Reef Check Australia

South East Queensland

Season Summary Report 2015

Reef Check Foundation Ltd
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1.0 Introduction

Reef Check Australia (RCA) has been supporting volunteer reef monitoring projects on Australian reefs since 2001. For the past 14 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 to abundance of key invertebrate species and target fish species as well as substrate cover. Additionally, natural and anthropogenic impacts affecting reef habitats are also monitored.

This report presents a summary of the findings for surveys conducted in South East Queensland (SEQ) during the 2015 season. Teams of trained volunteers monitored a total of 33 sites on 20 different reefs, which included survey sites ranging from Mudjimba (Old Woman Island) on the Sunshine Coast to Kirra Reef on the Gold Coast. In total, an area of 13,200m^2 of reef habitat was surveyed.

Five new sites were established this survey season to provide enhanced representation of reef habitats and human use areas. These included: One new site at the Pipe, in the Gold Coast Seaway- a heavily utilised area year round; one site at Kirra Reef in the Gold Coast – the most southern location of Reef Check Australia's monitoring sites; an additional site at Alden's Cave, Flinders Reef (Site 3) to build on survey efforts on the south east side of Flinders Reef and two additional sites within the Inshore Moreton Bay sub region; one at Green Island (Site 1), and one at Amity Point (Site 1) - a site continually exposed to anthropogenic activities.

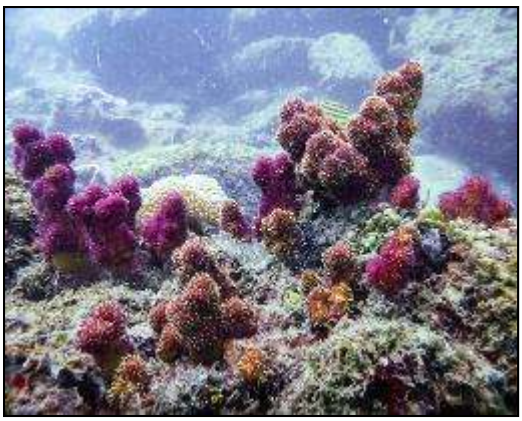
Some existing Reef Check Australia monitoring locations were not visited during the 2015 survey season due to weather conditions and or funding resources.

1.0 Introduction

SEQ represents a transitional area where temperate, tropical and sub-tropical species exist within the same habitat area (Perry & Larcombe 2003). The region is of significant importance because its waterways are impacted by a rapidly increasing population, which in turn affect coastal areas. With population growth estimated to reach 4 million people in 2026, the marine ecosystem along SEQ will be further impacted. Environmental factors such as poor light, temperature, and turbidity (Fellegara & Harrison 2008) can smother living corals and prevent larval recruitment of reef-building corals. These impacts will further be compounded by stresses such as habitat loss, nutrient runoff, boating and anchoring impacts, overfishing, marine debris and climate change.

SEQ includes various coral communities with a diverse and extensive range of coral growth forms, including offshore sites like Flinders where scientists have recorded up to 119 different coral species (Harrison, Harriot, Banks & Holmes 1998). There are also many other locations with considerable historical and existing coral cover (Wallace, Fellegara, Muir, & Harrison 2009), however, long-term monitoring of these habitats is currently limited.

As habitats and species shift as a result of climate change and anthropogenic impacts, SEQ has garnered recognition as an important area to study and protect (Wallace, Fellegara, Muir, & Harrison 2009), particularly due to its unique assemblages of marine species. RCA's monitoring program provides important long-term data to assess changing health conditions of reefs within SEQ and support appropriate management responses to ensure their long-term survival.



Images from top down: Australian Biscuit Seastar *Pentagonaster duebeni*; Soft Corals; Surveyors in action.

1.0 Introduction

1.1 Key Findings

The 2015 survey season included the monitoring of 33 survey sites. Of these, 28 were existing survey sites and five were new. Two sites; Flat Rock, Shark Alley, Site 1 and Shag Rock West, Site 2 in Outer Moreton Bay were surveyed twice; resulting in 35 surveys completed on 33 sites this season.

The Gold Coast Seaway is an artificial structure where hard coral growth has never been recorded by RCA. Similarly, no hard coral was recorded at the newly established sites at Amity Point and Kirra Reef. Sites without coral cover were excluded from hard coral analysis, including: three established sites at Gold Coast Seaway (2) and Narrowneck Artificial Reef, as well as the new sites at Amity Point and Kirra Reef.

Substrate

• Of the 28 existing sites surveyed, eleven sites experienced a decrease in hard coral cover compared to the previous year while an increase in cover was seen at eight sites. Eight sites remained stable.

• Hard coral cover ranged from 4% at Palm Beach Reef, Site 1 on the Gold Coast to 68% at Flinders Reef, The Nursery, Site 3, Offshore Moreton Bay. The average hard coral cover across all sites was 20%.

• The most significant substrate type recorded across all 35 surveys was rock, attributing an average of 36% 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).

Coral bleaching

• Bleaching was recorded at 90% (28 of 31 surveys with coral), affecting an average of 7% of the coral population on the transect, with an average of 27% of each coral colony affected (an increase from 6% in 2014).

• Inner Moreton Bay sites had the highest regional bleaching average, with just under 14% population level impacted across all sites.

Images from top down: Cowrie mollusc; Hard coral bleaching; Site photo with bleached soft coral.

1.0 Introduction

1.1 Key Findings (Continued)

Coral damage

• 199 incidences of Coral Damage (Other) were recorded over 23 of the 35 surveys. This equates to an average of five counts per survey, with a maximum of 33 counts on a single survey at Shag Rock Island, Shag Rock West, Site 2.

• 36 counts of anchor damage were recorded in total, with 15 instances at Shag Rock Island, Shag Rock West, Site 2 due to a small boat crashing on the site in 2015.

Coral disease

• A total of 40 instances of coral disease were recorded over 13 locations. The highest abundance (13) occurred at Mudjimba (Old Woman) Island, Site 1.

Marine debris

• 153 counts of marine debris were recorded on surveys. Gold Coast Seaway, The Pipe, Site 1 and Amity Point, Site 1 had the highest counts of marine debris (with 46 and 48 respectively).

• Fishing line was found on 14 of the 35 surveys with a total of 116 incidents recorded.

• The most significant record of fishing line was documented at the Gold Coast Seaway, The Pipe, Site with 46 incidents recorded, followed by Amity Point, Site 1 with 39 incidents.

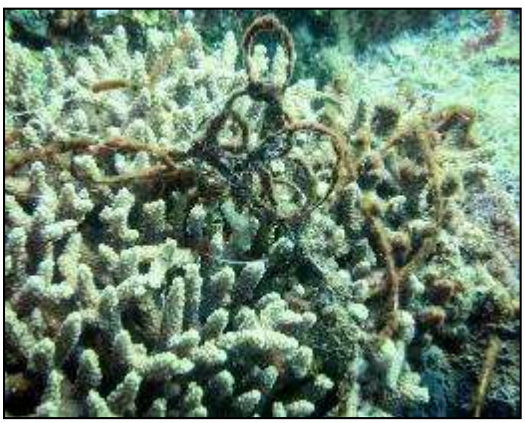
Coral scarring

• Of the 214 incidents of coral scarring recorded, 195 were unknown in origin with the highest number (28) recorded at Myora Reef, Site 1 in Inshore Moreton Bay.

***Drupella* sp. snails**

• Out of the 35 surveys, *Drupella* snails were recorded over 11 locations. A total of 113 *Drupella* snails were recorded, with a maximum of 23 recorded at two locations (Myora Reef, Site 1 and Palm Beach Reef, Site 1).

• *Drupella* scars were observed at five of the 33 sites with the highest abundance (6) at Myora Reef, Site 1.



Images from top down: Damaged and bleached hard coral; Coral Disease; Fishing line on branching hard coral

1.0 Introduction

1.1 Key Findings (Continued)

Invertebrate Abundance

• Anemones were the most abundant invertebrate recorded with a total of 465 documented. The highest count, 159, was recorded at Palm Beach Reef, Site 2.

• Long spined (*Diadema*) urchins were the second most abundant invertebrate with a total of 266 recorded.

• Fifteen Giant Clams were recorded over the season with five being recorded at Flinders Reef, Alden's Cave, Site 1.

• Over the 35 surveys, 98 pencil urchins, 68 collector urchins, 3 banded coral shrimp, 3 lobsters, 2 *Trochus* and 2 Tritons were recorded.

• No Crown of Thorns Starfish (COTS) were recorded during the 2015 survey season.

Fish Abundance

• Fish surveys were carried out on 11 of the 35 survey dives.

• Butterflyfish were the most abundant target fish species with a total of 100 counts. Twenty- five of the 100 were recorded at Myora Reef, Site 1.

• A total of 9 sweetlips, 18 snapper, 2 groupers, 1 barramundi cod, 1 moray eel, 1 bumphead parrotfish and 2 other parrotfish were recorded over the 11 fish surveys.

Rare animals

• Rare animals sighted during the surveys included wobbegong sharks (6), juvenile lionfish (1), rock cod (1), whiting (1), cuttlefish (1), turtles (8), lobster (1), black-tip reef shark (1), octopus (1) and a grey carpetshark (1).

Images from top down: Giant Clam; Butteflyfish; Grey Carpetshark

1.0 Introduction

Table 1. Summary table of RCA monitoring findings for surveys conducted in Sunshine Coast and Inner Moreton Bay in 2015 season. Information includes: average hard and soft coral cover (%), change in hard coral cover from 2014, total macro algae abundance, abundance of reef impacts (*Drupella* scars, unknown scars, coral damage, average coral bleaching of population %, average coral bleaching for colony surface %); and silt levels (N=none, L=low, M=medium, H=high).

Basic site summary						Presence of Impacts								
	Hard Coral Coverage (%)	Soft Coral Coverage (%)	Macroalgae (MA) per 80m transect	% Nutrient Indicator Algae (NIA)	Silt Loading	Drupella Scar (#)	Unknown Scar (#)	Anchor Damage (#)	Coral Damage (#) (unknown causes)	Fishing Line (#)	Fishing Net (#)	General Trash (#)	Coral Disease (#)	Coral population Bleaching (%)
Currumundi S1	33	14	13	1	N	0	5	0	3	0	0	0	1	1
Currumundi S2	25	10	26	4	N	0	1	0	1	1	0	0	2	1
Inner Gneerings S1	35	3	48	0	L	0	7	0	4	0	0	0	0	6
Inner Gneerings S2	33	9	7	1	L	0	10	0	1	0	0	2	0	0
Kings Beach	5	1	20	0	L	0	0	0	0	0	0	0	0	0
Mudjimba Island The Ledge S1	20	2	0	0	L	0	0	0	1	2	0	3	14	1
Mudjimba Island The Ledge S2	20	14	0	0	L	0	6	0	0	0	0	0	0	0
Mudjimba Island The Ledge S3	36	8	40	46	L	3	0	0	0	2	0	0	1	<1
Mudjimba Island Northwest Reef	18	1	0	1	L	0	12	0	0	1	0	0	1	1
Amity Point S1	0	1	0	0	H	0	0	0	0	39	0	9	0	N/A
Goat Island S1	44	16	0	0	N	0	0	5	9	0	0	0	0	6
Goat Island West S1	22	17	0	0	L	0	4	0	8	0	0	0	0	28
Green Island S1	6	23	30	13	L	0	1	0	0	0	0	0	0	20
Myora Reef S1	31	0	9	3	M	6	28	0	9	0	0	0	0	6
Myora Reef S2	32	0	7	6	N	0	12	0	2	0	0	0	0	0
Macleay Island S1	11	15	24	0	H	0	0	0	1	0	0	0	0	<1
Peel Island North S1	11	21	5	21	L	0	13	10	5	0	0	0	0	8
Peel Island East S1	11	22	22	23	M	0	5	0	5	2	0	0	0	35
Peel Island Northeast S1	10	2	5	5	M	0	2	0	1	0	0	4	0	11

1.0 Introduction

Table 2. Summary table of RCA monitoring findings for surveys conducted in Outer Moreton Bay and Gold Coast comparing 2015 and 2014 findings, including a basic summary of the survey findings with regards to substrate composition, change in coral cover, algae presence and silt loading as well as a summary of the recorded impacts at each site.

	Basic site summary					Presence of Impacts								
	Hard Coral Coverage (%)	Soft Coral Coverage (%)	Macroalgae (MA) per 80m transect	% Nutrient Indicator Algae (NIA)	Silt Loading	Drupella Scar (#)	Unknown Scar (#)	Anchor Damage (#)	Coral Damage (#) (unknown causes)	Fishing Line (#)	Fishing Net (#)	General Trash (#)	Coral Disease (#)	Coral Bleaching per population (%)
Flat Rock Shark Alley S1	16	1	25	16	N	0	3	0	16	1	0	0	2	4
Flat Rock The Nursery S1	16	3	21	24	N	3	3	0	6	0	0	0	0	5
Flinders Reef Nursery S1	24	19	21	0	N	1	2	0	0	0	0	2	0	1
Flinders Reef Nursery S2	68	1	0	9	L	0	6	0	3	0	0	0	1	2
Flinders Reef Alden's Cave S1	46	12	22	1	N	0	8	0	1	0	0	0	3	35
Flinder's Reef Alden's Cave S3	41	16	24	0	N	0	11	0	0	0	0	0	1	1
Shag Rock West S2	6	2	0	26	L	1	15	0	21	4	0	0	0	3
Shag Rock East S1	17	9	4	7	L	10	7	2	37	4	1	0	8	7
Gold Coast Seaway SW Wall S1	N/A	N/A	0	0	H	0	0	0	0	5	0	3	N/A	N/A
Gold Coast Seaway The Pipe S1	N/A	N/A	0	0	H	0	0	0	0	46	0	0	N/A	N/A
Narrowneck Artificial Reef, Site 1	N/A	N/A	21	44	N	0	0	0	0	0	0	0	N/A	N/A
Kirra Reef, Site 1	N/A	N/A	45	6	N	0	0	0	0	1	0	1	N/A	N/A
Palm Beach Reef, Site 1	4	6	3	16	L	0	0	0	3	0	0	0	0	1
Palm Beach Reef, Site 2	17	3	0	18	L	0	0	0	0	0	0	0	3	3

1.0 Introduction

1.2 Regional Summary

The SEQ region is broken down into the four sub-regions: Sunshine Coast, Inshore Moreton Bay, Outer Moreton Bay, and the Gold Coast. All survey site locations are included in the chart below (including those not surveyed in 2015).

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			

The Outer Moreton Bay and Sunshine Coast sub-regions had the highest average hard coral cover with 25% followed by the Inshore Moreton Bay sub-region with an average hard coral cover of 20% (Figure 1). The average hard coral cover for the entire SEQ region was 20% . The Gold Coast region had the lowest average hard coral cover with just 11% based on data from two surveys at Palm Beach Reef. Note that the Gold Coast Seaway Sites, Narrowneck Artificial Reef and Kirra Reef were excluded from this analysis due to no hard coral being recorded here.

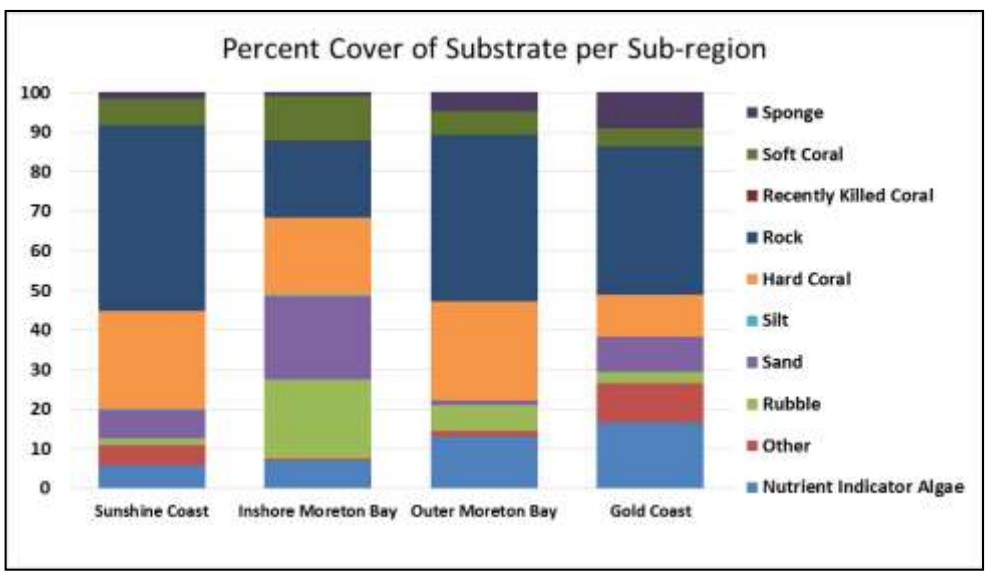


Figure 1. Percent cover of substrate for SEQ sub-regions in 2015 survey season.

Inshore Moreton Bay sites experienced the highest average coral bleaching per survey both at the level of individual coral colonies (12.6% average) as well as whole coral population (34% average). Outer Moreton Bay had the second highest coral bleaching levels, with an average of 9.1% of the coral population exhibiting signs of bleaching, and 29.2% of individual coral colonies. The Gold Coast had the lowest average bleaching (2.0 % of the total population), though low coral cover and a small number of sites contributes to this outcome (Figure 2).

1.0 Introduction

1.2 Regional Summary (Continued)

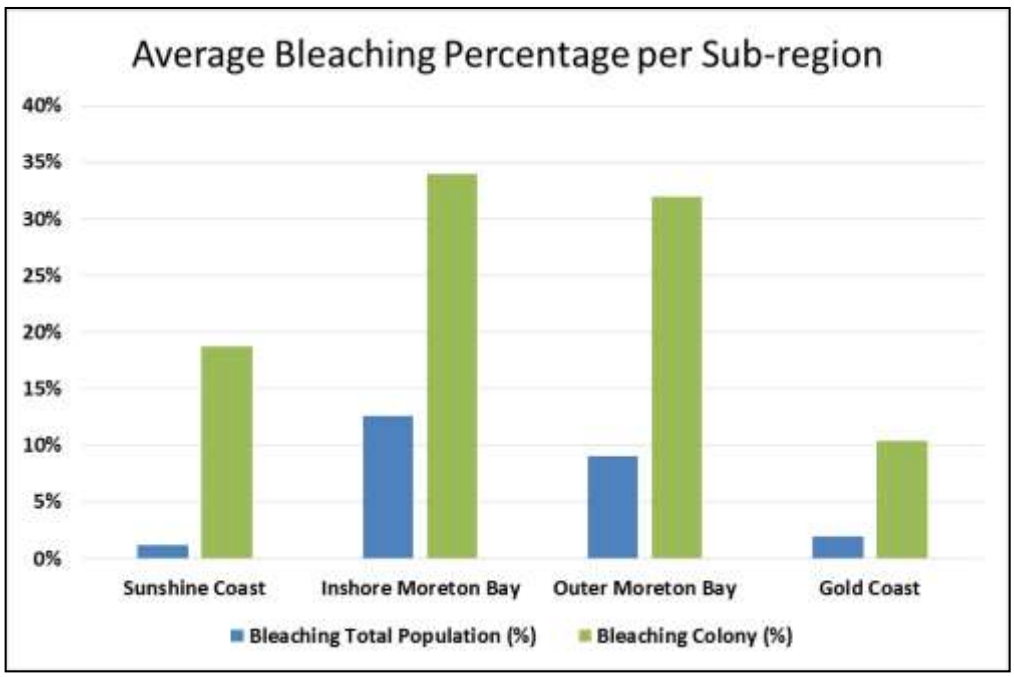


Figure 2. Average bleaching percentage per survey within the SEQ sub-regions.

While the Outer Moreton Bay surveys have recorded the highest coral cover, they also exhibited the highest average number of impacts per survey (an average of 25 incidents per 400m²) (Figure 3). The Sunshine Coast saw the lowest number of impacts with an average of just over 10 incidents per 400m^2 transect. While the composition of the impacts varied by sub-region, all contained counts of Coral Damage (Other), Fishing Line and Trash General.

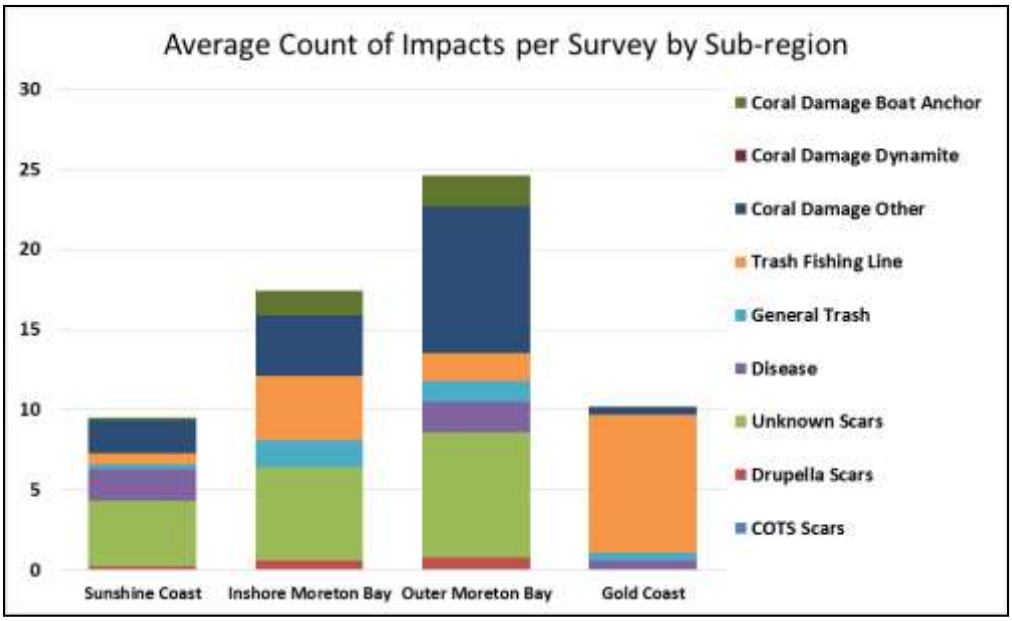


Figure 3. Average count of impacts per survey within the SEQ sub-regions.

1.1 Monitoring Sites

1.3 Monitoring Sites

RCA monitoring sites ranged from Mudjimba Island on the Sunshine Coast to Kirra Reef on the Gold Coast (See Figure 4 for map locations). Sites surveyed by RCA include varied reef habitats such as inshore and offshore areas as well as reef flats and reef slopes. For contrast and comparison, protected (marine national park, no-take areas) and non-protected areas were surveyed. Most surveys (18) were conducted within Moreton Bay Marine Park. During the 2015 SEQ season, RCA established five new sites, increasing the total number of RCA sites along the SEQ coast to 42. Thirty-three of these were surveyed during the 2015 survey season. Other monitoring locations were not re-visited due to weather related issues and funding restrictions.

Figure 4. Map of South East Queensland survey sites from Google Earth

1.1 Monitoring Sites

Table 3. Table of RCA monitoring locations in the Sunshine Coast visited in the 2015 SEQ season, including site number, location, depth, year of initial survey and site designation including 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	9	2013	N/A
Sunshine Coast	1	Kings Beach	3	2009	HP
Sunshine Coast	1	Mudjimba Island, The Ledge	6	2007	N/A
Sunshine Coast	2	Mudjimba Island, The Ledge	10	2013	N/A
Sunshine Coast	3	Mudjimba Island, The Ledge	6	2013	N/A
Sunshine Coast	1	Mudjimba Island, NW Reef	9	2013	N/A

1.1 Monitoring Sites

Table 4. Table of RCA monitoring locations in Inner Moreton Bay visited in the 2015 SEQ season, including site number, location, depth, year of initial survey and site designation including 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
Inshore Moreton Bay	1	Amity Point	5	2015	MNP
Inshore Moreton Bay	1	Goat Island	1	2009	CP, Ramsar
Inshore Moreton Bay	1	Goat Island West	2	2014	MNP
Inshore Moreton Bay	1	Green Island	2	2015	MNP
Inshore Moreton Bay	1	Myora Reef	3	2009	MNP, Ramsar
Inshore Moreton Bay	2	Myora Reef	2	2014	MNP, Ramsar
Inshore Moreton Bay	1	Macleay Island	1	2009	MNP
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	3	2014	MNP

1.1 Monitoring Sites

Table 5. Table of RCA monitoring locations in Outer Moreton Bay and Gold Coast visited in the 2015 SEQ season, including site number, location, depth, year of initial survey and site designation including 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, The Nursery	6	2007	MNP
Outer Moreton Bay	2	Flinders Reef, The Nursery	9	2009	MNP
Outer Moreton Bay	1	Flinders Reef, Alden's Cave	10	2008	MNP
Outer Moreton Bay	3	Flinders Reef, Alden's Cave	10	2015	MNP
Outer Moreton Bay	2	Shag Rock, West	6	2009	HP
Outer Moreton Bay	1	Shag Rock, East	6	2008	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
Gold Coast	1	Narrowneck Artificial Reef, Site 1	6	2007	N/A
Gold Coast	1	Kirra Reef	5	2016	N/A
Gold Coast	1	Palm Beach	9	2007	N/A
Gold Coast	2	Palm Beach	9	2009	N/A

2.0 Sunshine Coast

2.0 Sunshine Coast Sites

2.1 Currimundi Reef, Site 1

Currimundi Reef is situated on the reef flat at nine meters on an exposed rocky outcrop, off the Currimundi Coast. The site was added to the Reef Check reef health survey list in 2009, to gain a better spread of the southern Sunshine Coast reefs. This site is not frequented by divers, fishers or boaters.

Hard coral represented 33% of the total substrate at the Currimundi Reef Site 1; a decrease from 43% recorded in 2014. Of the hard coral, encrusting growth forms attributed 19% and massive growth forms attributed 13%. Rock (including rock with turf algae and rock with coralline algae) accounted for 47% of the benthos. Soft coral attributed 14%, and the 'other' category (consisting primarily of ascidians and crustose algae) accounted for an additional 4%. *Asparagopsis* was the only macro algae recorded on the transect (with thirteen counts).

Four anemones (none containing anemone fish) were the only indicator invertebrates recorded on the transect.

Bleaching affected 1% of the coral population and an average of 23% of the surface of coral colonies The impact survey recorded five incidents of unknown scars, three counts of other coral damage and one count of coral disease.

A fish survey was carried out; five snappers and five butterflyfish were recorded.

Site photo, Currimundi Reef, Site 1

Hard coral bleaching, Currimundi Reef, Site 1

Bornella anguilla Nudibranch, Currimundi Reef, Site 1

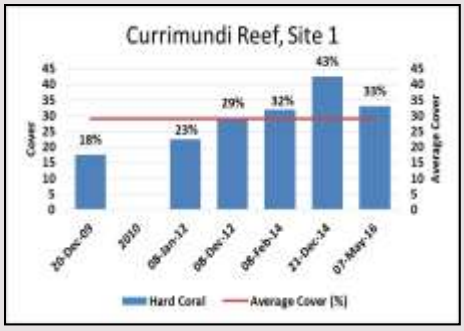


Figure 5: Hard Coral cover as a percent of total substrate

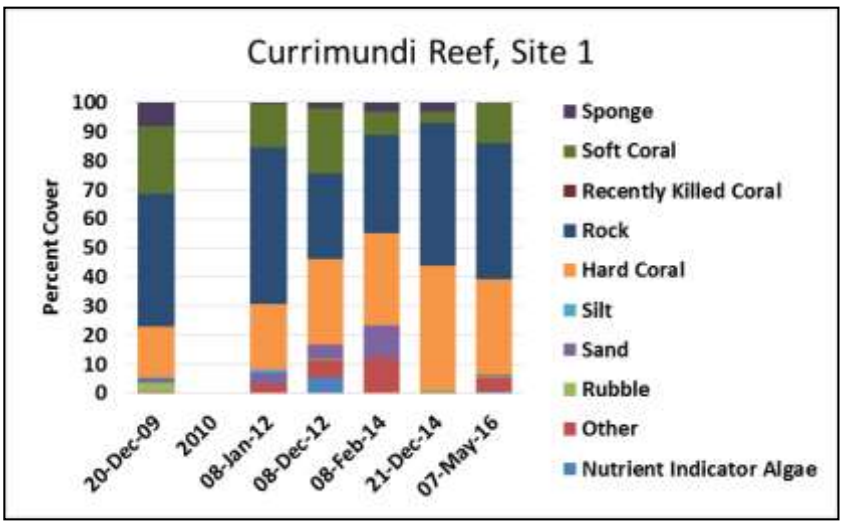


Figure 6. Benthic type and percent cover: Currimundi Reef, Site 1, 2009- 2016.

2.0 Sunshine Coast Sites

2.2 Currimundi Reef, Site 2

Currimundi Reef is situated at nine meters on an exposed rocky outcrop, off the Currimundi Coast. Currimundi Reef, Site 2 is not frequented by divers, fishers or boaters. This site is located on the reef flat adjacent to Currimundi Reef, Site 1, and was established in 2009.

Recorded hard coral cover at Currimundi Reef, Site 2 decreased from 34% in 2014 to 25% in 2016. The dominant hard coral growth form was encrusting, making up 19% of the substrate overall. Soft coral accounted for 10% of substrate cover (an increase from 6% in 2014). The remaining benthic surface was composed of rock (34%), the general 'other' category (10%; made up of crustose algae), sponge (1%), sand (9%), rubble (8%) and nutrient indicator algae (4%). *Asparagopsis* was the only macro algae recorded at this site, with 24 counts.

Three anemones (none of which contained anemone fish) were the only indicator invertebrates recorded.

One percent of the overall coral population was recorded bleached with only 3% average percentage of bleaching per affected colony. There were two instances of coral disease, one unknown scar, one count of fishing line and one incidence of other coral damage.

A fish survey was completed; eight snappers and two butterflyfish were recorded.

Site photo, Currimundi Reef, Site 2

Leathery soft corals, Currimundi Reef, Site 2

Surveyors in action, Currimundi Reef, Site 2

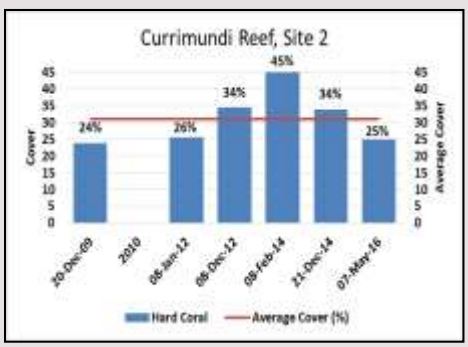


Figure 7: Hard Coral cover as a percent of total substrate

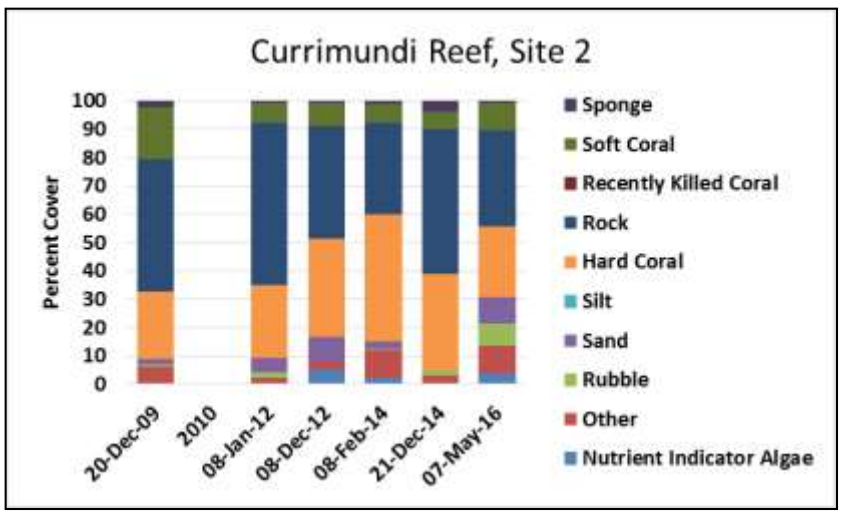


Figure 8. Benthic type and percent cover: Currimundi Reef, Site 2, 2009- 2016.

2.0 Sunshine Coast Sites

2.3 Inner Gneerings, The Caves, Site 1

This reef is situated off shore from Mooloolaba and covers a wide area of depths from 10 to 25m. The Caves, Site 1 is located at 10 meters deep on the reef floor. It is characterised by scattered rocky outcrops surrounded by coral, sponge and a collapsed cave structure, hence the name. This site is popular for recreational fishing and diving. This site has been surveyed annually since 2009.

The substrate composition at Inner Gneerings Site 1 has been relatively consistent since the site was set up in 2009, with rock (49%), hard coral (35%) and sand (10%) making up the majority of the site in 2015. Hard coral encrusting continues to be the dominant growth form, attributing 40% to the substrate. Hard coral cover has increased steadily since 2009 (20%), increasing 7% from last year (28% in 2014 to 35% in 2015). *Asparagopsis* was the only macro algae recorded at this site with 48 counts.

One giant clam was the only invertebrate found.

Bleaching was recorded on all transects at this site, affecting an average of 6% of the coral population, and an average of 48% of each coral colony affected (a notable increase from 12% in 2014). Seven incidents of scarring from an unknown source and four incidents of coral damage (other) were recorded at this site in 2015, compared to 30 and 5 respectively in 2014.

A fish survey was completed at this site; 38 butterfly fish were recorded.

Site photo, The Caves, Site 1

Unknown scar, The Caves, Site 1

Giant clam, The Caves, Site 1

Figure 9: Hard Coral cover as a percent of total substrate

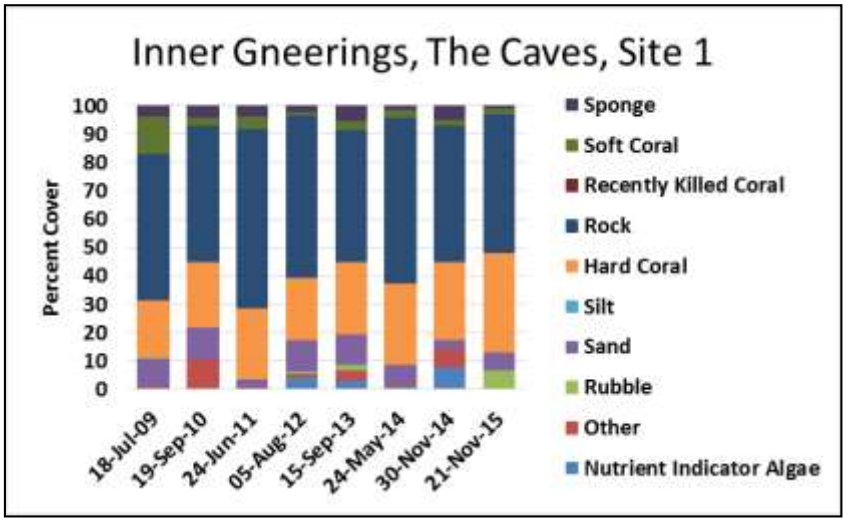


Figure 10. Benthic type and percent cover: Inner Gneerings, The Caves, Site 1, 2009- 2015.

2.0 Sunshine Coast Sites

2.4 Inner Gneerings, The Caves, Site 2

This reef is situated off shore from Mooloolaba and covers a wide depth range from 10 to 25m. Site 2 is situated approximately 150m parallel to Site 1 at a depth of 10m. This site was added to the RCA reef health survey site list in 2013 to gain a better understanding of this highly utilised reef structure. This site has been surveyed annually since it was established in 2013.

The substrate at Inner Gneerings, The Caves, Site 2 has remained relatively consistent since 2013, with rock (38%), hard coral (33%) and sand (10%) making up the majority of the site. Encrusting growth forms are the dominant hard coral structures, making up 82%, with branching growth forms attributing approximately 12%. The umbrella 'other' substrate category accounted for 4% of the benthos, consisting mostly of ascidians. The only macro algae recorded on the survey was *Asparagopsis,* with seven counts.

One anemone (with fish) was the only target invertebrate recorded at this site for 2015.

No bleaching was recorded at this site in 2015; a decrease from 2014 results in which 2% of the coral population showed signs of bleaching. One incident of unknown coral damage, ten unknown scars and two pieces of fishing debris were recorded in November.

A fish survey was completed at this site. Two butterfly fish and one sweetlip were recorded.

Site photo, The Caves, Site 2

Phyllidia varicosa nudibranchs mating, The Caves, Site 2

Macro Algae *Asparagopsis*, The Caves, Site 2

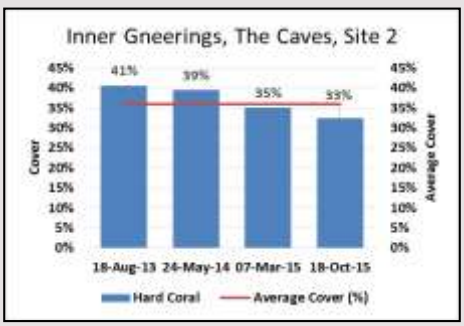


Figure 11: Hard Coral cover as a percent of total substrate

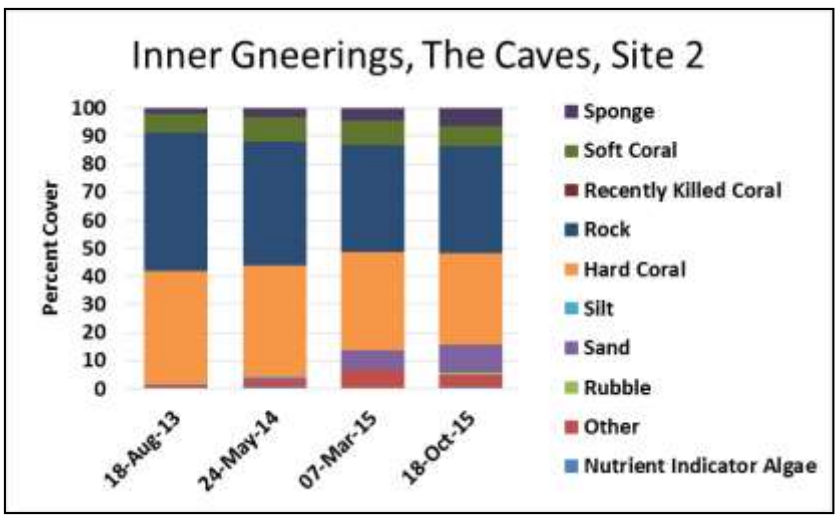


Figure 12. Benthic type and percent cover: Inner Gneerings, The Caves, Site 2, 2009- 2015.

2.0 Sunshine Coast Sites

2.5 Kings Beach, Site 1

Site photo, Kings Beach, Site 1

Fishing Line, Kings Beach, Site 1

Zoanthids, Kings Beach, Site 1

Figure 13: Hard Coral cover as a percent of total substrate

The site is located approximately 100m offshore, adjacent to a frequently utilized boat ramp and near to Caloundra's popular beach front area. This site is situated at a depth of three meters, and was added to the RCA reef health survey list in 2009, to gain a better understanding of reefs of the southern Sunshine Coast. 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 (14% to 2%). Annual monitoring efforts have shown signs of recovery of the site over time, however continued monitoring is required to document potential changes in the future.

Hard corals accounted for 5% of the benthos; 100% of which was encrusting growth forms. Rock (including rock with turf algae and rock with calcareous algae) attributed 64% to the substrate in 2015. Sand attributed 23%, and the 'other' category (consisting primarily of ascidians and crustose algae) accounted for an additional 5%. Twenty counts of macro algae were recorded; all of which were *Padina;* the second most dominant algae on the survey (turf algae being the first).

One *Drupella* snail was the only invertebrate recorded on site.

No bleaching was recorded on this site during the 2015 season; and less than 1% coral population bleaching was recorded in 2014. No other impacts were recorded this survey year (2015). A low silt loading level was recorded.

A fish survey was not conducted at this site for 2015.

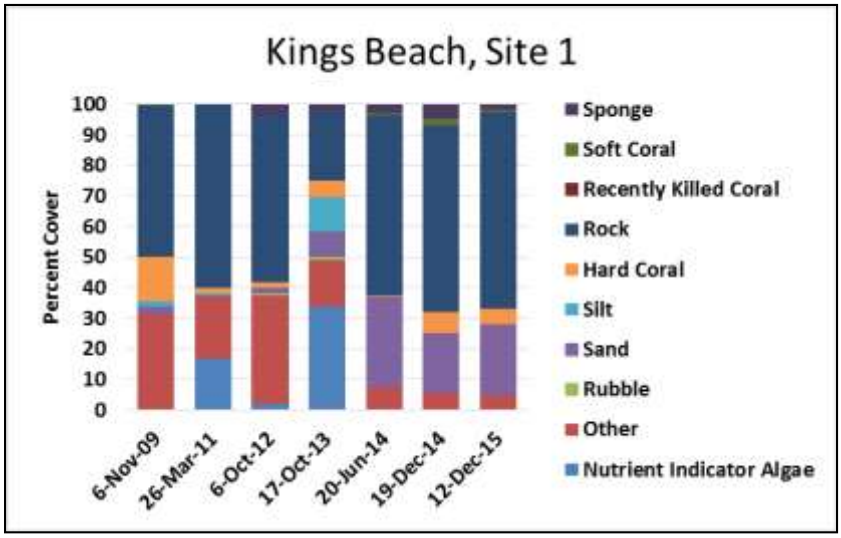


Figure 14. Benthic type and percent cover: Kings Beach, Site 1, 2009- 2015.

2.0 Sunshine Coast Sites

2.6 Mudjimba Island, The Ledge, Site 1

Mudjimba Island is located just off the mainland, close to Maroochydore and the Mooloolah River Mouth. It is a popular location for a variety of in water activities including fishing, diving and surfing. The RCA site 'The Ledge' Site 1 is situated on the reef flat at a depth of five meters, on the southern side of Mudjimba Island.

Hard coral (consisting primarily of encrusting growth forms) represented 20% of the total substrate cover at this site in 2015; a decrease from 39% recorded in 2014. Rock accounted for 53% of the benthos in 2015; an increase from 32% recorded in 2014. Sand (16%), soft coral (2%), the 'other' category (7%) and sponges (3%) also contributed to the benthic surface. No macro algae has been recorded at this site since 2009.

During the 2015 surveys, one anemone without fish was the only invertebrate recorded.

Bleaching affected 1% of the coral population and affected an average of 19% of the surface of colonies. This is a decrease from 2014 recorded levels (9% of the coral population and 21% of the surface of colonies). One incident of other coral damage and fourteen incidents of coral disease were recorded (an increase from 4 in 2014). Two counts of fishing line and three counts of general trash were recorded on the transect.

A fish survey was completed. One moray eel was recorded.

Site photo, The Ledge, Site 1

Linckia laevigata Sea Star, The Ledge, Site 1

Bleached soft coral, The Ledge, Site 1

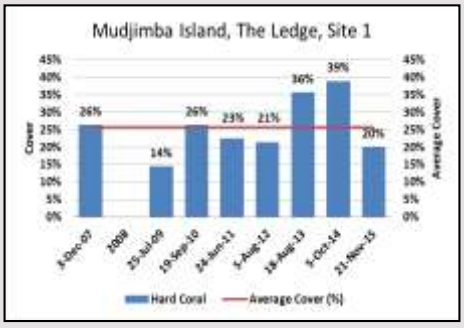


Figure 15: Hard Coral cover as a percent of total substrate

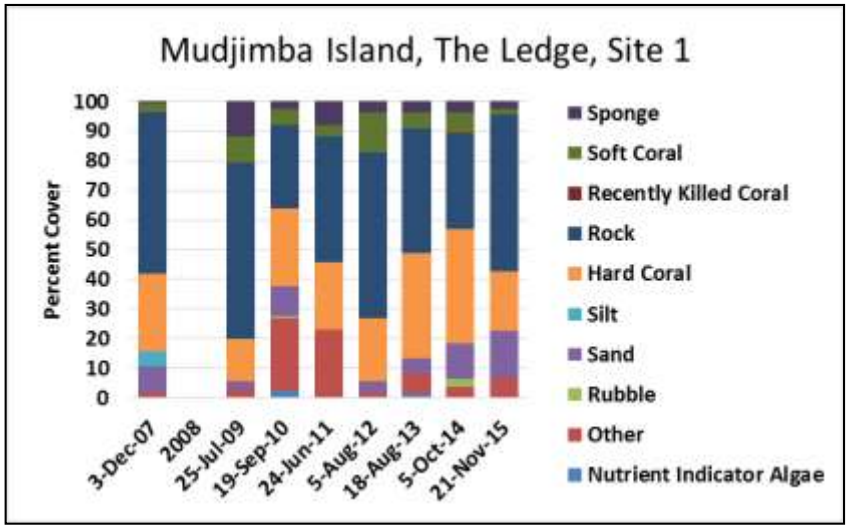


Figure 16. Benthic type and percent cover: Mudjimba Island, The Ledge, Site 1, 2007- 2015.

2.0 Sunshine Coast Sites

2.7 Mudjimba Island, The Ledge, Site 2

Site photo, The Ledge, Site 2

Sea star, The Ledge, Site 2

Hypselodoris tryoni Nudibranchs, The Ledge, Site 2

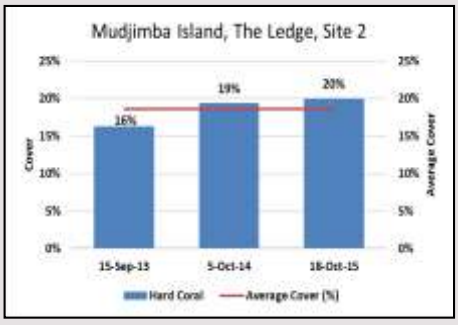


Figure 17: Hard Coral cover as a percent of total substrate

Mudjimba Island is located just off the mainland, close to Maroochydore and the Mooloolah River Mouth. It is a popular location for a variety of in water activities including fishing, diving and surfing. The RCA site 'The Ledge' Site 2 was established in 2013 to gather more information about this highly utilised area. Site 2 is situated on the reef slope at a depth of nine meters, and sits parallel to Site 1 on the southern side of Mudjimba Island. This deeper location represents a different habitat type to the long-established research Site 1.

Hard coral accounted for 20% of substrate in 2015, consistent with 2014 (19%) results, and consisting primarily of encrusting growth forms (14%). Rock (including rock with turf algae and rock with calcareous algae) attributed 55% to the benthos, with soft coral making up 14%. The remaining benthic surface was composed of the general 'other' category (6%; made up of corallimorphs and crustose algae), sponge (3%), sand (1%) and silt (1%). No counts of macro algae were recorded.

Four anemones; one with fish, three without, were the only invertebrates recorded.

Coral bleaching was recorded in low levels with only two instances recorded, with an average of 11% of the colony impacted. The only additional impacts recorded were two coral scars of unknown origin.

A fish survey was completed in 2015. Three butterflyfish and three sweetlips were recorded.

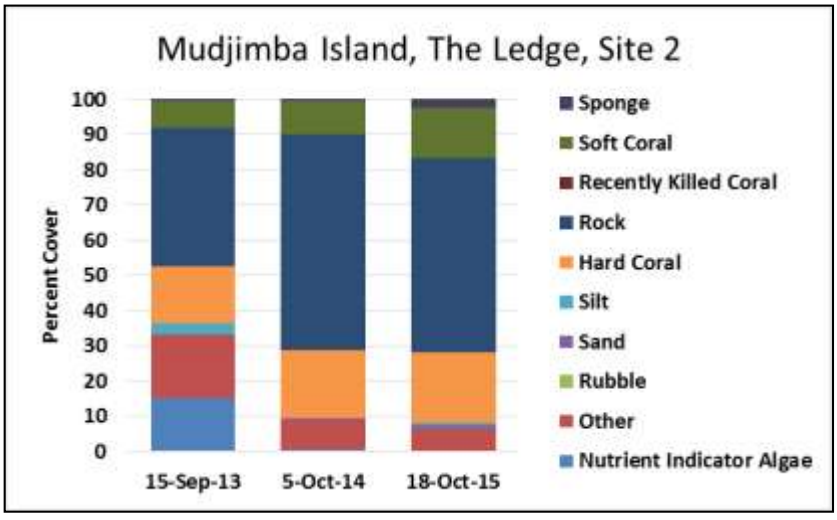


Figure 18. Benthic type and percent cover: Mudjimba Island, The Ledge, Site 2, 2013-2015.

2.0 Sunshine Coast Sites

2.8 Mudjimba Island, The Ledge, Site 3

Site photo, The Ledge, Site 3

Spiny Lobster, The Ledge, Site 3

Anemone with fish, The Ledge, Site 3

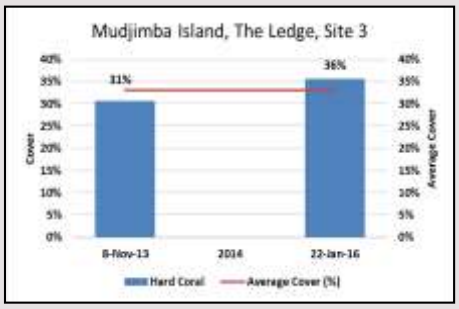


Figure 19: Hard Coral cover as a percent of total substrate

Mudjimba Island is located just off the mainland. It is a popular location for a variety of in water activities. The RCA site 'The Ledge' Site 3 was established in 2013, to gather more information about this highly utilised area. Site 3 is situated on the reef slope at a depth of six meters, and sits in between the shallow Site 1 and the deep Site 2 on the reef crest on the southern side of the island. This additional location represents a different habitat type to Site 1 and 2 - despite their close proximity to each other.

Hard coral accounted for 36% of substrate in 2015, a slight increase from 2013 results (31%), consisting primarily of encrusting growth forms (27%). Nutrient indicator algae attributed 46% to the benthic cover (an increase from 17% in 2013), with soft coral attributing 8%. The remaining benthic surface composed of the general 'other' (4%) category and rock (7%). Forty counts of macro algae were recorded.

One anemone with fish, one lobster, two *Drupella* snails and one *Diadema* long spined urchin were recorded on the invertebrate survey.

Coral bleaching was recorded in low levels with less than 1% of the coral population and 36% per individual bleached colony exhibiting signs of bleaching. Seven incidents of coral damage, one incident of coral disease, three *Drupella* scars and two counts of fishing debris (fishing line) were recorded.

A fish survey recorded three butterflyfish, three sweetlips, one grouper and one moray eel.

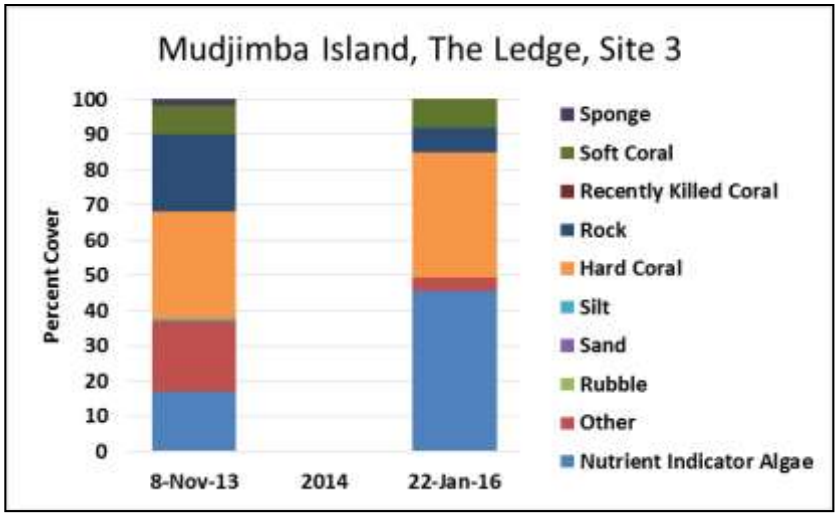


Figure 20. Benthic type and percent cover: Mudjimba Island, The Ledge, Site 3, 2013-2016.

2.0 Sunshine Coast Sites

2.9 Mudjimba Island, North West Reef, Site 1

Site Photo, North West Reef, Site 1

Bleached hard coral, North West Reef, Site 1

Moray eel and anemone, North West Reef, Site 1

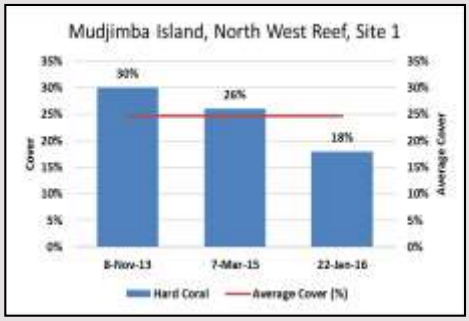


Figure 21: Hard Coral cover as a percent of total substrate

Mudjimba Island is located just off the mainland, close to Maroochydore and the Mooloolah River Mouth. It is a popular location for a variety of in water activities. In 2013, the North West Reef off Mudjimba Island was included as part of new SEQ survey sites to gather more information about this highly utilised area. This site faces the North West side of the island, and is situated at a depth of eight meters. It varies substantially from the southern sites, offering new insights to this culturally and ecologically important location.

Hard coral accounted for 18% of the benthos in 2015, a decrease from 2014 levels (26%), consisting primarily of encrusting growth forms (16%). Soft coral attributed just 1% to the benthos in 2015; a decrease from 8% in 2014. Rock (including rock with turf algae) made up 75% of the overall substrate recorded. The overall 'other' category (consisting primarily of ascidians) showed little change from 5% in 2014 to 4% in 2015. No macro algae has been recorded at this site since 2013.

Six anemones; four with fish, two without, were recorded.

An average of just 1% of the coral population and 29% of the coral colony was recorded as bleached. This is a decrease from 2014 recorded levels when 14% of the coral population, and an average of 42% of any impacted colony was bleached. Twelve incidents of coral scars of unknown origin, one incidence of coral disease, and one piece of fishing line were recorded.

No fish survey was conducted in 2015.

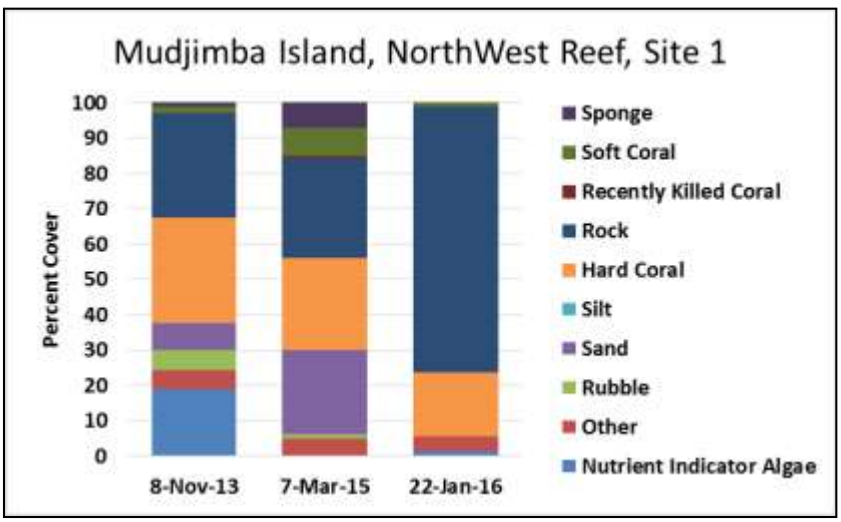
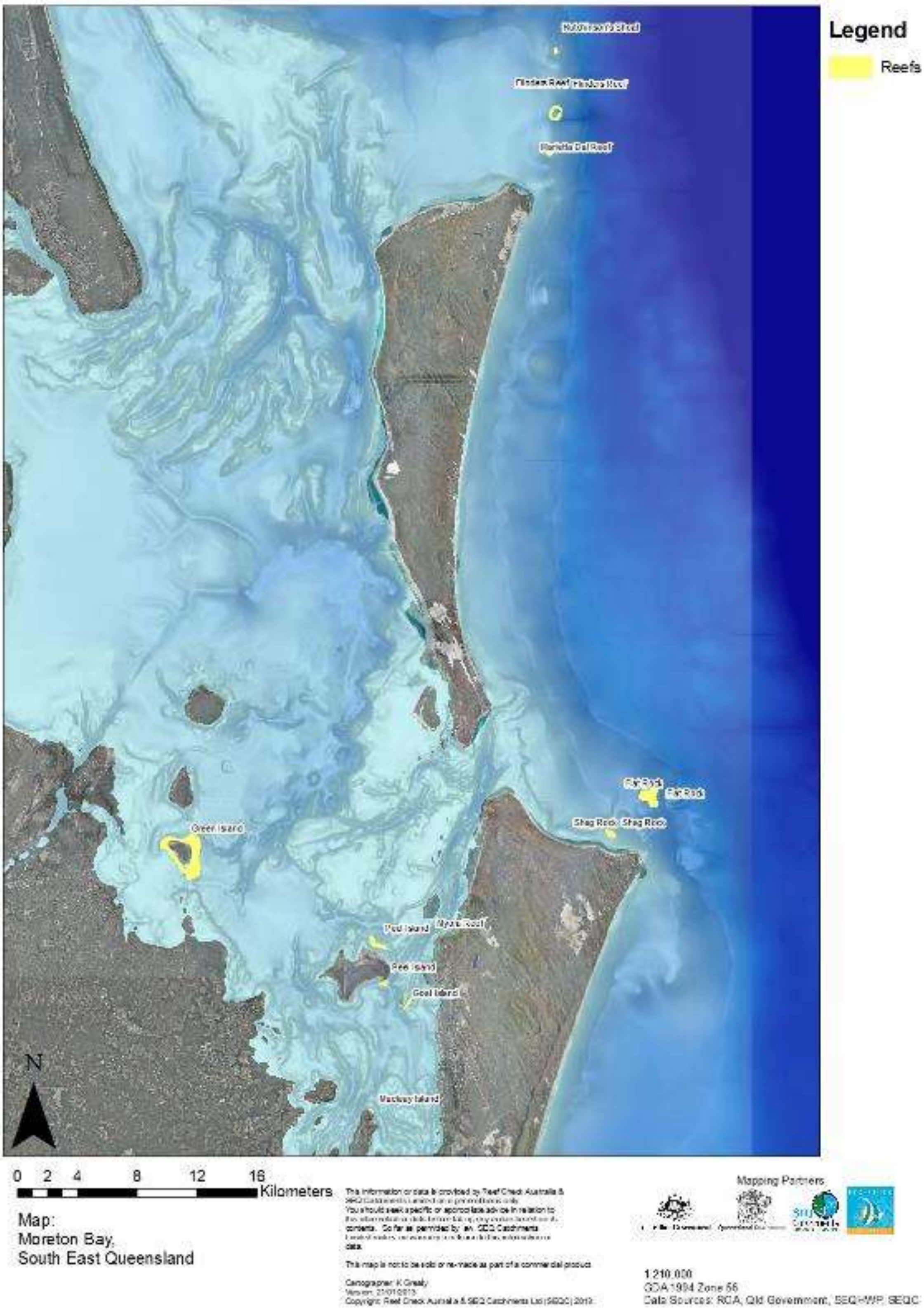


Figure 22. Benthic type and percent cover: Mudjimba Island, North West Reef, Site 1, 2013-2016.

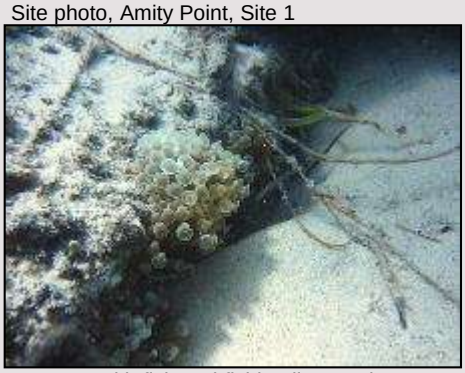
3.0 Moreton Bay



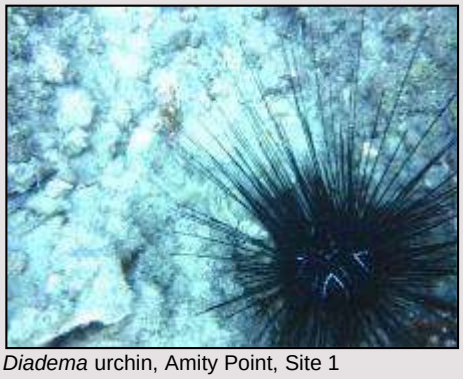
REEF CHECK

AUSTRALIA

Site photo, Amity Point, Site 1



Anemone with fish and fishing line, Amity Point, Site 1



Diadema urchin, Amity Point, Site 1

Porcupine fish, Amity Point, Site 1

***Note: No hard coral was recorded at Amity Point.**

3.0 Inshore Moreton Bay Sites

3.1 Amity Point, Site 1

Amity Point is one of the newly established sites in 2015. It is located on the south west end of North Stradbroke Island, and is frequented by vast numbers of fishers, boaters and divers all year round. The site is adjacent to a busy boat ramp and artificial rock wall near a popular camping and fishing ground. This site was added to the Inshore Moreton Bay survey sites to better understand and record impacts on this heavily utilized site. The site is situated at a depth of six meters, on the sandy slope parallel to the rock wall.

No hard coral was recorded at this site. The benthos at this site is dominated by sand (73%), sponge (4%), silt (2%) and rubble (2%). Soft coral attributed just 1%. The Other category accounted for 4%; made up primarily of ascidians.

One anemone with fish and 38 *Diadema* long spined urchins were recorded on the invertebrate survey.

Impacts recorded on the survey include; 39 counts of fishing line and nine counts of other general trash, including two car tyres and a rope.

A fish survey was not conducted in 2015.

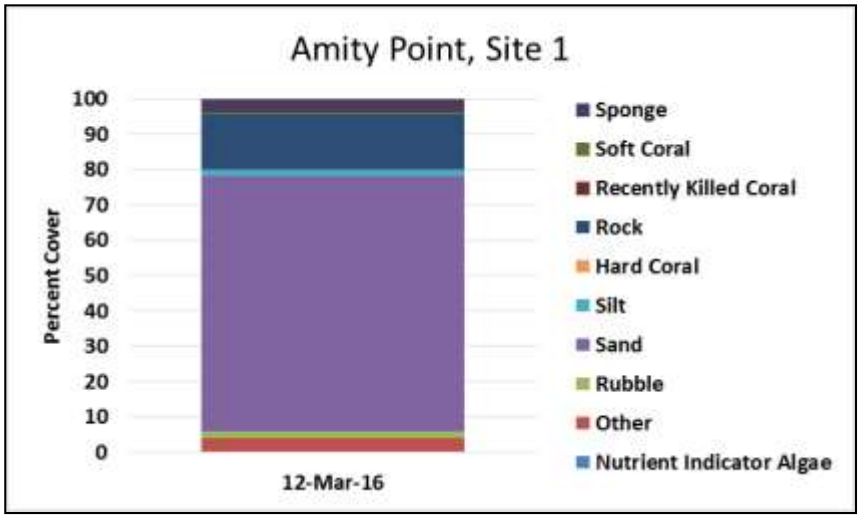


Figure 23. Benthic type and percent cover: Amity Point, Site 1, 2016

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 sandy reef fringes the island. Goat Island, Site 1 is situated at a depth of approximately one meter and was established in 2009. This site is exposed to regular traffic, and surge from the nearby boat channel, where the North Stradbroke Island ferries travel.

Hard coral abundance increased by 14% from last year (44% compared to 30% in 2014). Soft coral has been stable over the past eight years, attributing 16% to the benthos in 2015 (19% in 2014, 15% in 2013 and 15% in 2012). Sand attributed 19% to the substrate, and rubble made up 14%. No macro algae was recorded at this site.

No invertebrates were recorded on transect in 2015. One *Drupella* snail was documented in 2014; the only invertebrate sighted at this location since 2010.

Coral bleaching was estimated to affect 6% of the total coral population; a notable decrease from bleaching levels in 2014 (56%) and 2013 (53%). The average of the colony impacted was 49%, also a decrease from 2014 results (79%). Additional impacts recorded include nine incidents of coral damage, five incidents of anchor damage, and five unknown scars. Counts of trash have been recorded at this site since 2010, however no trash was recorded in 2015.

A fish survey was not conducted in 2015.

Site photo, Goat Island, Site 1

Unknown scar, Goat Island, Site 1

Hard coral bleaching, Goat Island, Site 1

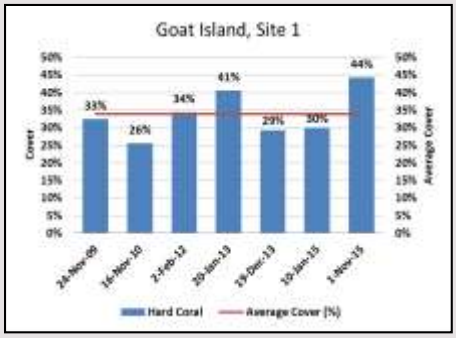


Figure 24: Hard Coral cover as a percent of total substrate

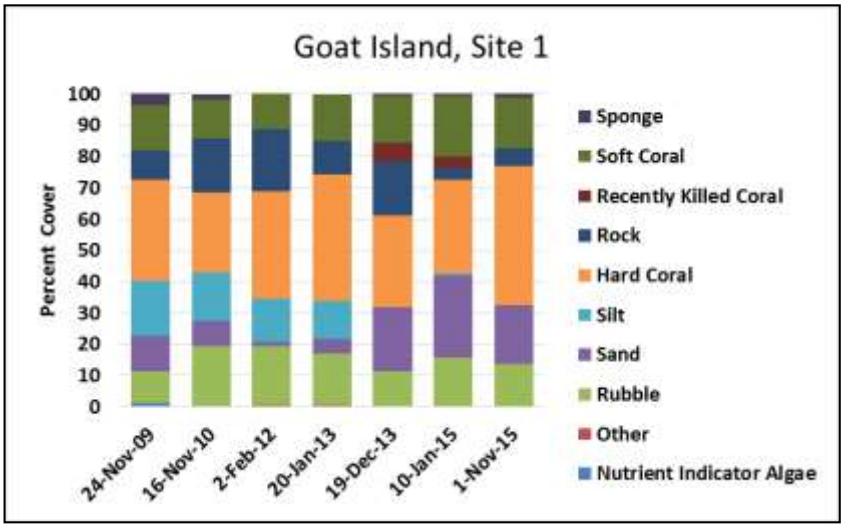
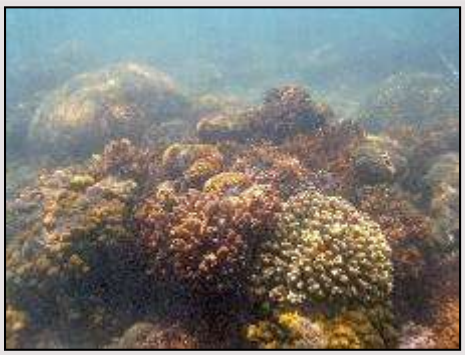


Figure 25: Benthic type and percent cover: Goat Island, Site 1, 2009- 2015

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

Hard coral, Goat Island West, Site 1

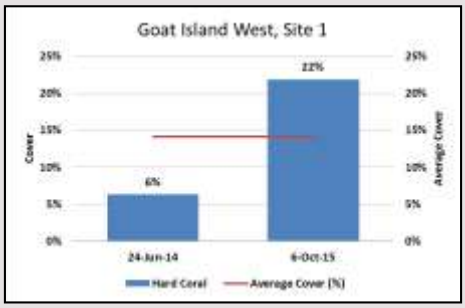


Figure 26: Hard Coral cover as a percent of total substrate

Goat Island is situated between North Stradbroke Island and Peel Island in Moreton Bay. A shallow sandy reef fringes Goat Island. Goat Island West, Site 1 was established in 2014 and is located on the western side of Goat Island. This site is located at a depth of approximately one meter and is exposed to regular boating traffic, and surge from the nearby boat channel.

Hard coral accounted for 22% of the benthos in 2015. This represents a notable change from 2014 levels (6%) and will be reviewed with subsequent surveys. The patchy nature of the coral communities at this site are a likely contributing factor to the different results and suggest that permanent site transect markers could strengthen assessments. The hard coral community in 2015 consisted primarily of encrusting (13%) and massive growth forms (8%). Soft coral attributed 17% to the benthos in 2015; a decrease from 29% in 2014. Sponges accounted for 3% in 2015 (1% in 2014). Rubble (26%), rock including rock with turf algae (19%) and sand (13%) made up the remainder of the substrate. No macro algae was recorded at this site in 2015 or in 2014.

No invertebrates were recorded on transect in 2015.

Coral bleaching affected an estimated 28% of the total coral population; with an average of 45% of each bleached colony affected, a notable increase from 2014 levels (1% and 37% respectively). Additional impacts include eight incidents of coral damage, and four unknown scars recorded on the impact survey.

A fish survey was not conducted in 2015.

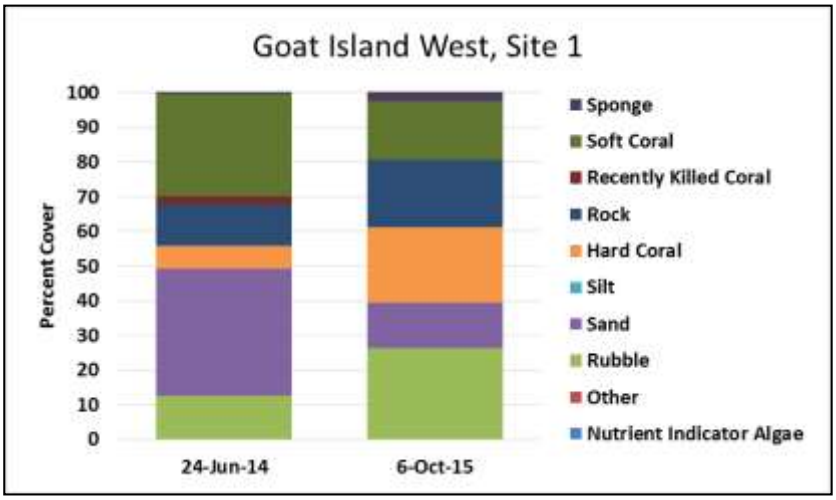
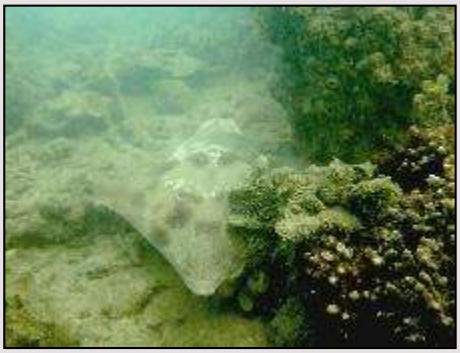


Figure 27: Benthic type and percent cover: Goat Island West, Site 1, 2014-2015

3.0 Inshore Moreton Bay Sites

3.4 Green Island, Site 1

Site photo, Green Island, Site 1



Shovelnose Ray, Green Island, Site 1

Crustose Algae, *Tricleocarpa*, Green Island, Site 1

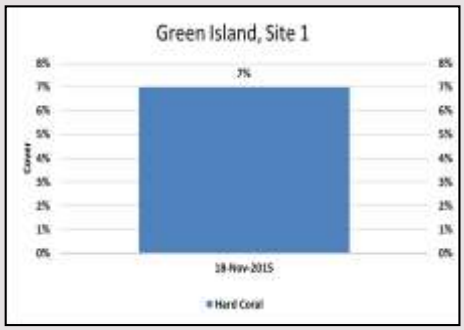


Figure 28: Hard Coral cover as a percent of total substrate

Green Island, Site 1, Site 1 is a new site in 2015. 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 east side of Green Island and sits at a depth of approximately two meters. The site was established as it hosted a higher concentration of coral based on benthic reef habitat inventories conducted at Central Moreton Bay reefs in 2015.

Hard coral accounted for 7% of the benthos, consisting primarily of massive growth forms (6%). Soft coral made up 23% of the substrate, as did sand (23%). Rock (including rock with turf algae) attributed 16%, rubble 14% and sponges 4%. *Padina* was the only macro algae on the transect, with 30 counts recorded.

No invertebrates were recorded on transect in 2015.

An average of 20% of the coral population and 44% of the coral colony was recorded bleached. The only other impact recorded on the transect was one coral scar from an unknown origin.

A fish survey was not conducted in 2015.

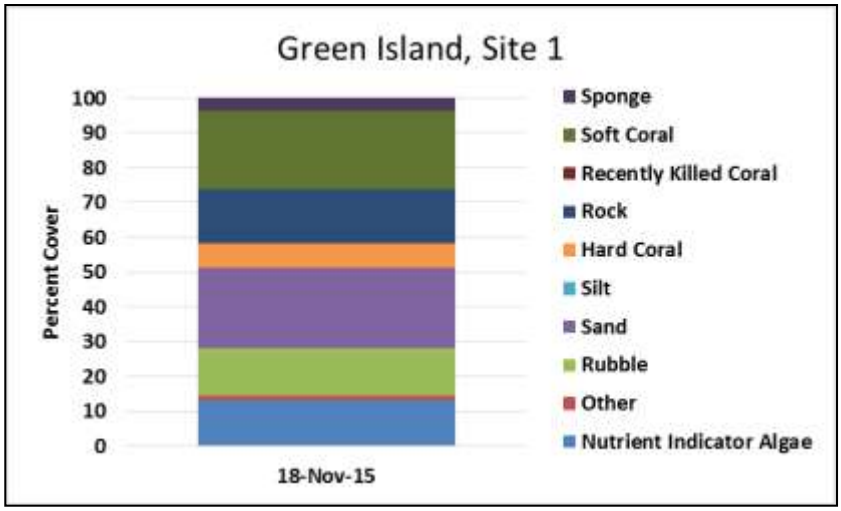
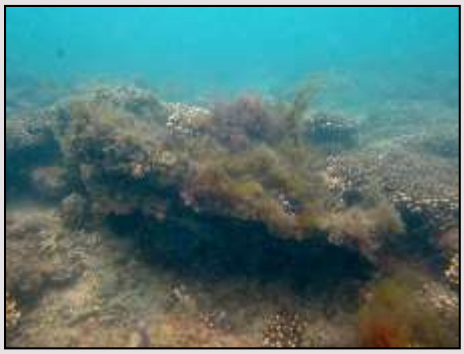


Figure 29: Benthic type and percent cover: Green Island, Site 1, 2015

3.0 Inshore Moreton Bay Sites

3.5 Myora Reef, Site 1

Site photo, Myora Reef, Site 1



Nutrient indicator algae, Myora Reef, Site 1

Hard coral and fishing line, Myora Reef, Site 1

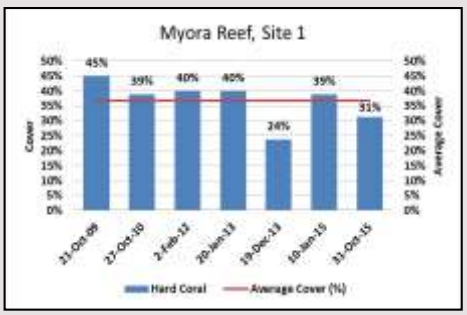


Figure 30: Hard Coral cover as a percent of total substrate

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

Hard coral cover recorded in 2015 was 31%; a slight decrease from 39% in 2014. The hard coral cover has fluctuated at this site, with a minimum of 24% in 2013 and a maximum of 45% in 2009. This is likely due to the dense, but patchy clusters of *Acropora* coral at this location. Rock made up 34% of the substrate type, followed by rubble (21%). Sponge attributed 4% to the benthos. No soft coral has been recorded at this site for the past three survey years. *Asparagopsis* was the only macro algae with nine counts recorded.

There were 25 *Diadema* long spined urchins and 23 *Drupella* snails found on the survey. This abundance of urchins has decreased from the 55 recorded in 2014, and 59 in 2013, whereas the number of *Drupella* snails increased from two recorded in 2014.

The average bleaching of a coral surface was 22%, which was similar to 2014 (21%) and 2013 (25%) records. The average coral population bleaching level was 6%, identical to 2014 records. The impact survey showed 28 incidents of unknown scars and nine incidents of coral damage (other). Six *Drupella* scars were also observed. Silt loading was recorded as medium.

A fish survey was carried out; 25 butterflyfish, five snappers and one juvenile barramundi cod were recorded.

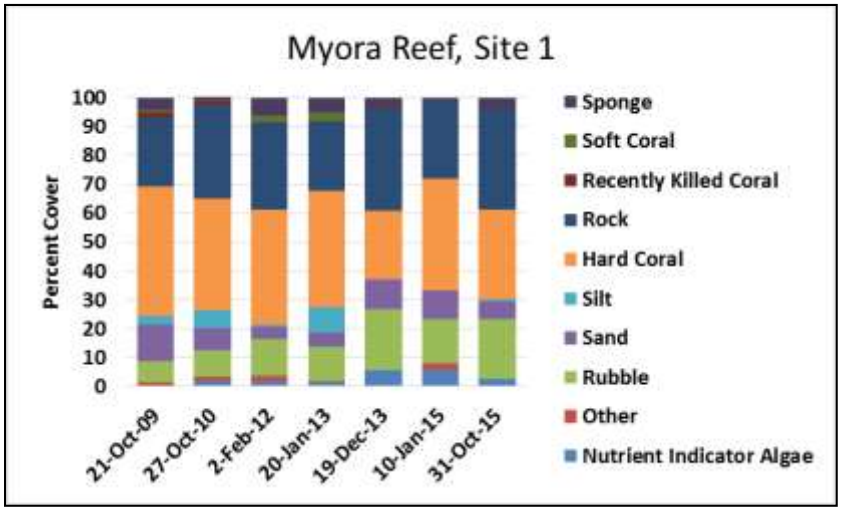
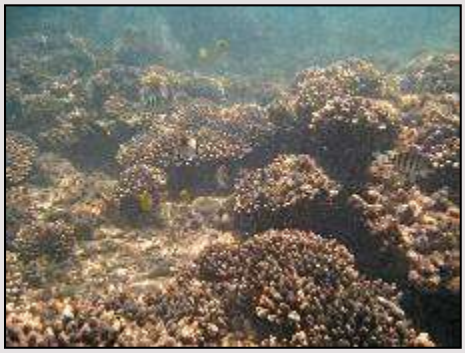


Figure 31: Benthic type and percent cover: Myora Reef, Site 1, 2009- 2015

3.0 Inshore Moreton Bay Sites

3.6 Myora Reef, Site 2



Site photo, Myora Reef, Site 2

Diadema long spined urchin hiding under a patch of hard coral, Myora Reef, Site 2

Unknown scar, Myora Reef, Site 2

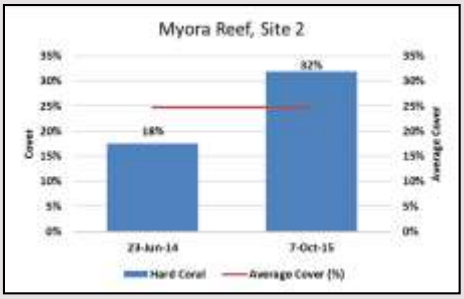


Figure 32: Hard Coral cover as a percent of total substrate

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

Hard coral (32%) and sponge (11%) accounted for the majority of the living substrate. Hard corals were dominated by clumped growth forms of *Acropora* (RCA HC category). The patchy and clumped distribution of coral is the likely explanation for an increased in recorded cover at this location. This site had similar hard coral cover (32%) when compared to the deeper Reef Check Australia survey location Myora Reef, Site 1 (31%). No soft coral was recorded; just 2% was recorded in 2014. Sand (16%), rock (21%) and rubble (15%) accounted for most of the non-living reef substrate.

Three *Diadema* urchins and two *Drupella* snails were recorded on the transect.

An average of 10% of the coral population showed signs of coral bleaching (average 32% of each colony). Coral scars were recorded on 22 colonies and physical coral damage was recorded on 12 colonies.

A fish survey was not conducted in 2015.

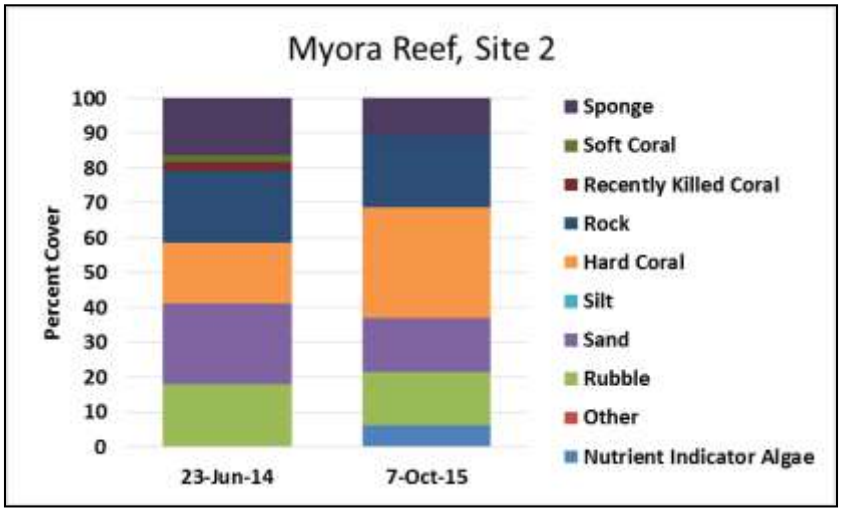


Figure 33: Benthic type and percent cover: Myora Reef, Site 2, 2014- 2015

3.0 Inshore Moreton Bay Sites

3.7 Macleay Island, Site 1

This site was established in 2009 and is situated on the north east side of Macleay Island in Moreton Bay. This site is located at a depth of approximately one meter and is exposed to regular surge from boating traffic. In 2015, the survey was carried out as a reef walk and snorkel. Due to low visibility from high sediment loading at this site, surveys have not been conducted annually since 2012.

Hard coral covered 8% of the substratum while soft coral (15%) dominated the living substrate at this site. The remaining benthic surface composed of rock including rock with turf algae (36%), sand (28%), rubble (15%) and silt (2%). Twenty four counts of macro algae were recorded; these included *Asparagopsis* and *Padina.*

No invertebrates were recorded on transect in 2015. The only invertebrate to be recorded at this site to date is one *Diadema* long spined urchin in 2010.

Only one incident of bleaching was recorded, with 20% of the colony bleached. One count of coral damage from unknown origin was the only other impact recorded. The silt loading was recorded as high at this site.

A fish survey was not conducted in 2015.

Site photo, Macleay Island, Site 1

Hard coral foliose, Macleay Island, Site 1

Macro algae, *Padina*, Macleay Island, Site 1

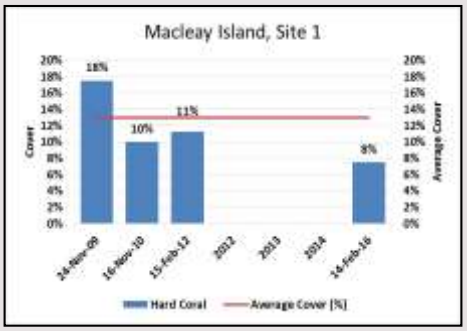


Figure 34: Hard Coral cover as a percent of total substrate

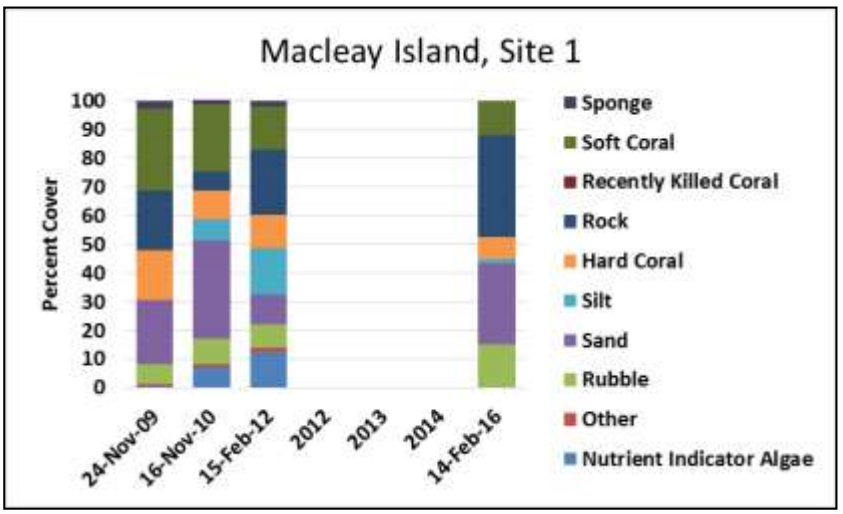


Figure 35: Benthic type and percent cover: Macleay Island, Site 1, 2009- 2016

3.0 Inshore Moreton Bay Sites

3.8 Peel Island North, Site 1

This is a shallow inshore site in Moreton Bay. It was established in 2009 and is located on the reef flat at a 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.

This site has shown minor fluctuations in hard coral cover over time, with 11% hard coral cover in 2015 (a decrease from 15% in 2014). Massive hard coral growth forms are the main hard coral structures recorded. Soft coral cover has also fluctuated (21% in 2015, an increase from 16% in 2014) with an average cover of 17% over the years since the site was first monitored in 2009. The remaining benthic surface composed of rubble (31%), rock with turf algae (9%), sand (6%) and nutrient indicator algae (21%). The majority of the nutrient indicator algae recorded at the site was *Lobophora,* which was the dominant algae at this site, followed by *Dictyota* and *Padina.*

No invertebrates were recorded in 2015. In 2014, three *Drupella* snails were the only invertebrates recorded.

An average of 8% of the coral population and 41% of the coral colony was recorded as bleached. Other recorded impacts at this site included 10 incidents of anchor damage, 13 counts of scars from unknown origins and five incidents of coral damage (other). Medium silt loading was recorded at the site.

A fish survey was not conducted in 2015.

Site photo, Peel Island North, Site 1

Recently killed coral, Peel Island North, Site 1

Phyllidia ocellata Nudibranch, Peel Island North, Site 1

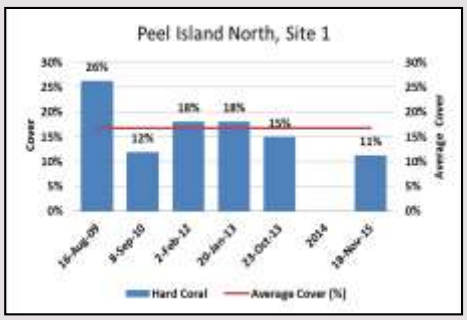


Figure 36: Hard Coral cover as a percent of total substrate

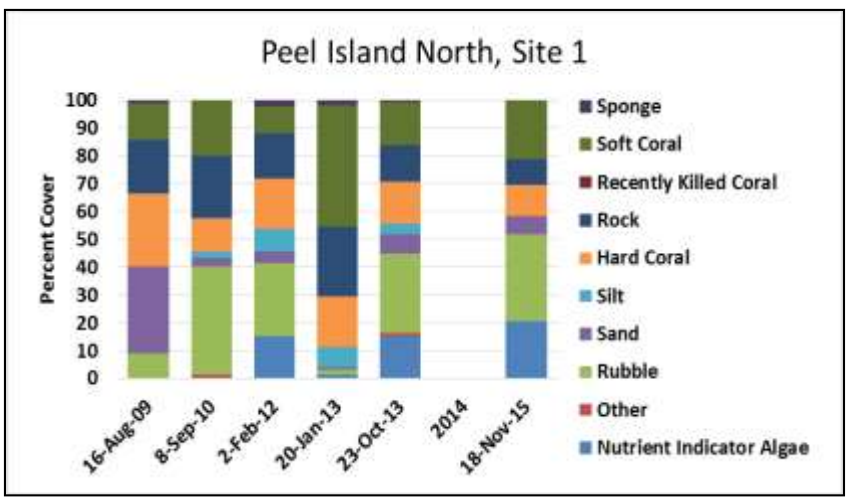


Figure 37: Benthic type and percent cover: Peel Island North, Site 1, 2009- 2015

3.0 Inshore Moreton Bay Sites

3.9 Peel Island East, Site 1

Site photo, Peel Island East, Site 1

Lionfish, Peel Island East, Site 1

Coral Disease, Peel Island East, Site 1

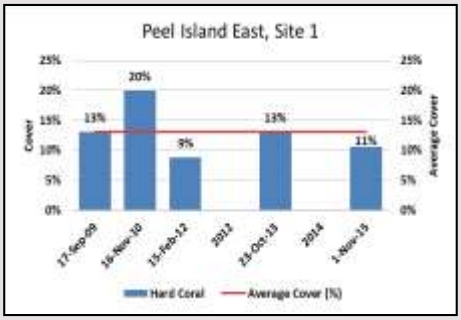


Figure 38: Hard Coral cover as a percent of total substrate

This is a shallow site inshore Moreton Bay and is located on the reef flat at a depth of two meters. Peel Island East, Site 1 was established in 2009. The site is easily accessible, and experiences heavy boat traffic due to its proximity to a deep channel.

Hard coral (consisting primarily of massive growth forms) accounted for 11% of the benthic surface. This site has shown fluctuations in recorded hard coral cover since establishment in 2009, with an average cover of 13% over the survey seasons (max. 20%, min. 9%). Soft coral cover increased notably to 22% from 10% in 2013. Prior to 2013, the soft coral cover was relatively consistent with an average cover of 11% over the preceding 5 years. Sand (15%), rock (24%) and nutrient indicator algae (23%) accounted for the other notable components of the survey area in 2015. There were 22 counts of macro algae recorded, all were *Padina.*

No invertebrates were recorded at the site.

An average of 35% of the coral population and 42% of the coral colony was recorded bleached. This is an increase from previous recorded levels; 0% in 2013, and less than 2% of the coral population recorded as bleached over the seasons the site has been monitored. Other recorded impacts at this site were five incidents of unknown scars and five counts of coral damage (other).

A fish survey was not conducted in 2015, however a juvenile barramundi cod was sighted on the transect.

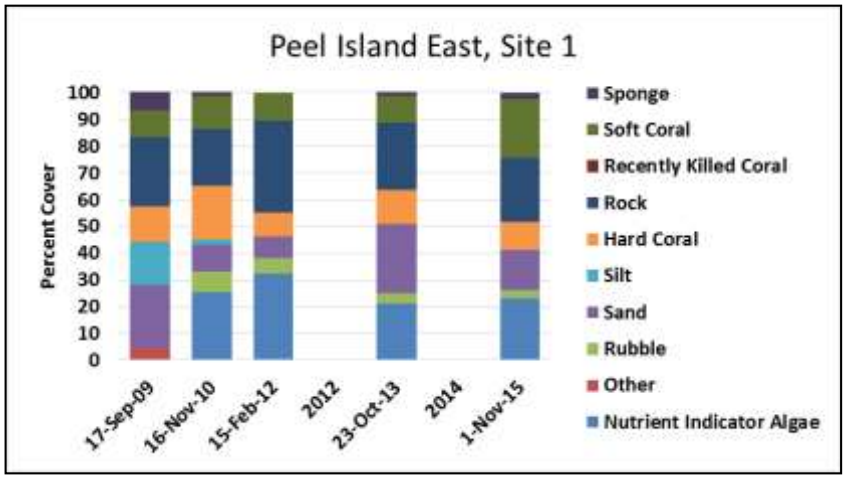


Figure 39: Benthic type and percent cover: Peel Island East, Site 1, 2009- 2015

3.0 Inshore Moreton Bay Sites

3.10 Peel Island Northeast, Site 1

This shallow site was established in 2014. The site is located on the shallow fringing reef to the north of the Platypus wreck. The site is easily accessible, and experience heavy boat traffic due to its proximity to a deep channel. The site is dominated by massive hard corals and is situated at a depth of approximately one meter.

Hard coral accounted for 10% of the substrate, similar to 11% in 2014. Hard coral growth forms were dominated by massive (6%) and foliose (4%) forms. Low levels of soft coral (2%) were documented. No sponges were recorded at this site. Recently killed coral accounted for 1% of benthic cover. The remaining benthic surface composed of rubble (60%), rock including rock with turf algae and rock with crustose algae (12%), sand (11%) and nutrient indicator algae (5%).

No invertebrates were recorded on the survey in 2015. In 2014, eight invertebrates were recorded, all of which were *Drupella* snails.

An average of 11% of the coral population and 43% of the coral colony was recorded as bleached. Additional impacts recorded at this site include; two coral scars from unknown causes, four counts of general trash and one incident of coral damage (other).

A fish survey was not conducted in 2015.

Site photo, Peel Island Northeast, Site 1

Hard coral, Peel Island Northeast, Site 1

General trash (glass bottle) in a massive hard coral, Peel Island Northeast, Site 1

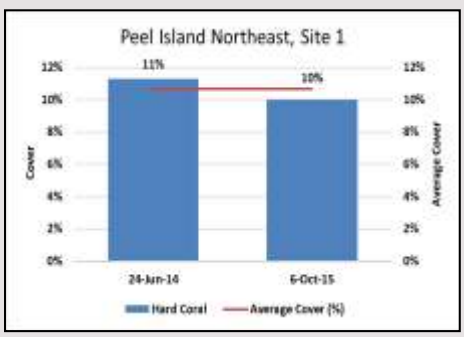


Figure 40: Hard Coral cover as a percent of total substrate

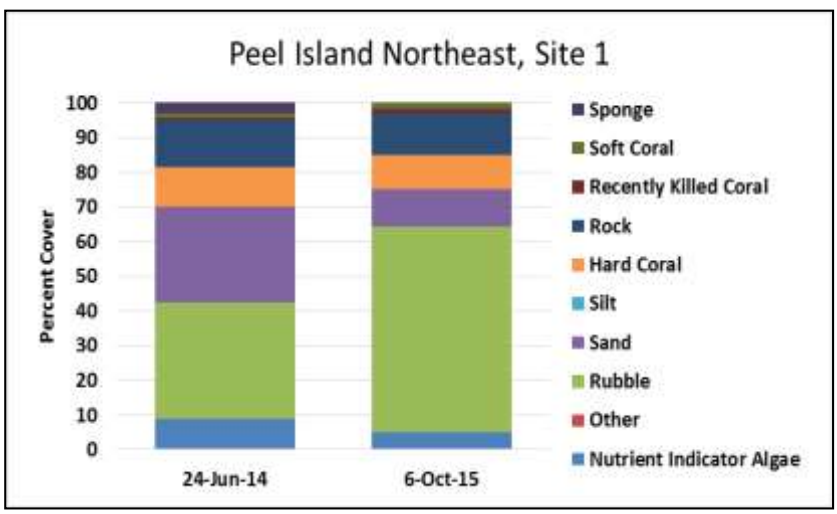


Figure 41: Benthic type and percent cover: Peel Island Northeast, Site 1, 2014- 2015

3.0 Outer Moreton Bay Sites

3.11 Flat Rock, Shark Alley, Site 1

Flat Rock is a popular recreational diving and boating location. Shark Alley, Site 1 was surveyed twice this season; in September 2015 and in March 2016, as a site of interest to document possible outcomes of the global bleaching forecast and high levels of bleaching recorded in 2014.

Hard coral cover attributed 19% to the benthic surface in March, an increase from September's survey (13%). However, an overall decrease was recorded from 27% in 2014. Branching (7%) and encrusting (7%) growth forms made up the majority of the hard coral cover. Soft coral accounted for just 1% of the benthos for both surveys compared to 3% in 2014. Nutrient indicator algae increased notably through the season to 31% in March (from 2% in September).

In September, 19 *Diadema,* 29 anemones and seven *Drupella* snails were recorded. In March, two pencil urchins, three *Diadema*, 20 *Drupella,* one lobster and one giant clam were recorded.

In September, an average of 3% of the coral population and 16% of the coral colony was recorded bleached, nearly identical to the levels of 2014. In March, an average of 4% of the coral population and 29% of the affected colony exhibited signs of bleaching. In September, 20 counts of coral damage (other) and two incidences of coral disease were recorded; in March 12 counts of other damage, two incidents of disease, five unknown scars and two counts of fishing line were recorded.

No fish survey was conducted in 2015.

Site photo, Shark Alley, Site 1

Hard coral, Shark Alley, Site 1

Bleached zoanthids, Shark Alley, Site 1

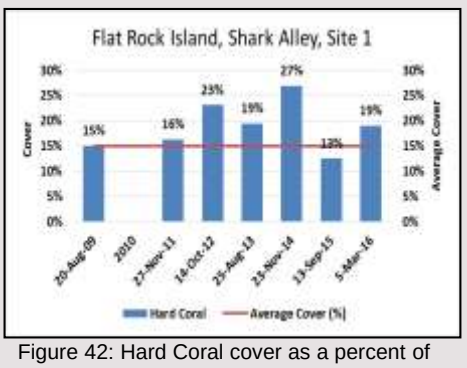


Figure 42: Hard Coral cover as a percent of total substrate

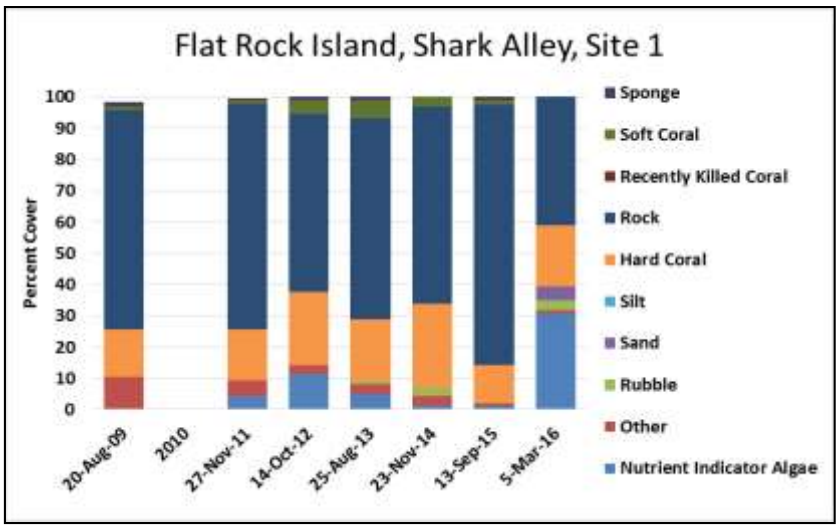


Figure 43: Benthic type and percent coverFlat Rock Island, Shark Alley, Site 1, 2009- 2016

3.0 Outer Moreton Bay Sites

3.12 Flat Rock, The Nursery, Site 1

Flat Rock is a popular diving location situated to the north of Point Lookout on North Stradbroke Island. This site is within a fully protected marine park, with a no-fishing zone within 1.2km radius of the reef. It is also a Grey Nurse Shark Protection area. This site was established in 2008 and sits at a depth of six meters.

Hard coral accounted for 23% of substrate in 2015, consistent with 25% in 2014. Encrusting growth forms (15%) dominate the hard corals. Soft coral cover accounted for 4% of the substrate; similar to previous years. Rock (encompassing all RCA rock categories) attributed 29% to the benthos. The remaining benthic surface was composed of sponges (10%), the general 'other' category (8%, consisting mainly of crustose algae), rubble (6%) and nutrient indicator algae which increased from 1% in 2014 to 21% in 2015. *Asparagopsis* was the only macro algae on the transect with 23 counts recorded. No macro algae was recorded in 2014.

The invertebrate survey recorded 16 *Diadema* long spined urchins, two *Drupella* snails, one lobster, one giant clam, one collector urchin and 41 anemones.

An average of 5% of the coral population and 37% of the coral colony was recorded as bleached (an increase from just 1% coral population bleaching in 2014). Impacts recorded include five unknown scars, five *Drupella* scars and two counts of unknown coral damage. Two counts of fishing debris (fishing line) were also recorded on the transect.

No fish survey was conducted in 2015.

Site photo, The Nursery, Site 1

Rabbitfish, The Nursery, Site 1

Giant clam, The Nursery, Site 1

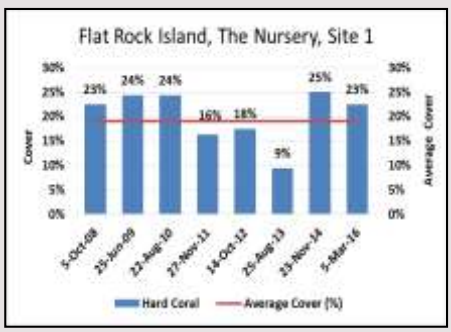


Figure 44: Hard Coral cover as a percent of total substrate

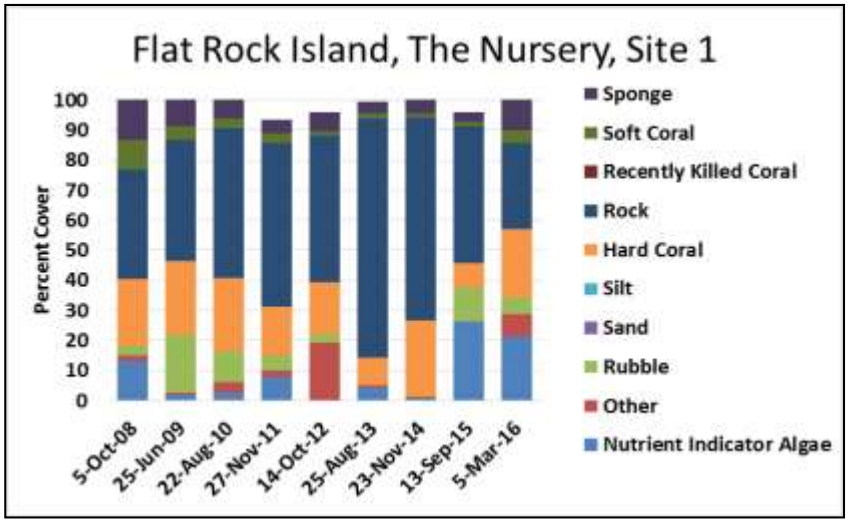


Figure 45: Benthic type and percent cover: Flat Rock Island, The Nursery, Site 1, 2008- 2016

3.0 Outer Moreton Bay Sites

3.13 Flinders Reef, The Nursery, Site 1

Flinders Reef is a located approximately five kilometers north of Moreton Island and is a popular reef among divers in South East Queensland. Flinders Reef is an established Marine National Park (Green) zone. 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.

Hard coral attributed 24% to the benthos in 2015, similar to 23% in 2014. Hard coral encrusting (11%) continues to be the dominant coral growth form. Soft coral decreased slightly from 25% in 2014 to 19% in 2015 and was dominated by leathery growth forms (11%). Rock encompassing all RCA rock categories (29%), rubble (19%), and sponges (9%) made up the rest of the substrate. *Asparagopsis* was the only macro algae with 21 counts recorded.

One *Drupella* snail and two giant clams were the only invertebrates recorded in 2015.

Coral bleaching affected an estimated 1% of the total coral population; with an average of 13% of each bleached colony affected, a decrease from 2014 levels (4% and 19% respectively). Two counts of coral scars from unknown origins, two counts of general trash, and one *Drupella* scar were recorded.

A fish survey was completed; one bumphead parrotfish, two other parrotfish, one grouper and eight butterflyfish were recorded.

Site photo, The Nursery, Site 1

Chromodoris kuiteri Nudibranch, The Nursery, Site 1

Green Sea Turtle, The Nursery, Site 1

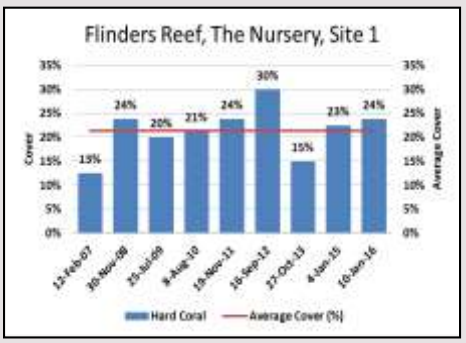


Figure 46: Hard Coral cover as a percent of total substrate

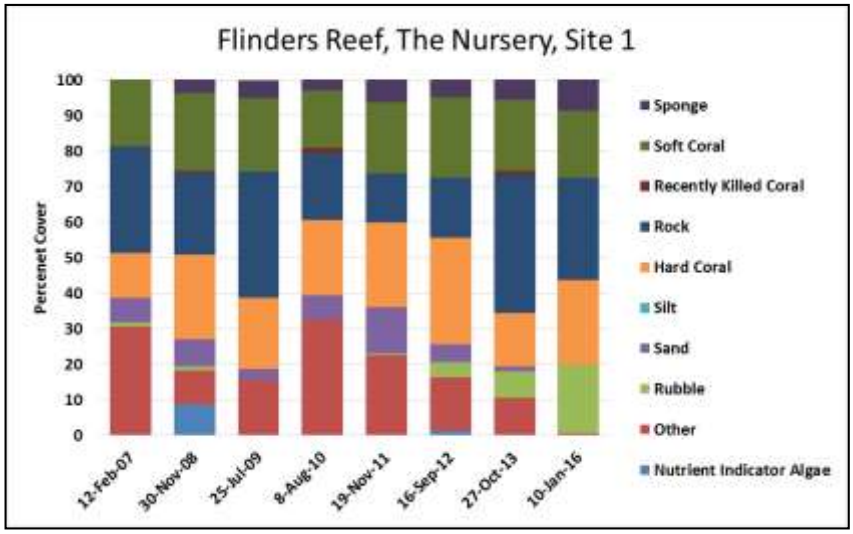


Figure 47: Benthic type and percent cover: Flinders Reef, The Nursery, Site 1, 2007- 2016

3.0 Outer Moreton Bay Sites

3.14 Flinders Reef, The Nursery, Site 2

Flinders Reef is a located approximately five kilometers north of Moreton Island and is a popular reef among divers in South East Queensland. Flinders Reef is an established Marine National Park (Green) zone. The Nursery, Site 2 is situated at a depth of nine meters and was established in 2009. A large patch of branching *Acropora* makes up the majority of the survey area.

This site has a high and relatively consistent hard coral cover with an average cover of 63% over the seven years of monitoring. This site had the greatest hard coral cover of the sites surveyed in 2015; with hard coral accounting for 68% of the substrate cover (branching growth forms accounted for 66%). Soft coral made up just 1% of the substrate. The remaining benthos composed of rock including rock with turf algae and rock with crustose algae (21%), nutrient indicator algae (9%) and sand (1%). The dominant macro algae was *Asparagopsis*.

Five *Drupella* snails and one anemone were the only invertebrates recorded.

Bleaching increased notably at this site to 21% of the total coral population affected, compared to 5% in 2014. The bleaching surface percentage increased from 11% of each bleached colony affected in 2014 to 55% in 2015. Six unknown scars, three incidents of coral damage and one instance of coral disease were recorded.

A fish survey recorded ten butterflyfsh.

Site Photo, The Nursery, Site 2

Coral Disease, The Nursery, Site 2

Acropora patch,The Nursery, Site 2

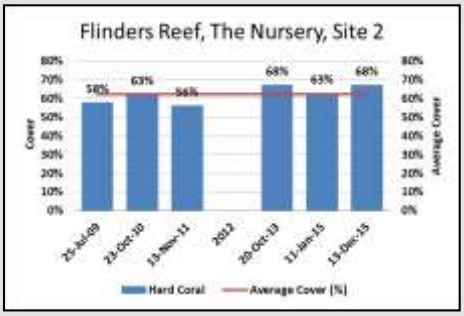


Figure 48: Hard Coral cover as a percent of total substrate

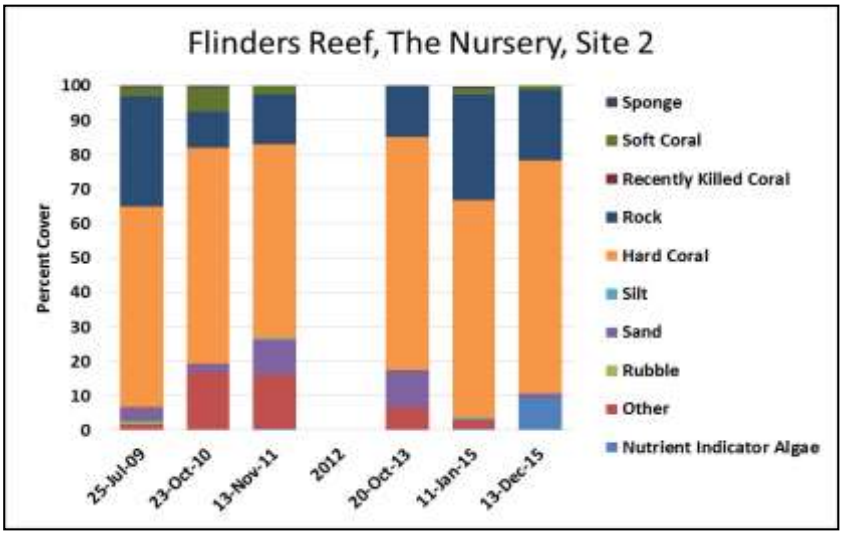
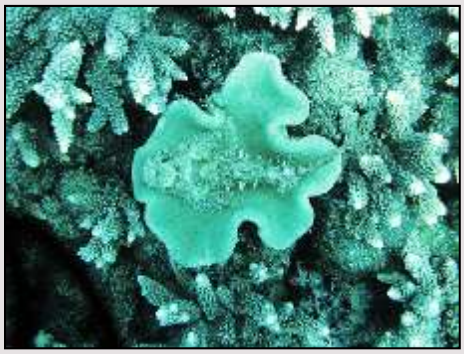


Figure 49: Benthic type and percent cover: Flinders Reef, The Nursery, Site 2, 2009- 2015

3.0 Outer Moreton Bay Sites

3.15 Flinders Reef, Alden's Cave, Site 1

Site photo, Alden's Cave, Site 1



Scorpionfish on soft coral, Alden's Cave, Site 1

Hard coral and Green Sea Turtle, Alden's Cave, Site 1

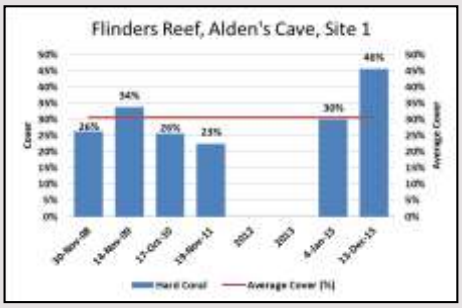


Figure 50: Hard Coral cover as a percent of total substrate

Flinders Reef is a located approximately five kilometers north of Moreton Island and is a popular reef among divers. Alden's Cave is situated at the southerly end of Flinders Reef, in a depth of ten 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 other side of the reef.

Hard coral accounted for 46% of benthic cover in 2015, increasing from 30% in 2014. Soft coral attributed 12% to the substrate in 2015, a decrease from 19% in 2014. Rock encompassing all RCA rock categories (26%), sponges (14%) and the general 'other' category (2%) made up the remaining components of the benthic surface. The dominant algae at this site was *Asparagopsis* with 22 counts.

The invertebrate survey recorded five giant clams, one collector urchin, one *Diadema* long spined urchin and one Triton in 2015.

Coral bleaching affected an estimated 35% of the total coral population; with an average of 32% of each bleached colony affected, a notable increase from 2014 levels (1% and 5% respectively). There were eight incidents of unknown scars, three incidents of coral disease and one count of other coral damage.

A fish survey was not conducted in 2015.

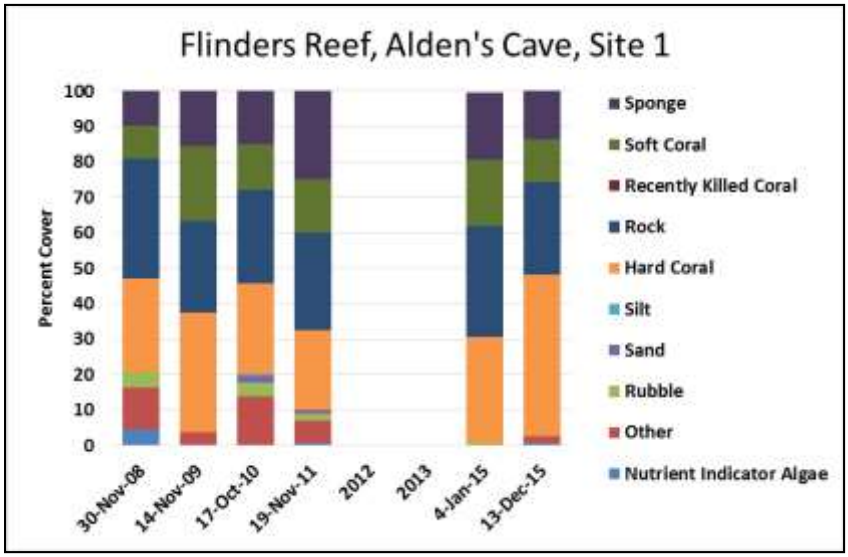


Figure 51: Benthic type and percent cover: Flinders Reef, Alden's Cave, Site 1, 2008- 2015

3.0 Outer Moreton Bay Sites

3.16 Flinders Reef, Alden's Cave, Site 3

Site photo, Alden's Cave, Site 3

Ascidians, Alden's Cave, Site 3

Octopus, Alden's Cave, Site 3

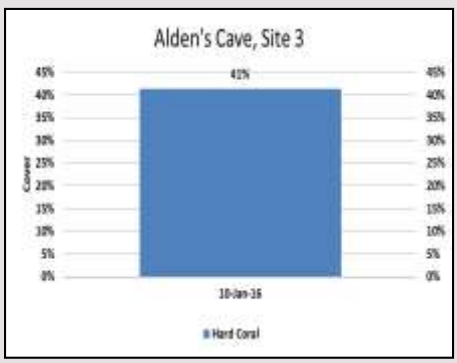


Figure 52: Hard Coral cover as a percent of total substrate

Flinders Reef is a located approximately five kilometers north of Moreton Island and is a popular reef among divers in South East Queensland. Flinders Reef is an established Marine National Park (Green) zone. Alden's Cave, Site 3 is one of the newly established sites in 2015. The site is located to the east of the long-established Alden's Cave, Site 1, near a rocky cave structure frequented by divers. The site was established to gain a better understanding of the variety of habitats found within the Flinders area.

Hard coral accounted for 41% of the benthos, consisting primarily of encrusting growth forms (25%). Soft coral made up 16% of the substrate. Rock (including all RCA rock categories) attributed 31% to the benthos, while sponges (11%) and rubble (1%) made up the remaining benthic surface. *Asparagopsis* was the only macro algae on the transect, with 24 counts recorded.

The invertebrate survey recorded two giant clams and one anemone without fish.

The site had low levels (1%) of bleaching recorded, with an average of 21% of each bleached colony affected. Other impacts recorded included; eleven scars from unknown origin and one instance of coral disease.

A fish survey was conducted; four butterflyfish and two sweetlips were recorded.

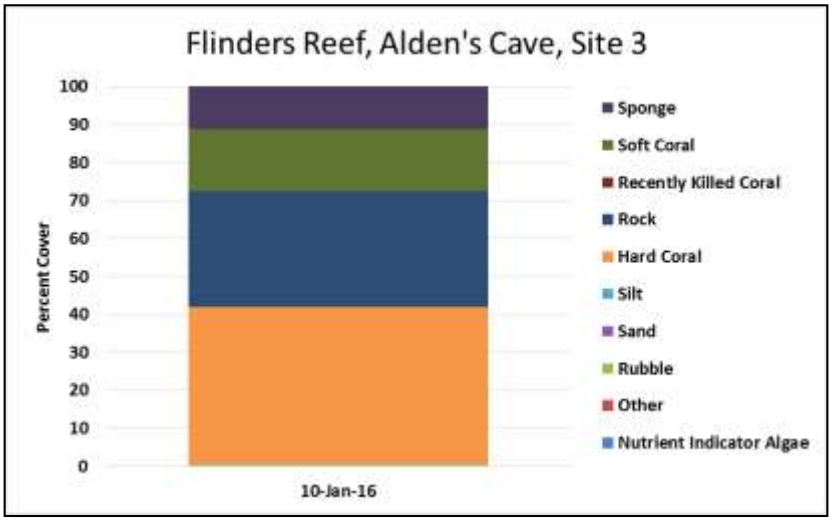


Figure 53: Benthic type and percent cover: Flinders Reef, Alden's Cave, Site 3, 2016

3.0 Outer Moreton Bay Sites

3.17 Shag Rock East, Site 1

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 and is popular among divers. It is also commonly used for fishing and boating.

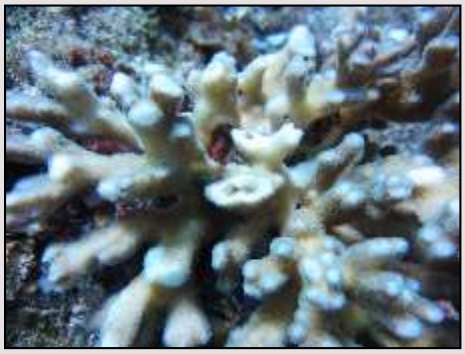
Hard coral (consisting primarily of branching growth forms) represented just 5% of the total substrate cover at this site in 2015; a notable decrease from 18% recorded in 2014. Rock accounted for 64% of the benthos in 2015; an increase from 48% recorded in 2014. Rubble (9%), sand (4%), soft coral (2%) and sponges (2%) accounted for the remaining benthic components. Nutrient indicator algae decreased from 24% in 2014 to 14% in 2015. No macro algae has been recorded at this site since 2012.

The invertebrate survey recorded two pencil urchins, 18 *Diadema* long spined urchins, 14 collector urchins, 10 *Drupella*, 2 giant clams and 23 anemones. One Hawksbill turtle was recorded in March.

Coral bleaching affected 7% of the population with an average of 62% of each bleached colony affected, an increase from 2014 levels (4% and 31% respectively). Four incidents of anchor damage as well as 13 counts of other coral damage, 11 unknown scars, seven counts of fishing line and one fishing net were recorded.

No fish survey was conducted in 2015.

Hard Coral polyps, Shag Rock East, Site 1



Coral damage and bleaching, Shag Rock East, Site 1

Hawksbill Turtle, Shag Rock East, Site 1

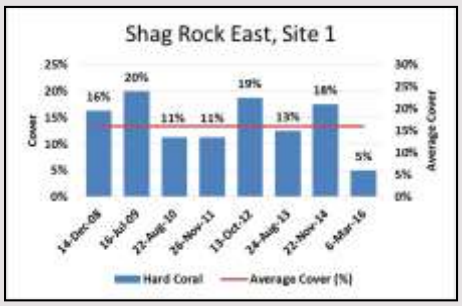


Figure 54: Hard Coral cover as a percent of total substrate

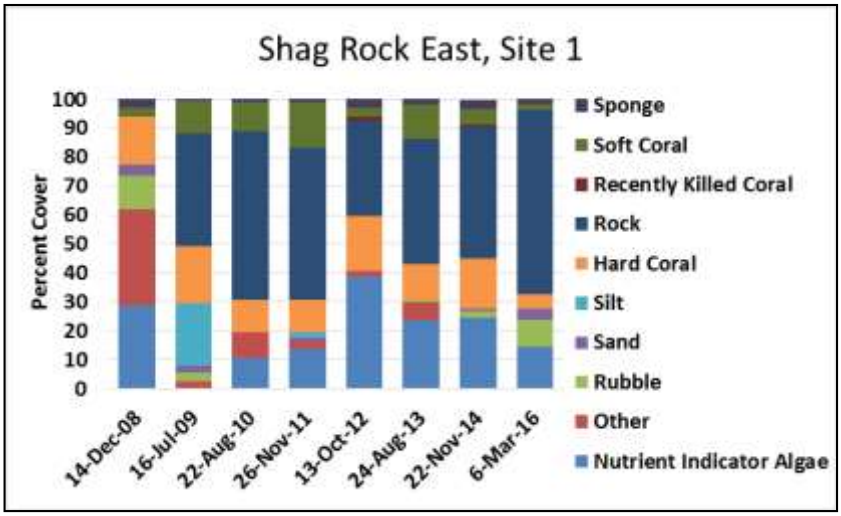


Figure 55: Benthic type and percent cover: Shag Rock East, Site 1, 2008- 2016

3.0 Outer Moreton Bay Sites

3.18 Shag Rock West, Site 2

Site photo, Shag Rock West, Site 1

Anchor, Shag Rock West, Site 1

Collector urchin, Shag Rock West, Site 1

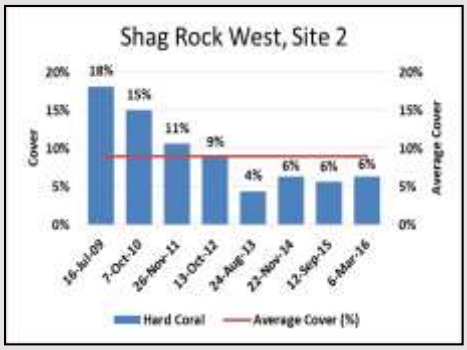


Figure 56: Hard Coral cover as a percent of total substrate

Shag Rock is a twin rock located on the north eastern edge of North Stradbroke Island. Shag Rock West, Site 2 is located on the exposed northern side of Shag Rock. This site was surveyed twice this season; in September 2015 and in March 2016, as a site of interest to document possible outcomes of the global bleaching forecast and high levels of bleaching recorded in 2014. 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. This site was established in 2009 to gain a better understanding of the variety of habitats around Shag Rock.

This site has shown an average hard coral cover of 9% over seven years of surveys. Hard coral accounted for 6% of the benthos both in September and March this season. Rock (57% and 40%) and rubble (7% and 20%) accounted for the substrate composition in September and March respectively. Nutrient indicator algae was abundant at this site (26%).

The invertebrate survey recorded 32 collector urchins, 31 *Diadema,* 16 *Drupella* snails, five anemones, one *Trochus* and one Triton in September. In March 28 *Diadema*, 13 collector urchins and two anemones were recorded.

This site was re-visited in March 2016 to check on potential impacts from coral bleaching. An average of 13% of the coral population was estimated to be impacted by bleaching in September compared to 3% in March, impacting 28% of each colony on average both in September and March. The impacts recorded during September and March surveys include counts of fishing line (three and five respectively), other debris (four and seven), unknown scars (twenty-five and five) and other coral damage (thirty three and eight).

No fish survey was conducted in 2015.

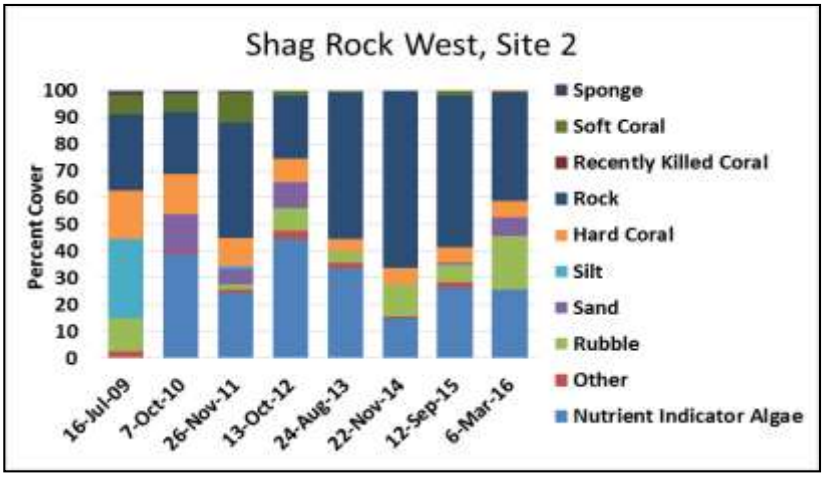
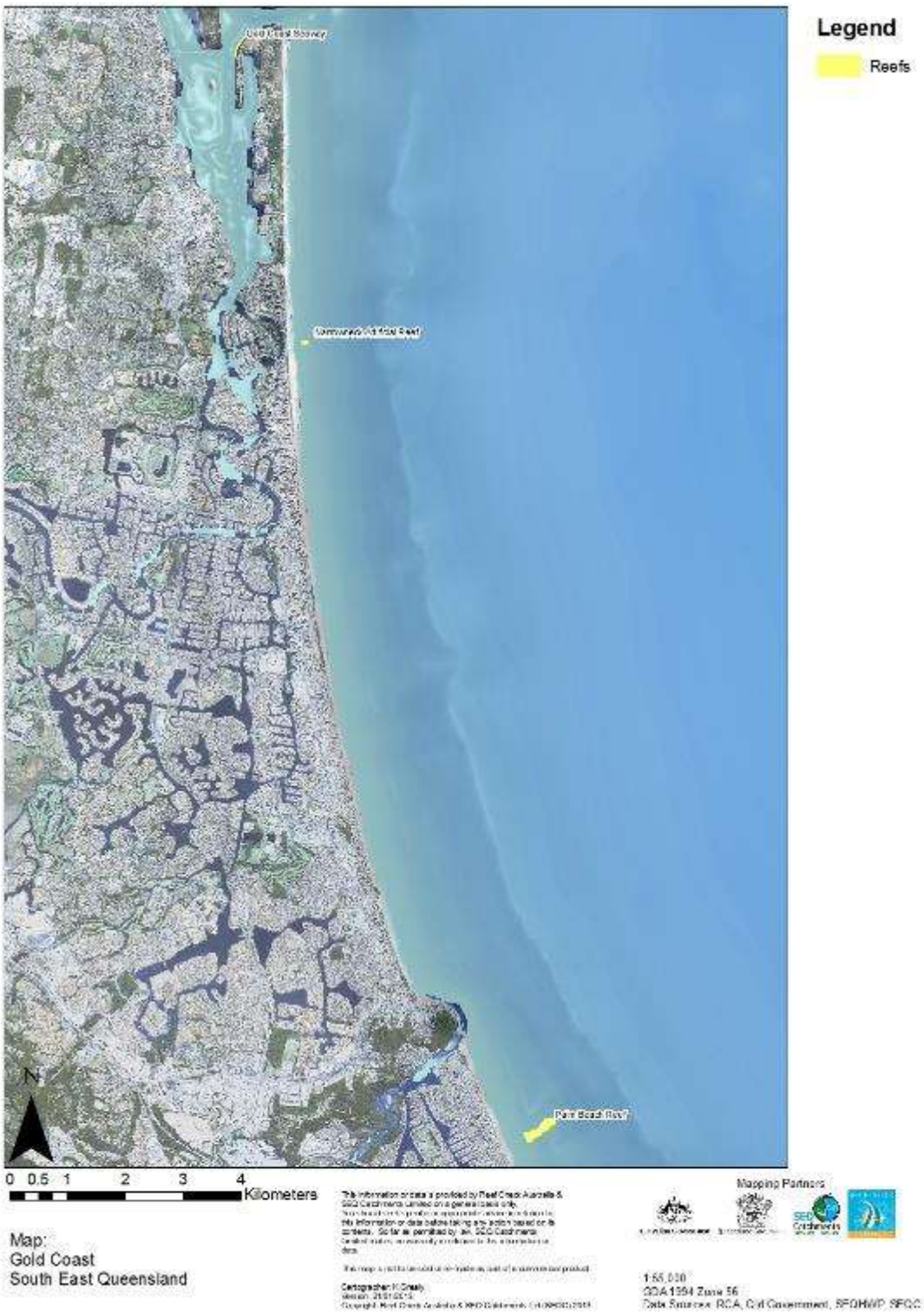


Figure 57: Benthic type and percent cover: Shag Rock West, Site 2, 2009- 2016

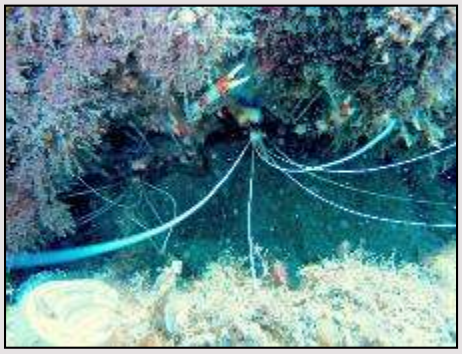
4.0 Gold Coast



4.0 Gold Coast Sites

4.1 Gold Coast Seaway, Southwest Wall, Site 1

Site Photo, Southwest Wall, Site 1



Banded coral shrimps, Southwest Wall, Site 1

Site photo, Southwest Wall, Site 1

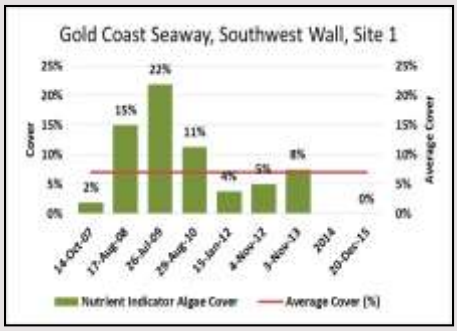


Figure 58: Nutrient Indicator Algae Cover as a percent of total substrate

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 and it is 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 two 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. Rock (encompassing all RCA rock categories) attributed 48% to the substrate at this site in 2015 (72% in 2013, 40% in 2012 and 86% in 2011). Sand (33%) and rubble (5%) accounted for the remaining substrate components. No nutrient indicator algae was recorded (a decrease from 8% in 2013).

Two banded coral shrimps were the only target invertebrates recorded on the transect in 2015. One octopus was sighted.

This site has consistently recorded high counts of trash in total (10 in 2013, 20 in 2012). In 2015, eight counts of trash were recorded, consisting of five counts of fishing line and three counts of general trash. High silt loading was recorded at the site.

A fish survey was not conducted in 2015.

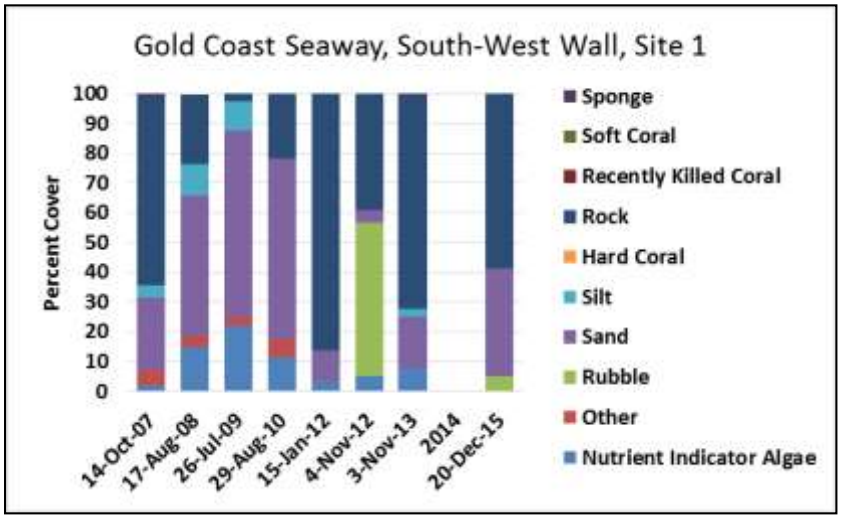
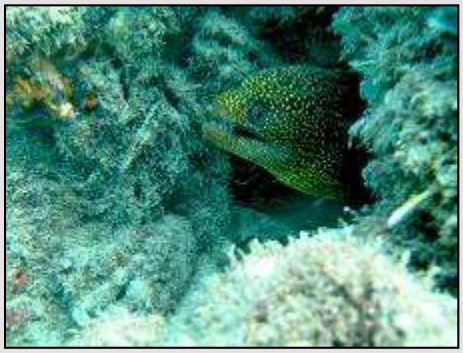


Figure 59: Benthic type and percent cover: Gold Coast Seaway, Southwest Wall, Site 1, 2007 - 2015



Moray eel, The Pipe, Site 1

Octopus, The Pipe, Site 1

Newly settled coral, The Pipe, Site 1

Fishing hook and sink, The Pipe, Site 1

***Note: No hard coral was recorded at Gold Coast Seaway, The Pipe, Site 1.**

4.0 Gold Coast Sites

4.2 Gold Coast Seaway, The Pipe, 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 Pipe, Site 1 is one of the new sites established in 2015. The site is situated at a depth of four meters in the heavily utilised Gold Coast Seaway, at the main diving and fishing site; The Pipe. The site is exposed to heavy boat traffic on a daily basis and is very tidal. The site was established to better document the impacts this heavily utilised site faces from anthropogenic activities, in particular fishing.

No hard coral has been recorded in the Seaway by RCA, however a small colony of coral polyps was sighted away from the transect at this new site in 2015. Similar to the nearby site Gold Coast Seaway Southwest Wall, Site 1, rock (61%), sand (33%) and rubble (6%) make up the benthic surface. Turf algae was the dominant algae, followed by the nutrient indicator algae *Lobophora*.

No invertebrates were recorded in 2015. An octopus was sighted on the transect.

Forty-six counts of fishing line were recorded. A high silt loading was recorded, similar to the nearby site Gold Coast Seaway Southwest Wall, Site 1.

A fish survey was not conducted in 2015, however two moray eels were sighted on the transect.

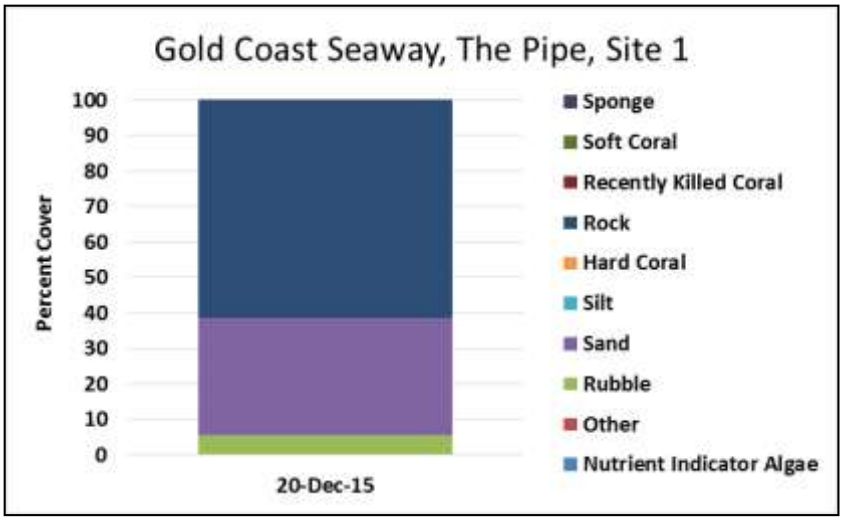


Figure 60: Benthic type and percent cover: Gold Coast Seaway, The Pipe, Site 1, 2015

4.0 Gold Coast Sites

4.3 Narrowneck Artificial Reef, Site 1

Site photo, Narrowneck Artificial Reef, Site 1

Wobbegong shark, Narrowneck Artificial Reef, Site 1

Prefabricated geo-textile bags, Narrowneck Artificial Reef, Site 1

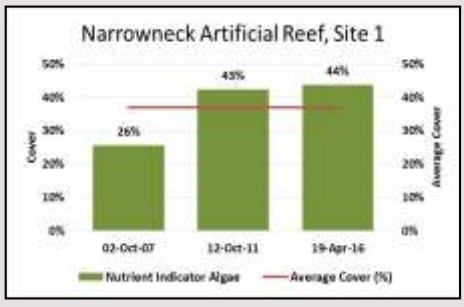


Figure 61: Nutrient Indicator Algae cover as a percent of total substrate

Narrowneck Artificial Reef, Site 1 is an artificially constructed reef structure, built in 1999 using prefabricated geo-textile bags. The artificial reef was built to create a storm buffer to protect the beach from erosion and to improve surf quality. The RCA monitoring site Narrowneck Artificial Reef, Site 1 was established in 2007 to gain further understanding of this artificial reef structure in the Gold Coast sub-region. Narrowneck Artificial Reef is characterised by high cover of macro algae. The site is sensitive to wave action due to its proximity to the shore and the surf zone. The site sits at a depth of approximately six meters.

No hard coral has been recorded at this site since established in 2007. Nutrient indicator algae attributed 44% to the benthos. Sponge cover increased from 6% in both 2007 and 2011 to 11% in 2015. The remaining benthic surface was composed of sand (39%), rock (6%; encompassing all RCA rock categories) and rubble (1%). *Sargassum* was the only macro algae on the transect with 21 counts recorded. Macro algae cover declined from 32 counts in 2007 and 28 counts in 2011.

One lobster recorded in 2007 is the only invertebrate recorded at this site since it was established. Two wobbegong sharks were sighted in 2015.

No impacts were recorded in 2015.

A fish survey was not conducted in 2015.

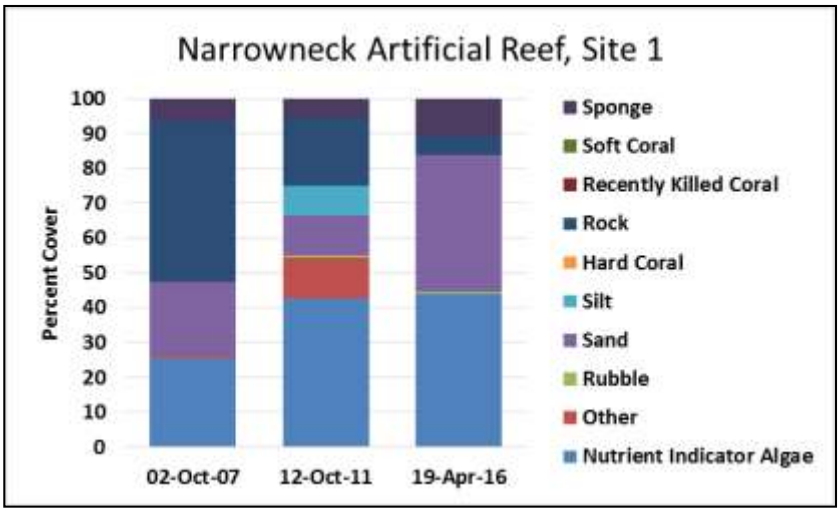


Figure 62: Benthic type and percent cover: Narrowneck Artificial Reef, Site 1, 2007-2015

4.0 Gold Coast Sites

4.4 Kirra Reef, Site 1

Kirra Reef is a collection of rocky outcrops located a few hundred meters offshore from Kirra Beach. Kirra Reef was added to the RCA monitoring sites in 2015 as a site of interest to monitor the condition of the reef after being exposed to increased levels of sand smothering from the Tweed River Entrance Sand Bypassing Project since 1995. Kirra Reef is characterised by a high cover of macro algae and turf algae, moderate numbers of sessile invertebrates and a few hard corals (Edwards & Smith 2005). Kirra Reef, Site 1 is situated on the reef flat at a depth of approximately five meters.

No hard coral or soft coral was recorded on the transect by RCA, however one small partially bleached hard coral colony (*Pocillopora*) and several soft coral colonies (*Dendronephthya*) were noted off the line transect. Rock (consisting of rock with turf algae) attributed 43% to the benthos. The remaining benthic surface was composed of the 'other' category (26%; consisting of crustose algae, ascidians and anemones), sand (13%), sponges (13%) and nutrient indicator algae (6%). *Sargassum* was the only macro algae on the transect with a 45 counts recorded. Of note, kelp (*Ecklonia*) was also patchy, but common across the transect.

The invertebrate survey recorded 36 anemones, seven *Diadema* long spined urchins, seven collector urchins, four pencil urchins and one *Trochus* in 2015. There were numerous crinoids across the reef area.

One count of fishing line and one count of general trash were the only impacts recorded.

Site photo, Kirra Reef, Site 1

Crinoids and ascidians, Kirra Reef, Site 1

Anemone with fish, Kirra Reef, Site 1

Partially bleached *Pocillapora* hard coral, off transect. Kirra Reef, Site 1

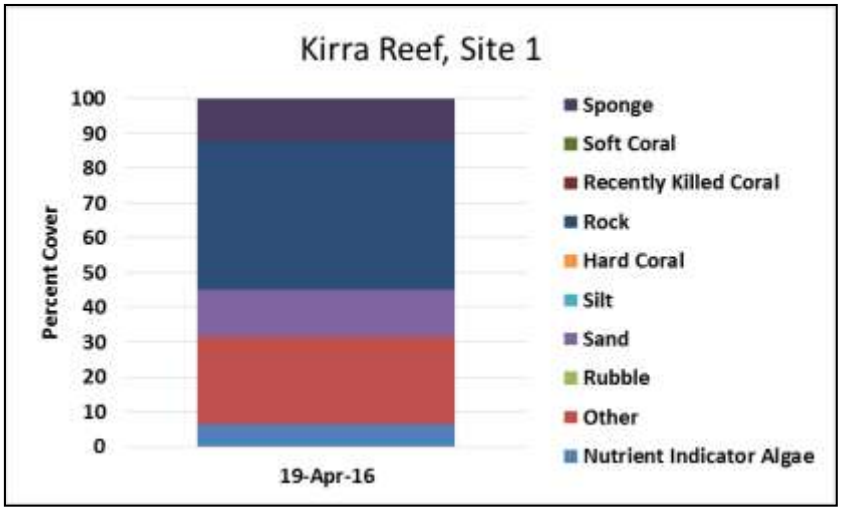


Figure 62: Benthic type and percent cover: Kirra Reef, Site 1, 2015

4.0 Gold Coast Sites

4.5 Palm Beach Reef, Site 1

Palm Beach Reef is an extensive rocky reef made up of numerous ridges and gullies, located just 800-1000 meters offshore. Palm Beach Reef is characterised by a high number of sessile invertebrates such as sponges, ascidians and coral (Edwards & Smith 2005). Palm Beach Reef, Site 1 was established in 2007 to gain further understanding of the subtropical reefs in the Gold Coast sub-region. The site is situated on the reef flat at a depth of nine meters.

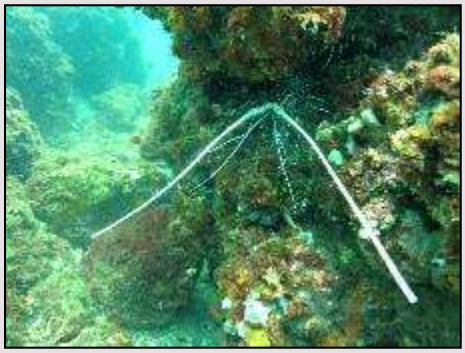
The hard coral cover at Palm Beach Reef Site 1 has seen a decline from 21% in 2008 to 9% in 2013, and 4% this season. Encrusting growth forms (2%) continue to be the dominant hard growth form. Soft coral cover decreased from 18% in 2011 to 3% in 2013, but has since increased to 6% in 2015. Sponge cover declined from 14% in 2013 to 11% in 2015. *Padina* was the only macro algae recorded, with three counts.

Anemone numbers have fluctuated (max. 201 in 2009, min. 19 in 2013) with 132 anemones recorded in 2015. Pencil urchin abundance declined to 16 (24 in 2013), as did *Diademas* (61 in 2013 to nine in 2015). Twenty-three *Drupella* snails were also recorded.

Coral bleaching affected just 1% of the total coral population; with an average of 7% of each bleached colony affected. Three incidents of coral damage from an unknown origin were recorded. Low silt loading was recorded.

A fish survey was not conducted in 2015.

Site photo, Palm Beach Reef, Site 1



Spiny Lobster, Palm Beach Reef, Site 1

Hexabranchus sanguineus Nudibranch, Palm Beach Reef, Site 1

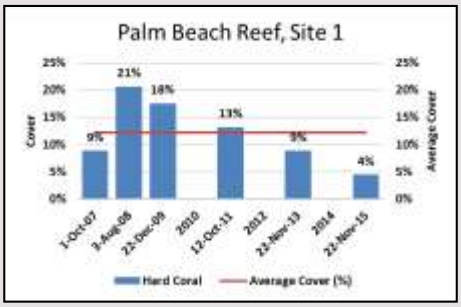


Figure 61: Hard Coral cover as a percent of total substrate

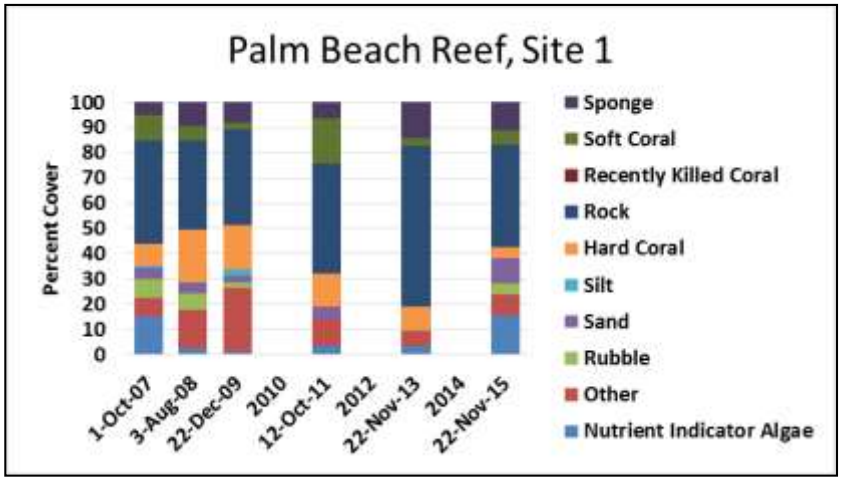


Figure 62: Benthic type and percent cover: Palm Beach Reef, Site 1, 2007- 2015

4.0 Gold Coast Sites

4.6 Palm Beach Reef, Site 2

Palm Beach Reef is an extensive rocky reef made up of numerous ridges and gullies, situated just 800 to 1000 meters offshore. Palm Beach Reef is characterised by a high number of sessile invertebrates such as sponges, ascidians and coral (Edwards & Smith 2005). Palm Beach Reef, Site 2 is located in close proximity to the long-established Palm Beach Reef Site 1. This site is located on the reef flat at a depth of nine meters.

Hard coral cover accounted for 17% of the benthos in 2015. The 'other' category (12%; consisting primarily of anemones and ascidians), sponges (8%) and soft corals (3%) attributed to the rest of the living benthic surface. Rock (34%), nutrient indicator algae (19%), sand (8%) and rubble (1%) accounted for the non-living reef substrate.

A high invertebrate abundance was recorded in 2015; 159 anemones, 74 pencil urchins and 68 *Diadema* long spined urchins were recorded. In fact, the numbers of *Diadema* doubled (from 34 in 2009) and the numbers of pencil urchins nearly tripled (from 25 in 2009).

Coral bleaching affected just 3% of the total coral population; with an average of 14% of each bleached colony affected. The only recorded impacts at this site were three incidents of coral disease. Low silt loading was recorded.

A fish survey was not conducted in 2015.

Site photo, Palm Beach Reef, Site 2

Diadema long spined urchin and pencil urchin, Palm Beach Reef, Site 2

Anemone and soft coral, Palm Beach Reef, Site 2

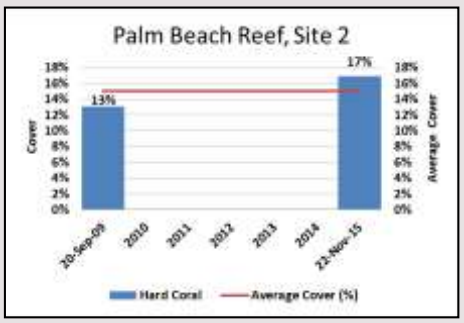


Figure 63: Hard Coral cover as a percent of total substrate

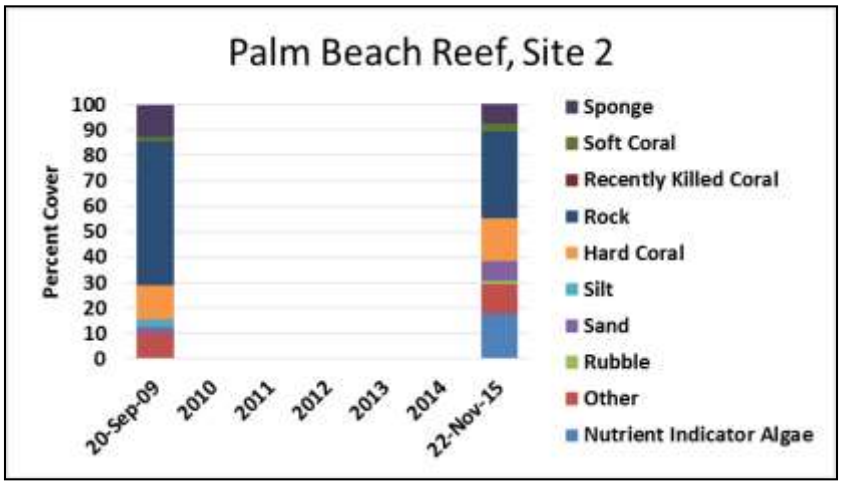


Figure 64: Benthic type and percent cover: Palm Beach Reef, Site 2, 2009- 2015

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