Reef Check Australia

South East Queensland

Season Summary Report 2016-2017

Reef Check Foundation Ltd
M. Welch, J. Salmond. J. Passenger, R. Pentti and J. Loder
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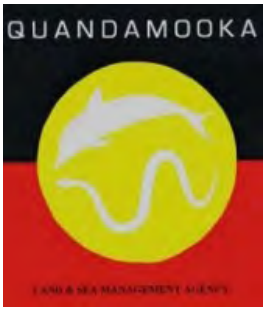

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1.0 Introduction

Since 2001, Reef Check Australia (RCA) has supported citizen science reef monitoring projects on reefs around Australia. For the past 15 years, our surveys have helped to collect 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.

This report presents a summary of the findings for surveys conducted in South East Queensland (SEQ) during the 2016-17 season. Teams of trained volunteers monitored a total of 29 sites on 14 different reefs, which included survey sites ranging from Mudjimba (Old Woman) Island on the Sunshine Coast to the artificial Seaway reefs on the Gold Coast. 11,600m^2 of reef habitat was surveyed in total during the 2016-2017 season (where one survey covers 400m^2).

The SEQ region is broken down into the four sub-regions: Sunshine Coast, Inshore Moreton Bay, Outer Moreton Bay and Gold Coast. Some existing Reef Check Australia monitoring locations were not visited during the 2016-17 survey season due to weather conditions and/or funding resources. All RCA survey site locations are included in Table 1 below, including those not surveyed in 2016-17 (italicised).

Table 1. List of all RCA survey reefs in South East Queensland by Sub-regions.

Sunshine Coast	Inshore Moreton Bay	Outer Moreton Bay	Gold Coast
Currimundi Reef	Amity Point	Flat Rock Island	Gold Coast Seaway Reefs
Dead Mans Reef	Goat Island	Flinders Reef	*Narrowneck Reef*
Hancocks Shoal	Green Island	*Hutchinsons Shoal*	*Kirra Reef*
Inner Gneerings	Macleay Island	*Marietta Dal*	*Palm Beach Reef*
Jew Shoal	Myora Reef	Shag Rock Island	
Kings Beach	Peel Island		
Little Halls Reef			
Mudjimba (Old Woman) Island			

1.0 Introduction

SEQ represents a transitional marine region (Perry & Larcombe 2003), where temperate, tropical and sub-tropical species co-exist. The corals in this transitional zone already live in environmental extremes that limit most reef accretion due to extremes in light, temperature, aragonite availability and/or turbidity (.

SEQ includes various coral communities with diverse and extensive coral growth forms. The offshore site Flinders Reef, for instance, is home to 119 distinct coral species (Harrison *et al.* 1998). A number of other SEQ locations have notable historical and current coral cover (Wallace, Fellegara, Muir, & Harrison, 2009; Harrison, Harriot, Banks, & Holmes, 1998).

The region's waterways are under growing pressure from rapidly increasing human population, with the SEQ population expected to reach 4 million in 2026. Stressors such as habitat loss, nutrient runoff, boating, anchoring, overfishing, marine debris and climate change will have increasing consequences on reefs in the SEQ region.

As a transitional marine zone located close to coastal influences, SEQ reefs are likely to show habitat and species shifts resulting from climate change and other anthropogenic impacts. Its unique assemblages of marine species have warranted recognition of the region as an important area to study and protect (Wallace *et al.* 2009).

While there is notable research in the region, long-term monitoring of these habitats is relatively limited. RCA's citizen science monitoring program provides crucial long-term data that contributes to assessment of changing health conditions of reefs within SEQ and supports management responses to ensure long-term survival of these important marine habitats (Schläppy et al 2017).

In 2015, the UniDive Point Lookout Ecological Assessment project coordinated through the University of Queensland Underwater Club provided a detailed assessment of important reef habitats at Point Lookout, North Stradbroke Island (Roelfsema et al 2016).

Images from top down: Sponges; Hard Coral Foliose; Surveyor in action.

1.0 Introduction

1.1 Monitoring Sites

In the 2016-17 season, RCA monitoring sites ranged from Mudjimba Island on the Sunshine Coast to the Gold Coast Seaway (See Figure 1 for map locations. Note that Narrowneck Artificial Reef was not surveyed this season). Reef habitats at the survey sites varied from inshore to offshore areas, and included reef flats, crests and slopes. Sites also spanned protected (marine national park, no-take zones) and non-protected areas. The majority (18 of 29) of surveys were conducted within the Moreton Bay Marine Park. Other RCA monitoring locations were not re-visited due to weather related issues and funding restrictions.

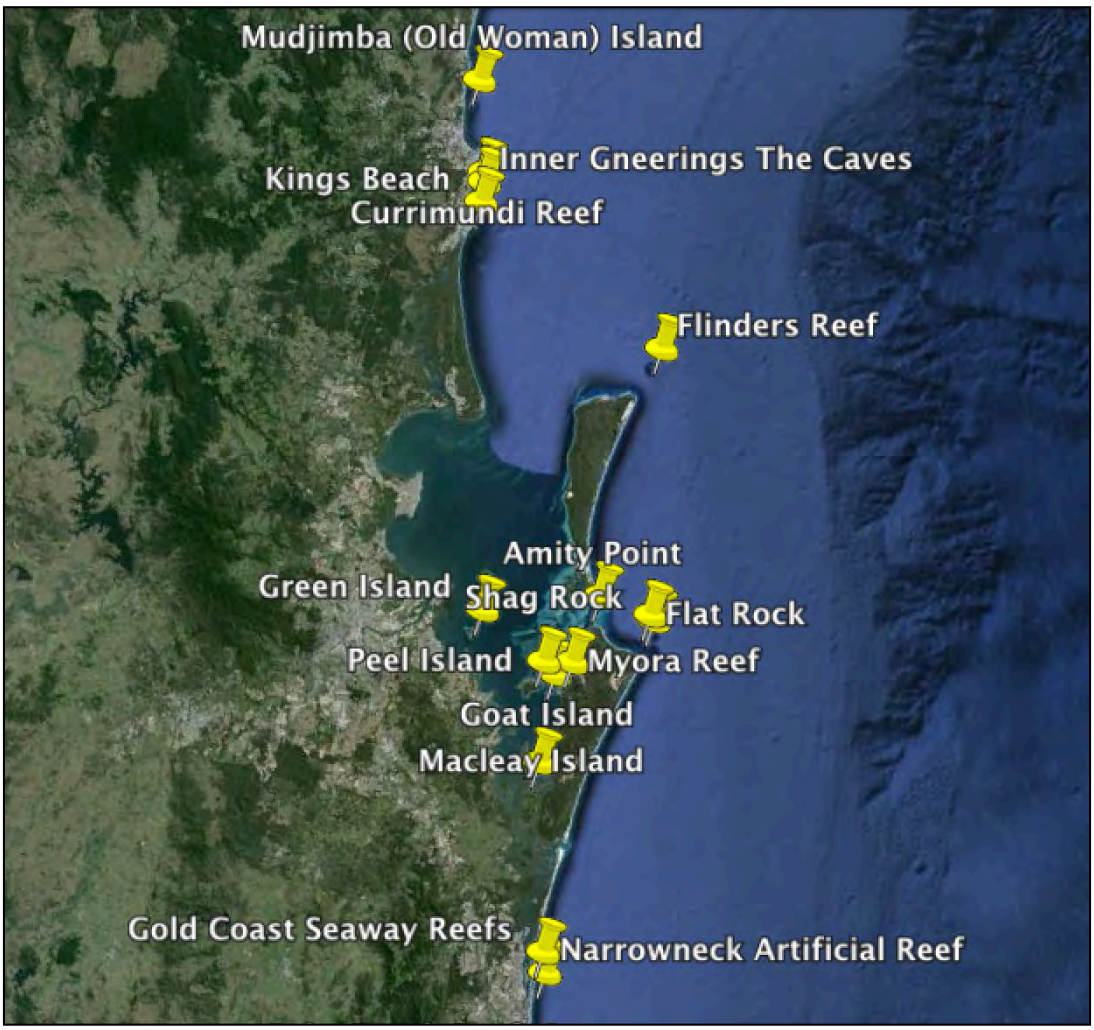


Figure 1. Map of South East Queensland survey sites from Google Earth.

1.0 Introduction

Table 2. Table of RCA monitoring locations in the Sunshine Coast and Inshore Moreton Bay visited in the 2016-2017 SEQ season, including site number, location, depth, year of initial survey and site designation. Site designation includes four zones within the Moreton Bay Marine Park: Marine National Park (MNP), Conservation Park (CP), Habitat Protection (HP) or Ramsar Wetland site status (Ramsar).

Location	Site #	Site	Depth (m)	1st Survey	Site Zoning
Sunshine Coast	1	Currimundi Reef	9	2009	N/A
Sunshine Coast	2	Currimundi Reef	9	2009	N/A
Sunshine Coast	1	Inner Gneerings, The Caves	10	2009	N/A
Sunshine Coast	2	Inner Gneerings, The Caves	10	2013	N/A
Sunshine Coast	1	Kings Beach	3	2009	HP
Sunshine Coast	1	Mudjimba Island, NW Reef	8	2013	N/A
Sunshine Coast	1	Mudjimba Island, The Ledge	5	2007	N/A
Sunshine Coast	2	Mudjimba Island, The Ledge	9	2013	N/A
Sunshine Coast	3	Mudjimba Island, The Ledge	6	2013	N/A
Inshore Moreton Bay	2	Amity Point	2	2016	MNP
Inshore Moreton Bay	1	Goat Island	1	2009	CP, Ramsar
Inshore Moreton Bay	1	Goat Island West	1	2014	MNP
Inshore Moreton Bay	1	Green Island	2	2015	MNP
Inshore Moreton Bay	1	Macleay Island	1	2009	MNP
Inshore Moreton Bay	1	Myora Reef	3	2009	MNP, Ramsar
Inshore Moreton Bay	2	Myora Reef	1	2014	MNP, Ramsar
Inshore Moreton Bay	1	Peel Island, North	2	2009	MNP, Ramsar
Inshore Moreton Bay	1	Peel Island, East	2	2009	MNP, Ramsar
Inshore Moreton Bay	1	Peel Island, Northeast	1	2014	MNP

1.0 Introduction

Table 3. Table of RCA monitoring locations in Outer Moreton Bay and Gold Coast visited in the 2016-2017 SEQ season, including site number, location, depth, year of initial survey and site designation. Site designation includes four zones within the Moreton Bay Marine Park: Marine National Park (MNP), Conservation Park (CP), Habitat Protection (HP) or Ramsar Wetland site status (Ramsar).

Location	Site #	Site	Depth (m)	1st Survey	Site Zoning
Outer Moreton Bay	1	Flat Rock, Shark Alley	9	2009	MNP
Outer Moreton Bay	1	Flat Rock, The Nursery	6	2008	MNP
Outer Moreton Bay	1	Flinders Reef, Alden's Cave	10	2008	MNP
Outer Moreton Bay	2	Flinders Reef, Alden's Cave	10	2013	MNP
Outer Moreton Bay	1	Flinders Reef, The Nursery	6	2007	MNP
Outer Moreton Bay	2	Flinders Reef, The Nursery	9	2009	MNP
Outer Moreton Bay	1	Shag Rock, East	5	2008	HP
Outer Moreton Bay	2	Shag Rock, West	6	2009	HP
Gold Coast	1	Gold Coast Seaway Southwest Wall	2	2007	N/A
Gold Coast	1	Gold Coast Seaway The Pipe	4	2015	N/A

1.0 Introduction

1.2 Regional Summary

The Outer Moreton Bay sub-region had the highest average hard coral cover of 31%, followed by the Sunshine Coast with 30% hard coral cover on average (Figure 2). The lowest hard coral cover was recorded in the Inshore Moreton Bay sub-region at 16%. Note that the Gold Coast Seaway sites had no hard coral recorded during the 2016-2017 season, and are therefore excluded from the average coral calculations. The average hard coral cover for the entire SEQ region was 26%.

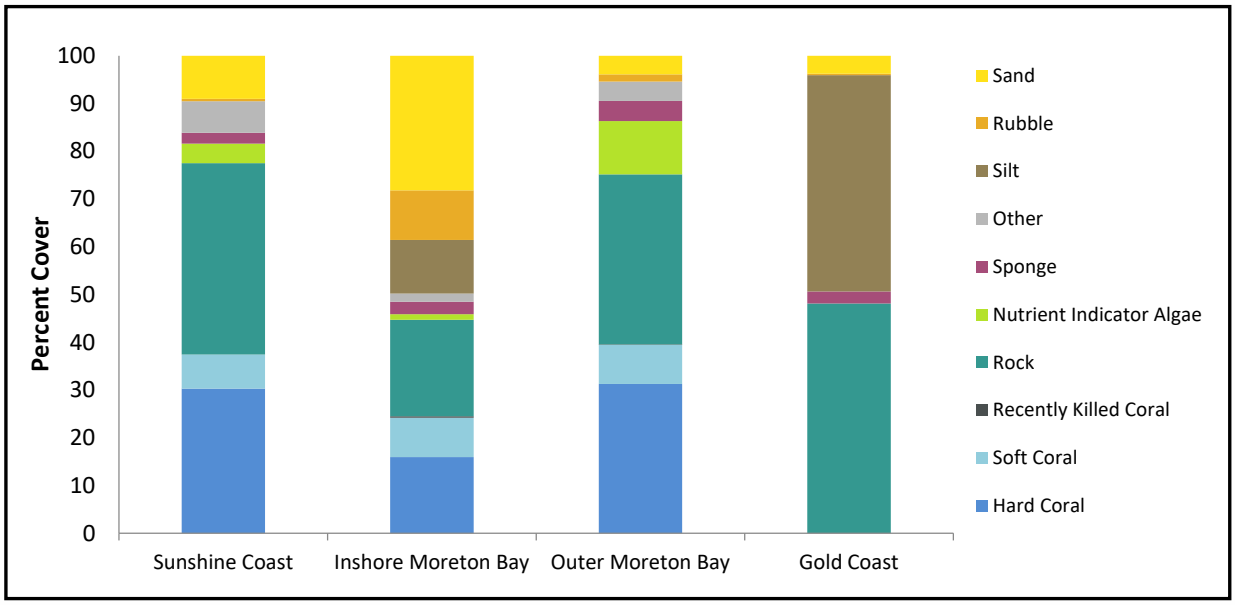


Figure 2. Percent cover of substrate for SEQ sub-regions in 2016 survey season.

Table 4. Key Abbreviations for substrate charts. Some of the upcoming charts will use shortened terminology. Listed below are the full category names for referencing purposes.

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

Inshore Moreton Bay sites experienced the highest average coral bleaching per survey both at the level of individual coral colonies (36.8% average) as well as whole coral population (11.1% average). Outer Moreton Bay had the second highest coral bleaching levels, with an average of 5.2% of the coral population exhibiting signs of bleaching, and 23.5% for individual coral colonies. Bleaching levels were third highest on the Sunshine Coast, with 2.2% of the coral population experiencing bleaching and 19.6% of individual colonies. No hard or soft coral was found on at the two Gold Coast sites, thus leading to 0% coral bleaching in this region (Figure 3).

1.0 Introduction

1.2 Regional Summary (Continued)

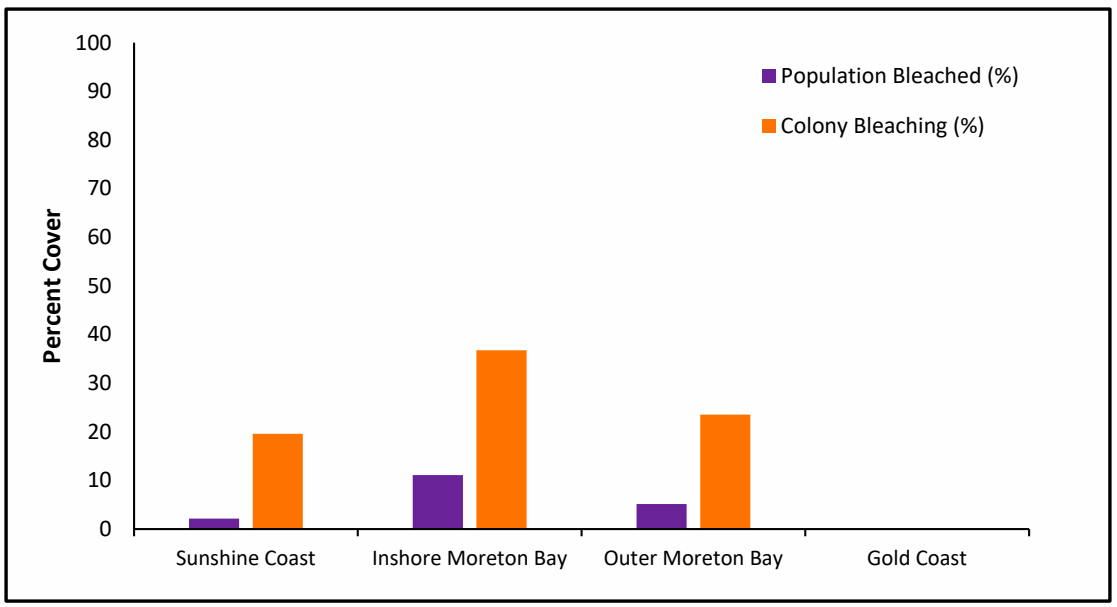


Figure 3. Average bleaching percentage per survey within the SEQ sub-regions.

The Gold Coast reported the highest number of impacts on average out of the 4 sub-regions; however, this record was highly influenced by an average of 33 pieces of fishing line per 400m² (Figure 4). Outer Moreton Bay had the second highest number of impacts on average (22 per 400m²), largely affected by coral damage of unknown causes. The three sub-regions with reported coral cover (Sunshine Coast, Inshore and Outer Moreton Bay) all contained counts of coral disease, fishing line, coral damage (unknown causes) and scars (both from *Drupella* sp. and unknown causes).

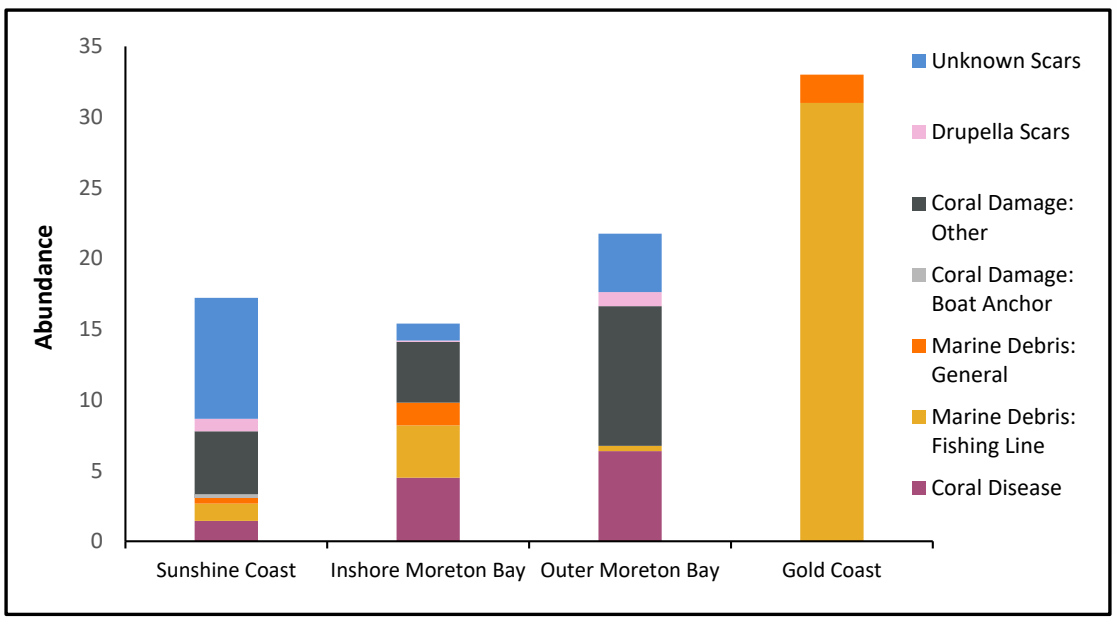


Figure 4. Average abundance of impacts per survey within the SEQ sub-regions.

1.0 Introduction

1.3 Key Findings

The 2016-17 survey season included the monitoring of 29 survey sites, including 28 existing monitoring locations. Amity Point, Site 2, in the Inshore Moreton Bay region was added to the list of survey sites during the 2016-17 season.

The Gold Coast Seaway sites are artificial structures where hard coral growth has never been recorded by RCA. The two sites within the Gold Coast Seaway are therefore excluded from hard coral cover and coral impacts analysis in this report.

Substrate

• Of the 25 sites surveyed in both the 2016-17 and 2015-16 season, only 2 sites experienced a decrease of 15-17% in hard coral cover compared to the 2015 season. HC cover remained stable (less than △10%) at 20 sites, and increased at 3 sites (△14-17%).

• Hard coral cover ranged from <1% (0.63%) at Green Island East, Site 1, in Inshore Moreton Bay to 71% at Flinders Reef Nursery, Site 2, in Outer Moreton Bay. The average hard coral cover across all surveyed sites was 26%.

• The most predominant substrate type recorded across all 29 surveys was rock, attributing an average of 33% to the benthos per survey. Rock, in this case, encompassed all RCA rock categories; rock (RC), rock covered with coralline algae (RCCA) and rock covered with turf algae (RCTA).

•The following 4 pages depict changes in coral cover over time at each site, and are categorised by sub-regions.

Coral bleaching

• Coral bleaching was recorded at 25 of the 29 sites (86% of the sites, compared to 77% in 2015). On average, 6% of the coral population was affected, with approximately 25% surface bleaching on individual colonies. These levels are on par with those recorded in 2015 (6% of the population and 24% individual colonies).

• Inner Moreton Bay sites had the highest regional bleaching average, impacting 11% population level on average. Inshore Moreton Bay also recorded the highest bleaching in SEQ in 2016 (13% of the coral population).

•In 2016, the Great Barrier Reef experienced mass coral bleaching; however, bleaching in SEQ was not as prominent compared to the northern reefs. The following 4 pages depict changes in coral bleaching over time at each SEQ site, and are categorised by sub-regions.

Images from top down: Close up of plate hard coral; Site photo (Mudjimba Island, North West Reef S1; Bleached hard coral.

1.0 Introduction

Sunshine Coast Regional Summary of Coral Trends and Bleaching

Hard coral cover in the Sunshine Coast has remained relatively constant over time. Similarly, all 2016-17 sites were relatively consistent regarding HC cover changes from the 2015 season, except Mudjimba Island North West Reef, which saw a 17% increase. Soft coral cover was within 5% of last season's records across this entire sub-region. In 2016-17 coral bleaching was recorded on 7 of the 9 sites (Figure 5). Kings Beach Reef exhibited the highest extent of bleaching in the Sunshine Coast region, with approximately 13% of the population affected. Inner Gneerings The Caves S2 and Mudjimba Northwest Reef S1 had no bleaching reported.

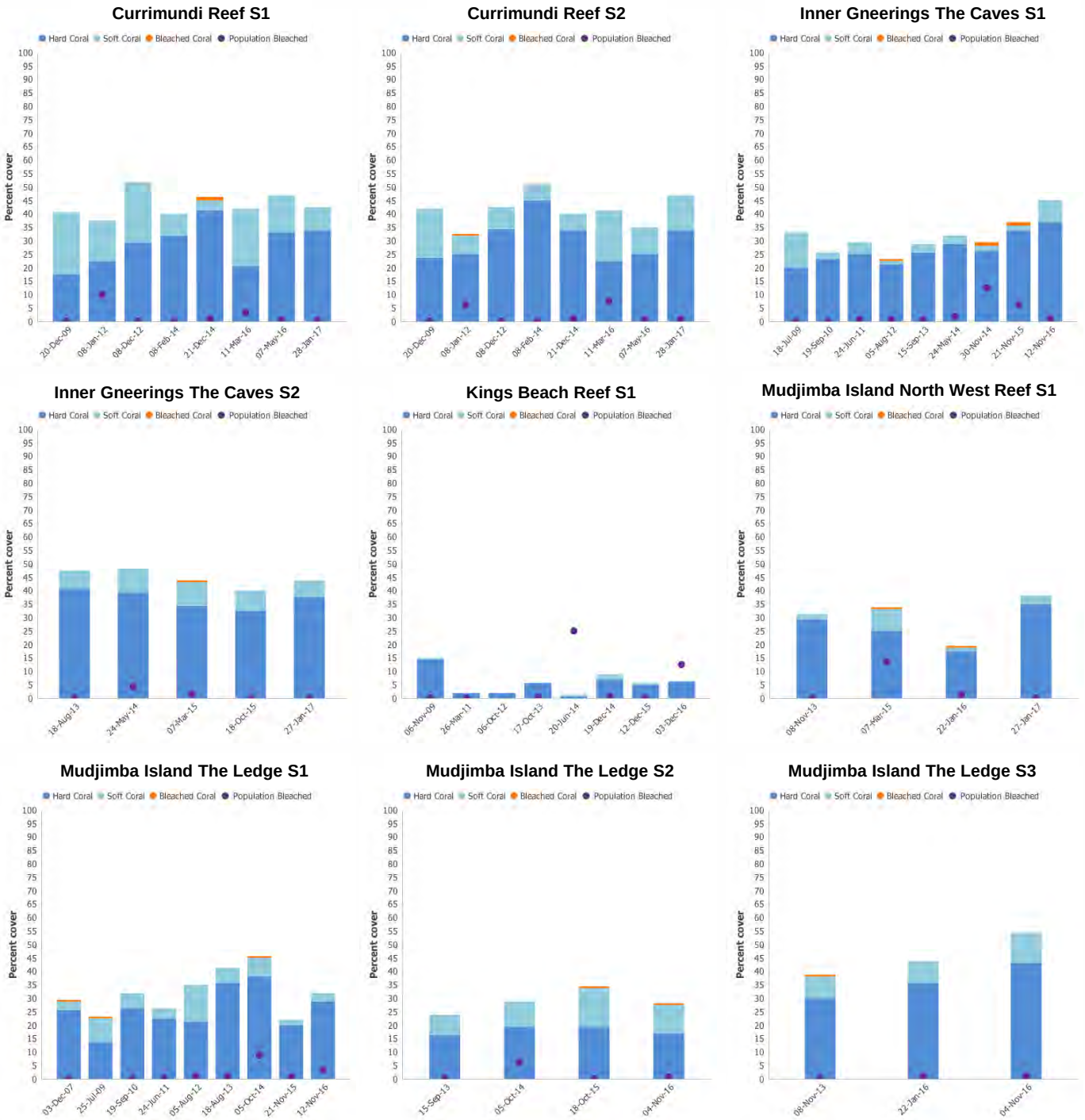


Figure 5. Percent cover of hard coral (blue), soft coral (light blue), and bleached coral (orange) by survey year at Sunshine Coast Reef Check Australia reef health monitoring sites, as per point-intercept substrate surveys for benthic composition. Percentage of the coral population exhibiting bleaching (purple dot), as documented on belt transect survey for reef health impacts, is included where available.

1.0 Introduction

Inshore Moreton Bay Regional Summary of Coral Trends and Bleaching

Both hard and soft coral cover saw substantial decreases in 2016-17 across the Inshore Moreton Bay sites compared to those sites also surveyed in 2015 (Goat Island 15% HC decrease, Myora Reef S2 17% HC decrease, Green Island East 22% SC decrease, Peel Island North 15% SC decrease). Coral bleaching was recorded on all 10 sites in this region (Figure 6). Green Island East, Site 1, exhibited the largest coral population bleaching at 38%. This is also the highest level of coral population bleaching for all SEQ Sites surveyed during the 2016-17 season. Amity Point, Myora Reef S2 and Peel Island North S1 tied for the lowest average coral population bleaching (1%) amongst the Inshore Moreton Bay survey sites.

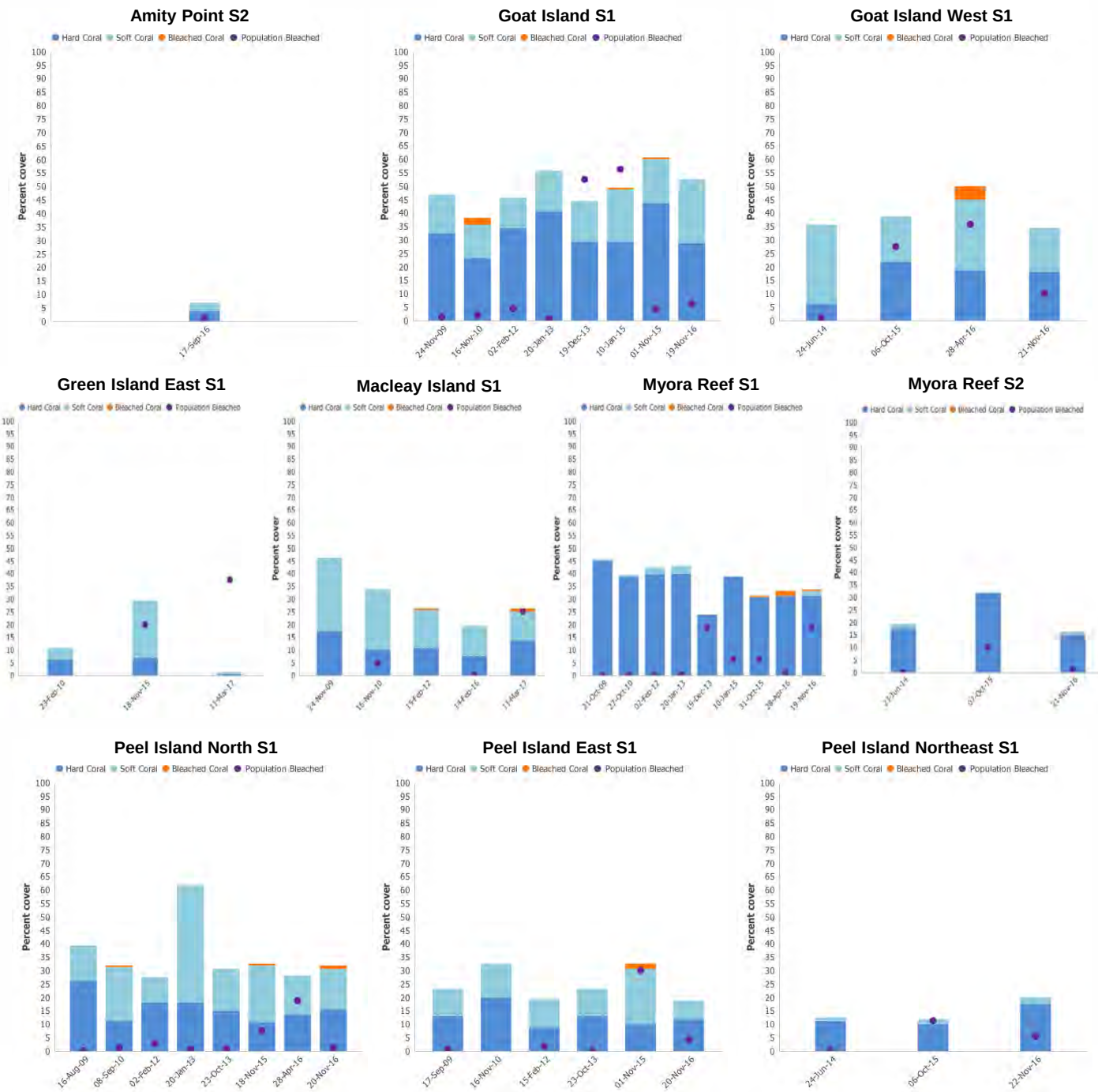


Figure 6. Percent cover of hard coral (blue), soft coral (light blue), and bleached coral (orange) by survey year at Inshore Moreton Bay Reef Check Australia reef health monitoring sites, as per point-intercept substrate surveys for benthic composition. Percentage of the coral population exhibiting bleaching (purple dot), as documented on belt transect survey for reef health impacts, is included where available.

1.0 Introduction

Outer Moreton Bay Regional Summary of Coral Trends and Bleaching

Hard and soft coral cover has remained relatively stable over the last 3 survey seasons (where applicable) in Outer Moreton Bay, with some sites seeing an increase in HC cover (e.g. Flat Rock Shark Alley). Compared to the 2015 season, Outer Moreton Bay saw an average increase in HC cover (14% at Flat Rock Shark Alley and 15% at Shag Rock East). Soft coral was recorded within 2% of last season's records across the entire region. Coral bleaching was recorded on all 8 sites in 2016-17 (Figure 7). Flat Rock Island, The Nursery, Site 1, portrayed the highest bleaching in this region, impacting approximately 13% of the coral population. The lowest bleaching levels were documented at Flinders Reef, The Nursery Site 2, where an average of 0.25% of the coral population, and only 1% of the colony's surface, was affected.

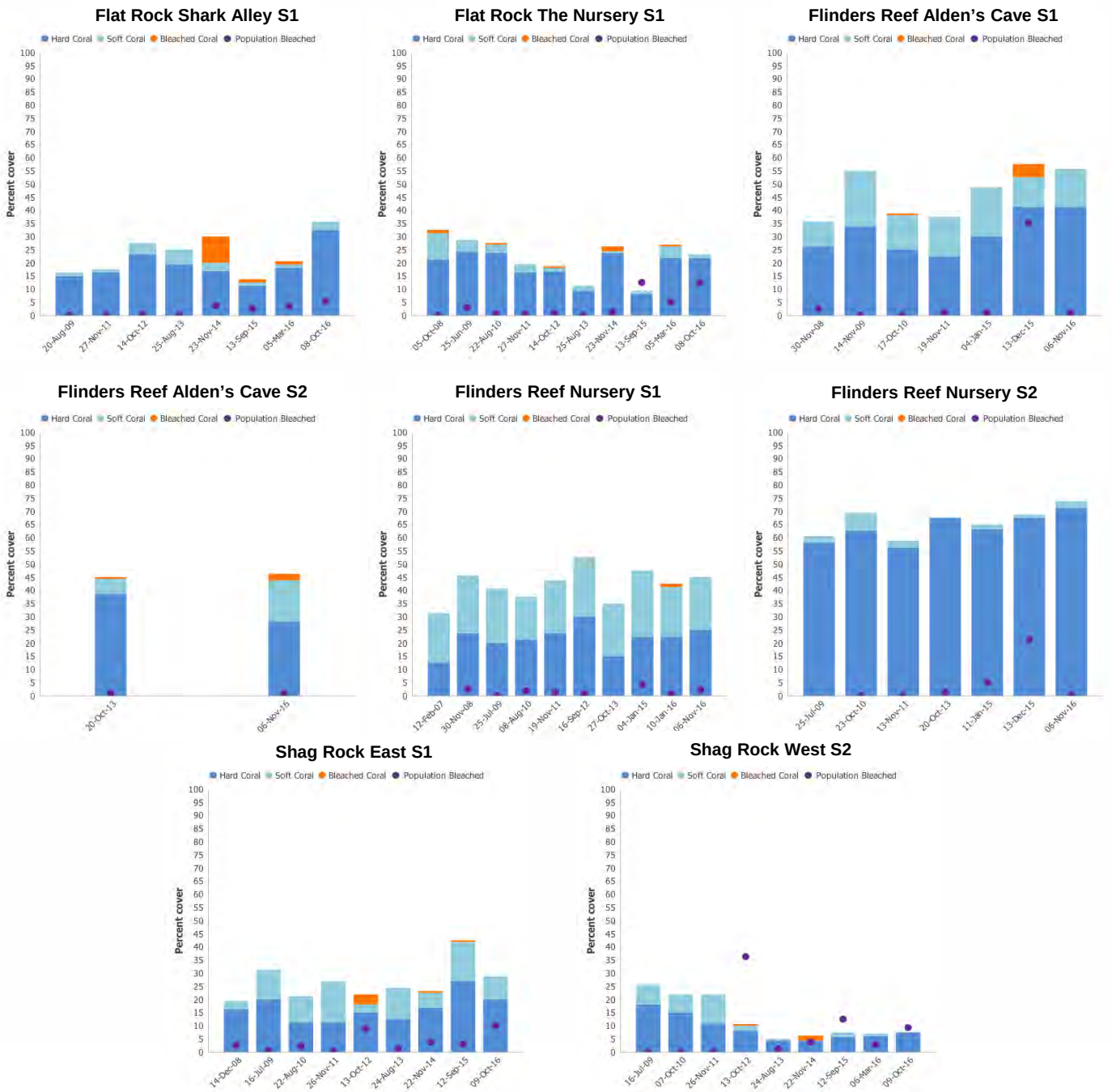


Figure 7. Percent cover of hard coral (blue), soft coral (light blue), and bleached coral (orange) by survey year at Outer Moreton Bay Reef Check Australia reef health monitoring sites, as per point-intercept substrate surveys for benthic composition. Percentage of the coral population exhibiting bleaching (purple dot), as documented on belt transect survey for reef health impacts, is included where available.

1.0 Introduction

1.3 Key Findings (Continued)

Coral damage

• A total of 162 incidents of coral damage (due to unknown causes) were recorded at 23 of the 29 sites. This equates to an average of 7 occurrences at each of the 23 noted sites. A maximum of 17 cases were recorded at Myora Reef, Site 1, with the lowest count of 1 incident at Mudjimba Island, North West Reef Site 1. An average of 7 reports of coral damage across 20 of the surveyed sites were similarly recorded in the 2015-16 season.

• Only 2 cases of boat anchor damage were recorded this season at Mudjimba Island, The Ledge Site 3, a reduction from the 36 total cases recorded in the 2015-16 season.

Coral disease

• 109 instances of coral disease were recorded at 13 of the 29 sites. This equates to an average of 8 occurrences at each of the 13 noted sites. Myora Reef, Site 1, had the highest disease count at 31, while only 1 case was recorded at Mudjimba Island, Northwest Reef Site 1. The total sum of diseases in 2016-17 nearly tripled that found in 2015 (40 cases in 2015).

Marine debris

• 137 items of marine debris were recorded during 17 surveys. The Gold Coast Seaway sites, Southwest Wall Site 1 and The Pipe, Site 1, had the highest totals of marine debris (33 counts each).

• Fishing line was found on 15 surveys, with 113 total incidents recorded. 33 of these were found at Gold Coast Seaway, The Pipe Site 1.

• One of the largest debris items recorded in 2016 was a push bike at Amity Point, Site 2.

Coral scarring

• Of the 134 coral scars recorded, 122 were of unknown origin, with the most recorded at Mudjimba Island, The Ledge Site 1 (32 incidents).

• *Drupella* sp. scars accounted for 17 total scars, and were found at 5 sites. Mudjimba Island, The Ledge Site 1, and Shag Rock East Site 1, tied for the highest counts of 7 scars each.

Images from top down: Damaged coral due to unknown causes; Marine debris: push bike; Scar from unknown causes.

Tables 5 and 6 on the subsequent pages display these key findings by survey name and sub-region.

1.0 Introduction

Table 5. Summary table of RCA monitoring findings for surveys conducted in Sunshine Coast and Inshore Moreton Bay in the 2016-2017 season. 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).

	Basic site summary					Presence of Impacts							
	Hard Coral Coverage (%)	Soft Coral Coverage (%)	Macroalgae (#) per 80m transect	Nutrient Indicator Algae (%)	Silt Loading	Coral Population Bleaching (%)	Coral Disease (#)	Fishing Line (#)	Marine Debris (General) (#)	Anchor Damage (#)	Coral Damage (#) (unknown causes)	*Drupella* Scar (#)	Unknown Scar (#)
Currumundi S1	34	9	50	5	L	<1	3	0	0	0	2	0	8
Currumundi S2	34	13	37	7	L	1	0	1	0	0	7	0	8
Inner Gneerings The Caves S1	37	8	17	0	N	1	7	0	0	0	6	1	15
Inner Gneerings The Caves S2	38	6	8	0	N	0	0	1	0	0	3	0	2
Kings Beach Reef S1	6	0	37	0	L	13	0	0	3	0	0	0	6
Mudjimba Island North West Reef S1	35	3	0	0	N	0	1	1	0	0	2	0	2
Mudjimba Island The Ledge S1	29	3	3	0	N	3	2	0	0	0	5	7	32
Mudjimba Island The Ledge S2	18	11	0	12	N	1	0	5	0	0	7	0	0
Mudjimba Island The Ledge S3	43	11	3	13	L	1	0	3	1	2	8	0	4
Amity Point S2	4	3	0	0	L	1	0	19	3	0	2	0	2
Goat Island S1	29	24	0	0	M	6	0	0	0	0	17	0	2
Goat Island West S1	18	16	0	0	H	10	4	5	7	0	5	0	1
Green Island East S1	1	1	19	1	M	38	0	0	2	0	0	0	0
Macleay Island S1	15	11	38	1	H	25	0	0	0	0	2	0	2
Myora Reef S1	32	2	3	0	L	19	31	1	0	0	9	1	0
Myora Reef S2	15	1	0	0	M	1	8	0	0	0	3	0	0
Peel Island North S1	17	15	12	6	H	1	0	3	1	0	3	0	0
Peel Island East S1	12	7	18	0	M	4	2	7	2	0	2	0	0
Peel Island Northeast S1	18	2.5	0	4	H	6	0	2	1	0	0	0	5

1.0 Introduction

Table 6. Summary table of RCA monitoring findings for surveys conducted in Outer Moreton Bay and Gold Coast in the 2016-2017 season. 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).

	Basic site summary					Presence of Impacts							
	Hard Coral Coverage (%)	Soft Coral Coverage (%)	Macroalgae (#) per 80m transect	Nutrient Indicator Algae (%)	Silt Loading	Coral Population Bleaching (%)	Coral Disease (#)	Fishing Line (#)	Marine Debris (General) (#)	Anchor Damage (#)	Coral Damage (#) (unknown causes)	Drupella Scar (#)	Unknown Scar (#)
Flat Rock Shark Alley S1	33	3	5	11	N	5	10	0	0	0	13	0	0
Flat Rock The Nursery S1	22	1	20	26	N	12	8	0	0	0	10	0	0
Flinders Reef Alden's Cave S1	41	14	28	1	N	1	3	0	0	0	0	0	3
Flinders Reef Alden's Cave S2	31	15	25	0	N	1	9	0	0	0	5	0	6
Flinders Reef Nursery S1	25	20	12	6	N	2	0	0	0	0	16	1	8
Flinders Reef Nursery S2	71	3	13	0	N	<1	18	0	0	0	5	0	1
Shag Rock East S1	20	9	0	16	L	10	3	2	0	0	15	7	12
Shag Rock West S2	8	0	0	29	L	9	0	1	0	0	15	0	3
Gold Coast Seaway SW Wall S1	0	0	24	0	H	0	0	29	4	0	0	0	0
Gold Coast Seaway The Pipe S1	0	0	0	0	H	0	0	33	0	0	0	0	0

1.0 Introduction

1.2 Key Findings (Continued)

Invertebrate Abundance

• *Diadema* long spined urchins were the most abundant indicator invertebrate recorded, totalling 208 individuals. Amity Point, Site 2, contributed 106 urchins to this count.

• Anemones were the second most abundant invertebrate with 69 present across 14 sites.

• Fifteen giant clams were recorded over the season with five recorded at Flinders Reef, Alden's Cave, Site 1. These records are identical to those from 2015.

• Across the 29 surveys, 1 banded shrimp, 3 pencil urchins, 13 collector urchins, 36 *Drupella* snails and 1 lobster were also recorded.

• No Crown of Thorns Starfish (COTS) were recorded during the 2016-17 survey season.

Fish Abundance

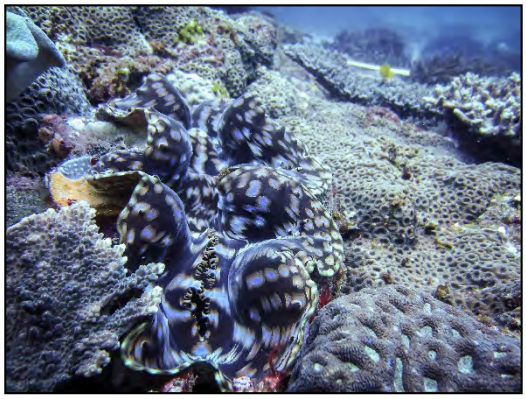
• Fish surveys were carried out on 20 of the 29 surveys.

• Butterflyfish were the most abundant target fish species with a total of 247 sightings. 54 of these were encountered at Myora Reef, Site 1, which also had the highest butterflyfish count in 2015.

• A total of 10 sweetlips, 9 snapper, 5 other parrotfish (not bumphead) and 15 moray eels were also recorded over the 20 fish surveys.

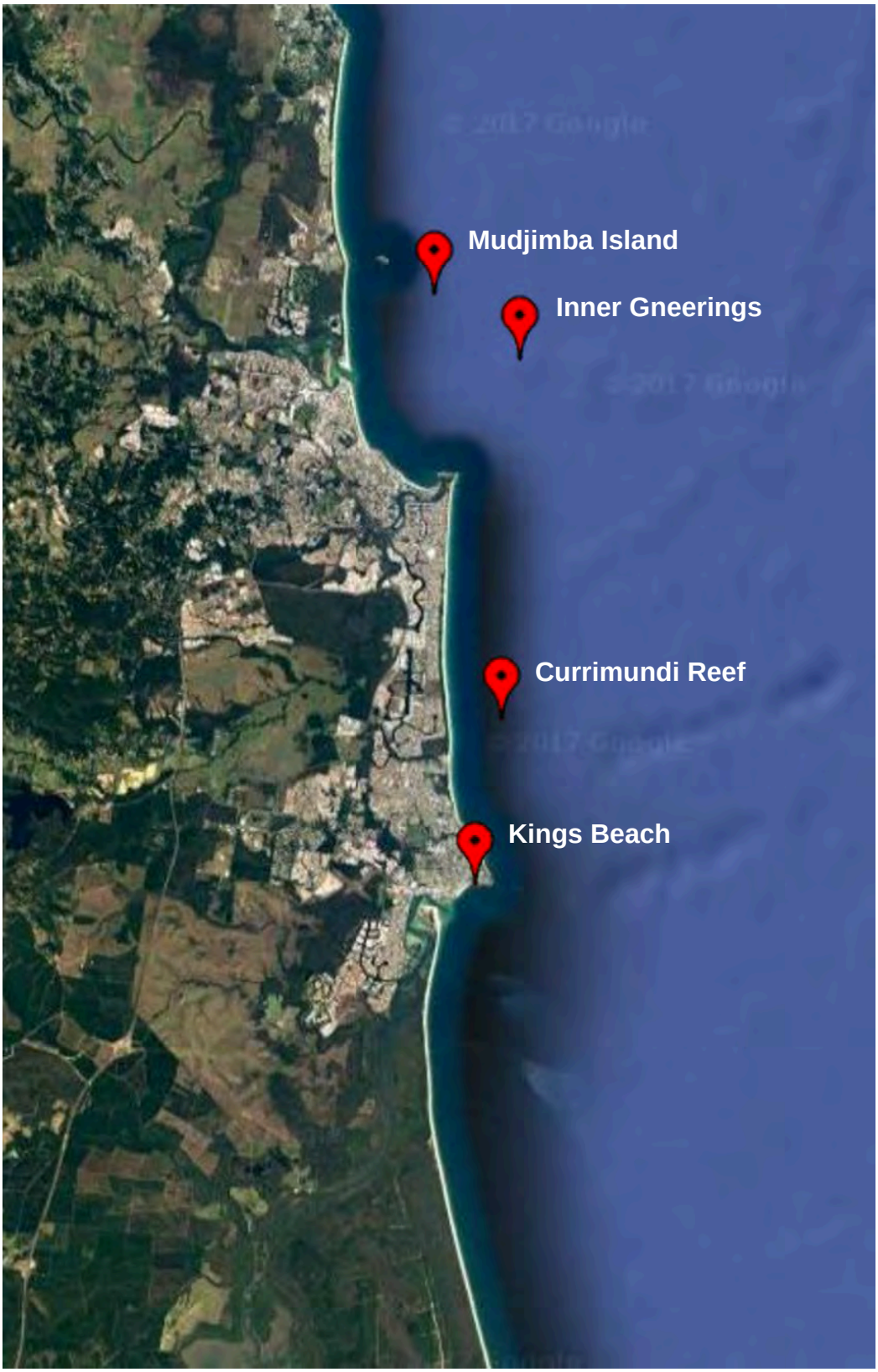
Rare animals

• Rare animals sighted during the surveys included wobbegong sharks (3), octopi (3), stonefish (3), cuttlefish (1), lionfish (1) and a nudibranch (1).



Images from top down: Giant Clam; Lobster; Cuttlefish.

2.0 Sunshine Coast



Map: Sunshine Coast, South East Queensland
Image courtesy of Google Earth

2.0 Sunshine Coast Sites

2.1 Currimundi Reef, Site 1

Soft coral & *Halimeda* Currimundi Reef, Site 1

Asparagopsis, Currimundi Reef, Site 1

Coral disease, Currimundi Reef, Site 1

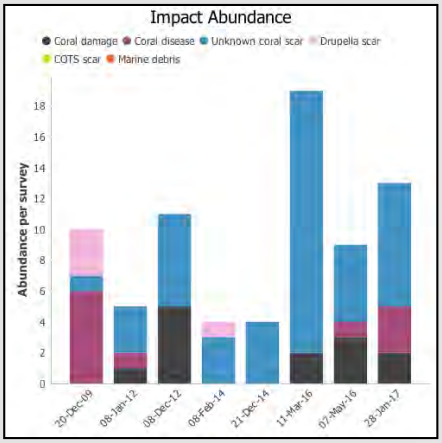


Figure 9. Impact abundance over time at Currimundi Reef, Site 1; 2009-2017.

Currimundi Reef is situated on the reef flat at nine meters on an exposed rocky outcrop off the Currimundi Coast. The site was first surveyed in 2009, strengthening the RCA spread of the southern Sunshine Coast reefs. This reef is not frequented by divers, fishers or boaters.

Hard coral made up 34% of the total substrate at the Currimundi Reef Site 1 (Figure 8); consistent with the 33% recorded in 2015. Encrusting growth forms attributed 70% of the hard coral total, with massive growth forms as the second largest contributor at 25%. Rock (including rock with turf algae and rock with coralline algae) accounted for 33% of the benthos. The 'other' benthic category (consisting primarily of ascidians and Halimeda) accounted for 14%, while soft coral made up an additional 9% of the benthic cover. *Asparagopsis* was the main macro algae recorded, totalling 50 counts along the transect.

The invertebrates noted at this site included 1 giant clam, and 2 anemones.

Bleaching affected less than 1% of the coral population and an average of 19% of individual coral colony surfaces. The impact survey additionally showed three counts of coral disease, two counts of coral damage (due to unknown causes) and 8 unknown scars (Figure 9).

A fish survey was carried out at this site, with 14 butterflyfish, 4 sweetlips and 6 snappers recorded.

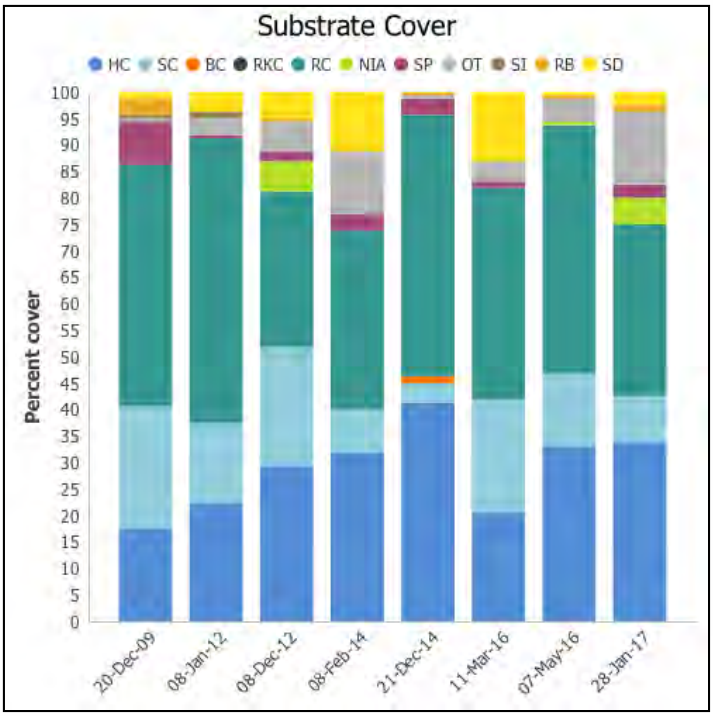


Figure 8. Benthic type and percent cover over time: Currimundi Reef, Site 1; 2009-2017.

2.0 Sunshine Coast Sites

2.2 Currimundi Reef, Site 2

Currimundi Reef, Site 2 is not frequented by divers, fishers or boaters, similar to Currimundi Site 1. Site 2 is located at 9 meters on the reef flat on the western side of Currimundi Reef, Site 1, and was also established in 2009.

Hard coral cover increased from 25% in the 2015-16 season to 34% in the 2016-17 survey season (Figure 10). Encrusting growth forms dominated this site (similar to Currimundi Site 1), contributing 69% of all hard coral cover. Rock (including rock with turf algae and rock with calcareous algae) was the second dominant substrate, accounting for 28% of the benthos. Soft coral made up 13%, a 3% increase from 10% in the 2015-2016 season. 'Other' benthos was mainly composed of *Halimeda* and attributed 12% to the substrate composition. The remaining benthos included 5% sand cover and >1% of rubble and sponge. 37 counts of macro algae were recorded at this site.

RCA indicator invertebrates recorded along the transect consisted of 8 anemones, 1 lobster and 1 *Diadema* long spined urchin.

Less than 1% of the overall coral population was recorded as bleached; however, the affected individual colonies were 54% bleached on average. 1 fishing line, 7 cases of coral damage (due to unknown causes) and 8 unknown scars were also recorded (Figure 11).

A fish survey was completed, where 6 butterflyfish, 1 sweetlips and 1 snapper were spotted.

Site photo, Currimundi Reef, Site 2

Bleached hard coral, Currimundi Reef, Site 2

Surveyors in action, Currimundi Reef, Site 2

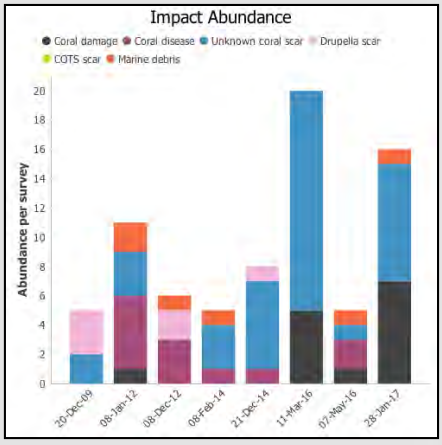


Figure 11. Impact abundance over time at Currimundi Reef, Site 2; 2009-2017.

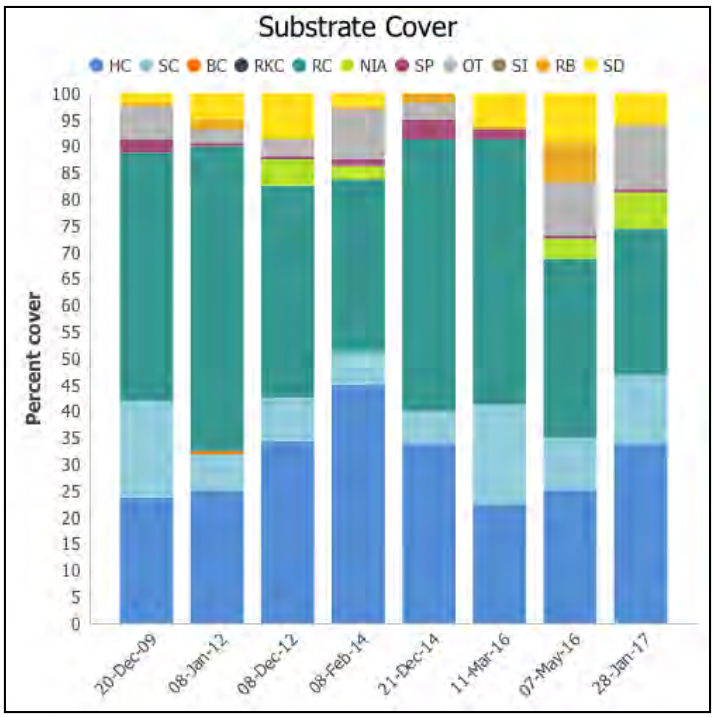


Figure 10. Benthic type and percent cover over time: Currimundi Reef, Site 2; 2009-2017.

2.0 Sunshine Coast Sites

2.3 Inner Gneerings, The Caves, Site 1

Site photo, The Caves, Site 1

Sponge, The Caves, Site 1

Surveyors in action, The Caves, Site 1

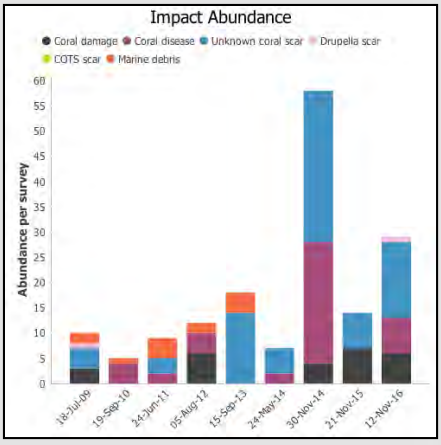


Figure 13. Impact abundance over time at Inner Gneerings, The Caves, Site 1; 2009-2016.

The Caves, Site 1, at Inner Gneerings is situated offshore from Mooloolaba and covers a wide area of depths from 10 to 25m. Site 1 is located at 10 meters depth on the reef floor, and is characterised by scattered rocky outcrops surrounded by coral, sponge and a collapsed cave structure. This site is popular for recreational fishing and diving. RCA has surveyed this site annually since 2009.

Rock has previously dominated the benthos at this site; however, this year hard coral overtook, making up 37% of the substrate (Figure 12). This was a 2% increase in hard coral cover from 2015, and a 17% increase from the initial survey in 2009 (20% hard coral). Sand attributed 27% (previously 10% in 2015), and rock (including rock with turf algae and rock with calcareous algae) fell to 24% (previously 49%). Encrusting hard coral continues to be the dominant growth form, composing 63% of the hard coral cover. 17 counts of macro algae were recorded this season.

Two *Diadema* long spined urchins were the only indicator invertebrates documented on the transect.

Bleaching affected 1% on the coral population, and only 8% of the affected individual coral colonies (a notable decrease from 48% of individual colonies in 2015). Additional impacts included 7 counts of disease, 6 counts of unknown coral damage, 1 *Drupella* scar and 15 unknown scars (Figure 13).

A fish survey was completed at this site, with 24 butterflyfish and 1 snapper recorded. A moray eel was also spotted at this site.

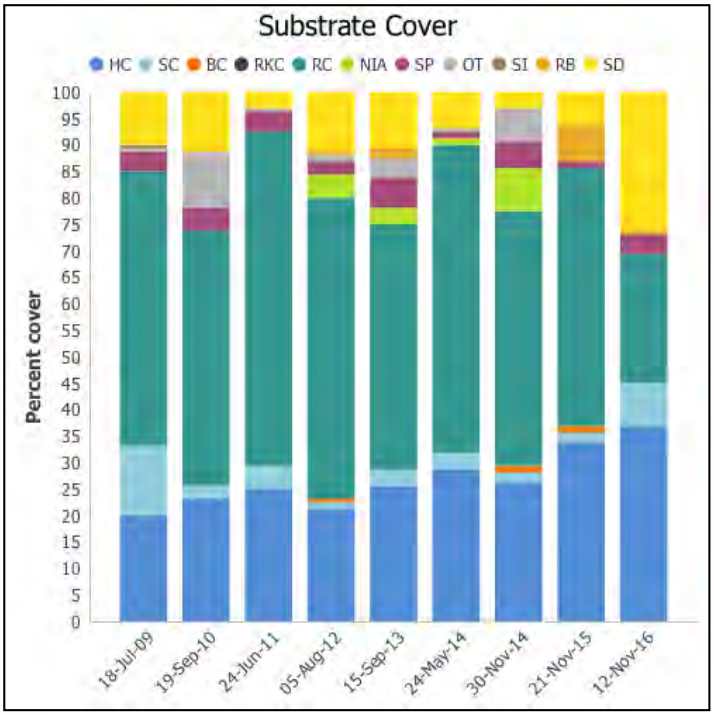


Figure 12. Benthic type and percent cover over time: Inner Gneerings, The Caves, Site 1; 2009-2016.

2.0 Sunshine Coast Sites

2.4 Inner Gneerings, The Caves, Site 2

Site photo, The Caves, Site 2

Hard coral encrusing, The Caves, Site 2

Phyllidia picta nudibranch, The Caves, Site 2

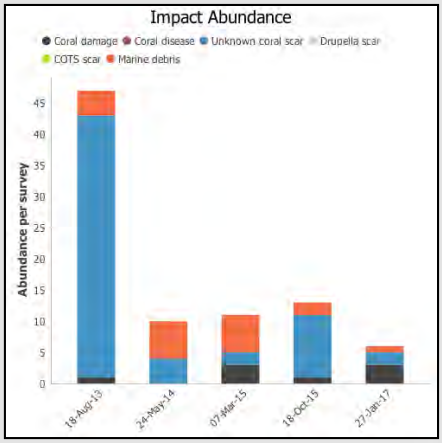


Figure 15. Impact abundance over time at Inner Gneerings, The Caves, Site 2; 2013-2017.

The Caves, Site 2, is situated approximately 150m parallel to Site 1, also at 10m. This site has been surveyed annually since it was added to the RCA list in 2013. RCA added Site 2 in order to better understand this highly utilised reef structure.

The substrate at The Caves, Site 2, has remained relatively consistent since 2013 (Figure 14), with hard coral (38%), rock (including rock with turf algae and rock with calcareous algae) (33%) and sand (14%) making up the majority of the benthos in 2016-17. 80% of the hard coral cover was composed of encrusting growth forms, with plate and branching growth forms attributing approximately 18% of the remaining hard coral. The 'other' substrate category contributed 3%, and was comprised of ascidians. 8 counts of macro algae were noted at this site.

One anemone was the only target invertebrate recorded this season.

No bleaching was recorded at this site in the 2016-2017 season, consistent with 2015 findings. Impacts at this site were comprised of one fishing line, 3 incidents of unknown coral damage and 2 unknown scars (Figure 15).

A fish survey was completed at Site 2, where 12 butterflyfish and one moray eel were seen. A wobbegong shark also made an appearance along the transect.

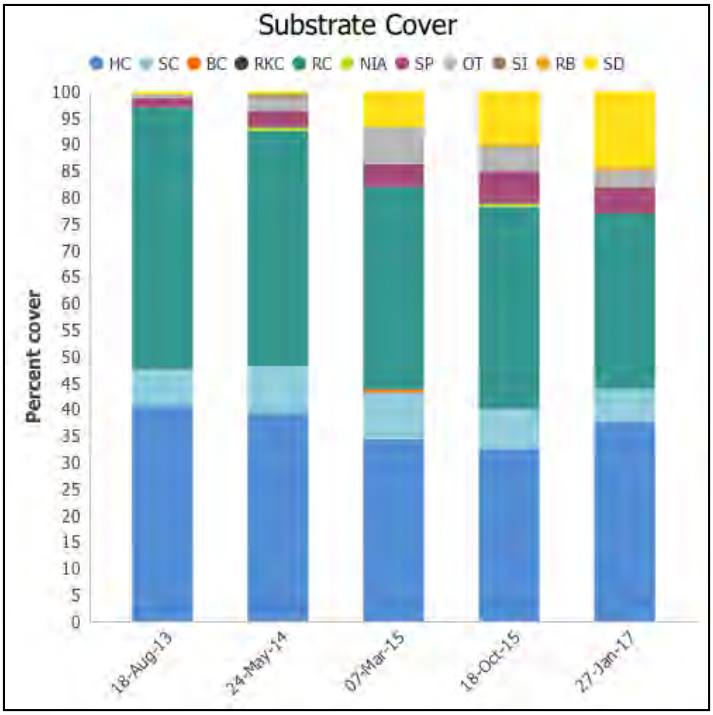


Figure 14. Benthic type and percent cover over time: Inner Gneerings, The Caves, Site 2; 2013-2017.

2.0 Sunshine Coast Sites

2.5 Kings Beach, Site 1

Kings Beach Reef is located approximately 100m offshore, adjacent to a frequently utilized boat ramp and near to Caloundra's popular beach front area. Site 1 is situated at a depth of three meters, and was added to the RCA reef health survey list in 2009. In 2011, this location was exposed to a flood plume resulting from the major SEQ flooding event. Data collected shortly after this event showed a dramatically reduced hard coral population (from 14% to 2%). Annual monitoring efforts have shown signs of recovery over time, and continued monitoring is required to document potential changes in the future.

Hard corals accounted for 6% of the benthos (Figure 16); comprised of encrusting (90%) and plate (10%) growth forms. Rock (including rock with turf algae and rock with calcareous algae) attributed 76% to the substrate in 2016. Sand made up 14%, and the 'other' category (consisting primarily of crustose algae and the sea squirt, Cunjevoi) accounted for an additional 3%. Macro algae counts totalled 37 at this site.

Five urchins were recorded in 2016; 3 *Diadema* long spined urchins and 2 collector urchins.

Bleaching affected approximately 13% of the coral population, with individual colonies displaying 60% bleaching on average. This is a substantial increase from no recorded bleaching in 2015. Three general marine debris items and 6 unknown scars were documented as additional impacts (Figure 17).

A fish survey was not conducted at this site in 2016.

Site photo, Kings Beach, Site 1

Hard coral encrusting, Kings Beach, Site 1

Collector urchin, Kings Beach, Site 1

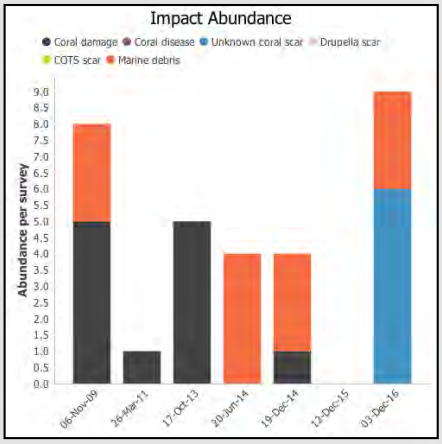


Figure 17. Impact abundance over time at Kings Beach, Site 1; 2009-2016.

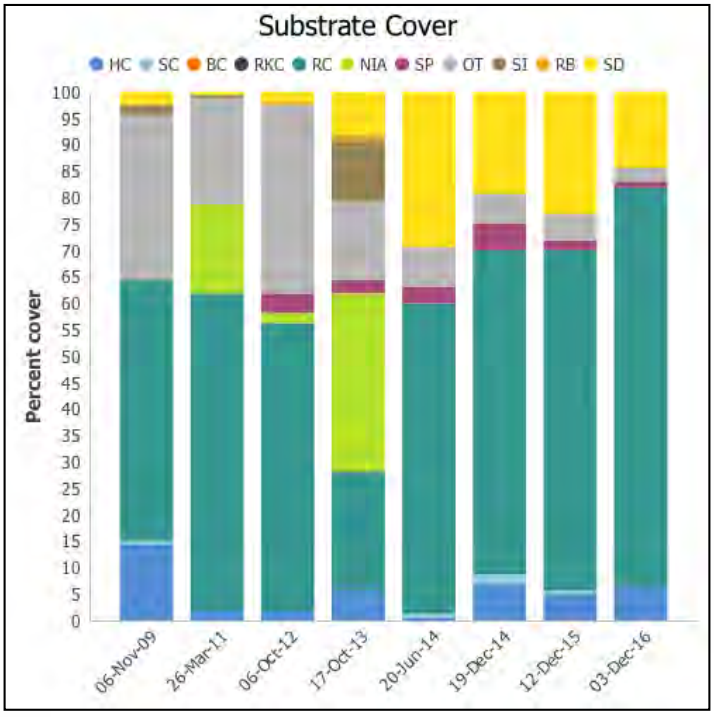


Figure 16. Benthic type and percent cover over time: Kings Beach, Site 1; 2009-2016.

2.0 Sunshine Coast Sites

2.6 Mudjimba Island, North West Reef, Site 1

Mudjimba Island is located just off the mainland, close to Maroochydore and the Mooloolah River Mouth. It is a highly visited area, popular for in-water activities. RCA began surveying this site in 2013 to attain more information about this frequented reef. This site faces the northwest side of the island, and is situated at a depth of eight meters. It varies substantially from the southern survey sites, offering new perspective of this culturally and ecologically important location.

Rock (including rock with turf algae and rock with calcareous algae) was the most prominent substrate with 51% benthos coverage (Figure 18). Hard coral accounted for 35%, an increase from 18% in the 2015-2016 season. Encrusting growth forms dominated the hard coral (80%) recorded in 2017. Sand (8%), soft coral (3%) and sponge (2%) made up the majority of the remaining substrate cover. No macro algae has been recorded at this site since 2013.

Two anemones were the only RCA invertebrates recorded; however, one spiny lobster was spotted just after the end of the transect.

No coral bleaching was recorded at this site in 2017; this is a decrease from the previous two survey seasons (2014 and 2015), where 14% and 1% of the coral population experienced bleaching. Impacts noted at this site included one diseased coral, 1 fishing line, 2 counts of unknown coral damage and 2 unknown scars (Figure 19).

A fish survey was conducted, documenting 4 butterflyfish and 2 moray eels.

Site Photo, North West Reef, Site 1

Rock and hard coral, North West Reef, Site 1

Moray eel, North West Reef, Site 1

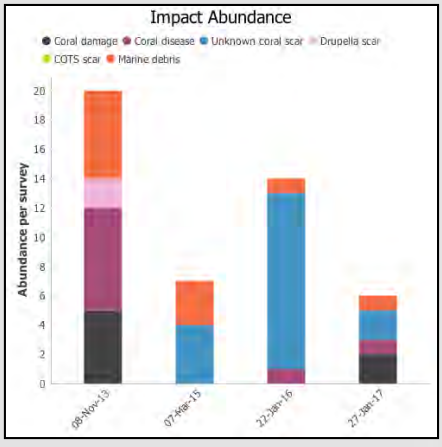


Figure 19. Impact abundance over time at Mudjimba Island, North West Reef, Site 1; 2013-2017.

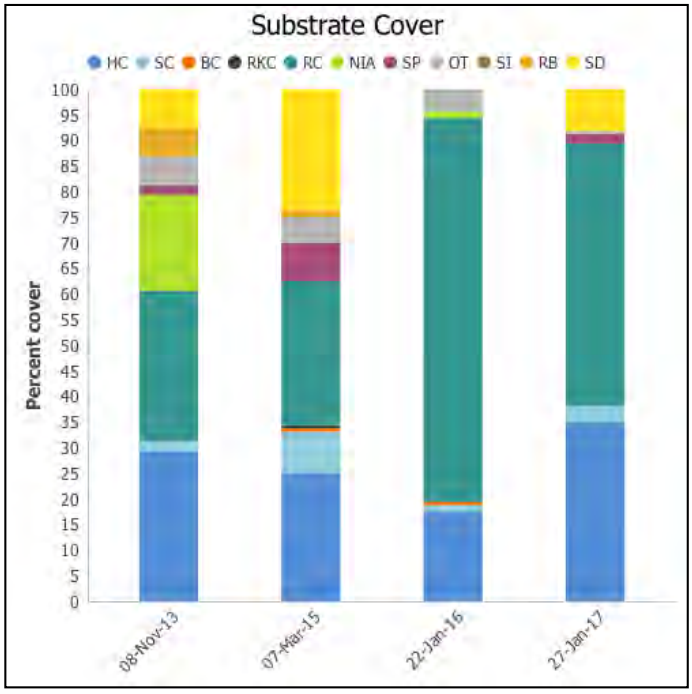


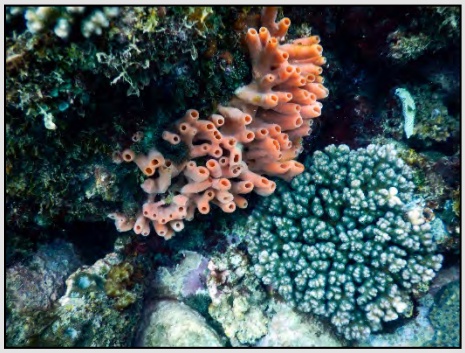
Figure 18. Benthic type and percent cover over time: Mudjimba Island, North West Reef, Site 1; 2013-2017.

2.0 Sunshine Coast Sites

2.7 Mudjimba Island, The Ledge, Site 1

Site photo, The Ledge, Site 1

Linckia laevigata Sea Star, The Ledge, Site 1



Sponge, The Ledge, Site 1

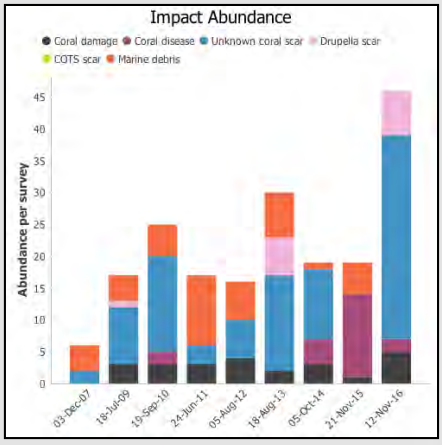


Figure 21. Impact abundance over time at Mudjimba Island, The Ledge, Site 1; 2007-2016.

The Ledge, Site 1, at Mudjimba Island also lays within the region frequented for a variety of in water activities such as fishing, diving and surfing. It is situated on the southern side of Mudjimba Island at 5 meters depth on the reef flat.

Hard coral (consisting primarily of encrusting growth forms (65%)) represented 29% of the total substrate cover in 2016, an increase from 20% recorded in 2015 (Figure 20). Rock (including rock with turf algae and rock with calcareous algae) accounted for 48%. Sand (9%), 'other' substrate (comprised of anemones, corallimorphs and Cunjevoi) (7%), soft coral (3%), sponges (3%) and rubble (1%) also contributed to the benthic surface. 3 counts of macro algae were recorded in 2016, the first time that macro algae has been documented at this site since 2009.

17 *Drupella* snails and two anemones were only indicator invertebrates noted this season.

3% of the coral population was bleached, and the affected individual colonies portrayed an average of 18% surface bleaching. This is comparable to the bleaching levels in 2015 (1% coral population and 19% colony surfaces). Additional impacts at this site consisted of 2 diseased corals (decrease from 14 counts in 2015), 5 counts of unknown damage, 7 *Drupella* sp. scars and 32 unknown scars (Figure 21).

A fish survey was not completed in the 2016-17 season.

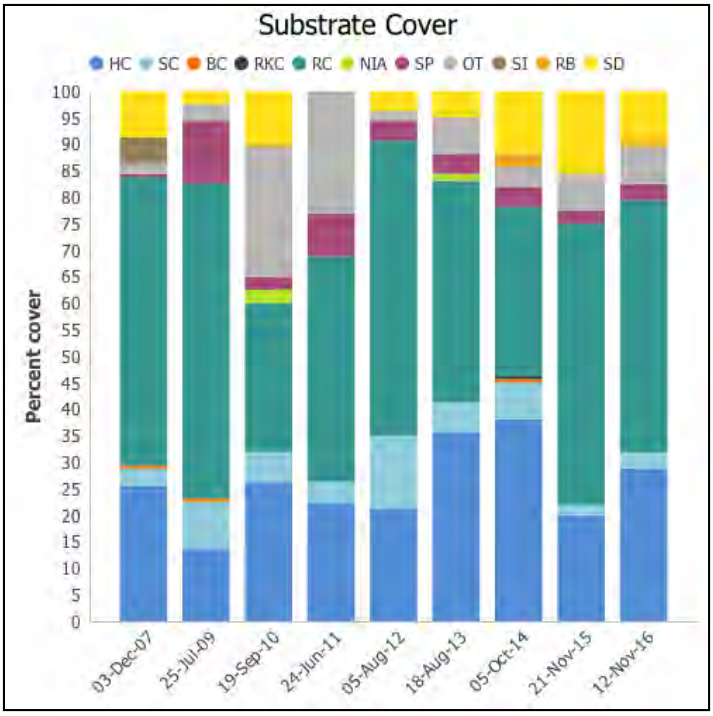
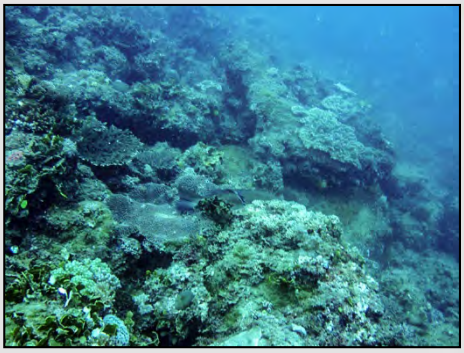


Figure 20. Benthic type and percent cover over time: Mudjimba Island, The Ledge, Site 1; 2007-2016.

2.0 Sunshine Coast Sites

2.8 Mudjimba Island, The Ledge, Site 2



Site photo, The Ledge, Site 2

Anemone, The Ledge, Site 2

Nudibranch, The Ledge, Site 2

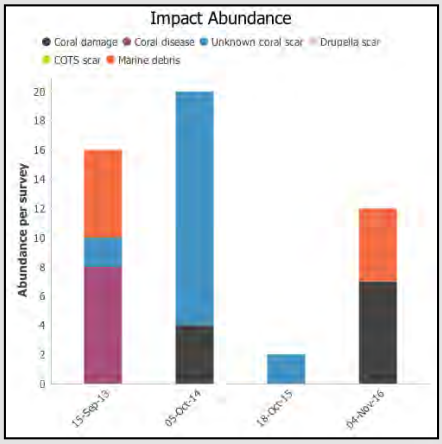


Figure 23. Impact abundance over time at Mudjimba Island, The Ledge, Site 2; 2013-2016.

The Ledge, Site 2, was established in 2013 to gather more information about this popular locale for in-water activities. Site 2 is parallel to Site 1 on the southern side of Mudjimba Island, and lays at 9 meters on the reef slope. This deeper location represents a different habitat type to the long-established research Site 1.

Rock (including rock with turf algae and rock with calcareous algae) was the dominant substrate at 46% (Figure 22) Hard coral accounted for 18% of the benthos, similar to the records in the previous years (20% in 2015 and 19% in 2014). Hard coral cover was comprised mainly of encrusting growth forms (72%). The remaining benthos was made up of 'other' substrate (Halimeda, calcareous algae and corallimorphs) (12%), nutrient indicator algae (12%), soft coral (11%), sponge (1%) and sand (<1%). No macro algae was recorded.

One *Diadema* long spined urchin and 3 anemones were the only invertebrates recorded at Site 2.

Less that 1% of the coral population was bleached, with those colonies affected only exhibiting 5% surface bleaching. Five pieces of fishing line and 7 counts of damage (due to unknown causes) were the only other impacts recorded in 2016 (Figure 23).

A fish survey was completed; 12 butterflyfish and 4 sweetlips were recorded.

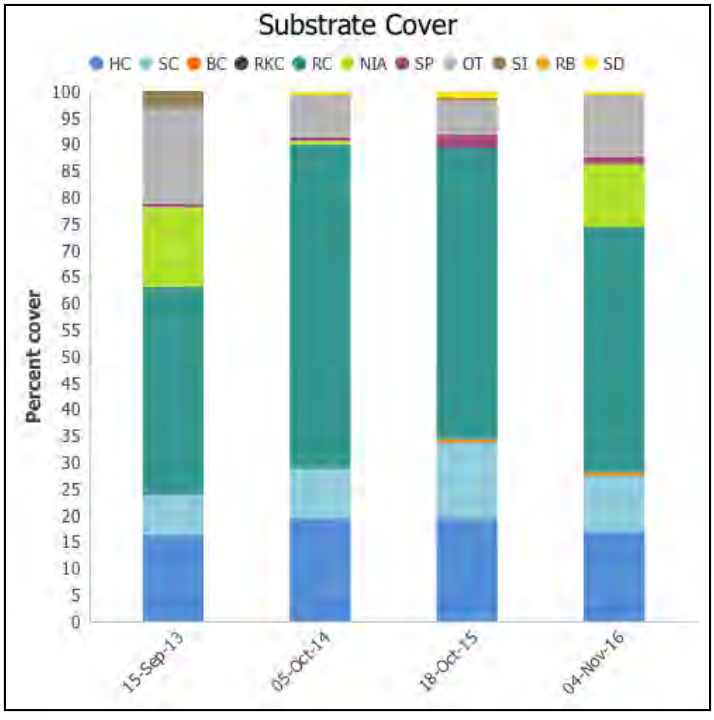


Figure 22. Benthic type and percent cover over time: Mudjimba Island, The Ledge, Site 2; 2013-2016.

2.0 Sunshine Coast Sites

2.9 Mudjimba Island, The Ledge, Site 3

Site photo with butterflyfish, The Ledge, Site 3

Anemone with fish, The Ledge, Site 3

Moray eel, The Ledge, Site 3

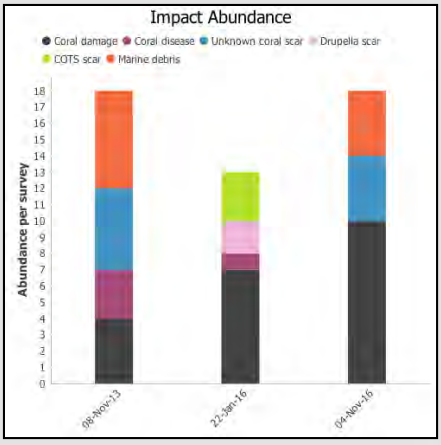


Figure 25. Impact abundance over time at Mudjimba Island, The Ledge, Site 3; 2013-2016.

The Ledge, Site 3, was established in 2013, the same year Site 2 was added. This third site expanded RCA survey area to more fully understand and monitor this highly utilised area around Mudjimba Island. Site 3 sits on the southern side of the island at 6 meters on the reef slope, located between the shallow Site 1 and the deep Site 2. Despite their close proximity, Site 3 represents a habitat type different to Site 1 and Site 2.

Hard coral was the predominant benthos, accounting for 43% this season (an increase from 36% in the 2015-2016 season) (Figure 24). Hard coral cover was comprised of mainly of encrusting growth forms (56%), along with branching and massive growth forms (40% combined). Rock (including rock with turf algae and rock with calcareous algae) contributed to 23% of the substrate, while nutrient indicator algae (13%), soft coral (11%), 'other' substrate (crustose algae, hydroids, 1 anemone and 1 ascidian) (9%) and sponge (1%) made up the remaining benthic cover. Three counts of macro algae were recorded, an immense decrease from the 40 counts documented in 2015.

Indicator invertebrates documented in the 2016-17 season included 3 *Diadema* urchins and 2 anemones.

Similar to Site 2, coral bleaching was recorded in low levels at Site 3, with 1% of the coral population and 13% per individual affected colony exhibiting signs of bleaching. This site had a number of other impacts including one fishing line, one general marine debris item, 2 incidents of anchor damage, 8 counts of unknown damage and 4 unknown scars (Figure 25).

A fish survey recorded 6 butterflyfish and 9 moray eels in 2016.

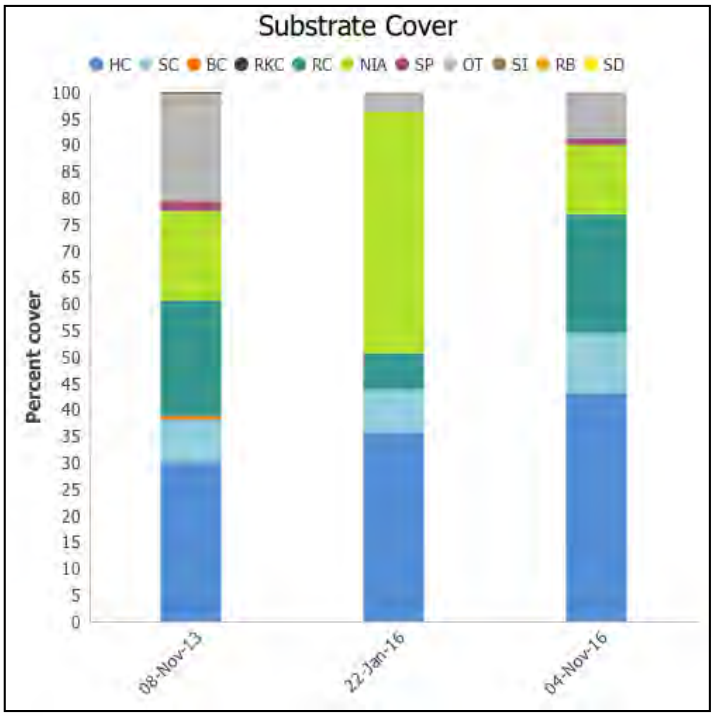
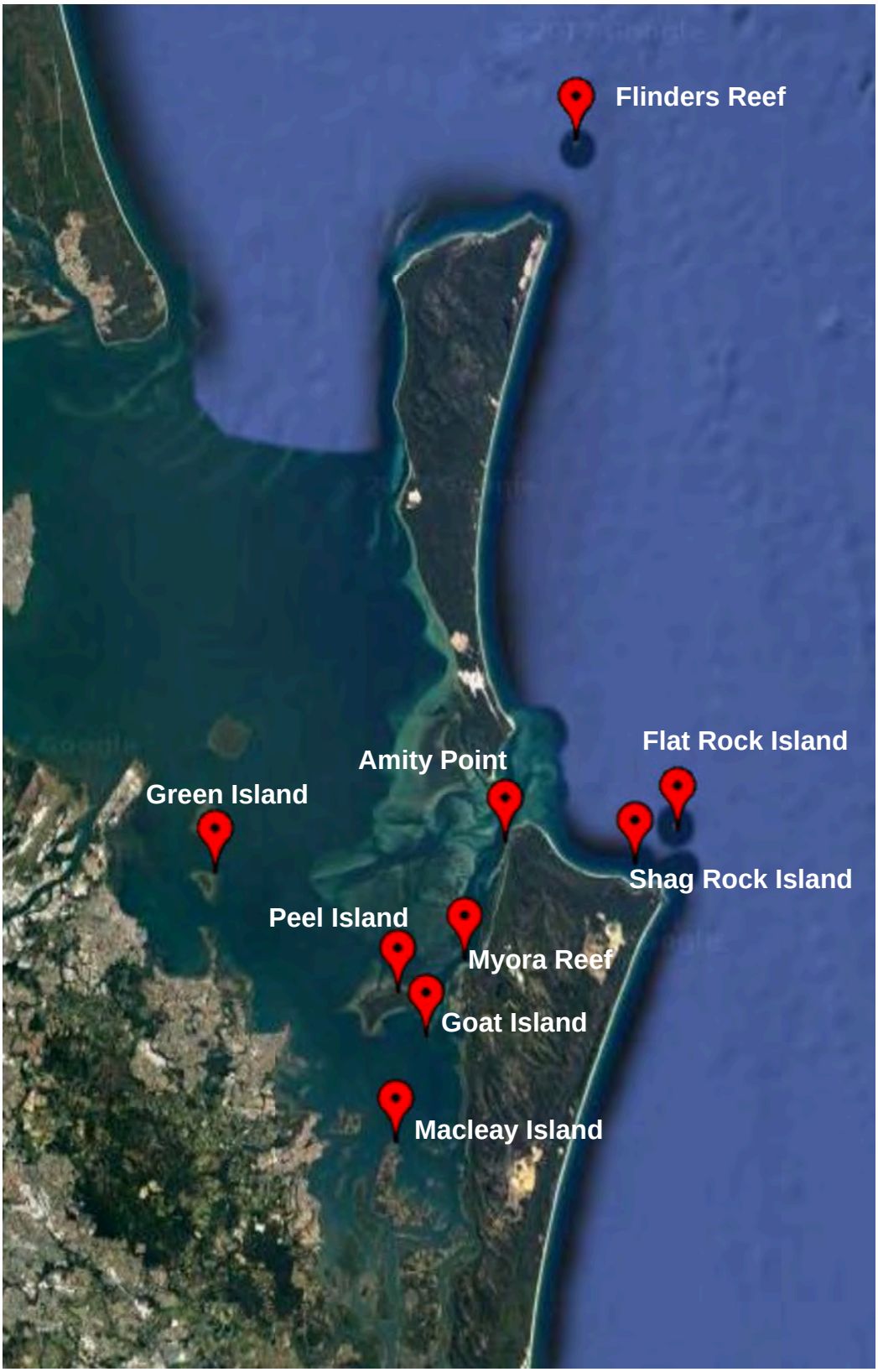


Figure 24. Benthic type and percent cover over time: Mudjimba Island, The Ledge, Site 3; 2013-2016.

3.0 Moreton Bay

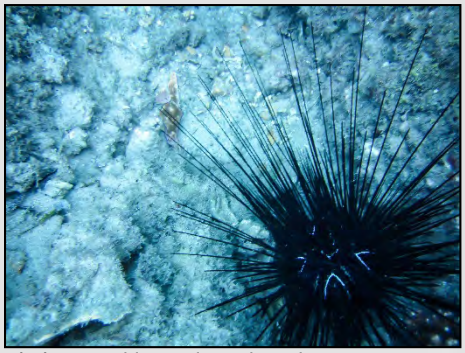


Map: Moreton Bay, South East Queensland
Image courtesy of Google Earth

3.0 Inshore Moreton Bay Sites

3.1 Amity Point, Site 2

Site photo, Amity Point, Site 2



Diadema urchin, Amity Point, Site 2

Push bike (marine debris), Amity Point, Site 2

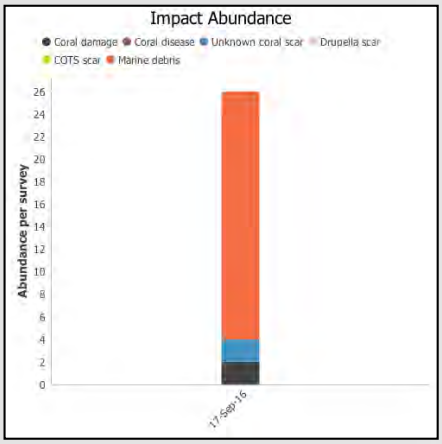


Figure 27. Impact abundance Amity Point, Site 2; 2016.

Amity Point, Site 2, was newly established in the 2016-17 season. It is located on the southwest end of North Stradbroke Island, and is frequented by vast numbers of fishers, boaters and divers all year round. The site begins at the public boat ramp and continues along the artificial rock wall near a popular camping and fishing ground. This site was added to better understand and record impacts on this heavily utilized area. The site is situated on the back reef wall at a shallow depth of 2 meters, above the deeper Site 1.

Sand covered the majority of the site (60%), followed by 25% rock cover (including rock with turf algae) (Figure 26). 'Other' benthos included shells and urchins, composing 6% of the substrate. Hard coral (4%) included 3 general hard coral growth forms, 2 branching and 1 encrusting. Soft coral (3%), sponge (2%) and rubble (<1%) were also recorded in the substrate composition. No macro algae was recorded at this site.

Two collector urchins and 106 *Diadema* long spined urchins were recorded for the invertebrate survey.

Bleaching was noted for approximately 1% of the coral population, and 10% of the surfaces of affected individual coral colonies. Low coral abundance may have also had an influence on overall coral bleaching findings. Additional impacts discovered at this site were 19 counts of fishing line, 3 bits of general marine debris (including a push bike!), 2 incidents of unknown coral damage and 2 unknown scars (Figure 27).

A fish survey was not conducted during the 2016-17 season.

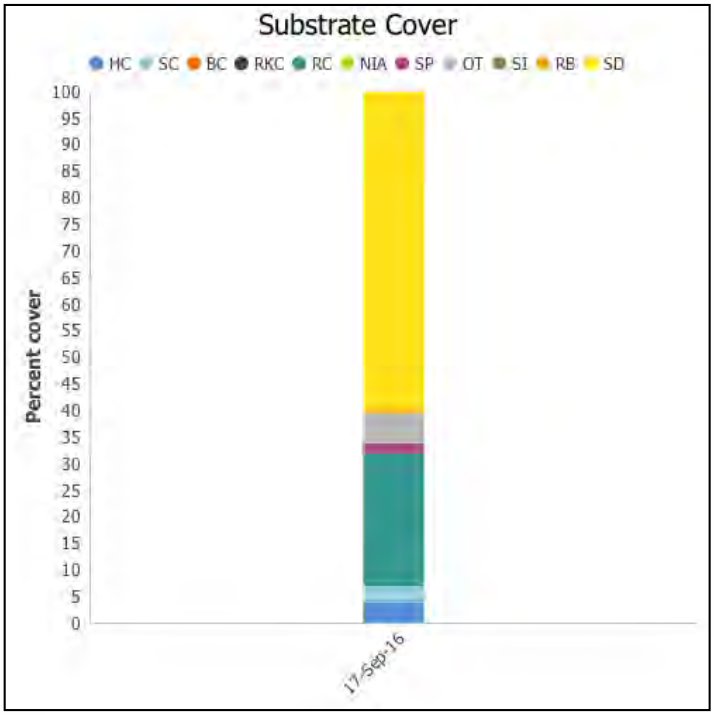


Figure 26. Benthic type and percent cover: Amity Point, Site 2, 2016.

3.0 Inshore Moreton Bay Sites

3.2 Goat Island, Site 1

Goat Island is situated between North Stradbroke Island and Peel Island in Moreton Bay. A shallow sand reef fringes the island. A boat channel lays adjacent to the Site 1 on the eastern side of the island, frequented by North Stradbroke Island ferries. The site's proximity to this channel, and its shallow depth (approximately one meter) means that it is exposed to regular traffic and induced surge. Site 1 was established in 2009 to monitor this highly trafficked area.

Hard coral composed 29% of the substrate cover, a 15% decrease from the 44% recorded in 2015 (Figure 28), and consisted primarily of branching growth forms (65%). Soft coral cover increased by 8% to 24% in 2016, compared to 16% cover in 2015. The remaining benthos included sand (15%), rock (including rock with turf algae and rock with calcareous algae) (14%), silt (15%), rubble (6%) and recently killed coral (1%).

One *Drupella* snail was recorded, the second invertebrate sighted at this location since 2010 (1 other *Drupella* in 2014).

Approximately 6% of the coral population was affected by bleaching (a consistent finding to 2015). The average bleaching on individual colonies was 45% (also similar to 49% in 2015). 17 counts of unknown damage and 2 unknown scars added to the list of impacts at this site (Figure 29).

A fish survey was conducted in 2016, documenting 20 butterflyfish.

Soft coral, Goat Island, Site 1

Hard coral foliose, Goat Island, Site 1

Soft coral and sponge, Goat Island, Site 1

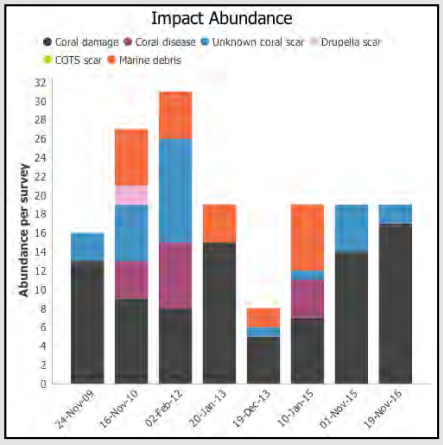


Figure 29. Impact abundance over time at Goat Island, Site 1; 2009-2016.

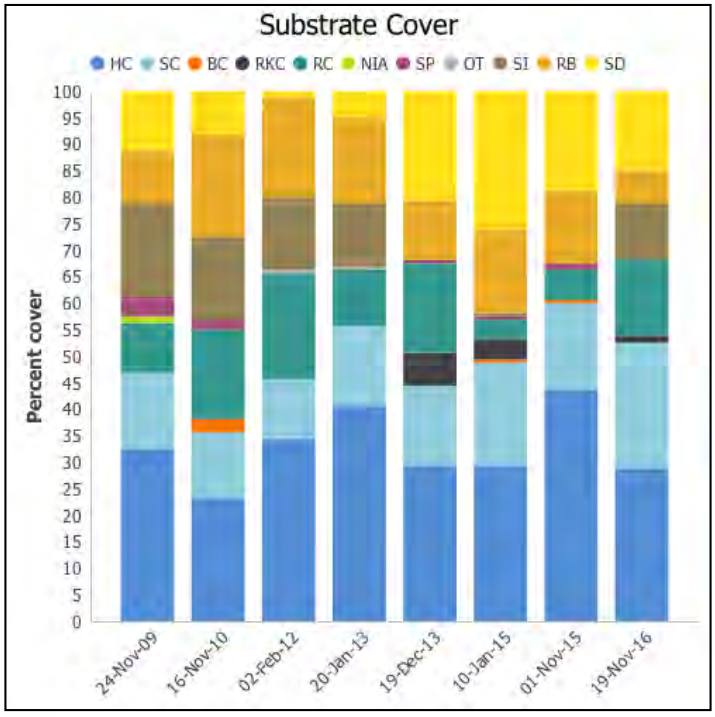


Figure 28. Benthic type and percent cover over time: Goat Island, Site 1; 2009-2016.

3.0 Inshore Moreton Bay Sites

3.3 Goat Island West, Site 1

Site photo, Goat Island West, Site 1

Hard coral bleaching, Goat Island West, Site 1

Coral damage, Goat Island West, Site 1

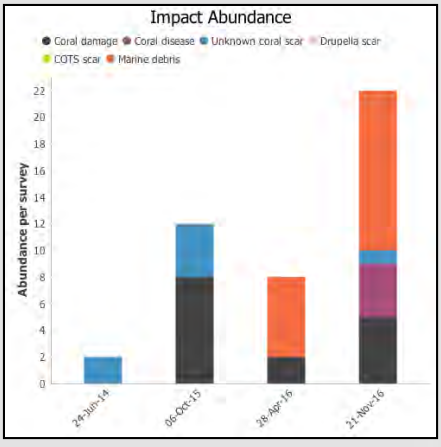


Figure 31. Impact abundance over time at Goat Island West, Site 1; 2014-2016.

Goat Island West, Site 1, was established in 2014 to increase understanding of various habitat types around Goat Island. Goat Island West, Site 1, is located at a shallow depth of approximately one meter, similar to Goat Island, Site 1. This site, like Goat Island, is exposed to regular boating traffic and surge from the nearby boat channel. This site is monitored in partnership with Quandamooka Rangers.

Hard coral accounted for 18% of the benthos in 2016, a small decrease from 2015 levels (22%) (Figure 30), and consisted primarily of massive (35%), foliose (31%) and encrusting growth forms (24%). Soft coral attributed 16%, consistent with 17% in 2015. Rock (including rock with turf algae) (26%), rubble (22%), sand (14%) and sponge (3%) composed the remaining substrate. Macro algae has not been documented at this site since its establishment.

Two *Drupella* snails were the only invertebrates recorded this season.

Coral bleaching affected an estimated 10% of the total coral population, with the affected colonies averaging 61% surface bleaching. This site was also impacted by 4 counts of disease, 5 fishing lines, 7 general marine debris items, 5 incidents of unknown damage and 1 unknown scar (Figure 31).

A fish survey was not conducted during the 2016-17 season.

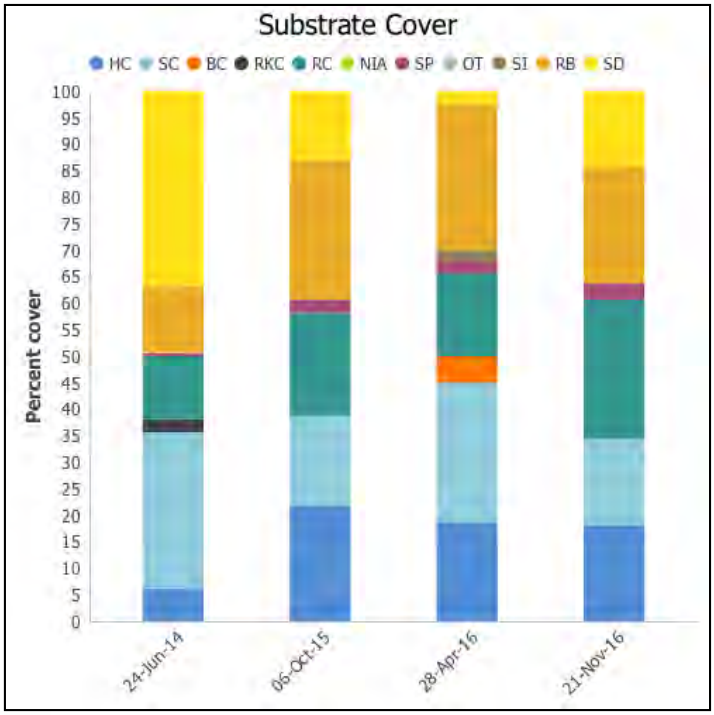


Figure 30. Benthic type and percent cover over time: Goat Island West, Site 1; 2014-2016.

3.0 Inshore Moreton Bay Sites

3.4 Green Island East, Site 1

Site photo, Green Island, Site 1

Bleached hard coral, Green Island, Site 1

Fishing debris, Green Island, Site 1

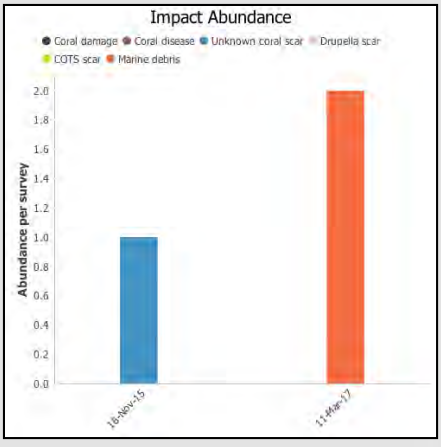


Figure 33. Impact abundance over time at Green Island East, Site 1; 2015-2017.

Green Island East, Site 1, was added to the RCA survey list in 2010. Green Island is situated on the western side of Moreton Bay, and is the site closest to the mouth of Brisbane River and the Port of Brisbane. The survey site is located on the eastern side of Green Island at a depth of approximately 2 meters. The site was established to expand the variety of sites within the Inshore Moreton Bay sub-region.

Hard coral accounted for <1% of the benthos, consisting of 1 encrusting coral, which was a decrease from the 7% recorded in 2015 (Figure 32). Soft coral was also <1%, a significant decrease from 2015 (23%). Sand made up the majority of the benthos at 60% coverage. Silt was the second most common substrate, contributing 21%. Rock (including rock with turf algae) attributed 15%, consistent with 2015 (16%), while rubble (2%) and nutrient indicator algae (1%) composed the remaining substrate cover. 19 macro algae counts were recorded for this year's survey.

No invertebrates were recorded on transect during the 2016-2017 season.

An average of 38% of the coral population and 28% of the individual coral colonies were bleached this season. These high amounts are likely attributed to the low coral cover at the site. The only other impacts recorded on the transect were 2 items of general marine debris (Figure 33).

A fish survey was not conducted during the 2016-17 season.

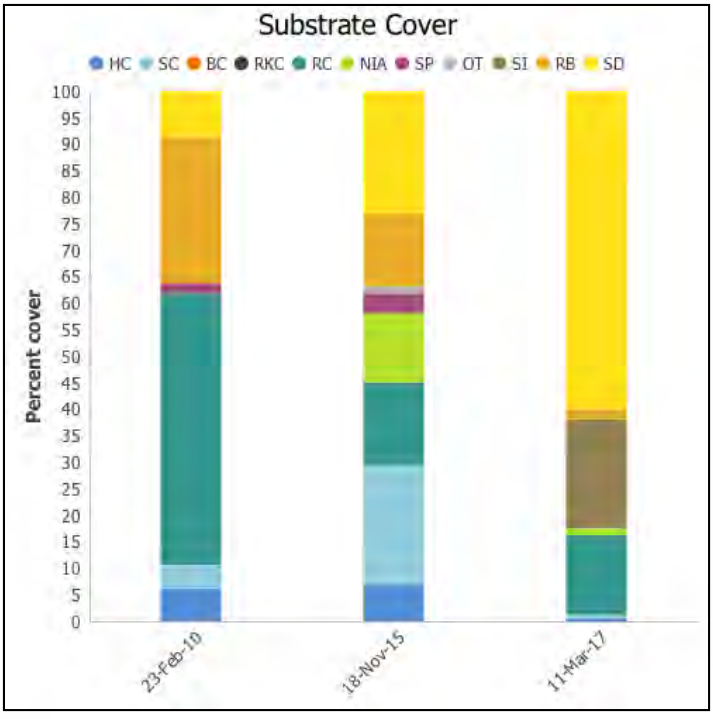
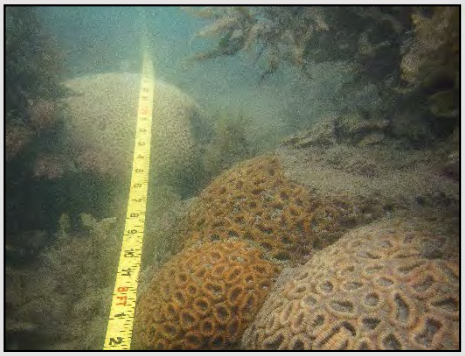


Figure 32. Benthic type and percent cover over time: Green Island, Site 1; 2010-2017.

3.0 Inshore Moreton Bay Sites

3.5 Macleay Island, Site 1



Site photo, Macleay Island, Site 1

Bleached hard coral, Macleay Island, Site 1

Bleached hard coral, Macleay Island, Site 1

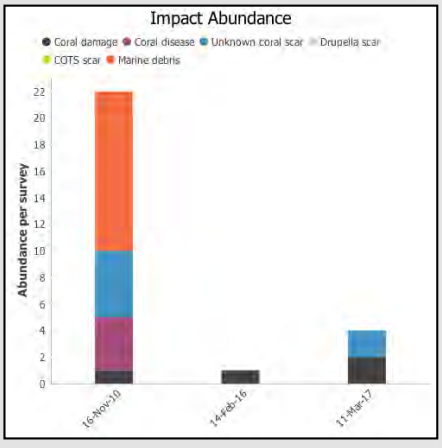


Figure 35. Impact abundance over time at Macleay Island, Site 1; 2010-2017.

This site was established in 2009 and is situated on the northeast side of Macleay Island in Moreton Bay. This site is located at a shallow depth of approximately one meter, and is exposed to regular surge from boating traffic.

Silt was the dominant benthos (61%), followed by hard coral (15%), which increased 7% from 2015 records (8% hard coral cover) (Figure 34). Hard coral was mainly comprised of massive growth forms (63%). Soft coral (11%), rock with turf algae (6%), rubble (4%) and sand (3%) were the other main contributors to the substratum. Macro algae counts totaled 38 this season.

No invertebrates were recorded on this year's transect. In fact, the only invertebrate to be recorded at this site to date is one *Diadema* long spined urchin in 2010.

Bleaching affected 25% of the coral population, with colonies portraying an average of 55% surface bleaching. This was a considerable increase from the one bleaching count in 2015. Two incidents of coral damage (due to unknown causes) and 2 unknown scars were the other impacts documents at this site (Figure 35).

A fish survey was not conducted in 2017.

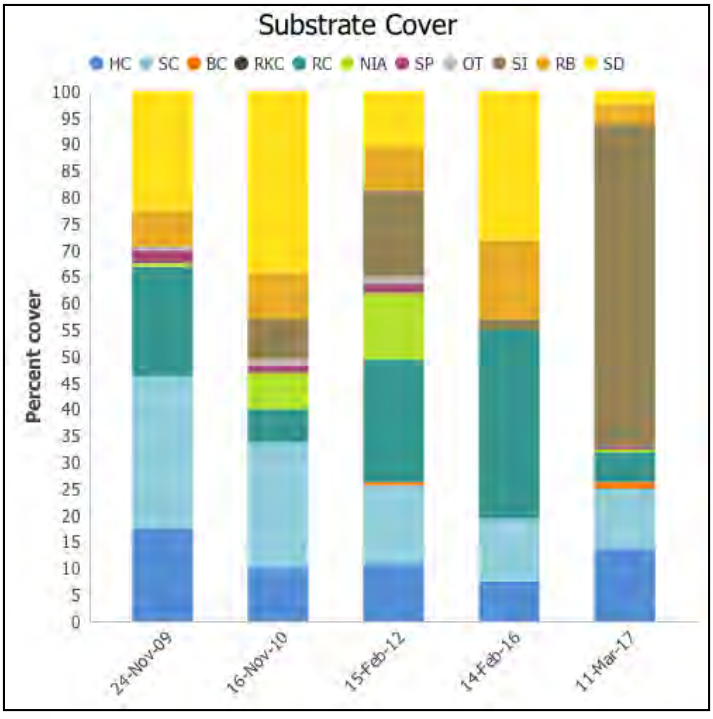


Figure 34. Benthic type and percent cover over time: Macleay Island, Site 1; 2009-2017

3.0 Inshore Moreton Bay Sites

3.6 Myora Reef, Site 1

Myora Reef habitat is unique in Moreton Bay as it is one of the only locations dominated by *Acropora* corals (Fellegara & Harrison 2008). This site is situated on a fringing reef on the western side of North Stradbroke Island, within the Green Zone. This site was established in 2009, and is located at a depth of three meters.

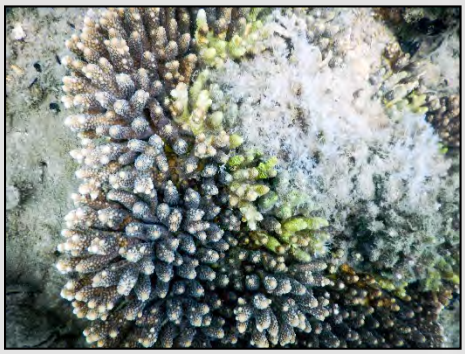
In the 2016-17 season, rock (including rock with turf algae and rock with calcareous algae) made up the majority of the substratum at 36% cover (Figure 36). Hard coral was the second most prominent, contributing 32% to the benthos, a level consistent with 2015 records (31%). Sand attributed 21%, while rubble made up only 3%, a large decrease from 21% in 2015. Soft coral was recorded for the first time at this site in the last 4 survey years, and contributed 2% to the substratum. Three counts of macro algae were recorded this season.

9 *Diadema* were noted, nearly three times less than the 25 spotted in last year's survey and six times less than the 55 recorded in 2014. Additional invertebrate findings in 2016 included 1 banded coral shrimp, 4 anemones and 4 *Drupella* snails.

Approximately 19% of the coral population showed bleaching, yet the affected individual colonies were only 8% bleached on average. Additional impacts revealed 31 counts of disease, 1 fishing line, 9 incidents of unknown coral damage and 1 *Drupella* scar (Figure 37).

A fish survey documented 54 butterflyfish, 1 snapper, 3 other parrotfish and 2 moray eels. An octopus was also observed during this site survey.

Site photo, Myora Reef, Site 1



Coral disease, Myora Reef, Site 1

Moray eel, Myora Reef, Site 1

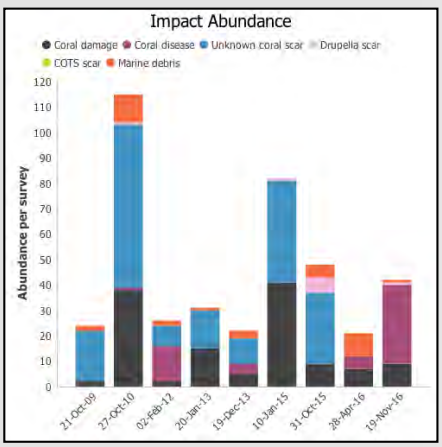


Figure 37. Impact abundance over time at Myora Reef, Site 1; 2009-2016.

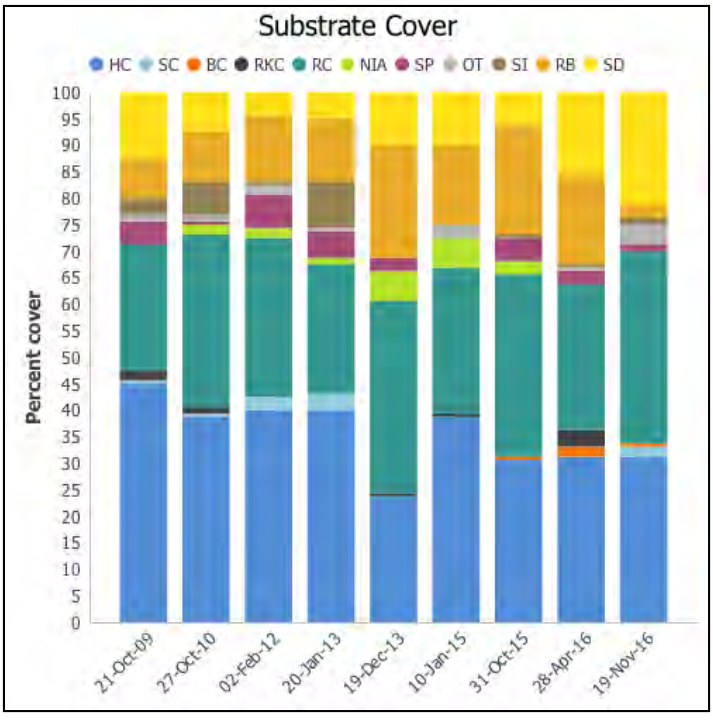


Figure 36. Benthic type and percent cover over time: Myora Reef, Site 1, 2009-2016

3.0 Inshore Moreton Bay Sites

3.7 Myora Reef, Site 2

Site photo, Myora Reef, Site 2

Bleached hard coral, Myora Reef, Site 2

Coral damage, Myora Reef, Site 2

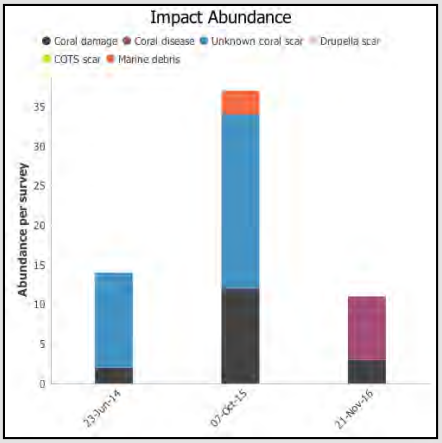


Figure 39. Impact abundance over time at Myora Reef, Site 2; 2014-2016.

Myora Reef, Site 2, was established in 2014 on a fringing reef on the western side of North Stradbroke Island, also within the Green Zone. Site 2 is shallower than the long-established Myora Reef, Site 1, sitting at only one meter. The site is highly influenced by tidal fluctuations, and is also dominated by *Acropora* corals (Fellegara & Harrison 2008). Site 2 is monitored in partnership with Quandamooka Rangers.

The substrate at Site 2 in 2016 consisted mainly of rock (including rock with turf algae and rock with calcareous algae) (29%), followed by sand (18%) and rubble (16%) (Figure 38). Hard coral attributed 15% of the benthic cover, a reduction from the 32% noted in the 2015 survey. Branching growth forms made up the majority of the hard coral cover (79%). Sponge (14%), 'other' substrate (comprised of large file clams and small bivalve beds) (8%) and soft coral (1%) constituted the remaining benthos.

Three *Diadema* urchins were the only indicator invertebrates recorded on the transect.

Only around 1% of the coral population was affected by bleaching, with an average of 28% surface bleaching on individual colonies. 8 diseases and 3 counts of coral damage (due to unknown causes) were the only other impacts at this site (Figure 39).

A fish survey was not conducted in 2016.

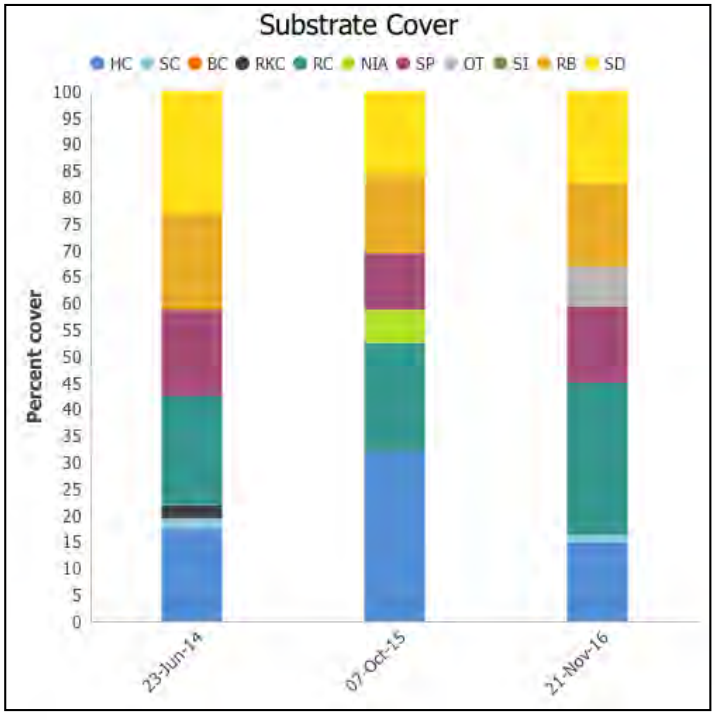


Figure 38. Benthic type and percent cover: Myora Reef, Site 2; 2014-2016.

3.0 Inshore Moreton Bay Sites

3.8 Peel Island North, Site 1

Peel Island North, Site 1, was established in 2009 and is located on the reef flat at a shallow depth of two meters. The site is easily accessible, and experiences heavy boat traffic due to its proximity to a deep channel. The northern area of Peel Island is an established MNP (green) zone.

Hard coral cover contributed 17% to the substratum, an increase from the 11% in 2015 and 15% in 2014 (Figure 40). Massive hard coral growth forms are the main hard coral structures recorded, likely due to the robust formation that may better tolerate heavy boat traffic (e.g. as opposed to more fragile branching growth forms). Soft coral made up 15% (decrease from 21% in 2015, but similar to the average of 17% over the surveyed years since 2009). The remaining benthic surface consisted of rubble (28%), sand (24%), rock with turf algae (6%), nutrient indicator algae (6%, a reduction from 21% in 2015), sponge (3%) and recently killed coral (2%). 12 counts of macro algae were recorded during this survey.

No invertebrates were recorded on the survey this season.

Approximately 1% of the coral population and 20% of the individual coral colonies were bleached. Additional impacts at this site in 2016 included 3 fishing lines, 1 item of general marine debris and 3 occurrences of coral damage (from unknown causes) (Figure 41).

A fish survey was conducted, with 6 butterflyfish recorded.

Site photo, Peel Island North, Site 1

Hard coral massive, Peel Island North, Site 1

Algae and soft coral, Peel Island North, Site 1

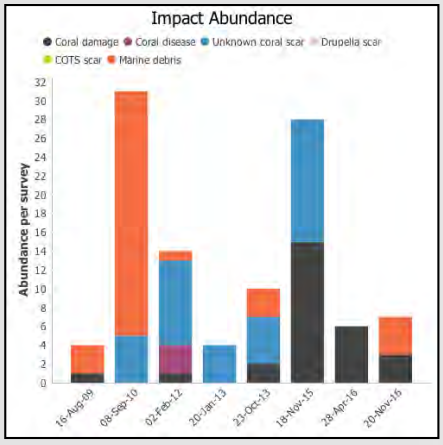


Figure 41. Impact abundance over time at Peel Island North, Site 1; 2009-2016.

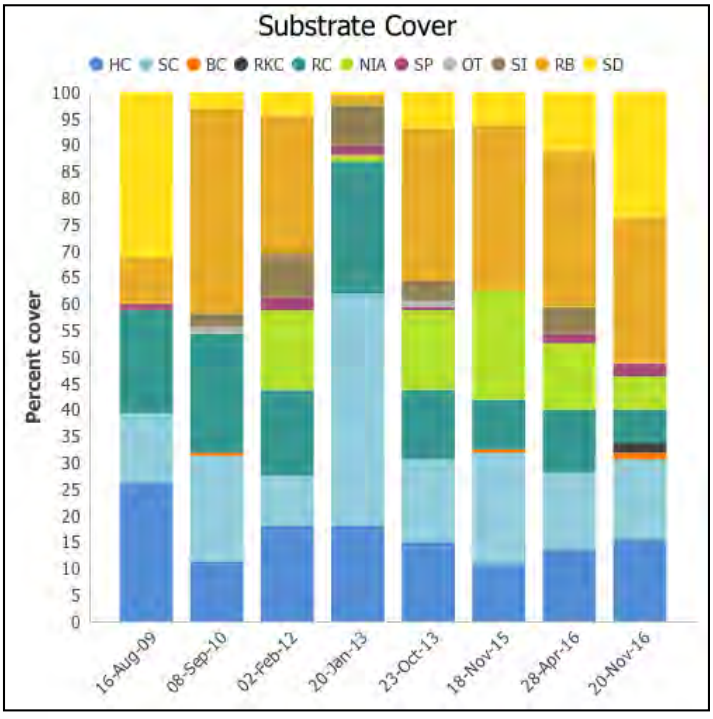


Figure 40. Benthic type and percent cover over time: Peel Island North, Site 1; 2009-2016.

3.0 Inshore Moreton Bay Sites

3.9 Peel Island East, Site 1

Peel Island East, Site 1, like Peel Island West, was established in 2009 and is situated on the reef flat at 2 meters depth. The site is easily accessible, and also experiences heavy boat traffic due to its proximity to a deep channel.

Hard coral (consisting primarily of massive growth forms, 63%) accounted for 12% of the benthic surface (Figure 42). This level is consistent with 11% in 2015 and the 13% average across all surveys since 2009. Soft coral contributed 7%, while sponges only made up 1% of the substratum. Sand dominated the site at 32% cover, with rock (including rock with turf algae and rock with calcareous algae) (28%), silt (19%) and rubble (2%) composing the remaining substrate cover. 18 occurrences of macro algae were noted.

No RCA indicator invertebrates were documented in the 2016-17 season.

Bleaching affected over 4% of the coral population; however, the affected colonies displayed 78% bleaching. The bleached population was considerably higher in 2015 (35%), but the 2015 coral colonies revealed only 42% surface bleaching. Two diseases, 7 fishing lines, 2 pieces of general marine debris and 2 cases of coral damage (unknown causes) were the other impacts recorded (Figure 43).

A fish survey was conducted in 2016, where 2 butterflyfish were seen, with a special appearance of a wobbegong shark in the transect.

Soft coral, Peel Island East, Site 1

Bleached hard coral, Peel Island East, Site 1

Coral disease, Peel Island East, Site 1

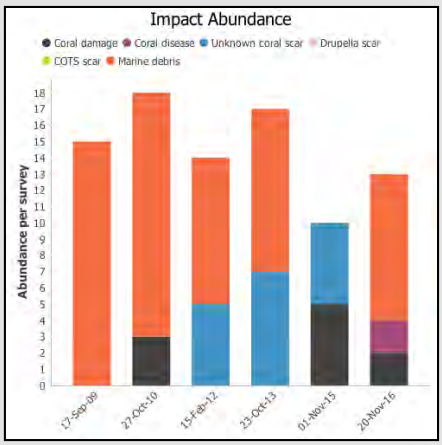


Figure 43. Impact abundance over time at Peel Island East, Site 1; 2009-2016.

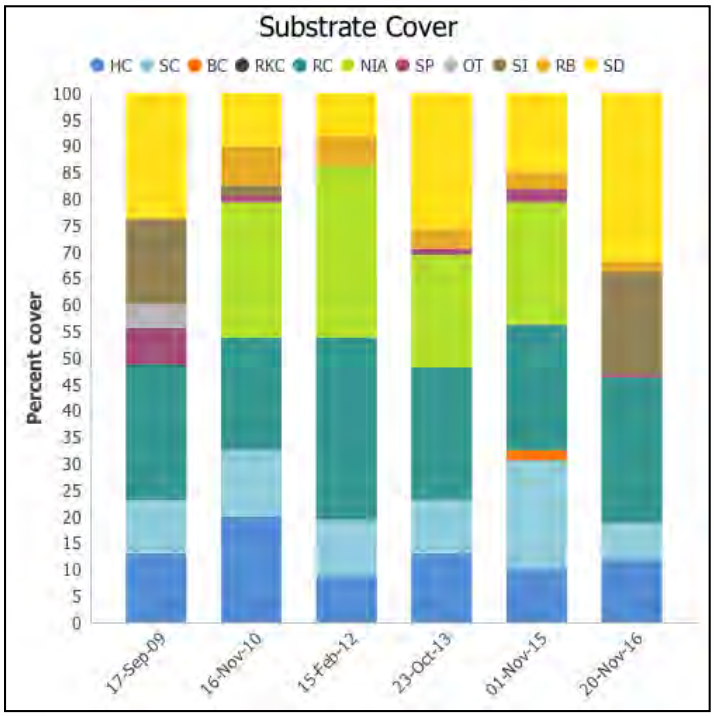


Figure 42. Benthic type and percent cover over time: Peel Island East, Site 1; 2009-2016.

3.0 Inshore Moreton Bay Sites

3.10 Peel Island Northeast, Site 1

Site photo, Peel Island Northeast, Site 1

Bleached hard coral, Peel Island Northeast, Site 1

Turf algae, Peel Island Northeast, Site 1

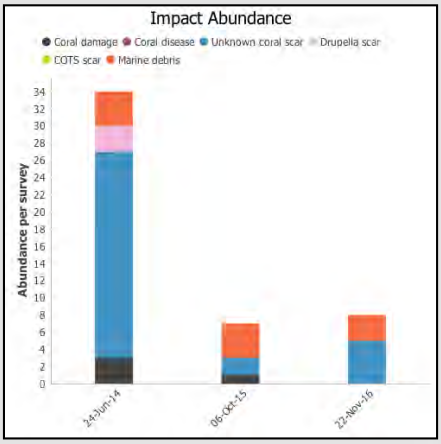


Figure 45. Impact abundance over time at Peel Island Northeast, Site 1; 2014-2016.

This shallow site was established in 2014. The site is located at 1 meter depth on the shallow fringing reef to the north of the Platypus wreck. Peel Island Northeast, like Peel Island North and Peel Island East, is easily accessible, and experiences heavy boat traffic due to its proximity to a deep channel. The site is dominated by massive hard corals. Peel Island Northeast is monitored in partnership with Quandamooka Rangers.

This season, hard coral accounted for 18% of the substrate (dominated by massive growth forms, 57%), an increase from 10% in 2015 (Figure 44). Soft coral (3%) and sponges (2%) contributed a small fraction of the benthic cover, while sand (36%), rubble (22%), rock with turf algae (17%) and nutrient indicator algae (4%) composed the majority of the substratum. No macro algae was recorded.

No invertebrates were recorded on the survey this season.

An average of 6% of the coral population and 37% of individual coral colonies were recorded as bleached. Additional impacts recorded at this site included 1 general marine debris item, 2 fishing lines and 5 unknown scars (Figure 45).

A fish survey was not conducted in 2016.

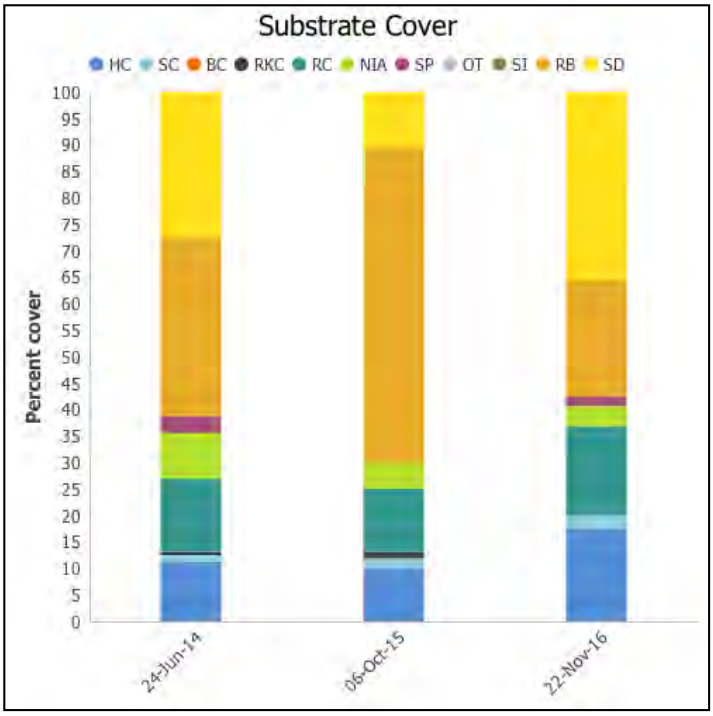


Figure 44. Benthic type and percent cover over time: Peel Island Northeast, Site 1; 2014-2016.

3.0 Outer Moreton Bay Sites

3.11 Flat Rock, Shark Alley, Site 1

Site photo, Shark Alley, Site 1

Pencil urchin, Shark Alley, Site 1

Coral damage, Shark Alley, Site 1

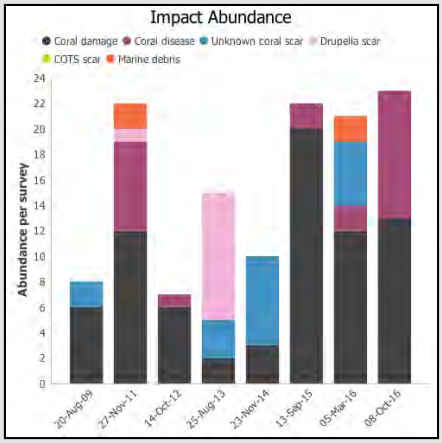


Figure 47. Impact abundance over time at Shark Alley, Site 1; 2009-2016.

Flat Rock is a popular recreational diving and boating location to the north of Point Lookout on North Stradbroke Island. Shark Alley, Site 1, was added to the RCA survey list in 2009, and lays at 9 meters on the seaward side of the fringing reef, sitting above a common gathering area for Grey Nurse Sharks.

Hard coral cover attributed 33% to the benthic surface (composed mainly of branching (48%) and encrusting (37%) growth forms). This was an increase from the March 2015-2016 survey (19% hard coral cover), and the 27% in 2014 (Figure 46). Soft coral and sponge cover accounted for 3% of the benthos each. Rock (composed of rock with turf algae and rock with calcareous algae) (44%), nutrient indicator algae (11%) and 'other' substrate (mainly burrowing urchins) (6%) made up the remaining substrate. Note that nutrient indicator algae decreased 20% from March in the 2015-16 season (31% NIA cover). 5 counts of macro algae were recorded, all of which were *Asparagopsis*.

3 *Diadema,* 1 pencil urchin and 12 anemones were recorded.

Bleaching was recorded for over 5% of the coral population, and 14% of individual coral colonies. 10 cases of disease and 13 counts of unknown coral damage were the other impacts recorded at this site (Figure 47).

A fish survey recorded 12 butterflyfish in the 2016-17 season.

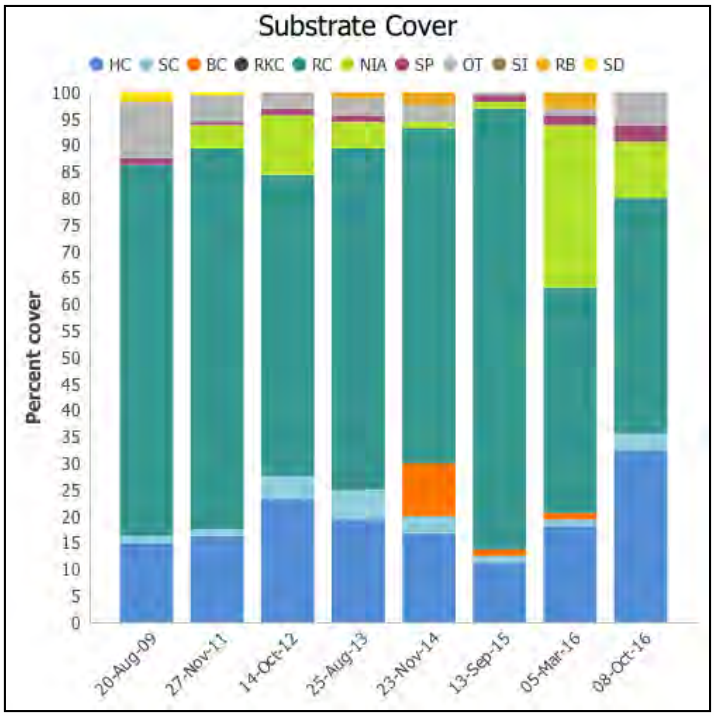
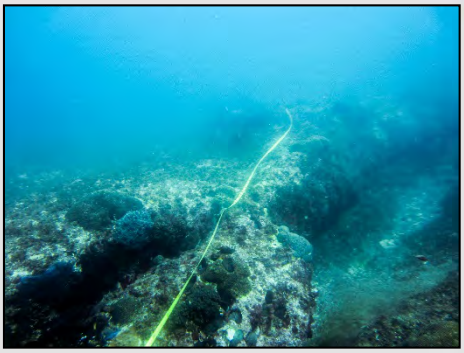


Figure 46. Benthic type and percent cover over time: Flat Rock Island, Shark Alley, Site 1; 2009-2016.

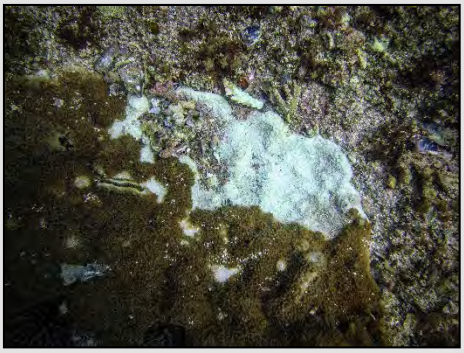
3.0 Outer Moreton Bay Sites

3.12 Flat Rock, The Nursery, Site 1



Site photo, The Nursery, Site 1

Anemone, The Nursery, Site 1



Bleaching disease, The Nursery, Site 1

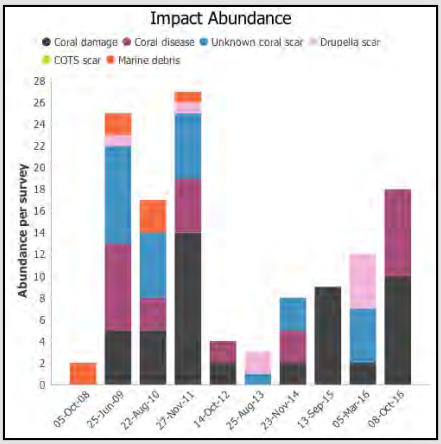


Figure 49. Impact abundance over time at The Nursery, Site 1; 2008-2016.

The Nursery, Site 1, was established in 2008, and is situated within a fully protected marine park that has a no-fishing zone within 1.2km radius of the reef. It is also a Grey Nurse Shark Protection area. This site sits at a depth of six meters on the leeward side of the fringing reef.

Hard coral accounted for 22% of substrate in the 2016-17 season, consistent with 23% in 2015 (Figure 48). Encrusting growth forms (71%) dominated the hard coral composition. Soft coral cover accounted for just 1% of the substrate, while sponges made up 4%. Rock (including rock with turf algae and rock with calcareous algae) was the principal benthos (44%), followed by nutrient indicator algae (26%). The remaining substrate included 'other' (*Halimeda* and burrowing urchins) (2%), as well as recently killed coral (less than 1%). *Asparagopsis* was the only macro algae on the transect with 20 counts recorded; this is similar to the 23 counts in 2015.

The invertebrate survey documented 2 *Diadema* long spined urchins and 4 anemones at this site.

Bleaching affected an average of 13% of the coral population and 25% of individual coral colonies. Additional impacts consisted of 8 counts of disease and 10 incidents of coral damage (due to unknown causes) (Figure 49).

A fish survey was conducted, and 2 butterflyfish were recorded. A large wobbegong was also spotted at this site.

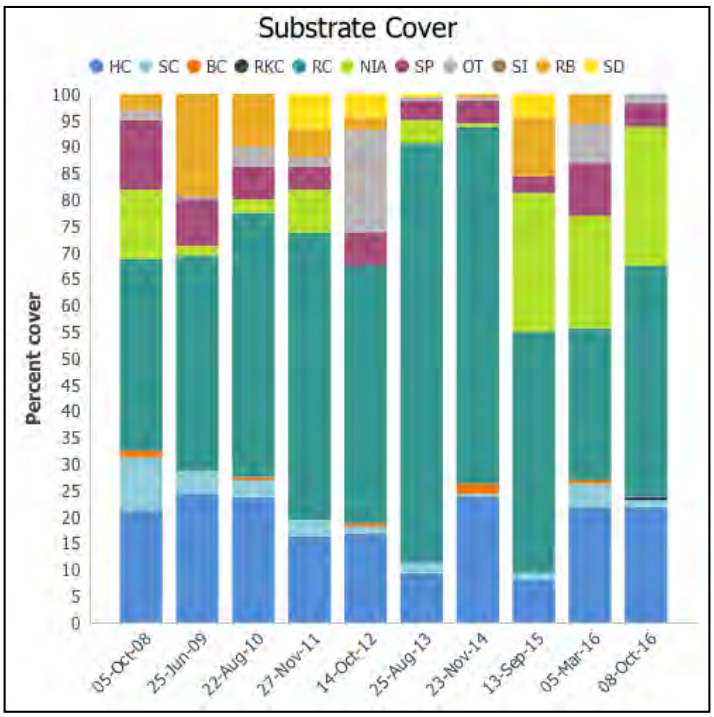


Figure 48. Benthic type and percent cover over time: Flat Rock Island, The Nursery, Site 1; 2008-2016

3.0 Outer Moreton Bay Sites

3.13 Flinders Reef, Alden's Cave, Site 1

Site photo, Alden's Cave, Site 1

Close up of hard coral plate, Alden's Cave, Site 1

Coral disease, Alden's Cave, Site 1

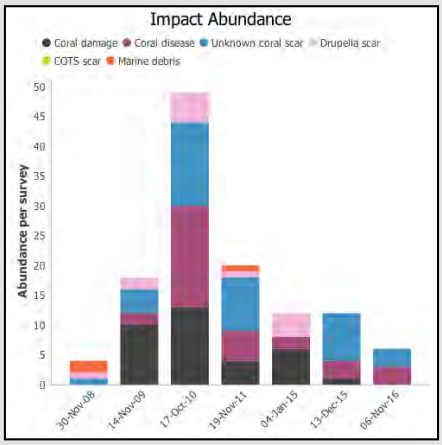


Figure 51. Impact abundance over time at Alden's Cave, Site 1; 2008-2016.

Flinders Reef is an established Marine National Park (Green) zone located approximately five kilometres north of Moreton Island, and is popular dive locale. Alden's Cave is situated at the southern end of Flinders Reef at a depth of 10 meters. Alden's Cave, Site 1, was established in 2008 to gain a better understanding of the variety of habitats found within the Flinders area. This southerly site tends to be more exposed to prevailing ocean swell than the protected Nursery area on the opposite side of the reef.

Hard coral (consisting mainly of encrusting growth forms, 52%) dominated the benthic cover at 41%, a 5% decrease from 2015 (46%) (Figure 50). Soft coral and sponges each covered 14% of substratum. Rock (composed of rock with turf algae and rock with calcareous algae) (25%), rubble (2%), sand (1%), nutrient indicator algae (1%) and 'other' (crustose algae) (<1%) made up the remaining components of the benthic surface. 28 macro algae counts were recorded this season.

5 giant clams, 2 *Drupella* snails and 1 anemone were recorded during the invertebrate survey.

Coral bleaching affected only 1% of the total coral population; with an average of 65% bleaching on each affected colony. There were also 3 diseases and 3 unknown scars that impacted the site (Figure 51).

A fish survey was conducted, with 10 butterflyfish spotted. An octopus was also observed along the transect.

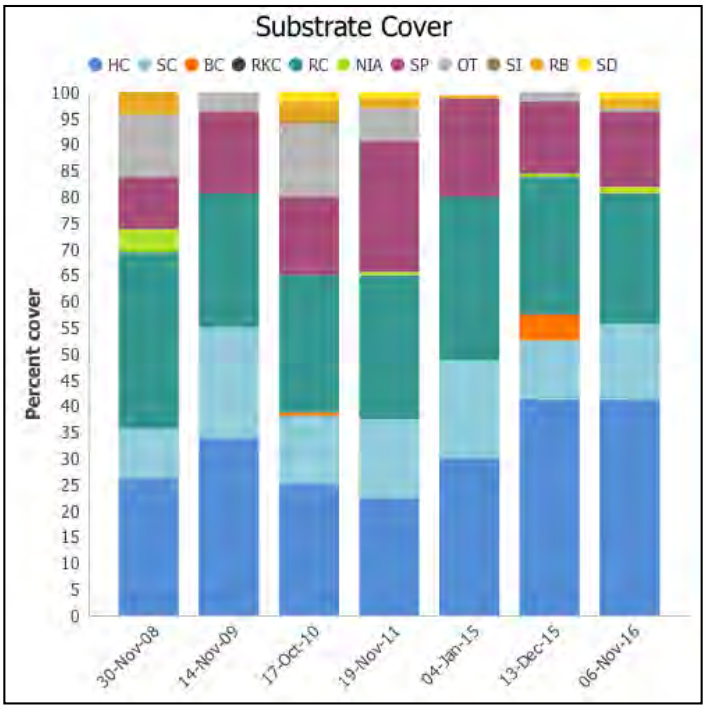
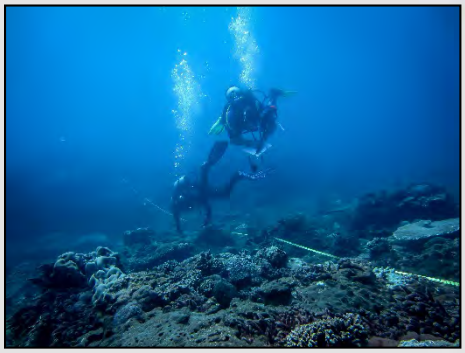


Figure 50. Benthic type and percent cover over time: Flinders Reef, Alden's Cave, Site 1; 2008-2016.

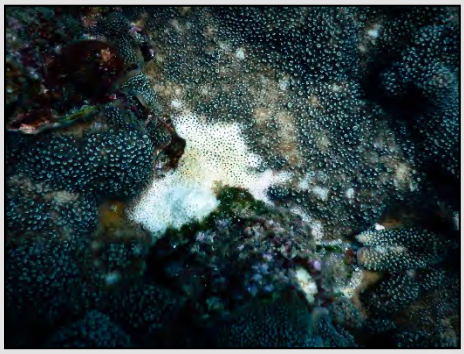
3.0 Outer Moreton Bay Sites

3.14 Flinders Reef, Alden's Cave, Site 2



Site photo, Alden's Cave, Site 2

Giant clam, Alden's Cave, Site 2



Coral disease, Alden's Cave, Site 2

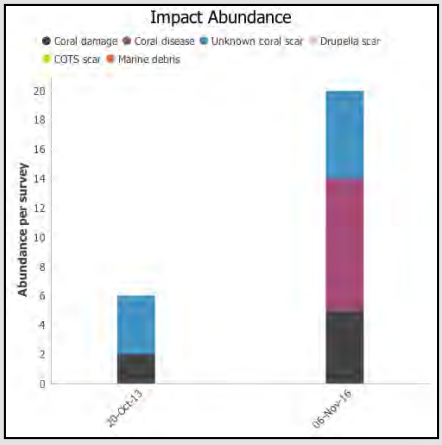


Figure 53. Impact abundance over time at Alden's Cave, Site 2; 2013-2016.

Alden's Cave, Site 2, was added to the RCA survey list in 2013. This site is situated at 10 meters on the reef flat to the east of Site 1. Site 2 lays near a rocky cave structure that is popular amongst divers in the SEQ region. The site was established to expand the research region in the Flinders Reef Green Zone and increase understanding of habitat variety in this area.

Hard coral was the predominant benthos, composing 31% of the benthos, with encrusting growth forms accounting for the majority of the hard coral cover (55%) (Figure 52). Soft coral made up 16% of the substrate. Rock (including all RCA rock categories) attributed 26% to the benthic cover, while sponges (10%), sand (16%) and rubble (3%) made up the remaining substratum. 25 counts of macro algae were noted during this survey.

The invertebrate survey recorded 4 giant clams and 3 *Drupella* snails. Two banded coral shrimps were spotted between transect replicates and were therefore not included in the indicator invertebrate count.

The site had low levels (<1%) of bleaching recorded for the overall coral population, and a low average of 4% on each affected colony. Other impacts consisted of 9 instances of disease, 5 counts of coral damage (due to unknown causes) and 6 scars (from unknown origins) (Figure 53).

A fish survey recorded 16 butterflyfish at this site.

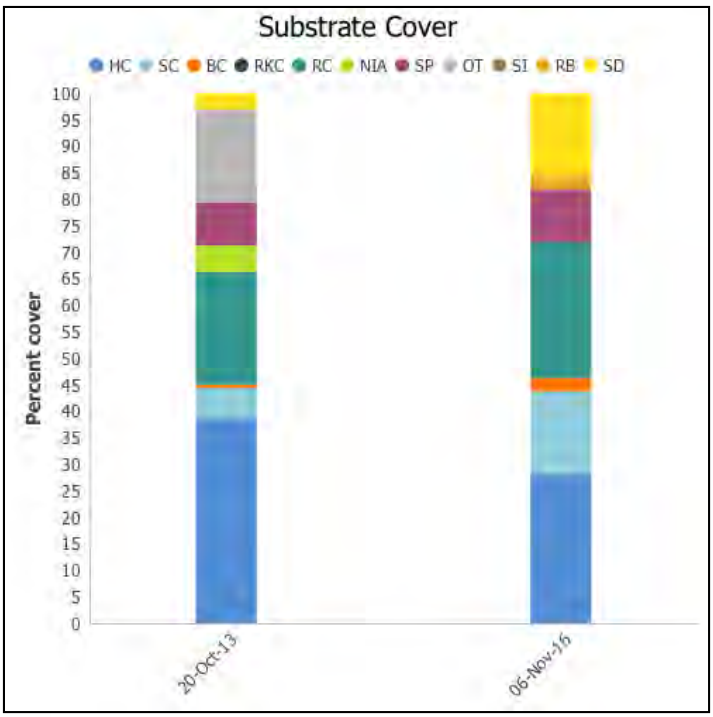


Figure 52. Benthic type and percent cover over time: Flinders Reef, Alden's Cave, Site 2; 2013-2016.

3.0 Outer Moreton Bay Sites

3.15 Flinders Reef, The Nursery, Site 1

Site photo, The Nursery, Site 1

Asparagopsis, dominant algae, The Nursery, Site 1

Cowries, The Nursery, Site 1

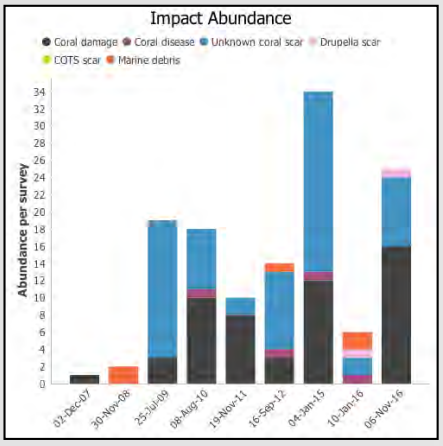


Figure 55. Impact abundance over time at The Nursery, Site 1; 2007-2016.

The Nursery, Site 1, is a long-term site that has been surveyed annually by Reef Check since its establishment in 2007. The site is situated at a depth of six meters on the northern side of Flinders Reef.

Rock (including rock with turf algae and rock with calcareous algae) was the dominant benthos, covering 31% of the survey site in 2016 (Figure 54). Hard coral composed 25%, consistent with the previous two survey years (24% in 2015 and 23% in 2014). Encrusting (45%) and foliose (23%) were the main growth forms attributing to hard coral cover. Soft coral (20%) was consistent from the levels recorded in 2015 (19%). Sand (8%), 'other' substrate (comprised of corallimorphs and crustose algae) (7%), nutrient indicator algae (6%) and sponges (2%) contributed to the remaining substrate. 12 counts of macro algae were recorded, with *Asparagopsis* as the dominant algae.

Two giant clams and 7 *Drupella* snails were the only indicator invertebrates recorded.

Coral bleaching affected an estimated 2% of the total coral population; with an average of 30% on each affected colony, an increase from 2015 levels (1% and 13% respectively). 16 incidents of unknown coral damage, 1 *Drupella* sp. scar and 8 scars of unknown origin also impacted this site (Figure 55).

A fish survey was completed, documenting five butterflyfish, as well as a guest octopus appearance.

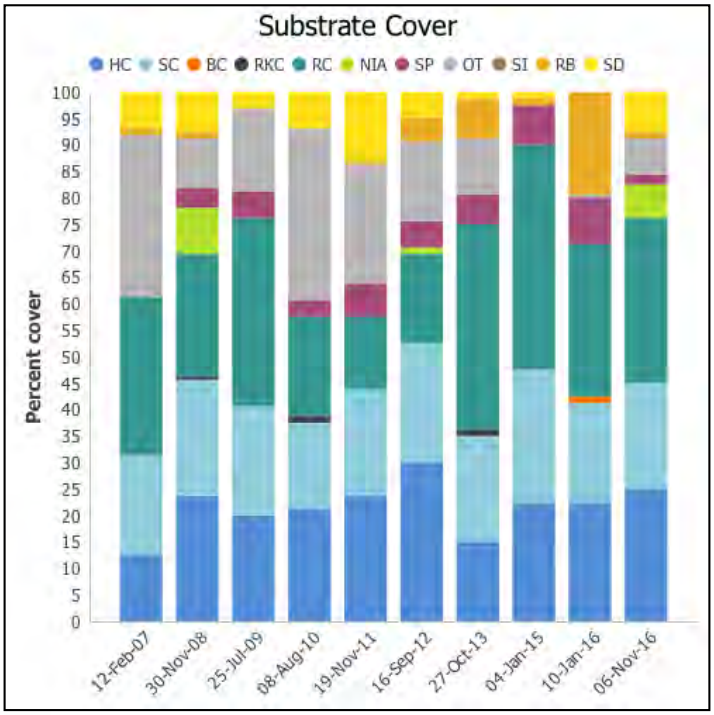


Figure 54. Benthic type and percent cover over time: Flinders Reef, The Nursery, Site 1; 2007-2016.

3.0 Outer Moreton Bay Sites

3.16 Flinders Reef, The Nursery, Site 2

Site Photo, The Nursery, Site 2

Branching hard coral, The Nursery, Site 2

Surveyor in action, The Nursery, Site 2

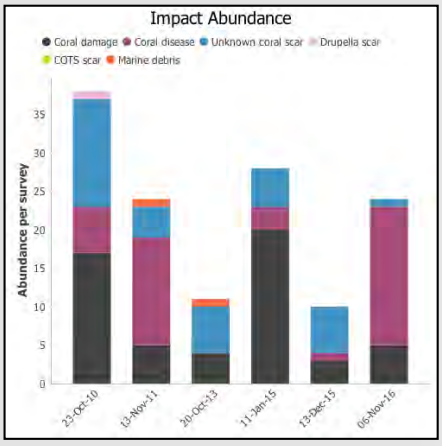


Figure 57. Impact abundance over time at The Nursery, Site 2; 2009-2016.

The Nursery, Site 2 is situated at a depth of nine meters on the back reef slope. Site 2 was added to the RCA survey list in 2009. A large patch of branching *Acropora* makes up the majority of the survey area.

Hard coral accounted for 71% of the benthic cover, the highest amount recorded since the site was established in 2009 (Figure 56), and the highest amount across all SEQ survey sites in the 2016-2017 season. Branching growth forms dominated the hard coral composition (98%). The remaining substrate consisted of rock (including rock with turf algae and rock with calcareous algae) (21%), sand (5%) and soft coral (3%). 13 counts of macro algae were also recorded.

The invertebrate survey documented only 1 giant clam at this site.

Bleaching was sparse, affecting less than 1% of the coral population and only 4% of the affected colonies. This was a substantial decrease from the levels recorded in 2015 (21% population and 55% individual colonies). However, this site was impacted by 18 diseases, 5 instances of unknown coral damage and 1 scar (of unknown origin) (Figure 57).

A fish survey in 2016 recorded 13 butterflyfish and 1 other parrotfish.

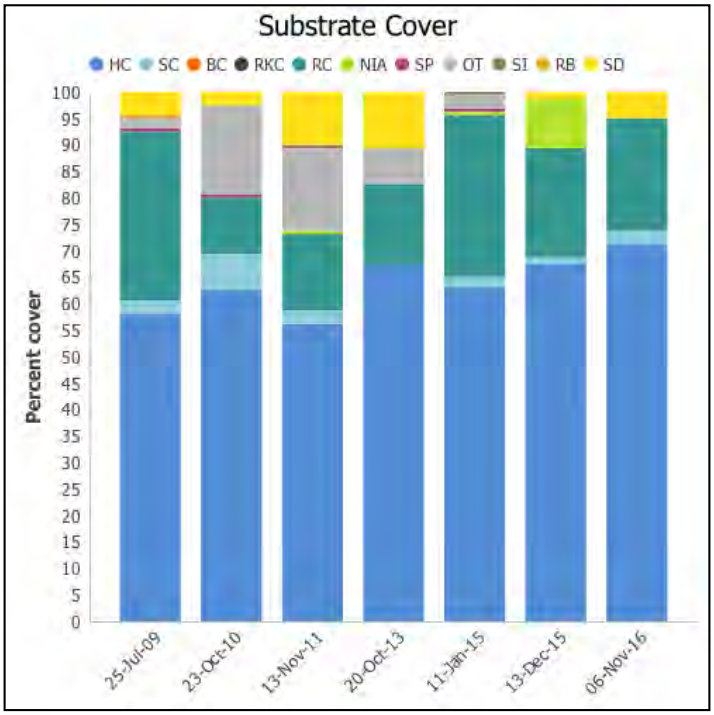
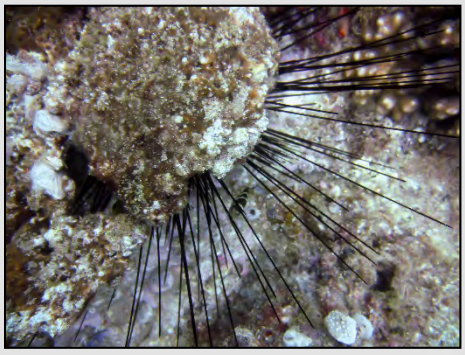


Figure 56. Benthic type and percent cover over time: Flinders Reef, The Nursery, Site 2; 2009-2016.

3.0 Outer Moreton Bay Sites

3.17 Shag Rock East, Site 1

Site photo, Shag Rock East, Site 1



Diadema, Shag Rock East, Site 1

Anemone, Shag Rock East, Site 1

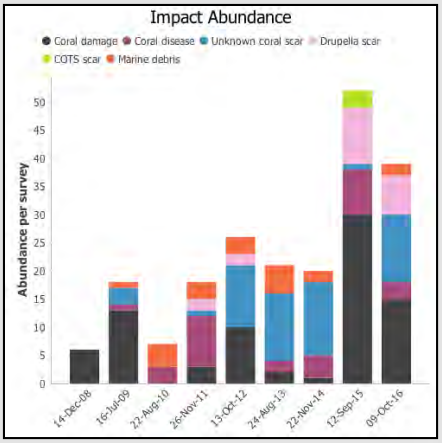


Figure 59. Impact abundance over time at Shag Rock East, Site 1; 2008-2016.

Shag Rock is a twin rock located on the north-eastern edge of North Stradbroke Island. Shag Rock East, Site 1, is situated in a relatively sheltered cove on the southern area of Shag Rock, and sits at a depth of five meters on the reef slope. This site was established in 2008. It is a popular locale for diving, fishing and boating.

Hard coral (consisting primarily of encrusting (41%) and branching (38%) growth forms) represented 20% of the total substrate cover, a notable increase from 5% in 2015, but similar to levels in 2014 (18%) (Figure 58). Soft coral contributed to 9% of the benthos. Rock with turf algae (34%), nutrient indicator algae (16%), 'other' substrate (corallimorphs, 16%) and rubble 6% rounded out the remaining benthic composition. No macro algae has been recorded at this site since 2012.

The invertebrate survey recorded 46 *Diadema* long spined urchins, 2 pencil urchins, 3 collector urchins, 2 giant clams and 15 anemones.

Coral bleaching affected 10% of the population with an average of 24% surface bleaching on the affected individual colonies. Three diseases, 2 fishing lines, 15 incidents of coral damage (due to unknown causes), 7 *Drupella* sp. scars and 12 unknown scars constituted the additional impacts recorded in 2016 (Figure 59).

A fish survey was conducted, with 16 butterflyfish recorded.

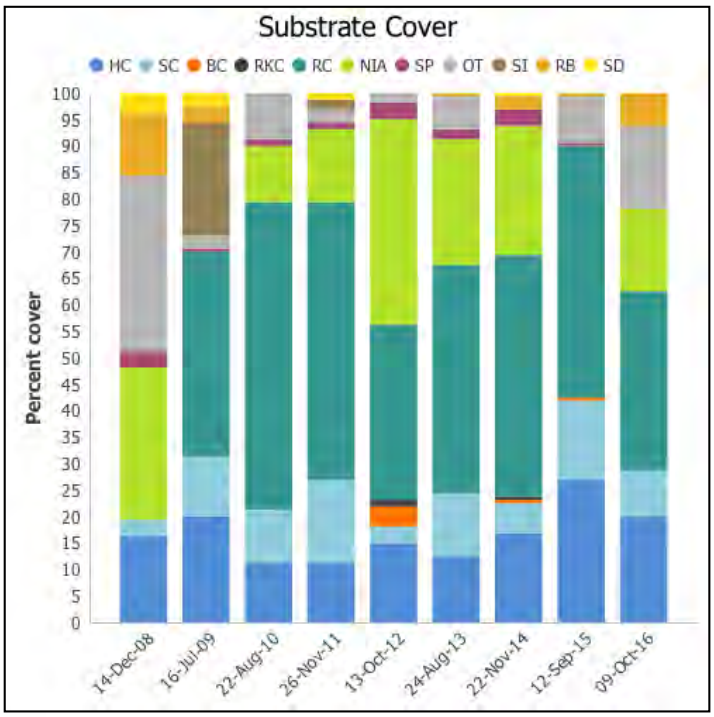


Figure 58. Benthic type and percent cover over time: Shag Rock East, Site 1; 2008-2016.

3.0 Outer Moreton Bay Sites

3.18 Shag Rock West, Site 2

Shag Rock West, Site 2, is located on the exposed northern side of Shag Rock, and sits at a depth of 6 meters on the fringing reef. This site was established in 2009 to gain a better understanding of the contrasting habitats surrounding Shag Rock. According to locals who frequent Shag Rock, a small boat crashed on the site in 2015, resulting in high counts of boat and anchor damage that year.

This site has shown an average hard coral cover of 9% over eight years of surveys, with 8% recorded in the 2016-2017 season (Figure 60). Hard coral cover was composed primarily of branching growth forms (67%). The remaining substrate recorded at this site included rock with turf algae (60%), nutrient indicator algae (30%), sand (2%) and 'other' substrate (1%).

29 *Diadema*, 6 collector urchins and 2 anemones were recorded during the invertebrate survey in 2016.

An average of 9% of the coral population was impacted by bleaching, covering 26% of the individual affected colonies on average. Other impacts at this site included 1 fishing line, 15 cases of unknown coral damage and 3 scars of unknown origin (Figure 61). While records note numerous boat damage in 2015, specific anchor/boat damages could not be attributed to the 15 cases of unknown coral damage this season.

A fish survey was conducted at this site, noting 4 butterflyfish, 1 other parrotfish and 1 moray eel.

Site photo with collector urchin, Shag Rock West, S1

Unknown coral damage, Shag Rock West, Site 1

Cuttlefish, Shag Rock West, Site 1

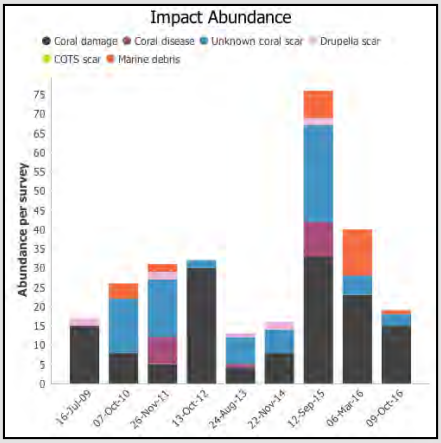


Figure 61. Impact abundance over time at Shag Rock West, Site 2; 2009-2016.

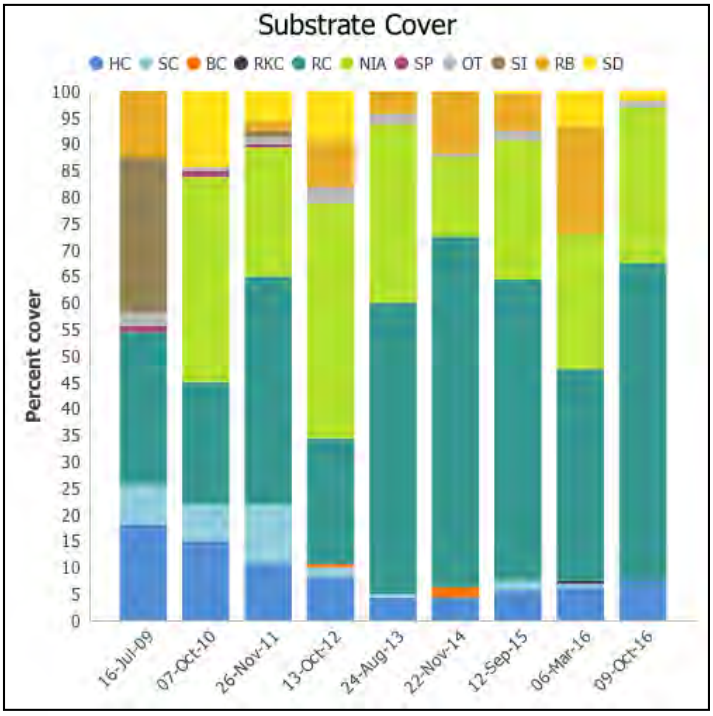


Figure 60. Benthic type and percent cover over time: Shag Rock West, Site 2; 2009-2016.

4.0 Gold Coast

Map: Gold Coast, South East Queensland
Image courtesy of Google Earth

4.0 Gold Coast Sites

4.1 Gold Coast Seaway, Southwest Wall, Site 1

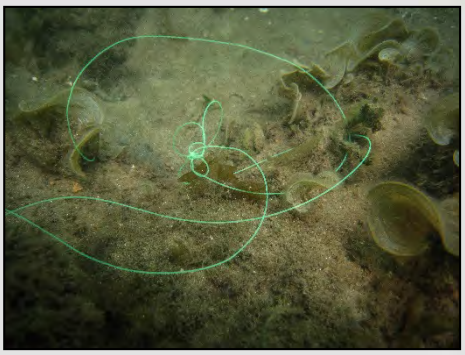
The Gold Coast Seaway was built in 1971 and is the main navigation entrance from the Pacific Ocean into the Southern Moreton Bay and the Gold Coast Broadwater. The site is characterised by high silt loading, but divers report numerous unique marine species making it a popular diving and fishing location. The Southwest Wall, Site 1, was established in 2007 to better understand and record impacts on this heavily utilized site. The site is situated at a depth of 2 meters on the sandy slope parallel to the artificial rock wall on the southwest side of Gold Coast Spit.

No hard coral has been recorded at this site since established in 2007 (Figure 62). Rock (including rock with turf algae) attributed 48% to the substrate in 2017. This site had a high silt loading, accounting for 44% of the benthic cover. Sand (8%) and a sponge (<1%) made up the remaining substrate. 24 macro algae counts were recorded.

11 anemones were the RCA indicator invertebrates recorded in 2017.

This site has consistently recorded high counts of marine debris (8 in 2015, 10 in 2013, 20 in 2012), with 2017 at the highest level since 2012 (Figure 63). 33 counts were recorded, including 29 fishing lines and 4 general debris items.

No fish survey was conducted in 2017; however, 3 stonefish, 2 moray eels and 1 cuttlefish were noticed on the transect.



Fishing line, Southwest Wall, Site 1

Leatherjacket, Southwest Wall, Site 1

Stonefish, Southwest Wall, Site 1

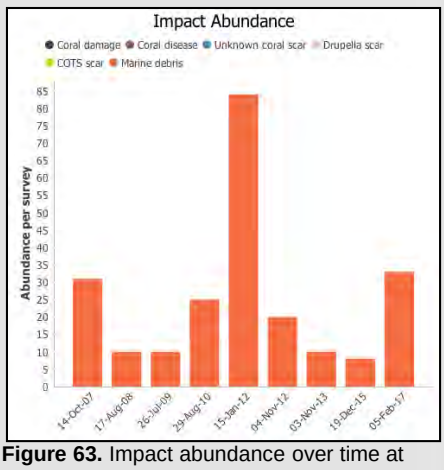


Figure 63. Impact abundance over time at Southwest Wall, Site 1; 2007-2017.

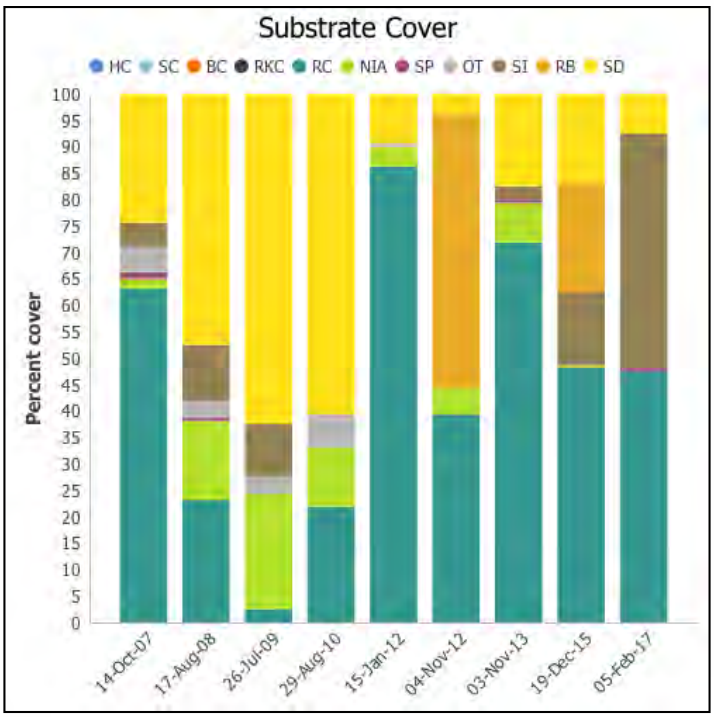


Figure 62. Benthic type and percent cover over time: Gold Coast Seaway, Southwest Wall, Site 1; 2007-2017.

4.0 Gold Coast Sites

4.2 Gold Coast Seaway, The Pipe, Site 1

The Pipe, Site 1, is situated at a depth of 4 meters in the heavily utilised Gold Coast Seaway, at the main diving and fishing site, The Pipe. This site is exposed to heavy boat traffic and tidal fluctuations on a daily basis. The Pipe, Site 1, was established in 2015, to better document the anthropogenic impacts facing this heavily utilised site, particularly effects from fishing.

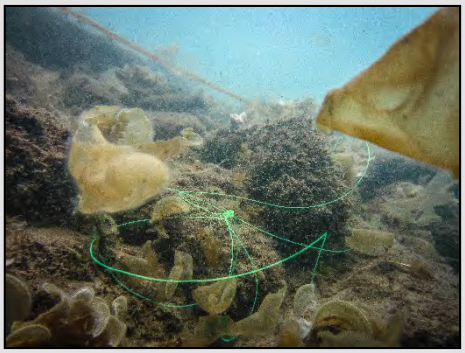
RCA has not recorded hard or soft coral in either survey year since this site was established (Figure 64). However, several colonies of soft coral were sighted off-transect. Similar to the nearby site Gold Coast Seaway Southwest Wall, Site 1, rock with turf algae (49%), silt (46%), sponges (4%) and rubble (1%) made up the benthic surface. This site portrayed high silt loading, also similar to the Southwest Wall, Site 1.

No invertebrates were recorded in the 2016-2017 season, nor were any recorded in 2015.

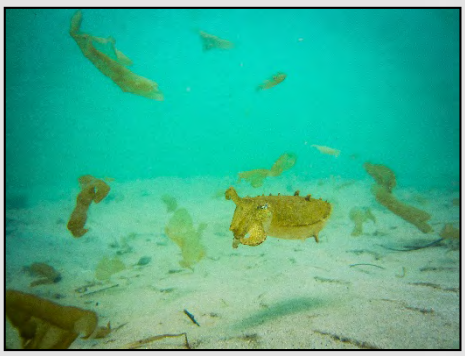
33 counts of fishing line were the only impacts recorded at this site this season (Figure 65). In 2015, the only impact was also fishing line (46 counts).

A fish survey was not conducted at this site; however, 1 lionfish and 1 nudibranch were spotted along the transect.

Site photo, The Pipe, Site 1



Fishing line, The Pipe, Site 1



Cuttlefish, The Pipe, Site 1

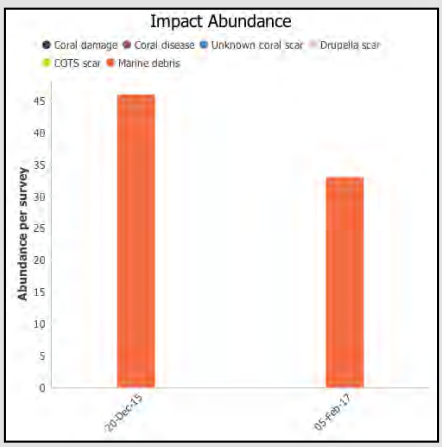


Figure 65. Impact abundance over time at The Pipe, Site 1; 2015-2017.

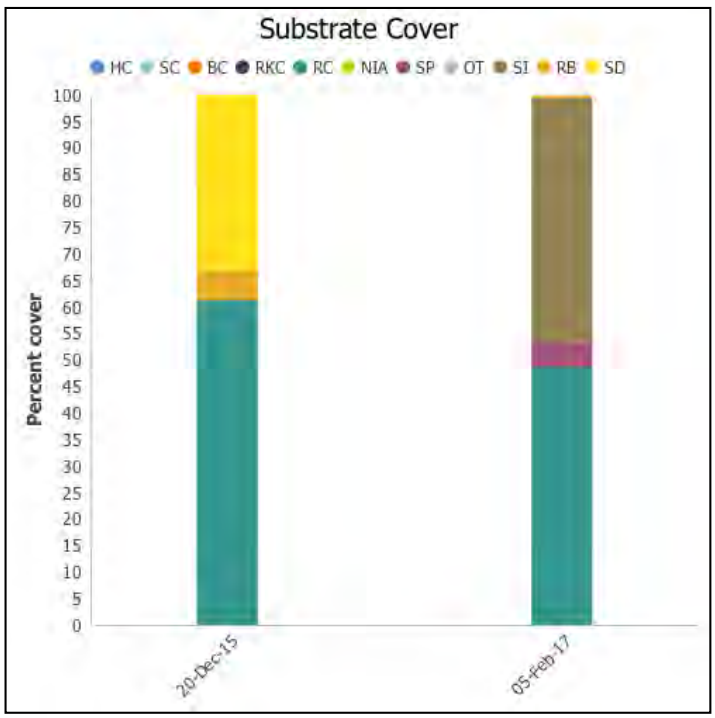


Figure 64. Benthic type and percent cover over time: Gold Coast Seaway, The Pipe, Site 1; 2015-2017

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