Reef Check Australia

Heron Island Reef Health Report 2019

Reef Check Australia

www.reefcheckaustralia.org

This report should be cited as: J. Salmond, J. Passenger, E. Kovacs, C. Roelfsema and J. Schubert. Reef Check Australia 2019 Heron Island Reef Health Report. Reef Check Foundation Ltd.

Reef Check Australia

Heron Island Reef Health Report 2019

A huge thank you and congratulations to the 2019 Heron Reef Research Team: Chris Roelfsema, Jodi Salmond, Josh Passenger, Eva Kovacs, Jenni Calcraft, Rodney Borrego, Phil Dunbavan and Doddy Yuwono.

Image from Chris Roelfsema.

This project was made possible by in-kind support and advice from The University of Queensland's Remote Sensing Research Centre, Heron Island Research Station and Heron Island Resort.

This report should be cited as: J. Salmond, J. Passenger, E. Kovacs, C. Roelfsema and J. Schubert. Reef Check Australia 2019 Heron Island Reef Health Report. Reef Check Foundation Ltd.

TABLE OF CONTENTS

1.0 PROJECT INTRODUCTION

Reef Check Australia's (RCA) monitoring program is a peer-reviewed, volunteer reef health monitoring program that trains volunteers to collect data on reef composition, abundance of indicator organisms (invertebrates and fish) and reef health impacts, using a globally standardized protocol (Done et al., 2017, Hill and Wilkinson, 2004).

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). The RSRC team has been cataloging the benthic composition of Heron Reef annually since 2001 via geo-referenced photo transects (Roelfsema et al 2010). This and other field data, in combination with satellite imagery, is used to create and validate benthic habitat maps. RCA survey data augments this substantial spatial dataset by offering further information on impact severity and abundance of key organisms, as well as allowing field-based comparisons of benthic composition.

Even though Heron's reefs are intensely studied, with hundreds of researchers visiting the University of Queensland's Research Station annually, there are limited programs that consistently document long-term reef health. Hence the RSRC and RCA initiative can offer a valuable perspective on these reefs, combining a variety of techniques for long-term, cohesive studies. Since the RCA Heron Reef program started in 2011 in partnership with the University of Queensland's RSRC, additional sites have been added to allow for a more representative collection of survey locations around the island. A total of 17 RCA Heron Reef Sites are now monitored as part of the long-term monitoring program.

Reef Check Australia's survey team monitored 14 of these 17 sites (seven reef slope sites and seven reef flat sites) around Heron Reef during the October 25 - November 1 2019 survey. Substrate line transects, in addition to invertebrate and impact belt transects, were conducted at each site. Fish surveys were completed at all 14 sites in 2019. Underwater cameras were used to document visual evidence of key site features, reef impacts and invertebrates. Summary findings for the 14 surveys conducted around Heron Island are presented in this report.

This project demonstrates the value of collaborative citizen-science initiatives as a powerful tool to contribute useful information for science, management and education initiatives. It is intended to continue the long-term monitoring program at Heron Island. This will provide important information in regards to the Health Status of the reef for Marine Park Managers, Island managers, researchers and resource users (including staff and guests), and the broader community.

The Heron Reef RCA dataset has been used as annual supplementary marine condition information for the Fitzroy Basin Report Card by the Fitzroy Partnership for River Health (https://riverhealth.org.au/). Environmental report cards are designed to distil complex scientific knowledge, and through long-term monitoring, determine status and trend of catchment and marine health. Additionally, the percent cover of hard and soft coral averaged across monitoring sites for each year has been scored using Reef Plan Reporting standardised scales, which provides regionally relevant reef health information for the Reef Plan Marine Monitoring Program (https://eatlas.org.au/).

2.0 SUMMARY OF FINDINGS

2.1 Key findings from the 2019 surveys:

- Total average hard coral cover across all sites was 37%; this is consistent with previous years (2018, 42%; 2017, 36%; 2016, 40%; 2015, 40%; 2014, 38%) results. Hard coral cover ranged from just over 1% to 74% across monitoring sites. Six sites had coral cover greater than 50%, one site had between 25-50% cover and seven sites had less than 25% coral cover.

- Most sites had low levels of soft coral (present at six of 14 sites and averaging 3% coverage).

- Four Crown of Thorns starfish were observed, all at Heron Bommie.

- Indicator sea cucumbers were recorded in higher abundances on sandy inshore reef flat sites. All snorkel sites (seven) had sea cucumbers. Four of the dive sites had sea cucumbers present.

- Giant clams were recorded on all but two sites. Heron Bommie and White Wedding had the highest abundance with 15 and 14 counts recorded respectively per 400m².

- Coral scarring from unknown causes was reported at 13 of the 14 sites, with the highest record of 24 counts per 400m² at Harry's Bommie. An average of 6.4 counts per 400m² were recorded for all sites.

- Of the 14 sites surveyed four sites had debris recorded; Coral Cascade had six pieces of general trash; Canyons, Harry's Bommie, and Research Zone all had one piece of general rubbish.

- Hard coral damage was recorded at nine of the 14 sites. The highest abundance (17 counts) was recorded at Gorgonian Hole.

- Coral bleaching was recorded on all sites, but in relatively low levels. The highest population bleaching was recorded at White Wedding (27.5% of the population; 17.5% of each colony on average). Coral Cascade had the highest individual colony bleaching average (41%) with population bleaching levels of just 1.5%. Total average coral population bleaching across all sites was 8%, an increase from 2018 levels (3%) but consistent with previous records (8% in 2017, and 5% in 2016).

- Coral disease was recorded at eight of the 14 sites. Of these, six had incidents of ten or less recorded. Coral Gardens had the highest counts of disease, with 57 incidents recorded per 400m². Heron Bommie had the second highest count of coral disease, with 18 per 400m². Average coral disease counts across all sites was 7.2 per 400m².

- Refer to Appendix A for comparative graphical representation of 2019 results for all survey locations.

3.0 INTRODUCTION

3.1 Reef Check Australia Overview

Trained Reef Check Australia (RCA) volunteers have been monitoring reef health around Australia since 2001. Annual surveys provide long-term data sets that can be used for local and regional reef management that can be compared to Reef Check data around the world. This temporal information can help reveal important patterns over time.

The Reef Check program is intended to supplement government and academic monitoring efforts, filling spatial and temporal gaps in reef monitoring. It also provides an opportunity for community members to play an active role in reef monitoring, education and conservation. Broad-scale reef data from Reef Check can act as an early warning system for changes in the health of coral habitats.

3.2 Reef Check Methodology

Reef Check uses a globally standardised protocol to collect data on 25 categories of substrate cover, as well as the abundance of 14 indicator invertebrates and 10 reef health impacts (Hill and Wilkinson, 2004). Reef Check surveys are conducted along a transect line marked by a graduated tape measure and laid at a constant depth. The transect length that is surveyed is 80 m, divided into four 20 m sections, each separated by 5 m (Figure 1a). This design allows for data comparisons within sites using the four independent replicates, as well as between sites.

The substrate survey collects information about the percentage cover of bottom-dwelling (benthic) organisms and substrate on the reef using a point-intercept method. A survey diver records the substrate type (Table 1) that is directly below the tape measure every 50 cm along each of the four 20 m sections interval (Figure 1b).

Invertebrate and impact surveys are conducted along the same transect line using a 5 m wide belt transect methodology. Divers search for indicator invertebrates and reef impacts on each 20 m replicate for 7 - 10 minutes using a u-shaped search pattern (Figure 1a). The 14 invertebrate indicators have been selected based on their economic and/or ecological importance. Reef health indicators include ten reef impacts, focusing on issues that may be addressed through management strategies. Similarly, fish surveys are conducted along a 5 m tunnel (Figure 1c).

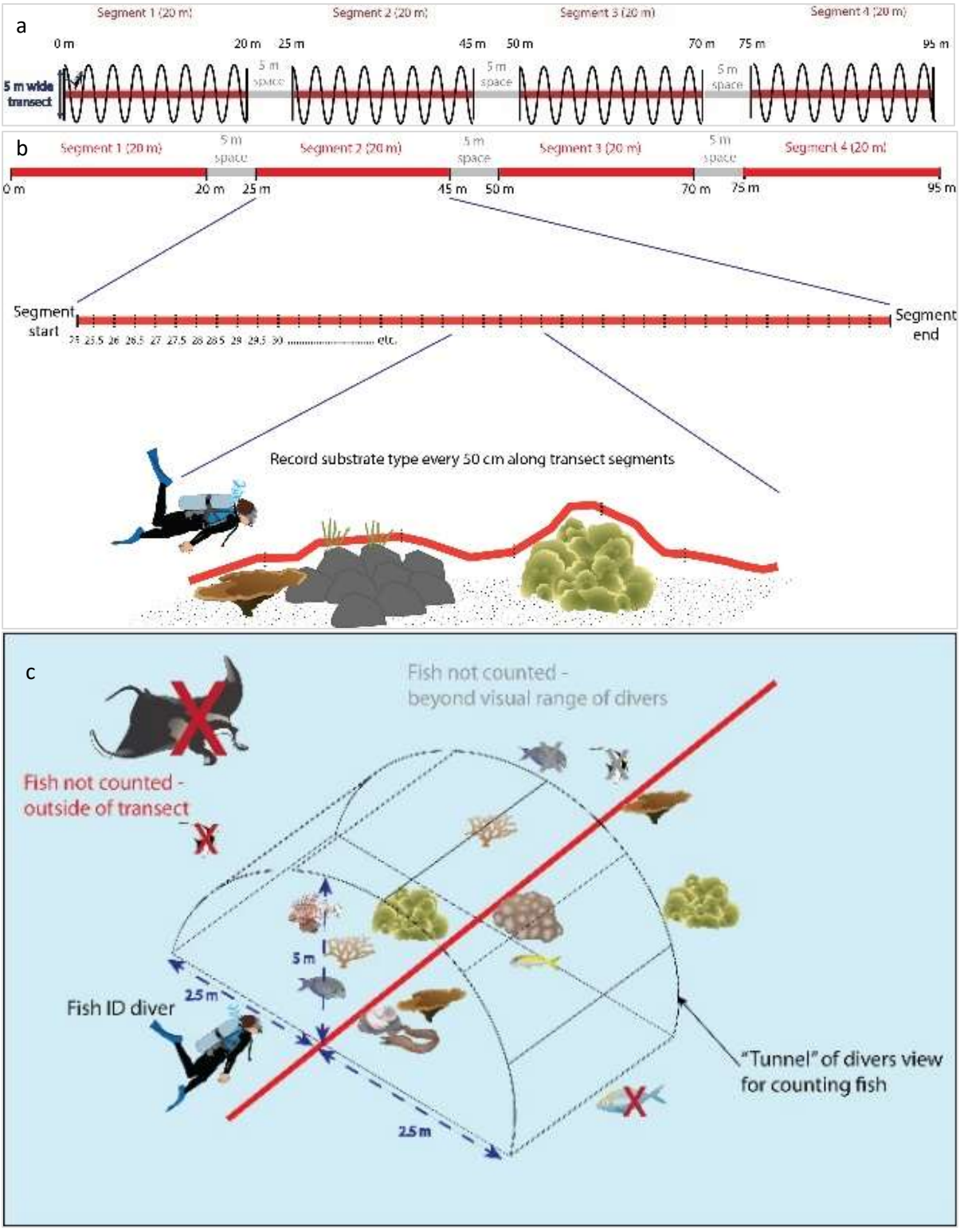

Figure 1: Reef Check survey methodology showing (a) line intercept and belt survey transect layout consisting of 4 x 20 m replicates, (b) line intercept substrate survey protocol showing data collection points at 50 cm intervals, and (c) diagram of the belt transect tunnel for fish surveys (Hill and Wilkinson, 2004).

Table 1. Codes for Reef Check Australia substrate categories

Hard Coral	HCBR: Branching Hard Coral
	HCF: Foliose Hard Coral
	HCM: Massive Hard Coral
	HCE: Encrusting Hard Coral
	HCP: Plate Hard Coral
	HC: All other growth forms
	HCB: Bleached Hard Coral
Soft Coral	SCL: Leathery Soft Coral
	SCZ: Zooanthids
	SC: Other Soft Coral (ornate)
	SCB: Bleached Soft Coral
Recently Killed Coral	RKCTA: Recently killed coral with Turf Algae
	RKCNIA: Recently Killed Coral with Nutrient Indicator Algae
	RKC: Recently Killed Coral (bare)
Rock	RCTA: Rock covered with Turf Algae
	RCCA: Rock covered with Coralline Algae
	RC: Rock (not covered with algae)
Sponge	SPE: Encrusting Sponge
	SP: All other Sponges

There are a total of 17 sites at Heron Reef monitored by Reef Check Australia which were established to allow for a detailed representation of Heron Island reef habitats, and were selected to represent diverse management and use areas - six sites are located in protected Green zones, six are located in general use areas, and five are located in a scientific research zone (allows extraction for experimental and educational purposes). During the 2019 RCA surveys, 14 of these 17 sites were revisited.

Reef Check transects are co-located with UQ Remote Sensing Research Centre survey sites. At these survey sites, geo-referenced benthic photo transects (Roelfsema et al 2010) are conducted annually as part of a coral reef monitoring research project that started in 2001. The research project involves using the collected benthic field data in combination with high spatial resolution satellite imagery to create and validate benthic community maps of Heron Reef (e.g. Roelfsema et al 2013).

Additionally, CoralWatch Coral Health Chart surveys were collected at survey sites to specifically assess coral colour as an indicator of coral stress (Siebeck et al 2006). Similarly, REEFSearch surveys were also conducted at the 14 survey locations to ensure the use of a diverse array of data collection tools.

3.3 Heron Island: Location and Demographics

Heron Island (0.62 km^2) is a coral cay located on the southern section of the Great Barrier Reef, approximately 80 km off the coast of Gladstone, Queensland with a 27 km^2 platform reef. The surrounding waters are divided into one of three management designations, including Marine National Park (Green Zone), Conservation Park or Scientific Research zones (Figure 2).

Heron Island hosts the Heron Island Resort and the University of Queensland's Research Station (HIRS). Heron Island Resort is a popular location for scuba diving and snorkelling that accommodates up to 200 guests and 100 staff members. The HIRS is a heavily utilised research station with visiting universities, schools, and researchers from Australia and the world, accommodating up to 150 people. The fringing reefs are well-utilised for snorkel and dive tourism as well as reef research. However, these activities may be having some unintended impacts. Factors such as extensive development in the nearby Gladstone region, and similar to other coral reefs, global climate change, also pose threats to this marine ecosystem. Thus routine monitoring of this reef is essential. The 17 RCA survey sites are shown in Figure 2 and a summary of site demographics is represented in Table 2.

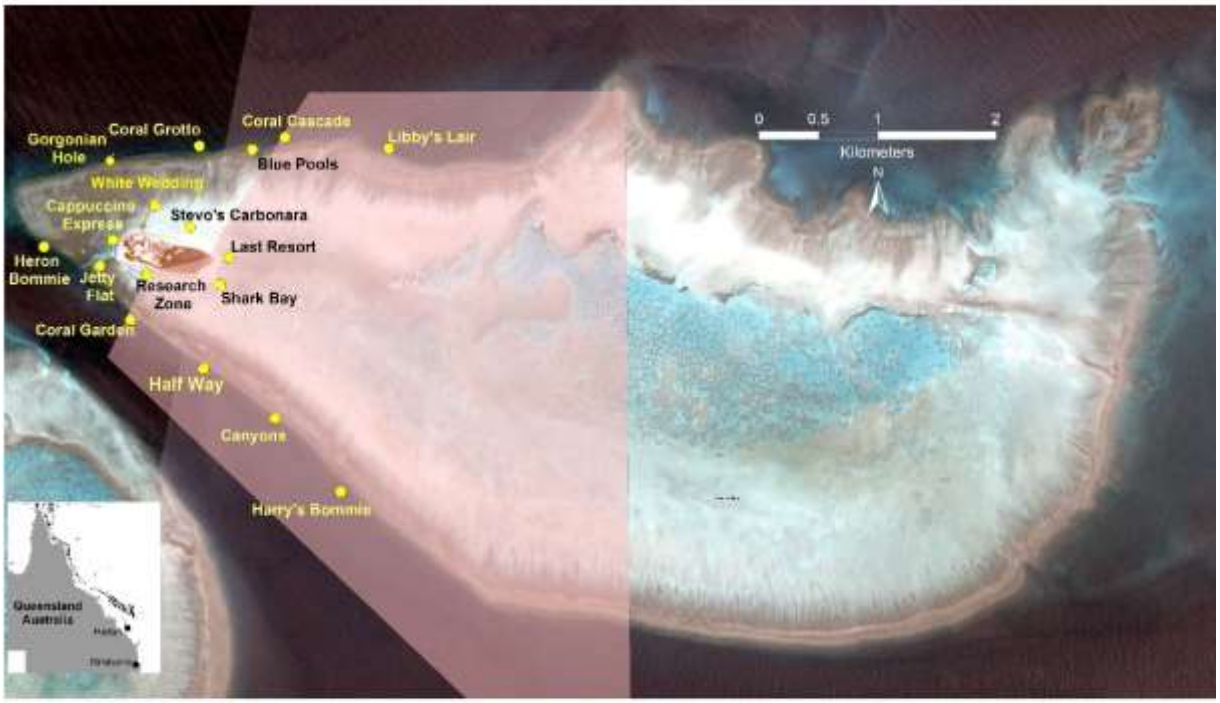

Figure 2. RCA field sites and the conservation zone overlaid on the Planet Dove image acquired on 9 November 2018 over Heron Reef (Image source: Planet Ltd).

Table 2. RCA Heron Island monitoring locations, with depth, hard coral cover for the current survey year, designation of site (Marine National Park, Conservation Park, or Scientific Zone), habitat type and survey years.

Site	Depth (m)	HC %	Site Designation	Habitat Type	Year surveyed								
					2011	2012	2013	2014	2015	2016	2017	2018	2019
Blue Pools	5	NA	Conservation Park	Reef Slope				■			■		
Canyons	5	67.5	Scientific Zone	Reef Slope			■	■	■	■	■	■	■
Capuccino Express	2	21.25	Marine Natl Park	Sandy reef flat with micro atolls			■	■	■	■	■	■	■
Coral Cascade	6	53.13	Conservation Park	Reef Slope			■	■	■		■	■	■
Coral Gardens	5	70	Marine Natl Park	Reef Slope	■		■	■	■	■	■	■	■
Coral Grotto	6	NA	Conservation Park	Reef Slope	■		■	■	■	■	■	■	
Gorgonian Hole	6	60.62	Conservation Park	Reef Slope								■	■
Halfway	6	NA	Scientific Zone	Reef Slope				■	■	■	■	■	
Harry's Bommie	9	65.63	Scientific Zone	Reef Slope	■		■	■	■	■	■	■	■
Heron Bommie	5	43.13	Marine Natl Park	Reef Slope	■		■	■	■	■	■	■	■
Jetty Flat	2	23.75	Marine Natl Park	Reef flat with micro atolls	■	■	■	■	■	■	■	■	■
Last Resort	2	6.25	Conservation Park	Sandy reef flat			■	■	■	■	■	■	■
Libby's Lair	6	73.75	Conservation Park	Reef Slope									■
Research Zone	1	19.38	Scientific Zone	Sandy reef flat	■	■	■	■	■	■	■	■	■
Shark Bay	2	9.38	Scientific Zone	Sandy reef flat	■	■	■	■	■	■	■	■	■
Stevos Carbonara	2	1.25	Marine Natl Park	Sandy reef flat with micro atolls						■	■	■	■
White Wedding	1	3.13	Marine Natl Park	Sandy reef flat				■	■	■	■	■	■

4.0 SUMMARY 2019 SURVEY REPORT

A summary of the findings for the 2019 RCA monitoring is shown in Table 3. Information includes: average hard coral cover (%), total macro algae abundance, abundance of invertebrates (collector urchin, sea cucumbers, giant clams, Triton, *Trochus, Drupella* snails, anemones), abundance of reef impacts (*Drupella* scars, unknown scars, coral damage, average coral bleaching of population percentage, average coral bleaching percentage for colony surface), and silt levels (N=none, L=low, M=medium, H=high). Categories are listed as abundance counts unless otherwise specified. The information represents data collected over a standard survey as described in section 3.2.

Table 3: Summarised RCA findings for Heron Reef survey sites in 2019.

Site	Substrate		Invertebrates								Impacts								
	Hard Coral Coverage (%)	Macro Algae (#)	Edible Sea Cucumbers (#)	Giant Clam (#)	Triton (#)	Trochus (#)	Drupella Snail (#)	Anemone (#)	Banded Coral Shrimp (#)	Crown of Thorns Starfish (#)	Drupella Scar (#)	Unknown Scar (#)	COTS Scar (#)	Coral Damage (#)	Coral Disease (#)	Coral Bleaching Population (%)	Coral Bleaching Colony (%)	Marine debris (#)	Silt Level*
Canyons	67.5	0	0	1	0	0	0	0	0	0	0	10	0	5	0	0.25	7.5	1	N
Cappuccino Express	21.25	1	8	9	0	0	0	0	0	0	0	6	0	0	4	17.5	22.5	0	N
Coral Cascade	53.13	0	2	2	0	0	1	3	0	0	1	2	0	9	3	1.5	41.25	6	N
Coral Garden	70	0	0	0	0	1	4	1	0	0	1	13	0	7	57	1	24.75	0	N
Gorgonian Hole	60.62	0	2	1	0	0	0	1	0	0	0	5	0	17	7	1.5	22.75	0	N
Harry's Bommie	65.63	0	0	1	0	0	2	0	0	0	2	24	0	2	5	1	55	1	N
Heron Bommie	43.13	1	1	14	0	0	0	0	0	4	0	10	12	7	18	0.5	22.5	0	N
Jetty Flat	23.75	2	2	4	0	0	0	4	0	0	0	3	0	0	0	1	32.25	0	N
Last Resort	6.25	3	12	2	0	0	0	0	0	0	0	1	0	1	0	15	13	0	L
Libby's Lair	73.75	0	1	2	0	0	0	0	0	0	0	2	0	15	4	0.5	3.25	0	N
Research Zone	19.38	6	9	5	0	0	0	1	0	0	0	7	0	1	0	2.25	13.25	1	L
Shark Bay	9.38	10	30	1	0	0	0	0	0	0	0	6	0	0	3	26.25	12.75	0	N
Stevo's Carbonara	1.25	0	1	0	0	0	0	0	0	0	0	1	0	0	0	22.5	15.75	0	N
White Wedding	3.13	7	5	15	0	0	0	0	0	0	0	0	0	0	0	27.5	17.5	0	N

* N=none, L=low, M=medium, H=high

To illustrate broad-spatial scale trends in the RCA data collected during the 2019 surveys, the data from each individual site was overlaid on a high spatial resolution pan-sharpened WorldView-2 image. Firstly, the percentage of hard coral coverage and bleaching incidence are depicted in Figure 3.

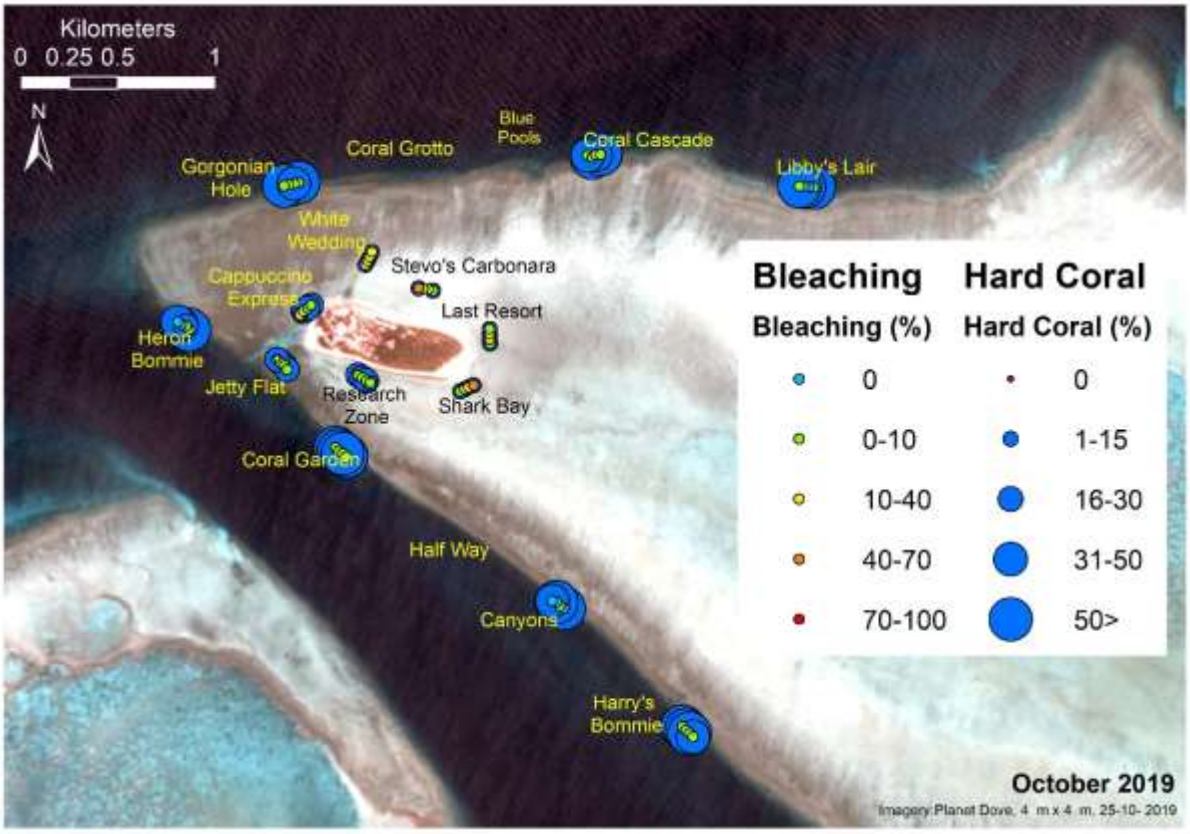

Figure 3. RCA hard coral cover and population level bleaching data for the 2019 surveys, overlaid on a Planet Dove image acquired 25 October 2019 (Image source: Planet Ltd). Each survey site is represented by four circles, each displaying summary data for one of the four 100 m^2 areas that makes up a full 400 m^2 transect.

For 2019, bleaching was recorded at all 14 sites. Higher levels of coral population bleaching were recorded on the shallow inshore sites of Heron Island (average of 16%), however, higher average coral colony bleaching was detected on deeper reef slope offshore sites (average 25% compared to 18% for shallow reef flat inshore sites). The highest average population bleaching across a single site was White Wedding with 27.5%.

Figure 4 shows the hard-coral data compared to the incidence of unknown scars.

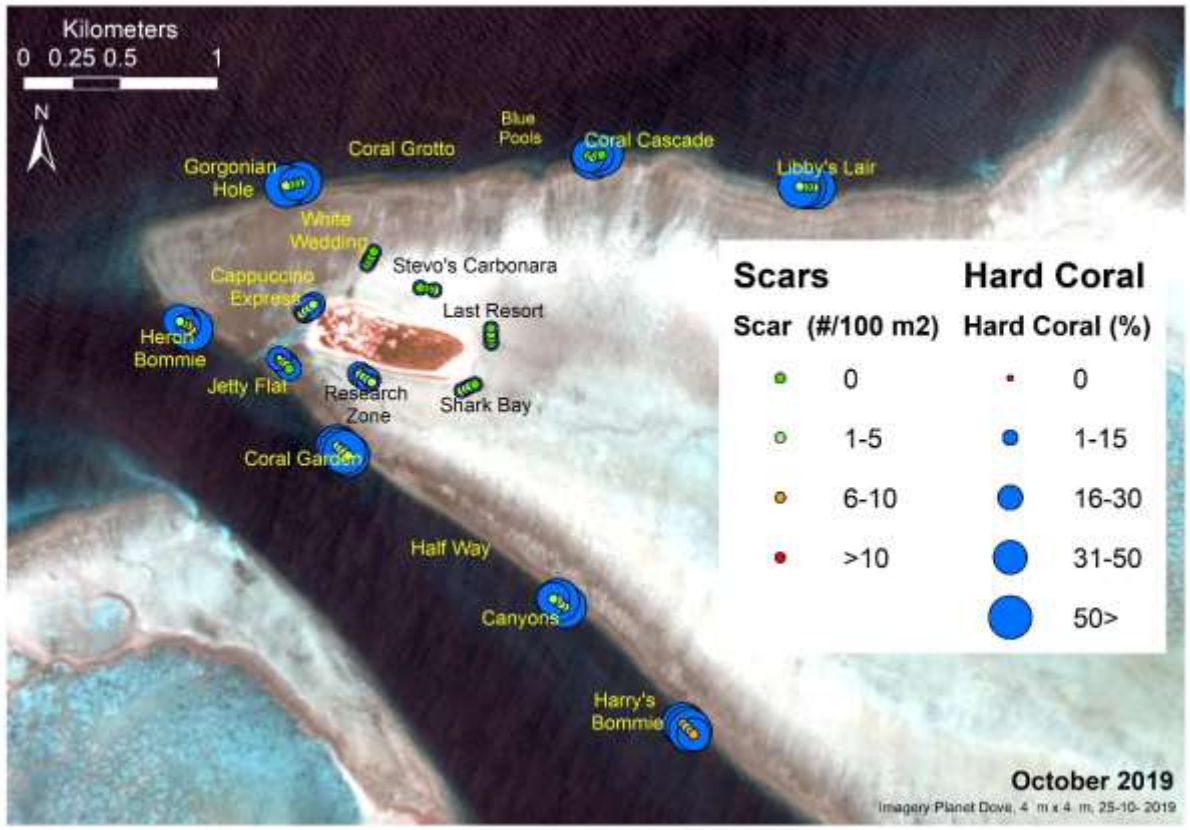

Figure 4. RCA hard coral cover and unknown scar data for the 2019 surveys, overlaid on a Planet Dove image acquired on 25 October 2019 (Image source: Planet Ltd). Each survey site is represented by four circles, each displaying summary data for one of the four 100m^2 areas that makes up a full 400m^2 transect.

Twelve of the 14 sites showed instances of unknown scars. Ten or more scars were recorded per 400m² for Harrys Bommie, Coral Garden, Heron Bommie and Canyons (24, 13, 10 and 10 respectively). The 2019 data indicates higher levels of coral scars on the southern side of Heron Island (average of 10 counts per 400m²) compared with the northern side (average of 3 counts per 400m²). Deeper, reef slope sites had a higher average of unknown coral scar occurrence (9 counts per 400m²) when compared to shallow inshore sites (3 counts per 400m²).

Figure 5 summarises the incidence of coral disease to hard coral cover recorded on the 2019 surveys.

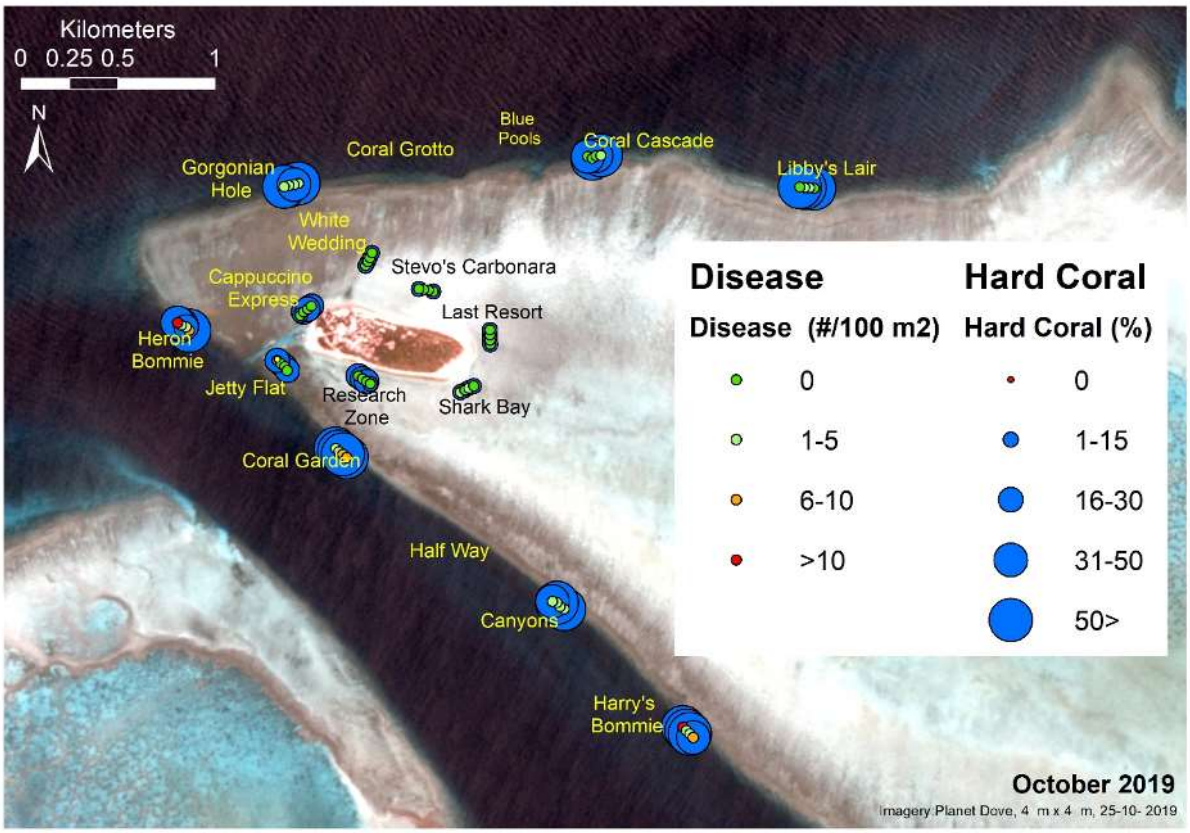

Figure 5. RCA hard coral cover and coral disease data for the 2019 surveys, overlaid on a Planet Dove image acquired 25 October 2019 (Image source: Planet Ltd). Each survey site is represented by four circles, each displaying summary data for one of the four 100m^2 areas that makes up a full 400m^2 transect.

Eight of the 14 sites had instances of coral disease recorded on transect. The 2019 data indicated a greater proportion of coral disease at Coral Garden (57 counts), and Heron Bommie (18 counts) than at other survey locations (average of 3 counts per 400m² for all other sites). Sites on the southern side of the island had a higher average incidence of disease (10 counts per 400m²) compared to the northern sites (4.5 counts per 400m²).

Shallow inshore, easily accessible sites had a much lower average of coral disease occurrence (average of 1 count per 400m²) when compared to deeper, reef crest/slope sites accessible only by boat (average of 13 counts per 400m²).

Coral damage is summarised relative to the percentage of hard coral cover in Figure 6.

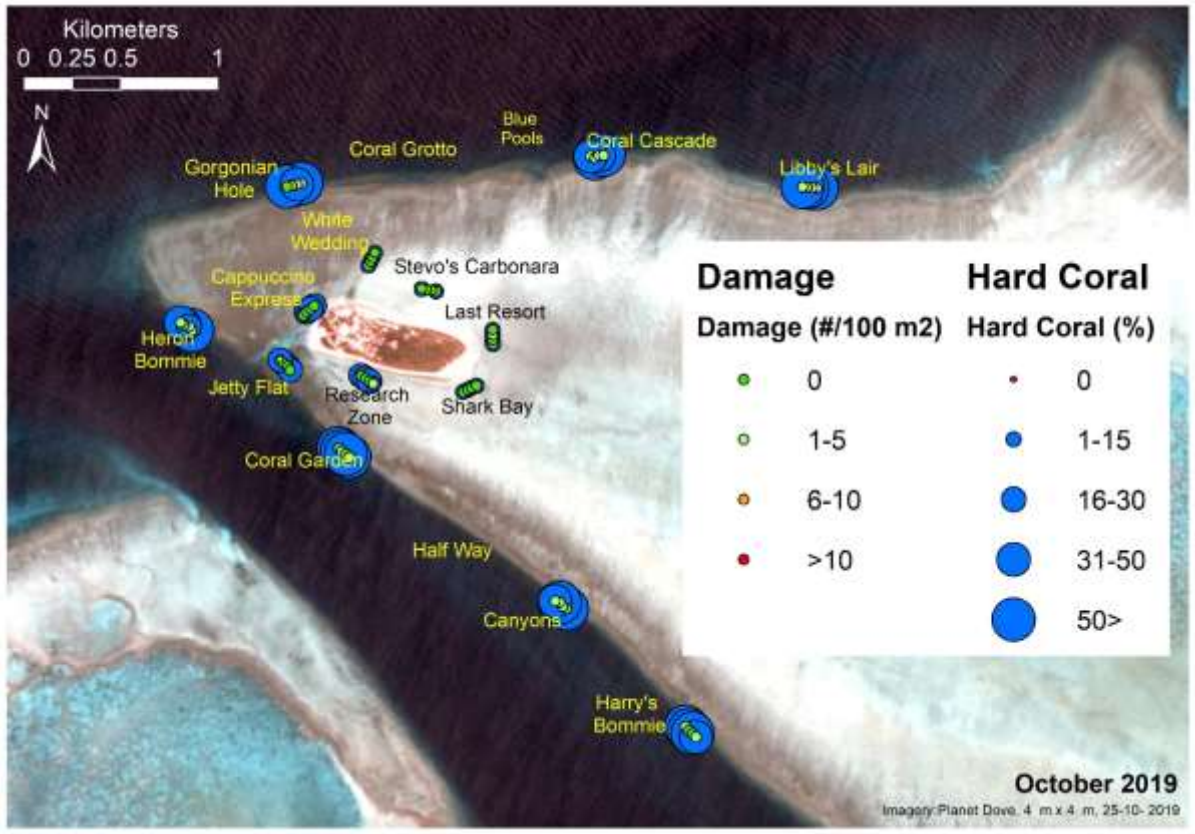

Figure 6. RCA hard coral cover and coral damage data, overlaid on Planet Dove image acquired 25 October 2019 (Image source: Planet Ltd). Each survey site is represented by four circles, each displaying summary data for one of the four 100m^2 areas that makes up a full 400m^2 transect.

Nine of the 14 sites had instances of coral damage. The average coral damage for all 14 sites was 4.5 counts per 400m². Higher than average counts of coral damage was recorded for Gorgonian Hole, Libby's Lair, Coral Cascade, Coral Garden, Heron Bommie and Canyons (17, 15, 9, 7, 7 and 5 counts per 400m² respectively). In contrast, no coral damage was recorded at Cappuccino Express, Jetty Flats, Shark Bay, Stevo' s Carbonara or White Wedding. Of note, all sites with zero damage counts also had significantly less coral cover.

Invertebrate surveys record the abundance of indicator invertebrates along each transect. Figure 7 and Figure 8 show the abundance of giant clams and indicator sea cucumbers respectively, for each survey site.

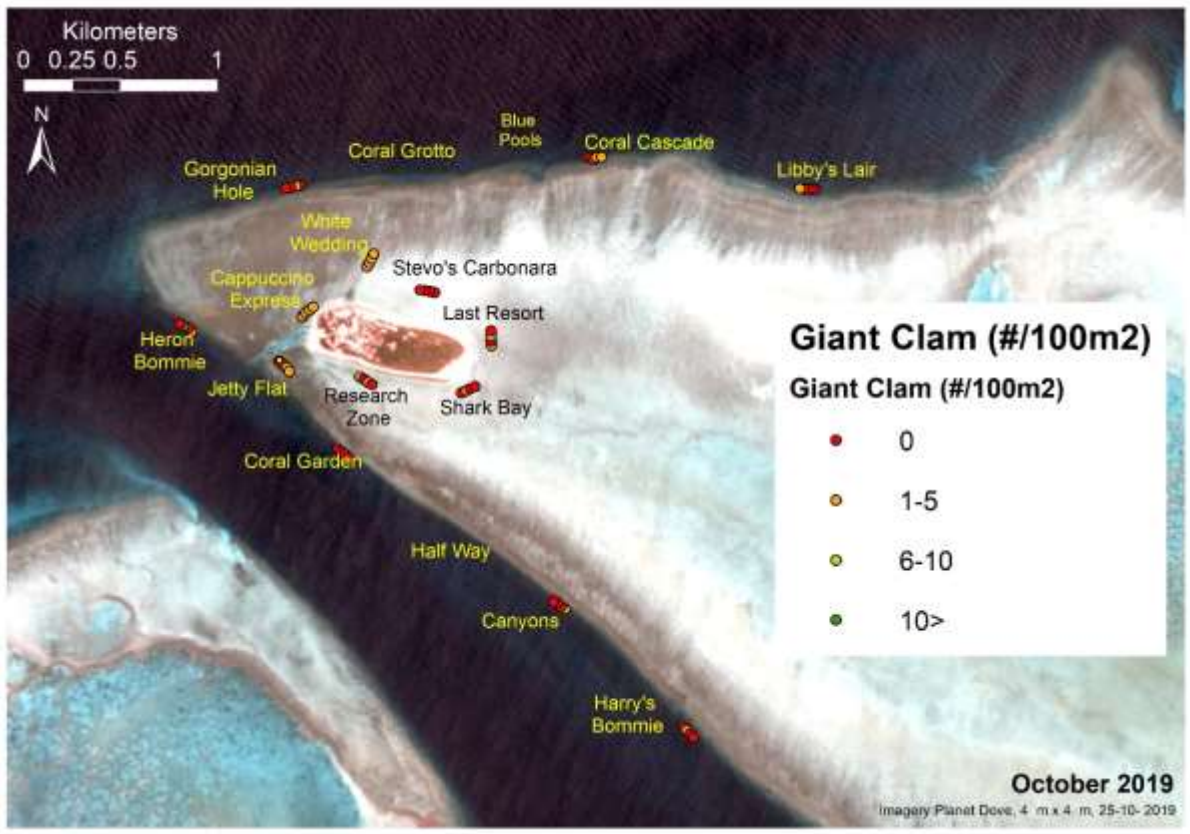

Figure 7. RCA Giant Clam abundance, overlaid on Planet Dove image acquired October 2019 (Image source: Planet Ltd) . Each survey site is represented by four circles, each displaying summary data for one of the four 100m^2 areas that makes up a full 400m^2 transect.

The distribution of giant clams was similar between inshore reef flat sites and deeper reef slope sites (5 and 3 counts per 400m² respectively). Heron Bommie (southern reef slope) and White Wedding (northern reef flat) had the highest recorded numbers of giant clams with 14 and 15 (respectively) found on transect. Coral Gardens, Gorgonian Hole and Stevo's Carbonara had no giant clams recorded on transect.

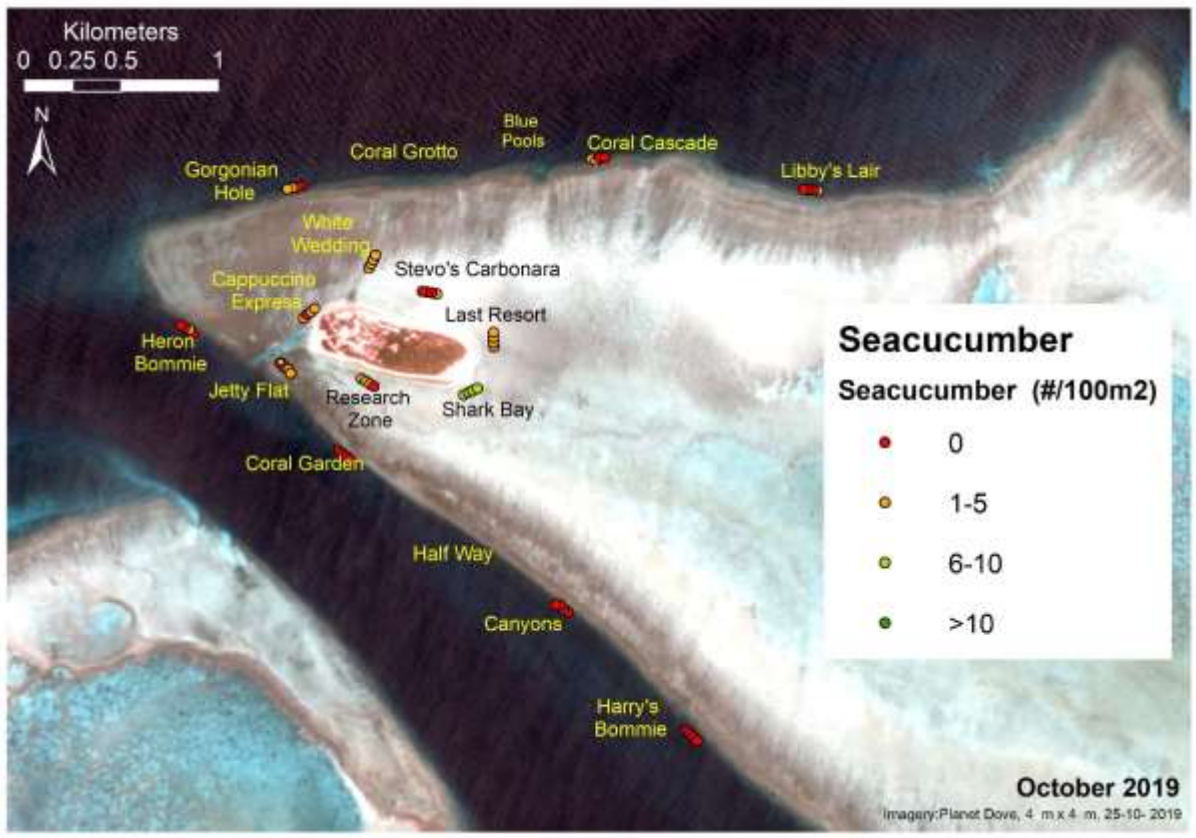

Figure 8. RCA abundance of sea cucumber, overlaid on Planet Dove image acquired 25 October 2019 (Image source: Planet Ltd). Each survey site is represented by four circles, each displaying summary data for one of the four 100m^2 areas that makes up a full 400m^2 transect.

Target sea cucumbers were recorded at 11 of the 14 sites. The 2019 data indicated higher numbers of sea cucumbers on shallow near shore, sandy reef flat areas, when compared with survey sites on the deeper reef slope sites - a finding consistent with all previous reports. Higher than average counts (> 5 per 400m²) of target sea cucumbers were found at Shark Bay (30 per 400m²), Last Resort (12 per 400m²), Research Zone (9 per 400m²) and Cappuccino Express (8 per 400m²). Sites located to the south of the island had a higher average count per transect with 7 target sea cucumbers recorded per 400m² compared with an average of 4 per 400m² recorded for northern sites.

5.0 INDIVIDUAL SITE REPORTS

5.1 Canyons

Canyons is situated along the reef slope, on the southern side of Heron Island. This site is characterised by a series of shallow canyons cutting into the edge of the reef, with scattered bommies out deeper, away from these ridges (Images 1-2).

Hard coral represented 68% of the total substrate cover (Figure 9); one of the highest hard coral covers recorded in 2019 (the same as 2018 levels recorded Figure 9). Rock (including rock with turf algae and rock with calcareous algae was the next greatest contributor to substrate at 24% cover. Rubble attributed 8%.

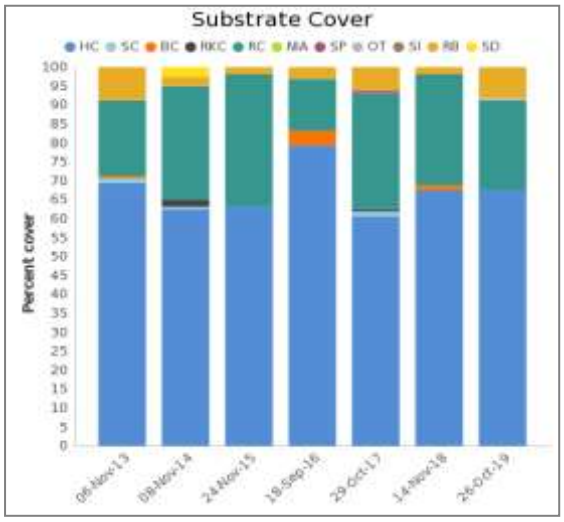

Figure 9. Benthic type and percent cover: Canyons, 2013 – 2019

One giant clam was recorded on the invertebrate survey.

Bleaching affected less than 1% of the coral population, with an average of 7.5% of each coral colony affected (a decrease from 1% population and 15% colony average in 2018 and 1% population and 17% colony level bleaching in 2017) (Image 3).

Ten incidents of unknown coral scars, five counts of coral damage and one piece of trash (researcher debris) was recorded.

A fish survey was conducted and six butterflyfish, five snapper, two grouper and one parrotfish were recorded (a decrease from the 52 butterflyfish recorded in 2018).

Image 1: Site Location – represented by circle

Image 2: Site Photo

Image 3: Hard Coral Bleached

5.2 Cappuccino Express

Cappuccino Express is on the reef flat. The site is characterised by small coral atolls and sandy patches, and is prone to strong currents (Images 4-5). This reef area is easily accessible on snorkel and often visited by tourists as it is situated close to the resort.

Hard Coral represented 21% of the total substrate at this site (Figure 10) for 2019. Rock was the greatest contributor to substrate, making up 47%. Sand constituted 20% and rubble attributed 9%.

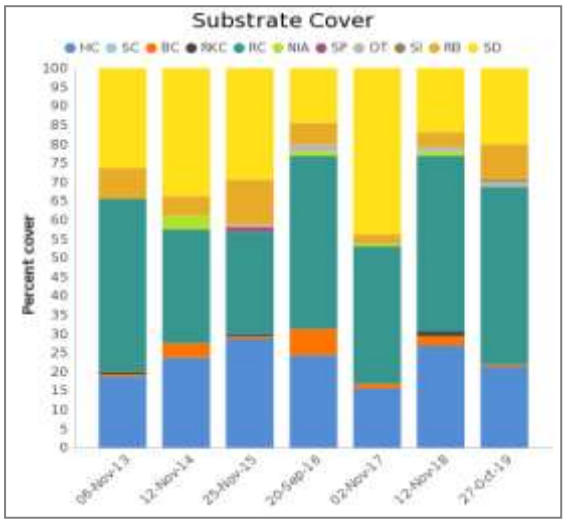

Figure 10. Benthic type and percent cover: Cappuccino Express, 2013 - 2019.

Nine giant clams and eight sea cucumbers (Image 6) were recorded on the invertebrate survey.

Coral bleaching affected 17.5% of the coral population, with an average of 22.5% of coral surfaces bleached; an increase in population bleaching levels from 2018 (just 1%) but a decrease in individual colony bleaching levels from 2018 (25.8%).

Six incidents of unknown scars and four counts of coral disease was recorded, down from 2018 results (19 unknown scars and 8 counts of coral damage).

A fish survey was conducted and seven snapper, five parrotfish, and three butterflyfish were recorded.

Image 4: Site Location – represented by circle

Image 5: Site Photo

Image 6: Pinkfish; Target Sea Cucumber

5.3 Coral Cascades

Coral Cascades is situated on the reef slope on the northern side of Heron Reef. Coral Cascades is a dive site often utilised by tourists and researchers alike. It is characterised by a high abundance of hard coral, hence the name (Images 7-8).

Hard coral cover represented 53% of the substrate at this site (Figure 11). Rock (including rock with turf algae and rock with coralline algae) constituted 31% of the substrate, rubble accounted for 4%, and soft coral; 4%.

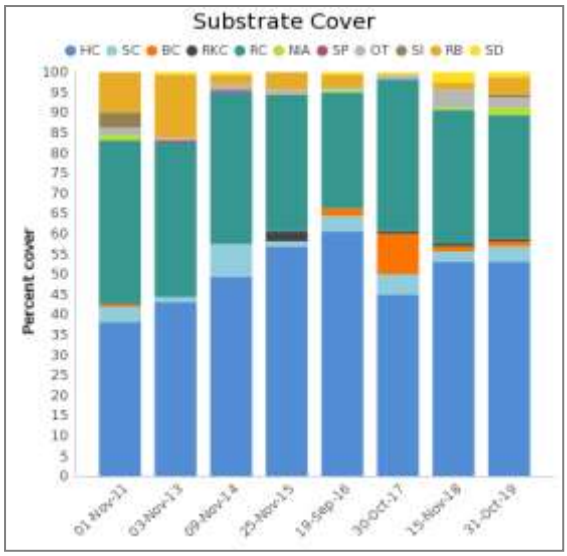

Figure 11. Benthic type and percent cover: Coral Cascades, 2013 - 2019.

Three anemones, two giant clams, two sea cucumbers and one *Drupella* snail were recorded on the invertebrate survey.

Bleaching was recorded on just 1.5% of the coral population, with an average 41% of each affected coral surface bleached; higher than 2018 levels (1% of coral population and 26% of individual coral colony's).

Other reef impacts recorded at this site included nine counts of coral damage, six pieces of marine debris (all researcher debris) (Image 9), three counts of coral disease, two unknown scars and one *Drupella* scar.

A fish survey was conducted and twenty-four parrotfish, nine butterflyfish, four coral trout, two grouper, two bumphead parrotfish and two snapper were recorded.

Image 7. Site Location – represented by circle

Image 8: Site photo

Image 9: Marine Debris

5.4 Coral Gardens

Coral Gardens is located on the southern side of Heron Island on the reef slope. It is characterised by high hard coral cover; particularly branching growth forms (Images 10-11). It is a popular dive destination for the resort.

Hard coral accounted for 70% of the benthos at this site, and was made up almost exclusively of branching coral growth forms (Figure 12). Rock (including rock with turf algae and rock with calcareous algae) accounted for 26% whilst soft coral, recently killed coral and rubble constituted 1% of total substrate each. No macro algae has been recorded at this site since 2011.

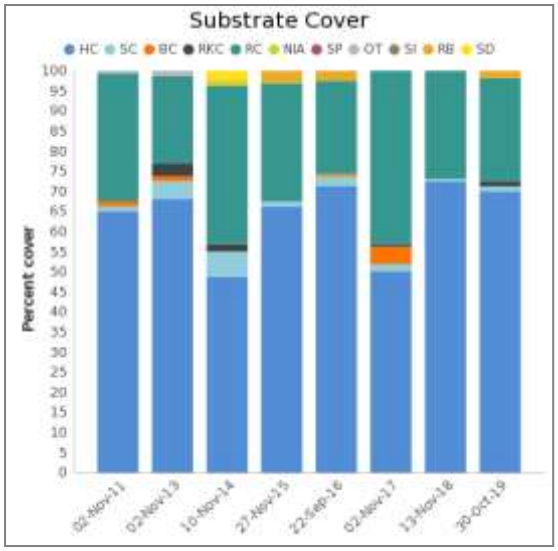

Figure 12. Substrate type and percent cover at Coral Gardens, 2011 - 2019.

Four Drupella snails, one anemone (with fish) and one *Trochus* snail was recorded on the invertebrate survey..

Bleaching was recorded on 1% of the coral population, with an average of 25% of each affected coral surfaces bleached; a decrease from 2018 levels (1% population and 36% coral colony bleaching).

Reef Impacts recorded at Coral Gardens include fifty-seven incidences of coral disease (Image 12), thirteen unknown scars, seven of coral damage, and one *Drupella* scar.

A fish survey was conducted and twelve butterflyfish, twelve parrotfish, six coral trout, four snapper, one grouper, one humpheaded wrasse and one bumpheaded parrotfish were recorded.

Image 10: Site Location – represented by circle

Image 11: Site photo

Image 12: Coral Disease

5.5 Gorgonian Hole

Gorgonian Hole is located on the reef slope on the northern side of Heron Island. It is characterised by high hard coral cover, particularly branching growth forms (Images 13-14).

Hard coral accounted for 61% of substrate (Figure 13). Rock constituted 25% of substrate cover, and soft coral 6%, nutrient indicator algae 3% and 'other' (mostly *Halimeda*) 3%.

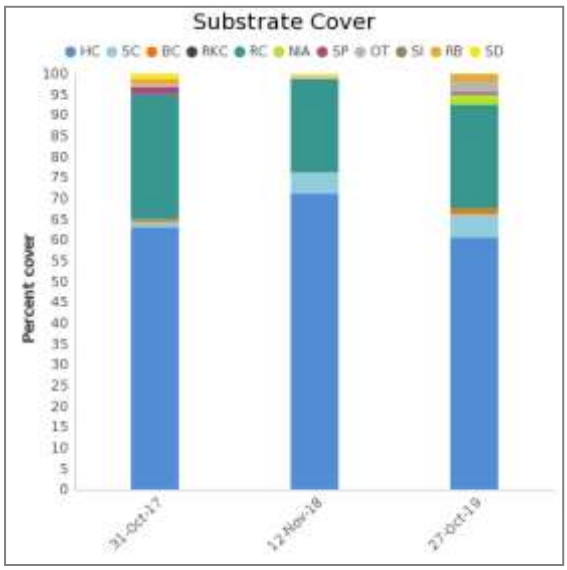

Figure 13: Benthic type and percent cover: Gorgonian Hole, 2017 - 2019.

Two sea cucumbers, one anemone and one giant clam were recorded for the invertebrate survey.

Coral bleaching was estimated to affect 1.5% of the total coral population and an average of 23% of each colony surface, an increase from 2018 levels (1% population and 13% colony average).

Additional impacts recorded include seventeen counts of coral damage, seven counts of coral disease and five unknown scars (Image 15).

A fish survey was conducted and twelve butterfly fish, seven parrotfish, six snapper, five coral trout, two grouper and one bump head parrotfish were recorded. Seventeen snapper were also noted sitting just off the transect (this site has recorded high numbers of snapper in previous years).

Image 13. Site Location – represented by circle

Image 14. Site Photo

Image 15: Unknown Scar

5.6 Harry's Bommie

Harry's Bommie is located on the southern side of Heron Island, on the reef slope. It is characterised by large coral bommies and high hard coral cover, particularly branching growth forms (Images 16-17).

Hard coral cover at this site accounted for 66% of substrate cover (a decrease from 73% in 2018) (Figure 14), consisting predominantly of branching coral. Rock (rock with turf algae and rock with calcareous algae) accounted for 19% of the total substrate, with rubble attributing 5% and bleached coral making up 3%.

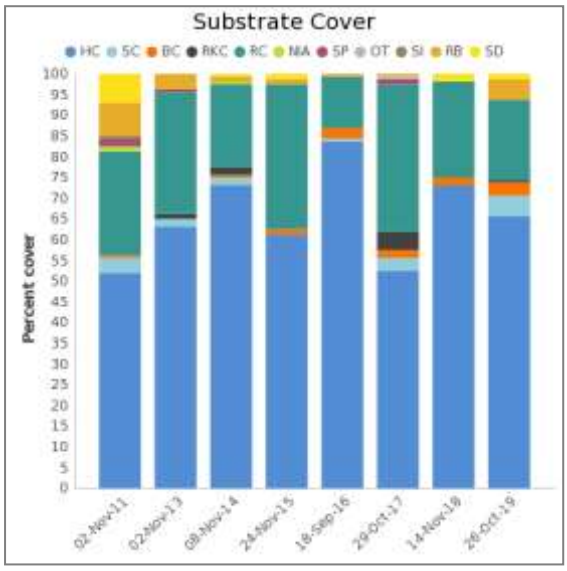

Figure 14. Benthic type and percent cover: Harry's Bommie, 2011 - 2019.

One giant clam and two *Drupella* snails were recorded during the invertebrate survey. One Crown of Thorns starfish was observed (Image 18) just off the transect. One Crown of Thorns was also recorded on Harrys Bommie in 2018.

Coral bleaching affected approximately 1% of the total coral population, with an average of 55% of each colony showing surface bleaching (similar to 2018 levels with 1% population and 46% colony bleaching).

Twenty-four incidents of unknown coral scars, five incidents of disease, two *Drupella* scars, two incidents of coral damage and one piece of marine debris (old researcher debris) were recorded on the impact survey.

A fish survey was conducted and eight parrotfish, seven butterflyfish, and one coral trout were recorded.

Image 16. Site Location – represented by circle

Image 17. Site photo

Image 18. Crown of Thorns Starfish

5.7 Heron Bommie

Heron Bommie is located on the south west of Heron Island fringing reef slope. It is characterised by a large coral bommie and high hard coral cover, particularly branching growth forms (Images 19-20). Heron Bommie is a popular dive site with the resort due to its close proximity and high coral cover.

Hard coral represented 43% of the substrate (Figure 15). Rock (including rock with turf algae and rock with calcareous algae) constituted 22% of substrate cover. Rubble attributed 19% and sand 13%. One count of macroalgae was recorded.

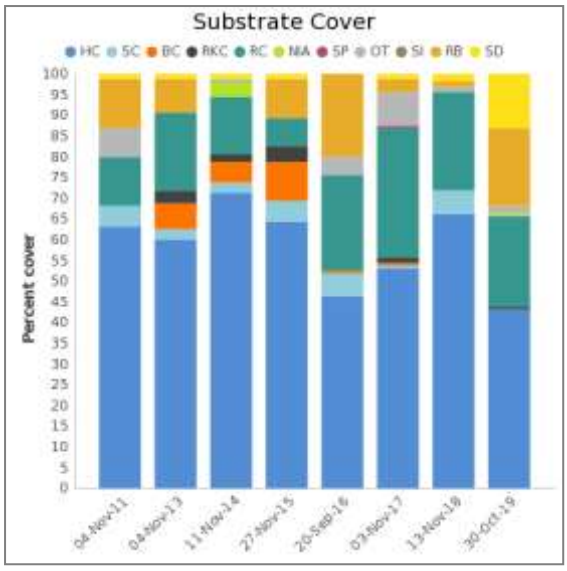

Figure 15. Benthic type and percent cover: Heron Bommie, 2011- 2019.

Fourteen giant clams (Image 21), four crown of thorns starfish and one sea cucumber were recorded on the invertebrate survey.

Coral bleaching affected approximately 1% of the total coral population, with an average of 23% of each colony showing surface bleaching.

Eighteen incidents of coral disease, twelve crown of thorns starfish scars, ten unknown scars and seven incidents of coral damage.

A fish survey was conducted and twelve snapper, eleven butterflyfish, eleven parrotfish, nine coral trout, four sweetlips and two grouper were recorded.

Image 19. Site Location – represented by circle

Image 20. Site Photo

Image 21. Giant Clam

5.8 Jetty Flat

Jetty flat is located on the south-western side of Heron Island, on the southeast reef flat near the boat channel. It is a shallow site often visited by snorkelers due to its location and ease of access. It is characterised by large areas of branching corals with flat, eroded tips (due to tidal extremes) and sandy patches (Images 22-24).

Hard corals accounted for 24% of the benthos (Figure 16). Rock (including rock, rock with turf algae and rock with calcareous algae) constituted 69% of the substrate, rubble and sand 8% combined. Two counts of macroalgae was recorded.

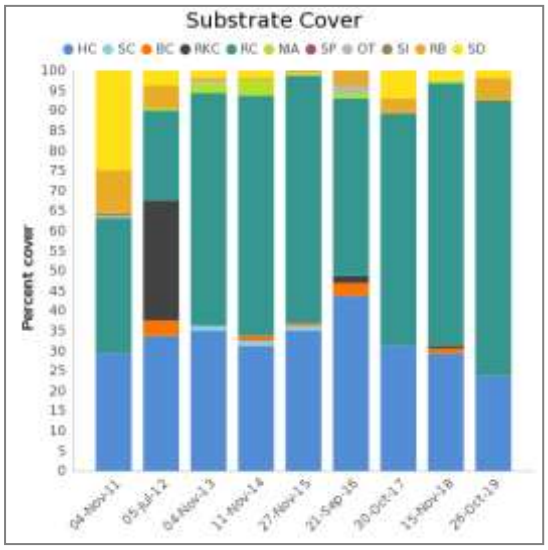

Figure 16. Benthic type and percent cover: Jetty Flat, 2011 - 2019.

Four giant clams, four anemones and two sea cucumbers were recorded on the invertebrate survey.

Coral bleaching affected approximately 1% of the total coral population, with an average of 32% of each colony showing surface bleaching.

Reef impacts recorded included three counts of unknown scars.

A fish survey was conducted and thirteen butterflyfish, ten parrotfish, two snapper and one coral trout were recorded.

Image 22. Site Location – represented by circle

Image 23. Site Photo

Image 24. Black Tip Reef Shark

5.9 Last Resort

Last Resort is a lagoonal site accessible on snorkel, located at the north-east corner of the island (Image 25). It is frequented by tourists as it is a popular spot for shark and ray sightings.

Hard corals accounted for 6% of the benthos (Figure 17). Rock (including rock with turf algae and rock with calcareous algae) constituted 11% of the substrate, whilst sand contributed 49% (Image 26). Nutrient indicator algae attributed 18% and rubble accounted for 11%. Three counts of macro algae were recorded.

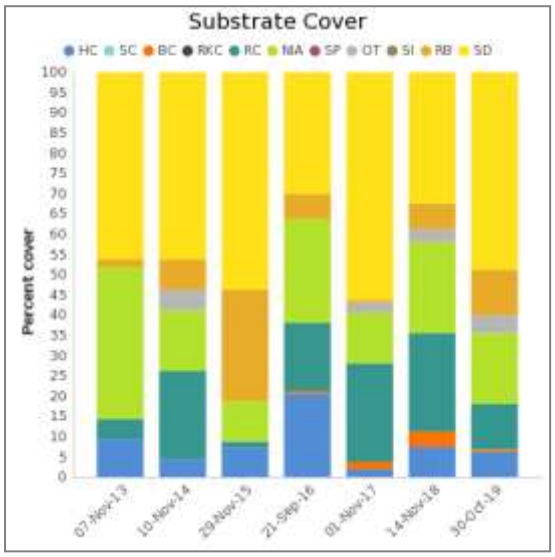

Figure 17. Benthic type and percent cover: Last Resort, 2013 - 2019.

Twelve sea cucumbers and two giant clams, were recorded on the invertebrate survey.

Coral bleaching affected 15% of the coral population and an average of 13% of each coral surface was affected (Image 27).

One count of coral damage and one incident of unknown scars were recorded.

A fish survey was conducted and seven snapper and four butterflyfish were recorded.

Image 25. Site Location – represented by circle

Image 26. Site Photo

Image 27. Hard Coral Bleached

5.10 Libby's Lair

Libby's Lair is located on the northern side of Heron Island, on the north east reef slope. It is characterised by high coral diversity and deep gullies (Images 28-29).

Hard coral accounted for 74% of the benthos, (Figure 18). Rock (encompassing both rock with turf algae and rock with coralline algae) made up 15% of the substrate, and soft coral 4%.

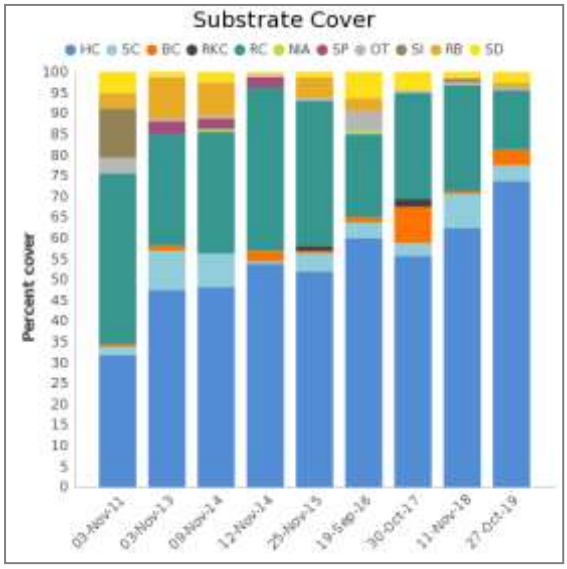

Figure 18: Benthic type and percent cover: Libby's Lair, 2011 - 2019.

Two giant clams and one sea cucumber (Image 30) were recorded on the invertebrate survey.

Coral bleaching affected less than 1% of the coral population, and an average of just 3% of each colony was bleached (a decrease from 2018 of 1% of the coral population and 16% surface bleaching, and from 2017 of 4% of the coral population; and 26% surface bleaching).

Additional impacts recorded included fifteen incidents of coral damage, four incidents of coral disease, and two unknown scars.

A fish survey was conducted and nine butterflyfish, four coral trout, four parrotfish and one humphead wrasse were recorded.

Image 28. Site Location – represented by circle

Image 29. Site Photo

Image 30. Prickly Green Fish

5.11 Research Zone

The Research Zone site is located on the southern side of Heron Island, within the scientific zone (Images 31-32). This area is designated for the harvesting of samples for scientific and educational purposes. It is a shallow site utilised by both researchers and tourists on snorkel due to its accessibility.

The majority of the substrate at this site is sand (45%), with hard coral constituting 19% of the benthos (Figure 19). Rock (including rock with turf algae and rock with coralline algae) contributed 16% of the substrate. Rubble attributed 9% and nutrient indicator algae attributed 7% to the benthos. Six counts of macro algae (Padina) (Image 33) were recorded.

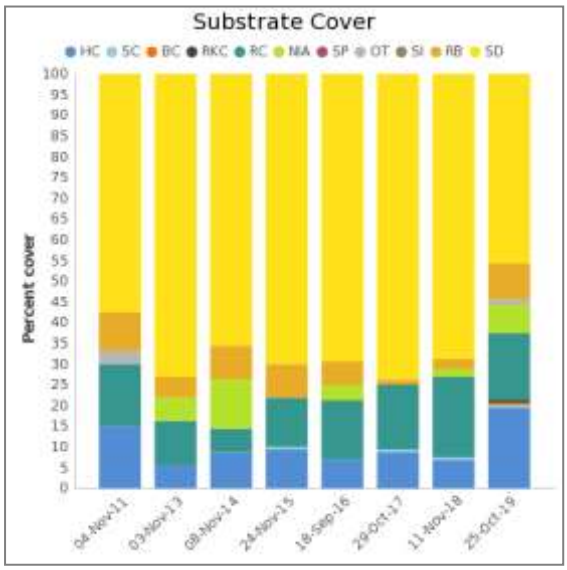

Figure 19. Benthic type and percent cover: Research Zone 2011 - 2019.

Nine sea cucumbers, five giant clams and one sea anemone were recorded on the invertebrate survey.

Coral bleaching affected 2% of the coral population with an average of 13% of each affected coral; a decrease from 2018 results (11% population bleaching, and 17% colony surfaces affected).

Seven unknown scars and one instance of unknown coral damage were recorded on the impact survey.

A fish survey was conducted and three snapper, two butterflyfish two parrotfish and one moray eel was recorded.

Image 31. Site Location – represented by circle

Image 32. Site photo

Image 33. Dominant algae, *Padina*

5.12 Shark Bay

The Shark Bay site is located on the eastern side of Heron Island. It is a shallow site frequented by tourists on snorkel due to its accessibility, and shallow depth. This reef area is a popular spot for shark and ray sightings (Images 34-35).

Hard coral accounted for 9% of the benthos at this sandy (52%) reef flat location (Figure 20). Rock (including rock with turf algae and rock with calcareous algae) attributed 5%, whilst nutrient indicator algae made up 29% of the benthos (an increase from 17% in 2018). Other (mostly *Halimeda*) made up 3%. Ten counts of macro algae were recorded.

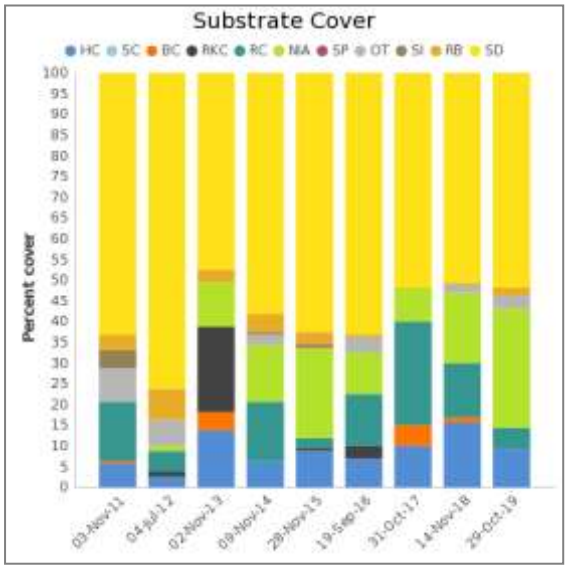

Figure 20. Benthic type and percent cover: Shark Bay, 2011- 2019.

Thirty sea cucumbers and one giant clam were recorded during the invertebrate survey - the highest count for 2019.

Coral bleaching affected 26% of the coral population, and an average of 13% of each affected colony; similar to 2017 levels (30% of the total coral population was affected).

Six counts of unknown coral scars (Image 36) and three of coral disease were recorded on the impacts survey.

A fish survey was conducted and twelve butterflyfish, six snapper, two parrotfish and one grouper were recorded.

Image 34. Site Location – represented by circle

Image 35: Site Photo

Image 36: Unknown Scar

5.13 Stevo's Carbonara

Stevo's Carbonara is located on the reef flat on the northern side of the island (Images 37-39). It is close to the resort and regularly frequented by tourists on snorkel and also reef walkers.

Hard coral represented 1% of the substrate in 2019 (Figure 21). Sand constituted 80% of the substrate, 1 nutrient indicator algae attributed 11%, other (mostly *Halimeda*) made up 6% and rock (including rock with turf algae and rock with calcareous algae) attributed the 1%. No macro algae was recorded on transect.

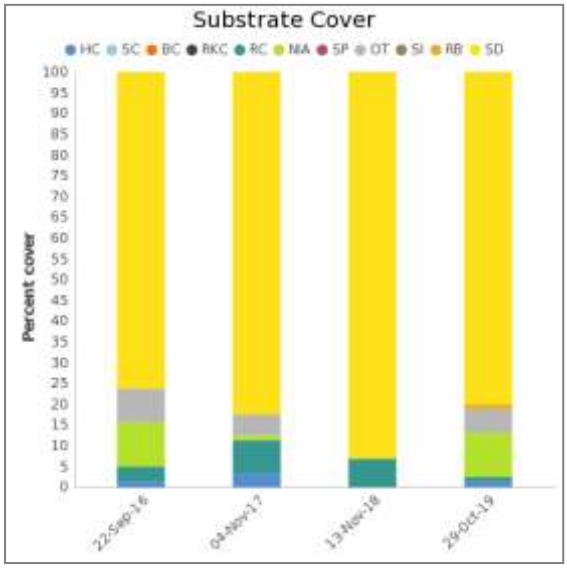

Figure 21. Benthic type and percent cover: Stevo's Carbonara, 2016 - 2019.

One sea cucumber was recorded on the invertebrate survey.

On the impacts survey, coral bleaching was recorded as affecting 23% of the coral population, and an average of 16% of the surface of coral colonies (an increase from 15% population and 4% colony bleaching in 2017). Additionally, one count of coral damage was recorded.

A fish survey was conducted and one butterflyfish was recorded.

Image 37. Site Location – represented by circle

Image 38: Site photo

Image 39: Turtle

5.14 White Wedding

White Wedding is located on the reef flat on the northern side of the island (Images 40-41). It is close to the resort and regularly frequented by tourists on snorkel and also reef walking.

Hard coral accounted for 3% of the benthic substrate (Figure 22). Sand constituted 57% of substrate, and rock (consisting of rock, rock with turf algae and rock with calcareous algae) 19%. Nutrient indicator algae attributed 8%, Rubble; 7%, other (*Halimeda*) 4% and silt 1%.

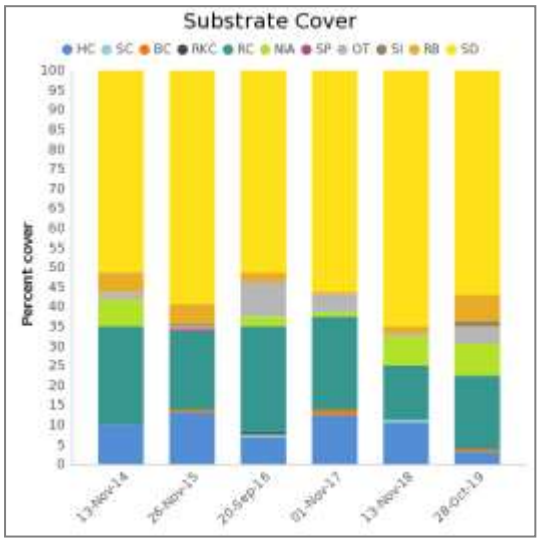

Figure 22. Benthic type and percent cover: White Wedding 2014-2019.

Fifteen giant clams (the highest recorded on any transect in 2019) and five sea cucumbers (Image 42) were recorded on the invertebrate survey.

Coral Bleaching affected 28% of the coral population and an average of 18% of the surface of affected coral colonies.

No additional impacts were recorded on the impact survey.

A fish survey was conducted and five butterflyfish, five snapper and four parrotfish were recorded.

Image 40. Site Location – represented by circle

Image 41: Site photo

Image 42: Prickly Greenfish

6.0 FURTHER INFORMATION

For more information on Reef Check Australia, survey methods, sites and previous reports, please go to www.reefcheckaustralia.org.

6.1 References

- Hill J, Wilkinson C. 2004. Methods for ecological monitoring of coral reefs: A resource for managers. Version 1. Australian institute of Marine Science. p. 117 p.
- Done T, Roelfsema C, Harvey A, Schuller L, Hill J, Schlappy ML, Lea A, Bauer-Civiello A, Loder J. 2017. Reliability and utility of citizen science reef monitoring data collected by reef check australia, 2002-2015. Marine Pollution Bulletin. 117(1-2):148-155.
- J Salmond, A Lea, J Loder, C Roelfsema and J Passenger (2014), Reef Check Australia Heron Reef Health Report 2014.
- J Salmond, J Loder, C Roelfsema, R Host and J Passenger (2016), Reef Check Australia 2015 Heron Reef Health Report.
- J. Salmond, J. Loder, C. Roelfsema, and J. Passenger (2017), Reef Check Australia 2016 Heron Reef Health Report.
- J. Salmond, J. Loder, C. Roelfsema, and J. Passenger (2017), Reef Check Australia 2017 Heron Island Reef Health Report.
- Roelfsema, C.M., and S.R. Phinn (2010). Calibration and Validation of Coral Reef Benthic Community Maps: Integration of Field Data with High Spatial Resolution Multi Spectral Satellite Imagery. Journal of Applied Remote Sensing, Vol. 4, 043527
- Roelfsema, C.M., S.R. Phinn, S. Jupiter, J. Comley, S. Albert, and P. Mumby (2013) Mapping Coral Reefs at Reef to Reef-System scales (10-600 km2) using OBIA Driven Ecological and Geomorphic Principles. Special issue on coral reefs in International Journal of Remote Sensing.
- Siebeck UE, Marshall NJ, Kluter A and Hoegh-Guldberg O (2006) Monitoring coral bleaching using a colour reference card. Coral Reefs 25:453-460

Image 43: Stingray at Libbys Lair

Image 44: Snorkel Surveyor at Last Resort

Image 45: Site photo from Stevo's Carbonara

APPENDIX A COMPARATIVE ISLAND WIDE GRAPHS FOR 2019 DATA