Reef Check Australia

Great Barrier Reef Summary Report 2011-2013

empowering PEOPLE to save our reefs and oceans

Reef Check Foundation Ltd

Annie Bauer

Edited by Jennifer Loder and Jodi Salmond

www.reefcheckaustralia.org

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1.0 Introduction

Reef Check Australia's (RCA) monitoring program helps to provide an early warning system for changes in the health of surveyed coral habitats. Annual surveys provide long-term data sets that can reveal important patterns over time. Quantitative data is collected in relation to substrate cover, as well as abundance of key invertebrate species and target fish species. RCA also monitors natural and anthropogenic impacts that affect coral habitats. The Great Barrier Reef (GBR) project was first implemented in 2001, and sites have been regularly monitored since.

A summary of the findings for surveys conducted in GBR during the 2011-2013 season are presented in this report. Teams of trained volunteers monitored a total of 41 sites across 12 different reefs. These sites included both new and existing survey sites ranging from Lady Elliot Island, the southern-most island of the GBR, to the northern outer reefs out from Port Douglas.

The GBR Marine Park spans a total of 344,400 km^2, and covers approximately two thirds of the coast of Queensland (Fernandes et al., 2005, GBRMPA, 2009). It includes the outer reefs that exist along the edge of the continental shelf, as well as the fringing reefs that occur close to the coast of the mainland and islands. In addition to the reefs, the park also protects other marine habitats adjacent to the reefs, such as seagrass, mangroves, soft substrate, and mudflats. In 2004, a new reserve network was implemented by the GBR Marine Protection Authority, which resulted in 33% of the GBR Marine Park protected by no take zones (Fernandes et al., 2005).These areas are important as they prohibit any harvest of marine organisms, and may act as a refuge to targeted species.

Over the last three years the Great Barrier Reef has endured a number of threats, one of which, was Cyclone Yasi, which hit the coast in February of 2011. This Category 5 Tropical Cyclone had estimated wind gusts up to 285 km per hour, wind speed of 185 km per hour, and resulted in much of the damage to several of the offshore and coastal sites (QLD, 2012). Other major threats to the Great Barrier Reef include crown of thorns sea star (COTs) outbreaks, coral bleaching, and disease (De'ath et al., 2012). Coastal development and agriculture has also been found to have negatives impacts on the reef. The large scale of agriculture that covers much of the Queensland coast is a cause of excess nitrogen and phosphorus runoff through soils, fertilizers, and pesticides (GBRMPA, 2009, De'ath et al., 2012). Cumulatively, these threats are causing declines in reef health.

Survey Methods

Surveys are typically conducted between three and eight meters above lowest astronomical tide utilizing SCUBA. However, some survey sites are monitored by shallow water snorkelling and reef walking. GPS and detailed maps are used to ensure that each site is surveyed within the same location every year and at a consistent depth (+/- 1m). Transect tapes are used to perform four 20 meter replicates, with five meters between each replicate (figure 1). If gullies are encountered, they are skipped, and additional space is added to the end of the transect to make up for the missed space (figure 2). Teams of three to five trained volunteers are used to conduct full surveys that monitor indicator fish and invertebrate abundance, and changes in substrate. In addition, reef

impacts such as abundance of coral scars, bleaching, disease, and marine debris are recorded.

Figure 1: Reef Check Australia surveys consist of four 20 meter replicates with 5 meter gaps between each replicate.

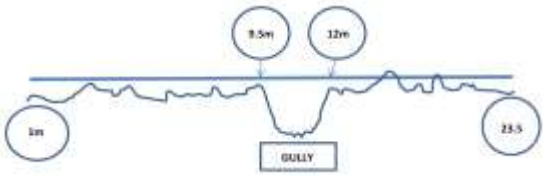

Figure 2: Example of a Reef Check survey with a gully in the middle of the transect line.

To monitor substrate changes, volunteers perform point intercept line transects, using a plum line to record the substrate under the transect tape every half meter. Reef Check Australia categories include the 10 general Reef Check categories: hard coral (HC), sponge (SP), soft coral (SC), other (OT), rock (RC), recently killed coral (RKC), nutrient indicator algae (NIA), silt/clay (SI), rubble, (RB), and sand (SD). An additional 15 Australia specific categories are also included: Bleached Hard Coral (HCB), Hard Coral Branching (HCBR), Hard Coral Encrusting (HCE), Hard Coral Foliose (HCF), Hard Coral Massive (HCM), Hard Coral Plate (HCP), Sponge Encrusting (SPE), Soft Coral Leathery (SCL), Soft Coral Zoanthids (SCZ), Soft Coral Bleached (SCB), Rock with Turf Algae (RCTA), Rock with Coralline Algae (RCCA), Recently Killed Coral with Nutrient Indicator Algae (RKCNIA), and Recently Killed Coral with Turf Algae (RKCTA). Seasonal Macroalgae abundance is also recorded separately on substrate surveys.

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

Fish surveys are conducted before the tape is laid. One volunteer moves slowly forward (approximately 10 minutes per 20 meters), recording all indicator fish that come within a 5 meter 'tunnel' in front of the volunteer. The tape is laid out behind the surveyor to ensure minimal disturbance during the fish survey. Indicator fish include barramundi cod, butterflyfish, coral trout, grouper, Queensland grouper, humphead wrasse, moray eel, bumphead parrotfish, other parrotfish, snapper and sweetlips.

1.1 Monitoring Sites

Reef Check Australia monitoring sites in the Great Barrier Reef range from Lady Elliot Island to Port Douglas (figure 3). RCA collects data in varied reef habitats, both within protected and non-protected marine park areas for contrast and comparison. During the 2011-2013 GBR seasons, 21 of the existing 55 reef sites were surveyed and 18 new sites

were implemented; giving a total of 39 sites surveyed. This number includes the 9 new sites in Heron Island implemented in 2011, two of which were revisited in 2012 (Table 1). For summary information on Heron Island, please see the Reef Check Australia 2011 Heron Island Reef Health Baseline Report.

Twenty-four of the 38 sites surveyed within 2011 to 2013 occurred within the protected national marine park zone. Site protection levels are listed in table 1. For more information about GBRMPA zoning, visit http://www.gbrmpa.gov.au/zoning-permits-and-plans/zoning.

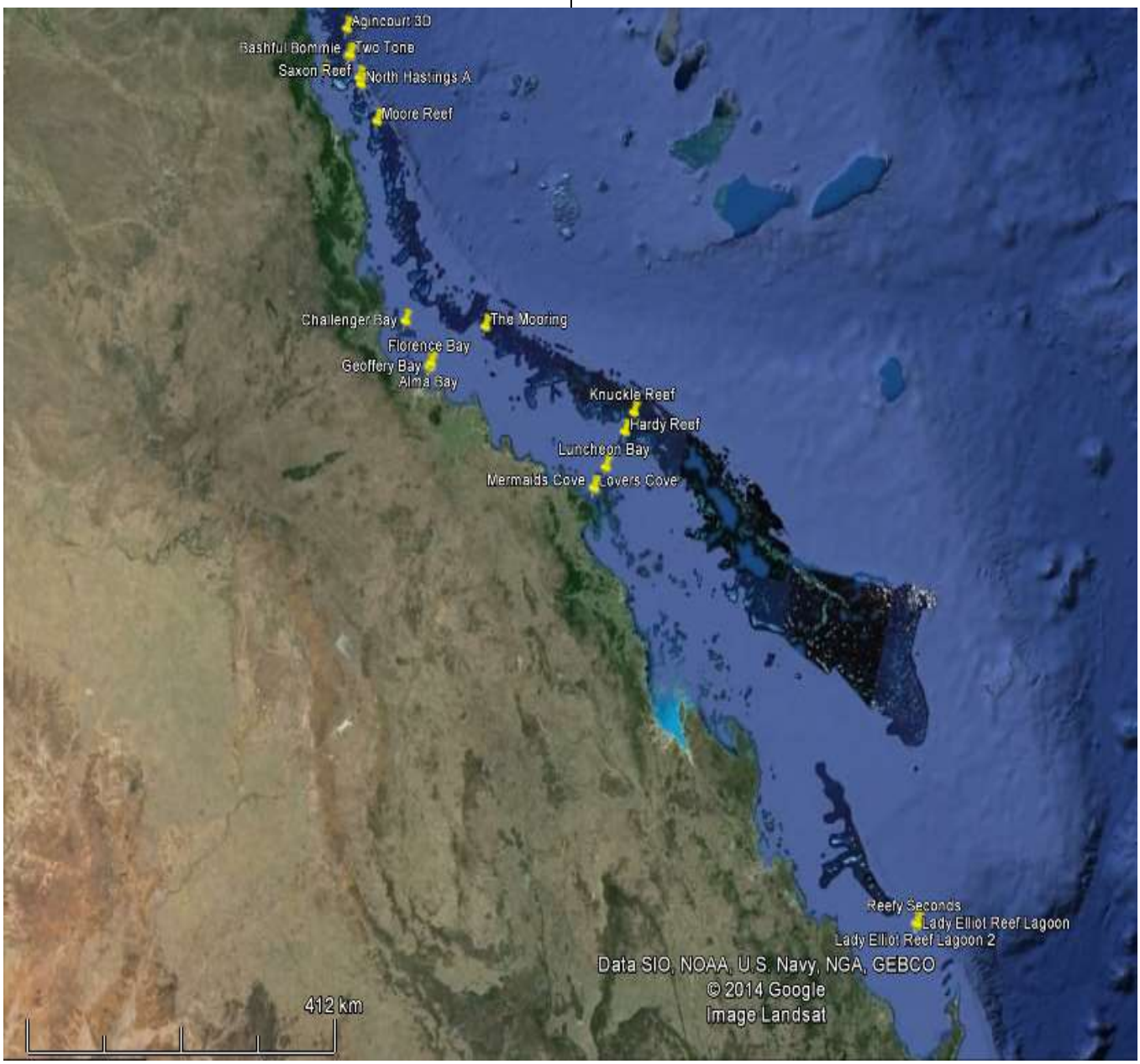

Figure 3: Map of the Great Barrier Reef survey 2011-2013 sites from Google Earth. For further details on site locations go to http://www.reefcheckaustralia.org/public-reports.html.

Table 1: Sites visited in 2011-2013. Site designation is according to the Great Barrier Reef Marine Park Authority protection levels (2004): Green: Marine national park zone, protected area, no recreational or commercial fishing permitted, tourism and research allowed with permit. Yellow: Conservation park zone, limited recreational and commercial fishing allowed, including limited impact research. Dark blue: Habitat protection zone, recreational and commercial fishing permitted. Blue: General use zone, recreational and commercial fishing permitted. Shipping permitted without permit. Orange: Scientific zone, designated for research. For those not participating in research, zone acts as a Green Zone. Note: sites with * were uncompleted surveys.

Site	#	Depth	Location	1st Survey	Last Survey	Site Designation
Hardy Reef	1	Shallow	Whitsundays	2002	2013	Green
Hardy Reef	3	Shallow	Whitsundays	2009	2013	Green
Luncheon Bay	1	Shallow	Whitsundays	n/a	2013	Green
Lover's Cove	1	Shallow	Whitsundays	n/a	2013	Green
Mermaids Cove	1	Shallow	Whitsundays	n/a	2013	Green
Knuckle Reef	1	Shallow	Whitsundays	2006	2011	Dark Blue
Saxon Reef	1	Shallow	Cairns	2004	2013	Green
North Hastings	1	Shallow	Cairns	2003	2013*	Green
Moore Reef	1	Shallow	Cairns	2005	2013	Green
Nelly Bay	1	Shallow	Magnetic Island	2003	2013	Blue
Nelly Bay	2	Shallow	Magnetic Island	2003	2013	Blue
Alma Bay	1	Shallow	Magnetic Island	2004	2012	Green
Alma Bay	2	Shallow	Magnetic Island	2005	2013	Green
Florence Bay	2	Shallow	Magnetic Island	2006	2012	Green
Geoffrey Bay	1	Shallow	Magnetic Island	2003	2011	Green
The Mooring	1	Shallow	Townsville	2004	2012	Green
Bashful Bommie	1	Shallow	Port Douglas	2002	2013	Green
Bashful Bommie	1	Medium	Port Douglas	2003	2012	Green
SNO	1	Medium	Port Douglas	2009	2011	Yellow
SNO	2	Shallow	Port Douglas	n/a	2013	Yellow
Two Tone	1	Shallow	Port Douglas	2003	2013	Green
The Wedge	1	Shallow	Port Douglas	2004	2013	Green
Agincourt 3D	1	Shallow	Port Douglas	2003	2013	Green
Agincourt 3D	2	Shallow	Port Douglas	2004	2013	Green
Low Isles	1	Shallow	Port Douglas	2002	2013	Green
Coral Gardens	1	Shallow	Lady Elliot Island	n/a	2013	Green
Reef Lagoon	1	Shallow	Lady Elliot Island	2011	2013	Green
Reef Lagoon	2	Shallow	Lady Elliot Island	n/a	2013	Green
Reefy Seconds	1	Shallow	Lady Elliot Island	n/a	2013	Green
Sandy Seconds	1	Shallow	Lady Elliot Island	n/a	2013	Green
Coral Garden	1	Shallow	Heron Island	2011	2011	Green
Coral Grotto	1	Shallow	Heron Island	2011	2011	Yellow
Harry's Bommie	1	Shallow	Heron Island	2011	2011	Orange
Heron Bommie	1	Shallow	Heron Island	2011	2011	Green
Jetty Flat	1	Shallow	Heron Island	2011	2012	Green
Libby's Lair	1	Medium	Heron Island	2011	2011	Yellow
Coral Cascade	1	Medium	Heron Island	2011	2011	Yellow
Research Zone	1	Shallow	Heron Island	2011	2011	Orange
Shark Bay	1	Shallow	Heron Island	2011	2012	Yellow
Challenger Bay	1	Shallow	Palm Island	n/a	2013	Blue
Challenger Bay	2	Shallow	Palm Island	n/a	2013	Blue

1.2 Trends and Patterns

Coral Cover

Of the 30 existing sites that were surveyed within 2011-2013 (including the 9 revisited Heron Island sites), 15 sites increased in coral cover since the last season summary report in 2010, and 14 sites decreased. Out of the six monitored regions, two of them, Magnetic Island and The Whitsundays had an overall decrease in hard coral cover. The Port Douglas region showed the highest hard coral cover, with an average amount of 48% (figure 4).

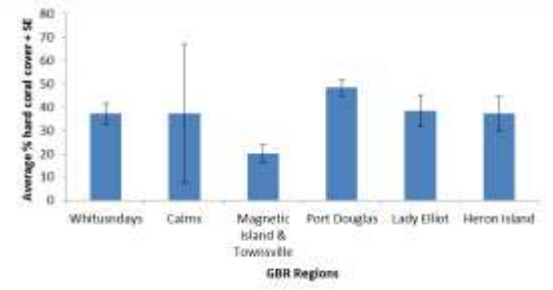

Figure 4: The average percent hard coral cover (+/-SE) among the five regions in North Queensland: The Whitsunday Islands, Cairns, Magnetic Island and Townsville, Port Douglas, and Lady Elliot from 2011 to 2013. Only two sites were surveyed in Cairns within this time, contributing to the high standard of error.

Reef Health Impacts

Impact surveys were performed at 38 of the 41 sites surveyed. Over the last three survey seasons, coral bleaching was observed at every site (table 2) and accounted for 29% of the total recorded coral impacts (figure 5). However, population level bleaching was low across surveyed sites, with an average of 3.40% of the population affected.

Coral disease was recorded at 29 of the 38 sites (76%) (table 3), with the highest reported incidence of 55 counts in one 400m² survey area in 2013. Many sightings appeared to be white syndrome or black band disease.

Drupella spp. (coral-eating snails) were recorded at 12 out of 38 surveys, but in fairly low abundance (average of 1 per 400m^2 on all transects). Drupella scarring was recorded at 14 sites (37%).

Coral scarring from unknown causes was commonly recorded on impact surveys (32 of 38 sites or 84%) which ranged from just one scar to as many as 36 per 400m^2. The majority of surveys reported hard coral damage (37 of 38 or 97%) from 2011 to 2013. The number of recorded incidents per site varied from only one, to as many as 68 per 400m^2. Coral damage contributed to 31% of the total recorded impacts on the reefs in 2011 to 2013.

Rubbish was not commonly reported on surveys from 2011-2013. Only two incidents of discarded fishing line was recorded, occurring at Lady Elliot Island and Heron Island. One incident of general rubbish was recorded at Low Isles and 12 incidents total were recorded at Heron Island.

Table 2: The percent of RCA survey sites with recorded impacts (of a total of 35 sites), and the average abundance of impacts recorded from 2011-2013

Impacts	% of sites with impact	Average abundance (per400m^2)
Coral Bleaching	100	3.40%
Coral Damage	97	14.84
Coral Disease	76	6.97
***Drupella* Scars**	37	1.01
Fishing line	8	0.03
Marine Debris	8	0.16
Unknown scars	84	10.07

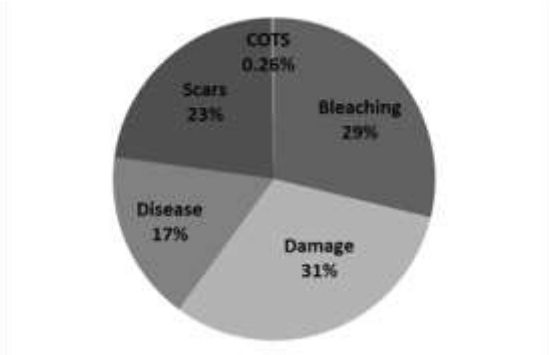

Figure 5: The cumulative percent of impact type from 2011- 2013 surveys. To calculate, the total number of incidents was divided by the total number of recorded impacts across all surveys.

Invertebrate Abundance

Invertebrate surveys were conducted at 38 sites.

Giant clams were the most abundant indicator invertebrate recorded on surveys, with a total of 431 individuals recorded from 2011 to 2013. Other indicator invertebrates such as sea cucumbers and long spined sea urchins (*Echinothrix* spp and *Diadema*) were also commonly observed. A total of six crown of thorn sea stars (COTs) were recorded, all in the 2013 survey season. Five were found at Moore Reef off of Cairns and one was found at Bashful Bommie in Opal Reef, off of Port Douglas. The long term monitoring program at Australian Institute of Marine Sciences (AIMS), have reported recent crown of thorn outbreaks in the northern reefs (AIMS, 2013). While AIMS monitoring sites are different from those of Reef Check Australia, 2013 reports of COT sightings have found to be incipient at Cairns sites, but active in more northern sites such as Cooktown and Lizard Island. For more information about COT outbreaks visit http://www.aims.gov.au/docs/research/biodiversity-ecology/threats/cots.html.

Fish Abundance

Fish abundance surveys were conducted on 21 of the 41 surveys completed in the 2011 to 2013 seasons.

Butterfly fish and parrotfish were the most commonly recorded fish groups. Coral trout, groupers, and snapper were recorded in smaller numbers. Queensland groupers, bumphead parrotfish, and humphead wrasse were not observed during any fish surveys within the last three years.

Photo 1: Grouper (family Serranidae) at Heron Island, Coral Gardens Site 1.

Photo 2: Breeding pair of clownfish and their anemone at Saxon Reef Site 1.

Table 3: Overview of basic site characteristics: percent cover of hard coral, percent cover of soft coral, whether hard coral cover increased or decreased from previous surveys, average macro algae (MA) count, percent cover of nutrient indicator algae (NIA), and silt loading levels (where low levels (L) are a light layer of silt visible on occasional surfaces, medium levels (M) are silt layer that cover most surfaces and high levels (H) cover all surfaces), presence of reef health impacts (including *Drupella* snail scars, unknown scars, coral damage, fishing line and net, marine debris (trash), coral disease, and coral bleaching). Boxes with "x" signify presence of impact. Boxes with "n/a" signify sites where impact surveys were not completed.

Basic site summary							Presence of Impacts								
Site	% Hard Coral	% Soft Coral	Hard coral increased or decreased from 2010	Average Macro algae (MA) per 100m²	% Nutrient Indicator Algae (NIA)	Silt	Drupella Scar	Unknown Scar	COT Scars	Anchor Damage	Coral Damage (Unknown cause)	Fishing Line/Net	General Trash	Coral Disease	Coral Bleaching
Alma Bay S2	16	3	↓	15	6	H		X			X				X
Bashful Bommie S1	33	6	↑	0	2	L		X	X		X			X	X
Coral Gardens	58	0	n/a	0	0	L		X			X				X
Hardy Reef S1	54	26	↓	0	5	L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hardy Reef S3	46	6	↑	0	2	M		X			X			X	X
LEI Lagoon	49	0	↑	0	0	L	X	X			X				X
LEI Lagoon 2	22	0	n/a	0	0	L	X	X			X				X
Lover's Cove	33	26	n/a	<1	0	H	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Luncheon Bay S1	37	26	n/a	0	1	M		X			X				X
Mermaids Cove	17	40	n/a	0	<1	H	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nelly Bay S1	13	0	↓	18	9	H	X	X			X				X
Nelly Bay S2	31	0	↓	16	3	H	X	X			X			X	X
Reef Magic Pontoon S1	67	9	↑	0	0	L	X	X	X		X			X	X
Reefy Seconds	53	<1	n/a	0	<1	L	X	X			X				X
Sandy Seconds	43	<1	n/a	0	0	L	X	X			X	X			X
Saxon Reef, S1	8	1	↓	0	3	L		X			X			X	X
SNO, S2	37	6	n/a	0	<1	L		X			X			X	X
The Wedge	33	11	↓	0	9	L		X			X			X	X
Two Tone	40	14	↑	0	0	L		X			X				X
Agincourt 3D, S1	48	<1	↓	0	29	L		X			X			X	X
Agincourt 3D, S2	66	1	↑	0	9	L					X			X	X
Low Isle, S1	13	59	↑	0	<1	M		X		X	X		X	X	X

2.0 Whitsundays

A total of 3 existing sites were surveyed within the Whitsundays from 2011 to 2013. One new site was implemented on Hook Island in 2013, along with 2 new snorkel based sites on Daydream Island. Coral cover on all 5 sites ranged from 17% to 54%. Coral cover decreased since 2010 on two of the three established sites.

2.1 Hardy Reef, Back Reef Wall, Site 1, Shallow

This site is comprised of a steep slope with a number of overhangs. A permanent pontoon roughly 75km from Airlie Beach allows this protected marine park to be visited daily by snorkelers and divers alike. This site was first visited in 2002 and has been regularly monitored since. After 2010, the site was surveyed only once, which was in 2013.

There has been a slow, net increase of hard coral cover over the last 11 years: 41% cover recorded in 2002 to 54% in 2013 (figure 6). Slight fluctuations in coral cover have occurred over time, with hard coral cover reaching a high of 61% in 2010, before decreasing to current levels. A survey was not conducted in either 2011 or 2012. While coral cover increased, the composition of hard coral was found to change over time. The Reef Check general 'Hard Coral' category (which includes digitate and submassive growth forms) dominated in both 2002 and 2003 at 41% and 35% respectively. However, this category declined to 1% in 2006, and has remained consistently low since this time. Conversely, branching, encrusting, and foliose corals increased to 43%, 3%, and 4% respectively in 2013 after having not been present at all in 2002 and 2003. Soft coral cover has also fluctuated over the years, almost doubling in cover from 2002 (27%) to 2005 (46%). Since then, a slow decrease in cover has occurred, with soft coral representing only 28% of the substrate in 2013. Rock with turf algae has remained relatively stable over the years, covering 21% of the substrate in the 2013 survey. Nutrient indicator algae has remained low, increasing from 1% in 2010 to 5% in 2013.

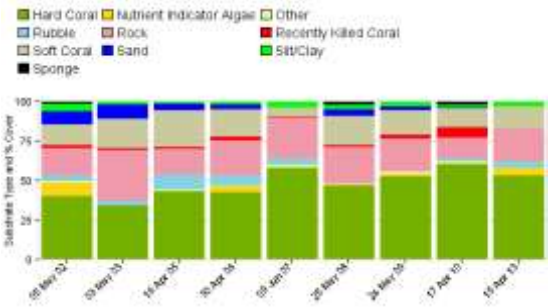

Figure 6: Substrate type and percent cover at Hardy Reef: shallow: Site 1: Back reef wall.

No fish, impact or invertebrate surveys were conducted at this site in 2013.

Photo 3: Green turtle at Hardy Reef, Site 1

2.2 Hardy Reef, Back Reef Wall, Site 3, Shallow

This site was first surveyed in 2009, and was revisited twice within the 2011-2013 period, once in 2011 and again in 2012. Hard coral cover has remained relatively stable since the first survey, ranging from 41% in 2009 to 46% in 2013 (figure 7). Branching coral has become the dominant hard coral structure, increasing from 16% in 2009 to 29% in 2013. In contrast, soft coral coverage has fluctuated considerably over the years. In 2009, soft corals represented 46% of the substrate, but decreased to 19% the following year. Soft coral rebounded back to 45% in 2011 before declining by half once again to 21% in the 2013 survey. Despite this, non-leathery corals have remained the dominant soft coral type. Siltation levels increased noticeably, peaking at 11% in the 2013 survey.

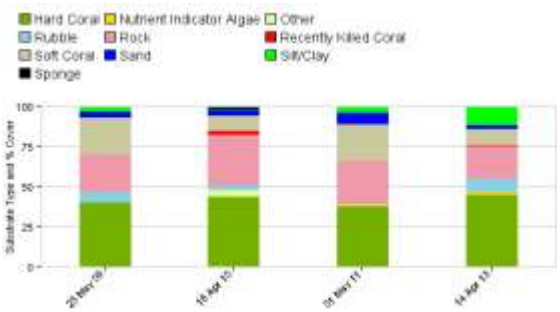

Figure 7: Substrate type and percent cover at Hardy Reef: shallow: site 3: Black reef wall.

Coral bleaching has increased over the years from an average of <1% in the 2009-2011 surveys, to affecting almost 14% of the coral population in 2013 (figure 8). Coral disease was observed for the first time on the 2013 survey, with an average of 31 incidents per 400m^2.

Anemones have been consistently observed on transect over the years, with one recorded in 2011, and two on the 2013 survey.

Fish surveys have never been completed at this site.

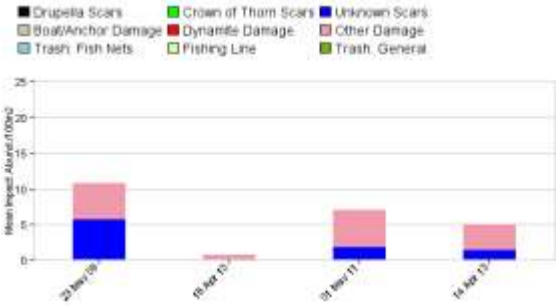

Figure 8: Mean abundance of impacts at Hardy Reef: shallow: Site 3: Back reef wall.

Photo 4: Disease at Hardy Reef, Site 3.

Photo 5: Bleached coral at Hardy Reef, Site 3.

2.3 Knuckle Reef, Back Reef Slope, Site 1, Shallow

This off-shore reef is located 100km from Airlie Beach, and was first surveyed in 2005. It contains a permanent pontoon, where many tourists visit frequently. The site follows the reef slope at approximately 4-5 meters. The last survey performed at this site was in 2011.

Hard coral cover was found to decrease from 51% in the 2010 survey to 27% in 2011, with branching coral growth forms as the most heavily impacted, declining by 14% (figure 9). Alternatively, encrusting hard coral increased from <1% in 2010 to almost 9% in 2011. The amount of soft coral has remained relatively steady over the years, decreasing by 2% from 2010, and covering approximately 6% of the benthic substrate in 2011. Rock with turf algae changed in cover, increasing from 3% in 2010, to 21% in 2011. A substantial increase in siltation occurred, from not being present in either 2009 or 2010 surveys to representing 31% of the substrate in 2011.

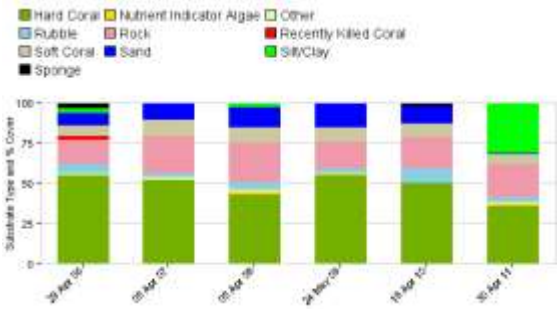

Figure 9: Substrate type and percent cover at Knuckle Reef: shallow: Site 1: Back reef slope.

Coral damage decreased by over half, from 17 incidents per 400m^2 in 2010 to 8 per 400m^2 in 2011 (figure 10). Coral bleaching has remained low at the site, affecting 1% of the total population. The number of unknown scars increased slightly from 6 incidents in 2010 to 9 in the 2011 survey.

Figure 10: Mean abundance of impacts at Knuckle Reef: shallow: Site 1: Back reef slope.

Giant clams continue to be the dominant indicator invertebrate at this site; however their numbers decreased by almost half from 47 individuals in 2010 to 26 in 2011 (figure 11). A total of 3 anemones were also recorded on the 2011 survey.

A fish survey was not conducted in 2011.

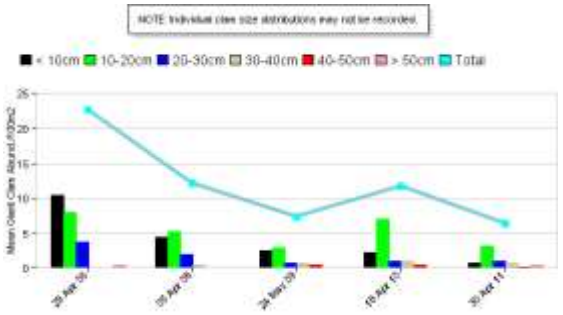

Figure 11: Mean abundance of giant clam size classes at Knuckle Reef: shallow: Site 1: Back reef slope.

Photo 6: Surveyor at Knuckle Reef, Site 1 (2009).

2.4 Hook Island, Luncheon Bay, Fringing Reef, Site 1, Shallow

This site is located on the north side of Hook Island in the Whitsundays, and was first implemented in 2013. It is a popular site visited by snorkelling, sailing, and diving boats. The site often has 15 or more boats on a daily basis. Boats use moorings located approximately 100m away from the site, and use small skiffs to transport snorkelers and divers to and from the site.

Hard coral was found to represent almost 37% of the benthic substrate, and was composed of mostly massive (16%) and encrusting corals (10%) (figure 12). Additionally there was a high abundance of fire corals. Soft coral was found to represent approximately 26% of the substrate, consisting largely of leathery corals (21%). Rock with turf algae was found to be the third most dominating substrate structure, representing 26%.

Figure 12: Substrate type and percent cover at Hook Island: Luncheon Bay: Shallow: Site 1: Fringing reef leeward.

There were 7 incidents of coral damage recorded at the site and one unknown scar. Additionally, coral bleaching affected 4% of the coral population. No coral disease was recorded on the transect.

Twenty-six giant clams were observed on the transect, along with a two anemones.

Butterflyfish and parrotfish were found to be in high abundance, with 26 and 25 individuals observed respectively. Furthermore, 2 barramundi cods, 3 groupers, and 1 coral trout were also recorded.

Photo 7: Large plate coral at Luncheon Bay Site 1.

Photo 8: Large massive coral at Luncheon Bay Site 1.

Photo 9: Silt and turf algae at Luncheon Bay Site 1

2.5 Daydream Island, Lovers Cove, Fringing Reef, Site 1, Shallow

This site is along the fringing reef on the leeward side of Daydream Island, and was first implemented in 2013. This site is very shallow, allowing snorkelers to survey the site. It is one of the more popular sites for resort guests to snorkel and swim. Additionally, there are regular fish feeding shows performed by a resort marine biologist in shallow waters.

Approximately 33% of this site was represented by hard coral; mostly consisting of branching corals (26%), encrusting (4%) and massive (1%) (figure 13). Soft coral was found to cover 26% of the substrate, mostly consisting of leathery corals (25%) and only 1% represented by zoanthids. No nutrient indicator algae, rock with turf algae, or macro algae were recorded; however, this may be due to the large amount of silt, which covered approximately 39% of the substrate.

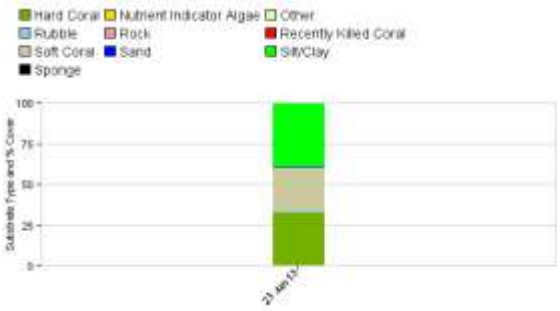

Figure 13: Substrate type and percent cover at Daydream Island: Lovers Cove: Shallow: Site 1: Fringing reef leeward.

Invertebrate, impact, and fish surveys were not completed due to low visibility.

Photo 10: Site photo at Daydream Island, Lovers Cove, Site 1.

Photo 11: Surveyors high-fiving after a job well done at Daydream Island, Lovers Cove, Site 1.

Photo 12: Surveyor at Daydream Island, Lovers Cove, Site 1.

2.6 Daydream Island, Mermaid Cove, Fringing Reef, Site 1, Shallow

This site is located on the northern-most, leeward side of Daydream Island, and was first implemented in 2013. A shallow, intertidal reef occurs along the rocks, where snorkelers are able to easily survey. On extremely low tides, corals are exposed. This site is hidden from most tourists, as it is off the beaten path. Instead, it is most frequently visited by the resort staff.

Hard coral was much less abundant than its adjacent site, Lover's Cove, representing only 17% of the substrate (figure 14). However, hard coral morphology was found to be heterogeneous, with 5% general hard coral, 5% branching, 4% encrusting, and 1% massive corals. Most of the branching coral consisted of fire coral. Approximately 40% of the substrate at this site was represented by soft coral, consisting of mostly general soft coral (not leathery corals) (37%), and a few zoanthids (3%). Similar to Lover's Cove, this site contained high amounts of siltation, representing 28% of the substrate. Rock with turf algae represented 4% of the survey area and 1% was recorded as nutrient indicator algae.

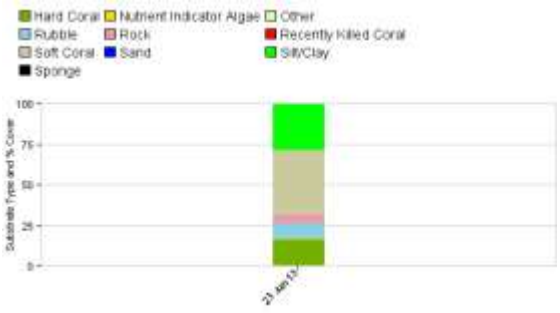

Figure 14: Substrate type and percent cover at Daydream Island: Mermaids Cove: Shallow: Site 1: Fringing reef leeward.

Invertebrate, impact, and fish surveys were not completed due to low visibility. However, the substrate survey showed that about 2% of the substrate was bleached. In addition, many burrowing giant clams were observed.

Photo 13: Site photo (right side) at Daydream Island, Mermaids Cove site 1.

Photo 14: Mermaid at Daydream Island, Mermaids Cove Site 1.

3.0 Cairns

Two surveys were completed within the Cairns region from 2011 to 2013. Both of the sites decreased in hard coral cover since 2010, with an average being 37%. The actual hard coral cover ranged from 8% to 67%.

3.1 Saxon Reef, Saxon Reef, Back Reef Slope, Site 1, Shallow

This site is a relatively protected reef that is located approximately 45 km from shore, and first surveyed in 2004. It was severely impacted early in 2011 by Cyclone Yasi. As a result of the damage that occurred, this site is rarely visited by dive operators. The 2013 survey was the first RCA survey completed on this reef since the cyclone.

The reef slope previously dominated by massive (mostly *Porites)* and branching hard corals has shown significant decreases in coral cover since 2010. Hard coral cover dropped from 40% in 2010 to 7.5% in 2013 (figure 15), with low percentages of massive and branching forms (4% and 2% respectively). The amount of rubble increased from 8% in 2010 to 27%. Rock with turf algae was found to cover about 41% of the substrate and high levels of silt was recorded. Additionally, the percent cover of soft coral declined from 6% in 2010 to 1%.

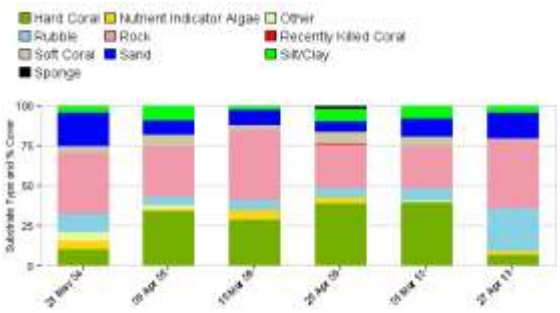

Figure 15: Substrate type and percent cover at Saxon Reef: shallow: Site 1: Back reef slope.

Coral damage was recorded on corals that persisted through the cyclone (9 per 400m^2) (figure 16). An average of 14% of the coral population was bleached, with an average of 40% of each colony affected. This is a notable increase, as the 2010 survey recorded less than 1% of total coral bleached. Nine unknown scars were observed and only one count of disease was recorded on the 2013 survey.

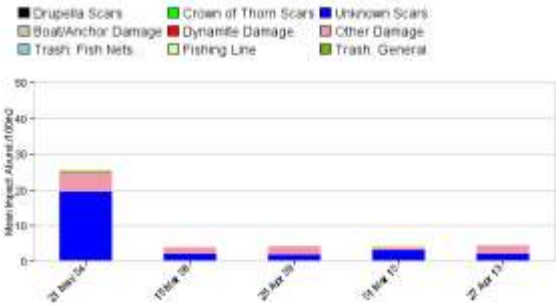

Figure 16: Mean abundance of impacts at Saxon Reef: shallow: site 1: Back reef slope.

One pencil urchin was recorded on the survey. Other indicator invertebrates observed during the survey included 2 giant clams, 1 lobster, and 1 anemone. In addition, extremely high numbers of burrowing sea urchins were found, with about 100 individuals per 400m^2.

A fish survey was not completed as part of the 2013 survey.

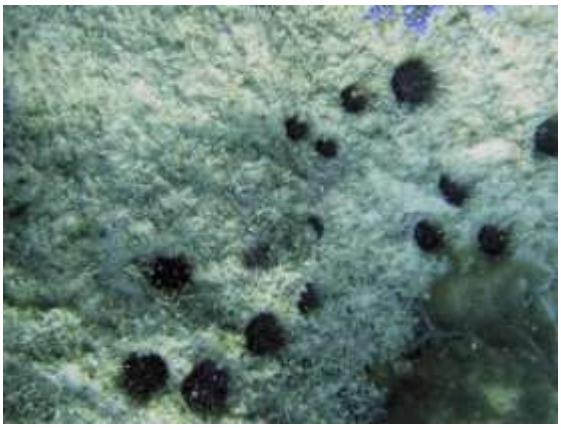

Photo 15: High abundance of burrowing sea urchins at Saxon Reef, Site 1.

3.2 Moore Reef, Reef Magic Pontoon, Back Reef Slope Site 1, Shallow

A permanent pontoon allows this protected marine park zone to be frequently visited by snorkelers and divers. This back reef slope contains a slight change in depth resulting in two survey sites, a shallow (3m) site and a medium depth (5m) site. The shallow site has been regularly monitored since 2005, and was last surveyed in 2013.

Hard coral cover has shown large variations in abundance since the initial survey in 2005. The general hard coral category has doubled since 2005, and now covers approximately 67% of the substrate (figure 17). Over this time, branching corals have shown a steady increase as well, representing 16% of the substrate in 2005 and 38% in 2013. The abundance of foliose coral increased from 0 to 16% within the last two years, yet the distribution of foliose corals were highly clumped at this site. Alternatively, soft coral has shown an overall decreasing trend, covering 24% of the total substrate in 2005 and only 9% in 2013, with leathery soft coral continuing to be the dominant form. Rock with turf algae covered approximately 15% of the benthic substrate.

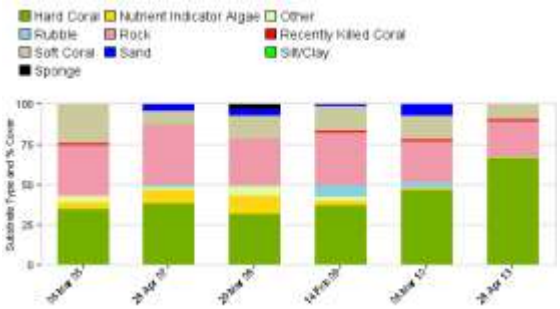

Figure 17: Substrate type and percent cover at Moore Reef: Reef Magic Pontoon: Shallow: Site 1: Back reef slope.

The occurrence of coral bleaching remained consistently low from 2005 to 2010, affecting <1% of the total population. However, in 2013, 16% of the total population was affected, with an average of 29% of each colony bleached. A total of 4 incidents of coral damage were recorded this year. Coral disease had a notable change, increasing from 2 counts per 400m^2 in 2010 to 55 in 2013.

For the first time since 2009, a total of 5 crown of thorn sea stars were recorded on the 2013 survey (figure 18). Two long spine sea urchins, one sea cucumber and two anemones were also recorded this year.

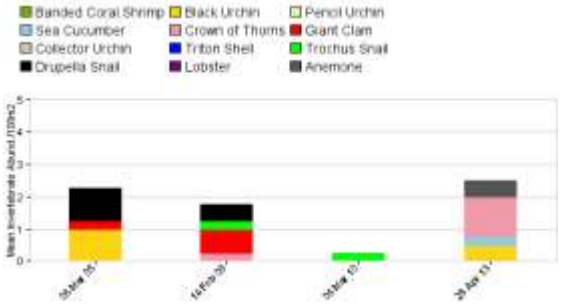

Figure 18: Mean abundance of invertebrates at Moore Reef: Reef Magic Pontoon: Shallow: Site 1: Back reef slope.

A fish survey was not completed in the 2013 survey.

Photo 16: COT scar and white band disease at Moore Reef: reef Magic Pontoon, shallow, site 1. COTs was within the location, but was not able to be clearly photographed.

3.3 Hastings Reef, North Hastings A, Back Reef Wall, Site 1, Shallow

This site, first monitored in 2003, consists of two habitat types, a back reef wall and a lagoon. A survey was attempted for the back reef wall in 2013, but only one half of the substrate survey was completed due to time constraints. To have a more accurate comparison of change over time, the 2013 survey is compared only to the first and second transects of the 2010 survey.

Despite its close proximity to Saxon Reef, this site was reported by the operator crew to have been less affected by Cyclone Yasi and is now the preferred site to visit by tourist operators.

Hard coral cover decreased from 33% in 2010, to approximately 16% in 2013 (figure 19). General hard coral decreased from 4% in 2010 to being absent in 2013. Branching corals also decreased by 4% (10% cover in 2010 to 6% in 2013). Massive corals declined by the least amount, with only a 2% drop, representing 6% in 2013. Rock with turf algae represented approximately 37% of the survey. This was a notable increase, as only 5% was represented in the 2010 survey. Nutrient indicator algae was absent in 2010, but increased to almost 3% in 2013. Additionally, the amount of rubble increased from 5% to 8% of the substrate.

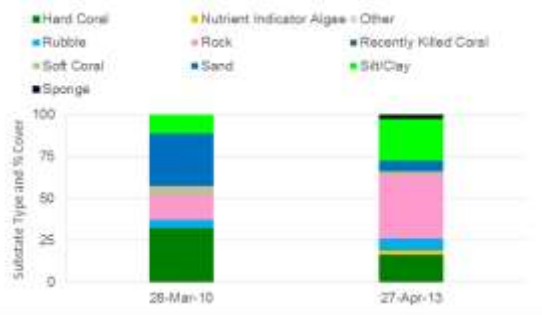

Figure 19: Substrate type and percent cover at Hastings Reef: North Hastings A: Shallow: Site 1: Back reef wall.

Photo 17: Coral bleaching at North Hasting A, back reef wall, Site 1 (taken in 2010).

Photo 18 & 19: Dominate algae: nutrient indicator algae (left) and turf algae (right) at North Hasting A, back reef wall, Site 1 (taken in 2010).

Photo 20: Site photo at North Hasting A, back reef wall, Site 1 (taken in 2010).

4.0 Townsville Region

Seven sites were surveyed from 2011 to 2013 around the Townsville Region, six of which were on Magnetic Island and one on the outer reef (Wheeler's Reef). Hard coral cover within the region was low over the last three years, with an average of 20% across all seven sites. Since 2010, six of the seven sites showed a decrease in coral cover with only Geoffrey Bay, off Magnetic Island, increasing in coral cover. The abundance of macro algae, which was absent when surveys started, has increased with an average count of 50 per 400m^2 from 2011 to 2013. While seasonal fluctuations in macro algae are normal, the Townsville region sites have shown a steady increase.

4.1 Magnetic Island, Nelly Bay, Fringing Reef, Site 1, Shallow

Nelly Bay is located on the South Eastern end of the Island. Both sites 1 and 2 are easily accessible from shore, and run parallel to the beach in relatively shallow water. Fishing practices are currently allowed in this area. Site 1 was first surveyed in 2003 and has been revisited twice within the 2011-2013 period, once in 2012 and again in 2013.

Hard coral cover has fluctuated at this site throughout the years. In 2003, hard coral was found to represent approximately 51% of the substrate (figure 20). This increased over the next few years peaking at 73% in 2008. Recorded hard coral cover, however, has decreased in the 2009, 2012 and 2013 surveys, reaching an all-time low of 13% in 2013. No soft coral has been recorded at this site since 2007. Abundance of macro algae increased from 3 counts in 2009 to 73 in 2013 (figure 21), and consisted mostly of *Sargassum*, *Padina* and *Turbinaria*. Nutrient indicator algae counts decreased from 21% cover in 2009 to 2% in 2012, then increased again to 9% in 2013.

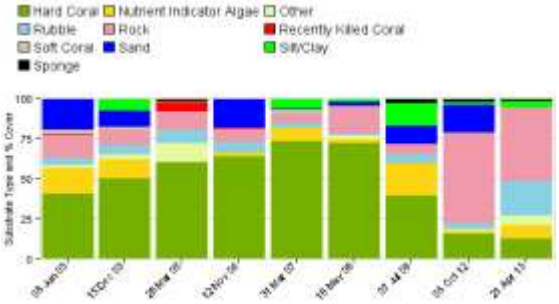

Figure 20: Substrate type and percent cover at Magnetic Island Reef: Nelly Bay: Shallow: Site 1: Fringing reef leeward.

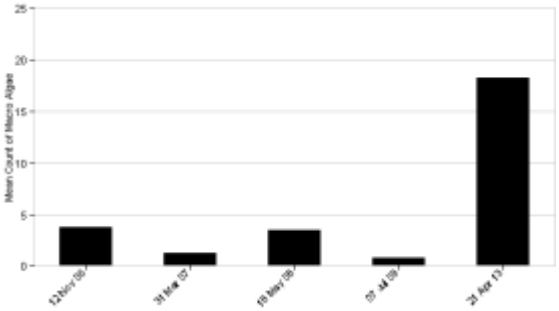

Figure 21: Mean count of Macro Algae at Magnetic Island Reef: Nelly Bay: Shallow: Site 1: Fringing reef leeward.

Recorded coral damage increased from zero in the 2009 and 2012 surveys to a total of 22 incidents in 2013 (figure 22). Low levels of coral bleaching were recorded (1% of population), affecting 6% of each colony in 2013. Unknown scars also increased from zero in the past two surveys to an average of 2 incidents per 400m^2.

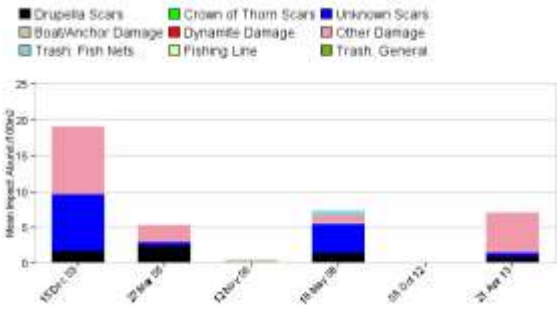

Figure 22: Mean abundance of impacts at Magnetic Island Reefs: Nelly Bay: Shallow: Site 1: Fringing reef leeward.

A total of 4 *Drupella* snails and 1 Trochus snail were recorded on the transect.

A fish abundance survey was completed in 2012, although no indicator species were recorded. A fish survey was not conducted in 2013.

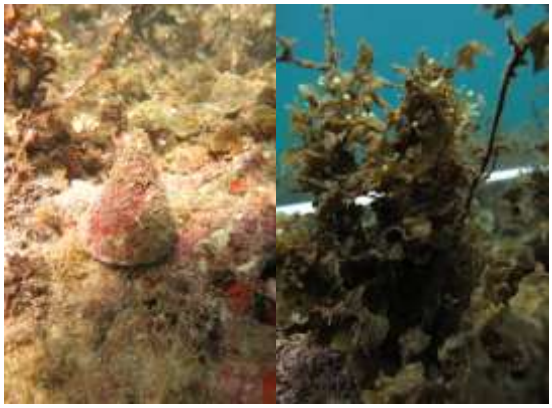

Photo 21 & 22: Trochus shell (left) and dominant algae, Sargassum (right) at Magnetic Island, Nelly Bay Site 1.

Photo 23: *Drupella* snail at Magnetic Island, Nelly Bay Site 1.

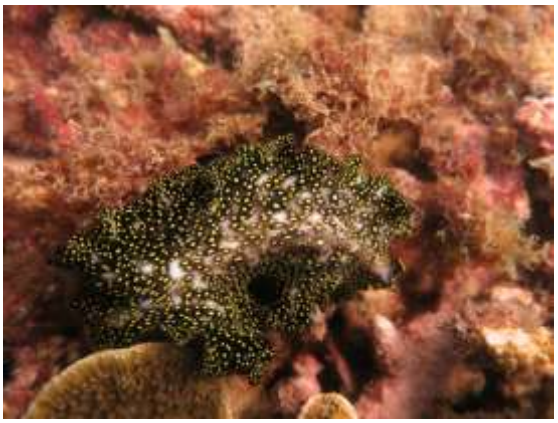

Photo 24: Nudibranch at Magnetic Island, Nelly Bay Site 1.

Photo 25: Blue spotted eagle ray at Magnetic Island, Nelly Bay Site 1.

Photo 26: Surveyors at Magnetic Island, Nelly Bay Site 1.

4.2 Magnetic Island, Nelly Bay, Fringing Reef, Site 2, Shallow

Site 2 was first surveyed in 2003 and was revisited only once within the 2011-2013 period in 2013. Hard coral cover decreased from 37% in 2009 to 31% in 2013 (figure 23). In 2006, branching hard coral was the dominant coral morphology, but decreased in 2009 and was absent on the 2013 survey. Hard coral foliose decreased considerably from 28% in 2009 to 4% in 2013. Encrusting hard coral increased from 2% to 15% of the benthic composition. Soft coral has never been observed on this site. Similar to Site 1, rubble increased from 1% in 2009 to 27% in 2013. Fewer counts of macro algae were observed on Site 2, with a total of 64 counts per 400m^2.

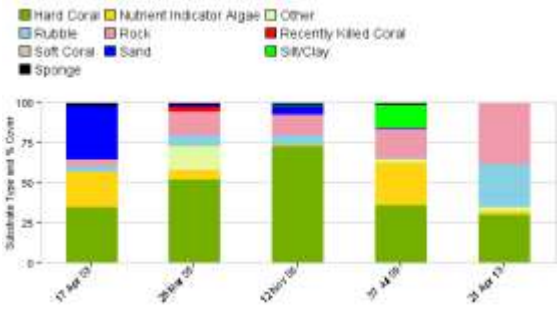

Figure 23: Substrate type and percent cover at Magnetic Island Reefs: Nelly Bay: Shallow: Site 2: Fringing reef leeward.

A total of 4 incidents of coral damage were recorded on the transect in 2013. A small amount of coral bleaching (2% of the population) was recorded. Coral scars from unknown causes increased in abundance from near absent in 2006 and 2009 (figure 24) to 9 in 2013.

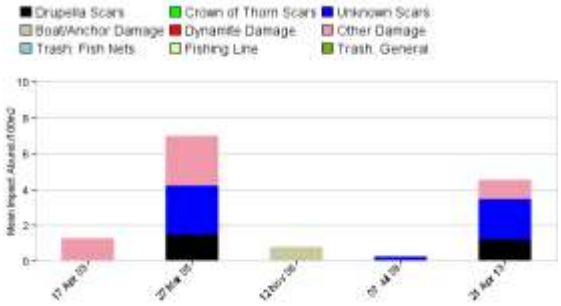

Figure 24: Mean abundance of impacts at Magnetic Island Reefs: Nelly Bay: Shallow: Site 2: Fringing reef leeward.

There was a high count of *Drupella* snails, with 23 individuals recorded on the transect in 2013. A total of 3 trochus shell snails were also recorded. No other indicator invertebrates were recorded.

A fish survey was not conducted in the 2013 survey.

Photo 27: Site photo of Magnetic Island, Nelly Bay Site 2.

4.3 Magnetic Island, Alma Bay, Fringing Reef, Site 1, Shallow

This small bay is protected from fishing activities, and is located on the exposed side of Magnetic Island, just north of Nelly Bay. It is commonly used recreationally by beach goers, and locals. A surveys began in 2004, and visited once in the 2011-2013 period, in 2012.

Hard coral cover has fluctuated over the last three surveys, representing 11% of substrate for the first survey in 2004, then increasing to almost 26% in 2009 (figure 25). A decrease in percent coral cover occurred in 2012, dropping to 14%. The dominant coral morphology, comprised largely of general hard coral and encrusting forms, has remained relatively consistent. On the other hand, foliose corals dropped from 11% in 2009 to 3% in 2012. Only leathery soft corals have ever been recorded on transect, with percent cover remaining consistent, at approximately 1%. Nutrient indicator algae decreased from 14% in 2009, to 4% in 2012. Rock accounted for more of the substrate composition in 2013, with rock with coralline algae making up 23% of the survey area and rock with turf algae making up 33%. Macro algae counts were recorded at an all-time high with a total of 60 counts in 2012 compared to 0 recorded in 2004, and 11 in 2009.

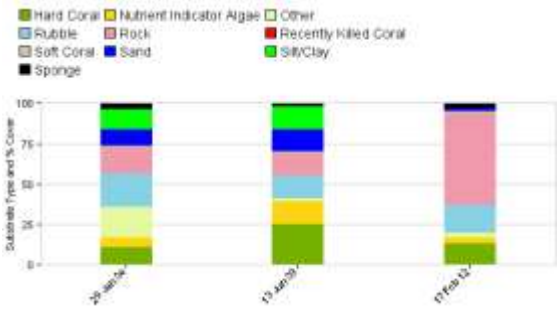

Figure 25: Substrate type and percent cover at Magnetic Island Reefs: Alma Bay: Shallow: Site 1: Fringing reef leeward.

The average level of coral bleaching continued to be relatively low, affecting <1% of the corals. One incident of coral disease was recorded for the first time since 2004. No coral scars or coral damage were recorded on transect.

Very few indicator invertebrates were recorded at this site. *Drupella* snails and Lobster were recorded on transect during the 2009 surveys, however none were recorded in 2012.

A fish survey was not completed in 2012.

Photo 28: Site photo of Magnetic Island, Alma Bay Site 1.

Photo 29: Coral bleaching at Magnetic Island, Alma Bay Site 1.

4.4 Magnetic Island, Alma Bay, Site 2, Shallow

A substrate survey at this site was first performed in 2005, however an impacts and invertebrate survey was not performed until it was revisited in 2008. One survey was performed within the 2011-2013 period in 2013.

Hard coral cover seemed to peak in 2008, and has been gradually decreasing since, with coral cover dropping from 64% to 15% in the 2013 survey (figure 26). There was a decrease in foliose coral, from 11% in 2009 to 4% in 2013, however the percent cover of hard coral encrusting remained the same. Similar to Site 1, soft coral cover has remained low over the years, accounting for 3% of substrate composition in 2013. Nutrient indicator algae increased by 2% since 2009 currently representing 6% of the substrate. The "other" category also increased, from 0% in the past three surveys to 8%, mostly represented by ascidians. Rock with turf algae decreased from 46% in 2009 to 19% in 2013. Macro algae counts were also at an all-time high, with a total of 61 counts per 400m^2.

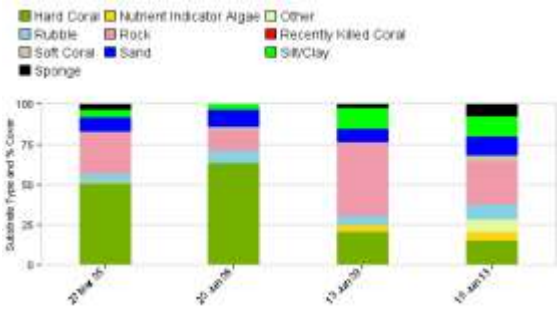

Figure 26: Substrate type and percent cover at Magnetic Island Reefs: Alma Bay: Shallow: Site 2: Fringing reef leeward.

Coral damage has remained low, with 3 incidents on survey. Additionally, an average of 5% of the coral population showed bleaching, affecting approximately 14% of each colony. No incidents of disease were recorded, but surveyors found 2 counts of unknown scars per 400m^2.

The numbers of *Drupella* snails recorded have decreased over the last three surveys (figure 27). In 2005, a total of 20 individuals were recorded on transect. This decreased to 13 individuals in 2009, and in 2013 only 1 *Drupella* individual was recorded. One embedded giant clam was recorded in the 2013, for the first time at this site.

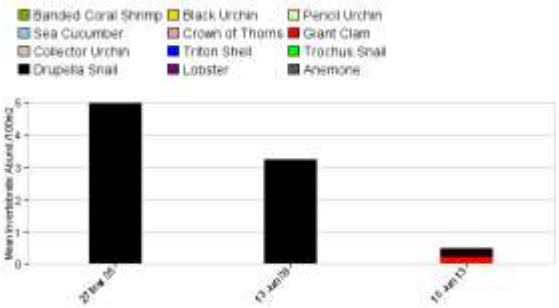

Figure 27: Mean abundance of invertebrates at Magnetic Island Reefs: Alma Bay: shallow: Site 2: Fringing reef leeward.

A fish survey was not conducted in 2013.

Photo 30: Site photo of Magnetic Island, Alma Bay Site 2.

4.5 Magnetic Island, Florence Bay, Fringing Reef, Site 2, Shallow

This site is located on the north eastern point of Magnetic Island and is a designated green zone, where fishing is prohibited. Site 2 has been surveyed twice by the Reef Check Australia team; in 2006 and in 2012.

Hard coral cover has shown a decrease over time, representing 46% of the substrate in 2006 to 37% of the substrate in 2012 (figure 28). Similar to Alma and Nelly Bay, very little soft coral has been recorded, representing only 1% of the substrate cover, and consisting entirely of either leathery corals or zooanthids. Nutrient indicator algae increased from 0 to 10%. Rock with coralline algae accounted for 19% of the substrate composition. Zero counts of macro algae were found on transect in 2006, increasing to a total of 16 counts per $100m^2$ in 2012.

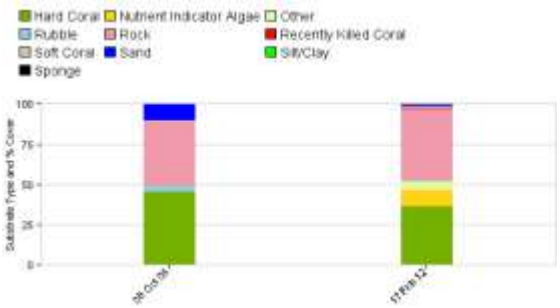

Figure 28: Substrate type and percent cover at Magnetic Island Reefs: Florence Bay: Shallow: Site 2: Fringing reef leeward.

No coral damage was recorded on transect, however 1 incident of coral disease, and 2 incidents of coral scars were recorded (figure 29). Coral bleaching affected approximately 2% of the total population, with an average of 25% of each of the affected coral colonies bleached. Previously, Florence Bay has been on of the few surveys where rubbish has been recorded in the GBR. However, no rubbish was found on transect, in contrast to the 3 fishing nets, and 1 piece of general trash found in the 2006 survey. Anecdotally, debris was found on the coastline of the survey area at the beach entry point (consisting mostly remnant plastic pieces).

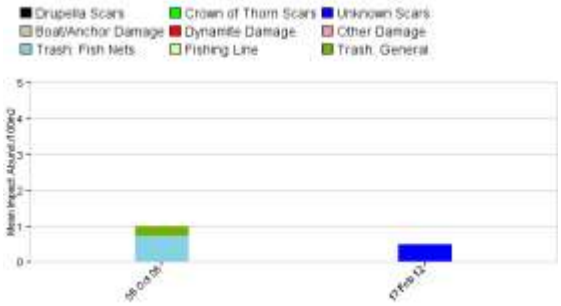

Figure 29: Mean abundance of impacts at Magnetic Island Reefs: Florence Bay: Shallow: Site 2: Fringing reef leeward.

1 giant clam and 1 anemone were recorded on the invertebrate survey for the first time at this site. No *Drupella* snails were observed, a decrease from the 6 observed in 2006.

A fish survey was not completed in 2012.

Photo 31: Giant Clam at Magnetic Island, Florence Bay, Site 2.

4.6 Magnetic Island Geoffrey Bay, Fringing Reef, Site 1, Shallow

Geoffrey Bay, Site 1 was first implemented in 2007 and is located between Nelly and Alma Bay, and is a designated green zone. A large fringing reef extends the length of the bay, and is frequently visited by tourists that snorkel and dive. The last monitoring survey for this site was completed in 2011.

Hard coral cover has fluctuated substantially since the first survey in 2003 (figure 30). Coral was initially recorded as representing 16% of the substrate cover, and showed a steady increase until 2008, when cover was recorded at its highest, with 66%. Cover subsequently declined, representing just 26% of the substrate in 2011. Similar to the other Magnetic Island sites, soft coral was found to be in low abundance, with only 1% of substrate recorded as soft coral leathery in 2011. The occurrence of nutrient indicator algae fluctuated over the years, representing 28% of the substrate category in 2009, 0% in 2010, and 9% in 2011. Macro algae counts increased (figure 31), from a total of 48 counts per 400m^2 in 2010, to 82 found in 2011.

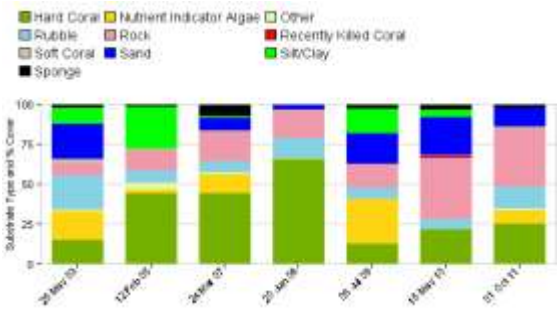

Figure 30: Substrate type and percent cover at Magnetic Island Reefs: Geoffrey Bay: Shallow: Site 1: Fringing reef leeward.

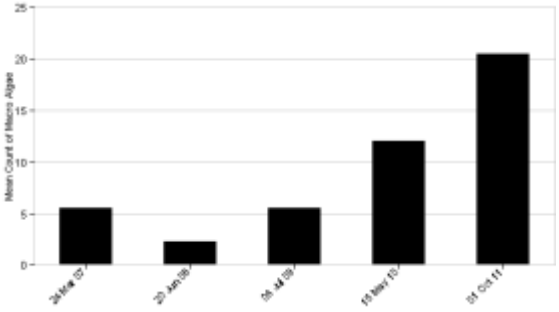

Figure 31: Mean count of Macro Algae at Magnetic Island Reefs: Geoffrey Bay: Shallow: Site 1: Fringing reef leeward.

Three incidents of coral damage were recorded, in addition to 1 incident of coral disease. Coral bleaching affected approximately 16% of each coral colony affected, although only 1% of the total population was reported to be bleached. These counts have remained relatively consistent since the first survey in 2003.

No indicator invertebrates were found in 2011, despite previous surveys recording lobster, *Drupella* snails, and Trochus shells over the years.

A fish survey was not conducted as part of the 2011 survey.

Photo 32: Dominant algae, *Dictyota, a* nutrient indicator algae at Magnetic Island, Geoffrey Bay, Site 1.

4.7 Wheelers Reef, The Mooring, Back Reef Slope, Site 1, Shallow

Wheelers Reef was first implemented in 2004, and is a frequently visited off-shore reef, situated approximately 90km from Townsville. The last survey was completed in 2012, shortly after Cyclone Yasi passed through, causing significant damage to the area.

Hard coral cover decreased from 65% in the 2005 substrate survey to 8% cover in 2012, likely due to the damage from cyclone Yasi (figure 32). Branching corals showed the largest decline in abundance, decreasing from 31% in 2005 to 5% 2012. Encrusting corals also declined considerably, decreasing from 18% in 2005 to 2% in 2012. Soft coral continued to be absent at this site. Rock with turf algae accounted for 64% of substrate cover in 2012. Nutrient indicator algae increased by 1%, but have remained low in cover, and now represent approximately 3% of the benthic substrate. The amount of rubble also increased from <1% to almost 4%.

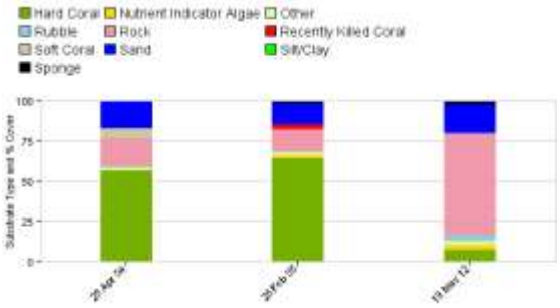

Figure 32: Substrate type and percent cover at Wheeler Reef: The Mooring: Shallow: Site 1: Back reef slope.

The amount of general coral damage increased from 5 recorded incidents in 2005 to 40 incidents per 400m^2 in 2012 (figure 33). The occurrence of coral bleaching has remained low at this site, affecting <1% of the population. No incidents of disease were observed, however a total of 3 unknown scars were recorded on transect.

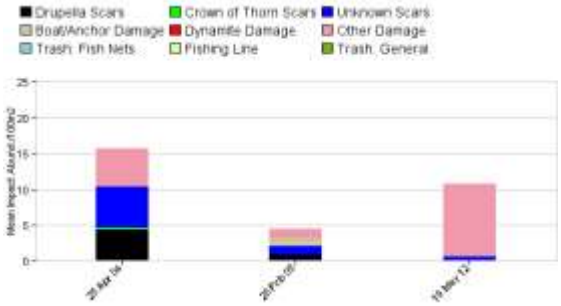

Figure 33: Mean abundance of impacts at Wheeler Reef: The Mooring: Shallow: Site 1: Back reef slope.

The number of sea cucumbers increased on this site, from 7 individuals recorded on transect in 2005 to 11 individuals in 2012. However, the number of giant clams decreased substantially, with previous counts of 28 individuals per 400m^2 in 2005, to 2 in 2012. Unlike previous survey years, no *Drupella* snails were recorded.

A fish survey was not conducted in 2012.

Photo 33: Coral rubble, the after math of Cyclone Yasi at Wheelers Reef, The Mooring, Site 1.

5.0 Port Douglas

Eight sites were surveyed from 2011 to 2013 in the Port Douglas region. Average hard coral cover across these sites over the last three years was 48%. Five of the eight sites showed an increase in coral cover since 2010.

5.1 Opal Reef, Bashful Bommie, Back Reef Slope, Site 1, Shallow

This is a protected site, located on the outer reef, near Port Douglas, and follows a shallow reef slope. This site was surveyed once in 2013 within the 2011-2013 period, however, has been regularly monitored since 2002.

Hard coral cover has shown an increasing trend since the first Reef Check Australia survey in 2002, where it represented 15% of the benthic substrate, currently shows an all-time high of 51% in the 2013 survey (figure 34). This mostly consisted of branching hard coral (13%), and massive hard corals (33%). Soft coral cover has remained relatively consistent, with very slight fluctuations over the years. There was an increase of 4% since the last 2010 survey, covering 6% of the benthic substrate in 2013. Recorded soft corals consisted of the general soft coral category (2%) and soft coral leathery (4%). The amount of nutrient indicator algae has also remained consistently low, increasing only 1% since 2010 and now only representing about 2% of the substrate.

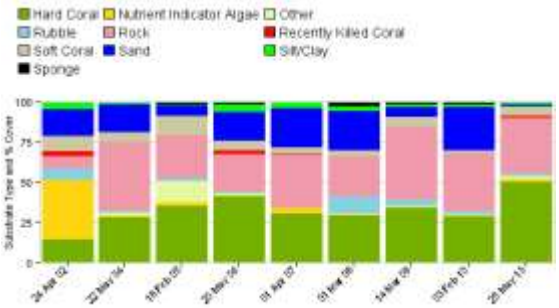

Figure 34: Substrate type and percent cover at Opal Reef: Bashful Bommie: Shallow: Site 1: Back reef slope.

Both unknown coral damage and coral disease were absent on transect in 2010, however this increased to 6 incidents of unknown coral damage, and 6 incidents of coral disease recorded in the 2013 survey. 2 unknown scars were also recorded, in addition to 1 crown of thorns sea star scar. Coral bleaching affected approximately 6% of the coral population, with an average of 34% of each coral colony affected.

One indicator sea cucumber was recorded on transect. The number of giant clams increased from 9 individuals per 400m^2 to 23 individuals per 400m^2. One crown of thorns sea star was also observed on transect.

A fish survey was not completed during the 2013 survey.

Photo 34: Crown of thorns sea star and scar at Opal Reef, Bashful Bommie Site 1, Shallow.

5.2 Opal Reef, Bashful Bommie, Back Reef Slope, Site 1, Medium

This site was first implemented in 2003 and follows along the same slope as site 1; however it is slightly deeper (7 meters deep). A complete survey was conducted in 2011, however, only fish, invertebrate and impact survey components completed in 2012.

There has been a consistent increasing trend in hard coral cover, increasing by 37% since the first survey in 2003 (figure 35). Massive hard corals have continued to be the dominant hard coral structure, covering approximately 27% of the 2011 transect. Alternatively, soft coral cover has remained relatively consistent over the years, representing approximately 6% of the benthic substrate in 2011. However, the general soft coral category has since been completely replaced by leathery soft corals in 2011. Rock with coralline algae accounted for 19% of the benthos in 2011. Sponges were not observed in 2011, and have been recorded infrequently over the years.

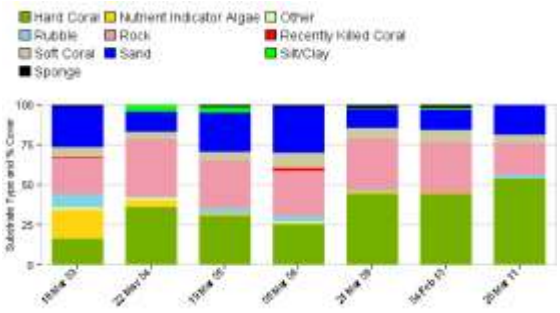

Figure 35: Substrate type and percent cover at Opal Reef: Bashful Bommie: Medium: Site 1: Back reef slope.

The number of recorded coral damage incidents has remained consistent since 2005, with a density of only 5 incidents per 400m^2. This did, however increase in 2012, with 15 incidents per 400m^2 recorded. Coral bleaching has affected a small portion of the coral populations at this site, with 5% of the corals affected in 2011, and 8% of the corals affected in 2012. Coral disease had not been recorded at this site until 2012, when 5 instances were recorded on transect. Additionally, the number of unknown scars increased from 4 incidents per 400m^2 in 2010 and 2011, to 18 per 400m^2 in 2012.

Giant clams increased in abundance from 4 individuals recorded in 2010 to 13 individuals in both the 2011 and 2012 surveys (figure 36). Few anemones have been found at this site, however, a total of five individuals were found in the 2012 survey. Unlike previous years, sea cucumbers were not recorded in neither the 2011 or 2012 surveys.

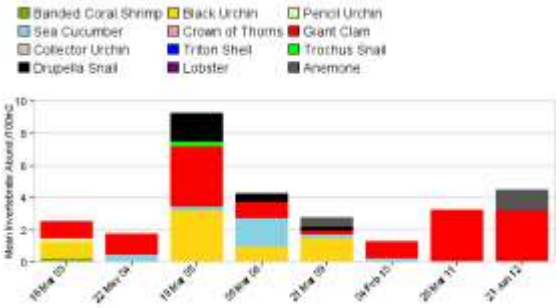

Figure 36: Mean abundance of invertebrates at Opal Reef: Bashful Bommie: Medium: Site 1: Back reef slope.

The first fish survey at this site was completed in 2009 (figure 37). Since then the number of recorded butterflyfish has increased from 6 individuals to 14 individuals in the 2011 survey, and 16 in 2012. Three snapper and 2 coral trout were recorded on transect in 2011, however none were recorded in 2012. Groupers have been consistently observed at this site in low densities, with 2 individuals recorded in 2010, and 1 in both 2011 and 2012. Similarly, the number of parrotfish has also remained consistent with 5 individuals observed during the 2010 and 2011 surveys, and 7 observed in 2012.

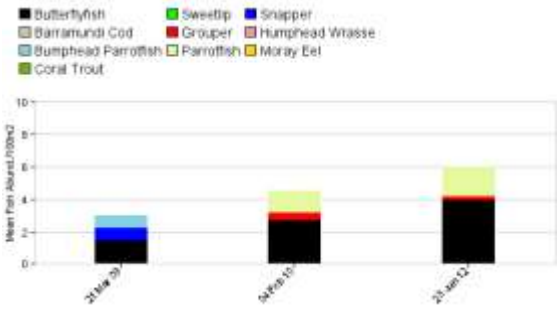

Figure 37: Mean abundance of fish at Opal Reef: Bashful Bommie: Medium: Site 1: Back reef slope.

Photo 35: Site photo at Opal Reef, Bashful Bommie Site 1, Medium

Photo 36: Site photo at Opal Reef, Bashful Bommie Site 1, Medium.

Photo 37: Giant clam at Opal Reef, Bashful Bommie Site 1, Medium

Photo 38: Damaged coral at Opal Reef, Bashful Bommie Site 1, Medium

Photo 39: Surveyors at Opal Reef, Bashful Bommie Site 1, Medium

5.3 Opal Reef, SNO (South North Opal), Back Reef Crest Site 1, Medium

This site follows a reef slope on the South side of the reef. Monitoring began in 2009, and the last survey completed was in 2011.

Hard coral cover increased slightly from 62% in 2010 to 65% in the 2011 survey (figure 38). Branching coral increased in abundance from 9% of the benthic substrate in 2010 to 18% in 2011. Massive coral growth forms decreased from 38% to 30% of the total hard coral during this same period. Soft coral cover decreased from 10% in 2010 to 6% in 2011. Zoanthids appeared for the first time in 2011 at this site, representing 1% of the benthic substrate. Rock with coralline algae accounted for almost 23% of substrate composition in 2011. Recently killed coral was found to represent approximately 4% of the benthic substrate in 2011. This has not been previously recorded on transect.

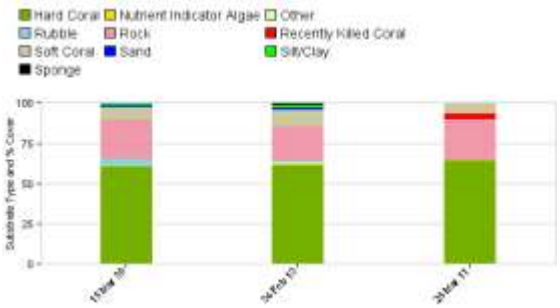

Figure 38: Substrate type and percent cover at Opal Reef: SNO (South North Opal): Medium: Site 1: Back reef crest.

The number of coral damage incidents increased from 4 incidents per 400m^2 to 16 in 2011. Coral bleaching has remained low the last few years, affecting approximately1% of the coral population. There have been no records of coral disease in the previous two surveys; although 3 incidents were recorded during the 2011 survey. The number of unknown scars decreased by half, with 18 incidents per 400m^2 recorded in 2010 to 9 per 400m^2 in 2011. One *Drupella* snail scar was also recorded.

The abundance of giant clams increased from 4 observed individuals in 2010 to 7 in 2011. 1 anemone and 3 *Drupella* snails were also recorded on transect. Both were found to be absent in the 2010 survey. No other indicator invertebrates were recorded.

The recorded density of butterfly fish increased, from 7 individuals in 2010 to 16 in 2011 (figure 39). For the first time, 2 groupers were recorded on survey. The number of parrotfish observed decreased from 19 in 2010 to 8 in 2011. Previous surveys recorded low numbers of snapper (2 individuals in 2009, and 1 in 2010); however these were absent in the 2011 survey.

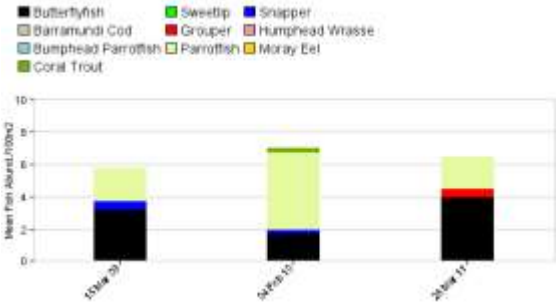

Figure 39: Mean abundance of fish at Opal Reef: SNO (South North Opal): Medium: Site 1: Back reef crest.

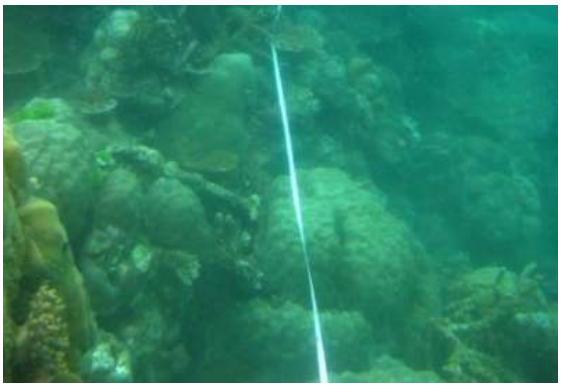

Photo 40: Site photo at Opal Reef, SNO, Site 1.

5.4 Opal Reef, South North Opal (SNO), Back Reef Slope, Site 2, Shallow

This outer reef site is located along the North side reef, following the reef slope opposite to Site 1. This is a new site, implemented in 2013.

Hard coral cover shows a high abundance, representing approximately 37% of the benthic substrate (figure 40). Coral morphology was found to be fairly heterogeneous; although branching corals were recorded as the dominant structure, with 18% cover. Soft coral was found to cover approximately 6% of the substrate, with general soft coral, and leathery corals as the dominant forms. Approximately 25% of the recorded substrate was rock with turf algae. Other algae, such as nutrient indicator algae, were found to be low in abundance (<1%).

Figure 40: Substrate type and percent cover at Opal Reef: SNO (South North Opal): Shallow: Site 2: Back reef slope.

Sixteen incidents of coral damage were recorded at this site (figure 41). Very little coral bleaching was observed, with only 1% of the coral colonies affected across the survey area. Ten incidents of coral disease (mostly white band disease) and 2 unknown scars were found on the 2013 survey.

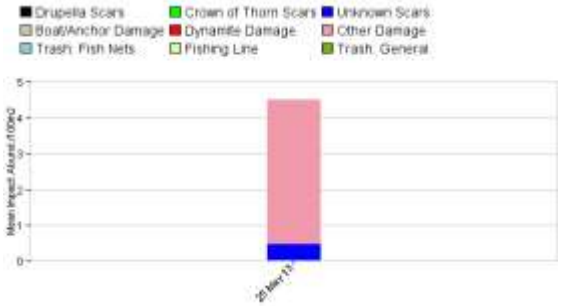

Figure 41: Mean abundance of impacts at Opal Reef: SNO (South North Opal): Shallow: Site 2: Back reef slope.

Indicator invertebrates found on transect included 1 long spined sea urchin, and 4 giant clams.

A fish survey was not conducted in 2013.

Photo 41: Site photo at Opal Reef, SNO (South North Opal) Site 2.

Photo 42: Coral with disease at Opal Reef, SNO (South North Opal) Site 2.

5.5 Opal Reef, Two Tone, Reef Flat, Site 1, Shallow

This reef, commonly known as “Pork Chop” due to its shape, follows a steep reef slope, along the top of a wall. Monitoring began in this site in 2003, and was surveyed in both 2012 and 2013.

Hard coral cover has shown a slow, but steady increase over the last 7 surveys performed at this site (starting in 2003) (figure 42). A change in cover has not been recorded since the 2010 survey, (where hard coral has continued to represent approximately 40% of the substrate) with the dominate morphologies remaining branching and massive. Soft coral has shown an overall increase in abundance, from approximately 6% in 2003, to 14% in 2013. Nutrient indicator algae have consistently made up little, if any of the substrate over the years, and has been recorded as absent within the last three surveys. Siltation levels peaked in 2009, representing 33% of the substrate, but have since dropped to 2% in 2013.

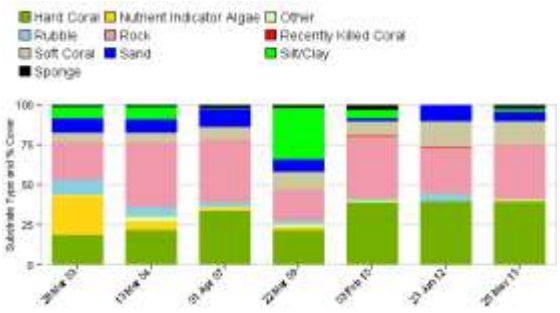

Figure 42: Substrate type and percent cover at Opal Reef: Two Tone: Shallow: Site 1: Reef flat.

The number of recorded coral damage incidents increased from 5 incidents per 400m^2 in 2010 to 16 incidents in 2012, then decreased to 2 incidents in 2013 (figure 43). Coral bleaching has been recorded in low levels (0 to1% of coral population affected) consistently from 2003 to 2010; however this increased to 5% of the total coral population bleached in 2012, before dropping once more to only 1% 2013. Incidents of coral disease have been near absent since the first survey in 2003, although this number increased to 2 incidences in 2012 to 10 incidents in 2013. Unknown scars have been recorded in all surveys, but in relatively low numbers, with 7 incidents recorded in 2011, and 4 recorded in 2013.

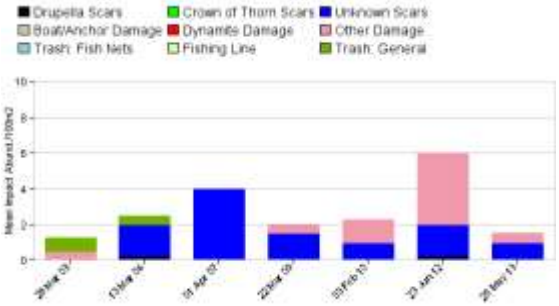

Figure 43: Mean abundance of impacts at Opal Reef: Two Tone: Shallow: Site 1: Reef flat.

A banded coral shrimp was observed for the first time in the 2012 survey, but not again in 2013 (figure 44). The number of long spined sea urchins has fluctuated; first showing densities of approximately 20 per 400m^2 in 2004. None were recorded again until 2012, where 1 individual was documented. This increased to 7 individuals recorded in 2013. Sea cucumbers continue to be present with consistent abundance within surveys, with 3 individuals observed in 2012, and 2 in 2013. Giant clams, have also been consistently abundant since 2009 with 10 individuals observed in 2012, and 9 in 2013. A total of 6 anemones were recorded on transect in 2012, but were not observed in the 2013 survey.

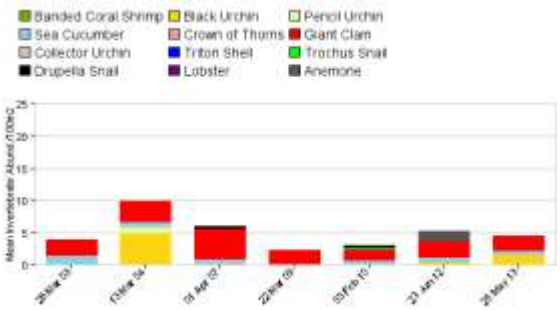

Figure 44: Mean abundance of invertebrates at Opal Reef: Two Tone: Shallow: Site 1: Reef flat.

The 2012 survey showed an increase in density of butterfly fish with 13 individuals observed in 2010 to 27 individuals in 2012. The number of recorded parrotfish also increased from 14 observed in 2010 to 22 in 2012. No additional indicator fish species were present for the 2012 survey.

A 2013 fish survey was not conducted.

Photo 43: Surveyors at Opal Reef, Two Tone Site 1.

Photo 44: Glass shrimp (*Ancylomenes venustus*) in an anemone at Opal Reef, Two Tone Site 1.

5.6 Opal Reef, The Wedge, Reef Flat, Site 1, Shallow

Similar to other Opal Reef sites, this site follows along a shallow reef slope. This site was first visited in 2004, and revisited in 2012 and 2013.

Hard coral cover has shown a general increasing trend over time, peaking at its highest percent cover in 2012 with 46% however cover decreased to 26% in 2013 (figure 45). Branching coral showed the largest decline in cover, decreasing from 29% in 2012 to 6% in 2013. Soft coral cover has remained relatively consistent, increasing from 9% in 2010 to 11% in both 2012 and 2013. Nutrient indicator algae increased from 2% in 2012 to 9% in 2013, the highest recorded since 2005. Rock with coralline algae decreased from 24% in 2010 to 3% in 2012 and continued to decrease further in the 2013 survey, representing <1% of the substrate.

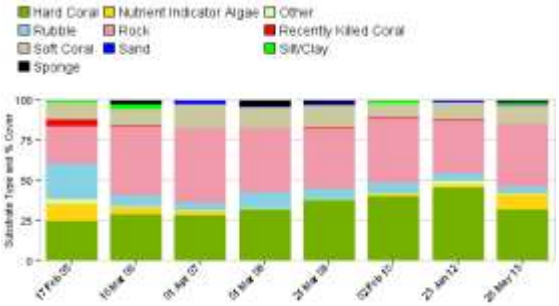

Figure 45: Substrate type and percent cover at Opal Reef: The Wedge: Shallow: Site 1: Reef flat.

The number of coral damage incidents increased over the last 3 years of surveys (figure 46). Recorded coral damage was near absent in 2009 and 2010, however, 21 incidents were observed in 2012, and 14 incidents in 2013. Unknown coral scars also increased in prevalence with 3 incidences recorded in 2010, 7 in 2012, and 14 recorded in 2013. The occurrence of coral disease has remained relatively low, with only 1 instance

found in 2012, and 4 in 2013. The occurrence of coral bleaching has also remained low, affecting approximately 5% of the population in 2012, and 1% in 2013.

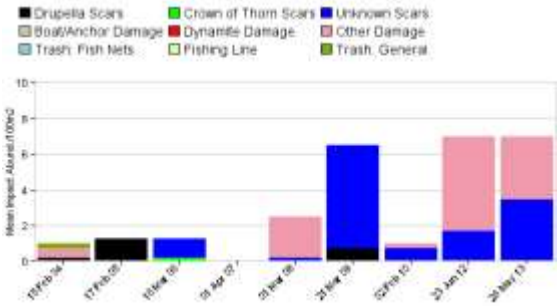

Figure 46: Mean abundance of impacts at Opal Reef: The Wedge: Shallow: Site 1: Reef flat.

Long spined sea urchin populations have fluctuated at this site. No individuals were recorded in 2010; however 10 individuals were recorded in 2012, and 6 in 2013. One indicator sea cucumber was observed for the first time at this site during the 2012 survey, but was absent in 2013. Giant clam numbers were consistent in 2010 and 2012 with 10 individuals, however only 4 were recorded in 2013. Anemones have been present in low numbers since 2009, with a density of 1 per 400m^2 from 2009 to 2012, and 2 in 2013.

The number of Butterflyfish recorded at this site doubled from 14 individuals observed on survey in 2010 to 33 in the 2012 survey (figure 47). Similarly, the number of parrotfish also increased, from 8 individuals observed in 2010, to 22 in 2012. Whilst snapper have commonly being spotted in the area in the past, no individuals were recorded for 2012. No coral trout have been recorded since 2010.

A 2013 fish survey was not completed.

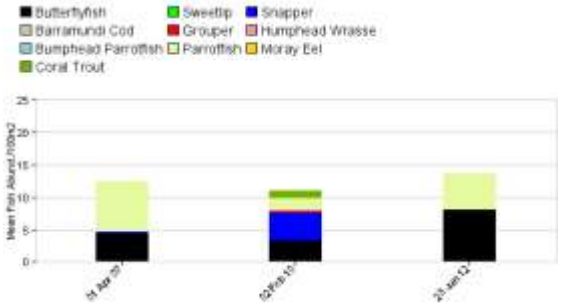

Figure 47: Mean abundance of fish at Opal Reef: The Wedge: Shallow: Site 1: Reef flat.

Photo 45: Unknown scar at Opal Reef, The Wedge Site 1.

Photo 46: Anemone fish in anemone at Opal Reef, The Wedge Site 1.

5.7 Agincourt Reef, Agincourt 3D, Back Reef Slope, Site 1, Shallow

This site is accessed by a permanent pontoon, which is visited daily by tourist operators. This reef has a steep slope that follows the contour of the reef on either side of the pontoon, and has been monitored regularly since 2003. It was revisited all three years, in 2011, 2012, and 2013.

Hard coral cover has remained relatively consistent since 2003, with only slight fluctuations (figure 48). Coral cover was at its highest in 2010; covering approximately 64% of the benthic substrate. Coral cover has since declined in this area, representing 48% of the substrate in 2013. The proportion of the different coral morphologies has remained consistent over time, with branching coral as the dominant growth form. Soft corals continue to be recorded in low abundance, representing approximately 1% of the substrate consistently since 2003. Algae abundance has shown an increase over the years. Nutrient indicator algae represented just 1% of the substrate in 2010, and 12% in 2013. No macro algae has ever been recorded at this site.

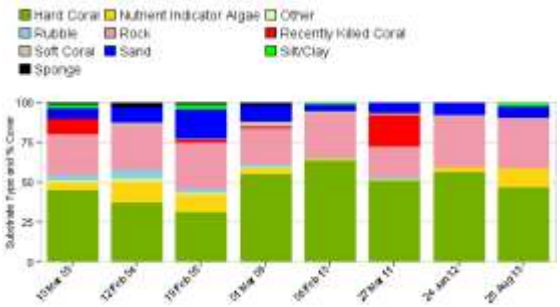

Figure 48: Substrate type and percent cover at Agincourt Reef: Agincourt 3D (Pontoon): Shallow: Site 1: Back reef slope.

The number of coral damage incidents has fluctuated over the years, and was found in highest densities 2004 (n=17) and 2009 (n=10). No incidents were observed in 2010; although 20 incidents were recorded in 2011, 24 incidents in 2012, and 28 incidents in 2013. No unknown scars were observed at this site until 2009, where 25 incidents per 400m^2 were recorded. The prevalence of unknown scars increased, with 5 incidents recorded in 2010, 13 in 2011, 15 in 2012, and 25 in 2013. Disease density peaked in 2013 with 16 incidents per 400m^2 recorded on transect. Bleaching was found to be in high abundance, affecting 13% of the population, with an average of 33% of each coral bleached.

Very few indicator invertebrates have ever been recorded at this site. In 2003, 37 giant clams per 400m^2 were recorded. However, this has decreased in abundance over the last 10 years, with 3 clams per 400m^2 recorded in 2013 (figure 49). Four anemones were observed in the 2012 survey, but were absent in the 2013 survey.

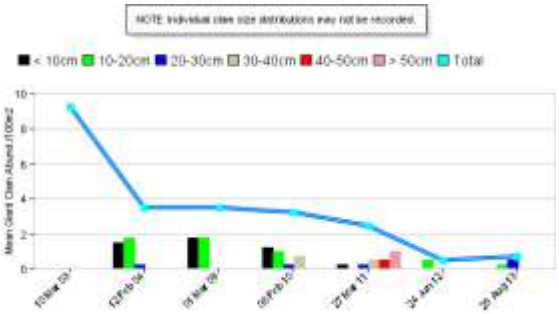

Figure 49: Mean abundance of giant clam size classes at Agincourt Reef: Agincourt 3D (Pontoon): Shallow: Site 1: Back reef slope.

A fish survey was first conducted at this site in 2009, however none of the indicator species were observed. Since 2011, butterflyfish have been found in density between 14 and 25 individuals per 400m^2 (figure 50). Nine snappers were recorded in the 2011 survey, but only one individual was recorded in 2013. Groupers were recorded on transect in 2013 for the first time (3 individuals), and parrotfish abundance was at its highest, with approximately 17 individuals per 400m^2.

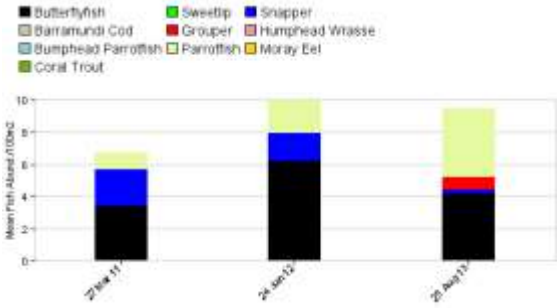

Figure 50: Mean abundance of fish at Agincourt Reef: Agincourt 3D (Pontoon): Shallow: Site 1: Back reef slope.

Photo 47: Unknown scars at Agincourt Reef, Agincourt 3D (Pontoon) Site 1.

Photo 48: Tumors on branching corals at Agincourt Reef, Agincourt 3D (Pontoon) Site 1.

5.8 Agincourt Reef, Agincourt 3D, Back Reef Slope, Site 2, Shallow

Similar to Site 1, the site was first implemented in 2004, and has been monitored regularly since. Surveys were performed in all three years, 2011, 2012, and 2013.

Hard coral cover has shown an increase at this site, from 54% in 20120 to 66% of the benthic substrate cover in 2013 (figure 51). A large proportion of this was branching coral, making up 61% of the benthos in 2013. Other coral growth forms such as encrusting, massive and 'general' hard coral have been recorded in low abundance since 2010. Branching coral has, however, remained the dominant coral form over time. Very few soft corals have been observed at this site, consistently contributing approximately 2% to the benthic substrate since the first survey in 2004. Rock with coralline algae was recorded at its highest abundance in 2013 at 10% cover. Nutrient indicator algae have shown considerable fluctuation. It was not recorded in 2011; increasing to 11% of the substrate in 2012, and declining to 4% of the substrate in 2013. Macro algae were recorded for the first time in 2011 with 11 counts. This declined to one count in 2012, and was absent in 2013. This may be due to natural seasonal fluctuations.

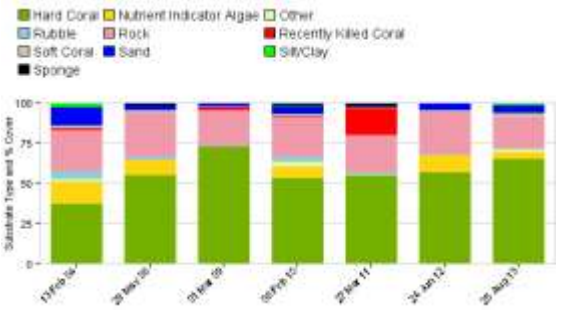

Figure 51: Substrate type and percent cover at Agincourt Reef: Agincourt 3D (Pontoon): Shallow: Site 2: Back reef slope.

The abundance of coral damage incidents increased from 4 in 2010 to 46 in 2012, then decreased to 21 in 2013. Unlike Site 1, very few scars were recorded. Four unknown scars were observed in the 2010 survey, only 1 was recorded in 2011, 9 were recorded in 2012 and 11 in 2013. Coral bleaching has remained low at this site with less than 6% of corals affected since it first survey in 2004. Coral disease was found to be near absent from 2004 to 2010, but 11 incidents were recorded on the 2011 transect, 4 in 2012, and 12 in 2013.

Similar to Site 1, there has been a high abundance of giant clams; however their abundance appears to be declining over time (figure 52). Since 2010, the number of giant clams within this site has remained at approximately 11 individuals per 400m^2, where previously, population density fluctuated between 18 to 24 individuals. Until 2009, individuals greater than 40cm were observed on transect, however were absent from 2010 onward.

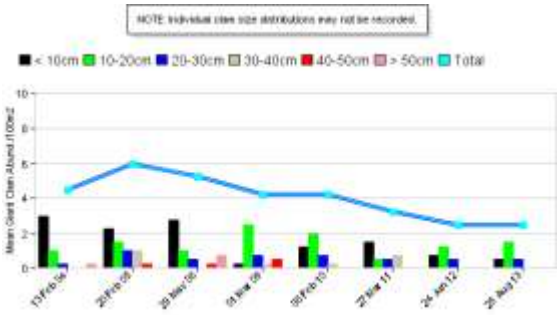

Figure 52: Mean abundance of giant clam size classes at Agincourt Reef: Agincourt 3D (Pontoon): Shallow: Site 2: Back reef slope.

Trochus snails have been observed infrequently over time, with one found on transect in the 2013 survey. Two anemones were observed in 2013.

A fish survey was not completed in 2013. Fish surveys were completed from 2004 to 2009, as well as 2011 and 2012. Butterflyfish were recorded in lower abundance in 2011 (9 individuals) and 2012 (27 individuals), when compared to the 38 individuals observed in 2006 (figure 53). Snapper were absent on transect in 2006, but recorded in 2011 (n=2) and 2012 (n=5). Groupers have been recorded in low abundance over time with 1 individual observed in 2006, and 2 individuals observed in 2011. No groupers were recorded in 2012. In 2006, 14 Parrotfish were observed, followed by 4 parrotfish in 2011, and 16 in 2012. Four coral trout were recorded in both 2006 and 2011, but were absent from the 2012 survey.

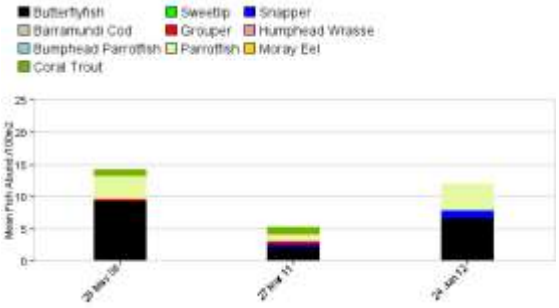

Figure 53: Mean abundance of fish at Agincourt Reef: Agincourt 3D (Pontoon): Shallow: Site 2: Back reef slope.

Photo 49: Tumour on branching coral at Agincourt Reef, Agincourt 3D (Pontoon) Site 2.

5.9 Low Isle Reef, Low Isle, Fringing Reef, Site 1, Shallow

Low Isle is a small island with a fringing reef located approximately 20 km off the coast of Port Douglas. It was first implemented in 2002, and has been regularly monitored since. Only one survey was completed within the 2011-2013 period in 2013. There are several snorkel operator moorings on the outskirts of the reef, where boats tie up for the day. On average, two to three boats make use of this site per day. Snorkelers are permitted beach access, and to swim in a designated area.

Soft coral has been found to be the consistently dominating coral type at this site, representing approximately 59% of the substrate in 2013 (figure 54). The 2013 survey consisted largely of leathery corals. Hard coral cover decreased from 32% in 2010 to 13% in 2013. Despite this decline, hard coral cover has remained morphologically diverse. The general hard coral category represented 4% of the substrate, branching corals 3%, foliose corals 1%, massive corals 4%, and plate corals 1%. Silt concentrations also increased from 0% in 2010 to 4% in 2013.

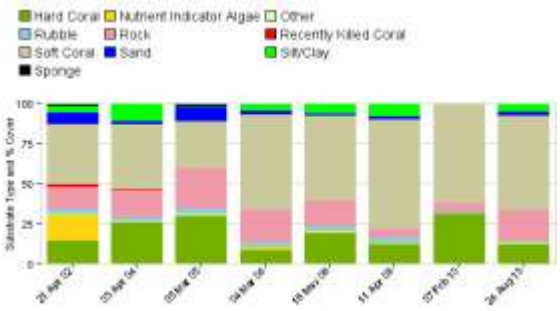

Figure 54: Substrate type and percent cover at Low Isles Reef: Low Isles: Shallow: Site 1: Fringing reef leeward.

Four incidents of coral damage were recorded in the 2013 survey, a decrease from the 13 recorded during the 2010 survey (figure 55). Coral bleaching has remained low since 2010, affecting approximately 2% of the total coral population in 2013. Surveyors first recorded coral disease in 2009, with 3 incidences recorded. This has remained relatively consistent since, with 4 incidences recorded in 2010, and 2 in 2013. Unknown scars were found to increase slightly, with 2 incidents in both 2010 and 2013, where incidents have been near absent since 2005. Rubbish is commonly recorded at this site, however, only one piece of rubbish found in the 2013 survey.

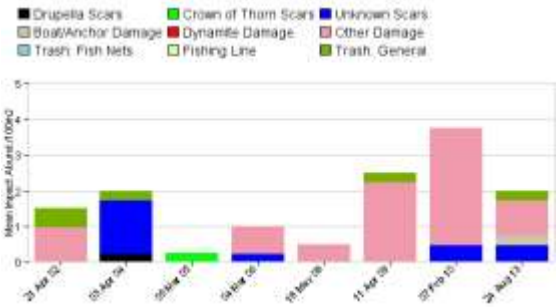

Figure 55: Mean abundance of impacts at Low Isles Reef: Low Isles: Shallow: Site 1: Fringing reef leeward.

Very few indicator invertebrates have been recorded at this site over the years. Giant clams have been found in high abundance, despite overall fluctuations in size and recorded number of individuals over time. No other indicator species were observed.

A fish survey was not completed in 2013.

Photo 50: Embedded giant clams at Low Isles Reef, Low Isles Site 1.

6.0 Lady Elliot Island

Five sites were surveyed around Lady Elliot Island in 2013, including four new sites and one existing site established in 2011. Average coral cover across the five monitored sites was 39% over the last two years of surveys.

6.1 Lady Elliot Island, Lady Elliot Reef Lagoon, Lagoon, Site 1, Shallow

This site was first implemented in 2011, and was revisited in 2013.

Hard coral cover was found to decrease from 31% to 24% from 2011 to 2013. The general hard coral category decreased from 21% in 2011 to 3% in 2013 (figure 56). Foliose corals, not recorded in 2011 represented almost 7% of the benthic substrate in 2013. The abundance of branching and massive corals remained consistent with the 2011 survey, representing 10% and 2% of the substrate respectively. No soft corals or sponges were recorded in either 2011 or 2013. Rock with coralline algae showed a decrease, comprising 21% of the substrate in 2011, to 9% in the 2013 survey.

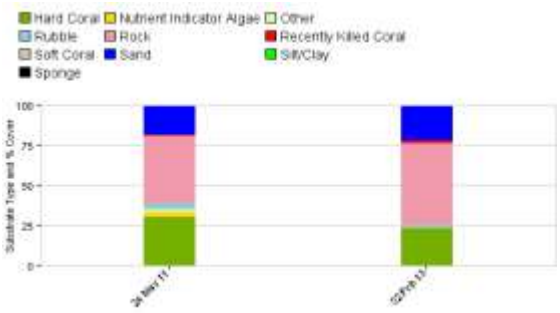

Figure 56: Substrate and percent cover at Lady Elliot Island: Lady Elliot Reef Lagoon: Shallow: Site 1: Lagoon.

Recorded incidents of coral damage increased from 2 per 400m^2 in 2011 to 14 in 2013. The occurrence of coral bleaching remained consistently low, with less than 2% of the total population affected, and an average of 32% of each colony affected. Prevalence of coral disease increased, with 1 incident found per 400m^2 in 2011, to 7 in 2013. The number of unknown scars increased from 6 per 400m^2, to 9 per 400m^2, as did as the number of *Drupella* scars (from 0 to 2 per 400m^2).

One pencil urchin was found (figure 57). The density of indicator sea cucumbers increased from 9 individuals to 21 per 400m^2 (mostly *S. chloronautus*). Similarly, the density of giant clams also increased, from 13 individuals to 46 per 400m^2 (most of them 10-30cm in size). A total of 5 *Drupella* snails and 8 anemones were recorded for the first time on transect.

A fish survey was not conducted in 2013.

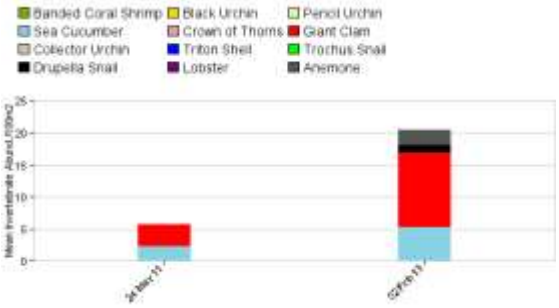

Figure 57: Mean abundance of invertebrates at Lady Elliot Island: Lady Elliot Reef Lagoon: Shallow: Site 1: Lagoon.

Photo 51: Giant clams at Lady Elliot Island, Lady Elliot Reef Lagoon, Site 1.

6.2 Lady Elliot Island, Lady Elliot Reef Lagoon, Reef Flat, Site 2, Shallow

This site was newly implemented in 2013 and is located in the shallow sandy lagoon fringing Lady Elliot Island. This is a popular area for snorkelling activities.

Hard coral cover at this sandy reef lagoon site, represented 22% of the substrate and consisting mostly of foliose growth forms (14%) (figure 58). Low numbers of massive corals (1%) branching corals (2%), and general hard corals (5%) were recorded. No soft corals were recorded at this site. Just over half of the substrate (53%) was dominated by rock with turf algae. Rock with coralline algae was recorded, representing 4% of the substrate. This was similar to rubble and bare rock, which combined made up only 3% of the survey area. Sand accounts for 21% of the benthic cover.

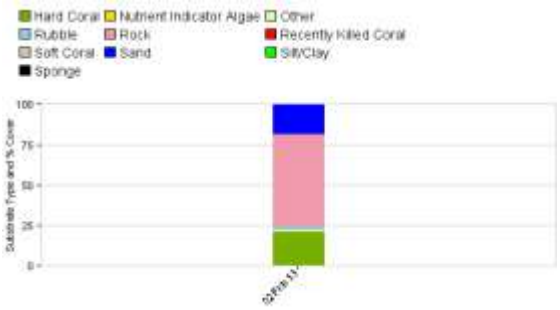

Figure 58: Substrate type and percent cover at Lady Elliot Island: Lady Elliot Reef Lagoon 2: Shallow: Site 1: Reef flat.

Coral damage was recorded at a density of 42 incidents per 400m^2 observed. Thirty-four incidents of unknown scars were recorded. Two *Drupella* scars were also found on transect. Coral bleaching affected approximately 1% of the population and no incidents of disease were found.

A total of 35 sea cucumbers were recorded, consisting only of prickly greenfish (*S. chloronotus)* (figure 59). 1 collector urchin was found on transect. Eleven giant clams and 6 *Drupella* snails were recorded during the 2013 survey.

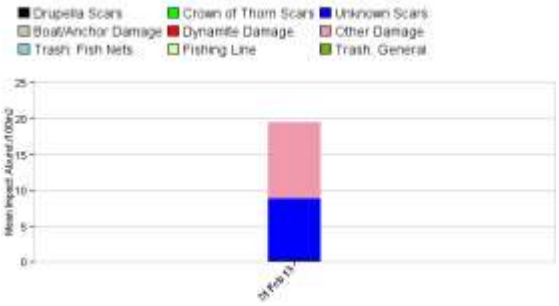

Figure 59: Mean abundance of invertebrates at Lady Elliot Island: Lady Elliot Reef Lagoon 2: Shallow: Site 1: Reef flat.

A fish survey was not completed at this site.

Photo 52: Prickly greenfish sea cucumber at Lady Elliot Island, Lady Elliot Reef Lagoon, Site 2.

Photo 53: Collector Urchin at Lady Elliot Island, Lady Elliot Reef Lagoon, Site 2.

6.3 Lady Elliot Island, Coral Gardens, Fringing Reef, Site 1, Shallow

This site was newly implemented in 2013.

Hard coral cover represented almost 58% of the benthic substrate (figure 60). This consisted of branching coral (25% cover), foliose coral (23% cover), general hard coral (7% cover), and a small amount of encrusting corals (3%). No soft corals were found at this site. Rock with coralline algae made up 8% of the substrate, and turf algae, covered approximately 19%. A small amount of rubble was also found, representing approximately 11% of the substrate.

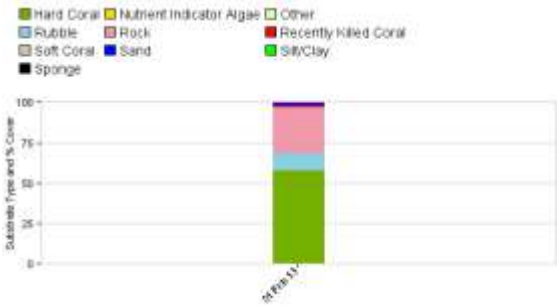

Figure 60: Substrate type and percent cover at Lady Elliot Island: Coral Gardens: Medium: Site 1: Fringing reef seaward.

Of the sites surveyed on Lady Elliot Island, the highest amount of coral damage was recorded at this site with 69 incidents observed. Damage was most likely from recent storm impacts and mostly impacted branching coral growth forms (figure 61). Coral scars were also recorded in high abundance, with 12 unknown scars, and 27 *Drupella* scars recorded. Six incidents of coral disease were recorded. Approximately 1% of the coral population on the transect were bleached, affecting 10% of each colony on average.

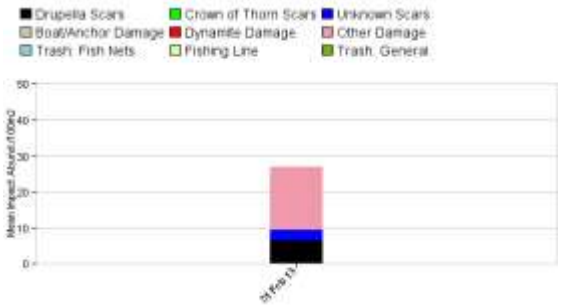

Figure 61: Mean abundance of impacts at Lady Elliot Island: Coral Gardens: Medium: Site 1: Fringing reef seaward.

Prickly green sea cucumbers (*S. chloronotus*) and *Drupella* snails were found in high density, with 17 and 16 individuals respectively. A total of 4 giant clams were found on the transect.

A fish survey was not performed at this site.

Photo 54: Coral damage at Lady Elliot Island, Coral Gardens, Site 1.

Photo 55: Surveyor at Lady Elliot Island, Coral Gardens, Site 1.

6.4 Lady Elliot Island, Reefy Seconds, Fringing Reef, Site 1, Shallow

This site was newly implemented in 2013.

Hard corals dominated this site, covering approximately 52% of the substrate (figure 62). This consisted mostly of branching corals, which represented 48% of the benthic substrate. Encrusting (3%), foliose (1%), and plate corals (1%) were also recorded. Soft coral made up less than 1%, consisting only of zooanthids. Rock with turf algae covered 21% of the total substrate, along with rock with coralline algae (7%) and rubble (14%).

Figure 62: Substrate type and percent cover at Lady Elliot Island: Reefy Seconds: Medium: Site 1: Fringing reef seaward.

A total of 58 incidents of coral damage were recorded (mostly on branching coral), in addition to 71 unknown scars. However, only 2% of the coral population were bleached (with an average of 24% of each coral affected) and no incidents of disease were found.

A total of 19 sea cucumbers (per 400m^2) were recorded, consisting of prickly greenfish (*S. chloronotus)* (figure 63). One giant clam was recorded on transect, along with 1 anemone and 2 banded coral shrimp.

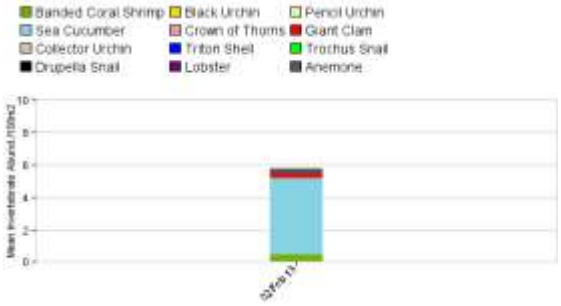

Figure 63: Mean abundance of invertebrates at Lay Elliot Island: Reefy Seconds: Medium: Site 1: Fringing reef seaward.

Photo 56: Site photo at Lady Elliot Island, Reefy Seconds, Site 1.

Photo 57: Banded coral shrimp at Lady Elliot Island, Reefy Seconds, Site 1.

6.5 Lady Elliot Island, Sandy Seconds, Fringing Reef, Site 1, Shallow

This site was newly implemented in 2013.

The site had 43% coral cover, dominated by branching corals, which covered 34% of the substrate. Encrusting and plate corals were also present, but represented only 7% of the substrate combined (figure 64). A very small amount of zoanthids were also found, representing less than 1% of the benthic transect. Rock with turf algae accounted for 31% of the substrate and rock with coralline algae covered approximately 9%. Nutrient indicator algae was found to be in low abundance, covering less than 1% of the substrate.

Figure 64: Mean abundance of impacts at Lady Elliot Island: Sandy Seconds: Medium: Site 1: Fringing reef seaward.

Coral damage abundance was recorded at 17 incidents. Twenty unknown scars were recorded, along with 2 *Drupella* scars. No coral disease was found, and very little coral bleaching was recorded (less than 1%). One incident of fishing line was also observed.

This site was found to have the highest density of prickly greenfish sea cucumbers (only *S. chloronotus* was found) of all the Lady Elliot Island sites, with 64 individuals per 400m^2. No other indicator invertebrates were observed.

A fish survey was not performed.

Photo 58: *Drupella* snail and scar at Lady Elliot Island, Sandy Seconds, Site 1.

Photo 59: Site photo at Lady Elliot Island, Sandy Seconds, Site 1.

Photo 60: Green turtle at Lady Elliot Island, Sandy Seconds, Site 1.

7.0 Palm Island

Two sites were newly implemented on Palm Island in 2013 with Bwgcolman Community School. Average hard coral cover across the two sites was found to represent 5% of the substrate.

7.1 Palm Island, Challenger Bay, Reef Flat, Site 1, Shallow

This shallow, protected fringing reef is located on the Southwest corner of the Island. On low tide, the site is often less than a meter deep, and can be surveyed via snorkel or reef walk.

Hard coral cover was low at this site, representing only 8% of the benthic substrate (figure 65). This consisted largely of branching (1%), encrusting (1%), and massive corals (6%). Instead, the site was mostly dominated by leathery soft corals, which represented 14% of the transect. The rest of the benthos was made up of rock with turf algae (28%), macro algae such as *Padina*, *Sargassum*, and *Turbinaria* (a total of 18 counts were recorded), and encrusting sponge (less than 1% of the substrate). Silt levels were high, representing approximately 9% of the substrate.

Figure 65: Substrate type and percent cover at Palm Island Reefs: Challenger Bay: Shallow: Site 1: Reef flat

Due to time constraints, fish, invertebrate, and impact surveys were not able to be completed. However surveyors anecdotally observed high numbers of giant clams.

7.2 Challenger Bay, Site 2

Site 2 lies parallel to Site 1, approximately 5 meters inshore.

Despite its close proximity to site 1, coral cover was significantly lower. Hard coral cover represented 2% of the benthic substrate, while soft coral represented less than 1% (figure 66). Rather, this site was dominated mostly by rock (28%), turf algae (6%), and the "other" category (16%), including crustose algae, clams, and seagrass. Macro algae counts were also high (66 counts), including *Padina*, *Sargassum*, and *Turbinaria.*

Figure 66: Substrate type and percent cover at Palm Island Reefs: Challenger Bay: Shallow: Site 2: Reef flat

Due to time constraints, fish, invertebrate, and impact surveys were not completed.

Photo 61: Site photo at Palm Island, Challenger Bay, Site 1 and 2

8.0 References

AIMS. 2013. *Crown of Thorns Starfish on the Great Barrier Reef* [Online]. Available: http://data.aims.gov.au/waCOTSPage/cotspage.jsp [Accessed 31 October 2013].

DE'ATH, G., FABRICIUS, K. E., SWEATMAN, H. & PUOTINEN, M. 2012. The 27–year decline of coral cover on the Great Barrier Reef and its causes. *Proceedings of the National Academy of Sciences,* 109**,** 17995-17999.

FERNANDES, L., DAY, J., LEWIS, A., SLEGERS, S., KERRIGAN, B., BREEN, D., CAMERON, D., JAGO, B., HALL, J. & LOWE, D. 2005. Establishing Representative No-Take Areas in the Great Barrier Reef: Large-Scale Implementation of Theory on Marine Protected Areas. *Conservation Biology,* 19**,** 1733-1744.

GBRMPA 2009. Great Barrier Reef Outlook Report 2009

QLD, G. 2012. Tropical Cyclone Yasi - 2011 Post Cyclone Coastal Fiel Investigation. *In:* QUEENSLAND DEPARTMENT OF SCIENCE, I., TECHNOLOGY, INNOVATION AND THE ARTS (ed.). Brisbane, Australia.