

Coral Cay Conservation Proposed Marine Protected Area Report

Santa Paz Norte “Ghost Town”



Santa Paz Norte
San Francisco, Southern Leyte, The Philippines

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EXECUTIVE SUMMARY

- Coral Cay Conservation conducted an assessment of the reef fish, invertebrates, substrates and anthropogenic impacts at a site known as Ghost Town in the waters of Santa Paz Norte. The site is proposed as a potential MPA.
- An enhanced Reef Check methodology was used to survey ten 100m transects, each containing four 20m replicates. The transects were equally divided between 6m and 12m depths.
- Additional visual surveys were conducted on areas of the reef that contained topography prohibitive to conventional surveys. These areas included a sheer reef wall, patch reef and the area in front of a river mouth (known as a 'muck' site).
- Abundance and diversity of fish families and species varied significantly between survey sites. Overall fish abundance was significantly greater at 12m than at 6m.
- Abundance and diversity of invertebrate species varied significantly between sites. The abundance of invertebrates was significantly greater at 12m than at 6m.
- Rock was the most commonly recorded substrate across the survey area followed by hard coral and then rubble. Generally hard coral cover was significantly higher on sites towards the southern end of the surveys area.
- Commercially important fish families including Barracuda, Emperors and Sweetlips were entirely absent from the surveys. Others including Grouper and Snapper were only recorded in low numbers and individuals were all generally small in size.
- Instances of damaging impacts such as trash, discarded fishing gear and boat damage were generally recorded in low abundance. Instances of coral damage from predation were high but are well within natural levels.
- The reef at Ghost Town is home to a wide array of marine life that are attractive to tourist divers.
- The reef wall and 'muck' diving areas towards the southern end of the survey have great potential as dive sites for tourists.
- It is recommended that consultation be started between the local community, municipal and provincial government and CCC on the creation of an MPA at the southern end of the surveyed area. This includes areas of high diversity and abundance and also sites with the potential for increased income generation from dive tourism.

ACKNOWLEDGEMENTS

Coral Cay Conservation would like to express our gratitude to the Provincial Government of Southern Leyte (PGSL). Our work would not be possible without the support of the Provincial Environmental and Natural Resource Management Office (PENRMO) and other members of the PGSL. We would also like to thank the Barangay Council of Santa Paz Norte and the Municipality of San Francisco for facilitating the MPA assessment. In particular we would like to acknowledge the cooperation of Federico Murillo Jr, Barangay Captain of Santa Paz Norte, and Servando Tio Jr., San Francisco SB Secretary. Finally, we would like to thank our trained volunteers and staff who collected the data during this PMPA assessment.

LIST OF ACRONYMS AND ABBREVIATIONS

CCC	: Coral Cay Conservation
CoTs	: Crown of Thorns Seastars (<i>Acanthaster planci</i>)
GPS	: Global Positioning System
IEC	: Information, Education, Communication
LGU	: Local Government Unit
MPA	: Marine Protected Area
MPA MEAT	: MPA Management Effectiveness Assessment Tool
MWU	: Mann-Whitney U test
NIA	: Nutrient Indicator Algae
NIPAS	: National Integrated Protected Area System
PGSL	: Provincial Government of Southern Leyte
PRRCFI	: Philippines Reef and Rainforest Conservation Foundation Inc.
RKC	: Recently Killed Coral
SE	: Standard Error

CORAL CAY CONSERVATION

Coral Cay Conservation (CCC) is a not for profit organisation, founded in 1986 by a British scientist. CCC's mission is:

"Providing resources to help sustain livelihoods and alleviate poverty through the protection, restoration and management of coral reefs and tropical forests."

In order to achieve this mission, CCC has carried out conservation projects all over the world, including in the Philippines, Belize, Honduras, Malaysia, Cambodia and Fiji. CCC successfully set up Marine Protected Areas and provided scientific data that has been used to manage local marine resources. Since 1995, CCC has worked with the Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and local communities to survey and safeguard reef and rainforest areas in the Philippines. To date these have included coastal regions of the Southern Negros Occidental, Anilao, Palawan, Danjungan Island and the forests of North Negros. The project in Danjungan Island in the Philippines between the years 1996-1999 was particularly successful and the reefs around the island received the accolade of Best Managed Reef in the Philippines in 2002.

At the invitation of the Provincial Government of Southern Leyte, CCC began its survey work in Sogod Bay in September 2002. CCC is conducting a collaborative program to survey the region's coral reefs and provide training and conservation education opportunities for project counterparts. The aim is to develop local capacity and ensure the long-term protection and sustainable use of marine resources throughout Southern Leyte.

1. INTRODUCTION

1.1. Marine Protected Areas

Marine resources have come under increasing pressure from an ever growing world population (Jackson *et al.* 2001). Strong declines in catch from fisheries worldwide, such as the North Atlantic Cod (Myers *et al.* 1997) and reef fisheries in the Caribbean (Hardt 2009), have illustrated that biological marine resources are limited (Jackson *et al.* 2001; Pauly *et al.* 2002). Additional pressures such as pollution, coastal development and the effects of climate change contribute to the stress the marine environment is under. This has given rise to the increased drive for conservation efforts and resource management in the marine environment (Wood *et al.* 2008; CBD 2010). Marine protected areas (MPAs) can achieve conservation and resource management targets simultaneously and are therefore considered instrumental to sustainable ocean utilization (Pauly *et al.* 2002). The International Union for the Conservation of Nature (IUCN) defines a MPA as:

“A clearly defined geographical space, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with the associated ecosystem services and cultural values.”

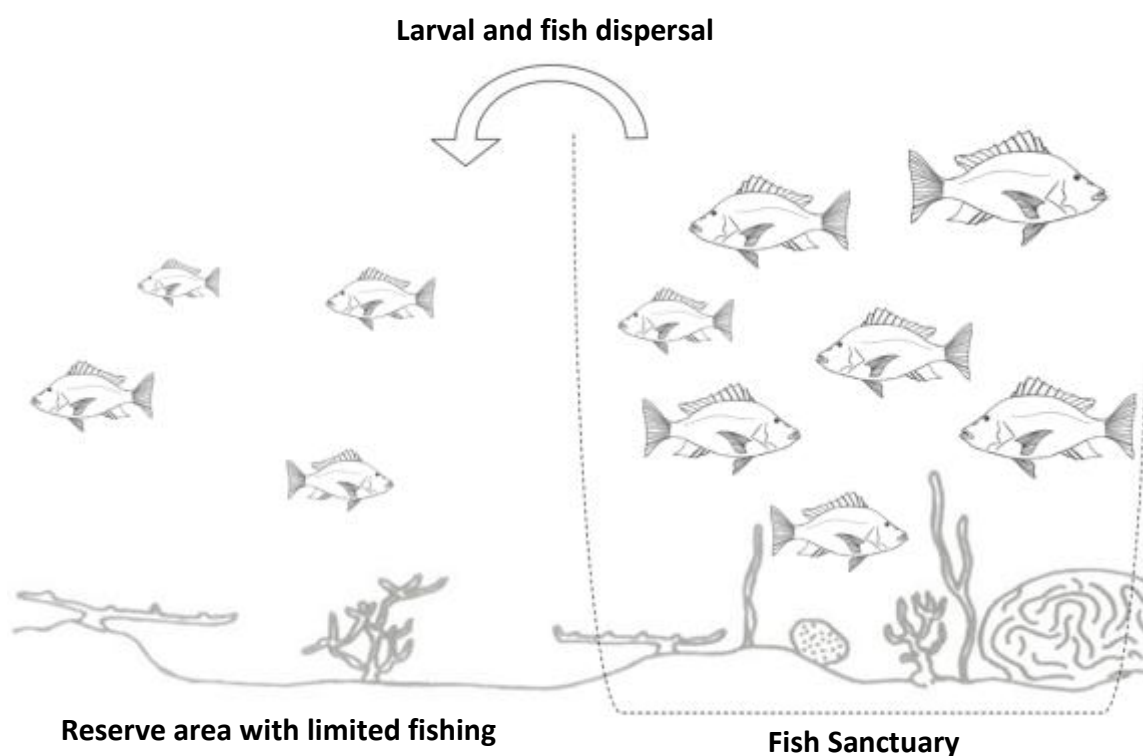


Figure 1 - Schematic diagram of MPA functioning. Protected inside the MPA fish grow larger and produce more offspring, this leads to 'overspill', increasing fish numbers outside the MPA. In addition, the corals inside the MPA are not disturbed by direct human impacts.

MPAs have become vital tools in conserving marine resources, not only for their own intrinsic value but also for the services they can provide humanity. The ecosystem within the MPA, if left undisturbed for an extended amount of time, has the potential to provide a sustainable supply of goods - such as fish, algae and salt - and services - such as shoreline protection, maintaining water quality and recreation (World Bank 2005). Increased fish catch is perhaps the most sought after potential benefit of MPAs. There are two ways that this can happen, through overspill and larval export (Figure 1). In areas where there is the potential for increasing tourism and therefore increased anthropogenic pressure on the marine environment for food, recreation and other resources, the benefits and necessities of having a network of functioning MPAs are increased.

However, the success of MPAs is for a large part dependent on the willingness of local people to adhere to the rules. Experience from around the world has shown that closely involving local people in the planning, implementation and management of their own MPA can increase their sense of ownership and pride. Only when the local stakeholders feel their concerns are taken seriously and they are consulted on management of the MPA regularly, will it be possible for the full beneficial potential of the MPA to be attained (Green *et al.* 2009, Human and Davies 2010).

1.2. Coral Reefs & Marine Conservation in the Philippines

The Philippines lies within a region known as the Coral Triangle. The Coral Triangle, which includes Indonesia, Malaysia, Papua New Guinea, Timor-Leste and the Solomon Islands, is recognized as the global centre of marine biodiversity (Roberts *et al.* 2002). It is home the oldest coral reefs in the world and the largest expanses of mangrove forest. More than 75% of the known coral species and over 30% of all the coral reefs in the world are found in the Coral Triangle (Veron *et al.* 2009). The same extraordinary diversity is found in the other types of marine creatures; with over 3,000 species of fish recorded, even higher figures for molluscs and new species still being discovered regularly (Allen 2008).

The waters of the Philippines contain roughly 25,000 km² of coral reefs. An estimated 60% of the country's 92 million citizens live in coastal regions, i.e. in close proximity to coral reefs, and over half of the consumed animal protein comes from marine sources (CTI 2012). This heavy reliance on marine resources has caused large areas of coral reef ecosystems to become threatened. In 1980 33% of coral reefs were characterized as being in poor condition, in 2008 this figure had increased to 40% (Wilkinson 2008). These figures make a strong case for increased marine conservation efforts. Legislation concerning marine conservation in the Philippines is probably one of the most advanced within the Coral Triangle (Jacinto *et al.* 2000). Some important laws include:

- 1998 Fisheries Code (Republic Act 8550): 15% of municipal water should be within a MPA

- Marine and Coastal Resource Protection Act: Each municipality should have at least one MPA that is bigger than 10 hectares (if the total municipal waters are larger than 15 hectares)
- The Philippine Marine Sanctuary Strategy (2002): By 2020, 10% of all the Philippine marine waters will be fully protected

Currently there are about 1,640 MPAs in the Philippines. Of these MPAs, 33 have been declared at national level as NIPAS sites and the remainder is managed by Local Government Units (LGU) (DENR-CMMO presentation, March 19 2013). Box 1 highlights a case study of successful MPAs in the Philippines.

Box 1 - Case study of successful MPAs in the Philippines: Apo Island & Sumilon Island

The MPAs at Apo Island and Sumilon Island are some of the best-known examples of successful tropical marine conservation efforts in the world. Years of monitoring provided accurate data that shows what can be achieved if the coral reef inside a MPA is given the chance to recover (Figure 2). These figures also show that although an increase of biomass was observed in the first years of reserve protection, the biggest increase in biomass took several years to become evident (5-10 years). Unequivocal evidence of overspill from these MPAs remains elusive but the increased number and size of fish within the reserves make it likely that the MPAs were a source for net larval export, which aided recovery of fish stocks in the area. Indirect positive effects of the effective management of these MPAs include increased tourism income and elimination of unsustainable fishing practices such as dynamite fishing (Russ and Alcala 2004).

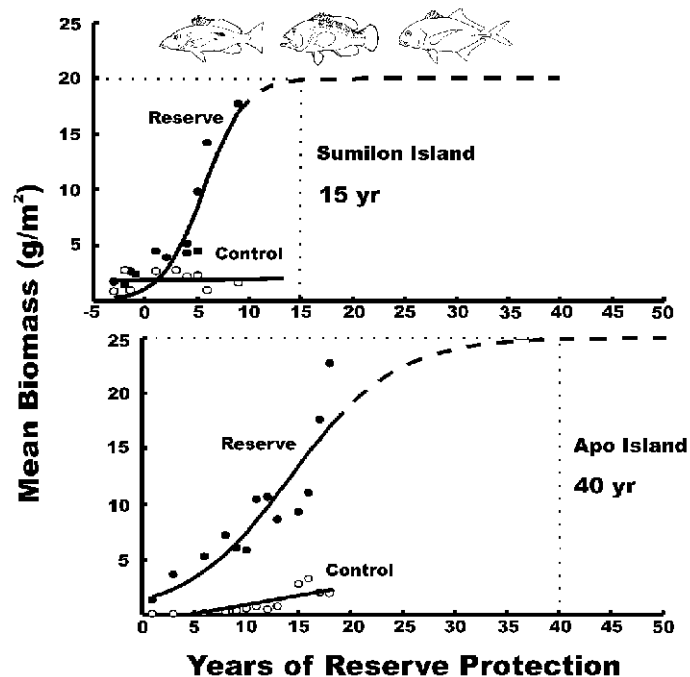


Figure 2 - Observed and projected increase in mean biomass of commercially important species of fish inside the MPAs at Apo Island and Sumilon Island.

Figure from: Russ and Alcala (2004).

1.3. Characterization of Study Region

1.3.1. Sogod Bay

The coral reefs of Southern Leyte remain some of the least disturbed habitats in the Philippines. Sogod Bay is an important fishing ground and the area is rich in tuna, flying fish, herrings, anchovies, shell-fish and Spanish mackerel. The bay has been targeted by the Fisheries Sector Program of the Department of Agriculture as one of the country's ten largest bays in need of assessment and management (Calumpang *et al.* 1994). Sogod Bay is also a feeding ground for attractive mega-fauna such as pilot whales, melon-headed whales, dolphins, manta rays and whale sharks. The bay is characterised by naturally limited mangrove areas, narrow fringing coral reefs, limited seagrass beds and narrow intertidal areas and beaches (Calumpang *et al.* 1994). Depths in the bay reach a maximum of approximately 1,400 metres in the central channel.

Currently there are 23 established MPAs within Sogod Bay covering an estimated 170 hectares. These figures will increase in the coming years as more MPAs are currently being set up. The size of the MPAs ranges from 2 hectares (Maujon/Juangon Fish Sanctuary) to 45 hectares (Limasawa Fish Sanctuary), with a mean average size of 8.7 hectares (± 2.1 SE) and a median average of 5 hectares. The sizes for several MPAs are not known, as accurate GPS coordinates are not available.

In 2013 under the new Governor, the Honourable Roger G. Mercado, a drive for increased tourism within Southern Leyte is high on the agenda. Currently dive tourism is located predominantly in the Municipalities of Padre Burgos, Malitbog and Macrohon with only one dive centre on the eastern side of Sogod Bay, in Pintuyan Municipality. Divers worldwide are very appreciative of marine conservation efforts and will willingly pay to dive in protected areas if they are well managed (Peters and Hawkins, 2009). On Bonaire, in the Netherland Antilles, users of the National Marine Park pay an annual fee of US \$10 (based on figures from 2002) to dive inside the reserve. A study by Thur (2010) suggested that divers would actually be willing to pay a greater annual fee up to US \$134 under the condition that the money is used to enhance conservation management.

The dive industry in Sogod Bay is mostly seasonal and the South-West monsoon followed by the North-East monsoon can make for unpredictable conditions at sea. In comparison to its neighbouring islands to the west, Bohol and Cebu, the diving in Southern Leyte is still relatively unknown to tourists, which is not for lack of beautiful dive sites and incredible marine creatures. Other tourism attractions in the area are relatively few, though another key event is the seasonal visits of majestic Whale Sharks (*Rincodon typus*) at the mouth of the bay. At this time, many aspects of tourism are being expanded in conjunction with improved infrastructure. Plans for a Dive Festival are underway as well as developing the potential for increasing accommodation facilities in various municipalities around the bay.

1.3.2. Santa Paz Norte, Proposed MPA Site

Surveys of the Santa Paz Norte Proposed MPA, also known as Ghost Town, were requested by PGSL and the Barangay Council of Santa Paz Norte with a view to designating the reef in part, or wholly, as an MPA. The site is located in the Municipality of San Francisco, in the waters of the barangay Santa Paz Norte. Ghost Town is a popular dive site for local dive operators and it is predominantly favoured for so-called 'muck diving'. This kind of diving focuses on the appeal of small, interesting creatures such as shrimp, cuttlefish and nudibranchs, rather than impressive reefs or an abundance of hard coral or fish. Currently the barangay does not have an MPA within its waters but the adjacent barangay of Santa Paz Sur does. The barangay is home to a population of approximately 765, 15 of these are fishermen. The boats used by the local fisherfolk are all non-motorized. The area surveyed was to the northern end of the barangay's waters, transects were between 200 and 800 metres from a river mouth and between 20 and 80 metres from shore (Figure 3).

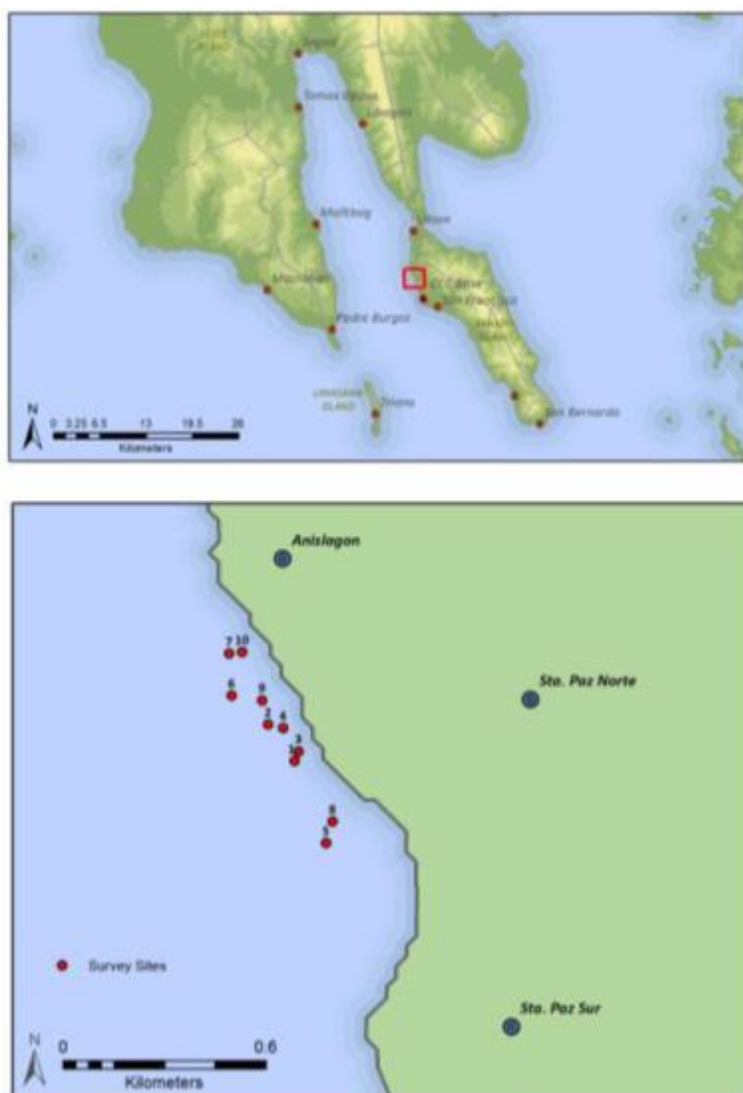


Figure 3 - Map showing the location of Santa Paz Norte survey sites

2. METHODS

2.1. Biophysical Survey

The assessment of the proposed MPA was conducted using an enhanced Reef Check method. The Reef Check methodology is widely recognised and is used to survey coral reefs around the world. It was developed in the 1990s with the aim of gathering as much data as possible about the global status of coral reefs (Hodgson 1999). The data from around the world is analysed on a yearly basis and updates about the status of coral reefs are published. Reef Check provides a general picture of the ecological status of a reef and the human impacts affecting it. CCC has augmented the methodology by adding additional target species of fish, coral and other invertebrates to better reflect the high biodiversity of the area (see Appendix A for target species).

Survey transects were conducted at depths of 6 metres and 12 metres (Table 1), along the outer reef on a North-South bearing and also adjacent to the reef wall. With this methodology it is not possible to survey a vertical or almost vertical reef wall so this area was visually assessed only. A summary of this qualitative assessment is provided in the discussion (Section 5). To give as full an overview as possible with available locations five transects were completed at 6 metres and five at 12 metres. Each transect was 100 metres long and divided into 4 replicates of 20 metres each. Between each replicate there was a 5 metre gap where no data was recorded. This survey set up allows for robust statistical analysis of the collected data.

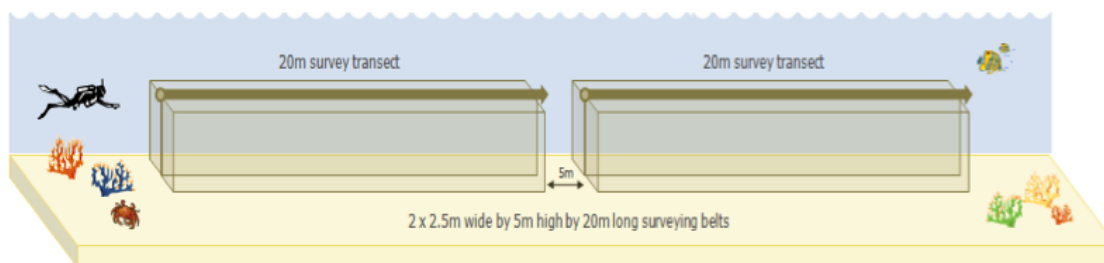
Table 1 - GPS coordinates and depths for the ten survey sites

Site Number	Depth (m)	Easting (UTM)	Northing (UTM)
1	12	732452	1116666
2	12	732374	1116774
3	6	732465	1116695
4	6	732419	1116764
5	12	732546	1116424
6	12	732266	1116860
7	12	732259	1116984
8	6	732565	1116487
9	6	732356	1116846
10	6	732297	1116989

2.1.1. Fish

The fish diversity and abundance data was collected using Underwater Visual Census. Selected fish families and species recognized as being good indicators of fishing pressure, aquarium collection and reef health were recorded (see Appendix A for target species lists). Three families of commercially important fish were also recorded by size: Groupers (Lapu Lapu, Serranidae), Parrotfish (Mulmul, Scaridae) and Snappers (Maya Maya, Lutjanidae).

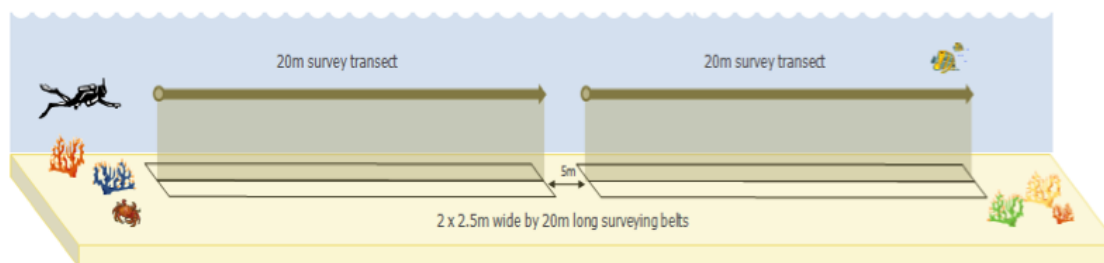
Fish data was recorded along a 'belt' transect, where fish were counted within an imaginary 5x5x5m box along the four 20m replicates (Figure 4). Surveying was carried out by two divers swimming slowly side by side along the transect and counting the indicator fish. The divers stopped every 5 metres and waited 1 minute for the indicator fish to come out of hiding before proceeding to the next 5 metre stop-point.



*Figure 4 - Survey method for recording fish.
The diagram shows 2 of the 4 replicates in a 100m transect.*

2.1.2. Invertebrates

The same areas used for the fish belt transect were used to record the diversity and abundance selected invertebrate species typically targeted as food species, collected as curios or important to the ecological balance of the reef (see Appendix A). The divers recorded invertebrates 2.5m either side of the transect line (Figure 5). Divers looked in holes and under overhangs to look for organisms such as lobsters, sea urchins or other cryptic species.

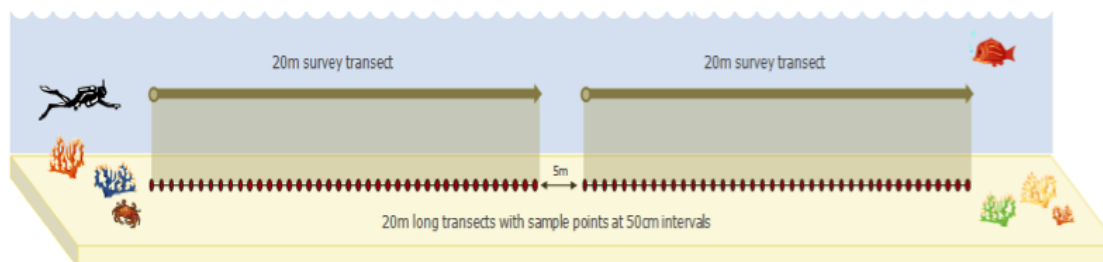


*Figure 5 - Survey method for recording invertebrates.
The diagram shows 2 of the 4 replicates in a 100m transect.*

2.1.3. Substrate

Benthic diversity was measured by recording living and non-living benthic categories along a point intercept transect. Along the transect line, benthic organisms and substrate types were recorded at 50cm intervals (Figure 6). To minimize bias, a plumb line was dropped at each designated 50cm point and the substrate type underneath was recorded. Every replicate contained 40 benthic points.

Benthic categories were: sand, rock, rubble, silt/mud, nutrient indicator algae, sponge, recently killed coral, soft coral, hard coral and any other biotic lifeforms. Hard corals were noted to species or genus level if the coral was a target species, otherwise, a note was made of the coral life form (see Appendix A).



*Figure 6 - Survey method for recording substrate data.
The diagram shows 2 of the 4 replicates in a 100m transect.*

2.1.4. Impacts

Within the same area assessed for invertebrates, divers recorded a number of impacts on the reef. They estimated the total percentage of bleached coral cover as well as the estimated percentage of each individual coral colony that was bleached. Coral diseases were recorded as a percentage of the colony infected and where possible, the disease was identified. Coral damage was recorded in three categories: boat/anchor, dynamite and other, on a categorical scale from 0 to 3 (0 = none, 1=low, 2= medium, 3 = high). Impact on the site from trash was recorded on the same scale and separated into general and fishing nets/traps.

2.2. Data Analysis

Each 20m replicate was treated as an independent sample. This produced $n=20$ at 6 metres and $n=20$ at 12 metres. The analysis of the data was structured in three ways. Firstly, each of the 10 sites surveyed was analysed independently and compared to the other sites in order to establish which areas of the reef are particularly healthy and which are not, with the view of being able to recommend suitable areas to be protected. Secondly the data were analysed according to depth, in order to compare differences between 6 meters and 12 meters. Finally the data was considered as a whole to provide an overall picture of the area surveyed. To test for statistically significant differences between sites and depths, Mann-Whitney U (MWU) tests were used. Preliminary inspection of the data revealed that the variances were not homogeneous and the data had a non-normal distribution. Transformations of the data did not sufficiently alter this to warrant using a parametric test.

Species diversity of fish and invertebrates was calculated using the Fishers α index. These index values too were then submitted to the Mann-Whitney U test to check for significant differences between depths and sites.

3. RESULTS

The assessment of the Santa Paz Norte proposed MPA was conducted between the 4th of June 2013 and the 2nd of August 2013. It was conducted over 30 dives by trained volunteer survey teams from Coral Cay Conservation. In general, the weather throughout the survey period was fair, with no major weather systems moving through the region. On average the air temperature was 27.5°C, the water temperature was 28.7°C at the surface and 28.3°C at 3m, as well as at 10m. Estimated horizontal visibility was 25m on average. Overall, 10 fishing Bankas were seen during survey times in the near vicinity, their origins were unknown.

3.1. Analysis between sites

3.1.1. Fish

Mean fish abundance over the 10 sites varied from 70.75 ± 3.5 (Site 8) to 331.75 ± 43.6 (Site 7) per 500m³ (mean $\pm$ SE, Figure 7). Several significant differences in fish abundance were found between individual sites (Figure 8). Site 8 was found to have significantly less fish than 77% of the other sites and Site 4 was found to have significantly less fish than 66% of the other sites, whilst Sites 1 and 7 had significantly more fish than 44% of the other sites.

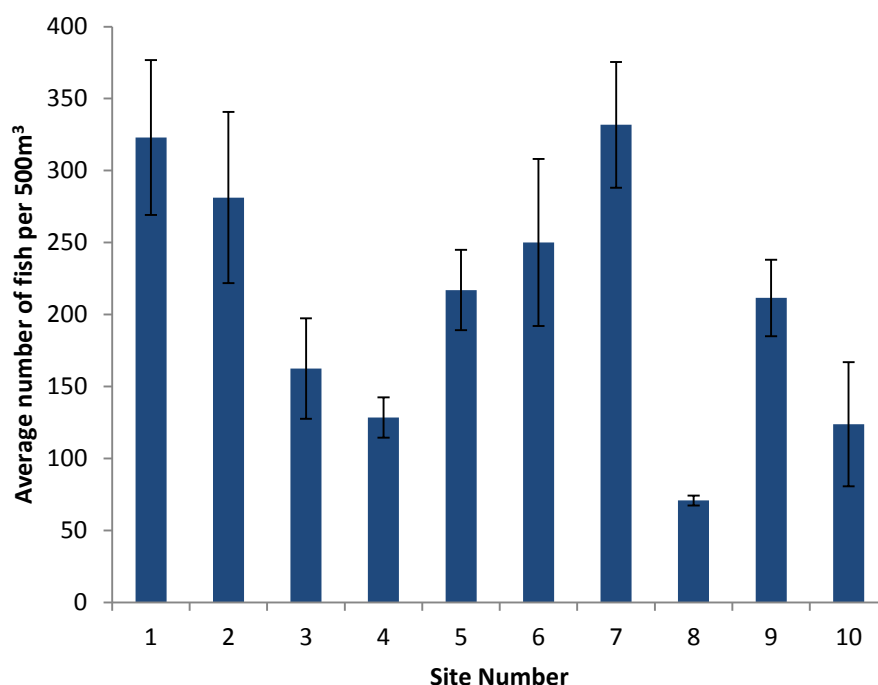


Figure 7 - Average fish abundance at each site. Data are mean number of individuals per replicate, error bars are standard error of the mean.

	1	2	3	4	5	6	7	8	9	10
1			+	+				+		+
2				+				+		
3	-						-			
4	-	-			-	-	-	+	-	
5				+				+		
6				+				+		
7			+	+				+		+
8	-	-		-	-	-	-		-	
9				+				+		
10	-						-			

Figure 8 - Matrix showing significant differences in fish abundance between sites. '+' significantly higher at site on the left compared to site at the top ($p < 0.05$). '-' significantly lower at site on the left compared to site at the top ($p < 0.05$). Blank cells indicate no significant difference.

Fish diversity also varied between sites (Figure 9) ranging from 2.78 ± 0.07 (Site 7) to 4.35 ± 0.53 (Site 3). The only two sites that showed statistically more or less diverse fish populations were Sites 4 and 7. Site 4 had a significantly more diverse fish population than Sites 5, 7 and 10 and Site 7 had a significantly less diverse population than Sites 1, 3 and 4 ($p < 0.05$).

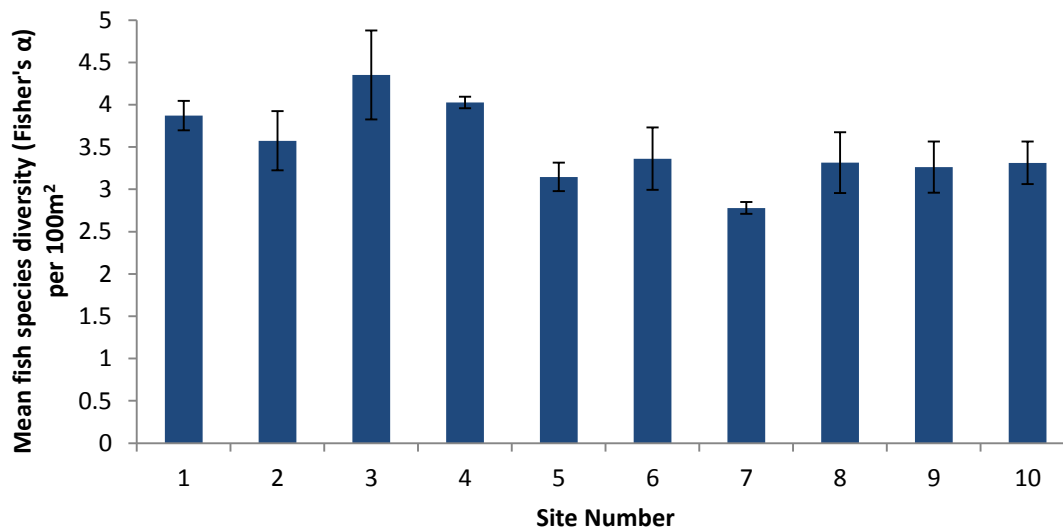


Figure 9 - Average fish diversity at each survey site. Data are mean Fishers α value per replicate, error bars show standard error of the mean.

3.1.2. Invertebrates

Mean invertebrate abundance ranged from 96.3 ± 9.8 per 100m^2 (Site 4) to 253.3 ± 16 per 100m^2 (Site 7) (Figure 10). Figure 11 shows significant differences in invertebrate abundance between individual sites. Site 4 had significantly lower invertebrate abundance than 66% of the other sites and Site 8 had significantly lower abundance than 44% of the other sites. No site showed significantly higher invertebrate abundance than more than 33% of the other sites.

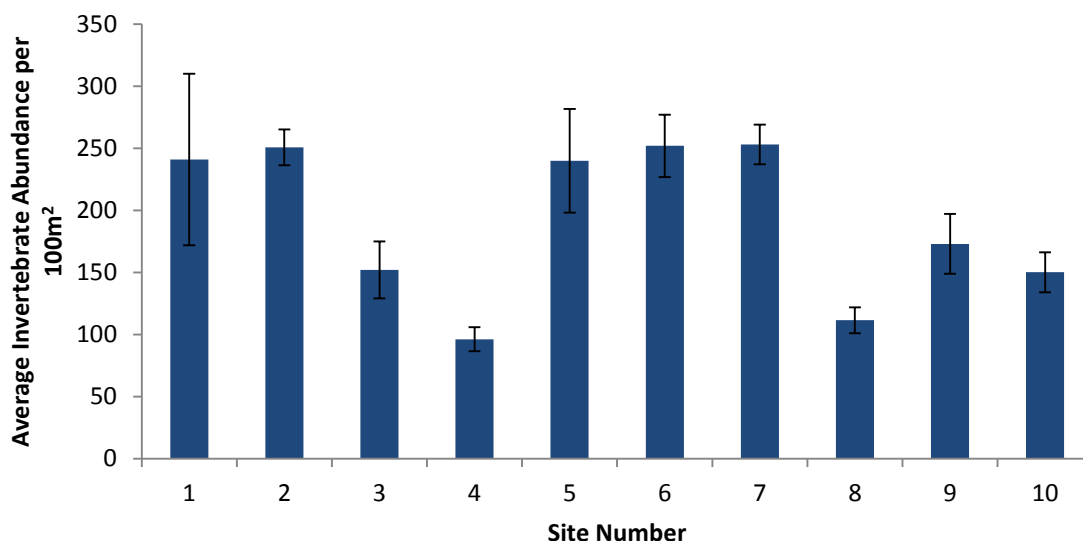


Figure 10 - Average invertebrate abundance at each site. Data are mean number of individuals per replicate, error bars are standard error of the mean.

	1	2	3	4	5	6	7	8	9	10
1				+						
2				+				+		+
3										
4	-	-			-	-	-		-	
5				+				+		
6				+				+		+
7				+				+		+
8		-			-	-	-			
9				+						
10		-				-	-			

Figure 11 - Matrix showing significant differences in invertebrate abundance between sites. '+' significantly higher at site on the left compared to the site on the top ($p < 0.05$). '-' significantly lower at site on the left compared to site at the top ($p < 0.05$). Blank cells indicate no significant difference.

Invertebrate species diversity was relatively even across all sites (Figure 12). The only statistically significant differences recorded were at Site 8 which had significantly higher diversity than both sites 3 and 9 ($p < 0.05$).

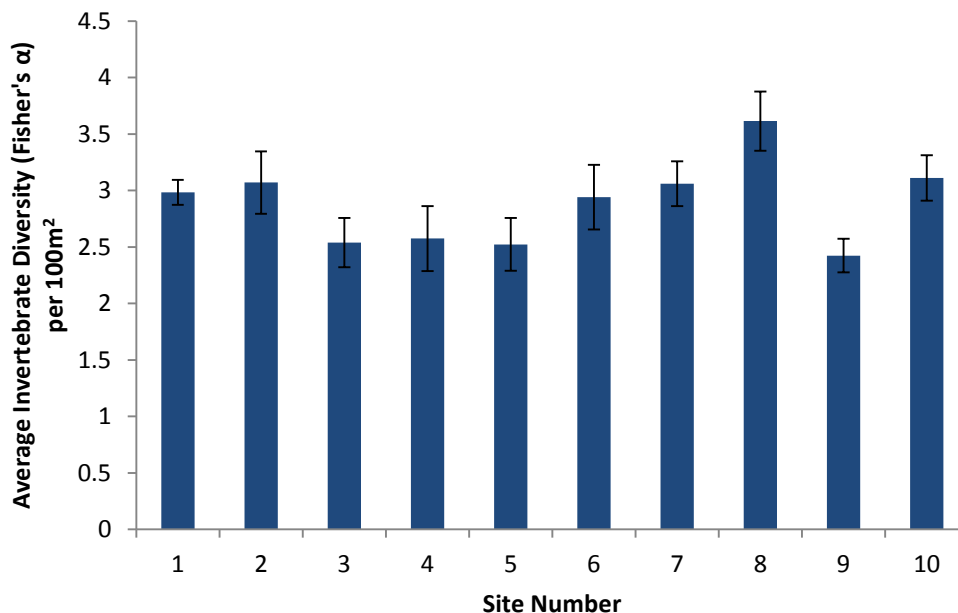


Figure 12 - Average invertebrate diversity at each survey site. Data are mean Fisher's α value per replicate, error bars are standard error of the mean.

3.1.3. Substrates

Benthic cover between sites was not homogenous (Figure 13), with the main differences between sites being between the amount of hard coral, rock, rubble and sand. The highest hard coral cover was found at Site 3 ($47.38\% \pm 5.8$), while the lowest hard coral cover was found at Site 7 ($11.88\% \pm 5.4$). Figure 14 shows significant differences in hard coral cover between sites. Site 3 had significantly higher hard coral cover than 77% of the other sites, while Sites 6 and 9 both had significantly lower hard coral cover than 55% of the other sites. Both recently killed coral (RKC) and nutrient indicator algae (NIA), which can be considered indicators of negative anthropogenic impacts, were found at low levels at all sites.

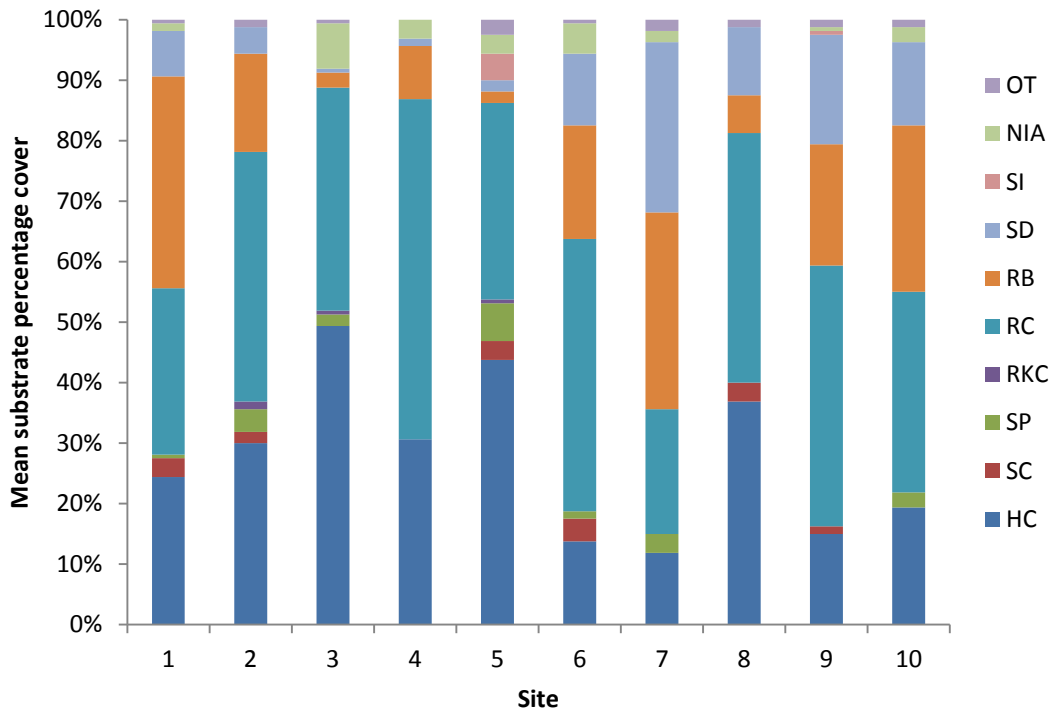


Figure 13 - Mean substrate percentage cover at each survey site. Data are mean average per replicate. HC – Hard coral; SC – Soft coral; SP – Sponge; RKC – Recently killed coral; RC – Rock; RB – Rubble; SD – Sand; SI – Silt/mud; NIA – Nutrient indicator algae; OT – Other living organisms.

	1	2	3	4	5	6	7	8	9	10
1			-							
2			-			+	+		+	
3	+	+		+		+	+		+	+
4			-			+	+		+	
5						+	+		+	+
6		-	-	-	-			-		
7		-	-	-	-					
8						+				
9		-	-	-	-	-				
10			-		-					

Figure 14 - Matrix showing significant differences in percentage hard coral cover between sites. '+' significantly higher at site on the left compared to site at the top ($p < 0.05$). '-' significantly lower at site on the left compared to site at the top ($p < 0.05$). Blank cells indicate no significant difference.

3.2. Analysis between depths

3.2.1. Fish

At 6 metres (Sites 3, 4, 8, 9 and 10) average fish abundance was 139.4 ± 15.5 per 500m^3 and at 12 metres (sites 1, 2, 5, 6 and 7) average fish abundance was 280.6 ± 22.2 per 500m^3 (Figure 15). This difference was found to be significant ($p < 0.001$). Analysis of individual fish families showed that Angelfish (Pomacanthidae), Lizardfish (Synodontidae) and Gobies (Gobiidae) were all significantly more abundant at 12 metres than at 6 metres ($p < 0.001$, $p < 0.05$ and $p < 0.001$ respectively).

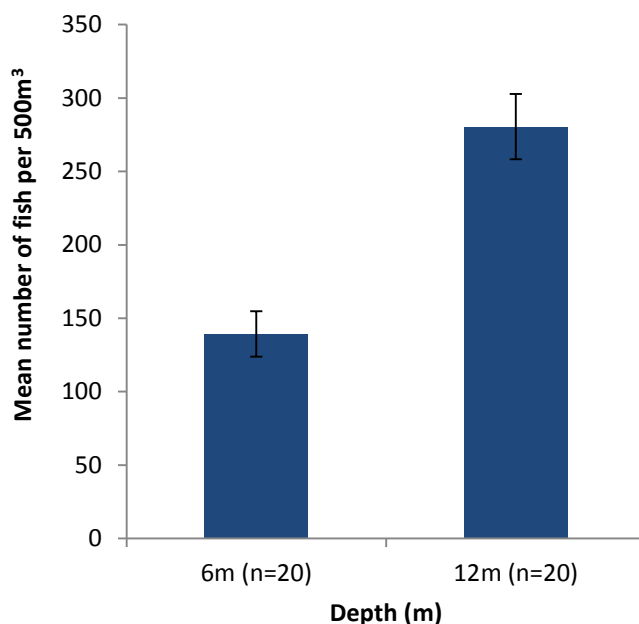


Figure 15 – Average fish abundance at each survey depth. Data are mean number of individuals per replicate by depth, error bars are standard error of the mean.

3.2.2. Invertebrates

At 6 metres (Sites 3, 4, 8, 9 and 10) average invertebrate abundance was 136.6 ± 9.6 per 500m^3 and at 12 metres (Sites 1, 2, 5, 6 and 7) average invertebrate abundance was 247.4 ± 15.6 per 500m^3 (Figure 16). This difference was found to be significant ($p < 0.05$). A number of invertebrate families and species were found at statistically higher abundances at 12 metres. These include Feather Duster Worms ($p < 0.05$), Nudibranchs ($p < 0.01$), *Linkia laevigata* sea stars ($p < 0.001$), Feather Stars ($p < 0.001$) and Brittle Stars ($p < 0.001$).

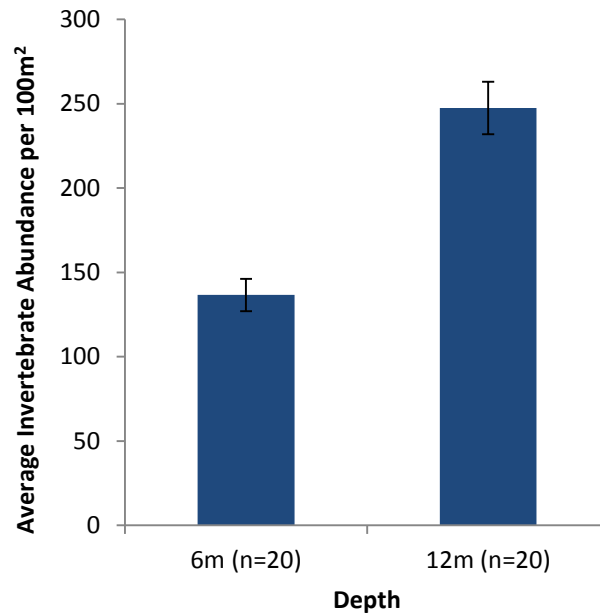


Figure 16 - Average invertebrate abundance at each survey depth. Data are mean number of individuals per replicate by depth, error bars are standard error of the mean.

3.2.3. Substrates

With the exception of the category 'Sponges', substrate cover between depths did not differ significantly. Sponges were found to be significantly more common at 12m (Figure 17).

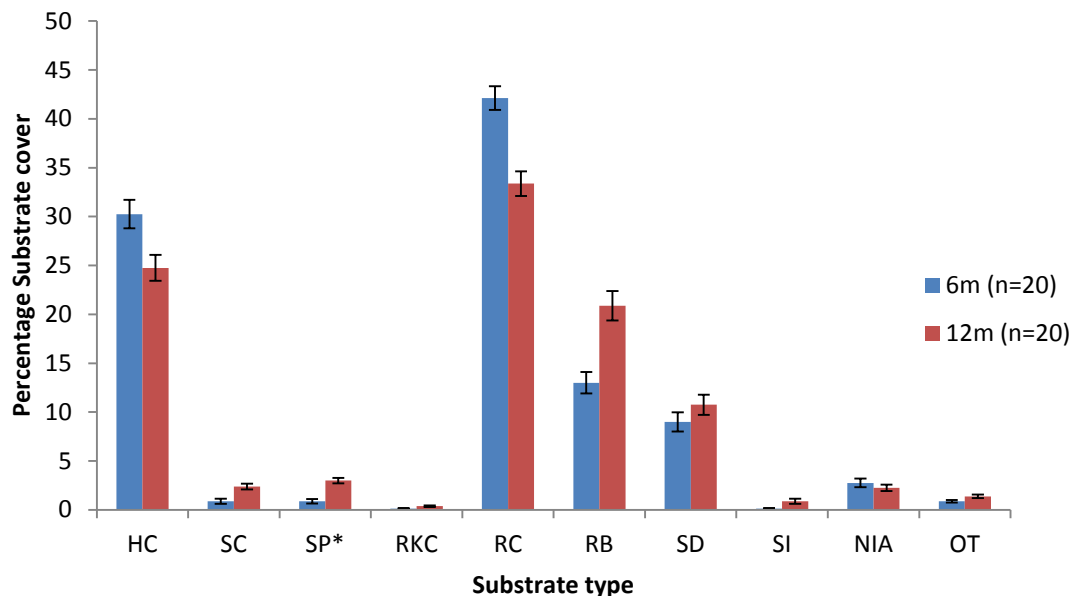


Figure 17 - All substrate types percentage cover at the two survey depths. Data are mean percentage cover per replicate, error bars are standard error of the mean. * indicates a significant difference ($p < 0.05$). HC – Hard coral; SC – Soft coral; SP – Sponge; RKC – Recently killed coral; RB – Rubble; SD – Sand; SI – Silt/mud; NIA – Nutrient indicator algae; OT – Other living organisms.

3.3. Analysis across all sites

3.3.1. Fish

Overall mean fish abundance across all sites was 210.0 ± 27.9 per 500m^3 . Some important commercial fish families were entirely absent throughout all surveys namely Barracuda (Sphyraenidae), Emperors (Lethrinidae) and Sweetlips (Haemulidae) as well as other, individual species and sub-families such as Humphead Wrasse and Unicornfish (related to Surgeonfish). Only 1 Jack/Trevally (Carangidae) was seen over all dives (at Site 1). Parrotfish were recorded across all sites (4.6 ± 1.1 per 500m^3), 75% of these were 20cm in length or smaller with no specimens estimated over 40cm. Low numbers of Groupers were recorded across the survey area (0.45 ± 0.09 per 500m^3) and only one Grouper over 20cm in length was recorded. With the exception of Site 5, Snappers were recorded in low numbers across all sites (3.85 ± 1.5). Over 60% of Snappers recorded were less than 20cm in length and only 6% were recorded at 30cm or greater in length (Figure 18). No sharks, rays or sea snakes were observed during surveys and only one turtle was seen.

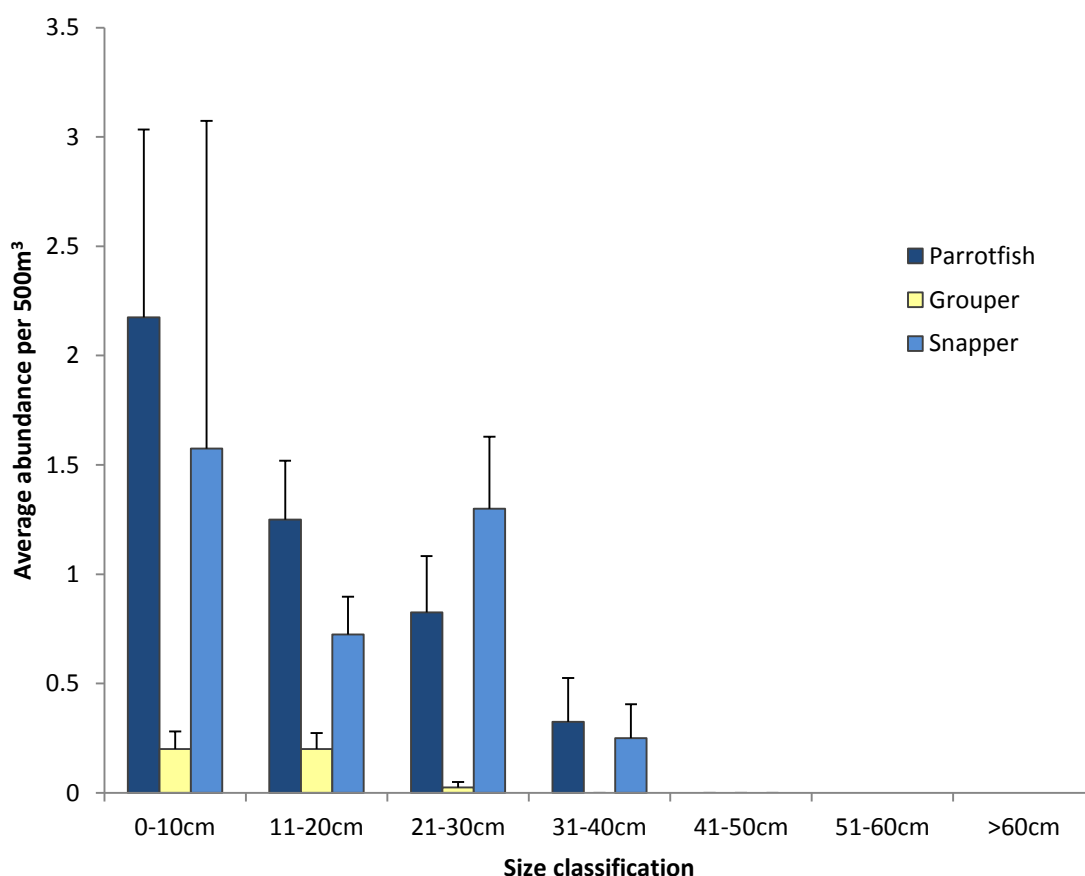


Figure 18 - Average abundance of Parrotfish, Groupers and Snappers in different size classes across all sites. Data are mean number of individuals per replicate, error bars are standard error of the mean.

3.3.2. Invertebrates

The most common invertebrates across all sites were Feather Stars, Brittle Stars and Shrimp (See Appendix B - Species abundance graphs). Long spine sea urchin populations appeared to be at healthy levels across all sites (20.90 ± 2.3 per 100m^2) and populations of coral-eating *Drupella* snails were relatively low across all sites (7.78 ± 1.6), though some sites did have locally high population levels (Sites 3, 4 and 9). Crown of Thorns Seastars (*Acanthaster planci*, CoTs) were rarely seen, with on average less than 1 individual observed per 100m^2 (0.58 ± 0.2). Many commercially important species were rarely seen (e.g. Giant Clams, Sea Cucumbers, Abalone) or were completely absent from the surveys (e.g. Lobster, Triton's Trumpet, Squid).

3.3.3. Substrate

The most commonly recorded substrate overall was rock, followed by hard coral then rubble with average percentage cover of $37.75 (\pm 0.9)$, $27.50 (\pm 1.0)$ and $16.94 (\pm 1.0)$ respectively (Figure 19). Sand was also relatively common ($9.88\% \pm 0.7$) and all other substrates were less common, with abundances at 2.5% or less. Across all sites, 28 of 33 target species of hard coral were found (see Appendix B - Species abundance graphs). The most common target species was *Porites cylindrica* followed by Massive *Porites* sp. All other hard coral target species encountered were found in relatively low abundance. *Acropora* corals were also encountered relatively infrequently. The most commonly occurring hard coral lifeforms were branching and submassive.

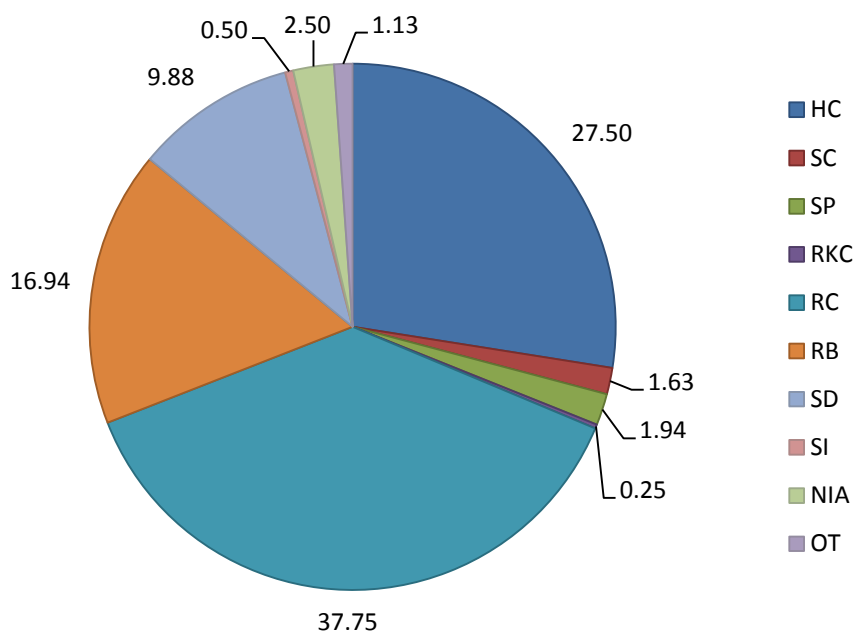


Figure 19 - Average substrate percentage cover across all sites. Data labels show mean percentage cover per replicate. HC – Hard coral; SC – Soft coral; SP – Sponge; RKC – Recently killed coral; RC – Rock; RB – Rubble; SD – Sand; SI – Silt; NIA – Nutrient indicator algae; OT – Other living organisms.

3.3.4. Anthropogenic Impacts

Anthropogenic impacts across all sites were generally low (Figure 20). No instances of boat/anchor damage or dynamite fishing damage to coral were recorded on any of the surveys. General trash was recorded in low to medium abundance at eight of the ten sites. A high occurrence of general trash was recorded at site 5. Trash from fishing was rarely recorded on the surveys, with Site 5 again showing the highest level of this impact. Coral predation was the most commonly observed form of coral damage. Sites 3, 4, 7, 8, 9 and 10 had high levels. This was largely attributed to predation from *Drupella* sp. and, to a lesser extent, Crown of Thorns Seastars. Bleaching events were only witnessed on 3 replicates, all of which were minor occurrences affecting less than 1% of the total population. White band disease was recorded only once and black band disease was not recorded at all.

	Trash: Fishing	Trash: General	Coral Damage: Other	Coral Damage: Boat/Anchor	Coral Damage: Dynamite
1	Blue	Yellow	Blue	White	White
2	Blue	Yellow	Yellow	White	White
3	White	Blue	Red	White	White
4	White	Blue	Red	White	White
5	Yellow	Red	Yellow	White	White
6	White	Blue	Yellow	White	White
7	Blue	Yellow	Red	White	White
8	White	Yellow	Red	White	White
9	Blue	Blue	Red	White	White
10	Blue	White	Red	White	White

Figure 20 - Matrix showing levels of impacts at all sites. White – None; Blue – Low; Yellow – Medium, Red – High.

4. VISUAL ASSESSMENT

The following pages present images taken by CCC divers in the waters of Santa Paz Norte.



Figure 21 - Reef Crest at Santa Paz Norte



Figure 22 - The reef crest and steep wall found at the southern points of the Santa Paz Norte Reef



Figure 23 - Pulsing Soft Coral (Xenia sp.)



Figure 24 - A pair of Coleman Shrimp (Periclimenes colemani) in their urchin home



Figure 25 - Blue-Ringed Octopus (*Hapalochlaena* sp.) in the sandy area to the south of the reef



Figure 26 - A white Feather Star (*Crinoidea*) with resident Elegant Squat Lobster (*Allogalathea elegans*)



Figure 27 - An Aeolid Nudibranch with size scale



Figure 28 - A male Orange and Black Dragonet (Dactylopus kuiteri) seen near the sandy areas around Sites 5 & 8



Figure 29 - A Tomato Anemonefish (*Amphiron frenatus*) in a Bulb-Tentacle Anemone (*Entacmaea quadricolor*)



Figure 30 - A Mushroom Coral Pipefish (*Siokunichthys nigrolineatus*) in a Mushroom Coral (*Heliofungia actiniformis*)



Figure 31 - The rare and beautiful Ornate Ghost Pipefish (Solenostomus paradoxus). This creature is the inspiration for the name 'Ghost Town'.

5. DISCUSSION

The assessment of the Santa Paz Norte reef revealed a variety of reef structures with a high level of topographic complexity. Due to the topographical nature of the reef, not all areas were surveyed fully. The reef wall, shallow area of coral bommies and area of silt (Figure 32) were visually assessed and this assessment is taken into consideration in the following discussion. Overall the reef at Santa Paz Norte was observed to be in generally good health. It contained large patches of healthy corals as well as areas of low coral cover. Species abundance and diversity was generally high, however there was a concerning lack of many commercial species of fish and invertebrates. The causes and implications of this trend are discussed in the following sections with particular regard to informing the creation of a Marine Protected Area.



Figure 32 - Map indicating distinct areas of the Ghost Town site. Image copyright Google.

Overall trends in fish and invertebrate abundance revealed significant differences between data collected at 6 and 12 metres. It is common to find greater species abundance and diversity on deeper reef slopes compared to the shallower reef crest as there are often a greater range of micro-habitats on the reef slope. Additionally, at shallower depths marine organisms are exposed to a variety of conditions that are less favourable than at depth. Increased wave action, relative depth changes due to tides, storms and ultra violet light exposure mean that conditions are more challenging in shallower areas. Because of this, organisms that inhabit shallower depths tend to be specially adapted to be more robust and resistant to these conditions. At a greater depth the effects these environmental stressors are reduced and as a

result a greater abundance and diversity of species can proliferate. When considering which areas to protect within an MPA, the shallower reef crest should not be ignored simply because it has lower species diversity and abundance and a successful MPA should protect within it a range of habitat types (IUCN-WCPA, 2008). It should be borne in mind when considering the data from Santa Paz Norte that sites at 6m will generally have lower species diversity and abundance than sites at 12m.

5.1. Fish

The abundance of fish between sites varied considerably, with Sites 1 and 7 having the highest levels of abundance. A large proportion of fish abundance at these sites was made up of the Goby family (Gobiidae) (60% and 66% of individual fish observed respectively). These small, benthic dwelling fish are found all over the reef and occupy many different ecological niches and habitats. Their high abundance at Site 7 is likely due to the quantity of sand substrate recorded on the transect (28% of all substrate cover). Many small species such as the Dwarf Goby (*Pandaka pusilla*) primarily associate with sand and also aggregate in large numbers and thus explain the high numbers recorded. Site 4, where lower fish numbers were recorded, by comparison had relatively low sand cover (>2%) and high bare rock cover which is less desired by most Goby species and thus there is a reduction in the numbers observed. Therefore caution must be used when considering fish abundance figures, since lower abundance does not necessarily mean that sites are in poor health. For example at Site 4 overall fish abundance was significantly lower than most other sites, however the diversity was higher suggesting a healthy population structure of fish species. No site exhibited a combination of both low fish diversity and low abundances. When considering a combination of both fish diversity and abundance Sites 1, 2, 3 and 6 were the 'best' sites. This includes three sites at 12m (Sites 1, 2 and 6) and one site at 6m (Site 3).

Sightings of commercially important species such as Groupers and Snappers as well as ecologically important species such as Butterflyfish and Parrotfish were fairly even across all sites and often with healthy population numbers. However, the lack of larger Groupers, Snappers and Parrotfish and the complete absence of other commercially important species like Emperors and Sweetlips is a concern. Snapper numbers were particularly low across most sites, although a school of approximately 60 small (>10cm) Bigeye Snapper (*Lutjanus lutjanus*) on a single transect at Site 5 has inflated the recorded average. This species of Snapper is known to form roving schools that move from reef to reef and, as such, the occurrence was likely due to chance since the school is unlikely to be resident in the area. The low abundance and size of commercially important food-fish is a key indicator that the fishery is under high and continued pressure.

The lack of larger fish is not just a concern from a fisheries point of view but also an ecological one. Many commercially important fish species take a long time to reach sexual maturity and therefore the selective removal of larger individuals through excessive fishing pressure reduces the numbers reaching breeding size and limits the total population of sexually mature adults.

Moreover, many species form breeding aggregations only once they attain a certain size. Some Grouper species for example have been shown to only aggregate at lengths greater than 40cm (Rhodes and Tupper, 2008) and 22cm (Sadovy *et al.*, 1994). As fecundity rate is known to increase with body length the lack of large individuals across the survey sites means reproduction rates may be low and suggest a population in decline. On-going fishing pressure is also a concern for families such as Parrotfish which exhibit protogynous hermaphroditism. This reproductive mechanism relies on a small number of large females changing sex to become Terminal Phase or “Super” Males. It allows these few males to fertilise many females and results in a higher number of offspring than would a 50:50 sex ratio. However removal of these large males by fishing severely disrupts the system, decreasing the reproductive capacity of the population as a whole.

The signs of overfishing in the area indicate that the Santa Paz Norte site could benefit from protection within an MPA. As shown in the case studies of Apo Island and Sumilon Island (Box 1), full recovery of certain fish species can take a substantial period of time, even when protected within an MPA. This is especially true of Grouper species which often have slow rates of reproduction and take a long time to reach sexual maturity. Species with higher reproductive rates, such as Emperors, may recover faster (McClanahan and Kaunda-Arara 1996; Russ and Alcala 2004). It is also important to understand that recovery will be quicker if overfishing is halted before the population reaches critically low levels (Russ and Alcala 2004). Moreover when abundances of fish and invertebrates begin to rise, the harvesting pressure needs to remain low as increased fishing at this point can destroy years of recovery in a short time (McCook *et al.* 2010).

5.2. Invertebrates

When considering invertebrate abundance and diversity together, Sites 1, 2, 6 and 7 had the highest values. However, all of these sites were at 12m and, as discussed above, we would expect these sites to have greater species abundance and diversity. Of the sites at 6m, Sites 8 and 10 had the best combined values for invertebrate abundance and diversity. Across all sites one of the most frequently occurring groups of invertebrates was Feather Stars (Crinoidea), mobile Echinoderms which filter feed from the water column. Feather Stars not only show a wonderful diversity in colour and size but are also commonly a microhabitat for other cryptic invertebrates and fish species such as Filefish and Ornate Ghost Pipefish. These species are often prized by recreational divers for their beauty and amazing abilities at camouflage. A further positive sign for recreational divers was the number of Nudibranchs seen; these small, brightly coloured and often extremely hard to find molluscs are another sought after group for hobbyists.

Diadema (long spine) species of urchin are voracious herbivores that normally hide during the day in cracks and crevices, and forage at night. They play an important role in the reef system, keeping algal populations in check and preventing them from competing with hard corals. However, populations should be in a healthy balance with other herbivorous species, most

importantly with those of the Parrotfish and Surgeonfish families. When in relative balance, competition for food resources will control individual populations, however if one or more herbivore populations are reduced there may be knock on effects for the ecosystem as a whole. The data indicates that fishing pressure on larger Parrotfish and most species of Surgeonfish around the area is high. If this continues or escalates, overall grazing pressure will be reduced threatening the health of the reef by allowing increased algal growth (McClanahan et al. 1996). In many cases corresponding increases in urchin populations as herbivorous fish populations decline keep the algal growth in check. However, as has been seen in the Caribbean, there is an increased risk that a disease outbreak which affects urchins could decimate their population leaving almost no herbivorous grazers on the reef (Lessios *et al.* 1984 and Bellwood *et al.* 2004). When this happens a phase shift can occur in which the algae begins to outcompete hard coral and the reef moves from a diverse coral dominated system to an impoverished algal dominated system. During all surveys the numbers of *Diadema* sp. urchins recorded were not considered to be high, indicating that the balance is still in place and that fishing pressure has not yet resulted in an increase in urchin populations. Protecting the area within an MPA should prevent a phase shift from occurring in the future by maintaining healthy populations of herbivorous fish, and monitoring the MPA regularly should flag any changes in species population levels that may cause concern.

Long term harvesting of commercially important invertebrate species is evident by their small size (in the case of Giant Clams) or their total absence (in the case of Triton's Trumpets). The specimens of Giant Clams found are a promising sign that a population could be encouraged in the area but, as they are extremely long lived and slow growing, they will require careful monitoring and protection.

5.3. Substrate

The surveys covered a variety of reef zones and as a result, substrate cover was varied and is indicative of a reef with a range of habitats. The most commonly found substrate across all sites was rock which is readily colonisable by new recruits of hard and soft coral as well as other benthic reef creatures such as sponges. The areas of rubble that were found in sites 1, 7 and 10 are less easy to colonise as most sessile benthic creatures require solid substrate to anchor to. In some cases large rubble patches are indicative of historic dynamite fishing taking place in the area as it weakens and destroys the hard substrate. The discovery of what appeared to be very old, unexploded pieces of dynamite within the survey area lends support to this theory, though it does not appear that this type of fishing has taken place recently. Rubble can be re-consolidated to a hard substrate suitable for colonisation by hard coral and other sessile benthic organisms by certain slow growing algae but this process takes a long time. It is imperative that, whether or not an MPA is established, the practice of destructive fishing techniques which damage coral, like dynamite fishing, continues to be prevented in the area.

The percentage of live hard coral cover was relatively good across all sites, with Sites 3 and 5 exhibiting the highest levels. However, Sites 6, 7 and 9 had much lower hard coral cover that

would be described as 'low' or 'poor' (Bruno and Selig 2007, GCRMN 2004). Average hard coral cover across all the sites was lower than that in some areas of Sogod Bay, e.g. inside Napantao MPA (Longhurst *et al.* 2013), but is comparable to other areas in the Bay, e.g. San Augustin-Lugsongan MAP, Limasawa (Longhurst and Ferguson, 2013) and Santa Paz Sur MPA (Longhurst and van de Geer, 2013). With long term management and monitoring there is the potential for hard coral cover to increase. Coral polyps require a hard substrate on which to settle. At both sites 6 and 9 the most commonly observed substrate was rock (45% and 43.1% respectively). Therefore, there is a large potential surface area on which new coral recruits may settle.

Low levels of Nutrient Indicator Algae (NIA), coral bleaching and coral diseases indicate the reef is in overall good health. However due to the topography of the coastal region, which is steep with hills rising sharply from the shore, the potential for negative land based impacts is high. The location of Sites 5 and 8 close to a river mouth make the reef in that area vulnerable to siltation and the effects of surface runoff. Nutrient loading from agricultural practices on land can lead to blooms in algae that smother corals and compete for bare rock to colonise. However, the data suggests that this is currently not the case. Observational dives around the southern area of the survey and adjacent to the river mouth did find excessive amounts of household wastes (discussed in 5.4) and elevated levels of siltation. Some interesting marine animals proliferate in silty and sandy substrates, (See Section 4 – Visual Assessment) but care must be taken in not allowing the siltation levels to increase.

5.4. Impacts

Of the impacts recorded during surveys, 'coral damage: other' was the most frequently occurring. However, the vast majority of this impact recorded were as a result of natural predation on coral by *Drupella* snails. All of these instances were small and localised and were not considered to be a concern. Although levels of other anthropogenic impacts, including anchor damage, dynamite damage and fishing debris were low, high levels of household trash were observed at Site 5. The frequency of observed instances of household trash did vary but, with the exception of Site 10, trash was found on all sites. Aside from obvious aesthetic concerns for tourist divers, marine trash can also have severe impacts on the reef ecosystem itself. Some items such as batteries, detergents, chemicals and petrol bottles release extremely toxic chemicals into the water over time. These harmful substances can be ingested by living organisms and enter into the food chain. Some chemicals, known as persistent pollutants, cannot be broken down by organisms and so accumulate in their tissues. Such toxins bioaccumulate up the food chain until they reach top predators such as Groupers and Tuna. At these high concentrations the toxins threaten both the health of the animals themselves and the humans who catch and eat such species. Other types of trash, such as plastic bags, smother coral heads reducing their ability to catch food and limiting the availability of light for photosynthesis. Additionally trash floating in the water column can be mistaken for food by marine creatures and be ingested, leading to the death of the animal. It is therefore important to ensure proper waste management is carried out in the near vicinity to the reef as well as further inland.

6. RECOMMENDATIONS

This section is designed to provide recommendations regarding the future of the Ghost Town site and the potential for making part or all of the area a Marine Protected Area (MPA). The recommendations are based on the findings of both the quantitative transect surveys and the qualitative underwater visual assessments which were conducted to gain a broad scale view of the reef environment.

It has been shown worldwide that MPAs can have positive effects for both the ecosystem they are protecting and the local communities that rely on them. With this in mind the potential for creating a MPA at Ghost Town can be considered with three key perspectives in mind: species and ecosystem protection; fisheries and the livelihoods that depend on them; and potential income generation through tourism. These perspectives whilst all distinct in their own right also have many overlapping and complex interactions. Additionally what is right for one may well not be appropriate for another.

From the perspective of species protection the designation of the Ghost Town site as an MPA is positive. By removing anthropogenic stressors such as fishing pressure, populations of fish, corals and invertebrates within the MPA are likely to increase. As a general rule the larger the MPA the greater the benefit to the marine life within it. However, the designation will inevitably have an impact on the local fishing community which would lose a proportion of their fishing grounds within the boundaries of the MPA. In the short term this may be perceived as a negative, however many successful MPAs around the world have actually increased fishing catch in surrounding areas by allowing organisms within the MPA to attain a larger size and greater fecundity levels. The spill-over of organisms from within the MPA can, in the long term, boost fish stocks and ensure food security. Therefore the scale and protection of any proposed MPA at Ghost Town needs to be considered both in terms of the livelihoods of local people and the benefits to the ecosystem.

Similarly, the impact of an MPA for tourism is a complex issue. Tourists will pay to dive within an MPA because such areas are often designated to protect sites with the highest abundance and diversity of marine creatures. Therefore species protection is also important for tourism and for providing a desirable dive site. The income from tourism can in some instances help provide alternative livelihoods for members of the community and may further aid in reducing the impact of fishing pressure, as well as providing sustainable financing for the MPA. However, tourism can also have a negative impact on reef environments. Novice divers or high numbers of individuals can damage corals and affect the behaviour of fish, thus negating the aims of the MPA to protect the ecosystem and increase the abundance and diversity of organisms. Tourism potential must therefore be balanced with the requirements of the MPA to protect the reef environment. At this time, tourism in Sogod Bay is not at a level that would generate significant concern about impacts to the reef ecosystem should the MPA be declared. However, careful monitoring of tourist numbers visiting the MPA should take place in order to flag up any potential issues early and allow management actions to be taken.

The area surveyed during this assessment has good potential to be designated as an MPA. Figure 32 highlights some of the areas identified on the reef (see Section 5 – Discussion). Taking into account the considerations of species protection, fisheries and tourism, different areas have different levels of importance. The data suggest that areas of reef slope to the north, indicated with a yellow box, have the highest levels of species diversity and abundance and thus would benefit from protection. Furthermore this would benefit fisheries in the long term by boosting fish stocks. The reef wall and silty areas indicated in red and blue are prime sites for divers. The wall boasts a spectacular diversity of species and would be highly valued as a dive site. Furthermore, the silty area, presents an interesting ‘muck’ site for recreational divers. This area is home to a range of different and rare species not often found in other reef habitats (See Section 4 – Visual Assessment). The area indicated in green contains a mix of different topographies including coral bommies and patch reef. Whilst not the most important area for tourism or species preservation the area provides a unique habitat type that could conveniently be included in any designation with ease due to its proximity to the shore.

In order to maximise the potential for an MPA on this site any designation should consider each of the three perspectives and how each will affect the ecosystem and local community. Based purely on the biophysical data it is our recommendation to place an MPA that extends west from the shore at the southern edge of the river mouth to include the silt area and reef wall and then north along the coast to incorporate a proportion of the reef slope including survey Sites 1 and 3, identified as having some of the highest coral cover, species abundance and diversity (Figure 33). This recommendation does not take into account the loss of fishing grounds for local fishers which should be reviewed before any formal designation is made.

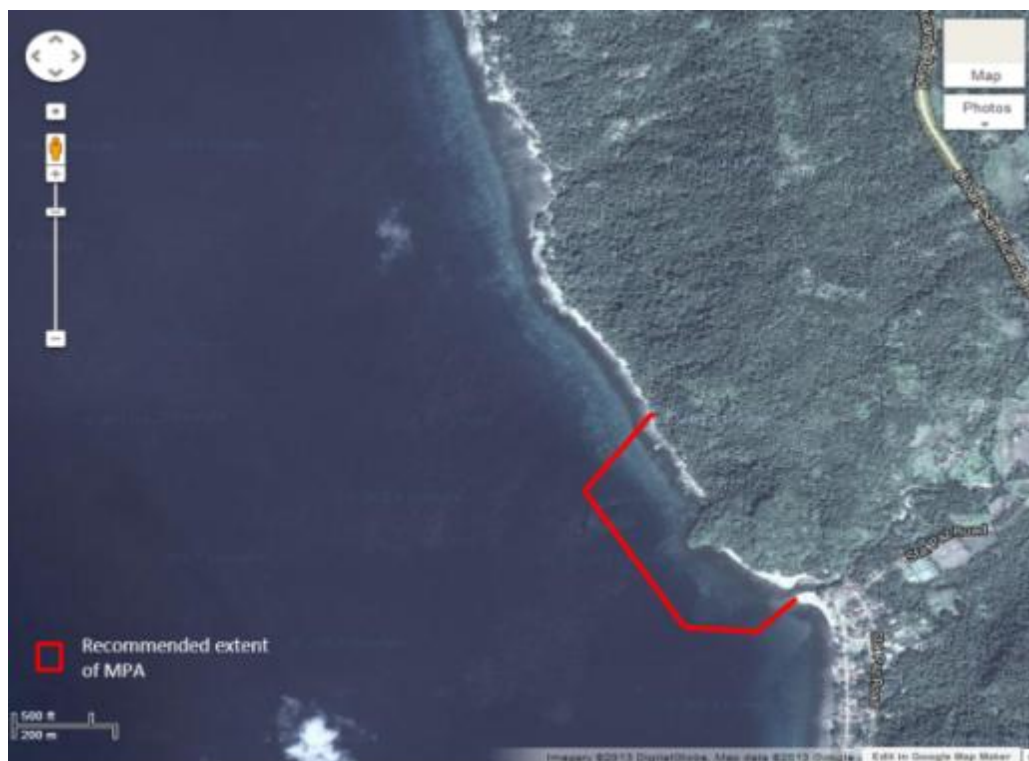


Figure 33 - Recommended MPA site at Santa Paz Norte. Image copyright Google.

This recommendation should not however be viewed as a holistic answer to the future of the Ghost Town site. Instead it should be used as the first step in opening dialogue between all relevant members of the local community, Municipal and Provincial Governments, and CCC. Consultation will be essential within the local community, particularly with the fishers whose livelihoods may be affected by the designation of an MPA. Many studies from existing MPAs have shown that without the involvement of the local community the effectiveness of a MPA is greatly reduced. This report should be used to stimulate discussion between all levels of the local community in order to allow individuals to voice concerns and raise issues with designating an MPA. By providing all of the community with the opportunity to have their say and to make recommendations a culture of ownership over the MPA will be produced, resulting in enhanced local support and compliance in the long term. If individuals are involved from the start they will have a vested interest in the effective running and management of the MPA. If an MPA is declared, an awareness campaign is essential to ensure that everyone is aware of the new MPA, its extent and the rules that they will be expected to follow. CCC can help at all levels of this process by providing educational support and conducting an IEC campaign to provide the community with information on how and why MPA can be successful.

It is also advised that a management committee be created to oversee the effective running of the MPA should it be established. The purpose of this committee would be to coordinate the collection of MPA fees, provide training and support to Bantay Dagat, oversee the enforcement of the MPA and be a link to the Municipal Government for matters concerning the MPA. Some of the primary considerations that need to be addressed in the establishment of an MPA will relate to enforcement. Just designating an MPA does not mean that there will be success in terms of conservation, fisheries or tourism. How the MPA will be enforced and by whom is very important. CCC can also help in this manner by providing training to individuals to become Bantay Dagat, though the management committee should give thought to how the Bantay Dagat will operate and how violations will be dealt with. Furthermore it will be important for the management committee to establish goals and objectives for the MPA based on the criteria of species protection, fisheries and tourism. Reviewing these objectives will help inform management decisions.

Support for the establishment of an MPA is available from both Municipal and Provincial government levels. It will be important to secure funding from the outset to aid in the establishment of the MPA. Demarcation buoys, and signage are essential tools for raising awareness and promoting enforcement. Securing sustainable financing will help to secure the long term future and success of an MPA.

If, after detailed consultation and evaluation, an MPA is designated at Ghost Town it will be important to ensure that monitoring of the effect of the MPA is conducted on a regular basis. Assessing temporal trends in abundance and diversity is crucial in determining how successfully the MPA is achieving its goals. The MPA Management Effectiveness Assessment Tool (MPA MEAT) is a national government programme designed to enable MPA manager to assess the effectiveness of their MPA. It uses detailed questionnaires and documentation to highlight limitations of MPA management and also suggests ways to improve it. CCC can provide further

support by conducting MPA assessments to provide the biophysical data required by the MPA MEAT. CCC can also provide training to allow the barangay to develop their own MPA monitoring team.

Overall the future of the Ghost Town site should be reviewed with consultation between all stakeholders involved. The site is highly suitable for an MPA but it should only be established with the support of the local community and with management and monitoring coming from both Barangay and Municipal levels.

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APPENDIX A: TARGET SPECIES LISTS

SUBSTRATES

Soft Coral	Sponge	Recently killed coral
Rock	Silt/mud	Rubble
Sand	Nutrient indicator algae	Other*
Hard Coral Lifeforms**:		
Acropora branching	<i>Acropora</i> encrusting	<i>Acropora</i> submassive
Acropora digitate	<i>Acropora</i> tabulate	Non- <i>Acropora</i> branching
Non-<i>Acropora</i> encrusting	Non- <i>Acropora</i> foliose	Non- <i>Acropora</i> submassive
Non-<i>Acropora</i> mushroom	<i>Heliopora</i> (blue coral)	<i>Millepora</i> (fire coral)
<i>Tubipora</i> (organ-pipe coral)		
*Other:		
Anemone	Corallimorph	Halimeda
Tunicate	Zoanthid	Gorgonian
Hydroids		

** If hard coral, also record target species

TARGET HARD CORALS

Brain small	Brain medium	Brain large
<i>Ctenactis echinata</i>	<i>Diploastrea heliopora</i>	<i>Echinopora</i>
<i>Euphyllia</i>	<i>Favia</i>	<i>Favites</i>
Foliose <i>Montipora</i>	<i>Galaxea</i>	<i>Goniopora</i> / <i>Alveopora</i>
<i>Herpolitha limax</i>	<i>Hydnophora</i>	<i>Lobophyllia</i>
Massive <i>Porites</i>	<i>Montipora digitata</i>	<i>Mycedium elephantotus</i>
<i>Pachyseris rugosa</i>	<i>Pachyseris speciosa</i>	<i>Pavona clavus</i>
<i>Pectinia lactuca</i>	<i>Plerogyra</i>	<i>Pocillopora</i> small
<i>Pocillopora</i> medium	<i>Pocillopora</i> large	<i>Polyphyllia talpina</i>
<i>Porites cylindrica</i>	<i>Porites nigrescens</i>	<i>Porites rus</i>
<i>Seriatopora hystrix</i>	<i>Tubastrea micrantha</i>	<i>Turbinaria</i>
Upside-down Bowl		

Target Invertebrates

Feather duster worms	Christmas tree worms	Flatworms
Crabs	Shrimps	Banded coral shrimp
Lobsters	Nudibranch	Abalone
Conch	Cowrie	Triton's trumpet
Cone shell	Drupella	Top shell
Other gastropod	Giant clam	Octopus
Cuttlefish	Squid	<i>Acanthaster planci</i>
<i>Linkia laevigata</i>	<i>Culcita novaeguineae</i>	<i>Protoreaster nodosus</i>

<i>Choriaster granulatus</i>	Feather star	Brittle star
Long spine sea urchin	Pencil urchin	Collector urchin
Prickly redfish	Pinkfish	Greenfish
Other sea cucumber	Giant Clam	

Target Fish

Common Name	Latin Name	Visayan Name
Angelfish	Pomacanthidae	Adlo
Barracuda	Sphyraenidae	
Blenny	Blenniidae	
Butterflyfish*	Chaetodontidae	Alibangbang
Cardinalfish	Apogonidae	
(Damsel fish)	(Pomacentridae)	
Anemonefish	<i>Amphiprion</i> sp.	
Sergeant Damsel fish	Pomacentridae	
Emperor	Lethrinidae	Katambak
Filefish	Monacanthidae	Ilak
Fusilier	Caesionidae	Dalagang bukid
Goatfish	Mullidae	Timbongan
Goby	Gobiidae	
Groupers	Serranidae	Lapu-lapu
Flagtail Grouper	<i>Cephalopholis urodeta</i>	
Honeycomb Grouper	<i>Epinephelus</i> sp.	
Humpback Grouper	<i>Cromileptes altivelis</i>	
Lyretail Grouper	<i>Variola louti</i>	
Peacock Grouper	<i>Cephalopholis argus</i>	
Jack/Trevally	Carangidae	Talakitok
Lionfish	Scorpaenidae	
Lizardfish	Synodontidae	
Moorish Idol	<i>Zanclus cornutus</i>	Sanggowanding
Moral Eel	Muraenidae	
Parrotfish	Scaridae	Mulmul
Pipefish	Syngnathidae	
Porcupinefish	Diodontidae	
Pufferfish	Tetraodontidae	
Rabbitfish	Siganidae	Kitong
Virgate rabbitfish	<i>Siganus virgatus</i>	
Ray	Rajiformes	
Sandperch	Pinguipedidae	
Scorpionfish/Stonefish	Scorpaenidae	
Snapper	Lutjanidae	Maya-maya
Black and White Snapper	<i>Macolor macularis</i>	
Checkered Snapper	<i>Lutjanus decussatus</i>	

Two Spot Snapper	<i>Lutjanus biguttatus</i>	
Spade/Batfish	Ephippidae	
Spinecheeks	Nemipteridae	Silay
Twoline Spinecheek	<i>Scolopsis bilineatus</i>	
Squirrelfish/Soldierfish	Holocentridae	
Surgeonfish	Acanthuridae	Indangan
Unicornfish	<i>Naso</i> sp.	
Sweeper	Pempheridae	
Sweetlips	Haemulidae	Lipti
Toby	Tetraodontidae	
Triggerfish	Balistidae	Pakol
Trunk/Box/Cowfish	Ostraciidae	
(Wrasse)	(Labridae)	
Crescent Wrasse	<i>Thalassoma lunare</i>	
Humphead Wrasse	<i>Cheilinus undulatus</i>	
Red Breasted Wrasse	<i>Cheilinus fasciatus</i>	

***Target Butterflyfish**

Vagabond Butterflyfish	Spot-Banded Butterflyfish	Merten's Butterflyfish
Klein's Butterflyfish	Dot and Dash Butterflyfish	Chevroned Butterflyfish
Latticed butterflyfish	Singular Bannerfish	Threadfin Butterflyfish
Eastern Triangle Butterflyfish	Longfin Bannerfish	Teardrop Butterflyfish
Redfin Butterflyfish	Masked Bannerfish	Spot-Nape Butterflyfish
Pyramid Butterflyfish	Pennant Bannerfish	Lined Butterflyfish
(Big) Long-Nosed Butterflyfish	Racoon Butterflyfish	Yellow-Dotted Butterflyfish
Copper-Banded Butterflyfish	Dotted Butterflyfish	Black-Backed Butterflyfish
Orange-Banded Butterflyfish	Ovalspot/Mirror Butterflyfish	Spot-Tail Butterflyfish
Humphead Bannerfish	Bennett's/Eclipse Butterflyfish	Panda Butterflyfish
Asian Butterflyfish	Bluespot Butterflyfish	Eight-Banded Butterflyfish
Burgess' Butterflyfish	Highfin Coralfish	Reticulated Butterflyfish
Ornate Butterflyfish	Two-Eyed Coralfish	Saddled Butterflyfish
Meyer's Butterflyfish	Brown Banded Butterflyfish	Spotted Butterflyfish
Speckled Butterflyfish	Ocellate Coralfish	Yellowtail Butterflyfish
Pacific Double-Saddle Butterflyfish		

APPENDIX B - SPECIES ABUNDANCE GRAPHS

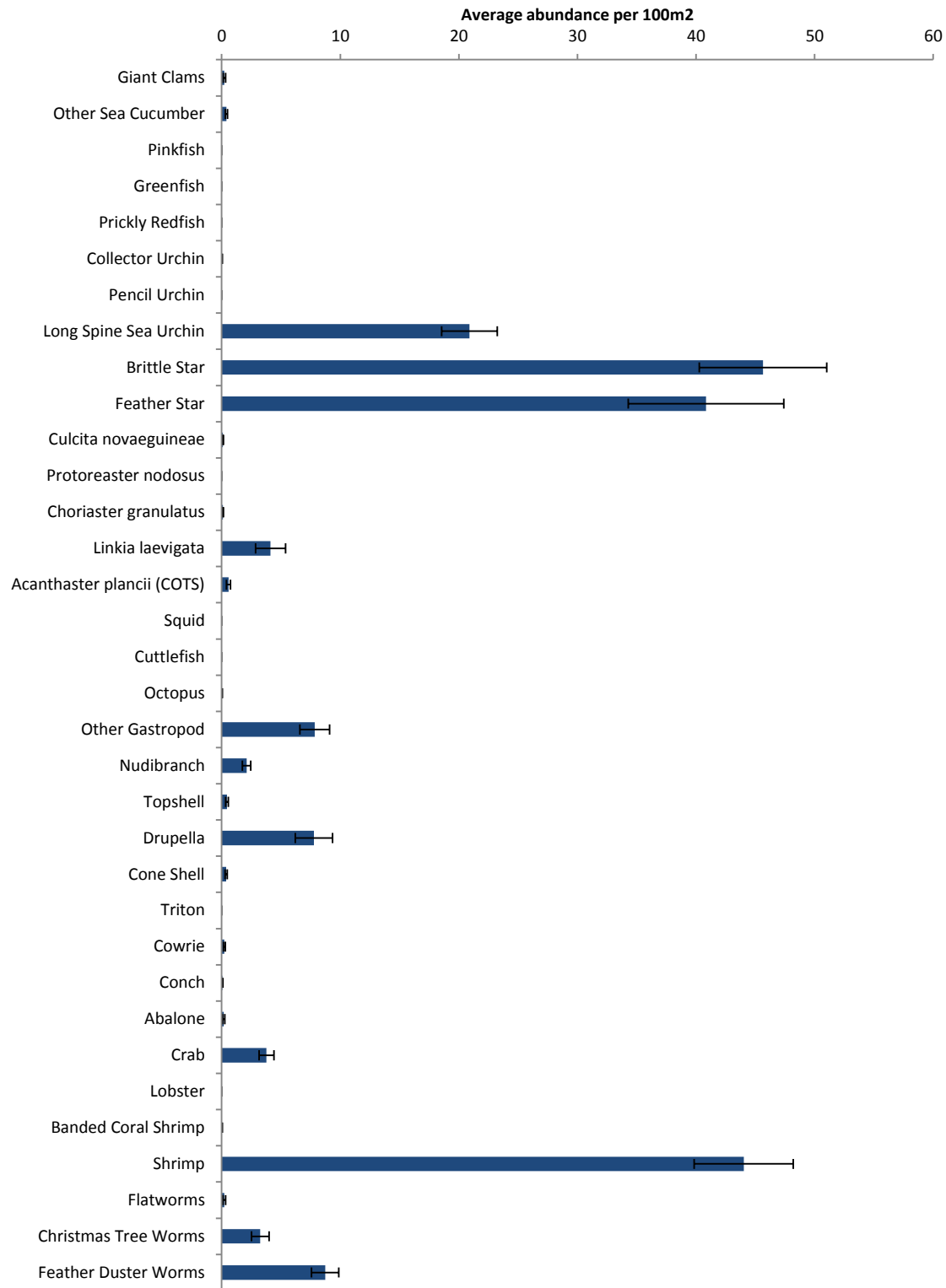


Figure 34 - Average abundance of target invertebrates across all sites. Data are mean average per replicate, error bars show standard error of the mean.

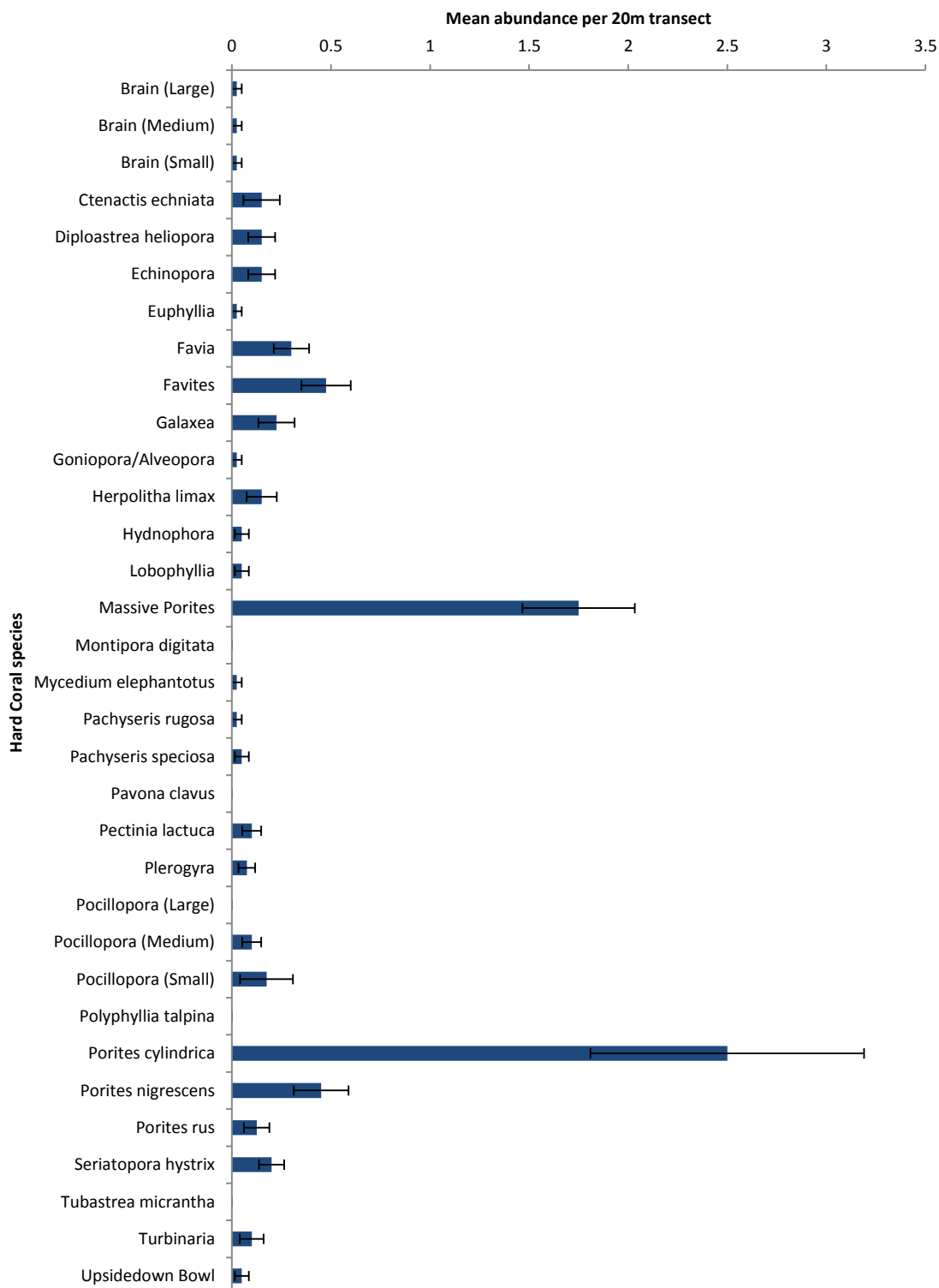


Figure 35 - Average abundance of target hard coral species across all sites. Data are mean number of points per 20m transect, error bars show standard error of the mean.

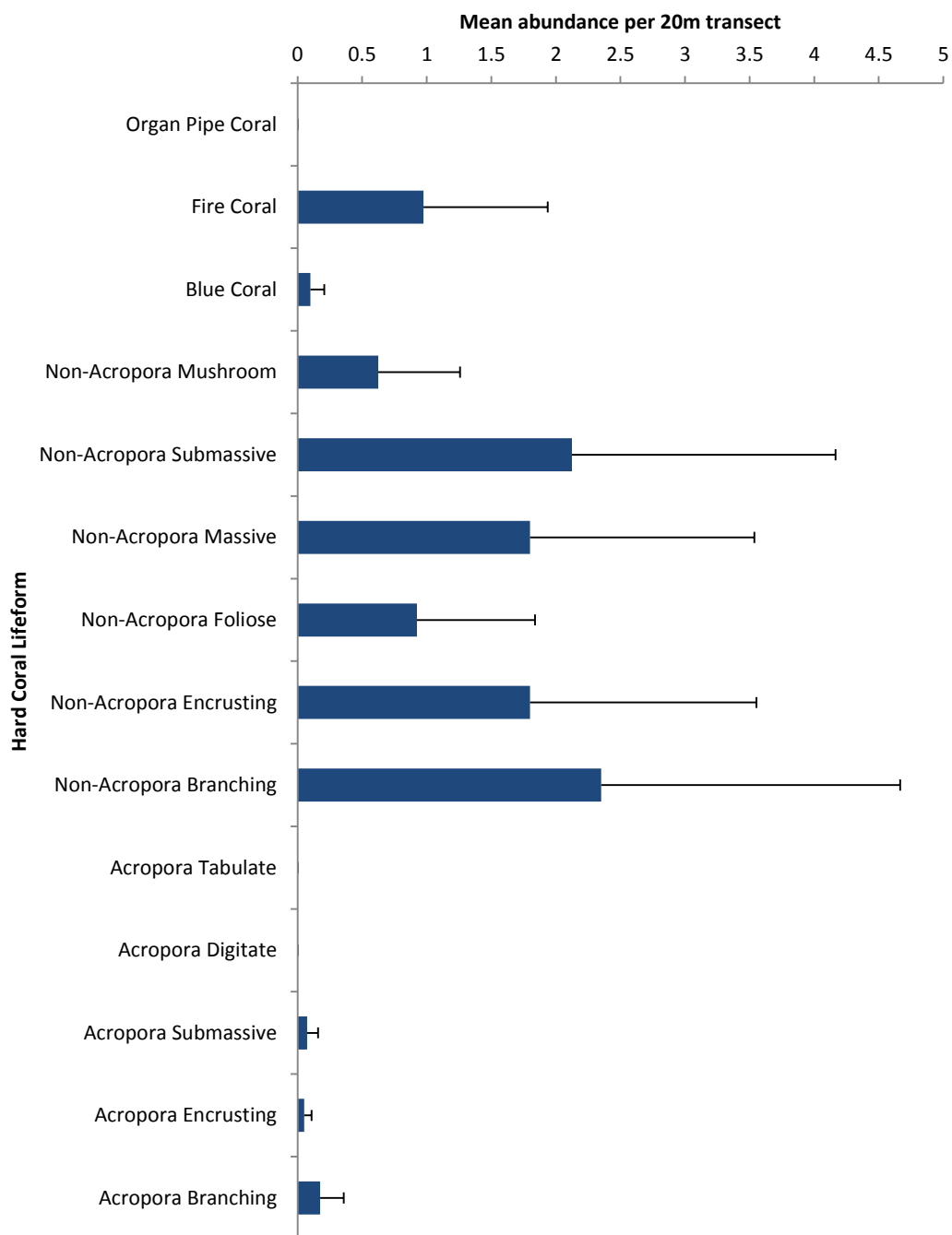


Figure 36 - Average abundance of hard coral lifeforms across all sites. Data are mean number of points per 20m transect, error bars show standard error of the mean.