Reef Check Australia

Great Sandy Marine Park
Reef Health Survey Report 2017

Reef Check Foundation Ltd
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www.reefcheckaustralia.org
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We acknowledge the Traditional Custodians of the land on which project activities were conducted, and pay our respects of Elders past, present and future.

Thank you to the dedicated citizen scientists, advisors and professional volunteers who have contributed to survey and reporting activities: Paul Colquist, Amanda Delaforce, Jody Kreuger, Jennifer Loder, Josh Passenger, Rebekka Pentti, Chris Roelfsema, Jodi Salmond, Julie Schubert, Megan Welch and Maria Zann.

We would like to thank our local industry champions, Subsurface SCUBA and Bundaberg SCUBA, for their support.

This project was supported by Reef Check Australia, through funding from Queensland Government Department of Environment and Science.

Front Cover Image: Foliose coral at Gatcker's West, Hervey Bay. Back Cover images: Surveyor at Big Woody Island, and surveyor at Barolin Rocks. Many of the images used within this document were taken by Reef Check Australia Community Engagement Manager Jodi Salmond.

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1.0 Introduction

1.0 Reef Check Australia Introduction

Since 2001, Reef Check Australia (RCA) has coordinated citizen science reef monitoring projects on Queensland reefs to record long-term data relating to reef health at a local, national and global scale. RCA's survey methods collect quantitative data in relation substrate cover, key invertebrate species, target fish species, as well as anthropogenic and natural impacts on reef habitats.

1.1 Monitoring Sites

This report presents a summary of the findings for RCA surveys conducted in Great Sandy Marine Park in June 2017. Teams of trained volunteers monitored a total of six reefs in the region. The Great Sandy Marine Park extends from Baffle Creek in the north to Double Island Point in the south, including Hervey Bay, Great Sandy Strait, Tin Can Bay Inlet and waters seaward to three nautical miles.

This project builds on data collected since the original RCA sites were set up in 2012. Five sites were existing monitoring sites (Barolin Rocks, Burkitt's Reef, Big Woody Island, ESA Park, Gatakers Reef West). One additional site was added at Round Island (See Fig 1 for locations) during the 2017 surveys. A total of 2,400m^2 of reef habitat was surveyed in 2017, where one survey covers 400m^2.

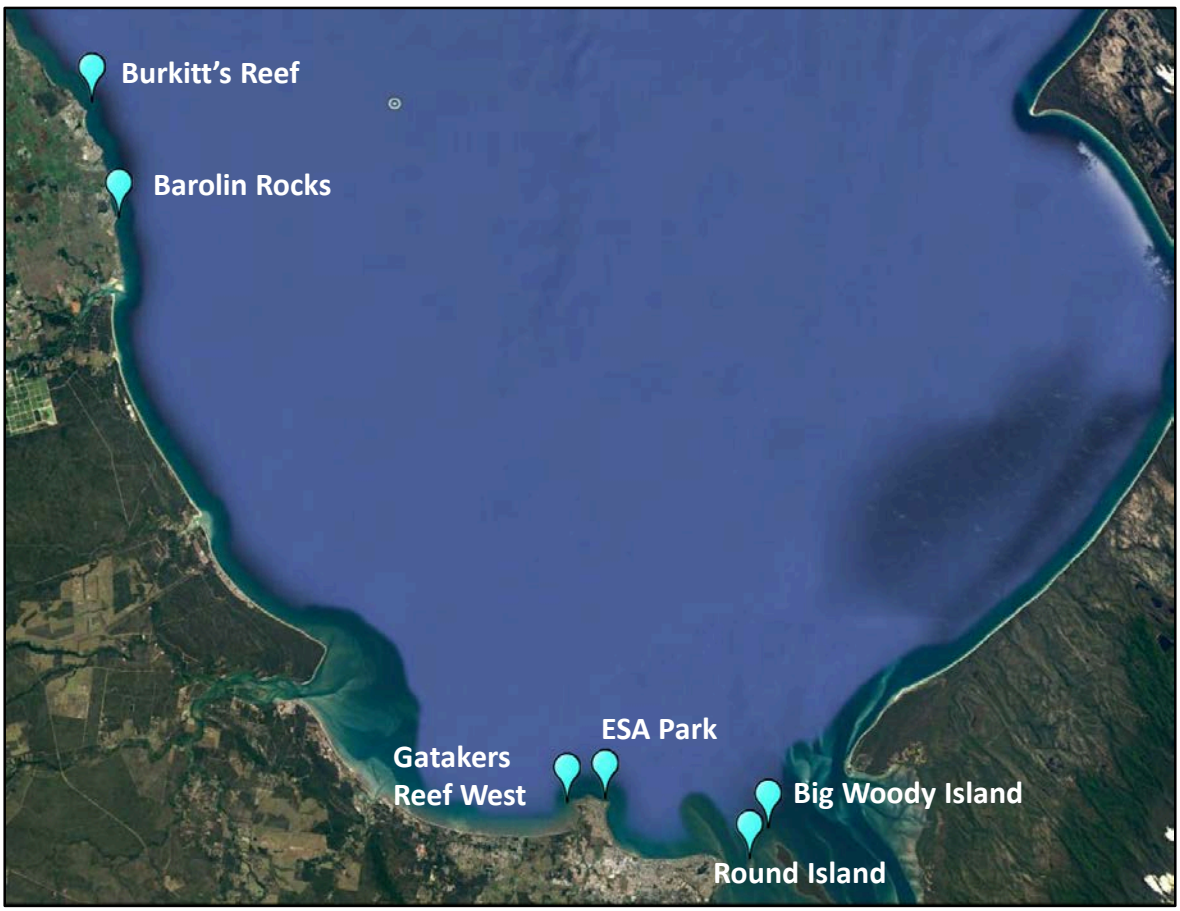
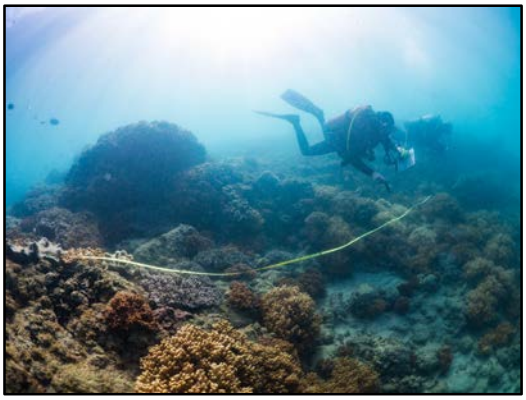
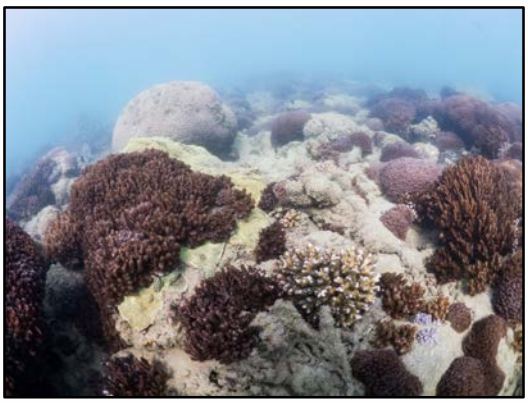


Figure 1. Map of Reef Check Australia monitoring sites in Great Sandy Marine Park from Google Earth.

1.0 Introduction





Images from top down: Surveyor at Barolin Rocks, Gatackers reef monitoring site, Coral at Big Woody Island with sediment

1.2 Great Sandy Marine Park reefs

The Great Sandy Marine Park hosts unique subtropical coral communities. In Queensland, inshore fringing reefs off the mainland coast is relatively unique (DeVantier 2010). Their subtropical locations means these reefs are also considered to be in a region considered 'marginal' for coral growth (Guinotte et al. 2003), with limited light availability, water chemistry for coral growth and extreme water temperature ranges.

In 2010, a study was conducted to document composition and condition of eight reefs in Hervey Bay from Gatakers Bay to Point Vernon, and off Woody and Little Woody Islands in the Great Sandy Strait (DeVantier 2010). 46 species of reef building corals were recorded, with the highest site diversity (31 species) recorded at Woody Island. The relatively robust coral genera *Turbinaria, Goniopora* and *Favia* are the most common in Hervey Bay (Zann 2012).

Of particular relevance for these nearshore reef communities is water quality. A 2011 study (Kroon et al 2011) identified that the average annual sediment and nutrient (total nitrogen and phosphorus) output was estimated to be 8–13 times greater than prior to European colonisation. Episodic flooding is considered to be relatively common (Butler et al 2013,). Intense rainfall and flood events of 2011 and 2013 resulted in a cumulative decrease in coral cover in Hervey Bay by 56% (Butler et al 2015).

The Joint Australian and Queensland Government Reef Water Quality Protection Plan Report Cards use graded metrics to assess targets for the Reef Water Quality Protection Plan 2013 to 2018. In 2016, the Burnett Mary region was scored "Very Poor" (E) for sediment and particulate nitrogen, "Poor" (D) for pesticides, and "Moderate" (C) for dissolved inorganic nitrogen and particulate phosphorous.

1.0 Introduction

Images from top down: Nudibranch at Big Woody Island, Barolin Rocks site photo, Round Island monitoring site from the surface

1.2 Great Sandy Marine Park reefs

These fringing reef and the diverse marine wildlife in the region have been identified as high conservation value by the regional Natural Resource Management body, Burnett Mary Regional Group (BMRG).

The proximity of these reefs to the coast offers notable opportunities for people to snorkel and/or dive these locations to visit reefs, as well as using them for other recreational activities such as fishing or boating. This provides an excellent opportunity to help more people appreciate, understand and enjoy these marine resources, but also presents a challenge for management to help protect these habitats and associated wildlife from both direct (fishing, anchor damage) and indirect (water quality) pressures.

The location of these subtropical reef communities are areas likely to see early signs of changing climates such as species range shifts and may also be subject to changing environmental conditions (such as changed weather regimes and water temperatures). These fringing reef areas are also located next to relatively rapidly growing coastal populations.

Their unique value and associated pressures makes it particularly important to have long-term monitoring at these locations to indicate potential changes. Citizen science programs such as Reef Check Australia offer an opportunity to help both complement existing government monitoring and academic research, as well as provide additional information for the community to learn about and help care for local reef environments.

1.0 Introduction

1.1 Monitoring Sites (Continued)

Monitoring sites include six sites within the Great Sandy Marine Park – two along the Woongarra coast (Burkitt's Reef, Barolin Rocks) and four along the Hervey Bay coast (Gatakers Reef West, ESA Park, Round Island and Big Woody Island Reef)(Fig 2)."

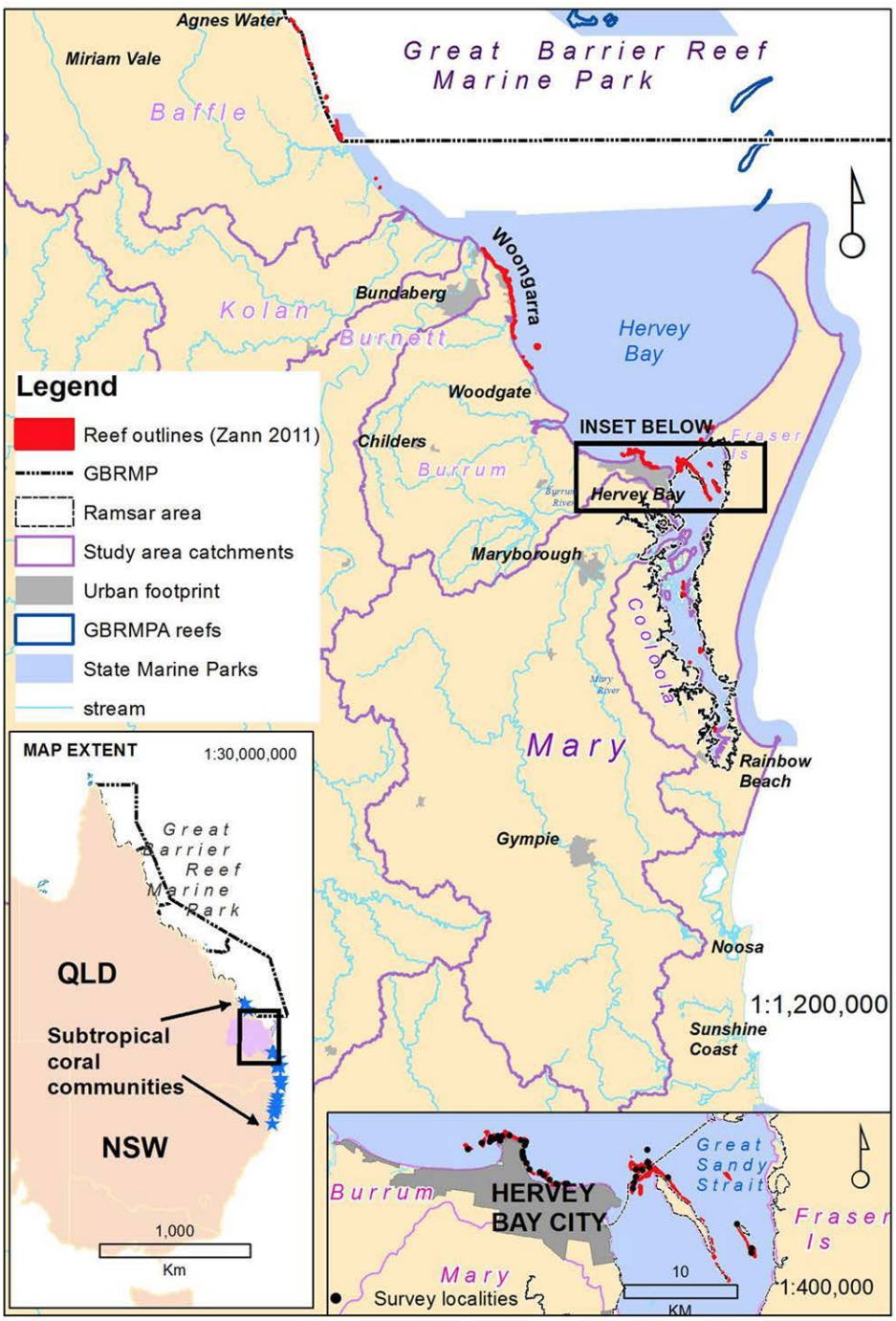


Figure 2. Map of RCA survey areas of Woongarra Coast and Hervey Bay (top right), within the larger range of subtropical reefs (left), as well as surrounding catchments, management areas and reef areas mapped in the study by Zann et. al 2012 (bottom right). Map courtesy of Zann et al 2012.

1.0 Introduction

1.2 Key Findings

Substrate

• Both monitoring sites in the Woongarra Coast region (Barolin Rocks and Burkitt's Reef) were dominated by soft coral, accounting for 58% and 28% cover, respectively (Fig 3). Both sites had low hard coral cover, 6% and <1%. The four monitoring sites in the Great Sandy Marine Park region had higher levels of hard coral, contributing (16-40%), and lower levels of soft coral cover (2-18%) of the benthic coverage.

• Of the 5 sites previously surveyed, 3 saw an increase in hard coral cover since being surveyed in 2014. Burkitt's Reef and Big Woody Island Reef, however, saw decreases in the amount of hard coral recorded (Fig 4).

• Rock and sand were the most common non-living substrate, attributing an average of 22% and 19% respectively across all sites. Burkittt's Reef had the highest percent cover of rock out of all the sites (51%). Rock and sand (11%) at Burkitt's Reef all had a layer of fine sediment on top (62%). Round Island had the highest amount of sand, making up 48% of the substrate. The highest silt recording was 19% at ESA Park.

Table 1. Key abbreviations for substrate charts. Some of the upcoming charts will use shortened terminology. Listed below are the full category names for referencing purposes. Macroalage (*Asparagopsis, Padina, Sargassum* and *Turbinaria*) are recorded as separate tallies on the substrate surveys.

Abbreviation	Full Name
HC	Hard Coral
SC	Soft Coral
BC	Bleached Coral
RKC	Recently Killed Coral
RC	Rock
RB	Rubble
SD	Sand
SI	Silt
SP	Sponge
OT	'Other'
NIA	Nutrient Indicator Algae

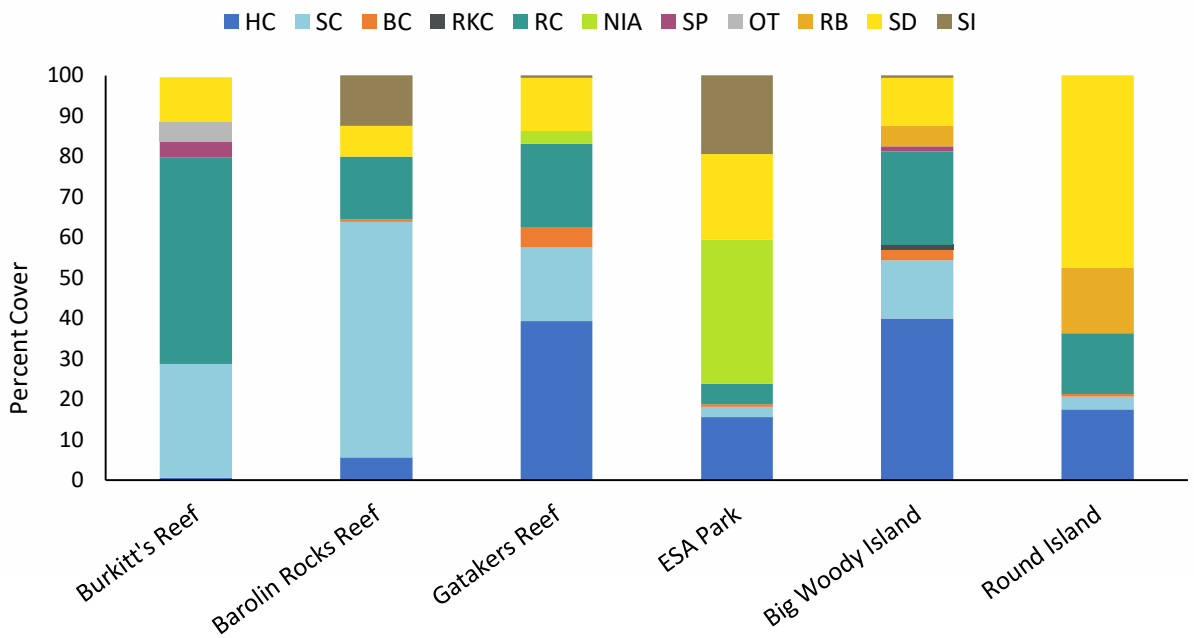


Figure 3. Percent cover of substrate for Great Sandy Marine Park surveys conducted in 2017.

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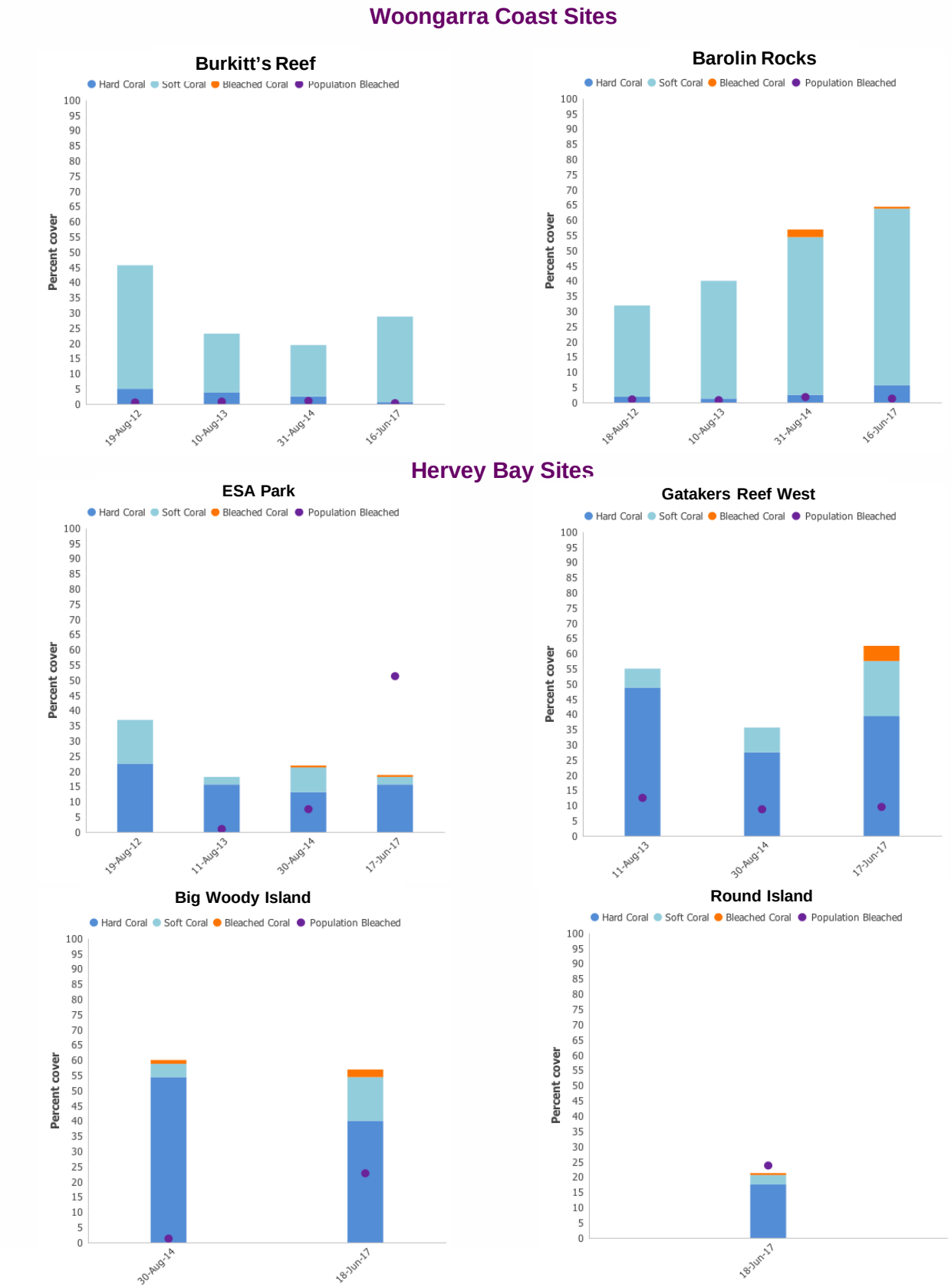


Figure 4. Percent cover of hard coral (blue), soft coral (light blue), and bleached coral (orange) by survey year at Reef Check Australia reef health monitoring sites, as per point-intercept substrate surveys for benthic composition. Percentage of the coral population exhibiting bleaching (purple dot), as documented on belt transect survey for reef health impacts, is included where available.

1.0 Introduction

1.2 Key Findings (Continued)

Coral bleaching

• Coral bleaching was recorded at all sites, affecting 18% of the population on average. Burkitt's Reef had the lowest level of bleaching recorded, with <1% of the population impacted. However, 51% of the coral population was bleached at ESA Park (Table 2).

• On average, bleaching affected 34% of each coral colony, ranging from 15-63% (Fig 4).

Coral disease

• Coral disease was only recorded within the region, with 2 instances at Barolin Rocks and 1 instance at Burkitt's Reef (Table 2). This is comparable to the two counts recorded at Burkitt's Reef in 2014.

Coral damage

• Coral damage was recorded on all sites except Gatakers Reef West. The highest overall incidence was recorded at Big Woody Island (10 counts, 57% coral cover). The highest ratio of damaged coral to coral cover was recorded at Round Island (8 counts, 21% coral cover).

Coral scarring

• Two scars from unknown causes were recorded in 2017, one instance each at Barolin Rocks and Gatakers Reef West.

• One *Drupella* sp. scar was also recorded at Gatakers Reef West.

Marine debris

• Marine debris was only recorded at the Hervey Bay sites.

• Fishing line was recorded on all four Hervey Bay survey locations (10 in total) and 2 pieces of other marine debris were found at ESA Park (Table 2).

Images from top down: Hard coral bleached; Coral damage due to unknown causes; Coral scar from unknown causes.

1.0 Introduction

1.2 Key Findings (Continued)

Table 2. Summary table of RCA monitoring findings for surveys conducted in Great Sandy Marine Park in 2017. Information includes a basic site summary of average hard and soft coral cover (%), total macroalgae (MA) abundance, nutrient indicator algae (NIA) cover (%) and silt levels (N= none, L=low, M=medium, H=high), as well as a summary of the impacts at each site: average coral bleaching of the population (%) and abundance of reef impacts (marine debris, coral damage and coral scars).

Reefs	Site Summary					Presence of Impacts per survey (400m²)								
	Hard Coral Coverage (%)	Soft Coral Coverage (%)	Macroalgae (#) per transect	Nutrient Indicator Algae (%)	Silt Loading	Coral Population Bleaching (%)	Coral Disease (#)	Fishing Line (#)	Marine Debris (General) (#)	Anchor Damage (#)	Coral Damage (#) (unknown causes)	*Drupella* Scar (#)	Crown of Thorns Scar (#)	Unknown Scar (#)
Barolin Rocks	6	58	0	0	L	1	2	0	0	0	5	0	0	1
Big Woody	43	14	0	0	L	23	0	2	0	0	10	0	0	0
Burkitt's Reef	1	28	1	0	M	<1	1	0	0	0	1	0	0	0
ESA Park	16	3	20	36	M	51	0	4	2	0	1	0	0	0
Gatakers Reef	44	18	0	3	H	10	0	3	0	0	0	1	0	1
Round Island	18	3	50	0	L	24	0	1	0	0	8	0	0	0

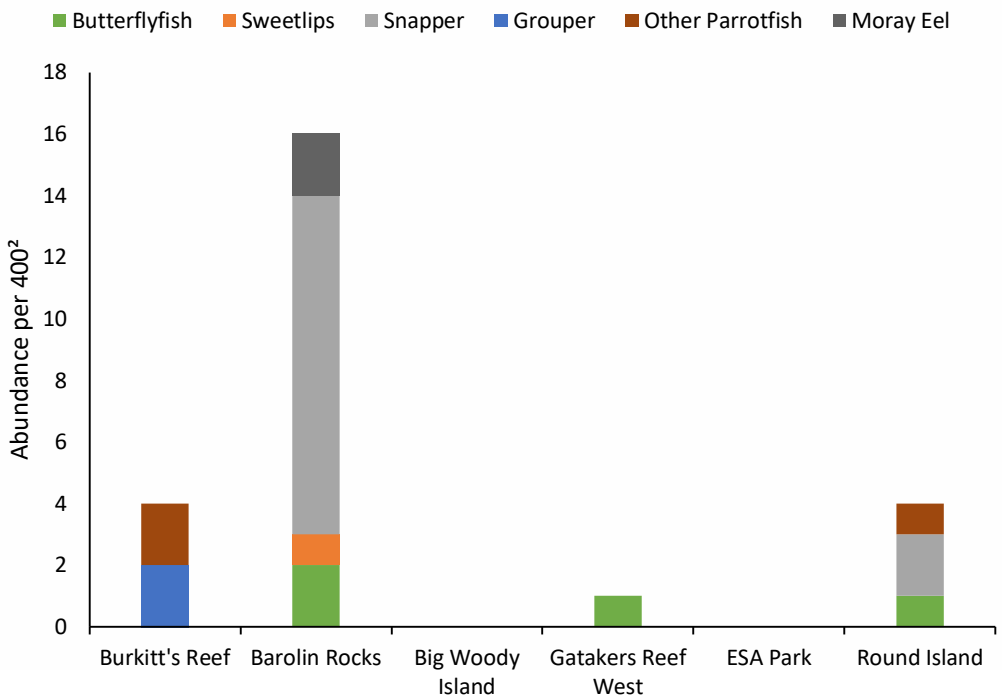


Figure 5. Fish abundance per survey (400m²) for Great Sandy Marine Park reef surveys conducted in 2017.

1.0 Introduction

1.2 Key Findings (Continued)

Indicator Invertebrates

• Nine *Drupella* sp. snails were the only RCA indicator invertebrates recorded across surveys in the Great Sandy Marine Park conducted in 2017. The snails were seen at Barolin Rocks, Burkitt's Reef, ESA Park and Gatakers Reef.

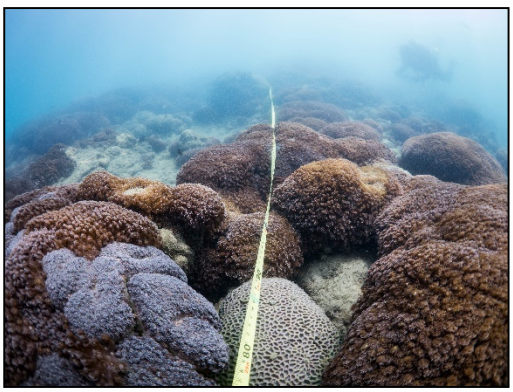
Fish

• The most abundant fish type recorded across all sites was snapper, with 13 individuals spotted. Eleven were recorded at Barolin Rocks, and 2 were recorded at Round Island (Fig 5).

• Other RCA fish types that were spotted along the transcect included butterflyfish, sweetlips, grouper and parrotfish.

• Surveyors further noted the presence of 1 grouper at ESA Park, and 1 grouper and 3 butterflyfish at Round Island; however, these fish were outside of the transect markings and not quantified.

• Non-target fish seen included 15 whiting, 2 bream, 1 flathead and 15 rabbitfish.



Rare Animals

• Rare animal sightings included 2 moray eels, 1 blue spotted ray, 1 shark and 3 stingrays.

Images from top down: ESA Park hard coral; Gatakers Reef West transect line
Images from left to right: Above and below; Surveyors in action; Hard coral at Burkitt's Reef

2.0 Woongarra Coast sites

2.1 Burkitt's Reef

Burkitt's Reef is a popular dive and snorkel site, situated approximately 800m from the coast. It is a marine national park (green) zone, where fishing or collecting is prohibited. The relatively exposed site is characterised by basalt rock and soft corals. The reef, surrounded by a flat sandy area, extends over 20 metres wide and curves seawards. The site is also near Burnett River, with potential for high sediment runoff.

Rock and sand made up 51% and 11% of the benthos respectively. All of these surfaces had a thin layer of siltation (62%). Soft coral was found in high concentrations (28% cover) at this site. This is an increase from the SC levels recorded in 2014 and 2013 (17% and 19%, respectively) (Fig 8). Other substrate contributed to 5% of the substratum, with sponges attributing 4% and both hard coral and rock with coralline algae making up <1% coverage. Hard coral presence was also scarce in 2014 and 2013, with levels at 3-4% of the total substrate.

The only RCA invertebrates recorded at this site were 3 *Drupella* snails.

Less than 1% of the coral population was bleached, and coral colony surfaces had an average of 20% bleaching. One count of unknown coral damage and 1 instance of coral disease were the only additional impacts recorded at this site (Fig 9).

A fish survey was completed at this site, where 2 grouper and 2 parrotfish were spotted. An unknown shark species was also seen at this site.

Site photo, Burkitt's Reef

Bleached hard coral, Burkitt's Reef

Soft coral, Burkitt's Reef

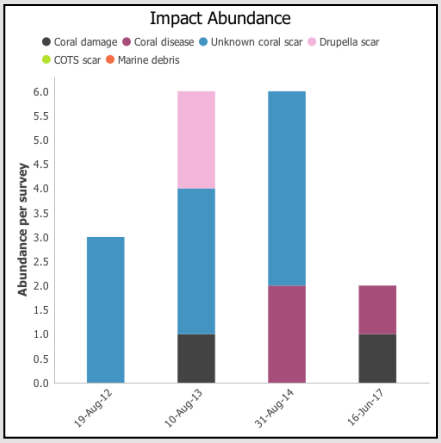


Figure 9. Impact abundance over time at Burkitt's Reef; 2012-2017.

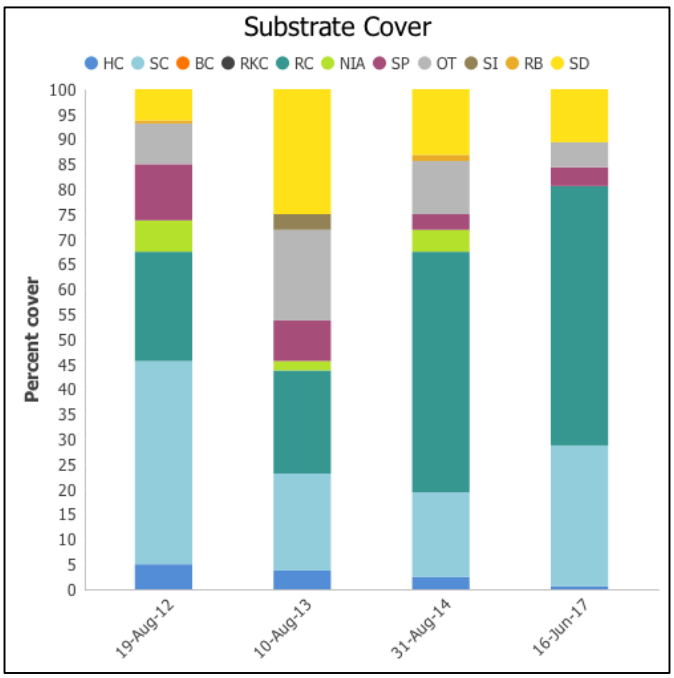


Figure 8. Benthic type and percent cover over time: Burkitt's Reef; 2012-2017.

2.0 Woongarra Coast sites

2.2 Barolin Rocks

Site Photo, Barolin Rocks.

Surveyor conducting RCA survey, Barolin Rocks

Bleached soft coral, Barolin Rocks

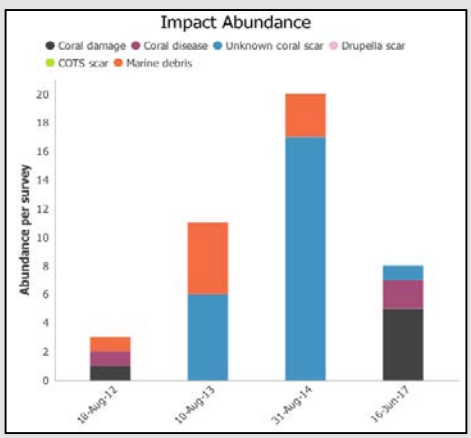


Figure 7. Impact abundance over time at Barolin Rocks; 2012-2017.

Barolin Rocks is a popular dive and snorkel site that is easily accessible from the shore close to Bargara, a small coastal town. It is a marine park green (no take) zone. This survey site is located just off the shoreline at 6m depth, and is partially protected from wind and weather conditions due to its close proximity to the headland.

Soft coral made up 58% of the substrate, similar to 2014 results (54%) (Fig 6). Rock, consisting of rock with turf algae (14%) and rock with coralline algae (2%) was the second most dominant benthos. Silt contributed 13% of the substrate. The remaining substrate was made up of sand (7%) and hard coral (6%, an increase from the 3% recorded in 2014).

Four *Drupella* snails were the only RCA indicator invertebrates spotted at this site.

Bleaching affected just 1% of the coral population, with an average of 63% of the individual coral colony surfaces. Additional impacts noticed at this site included 5 counts of coral damage from unknown causes, 2 instances of coral disease and 1 coral scar from unknown causes (Fig 7).

A fish survey was carried out at this site, noting 11 snapper, 2 butterflyfish, 1 sweetlips and 2 moray eels. A blue spotted ray was also seen on this survey.

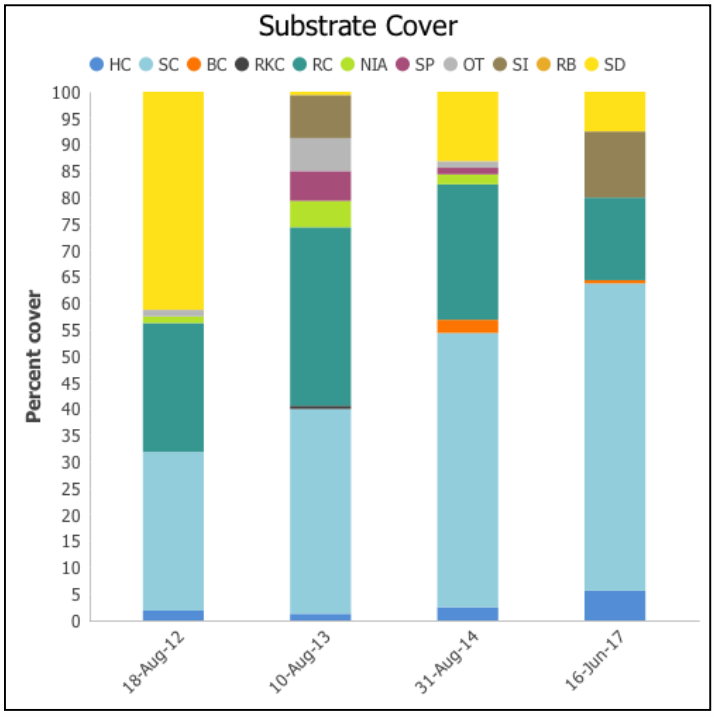
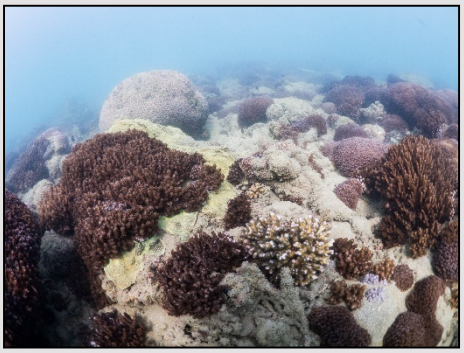


Figure 6. Benthic type and percent cover over time: Barolin Rocks; 2012-2017.

3.0 Hervey Bay sites

3.1 Gatakers Reef West



Site photo, Gatakers Reef West

Hard coral with bleaching, Gatakers Reef West

Macro Algae: *Asparagopsis,* Gatakers Reef West

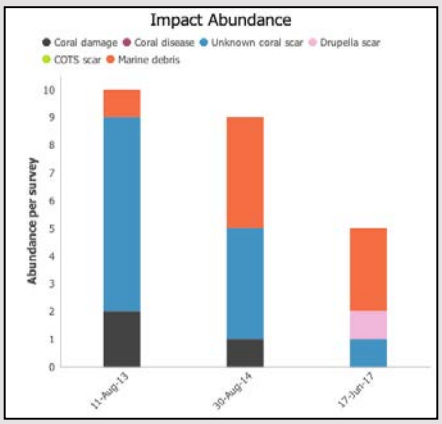


Figure 15. Impact abundance over time at Gatakers Reef; 2013-2017.

Gatakers Reef West was re-established in 2013, close to its original 2012 location, in order to encompass a large area of *Goniopora* hard coral. Coral collecting is known in this area. The site is in a conservation park (yellow) zone, which allows limited fishing activities.

Hard corals composed 44% of the substrate at this site (5% bleached), an increase from the 28% seen in 2014 (Fig 14). Rock (consisting of rock with coralline algae and bare rock) had the second highest abundance of all benthos, covering 21%. Soft coral contributed 18% to the substratum, while sand (13%), NIA (3%) and silt (1%) made up the remaining coverage. The NIA was mostly *Lobophora.* No counts of macro algae were recorded.

One *Drupella* snail was the only RCA indicator invertebrate recorded.

Bleaching at Gatakers Reef West was lower than the other sites within the Great Sandy Marine Park area. Approximately 10% of the coral population was affected, with an average 16% of the individual coral colonies showing signs of bleaching. Three incidents of fishing line, 1 *Drupella* scar and 1 scar due to unknown causes were also found at this site (Fig 15).

One butterflyfish was recorded during the fish survey in 2017.

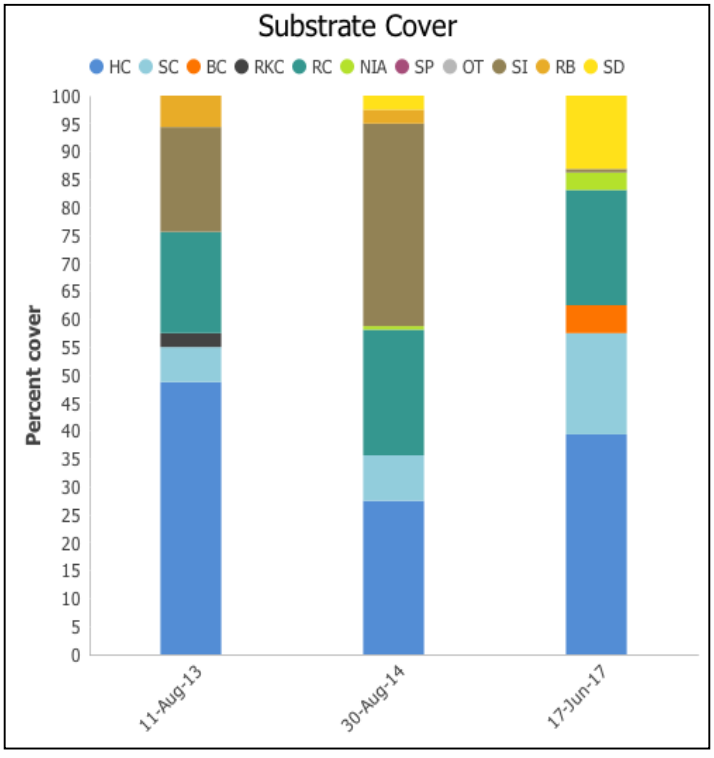


Figure 14. Benthic type and percent cover over time: Gatakers Reef West; 2013-2017.

3.0 Hervey Bay sites

3.2 ESA Park

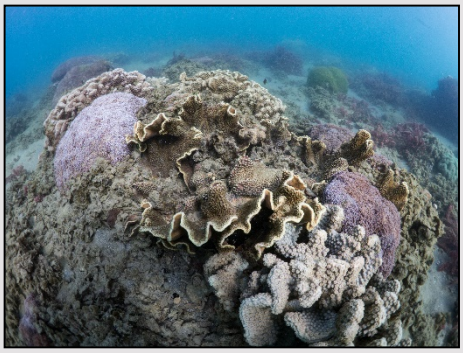
The ESA Park survey site is located off the coast, close to the ESA Park sign. The sandy site has patchy coral cover, with heavy siltation from the Mary River. The accessibility of ESA Park also makes it a popular site for recreational fishing boats. ESA Park sits within conservation park (yellow) zone which allows limited fishing activities.

This substratum at this site consisted mainly of nutrient indicator algae (36%), a large increase from 2014 and 2013 when no NIA was recorded, but similar to the 24% found in 2012 (Fig 12). Sand and silt accounted for 21% and 19% of the benthos, respectively. Hard coral amounted to 16%, comparable to the 13% of hard coral recorded in 2014, and was composed primarily of encrusting and general hard coral growth forms. Rock (5%) and soft coral (3%) contributed to the remaining substratum. Twenty counts of algae were recorded at this site, composed primarily of *Lobophora*.

One *Drupella* snail was the only target invertebrate recorded this season at this site.

Over half (51%) of the coral population at ESA Park was impacted by bleaching, with an average of 34% bleaching of the individual coral colonies. Other impacts at this site included 1 instance of unknown coral damage, 4 instances of fishing line and 2 items of general marine debris (Fig 13).

No target fish were recorded on the transect; however, 1 grouper was spotted outside of the survey area. Additional fish sightings included 15 whiting, 2 bream and 1 flathead.



Site photo, ESA Park

Large amounts of fishing line, ESA Park

Lobophora (NIA), ESA Park.

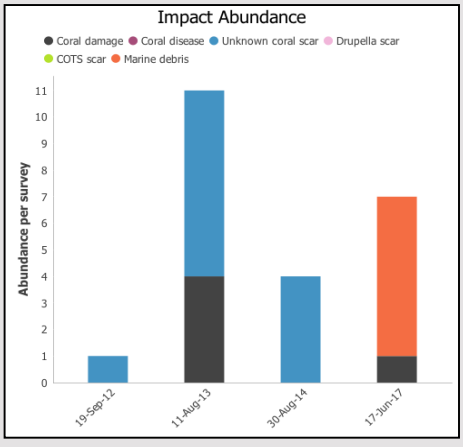


Figure 13. Impact abundance over time at ESA Park; 2012-2017.

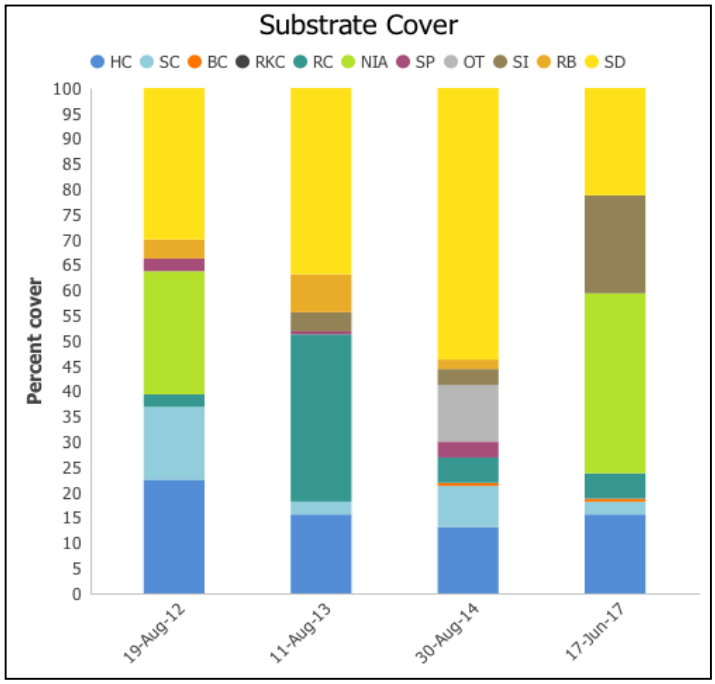


Figure 12. Benthic type and percent cover over time: ESA Park; 2012-2017.

3.0 Hervey Bay sites

3.3 Big Woody Island

Big Woody Island was added as a RCA monitoring site in 2014, to include the large notable *Acropora* patch. This is a popular boating site for both fishing and recreational purposes. The survey site is just outside the marine park green zone where fishing and collecting is prohibited. Coral collecting, anchoring and spearfishing are known to take place at or near this site.

Hard coral accounted for 43% of the benthos, a decrease from the 56% recorded in 2014 (Fig 10). Branching growth forms were most prevalent, consistent with the large *Acropora* patch known to this site. Rock covered the second largest area at 23%, with soft coral (14%) and sand (12%) following. Rubble (5%), recently killed coral (1%), sponge (1%) and silt (1%) composed the remaining substratum.

No RCA indicator invertebrates were located at this site in 2017.

Coral bleaching affected 23% of the population and 43% of the surface of coral colonies. These levels are higher than what was recorded in 2014 (1% population, 17% colonies). 10 counts of coral damage due to unknown causes and 2 instances of fishing line were also found in 2017, similar to those noticed in 2014 (10 instances of coral damage and 4 of fishing line) (Fig 11).

Although a fish survey was conducted at this site, no RCA target fish were seen. One stingray was recorded on the transect.

Site photo, Big Woody Island

Nudibranch, Big Woody Island

Surveyor in action, Big Woody Island

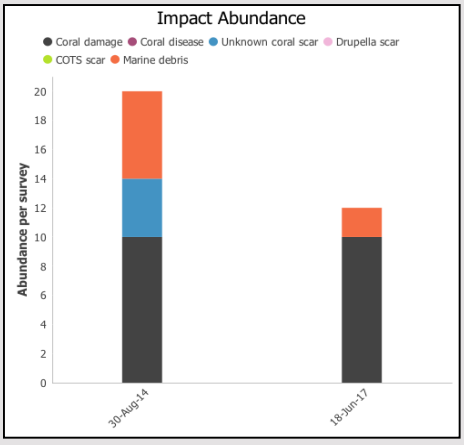


Figure 11. Impact abundance over time at Big Woody Island; 2014-2017.

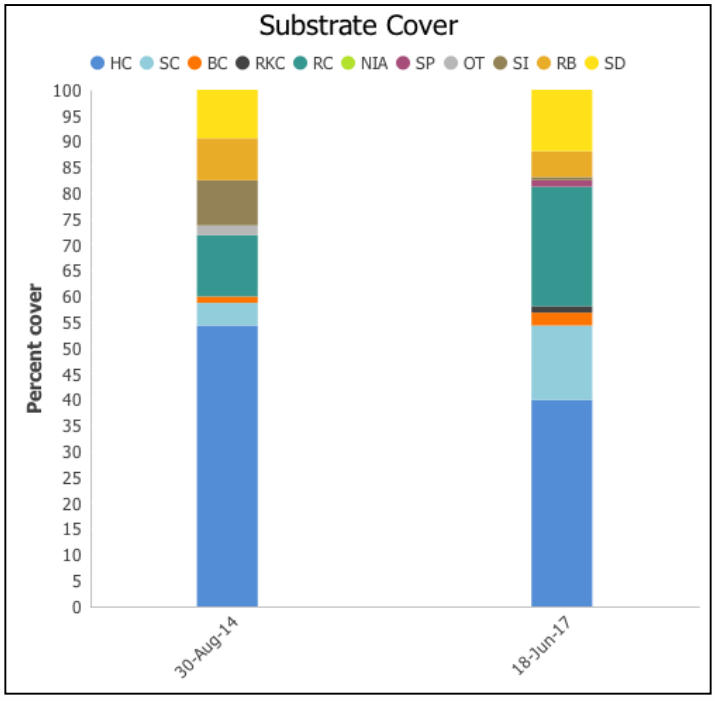


Figure 10. Benthic type and percent cover over time: Big Woody Island; 2014-2017.

3.0 Hervey Bay sites

3.4 Round Island

Round Island was a newly established monitoring site in 2017. This small sand island is located just outside Urangan Boat Harbour, and is heavily utilised by locals and tourists. The monitoring site is located approximately 150m from the island and lies at a shallow depth of 2m. Strong currents pass on either side of the island, which may help support small patches of corals to grow amongst the sandy patches.

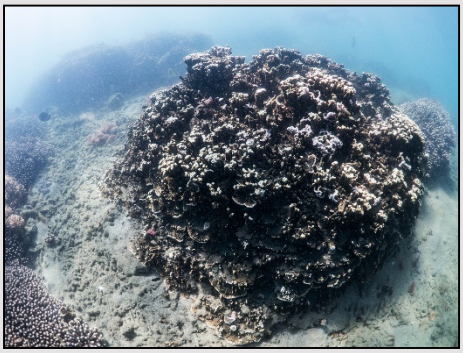
Sand dominated the benthos at 48% coverage (Fig 16). Hard coral contributed 18% to the substratum, and consisted primarily of branching growth forms. Rubble (16%) and rock (consisting of bare rock and rock with coralline algae) (15%) were the next largest substrate contributors. Soft coral was found in low levels, attributing 3% to the benthos. Fifty counts of macro algae were recorded during the 2017 survey.

No RCA indicator invertebrates were recorded at Round Island.

Coral bleaching impacted 24% of the population, a similar level to what was seen at neighbouring Big Woody Island (23%). 27% of the coral colony surfaces were affected at Round Island. Other impacts affecting this site included 8 instances of coral damage due to unknown causes and one piece of fishing line (Fig 17).

A fish survey was conducted at Round Island with records noting the presence of 1 butterflyfish, 2 snapper and 1 parrotfish. A grouper and 3 butterflyfish were seen outside of the transect area. Other animal sightings included 2 stingrays and 15 rabbitfish.

Site photo, Round Island



Bleached hard coral, Round Island.

Macro algae, *Asparagopsis,* Round Island.

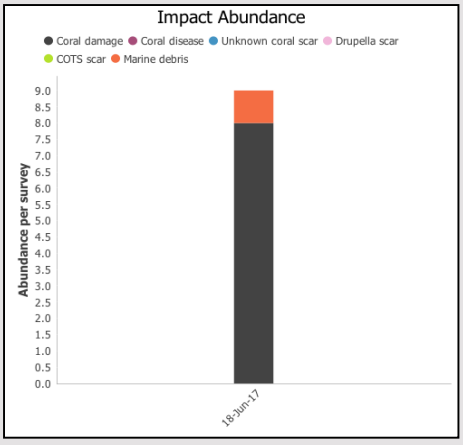


Figure 17. Impact abundance over time at Round Island; 2017.

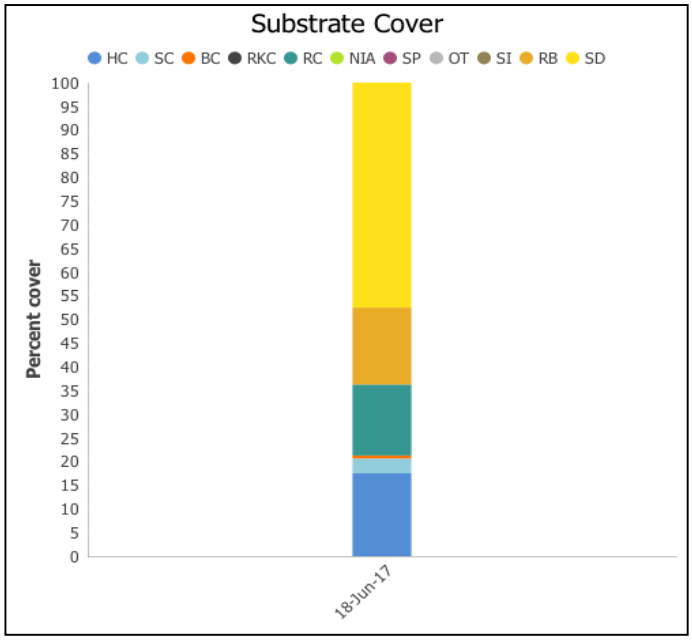


Figure 16. Benthic type and percent cover over time: Round Island; 2017.

4.0 Summary and Recommendations

4.0 Summary

The Great Sandy Marine Park hosts patchy, but notable fringing nearshore reef areas that are often under recognised for their unique value. Surveys in 2017 indicate that these sites are showing some signs of stress.

Inshore coral reefs within the Great Sandy Marine Park experience a range of pressures including sediment and nutrients loads from flooding and runoff, fishing, anchor damage, aquarium collection and climate change. With only a few key reef sites in the marine park, ensuring the long-term resilience of these reefs is important for sustaining the health of these systems and maintaining opportunities for use. There are various management tools available to support the health and resilience of these areas including possible no anchoring areas or regulating use, and these tools could be explored further.

The draft Reef 2050 Water Quality Improvement Plan 2017–2022 also highlights several goals relevant to how citizen science and community engagement can directly contribute to managing the health of Great Sandy Marine Park. Goals include incorporating community knowledge contributions for the best available science, engaging in education to help community understand and act on water quality issues, and fostering partnerships to improve water quality.

4.1 Recommendations

- Water quality represents one of the more notable challenges for these reefs fringing the coastline. The inclusion of inshore reef indicators in the Burnett Mary region for the Great Barrier Reef Report Card would be beneficial to improve opportunities for targeted and measurable management responses related to reef health.

- Annual RCA reef health monitoring on these sites, coupled with more regular Great Barrier Reef Marine Park Authority (GBRMPA) Reef Health Impact Surveys (RHIS) and/or Rapid Monitoring surveys could help to more closely track changes in these communities and alert management to trends. There is community interest in engaging in these activities.

- Identifying pathways to connect Reef Guardian schools in the Burnett Mary region with local reef monitoring activities (either through field activities, application of data or communications projects) could build science literacy and help apply results from monitoring programs.

- RCA should share and discuss results with the GBRMPA Local Marine Advisory Committee (LMAC) to both provide updates on current results and identify potential partnership opportunities for community projects.

- Local scale water quality monitoring, including through citizen science programs, could offer additional information throughout the year on specific sites of interest, especially given the sedimentation documented at several sites such as Burkitt's Reef, Barolin Rocks and ESA Park.

4.1 Recommendations (continued)

- Coral damage at Big Woody Island and Round Island may be due to anchoring and boating activities. The large branching coral (*Acropora*) at Big Woody Island is unique and currently sits outside of the marine park zone. Reconsidering this zoning to offer additional protection from anchoring activities for these habitat areas should be discussed in future zoning reviews.

- Marine debris appears to be a consideration for Hervey Bay sites, with documented debris at Big Woody, West Gatakers and ESA Park. Given this is a direct pressure that can be addressed via local actions, continued campaigns on the impacts of marine debris and how Bay visitors can adapt behaviours to reduce impacts would be beneficial.

5.0 Literature Cited

Butler, I. R., B. Sommer, M. Zann, J-x Zhao and J. Pandolfi (2013) The impacts of flooding on the high-latitude, terrigenoclastic influenced coral reefs of Hervey Bay, Queensland, Australia. *Coral Reefs*: 32(4): 1149-1163.

Butler, I. R., B. Sommer, M. Zann, J-x Zhao and J. Pandolfi (2015) The cumulative impacts of repeated heavy rainfall, flooding and altered water quality on the high-latitude coral reefs of Hervey Bay, Queensland, Australia. Marine Pollution Bulletin 96:356-367.

DeVantier (2010) Reef-building Corals of Hervey Bay, South-east Queensland. Available from: https://www.researchgate.net/publication/285100297_DeVantier_2010_Reef-building_Corals_of_Hervey_Bay_South-east_Queensland.

Kroon FJ, Kuhnert PM, Henderson BL, Wilkinson SN, Kinsey- Henderson A, Abbott B, Brodie JE, Turner RDR (2011) River loads of suspended solids, nitrogen, phosphorus and herbicides delivered to the Great Barrier Reef lagoon. Mar Pollut Bull 65:167–181

Lea, A., Loder, J. and J. Salmond (2014). Fraser Coast Season Summary Report 2014. Reef Check Foundation Ltd.

Zann M (2012) The use of remote sensing and field validation for mapping coral communities of Hervey Bay and the Great Sandy Strait and implications for coastal planning policy. M Phil Ph.D. thesis, University of Queensland, St Lucia, p 216

Zann, M., Phinn, S. and T. Done (2012). Towards marine spatial planning for Hervey Bay's coral reefs. Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia, 9-13 July 2012. Available online at: http://www.icrs2012.com/proceedings/manuscripts/ICRS2012_18C_2.pdf

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