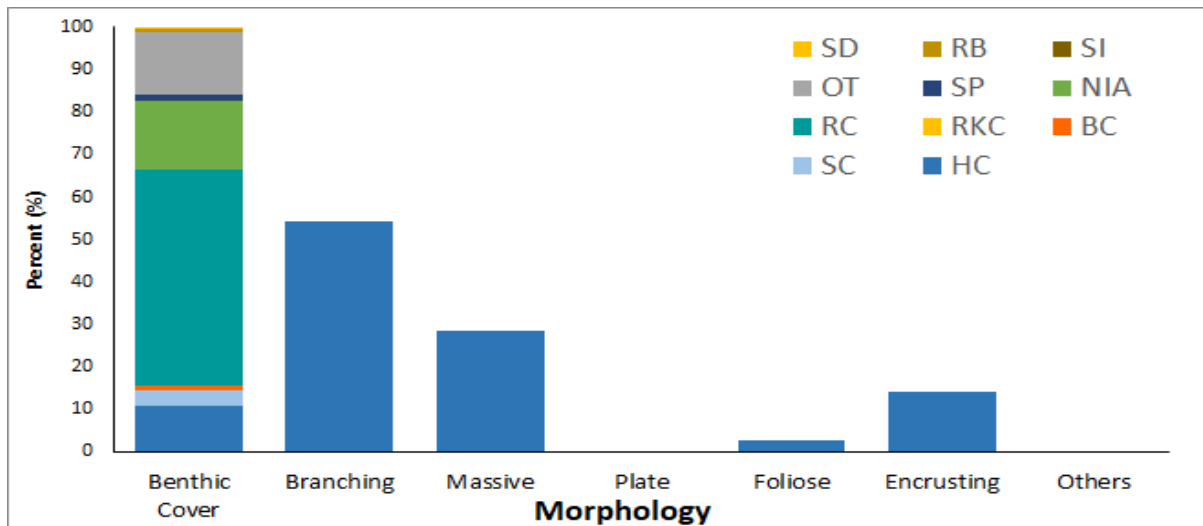


Figure 75: Percent cover of different benthic categories and dominant hard coral morphologies at Lodestone Reef Check Australia monitoring site.

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.

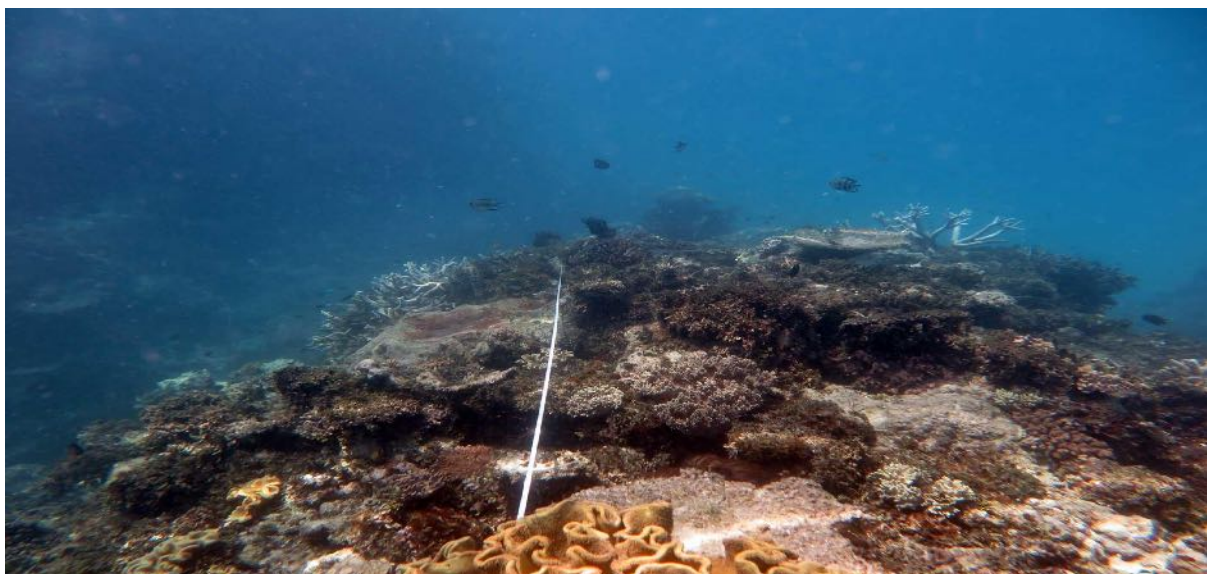


Figure 76: Reefscape at Gemma’s Bommie, Lodestone Reef showing large amounts of reef rock.

6. Whitsunday Region

Known as the ‘heart of the Great Barrier Reef’, the Whitsunday region is iconic for its continental islands with fringing reefs and stunning offshore reefs. The community of Airlie Beach hosts a large tourism industry, which relies heavily on local reefs (Figure 77). Tourism in the Whitsundays is important, with more than 40% of visitors to the Great Barrier Reef Marine Park visiting the region.



Figure 77: Airlie Beach is the Gateway to the Whitsundays region.

Blue Pearl Bay around Hayman Island is one of the first survey locations implemented in the Whitsundays region. During the 2019 season, surveyors completed a total of five sites across four reefs at several long-term sites on Hayman (Figure 78), Hook and Daydream islands and were able to revisit offshore sites at Hardy Reef. Reef Check Australia plans to continue building on monitoring in this region and revisit established sites at other offshore reefs and the south Cumberland Islands out of the Mackay region.

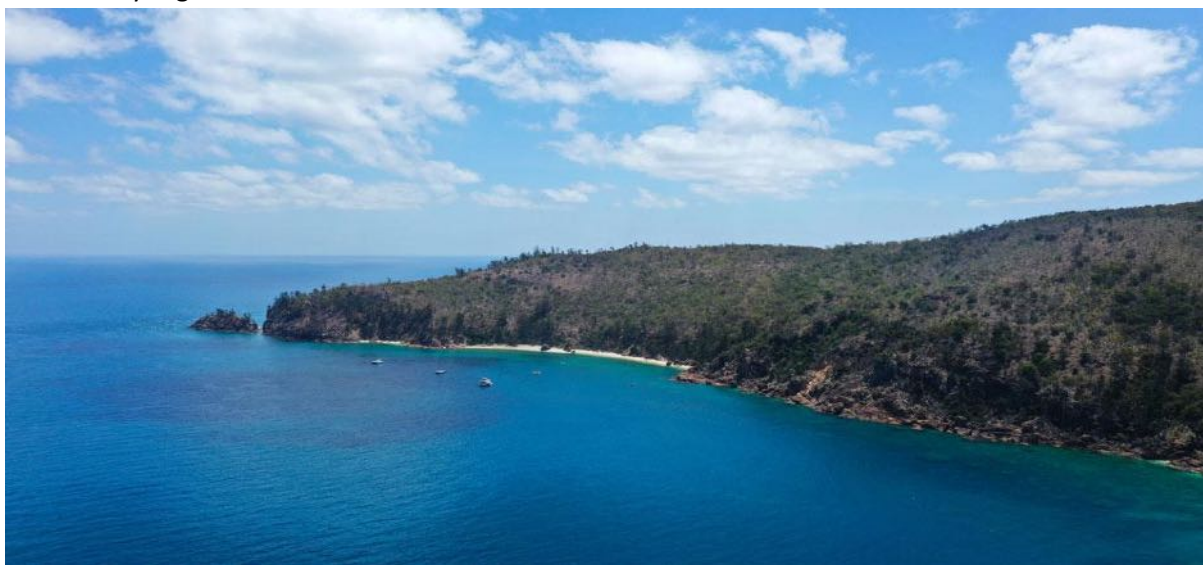


Figure 78: Blue Pearl Bay at Hayman Island.

6.1. Hayman Island - Blue Pearl Bay

Site Description

Hayman Island is one of 74 islands in the Whitsunday region. This small, private island can be found in the northern part of the archipelago and has been home to a luxury resort since the 1950s. On the island's north-western side is Blue Pearl Bay, a 1km long relatively sheltered bay with two small sandy beaches. The Reef Check Australia survey site is located on the reef at the northern end of the bay (Figure 79 and 80). This beach faces west and has reef flats extending about 100m off the beach. The reef depth ranges from 3-18m, with visibility typically between 3-15m. Blue Pearl Bay is a Marine National Park Green Zone and is a popular snorkelling and diving site for tourists. Several operators frequent the area for day or overnight trips.



Figure 79: Survey location at Blue Pearl Bay, Hayman Island.



Figure 80: Map showing survey site in Blue Pearl Bay, on the north-western side of Hayman Island in the Whitsundays.

Substrate Survey

Coral cover for 2020 was relatively low at 21.88% hard coral cover and 0% soft coral cover (Figure 81). This is similar to the 2019 data, a consistent trend after the impacts of ex-Tropical Cyclone Debbie that resulted in very low coral cover in 2018. Of the coral population present, 2.5% was bleached, only slightly higher than recorded in 2019.

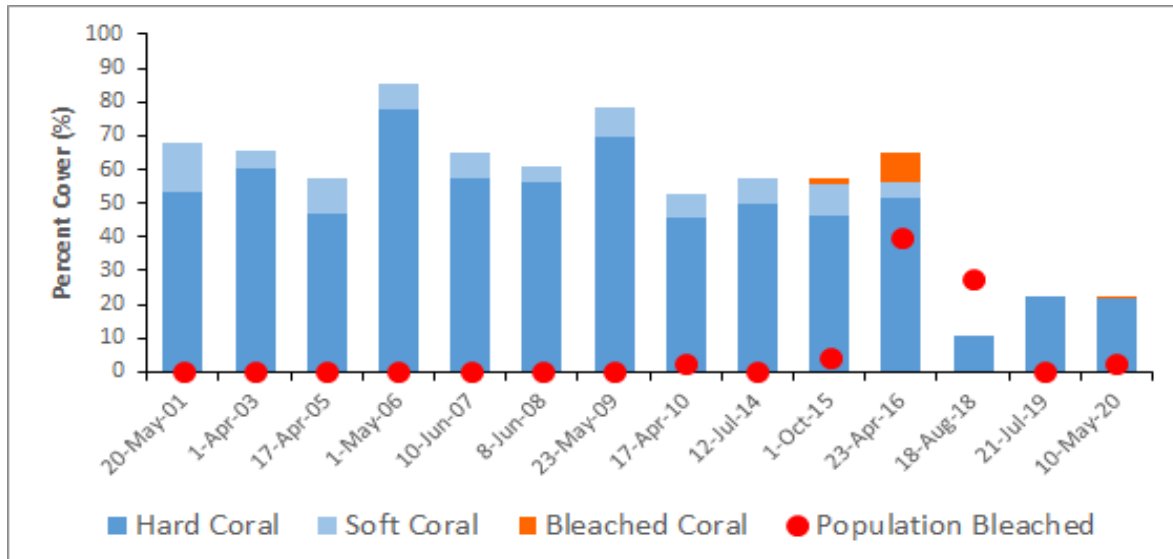


Figure 81: Long-term percent cover of hard and soft corals and bleached corals by survey year at Blue Pearl Bay, Hayman Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey.

Long-term Substrate Trend

In 2020, the percentage of nutrient indicator algae (NIA) was substantially higher than in previous years (Figure 82). Specifically, NIA cover was 42.5% in 2020 compared to 12.5% in 2019 and 10% in 2018. The percentage cover of coral (including hard (HC), soft (SC) and bleached coral (BC)), was relatively low at 22.5%. This was at the same level as 2019, suggesting that the high percentage of NIA was not necessarily directly associated with the low-level of observed coral cover. The level of silt (SI) and sand (SD) reported in substrate surveys also increased in 2020 (22.5%) compared to 2019 (14.38%) (Figure 82).

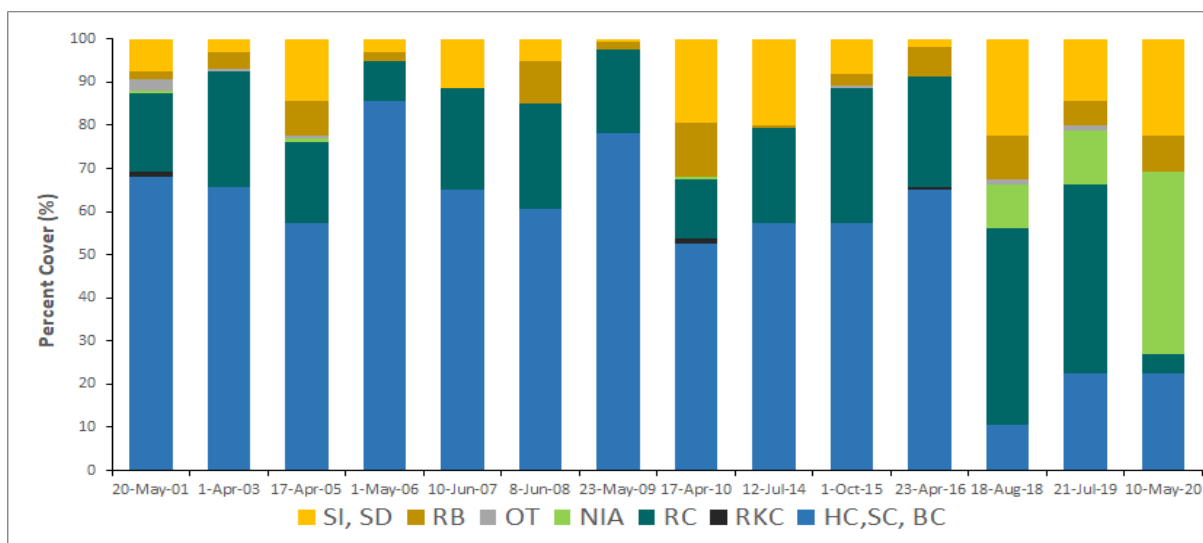


Figure 40: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Blue Pearl Bay, Hayman Island Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

Benthic cover was dominated by NIA in 2020 (42.5%), with hard coral making up the second largest percentage of cover observed (21.88%) (Figure 78). The percentage of silt cover was also relatively high at 11.88%, being of concern for the health of hard and soft coral colonies. The specific morphology of each hard coral surveyed was also recorded. A low diversity of morphologies was found at this site, with 94.29% of hard coral cover represented by the massive-type and the remaining 5.71% made up of encrusting hard corals (Figure 83).

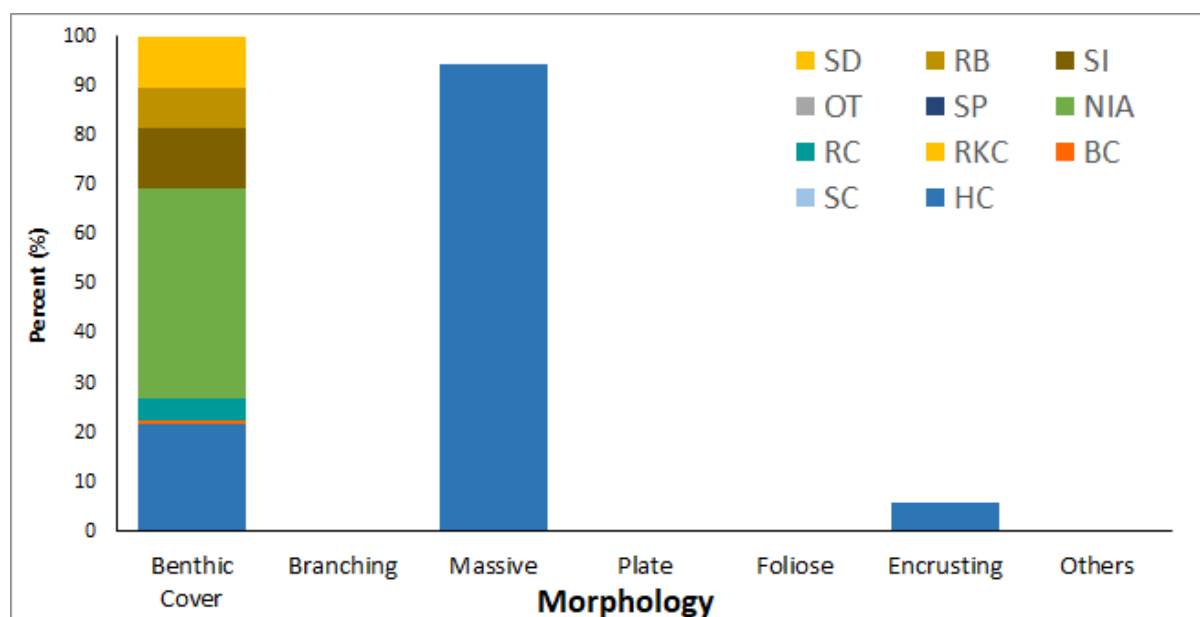


Figure 83: Percent cover of different benthic categories and dominant hard coral morphologies at Blue Pearl Bay, Hayman Island Reef Check Australia monitoring site.

Invertebrates and Impacts

There was little change in the number and type of invertebrates found at Blue Pearl Bay between the 2019 and 2020 surveys. Specifically, there were slightly fewer giant clams in 2020 (28) than reported in 2019 (32), and an absence of the coral predator, *Drupella* snails in both years (Table 3). Consequently, there were no reports of *Drupella* snail scars on coral colonies again in 2020. There was a substantial decrease in the number of unknown scars from 16 in 2019 to zero in 2020. Coral bleaching did, however, marginally increase between the two years. In 2020 surveys, 2.5% of the coral population was bleached, with an average of 28.75% of each affected colony being bleached. This is in comparison to no reported bleaching in Blue Pearl Bay in 2019 surveys. The level of silt remained high, posing a threat to coral population resilience and growth.

6.2. Hook Island - Luncheon Bay

Site Description

Luncheon Bay is located on the northern side of Hook Island in the Whitsundays. It is a popular site visited by most snorkelling, sailing, and diving boats, and usually contains about 15 or more boats on a daily basis. The bay is located on the exposed, seaward side and can be particularly affected by swells from the North-easterlies. However, winds predominantly come from the south, where it is protected. Boats use moorings located about 100m away from the site and use small skiffs to transport snorkelers and divers to and from site (Figure 84).

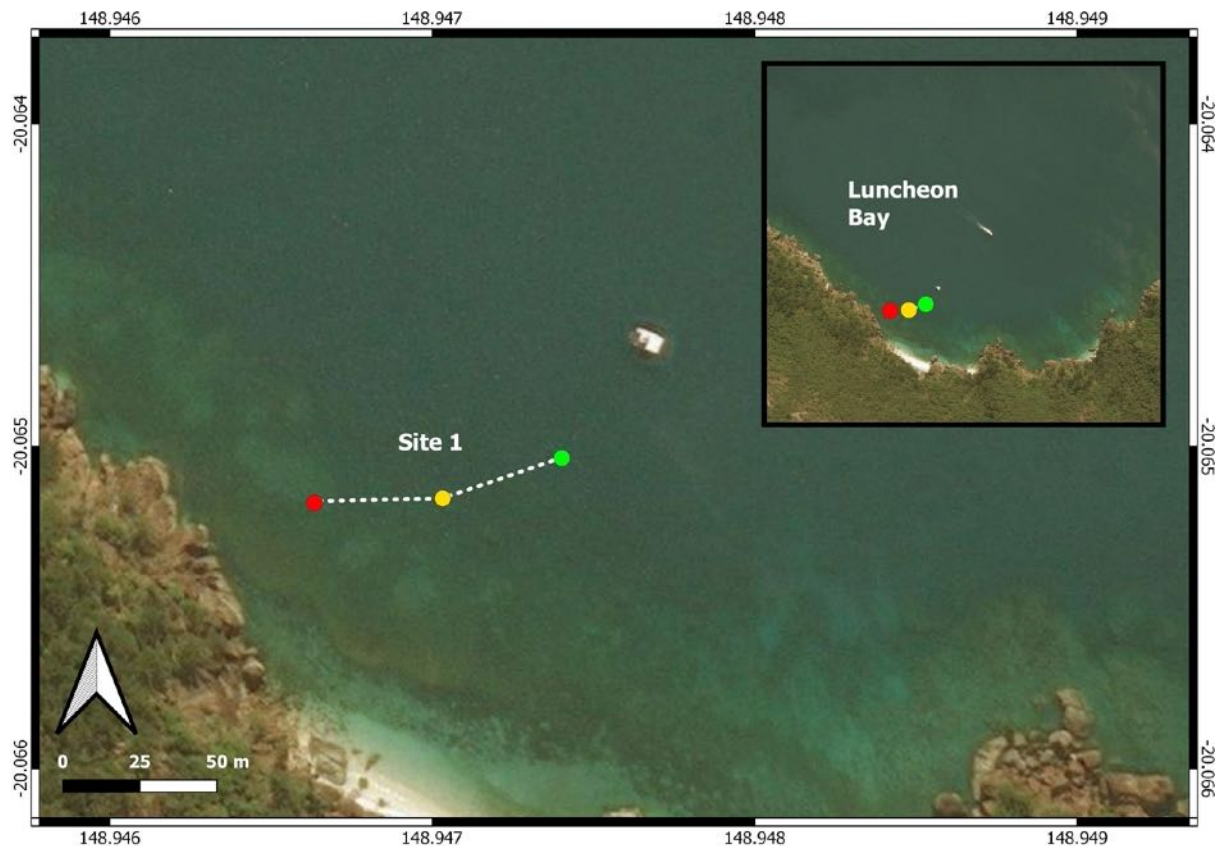


Figure 41: Map showing survey site in Luncheon Bay, Hook Island.

Substrate Survey

Live coral cover (LCC) was measured at just 5%, consisting of solely hard coral (Figure 85). There has been a continuous decline in hard coral cover since the survey records began in 2013, and in 2020 there was a complete absence of soft coral cover. Of the coral population present, 26.25% was bleached – the first bleaching recorded since 2016 (Figure 85).

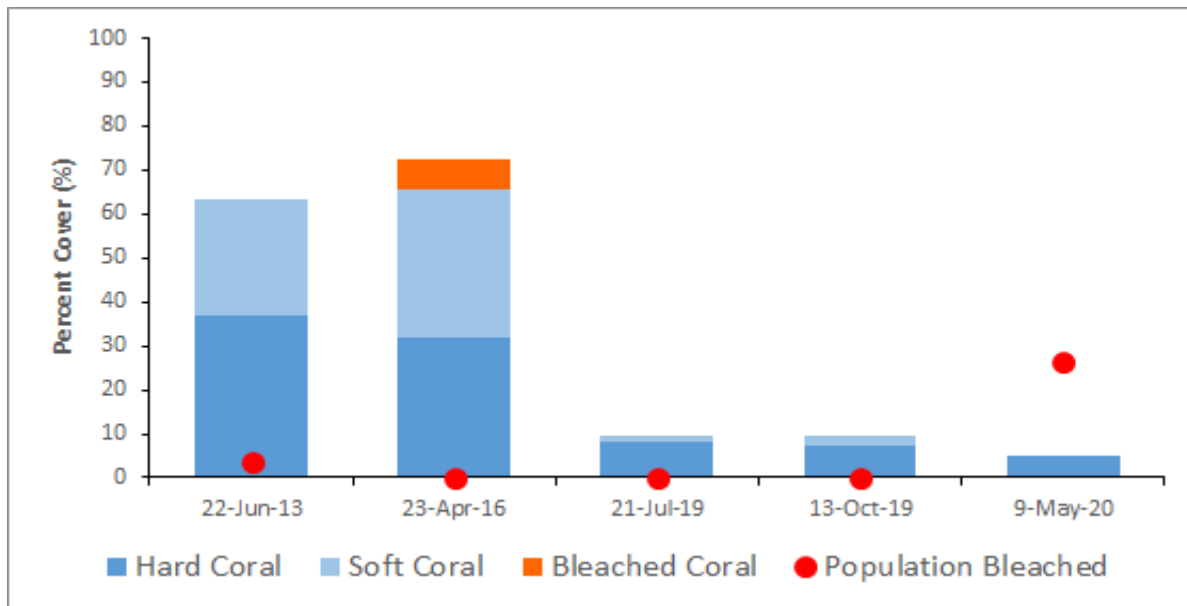


Figure 85: Long-term percent cover of hard and soft corals and bleached corals by survey year at Luncheon Bay, Hook Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

Live coral cover (LCC) decreased by 46.8% since 2019 at Luncheon Bay from an already low 9.4% to just 5% (Figure 86). Since the first survey in 2013, LCC has decreased by 86.4%. In 2020, the complete absence of soft coral cover and the level of bleaching recorded at the site, after a small increase in soft coral cover recorded between June and October 2019, indicate soft coral mortality through bleaching. Reef composition has been increasingly dominated over the years by rock and sand/silt, as hard and soft coral cover has declined. However, even the levels of rock plummeted from 58.75% in 2019 to 11.25% in 2020 as levels of sand/silt, rubble and NIA increased. Contributions of nutrient indicator algae (NIA) in 2020 have hit a record high of 44.38%, from 1.25% in 2013.

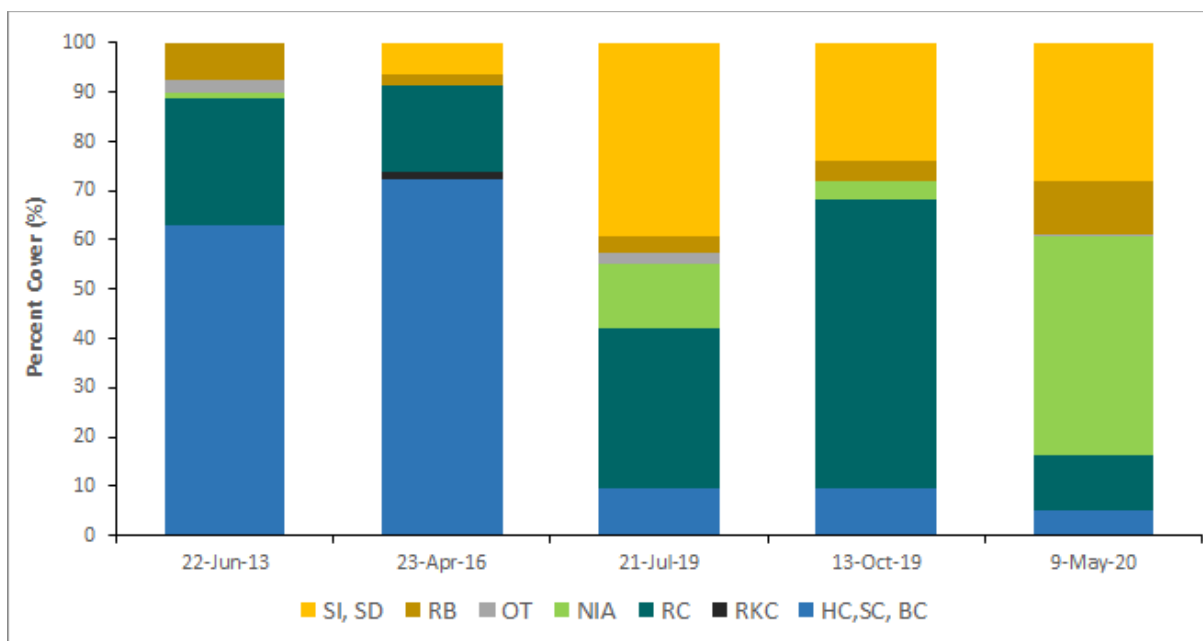


Figure 86: Percent cover of different benthic categories and dominant hard coral morphologies at Luncheon Bay, Hook Island Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

Nutrient indicator algae (44.38%) and sand/silt (28.13%) dominated the benthic surveys at Luncheon Bay in 2020. Rock (11.25%), rubble (10.63%) and hard coral (5%) made up the other major benthic organisms equal to or greater than 5% (Figure 87). Hard corals were dominated by massive (87.5%) and branching (12.5%) morphologies (Figure 88).

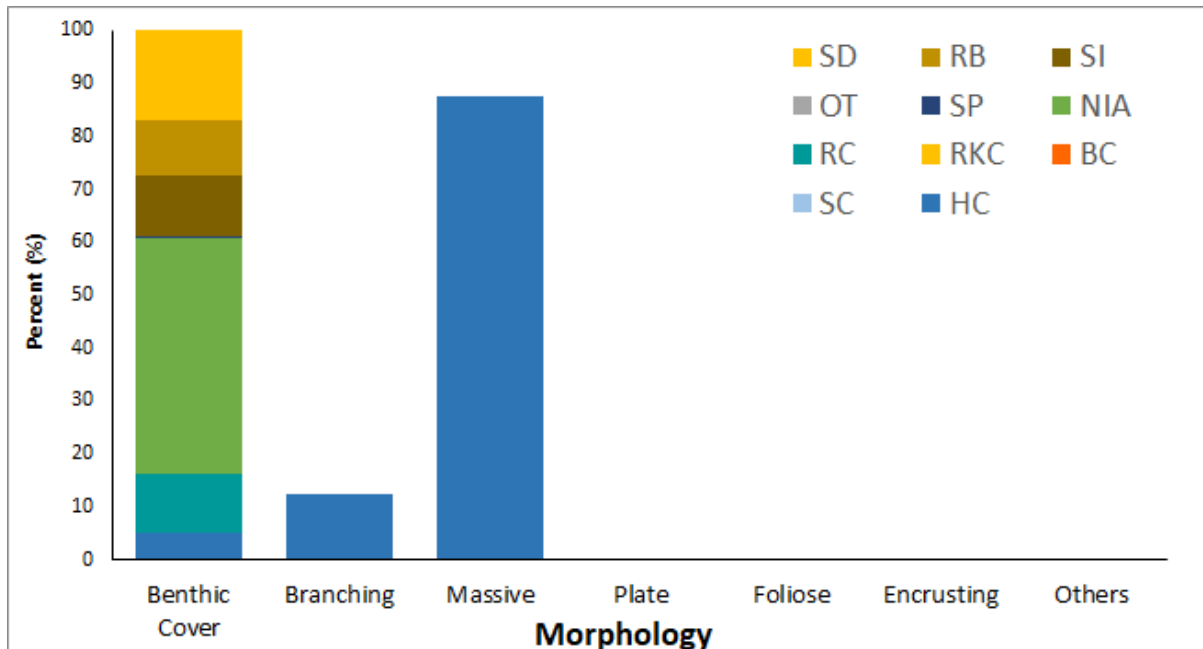


Figure 87: Percent cover of different benthic categories and dominant hard coral morphologies at Luncheon Bay, Hook Island Reef Check Australia monitoring site.

Invertebrates and Impacts

The lack of coral cover likely affected the number of invertebrates observed at Luncheon Bay site. A mean of 1.7 unknown scars and coral damage of 0.3 incidences per survey and 10 giant clams (*Tridacna* spp.) predominantly boring clams were observed (Table 3). Coral bleaching as a percentage of population averaged 8.8% while each colony was bleached 9.3% (Figure 88). Silt levels were observed as being high.

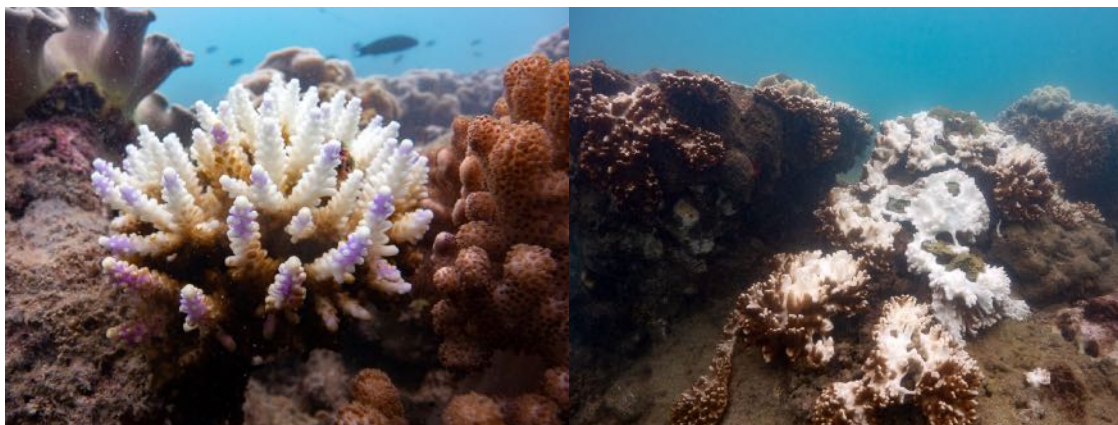


Figure 8842: Bleached *Acropora* sp. coral (left) and bleached soft corals at Luncheon Bay (right).

6.3. Hook Island - Butterfly Bay

Site Description

Butterfly Bay is on the northern side of Hook Island and has become an alternative destination for tourism operators following Cyclone Debbie (Figure 89). The bay is located 30km from Airlie Beach and takes approximately 60 minutes by speedboat. Visitor access is only by boat and there are limited public moorings available. The site sees medium tourism use from small and large boats. Reef Check Australia surveys at a location anecdotally known as 'The Keyhole'. Coral cover (10%) was dominated by soft coral with some massive boulder, branching, bushy and tabulate species present, and small fish. The up current drop off had current and good coral and fish life. This site has been surveyed by RCA three times; 2018, 2019 and 2020.

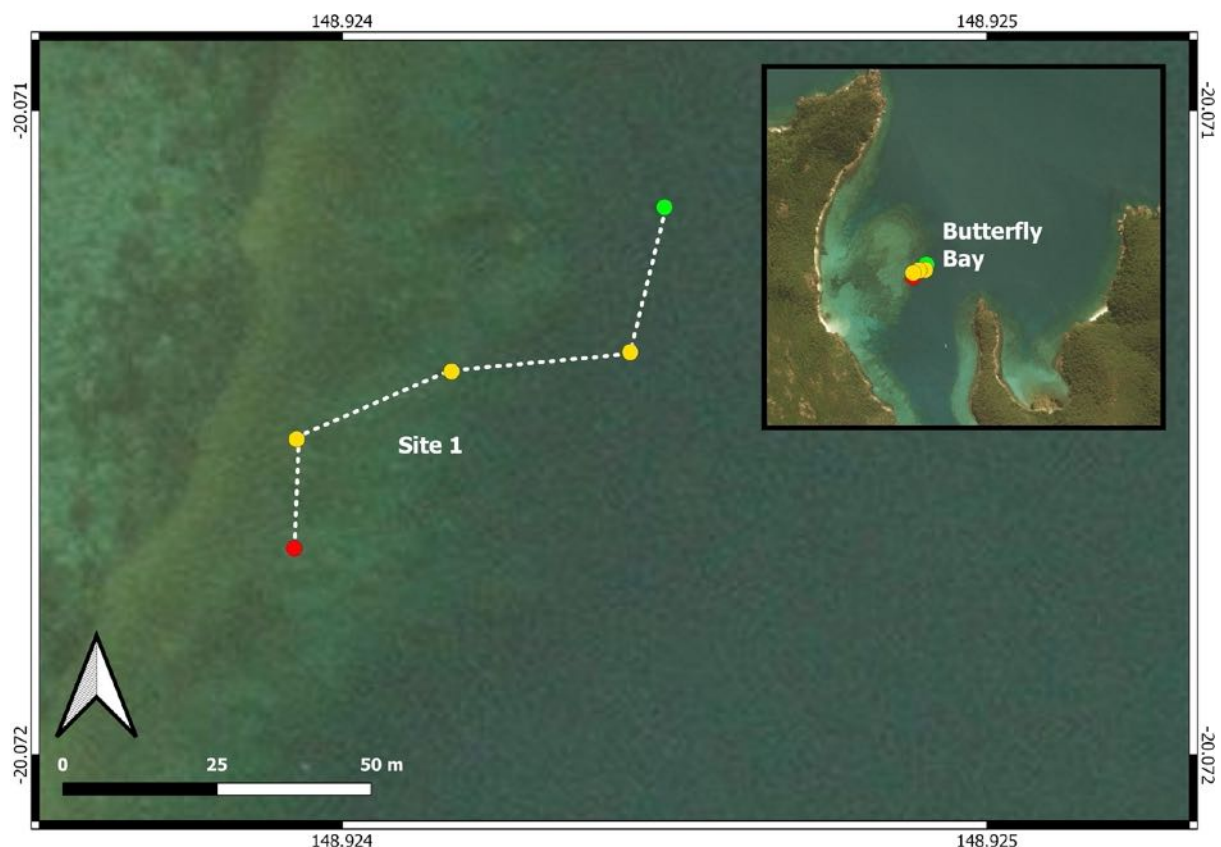


Figure 89: Map showing survey site in Butterfly Bay, Hook Island.

Substrate Survey

Overall, live coral cover (LCC) has remained relatively stable over the three survey years, within the range of 37-40% (Figure 90 and 91). However, the amounts of hard, soft and bleached corals making up this value do vary significantly. The amount of bleached coral population increased from 0% in 2018 to 6% in 2020. Hard coral cover showed significant variation over the three years; 21% in 2018, 31% in 2019 and 11% in 2020. Soft corals became the dominant coral type when the hard coral cover reduced.

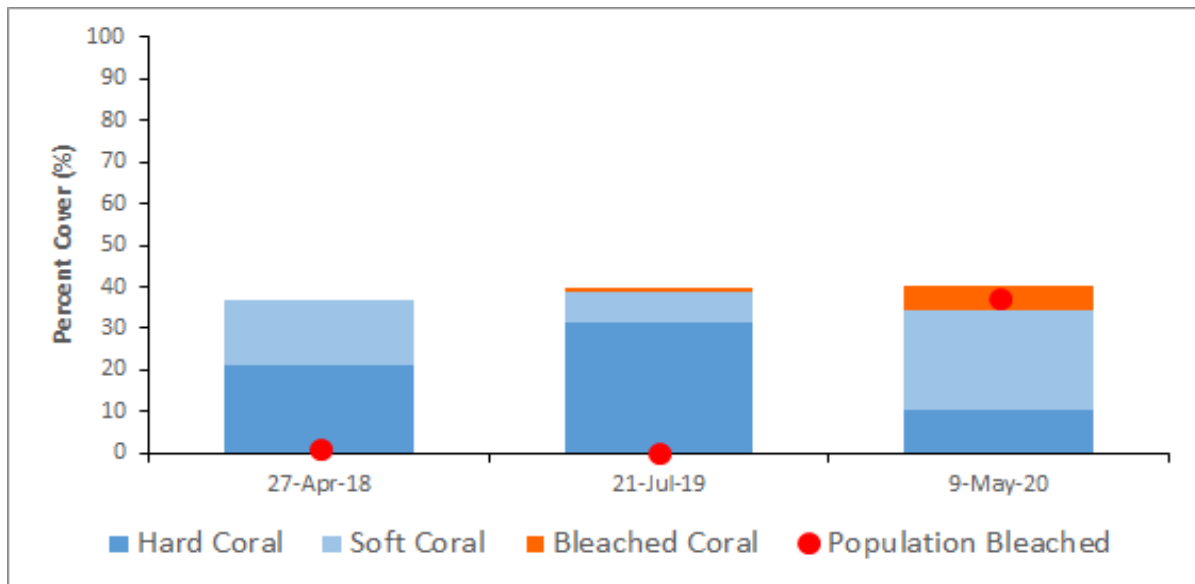


Figure 90: Long-term percent cover of hard and soft corals and bleached corals by survey year at Butterfly Bay, Hook Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

The dominant substrate observed during both the 2018 and 2019 RCA surveys was rock, followed by coral cover (Figure 91). In 2020, the dominant substrate observed was coral cover, followed by rubble, which showed an approximate five-fold increase from 2019 to 2020, and corresponded with a significant reduction in rock cover. NIA has remained low throughout all survey years, at coverage of approximately 0-1%.

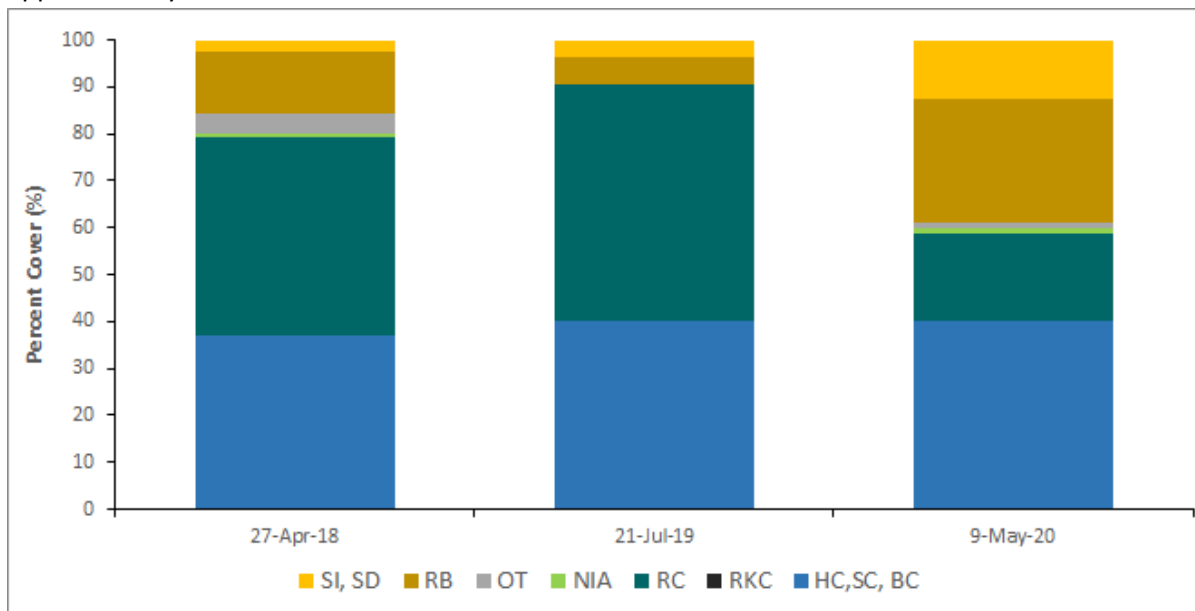


Figure 91: Long-term substrate cover showing per cent benthic cover relative to hard, soft and bleached corals by survey year at Butterfly Bay, Hook Island Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

In 2020, hard coral cover was 11%. The hard coral cover morphology consisted predominantly of 'other' varieties (65%), followed by branching (24%) and massive (12%) varieties. The dominant substratum types were rubble and soft coral (Figure 92 and 93).

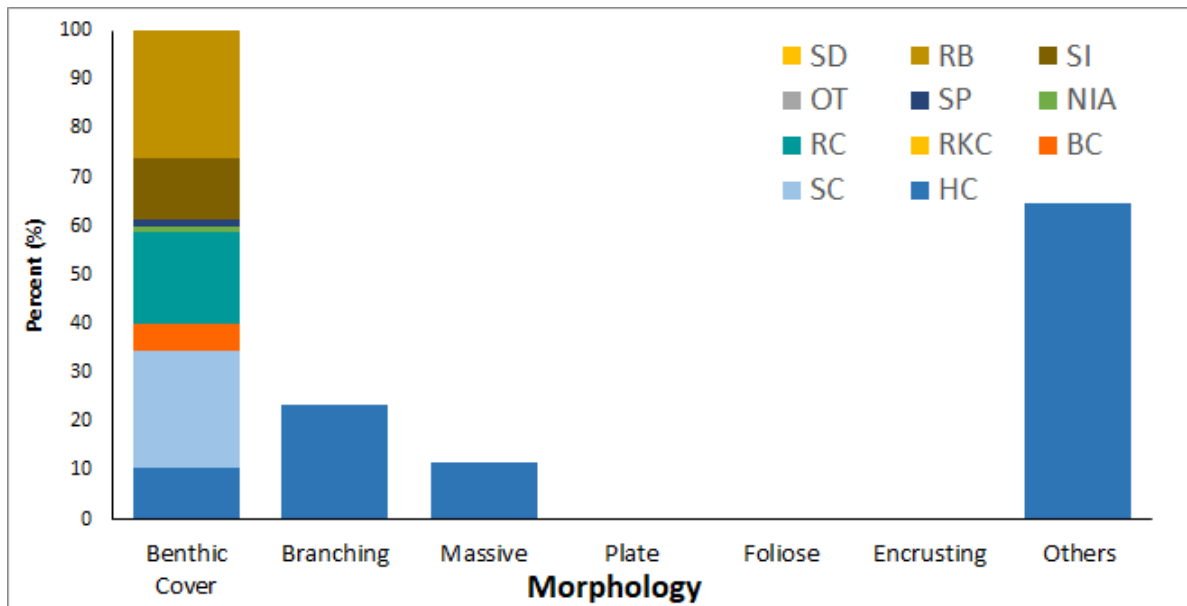


Figure 92: Percent cover of different benthic categories and dominant hard coral morphologies at Butterfly Bay, Hook Island Reef Check Australia monitoring site.

Invertebrates and Impacts

The average numbers of observed giant clams and drupella were 41 and 3, respectively. No other invertebrates of note were observed (Table 3). Only one instance of drupella scarring was observed, along with four instances of other coral damage. COTS were not seen during the RCA surveys. An average population bleaching of 18.8% was recorded, with a colony bleaching of 29.9%. There was a medium level of silt recorded at the Butterfly Bay site.



Figure 93: Diver conducting survey at Butterfly Bay (left) and branching and soft corals (right)

6.4. Daydream Island



Figure 94: Aerial view of Daydream Island and fringing reef where surveys are conducted.

Site Description

Reef Check established two sites on Daydream Island in 2013 (Figure 94 & 95). The first site, Lovers Cove, is situated along the shallow fringing reef on the leeward side of Daydream Island, allowing snorkelers to survey the site. Lovers Cove is one of the more popular reefs for resort guests to snorkel and swim, and the resort's marine biologist hosts frequent fish feeding shows in the beach's shallow waters. The second site, Mermaids Cove, is located on the northern tip of the leeward side of Daydream Island (Figure 95). A shallow, intertidal reef occurs along the rocks, allowing surveys to be conducted on snorkel. On extreme low tides, corals are exposed here. Mermaids Cove is relatively hidden from most tourists, as it is off the beaten path. It is most frequently visited by the resort staff.



Figure 95: Map showing survey sites in Daydream Island.

Substrate Survey

Live coral cover (LCC) was first documented in 2013 at 57.19%, diminishing in 2017 and at the most recent survey in 2020, recorded a mere 2.51% (Figure 96). Hard coral cover was consistent over the survey periods of 2013 – 2014 at 24% and has rapidly declined since, with the most recent survey period of 2020 recording just 0.9%. Soft coral dominated the LCC in 2016 consisting of 32.82% of the total 40.94% LCC reported. In 2017, a drastic decline of zero soft coral was reported and there was a slight increase in the most recent 2020 survey period of 1.57% soft coral. Owing to this, percentages reported for the population of bleached coral rose substantially to 31.75% in the most recent 2020 survey period, consisting of 1.9% individual bleached coral. Previously, 2016 reported the highest individual bleached coral percentage for this site at 13%.

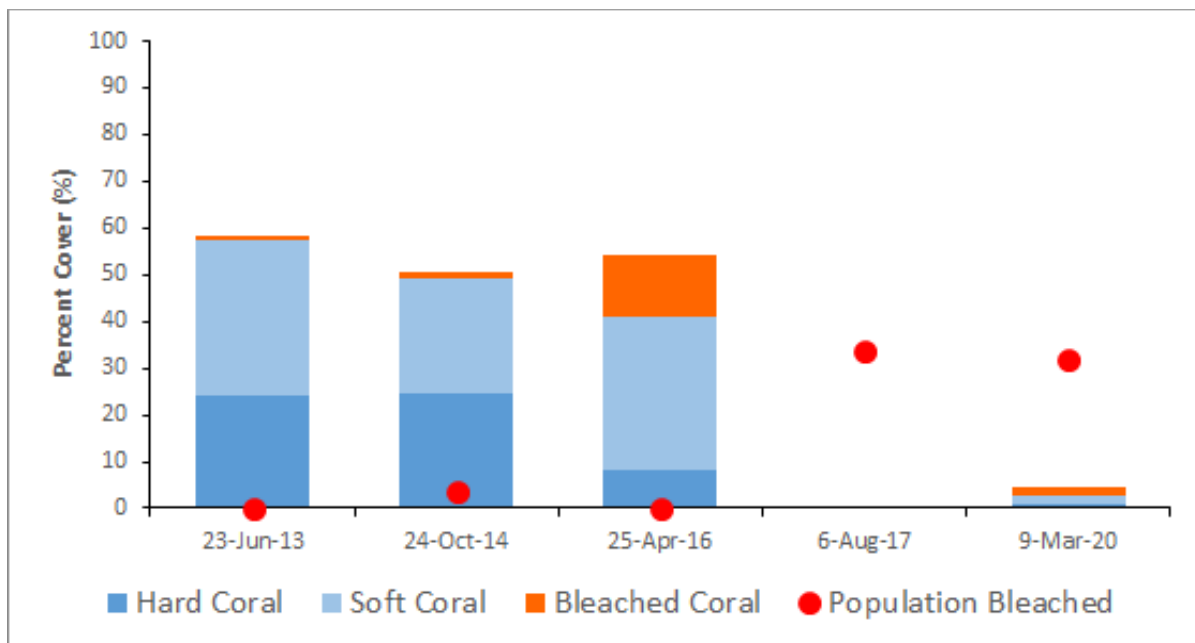


Figure 96: Long-term percent cover of hard and soft corals and bleached corals by survey year at Daydream Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

The reef composition of these sites was first recorded to be largely dominated by live coral, consistently comprising >50% of substrate cover through the survey years 2013, 2014 and 2016 respectively (Figure 97). LCC has increased by 2.51% in 2020 comparative to the last survey period in 2017, where zero live coral were observed on site, a rapid decline of 54.69% since the first survey in 2013. Hard coral drove this decline in 2016, contributing to only 8.13% of the LCC, (2013-2014 saw relatively consistent contribution of both hard and soft corals to LCC, with soft coral averaging 4.68% higher composition than hard coral over these years). Sand and silt are now the principal features of these sites, comprising 27.19% as of 2020, down 52.81% since 2017. Rock (32.5%) and rubble (19.69%) encompass the remaining dominant substrate cover, with an average 7.81% increase in nutrient indicator algae (NIA) in 2020, since 2017 surveys.

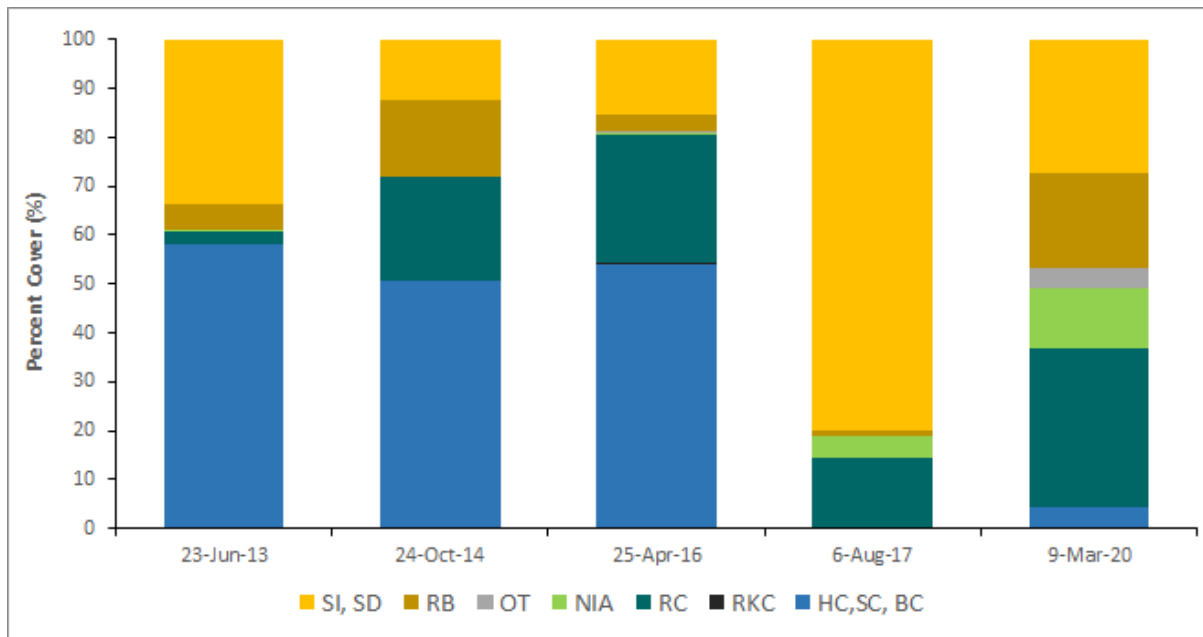


Figure 97: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Daydream Island Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

The recent September 2020 surveys identified four main categories contributed to > 90% of benthic cover at the Daydream island sites: rock (32.5%), silt (26.25%), rubble (19.69%) and nutrient indicator algae (12.19%). Hard coral contributed 0.94% of the remaining benthic cover, with largely plate (66.67%) and encrusting (33.33%) morphologies observed (Figure 98).

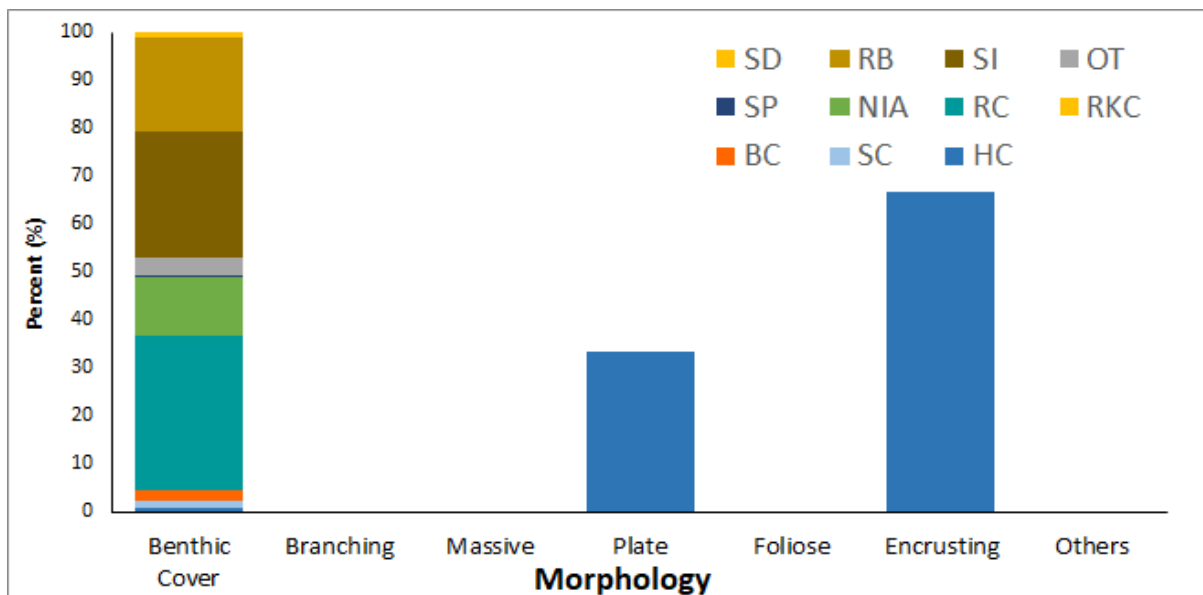


Figure 98: Percent cover of different benthic categories and dominant hard coral morphologies at Daydream Island Reef Check Australia monitoring site.

Invertebrates and Impacts

From the 2020 survey period, one giant clam and one anemone were the key invertebrates recorded at these sites. No marine debris or coral damage was documented at these popular Daydream Island sites, with coral bleaching the only impact observed during the survey, affirming an average of 27.4% recorded bleaching of the colony between the two sites.

6.5. Whitsunday Island - Peter's Bay

Site Description

Peter's Bay is a newly established RCA survey site with important cultural connections for the local seafaring First Nations people, the Ngaro. It is located on the fringing reef on the North-eastern shore of Whitsunday Island, the largest island of the famous Whitsundays group and hosts the even more famous Whitehaven beach further south. Two transects have been set up in shallow 2-4m water, both sheltered by an intertidal sand and rock flat (Figure 99). High abundance of soft coral and good hard coral diversity is observed. This site could be surveyed on snorkel in good conditions however Site 1 is 1-2m deeper than Site 2 further north along the reef crest. These sites were established and surveyed in May 2020.

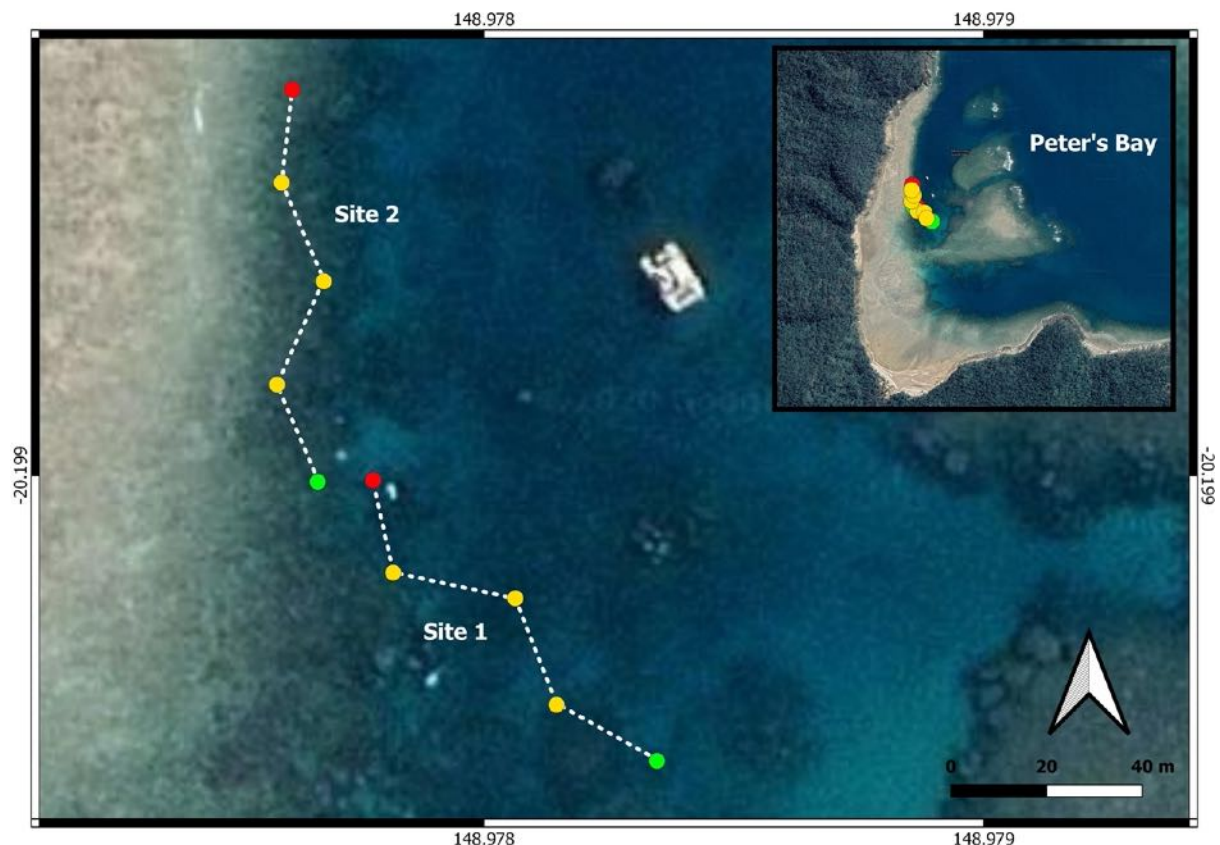


Figure 99: Map showing survey site 1 and 2 in Peter's Bay, Whitsunday Island.

Substrate Survey

Live coral cover was recorded at 50% in May 2020, consisting mostly of 35% soft coral and 11% hard coral (Figure 100).

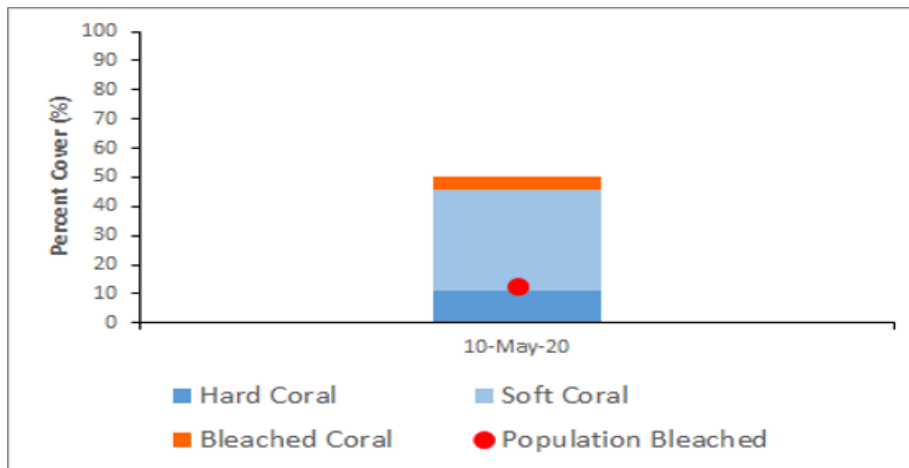


Figure 100: Per cent cover of hard and soft corals and bleached corals by survey year at Peter's Bay, Whitsunday Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

2020 Survey Benthic Cover and Dominant Morphology

Live coral cover was the dominant benthos at Peters Bay (50%), followed by rock (37%), silt and sand (13%) (Figure X). Morphology of the hard coral consisted of branching (71%), massive (11%), "other" (11%), plate and encrusting represented less than 3% cover. However the dominant coral type was soft coral (Figure 101).

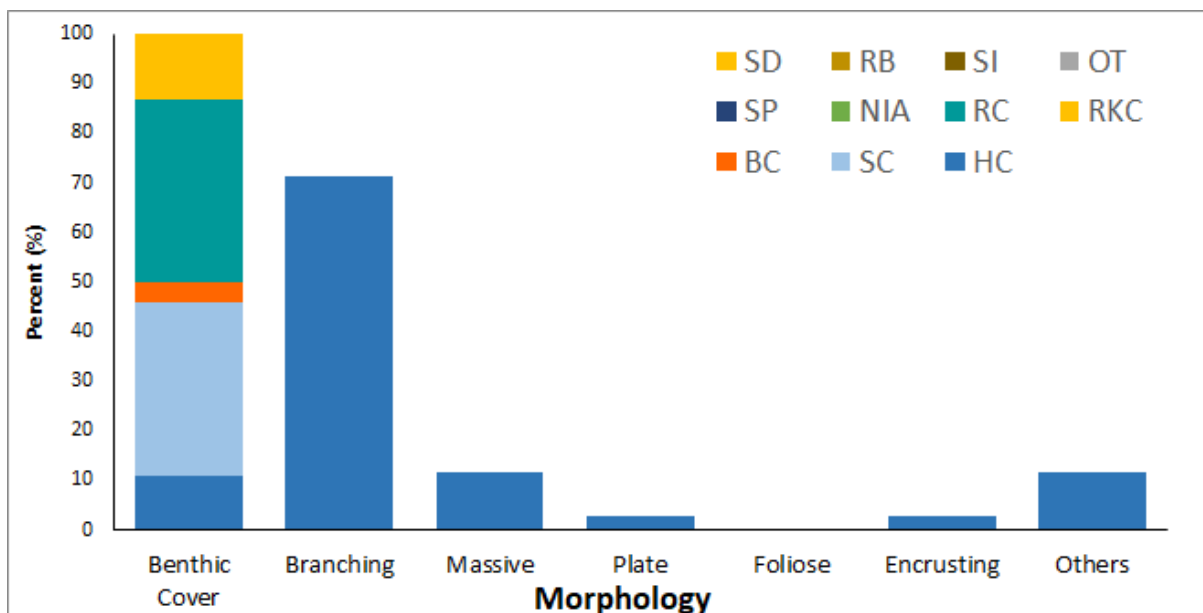


Figure 101: Percent cover of different benthic categories and dominant hard coral morphologies at Peter's Bay, Whitsunday Island Reef Check Australia monitoring site.

Invertebrates and Impacts

Giant clams were the most abundant invertebrate at Peter's Bay Site 1 and 2 with a total of 15 counted. Two drupella snails and one anemone were also observed. Impacts included one drupella scar, two incidents of unknown coral damage and 13% of colonies showing levels of bleaching up to an average of 66% per colony. One piece of marine debris was observed.

6.6. Hardy Reef

Site Description

Hardy Reef is approximately 75km from Airlie Beach. There are two permanent pontoons moored in the protected marine park allowing snorkellers and divers to visit the reef daily (Figure 102 & 103).



Figure 102: Cruise Whitsundays pontoon with snorkellers in the water at Hardy Reef.

This site consists of a steep wall, and a wide slope halfway between the reef flat and reef base. A number of overhangs, incorporated as large gaps within the surveys, dominate this site.



Figure 103: Map showing survey sites 1 and 2 in Hardy Reef.

Hardy Reef contains two RCA survey locations (Figure 103). Each site is located at a 5m depth on the reef slope, close to the two permanent pontoons at this reef. Both of these sites have been monitored a total of 15 times since 2002.

Substrate Survey

Live coral cover (LCC) was measured this year at 58%. This percentage consisted of 26.57% of hard coral, 16.88% soft coral and 14.69% of bleached coral. The population of corals bleached was 49.38%. This is the highest population bleached percentage recorded at this site by RCA. This percentage is almost double the next highest percentage from 2016 (24.88%) which was known to be a major bleaching year for the GBR (Figure 104). This indicates a severe bleaching event at Hardy Reef has occurred over the summer of 2020.

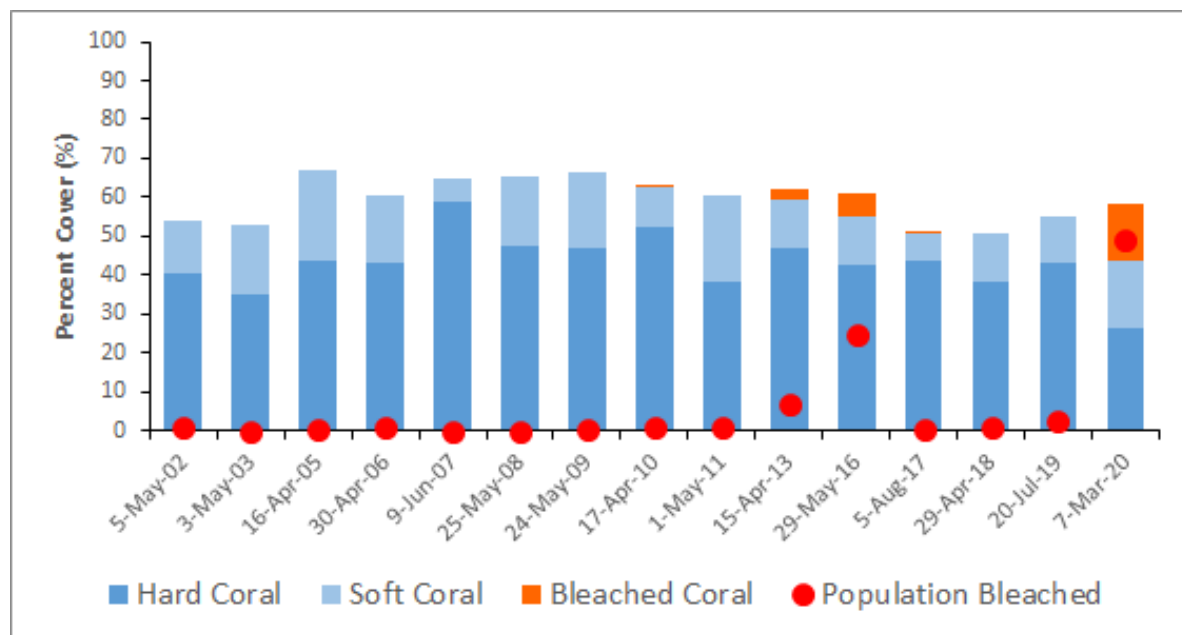


Figure 104: Long-term percent cover of hard and soft corals and bleached corals by survey year at Hardy Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

Based on the long-term data for this reef, there has been an increase in live coral cover (LCC) since 2017. However, it should be noted that 14.69% of this LCC was bleached coral, so current LCC values may be lower. In addition, hard coral percentage (26.57%) is the lowest ever recorded for Hardy Reef by RCA., while the percentage of soft coral (16.89%) is the highest percentage recorded since 2011. The next main substrate type over the years has been rock, with silt and sand being the only other substrates to have been seen to exceed 10% of cover (Figure 105).

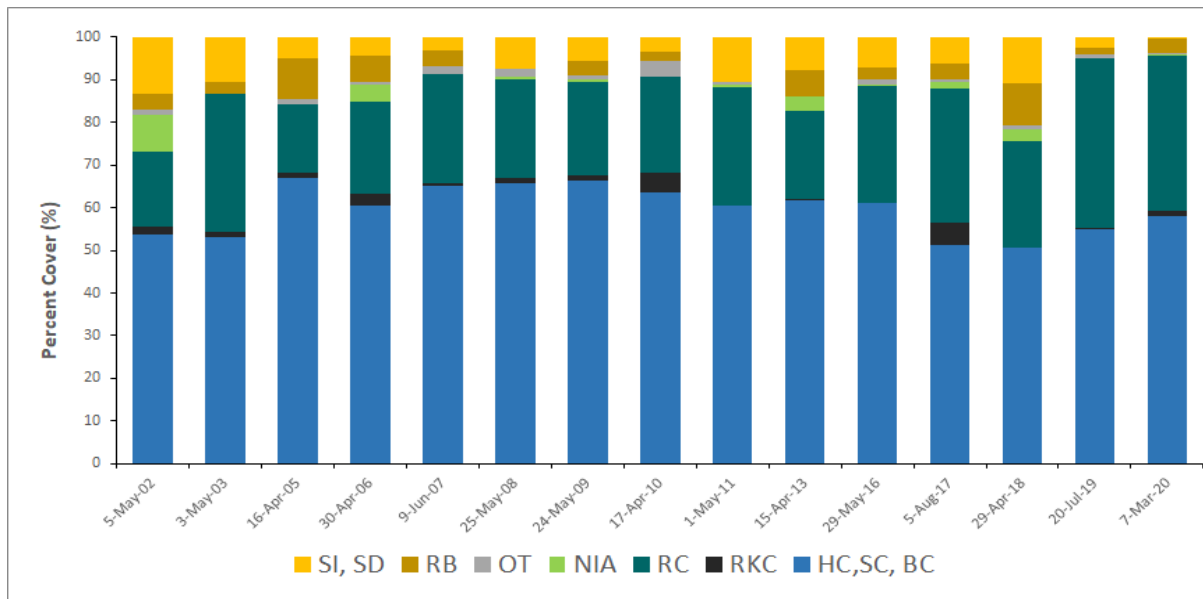


Figure 105: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Hardy Reef Check Australia monitoring site.

2020 Survey Benthic Cover and Dominant Morphology

During the 2020 survey in March, the main benthic cover was rock (36.25%), followed by hard coral (26.56%), soft coral (16.88%) and bleached coral (14.69%). The hard coral was mainly branching (65.88%), with the 'other' growth forms comprising 20%. The only other growth form over 5% was the encrusting morphology (5.88%) (Figure 106 and 107).

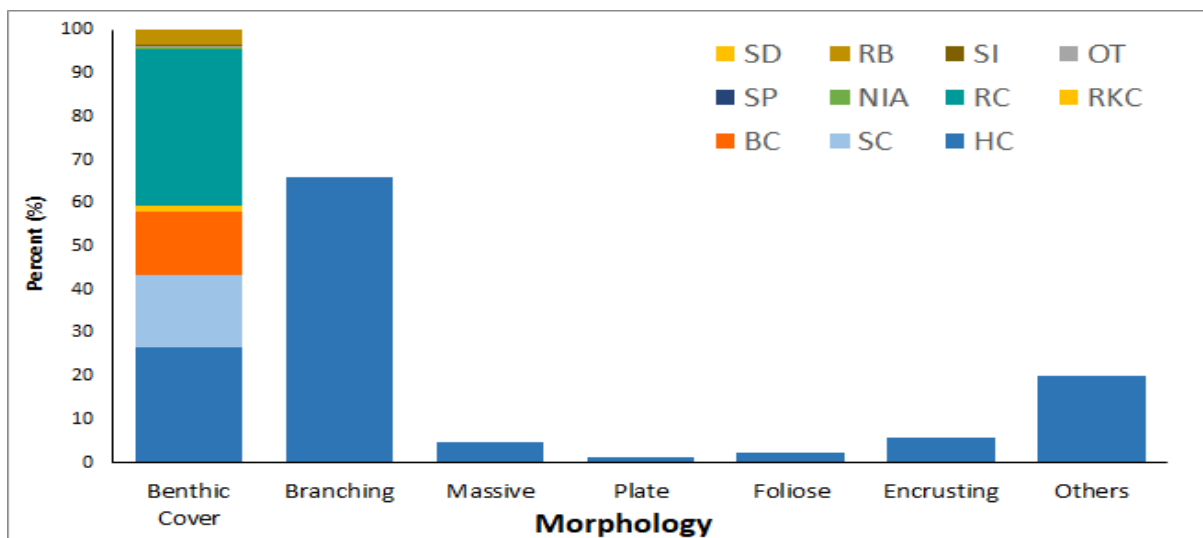


Figure 106: Percent cover of different benthic categories and dominant hard coral morphologies at Hardy Reef Check Australia monitoring site.

Invertebrates and Impacts

During the 2020 survey, the main indicator invertebrates that were found were giant glams (23) followed by anemones (7), and one triton snail was present. Ten unknown scars were observed at this location in addition to seventeen incidences of coral damage. The timing of surveys at Hardy Reef, conducted in March 2020 at the height of regional bleaching resulted in higher than expected levels of coral bleaching. The coral population bleached was 49.38% and the percentage of each colony bleached was 62.25%. This shows severe bleaching in Hardy Reef during the summer of 2020.



Figure 107: Divers conducting RCA survey at Hardy Reef (top and bottom left), bleached branching *Acropora* sp. hard coral (bottom right).

7. Southern Great Barrier Reef

The Southern Great Barrier reef is “Where Great Begins” and the official start of the well-known Great Barrier Reef. From Bundaberg through to Gladstone and up to the Capricorn Coast, the southern region of the Great Barrier Reef is a paradise of coral cay islands and coastal beach towns.



Figure 108: Entrance to Heron Island with the lagoon in the foreground.

Reef Check Australia has a number of sites out of Bundaberg, Lady Elliot Island and Heron Island (Figure 108) with the latter being part of a long-term monitoring collaboration with the University of Queensland’s Remote Sensing Research Centre (RSRC). During the 2019 season, surveyors completed a total of 14 sites at Heron Island. Reef Check Australia hopes to continue to build partnerships in this region to revisit established and new sites.

7.1. Heron Island

Heron Island is a coral cay located on the southern section of the Great Barrier Reef, approximately 80km off the coast of Gladstone, Queensland. The Traditional Owners in the Gladstone region are the Port Curtis Coral Coast People which comprises the Gurang, Gooreng Gooreng, Bailai and Bunda tribes. The island hosts the Heron Island Resort and the University of Queensland’s Research Station (HIRS). The fringing reefs are well-utilised for snorkel and dive tourism as well as reef research.

RCA monitoring sites were established on Heron Island in 2011, as a joint annual collaboration with University of Queensland’s Remote Sensing Research Centre (RSRC). A total of 17 RCA Heron Reef Sites are now monitored as part of the long-term monitoring program. During the 2019 RCA surveys, 14 of these 17 sites were revisited (seven deeper reef slope offshore sites and seven shallow reef flat inshore sites). Detailed summaries of each individual site at Heron Island can be found in the [Heron Island Reef Health Report 2019](#).

7.1.1. Heron Island - Offshore Reefs

Site Description

In the 2019 season, the RCA team surveyed seven sites on the north-west and south-west aspect of the Heron Island reef platform (Figure 109). These seven sites are located offshore on the reef slope in 5-9m of water and surveyed on scuba with vessel support. Coral cover is generally high with some sites accessed more regularly than others by researchers and tourism operators alike. Most sites have been regularly surveyed since being established in 2011.

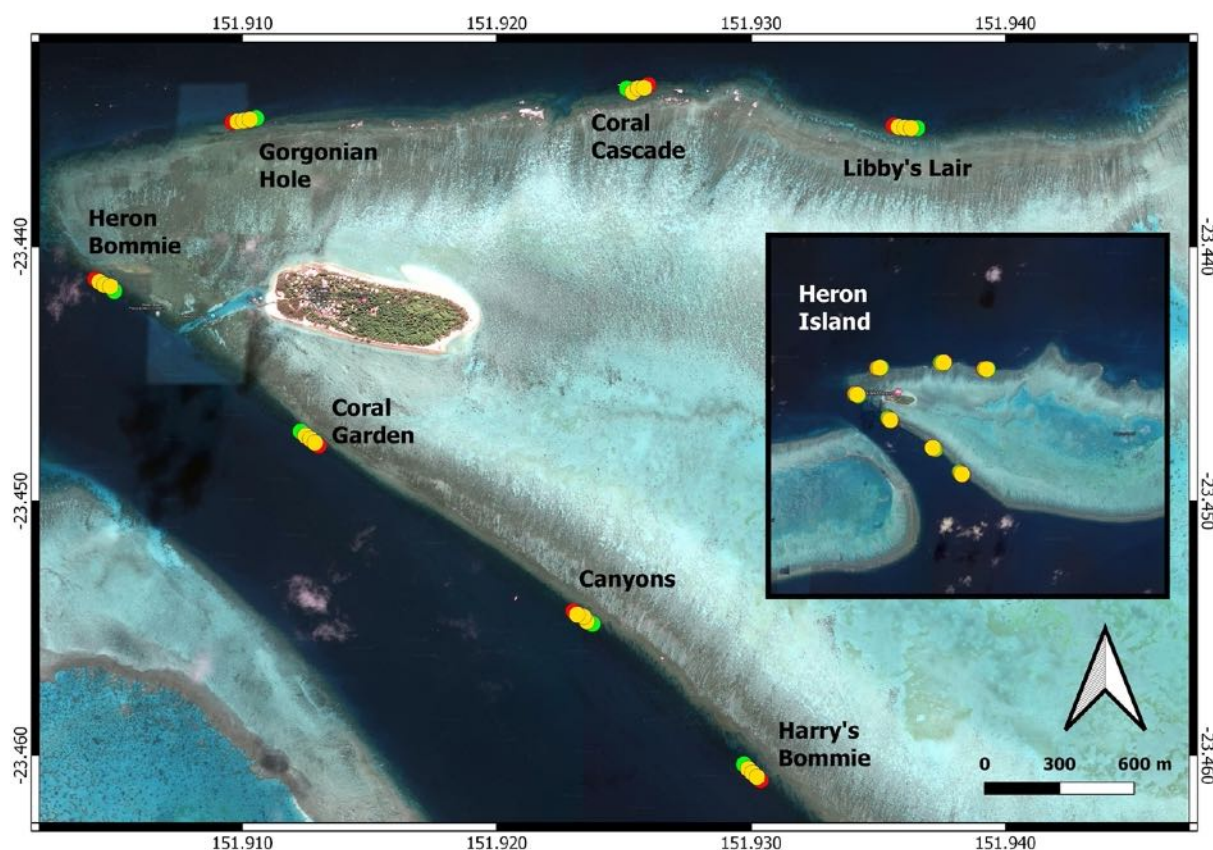


Figure 109: Map showing 7 offshore reef crest survey sites in Heron Island.

Substrate Survey

Average live coral cover across the seven offshore reef slope sites at Heron Island was observed at 66% in 2019 which is fairly consistent with previous live coral cover observations since 2011 (Figure 110). Coral cover is dominated by hard coral (62%) and a low level of soft coral (3%) with less than 1% of the population observed to be experiencing bleaching during surveys in November 2019.

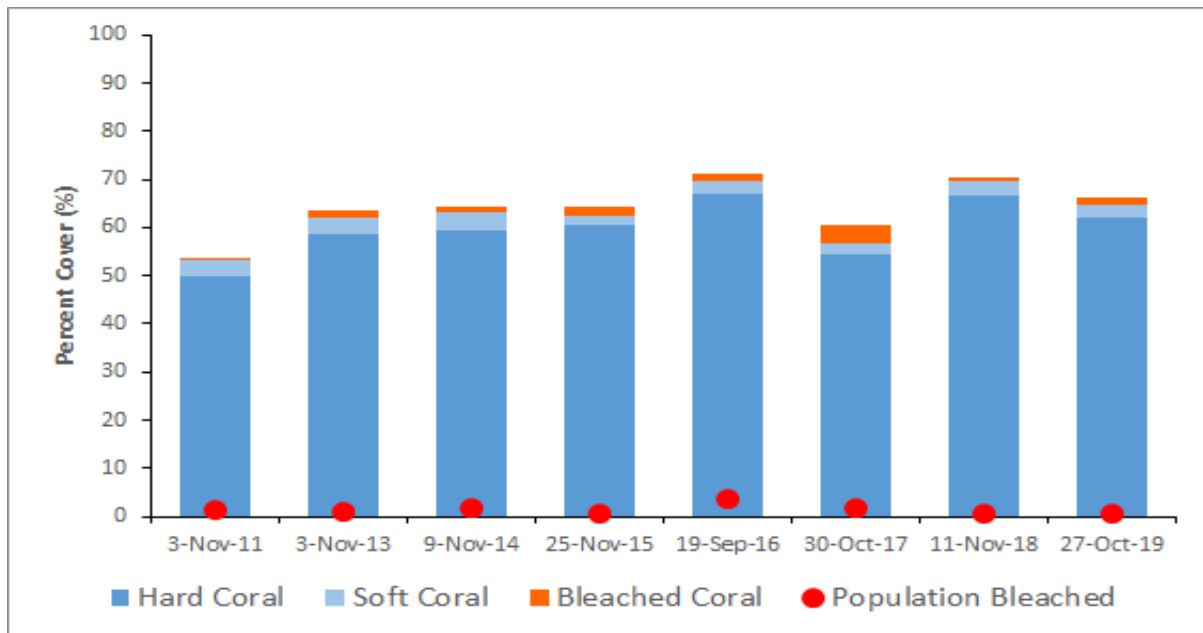


Figure 110: Long-term percent cover of hard and soft corals and bleached corals by survey year at Offshore Reefs, Heron Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

Substrate cover at these sites continue to be dominated by live coral followed by rock with low levels of silt, sand and rubble in 2019 (Figure 111).

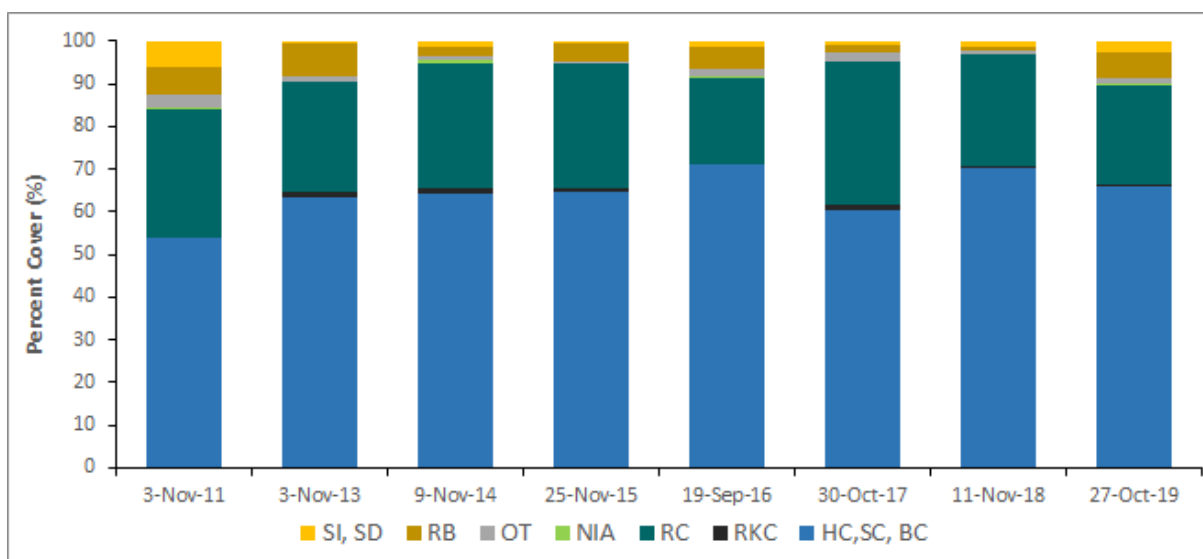


Figure 111: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at Offshore Reefs, Heron Island Reef Check Australia monitoring site.

2019 Survey Benthic Cover and Dominant Morphology

Benthos at the offshore reef slope sites on Heron Island in 2019 were dominated by live coral with a branching morphology (61%), followed by those with foliose, encrusting, plating and other types (Figure 112 and 113).

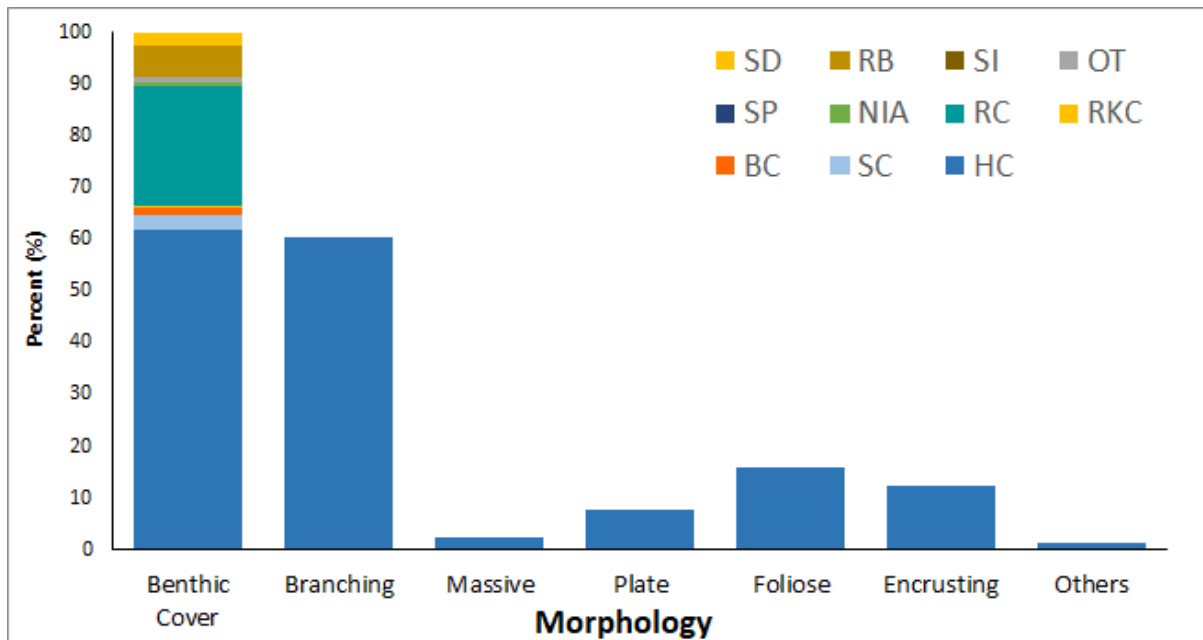


Figure 112: Percent cover of different benthic categories and dominant hard coral morphologies at Offshore Reefs, Heron Island Reef Check Australia monitoring site.

Invertebrates and Impacts

Invertebrates observed in the combined offshore reef slope sites at Heron Island include one target sea cucumber, three giant clams, one drupella snail and one anemone in the 2019 season. Impacts were observed at these sites however note that a higher proportion of coral cover will naturally be associated with higher levels of impacts. For example in 2019, the average reef crest site experienced 13 incidences of coral disease, nine unknown scars, nine incidents of coral damage, two COTS scars, one drupella scar and one piece of marine debris. However bleaching represented less than 1% of coral population on average (Figure 110).

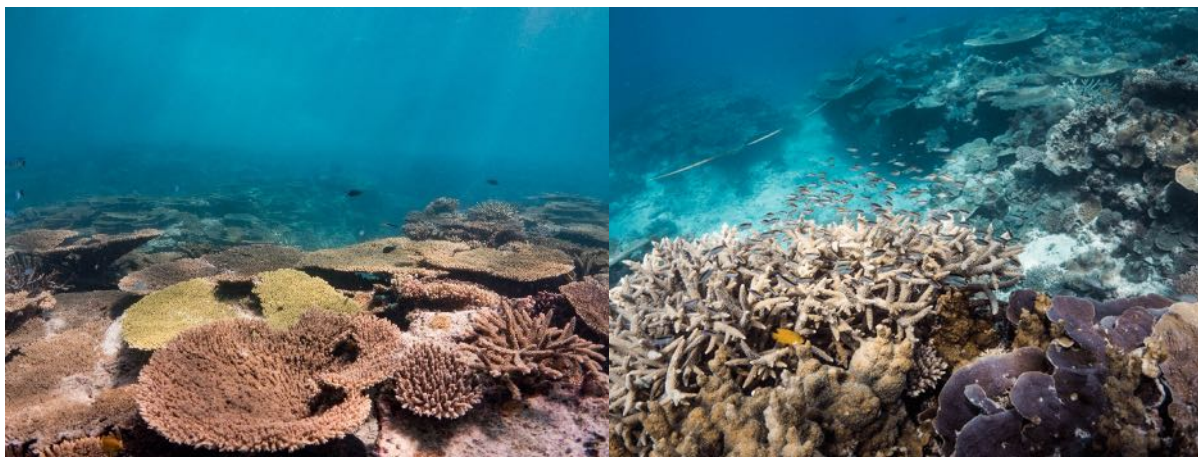


Figure 113: Reefscape at various offshore sites at Heron Island's fringing reefs.

7.1.2. Heron Island - Inshore reefs

Site Description

In the 2019 season, the RCA team surveyed seven inshore reef sites surrounding the Heron Island coral cay (Figure 114). These seven sites are located in the shallow reef flat in 1-2m of water and surveyed on snorkel with shore support. These sites are easily accessed and popular with researchers and tourists. All sites have been regularly surveyed since being established in 2011 or later.

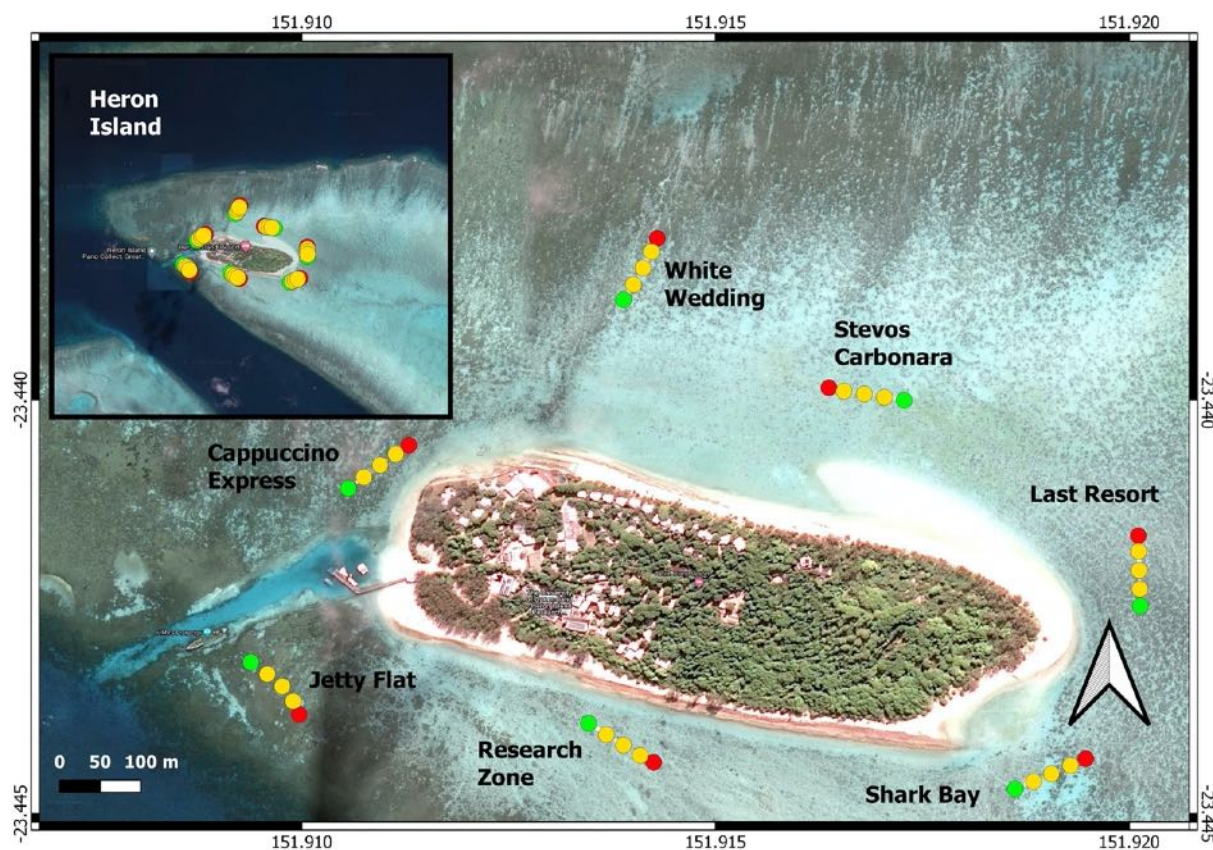


Figure 114: Map showing 7 inshore reef flat survey sites in Heron Island.

Substrate Survey

Average live coral cover (LCC) across the seven inshore reef flat sites at Heron Island was observed at 13% in 2019 which is again consistent with previous observations since surveys of these sites began in 2011 (Figure 115). LCC is dominated by hard coral (12% in 2019) and a higher level of bleaching (16% in 2019) of the coral population was observed at the warmer and shallower lagoon reef flat sites compared to the outer sites surveyed (Section 8.1). This is consistent with the bleaching of the shallower corals reported at Heron Island in early 2020 (Coralwatch 2020).

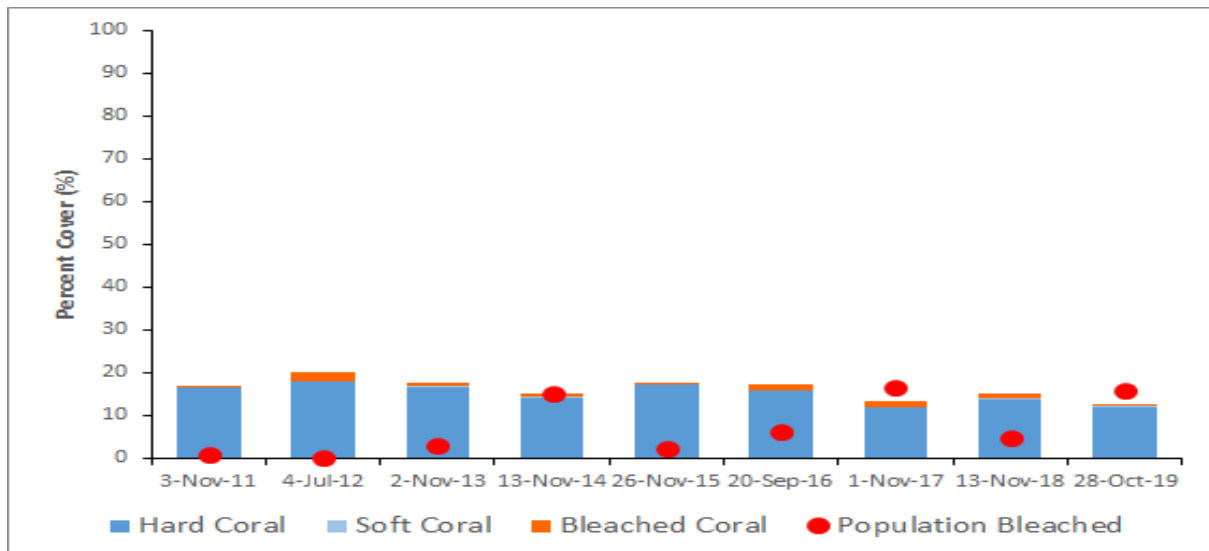


Figure 115: Long-term percent cover of hard and soft corals and bleached corals by survey year at inshore reefs, Heron Island Reef Check Australia monitoring site. Percentage of bleaching relative to total coral population (red dot) as documented on belt transect survey for reef health impacts are included where available.

Long-term Substrate Trend

Naturally these inshore reef flat sites are more dominated with sand (44%) and rock (24%) with low levels of live coral (13%) compared with the outer reef sites. Observations in 2019 remained a similar composition to previous years (Figure 116).

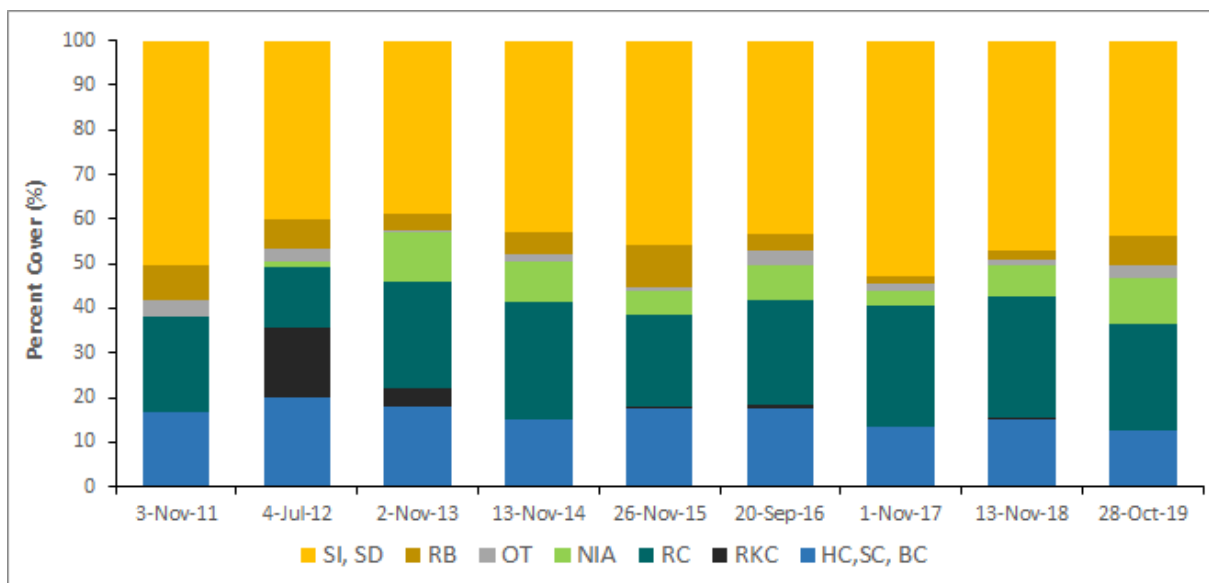


Figure 43: Long-term substrate cover showing percent benthic cover relative to hard, soft and bleached corals by survey year at inshore reefs, Heron Island Reef Check Australia monitoring site.

2019 Survey Benthic Cover and Dominant Morphology

Live coral cover in the inshore sites on Heron Island are dominated by corals with a branching morphology followed by “other” consisting of calcareous algae, corallimorphs and anemones, encrusting and some low levels of plate and massive coral types (Figure 117).

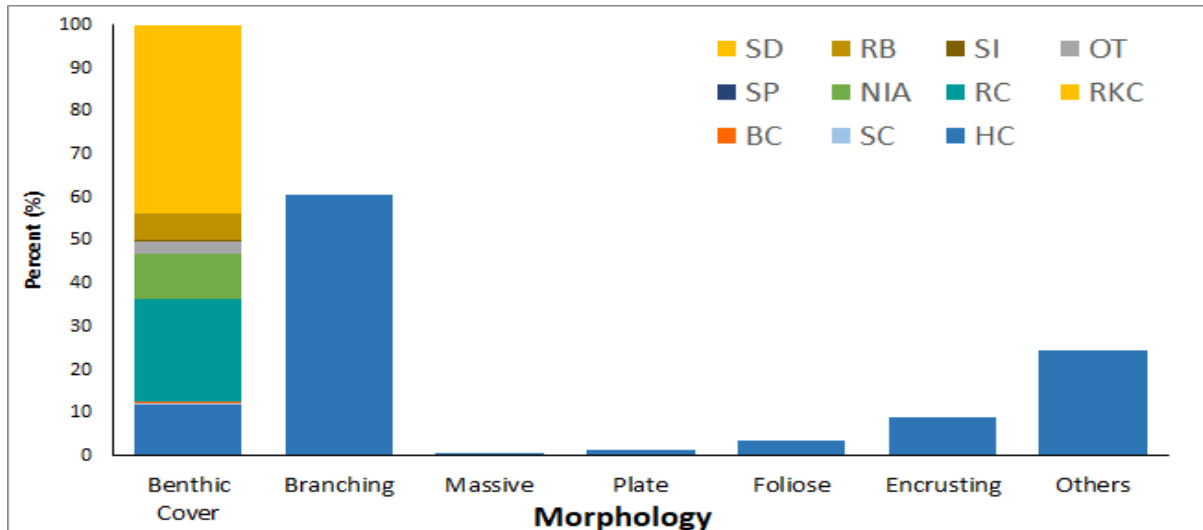


Figure 117: Percent cover of different benthic categories and dominant hard coral morphologies at Inshore sites, Heron Island Reef Check Australia monitoring site.

Invertebrates and Impacts

On average a higher number of target species sea cucumber (10) were observed at sites located in the inshore reef flats of Heron Island most likely due to the higher percentage of sand (Figure 118) compared to the coral and rock dominated fringing reef crest sites. Other invertebrates recorded in 2019 included on average 5 giant clams and one anemone. Impacts related to coral scarring (unknown scarring = 3.4), disease (1) and damage (<1) were less abundant in the lagoonal sites however bleaching was recorded as mentioned (Figure 115).



Figure 118: Snorkel surveyor at Heron Island lagoon site (left) and micro-atoll in Heron island lagoon (right).

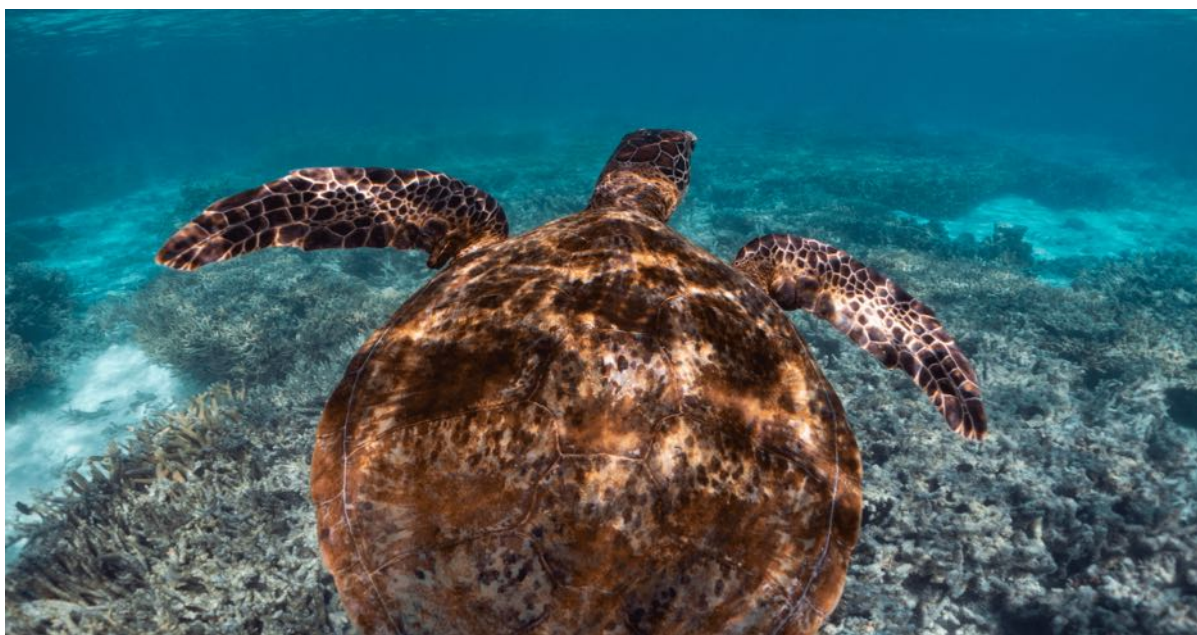


Figure 119: Green turtle at Heron Island.

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