

Coral Cay Conservation Marine Protected Area Assessment Report

Santa Paz Sur MPA “Anna’s Garden”



Santa Paz Sur
San Francisco, Southern Leyte, the Philippines

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EXECUTIVE SUMMARY

- Coral Cay Conservation conducted an assessment of the reef fish, invertebrates, substrate and anthropogenic impacts in and around the Santa Paz Sur MPA, also known as Anna's Garden, between January and March 2013.
- A modified Reef Check protocol was used to survey 8 transects, each containing four 20m replicates. Four transects were placed inside and 4 outside the MPA equally divided between 12m and 6m depths.
- Overall, fish abundance was not significantly higher inside the MPA and at 12m significantly more fish were recorded outside the MPA.
- Invertebrates were significantly more abundant inside the MPA overall as well as at 12m.
- Generally crown of thorns seastars (*Acanthaster planci*) were observed in low numbers except for in a small area at 6m outside of the MPA to the south, where a high concentration was observed.
- Hard coral was more abundant outside the MPA and sand was more abundant inside the MPA.
- Commercially important species, such as Groupers, Sweetlips, Giant Clams, Tritons Trumpet and species of Sea Cucumber, were observed in low abundances or were absent wholly from the entire area that was assessed.
- Damaging impacts such as household trash, discarded fishing gear and anchor damage were observed in very low frequency or not observed at all.
- Low abundances of commercially important species both in- and outside the MPA is indicative of unsustainable fishing pressure and of poaching inside the MPA.
- It is recommended that management of the Santa Paz Sur MPA be assessed using the MPA Management Effectiveness Assessment Tool (MEAT) and steps to improve management taken. These should include active enforcement of the MPA and prosecution of offenders, as well as an information, education and communication (IEC) campaign to raise awareness and understanding of the potential benefits that the MPA can provide to the local stakeholders.

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 Sur and the Municipality of San Francisco for facilitating the MPA assessment. In particular we would like to acknowledge the cooperation of Rodrigo Baluran, Barangay Captain of Santa Paz Sur, 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 MPA 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
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 & alleviate poverty through the protection, restoration & management of coral reefs & 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. 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. 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.

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 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.”

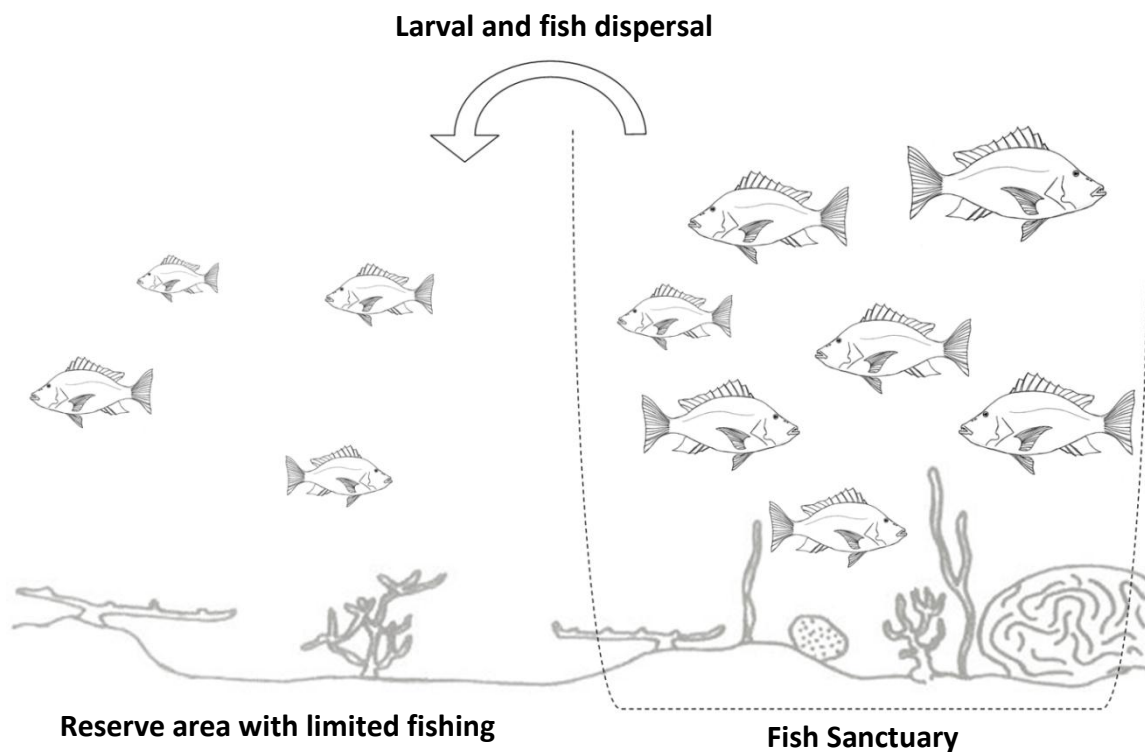


Figure 1 – Schematic diagram of MPA functioning. Protected fish in the MPA grow larger and produce more offspring, this leads to ‘overspill’, increasing fish numbers outside the MPA. In addition, the corals inside the MPA are not disturbed by direct human impacts.

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 spillover and larval export (Figure 1).

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 have 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 spillover from these MPAs remains elusive but the increased number and size of fish within the reserve make it likely that the MPA is a source for net larval export, which can aid 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).

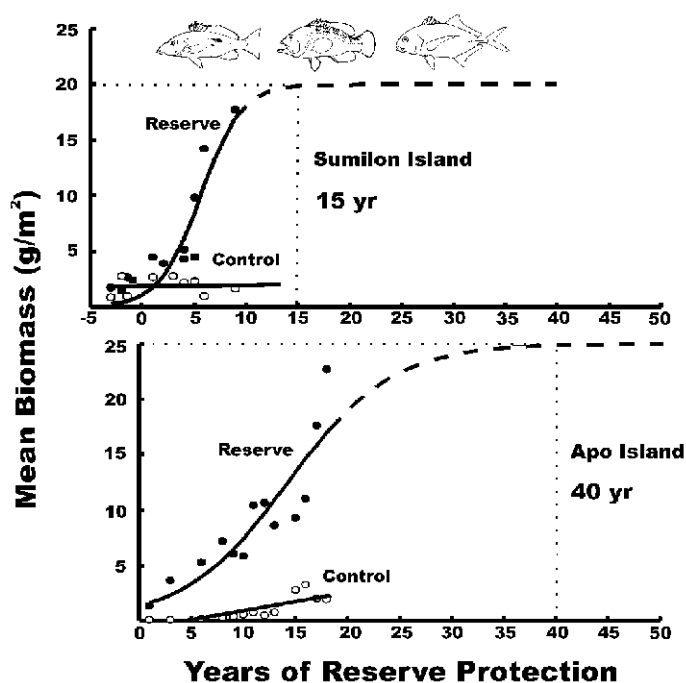


Figure 2 - observed and projected increase in mean biomass of commercially important species of fish inside the MPAs at Apo Island and Sumilon Island.
Figure from: Russ and Alcala (2004).

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 (Calumpong *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 (Calumpong *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.

1.3.2 - Santa Paz MPA

The Santa Paz MPA, also known as Anna's Garden, was established in 2009 and covers 4.4 hectares. It is located in the Municipality of San Francisco, in the waters of the barangay Santa Paz Sur. The barangay is home to just under 600 people, of which 25 are fishers. The boats used by the local fisherfolk are all non-motorized, except one. The MPA is to the south of the village (Figure 3). There is a fisherfolk lodge just to the north of the MPA that is used to store gear. Currently, the MPA infrastructure is virtually non-existent but buoys marking the MPA boundaries were installed just prior to this assessment (Table 1). Fishing takes place in the area surrounding the MPA and on one occasion the CCC survey team witnessed poaching inside the MPA. Illegal fishing inside the MPA was noted to be an ongoing problem (Barangay Captain, Pers. Comm.).

Table 1 – Summary of MPA infrastructure at Santa Paz Sur MPA

MPA Infrastructure	Present?
Trained Bantay Dagats	X
Permanent Bantay Dagat presence	X
MPA guardhouse	X
Demarkation buoys	✓
Patrol boat	X
Bantay Dagat gear (flashlight, fins, mask, etc.)	X
User fees collected	X

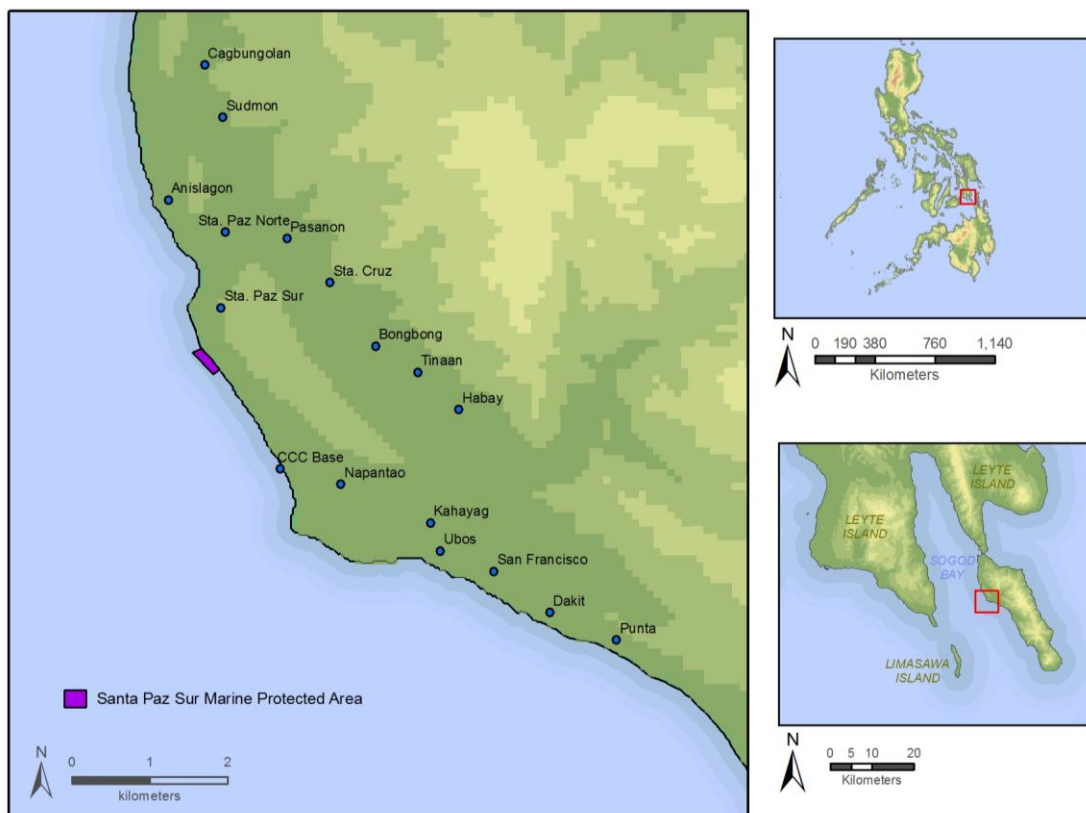


Figure 3 – Map showing the location of Santa Paz Sur Marine Protected Area

2. METHODS

2.1 Biophysical Survey

The assessment of the 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 analyzed 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, both inside and outside the MPA (Figure 4). 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.

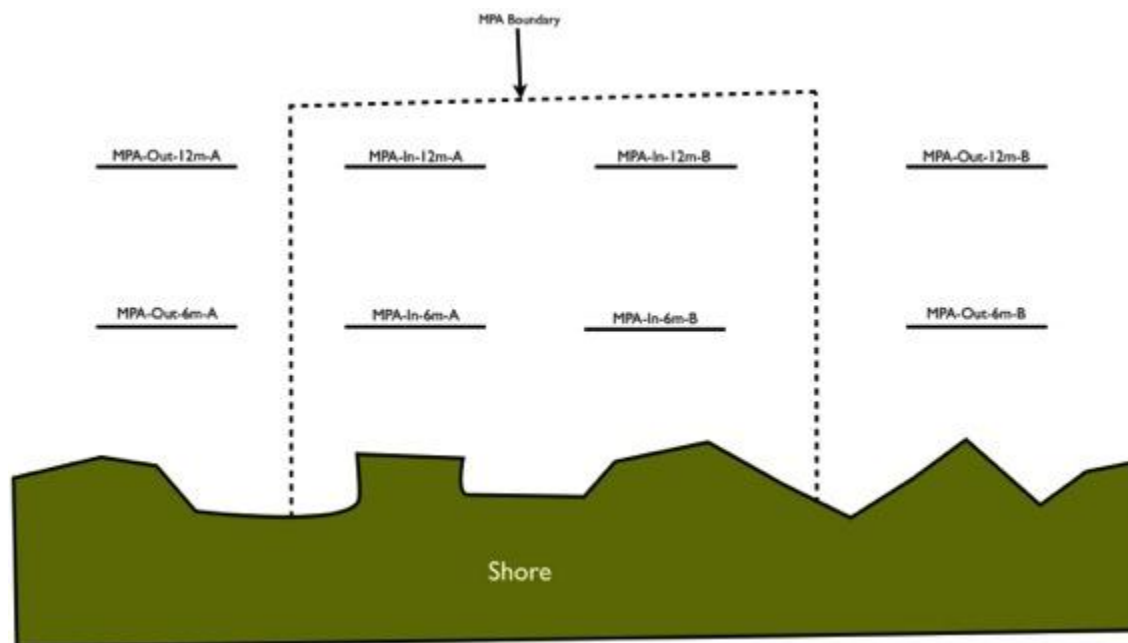
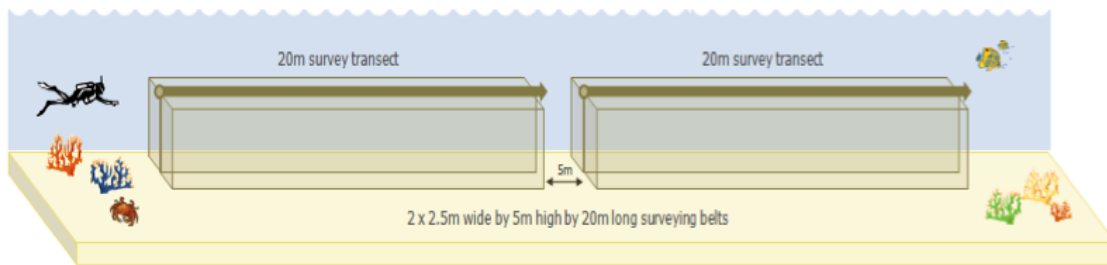


Figure 4 – Survey plan of the MPA assessment.
Each transect was 100 meters long and is divided into 4 replicates.

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. Three families of commercially important fish were also recorded by size: Groupers (Lapu Lapu, Serranidae), Parrotfish (Mulmul, Scaridae) and Snappers (Maya Maya, Lutjanidae).

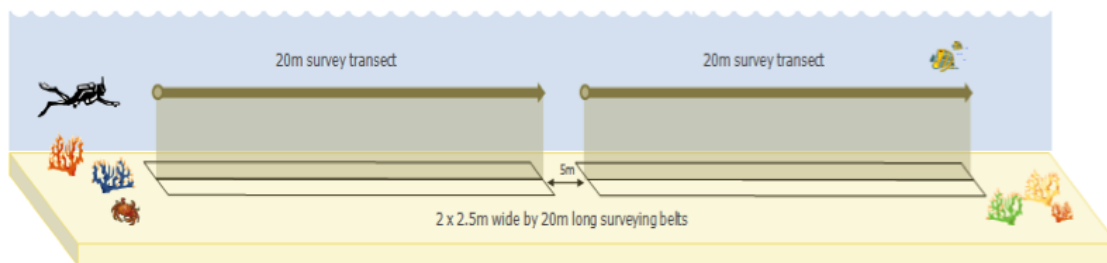
Fish data was recorded along a 'belt' transect, where fish were counted within an imaginary 5x5x5m box along the four 20m replicates (Figure 5). Surveying was carried out by two divers swimming slowly side by side along the transect and counting the indicator fish. The divers stopped every 5 metres and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



*Figure 5 – 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. The divers recorded invertebrates 2.5m either side of the transect line (Figure 6). Divers looked in holes and under overhangs to look for organisms such as lobsters, sea urchins or other cryptic species.

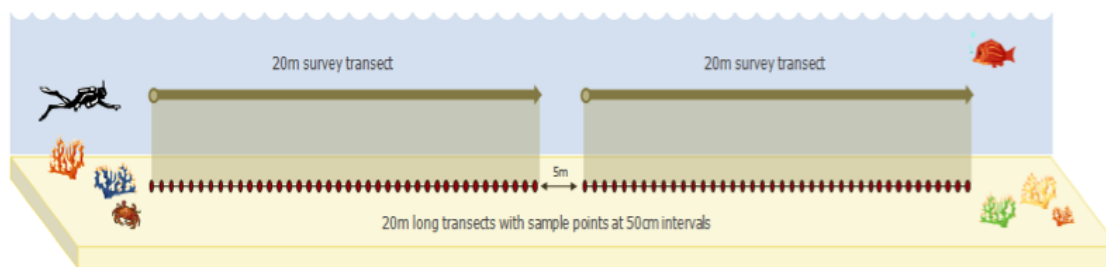


*Figure 6 – Survey method for recording invertebrates.
The diagram shows 2 of the 4 replicates in a 100m transect.*

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 7). 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 7 – 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. 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 belt transect was treated as an independent replicate. This produced n=16 inside the MPA and n=16 outside the MPA, when not considering depth. At each of the survey depths, 6m and 12m, there were n=8 replicates inside and outside the MPA. To test for statistically significant differences between inside and outside the MPA, Mann-Whitney U 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.

3. RESULTS

The assessment of the Santa Paz Sur MPA was conducted between the 31st of January 2013 and the 1st of March 2013. It was conducted over 24 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 30.0°C. The water temperature was, on average, 27.0°C at the surface and 26.6°C at 3m as well as at 10m. Estimated horizontal visibility was 23m on average.

3.1 - Fish

Overall mean fish abundance inside the MPA was 51.0 ± 4.6 per 500m³ (mean $\pm$ SE). Outside the MPA, the overall mean fish abundance was 64.1 ± 6.1 per 500m³ (Figure 8A). Although the overall mean fish abundance was lower inside the MPA, the difference was not statistically significant. At 12 metres overall fish abundance was found to be significantly higher outside the MPA (inside: 50.3 ± 7.67 per 500m³, outside: 79.6 ± 9.0 per 500m³, $p=0.03$) (Figure 8A). At 12 metres, Snappers were found to be significantly ($p<0.01$) more abundant outside the MPA (6.0 ± 1.5 SE per 500m³) compared to inside (1.4 ± 0.3 SE per 500m³). On several occasions a school of fusiliers was observed, this occurred more frequently outside the MPA. However, these sightings were highly variable and did not return a significant result from the MWU test. There was no significant difference between the fish abundance at 6 metres.

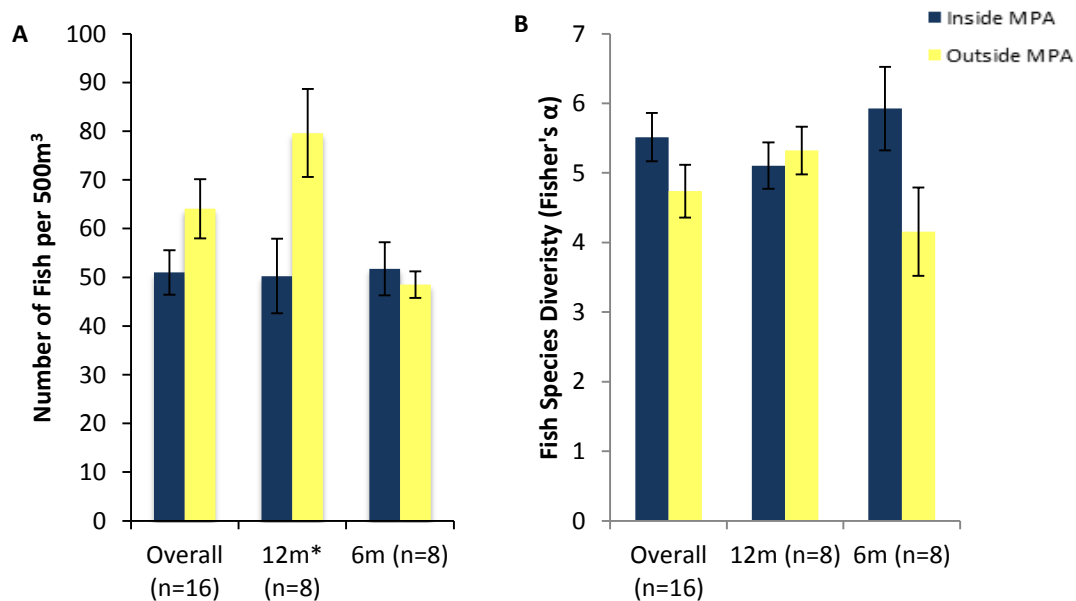


Figure 8 – Average abundance (A) and diversity (B) of fish inside and outside the MPA. Data are mean average per replicate, error bars indicate standard error of the mean. * = significant difference ($p<0.05$).

The diversity of the fish that were observed inside and outside the MPA, while generally higher inside the MPA, was not significantly different (Figure 8B). There were notable absences of fish species and families. Inside and outside the MPA no Sweetlips (Lipti), Emperors (Katambak) or Humphead Wrasse were observed. Other families were observed only in low numbers, these included Groupers (Lapu-lapu), Snappers (Maya-maya) and Jacks (Talakitok). The Parrotfish (Mulmul) were also generally small in size, roughly 90% were smaller than 20 cm and none were bigger than 30 cm. No turtles, sharks, or sea snakes were recorded but 1 ray was observed outside the MPA.

3.2 - Invertebrates

Inside the MPA the average overall abundance of invertebrates was 168.3 ± 15.8 per 100m^2 (Figure 9A). Outside the MPA the average overall abundance of invertebrates was 117.7 ± 13.1 per 100m^2 (Figure 9A), which was significantly lower compared to inside the MPA ($p < 0.01$). The largest differences were observed in the abundance of Feather Stars (inside: 48.0 ± 12.9 per 100m^2 , outside: 16.1 ± 4.0 per 100m^2 , $p = 0.29$) and Long Spine Urchins (inside: 22.1 ± 3.8 per 100m^2 , outside: 9.3 ± 2.2 per 100m^2 , $p < 0.01$). At 12 metres a similar trend was found; 207.4 ± 19.6 invertebrates were recorded per 100m^2 inside the MPA and 125.3 ± 22.1 invertebrates observed per 100m^2 outside the MPA ($p < 0.01$) (Figure 9A). At 6 meters there was no significant difference in the abundance between inside and outside the MPA. Appendix B shows the overall abundance for each target fish species recorded both inside and outside the MPA.

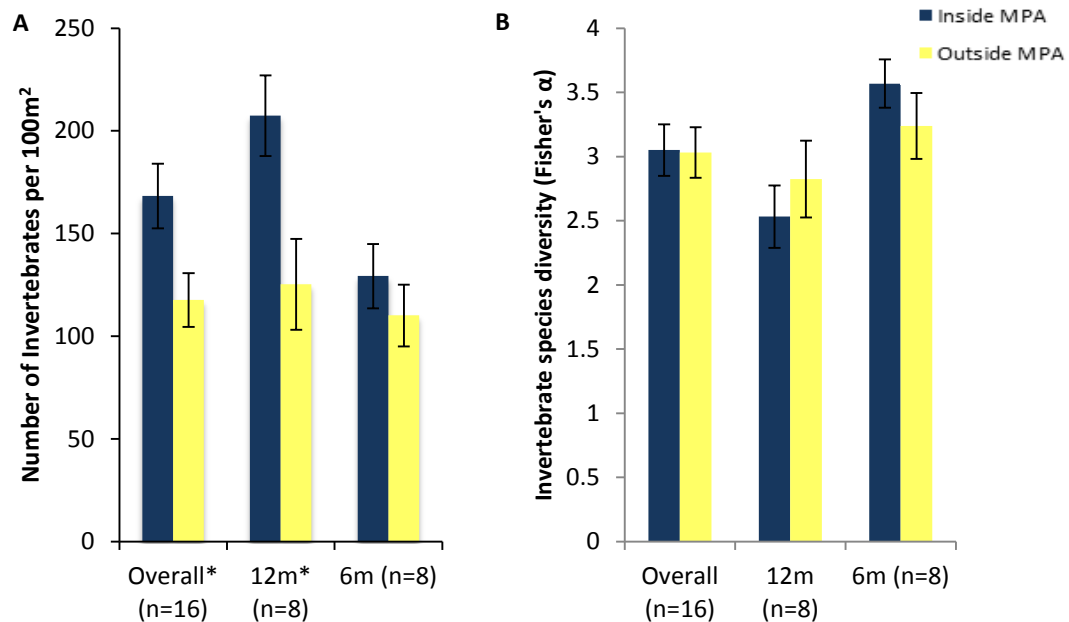


Figure 9 – Average abundance (A) and diversity (B) of invertebrates inside and outside the MPA. Data are mean average per replicate, error bars indicate standard error of the mean. *=significant difference ($p < 0.05$)

There were no significant differences in the diversity of invertebrates observed inside the MPA compared to outside the MPA (Figure 9B). Several species and families were either completely absent or only seen in very low numbers. These include target sea cucumbers (*Holothuria edulis*, *Thelenota ananas*, *Stichopus chloronotus*), Triton's Trumpet (*Charonia tritonis*) and cephalopods. Although Giant Clams (*Tridacna* sp.) were recorded inside and outside the MPA, 6 and 11 in total respectively, they were generally small (11-20cm). Crown of Thorns sea stars (CoTs) were observed in low numbers, generally 1-3 per 100m². However, at 6 metres on the south of the MPA 30 CoTs were recorded in a small area (<100m²) and more were observed outside beyond the survey area.

3.3 - Substrate

Inside the MPA the most commonly recorded substrate category was rock, followed by hard coral and sand (Figure 10A). Outside the MPA, hard coral was most common, followed by rock and 'other' (see Appendix A for list of organisms that fall in the category 'other').

When considering the entire survey area, the abundance of hard coral was significantly higher outside the MPA compared to inside ($p=0.04$), 15.5 ± 1.6 points per replicate and 10.8 ± 1.2 points per replicate, respectively (Figure 10A). On the 12m replicates, hard coral was also significantly more common outside the MPA compared to inside ($p<0.01$), 15.3 ± 1.4 points per replicate and 7.3 ± 1.0 points per replicate, respectively (Figure 10B). On the 6m replicates there was no significant difference between the hard coral inside and outside the MPA. The area inside the MPA does contain substantial and healthy hard coral cover but is characterized by plentiful patches of sand and coral rubble. There was significantly more sand inside the MPA compared to the area outside the MPA (overall: $p<0.01$, at 12m: $p<0.01$ and at 6m: $p=0.01$). Recently Killed Coral or Nutrient Indicator Algae were observed in relatively low abundances (Figure 10A).

Inside the MPA 19 different target species of hard coral were recorded. Outside the MPA 24 target species of hard coral were recorded (see Appendix C). The most commonly recorded hard coral category, both inside and outside the MPA, was Non-*Acropora*, Massive. The most commonly recorded target species of hard coral, both inside and outside, was *Porites cylindrica*. Inside, massive *Porites* sp. and *Porites nigrescens* were also relatively abundant. Outside, *Hydnophora* sp. and *Ctenactis echinata* were commonly recorded.

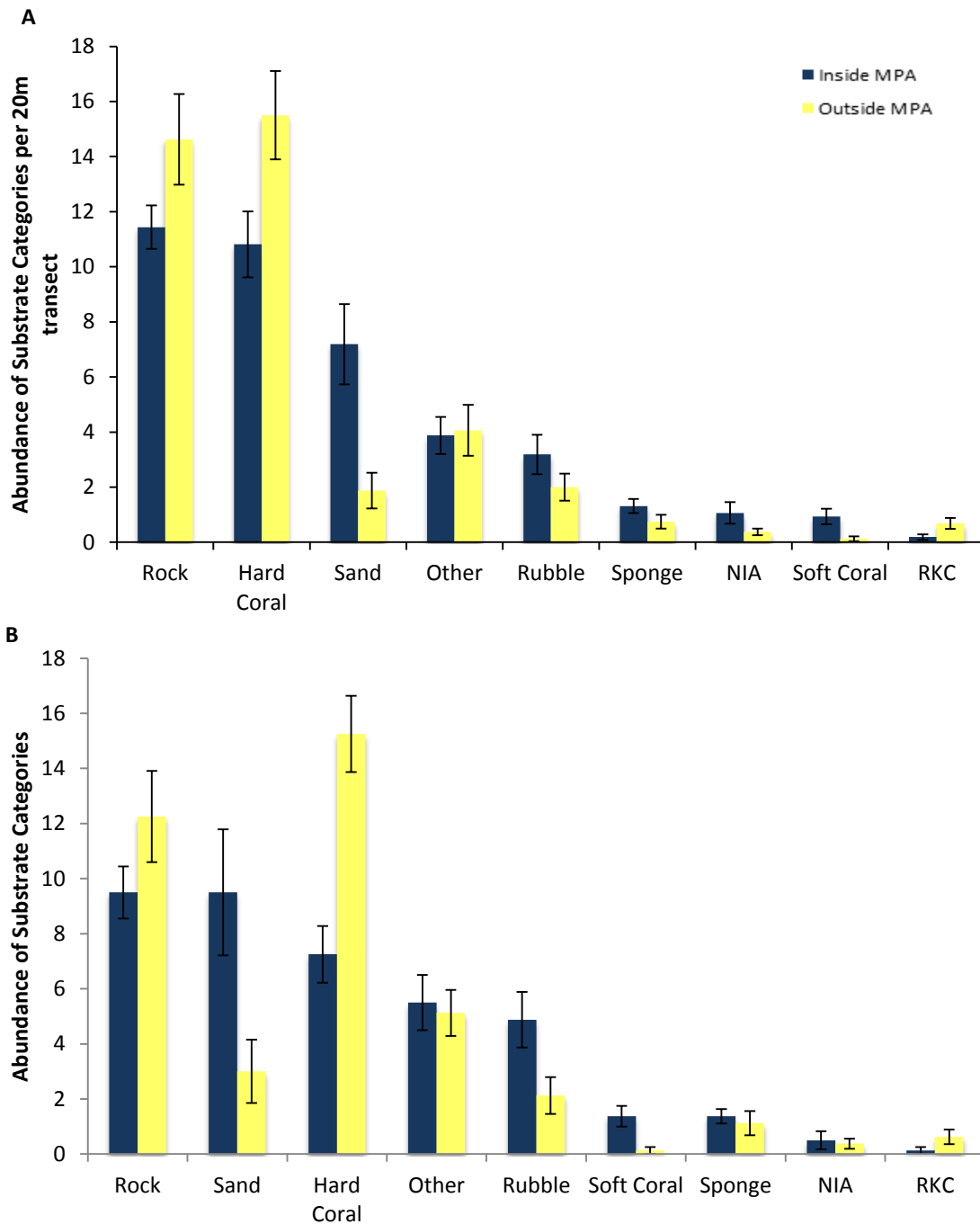


Figure 10 – Average abundance of substrate categories inside and outside the MPA overall (A) and at 12m only (B). NIA = nutrient indicator algae, RKC = recently killed coral. Data are mean average per replicate, error bars indicate standard error of the mean.

3.4 - Anthropogenic Impacts

Anthropogenic impacts were low both inside and outside the MPA. No boat or anchor damage was observed and there was no evidence of dynamite fishing. Very little trash

was found on the reef. Inside the MPA general household trash was found to a level of 0.5 ± 0.2 per replicate on the impact scale and 0.4 ± 0.1 per replicate outside the MPA. Trash categorized as discarded or lost fishing gear was recorded inside the MPA only on 2 instances. Outside the MPA fishing trash was recorded 3 times.

Coral predation was more commonly observed outside the MPA compared to inside the MPA, 2.1 ± 0.3 and 1.4 ± 0.3 , respectively. Most of this predation was attributed to *Drupella* sp., a snail that feeds on coral polyps. The area south of the MPA where a high number of CoTs were observed showed evidence of their predation, with 15 instances of CoTs predation recorded. This transect was also where the most widespread coral bleaching was recorded, although this was still at a low overall level of 0.6% (± 0.2 , $n=4$) of the hard coral colonies bleached per 100m². No coral disease was observed throughout the assessment.

4. Visual Assessment

The following pages present images taken by the CCC survey team during the course of the survey work in Santa Paz MPA.



Figure 11 – Santa Paz MPA



Figure 12 – Coral reef inside the Santa Paz MPA at 6m



Figure 13 – Coral reef inside the Santa Paz MPA at 6m



Figure 14 – Coral reef inside the Santa Paz MPA at 12m



Figure 15 – Coral reef inside the Santa Paz MPA at 12m

Figures 16-22 show species of particular interest, recorded within the MPA, including species considered attractive to divers and other tourists.



Figure 16 – Golden Spadefish, Platax boersii



Figure 17 – Warty Frogfish, *Antennarius maculatus*



Figure 18 – Anna's Chromodoris, *Chromodoris annae*



Figure 19 – Tomato Anemonefish, *Amphiprion frenatus*

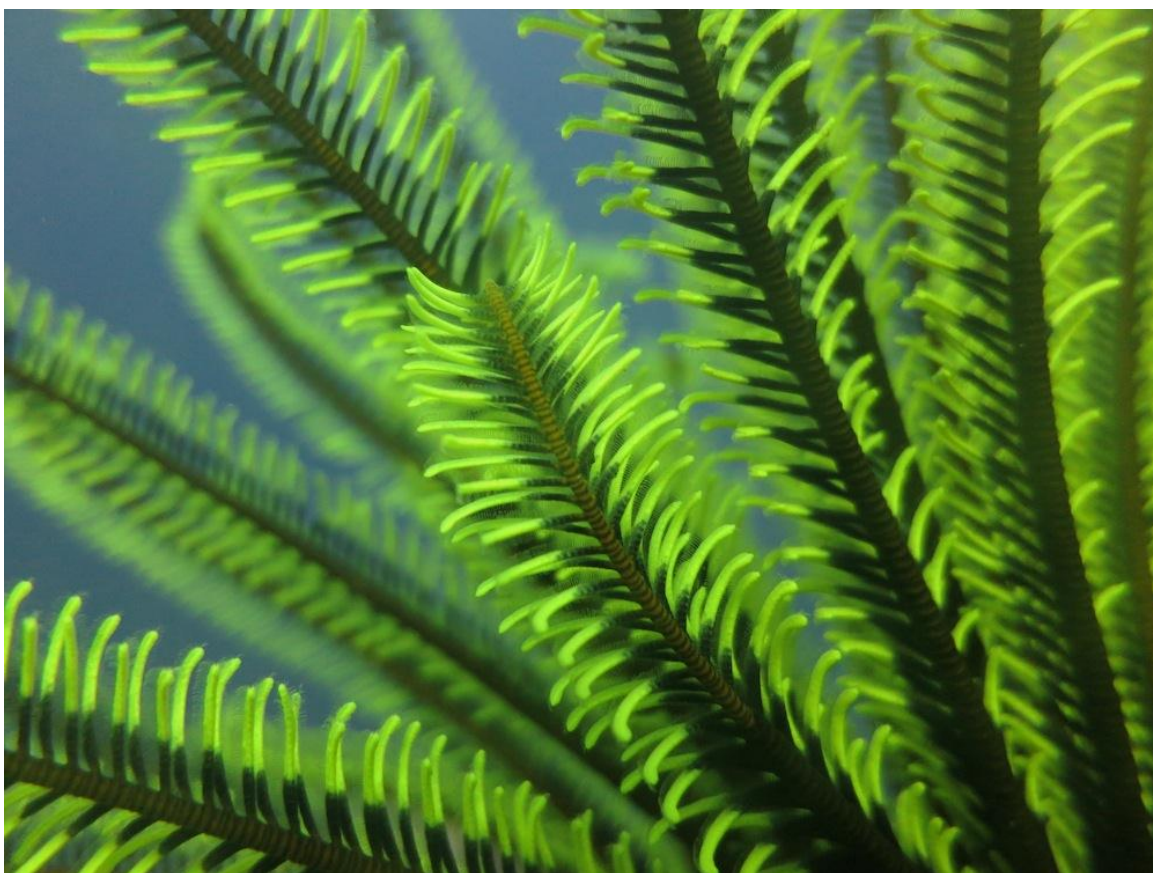


Figure 20 – Feather star, *Crinoidea*



Figure 21 – Clack Spotted Egg Cowrie, Calpurnus verrucosus



Figure 22 – Squat Shrimp, Thor amboinensis



Figure 23 – A CCC survey team collects data within the Santa Paz MPA

5. DISCUSSION

The assessment of the area inside the Santa Paz Sur MPA and the direct vicinity gave the general impression of a reasonably healthy reef ecosystem. Nevertheless, the data revealed some cautionary trends that will need careful consideration in future management of the MPA and the surrounding area. In this section, trends that were found in the collected data are discussed and recommendations for future management of the area are given.

5.1 – Fish

Overall trends in abundance and diversity of fish revealed no significant differences between the areas inside the MPA compared to outside the MPA. However, the data collected at 12m did reveal a significantly higher abundance of fish outside the MPA. This higher abundance is mainly caused by recorded numbers of Fusiliers and Snappers. Fusiliers are a pelagic, schooling fish that were observed on several occasions in schools ranging from 20-50 individuals. These highly mobile species were, probably by chance, observed more frequently outside the MPA, reflected by the difference not being statistically significant and the high standard error of the mean. The higher abundance of Snappers outside the MPA, however, was found to be significant. These differences are attributable to sightings on Checkered Snapper and Two-Spot Snapper. Closer investigation of the Snapper data revealed that they were significantly more abundant at 12m. It is possible that these species of Snapper prefer habitat with high hard coral abundance at depths of more than 10m.

The most noteworthy result of this MPA assessment was the absence or low abundance of large predatory fish, namely Groupers, Sweetlips, Emperors, Humphead Wrasse and Jacks. Snappers, although more abundant than these other families and species, were still recorded relatively low numbers. This trend will be discussed further in section 5.4.

5.2 – Invertebrates

The higher abundance of invertebrates inside the MPA compared to the area outside the MPA was largely due to the high counts of Long Spine Urchins (*Diadema sp.*) and Feather Stars (Crinoidae). Feather Stars were especially prolific in areas with low hard coral abundance, i.e. inside the MPA at 12m. Feather Stars provide an excellent microhabitat for numerous species of invertebrates such as shrimp and squat lobster, as well as fish such as the Ornate Ghost Pipefish, a species much sought after by recreational divers.

The high occurrence of Long Spine Urchins inside the MPA bears some cause for concern. Long Spine Urchins feed on algae that are also the preferred food for herbivorous fish species of Parrotfish and Surgeonfish. High numbers of Long Spine Urchins could indicate that competition for these algae from the fish has been reduced which has allowed the Urchins to increase in numbers. This trend will be discussed further in section 5.4.

Several of the species that were found in low numbers or were absent entirely, are targeted for consumption. Many of these species, such as the Triton's Trumpet and Giant Clam, are important species in maintaining the stability of the coral reef ecosystem. These two specific examples are known to be instrumental in suppressing populations of CoTs. Possible consequences of the low abundances of these species will be discussed further in section 5.4.

Although CoTs were observed in low numbers in most of the surveyed area, they were observed in higher number in a small area outside the MPA, to the south. Only in this area is the abundance of CoTs considered to be at an unsustainable, or outbreak, level. Research by the Australian Institute of Marine Science has shown that survival of CoTs larvae increases dramatically in response to higher abundances of their food source phytoplankton. Phytoplankton can peak in response to runoff rich in fertilisers and other pollutants. The area where the CoTs outbreak was observed is close to where a freshwater stream flows into the sea. The strong rains of the previous months (December and January) may have resulted in increased nutrient-rich run-off from the land at this location, leading to an increase in abundance of phytoplankton and therefore higher numbers of CoTs. The CoTs outbreak is relatively small and localized and is unlikely to pose a threat to the reef. However, monitoring of the developments in this area is recommended and as it is shallow (<6 metres), this can be done fairly simply while snorkeling.

5.3 – Substrate

The differences between the substrates inside and outside the MPA were attributable to natural distribution. The deeper area inside the MPA is more sandy thus less suitable for hard coral to settle. The shallow area inside the MPA is characterized by large areas of hard coral interspersed with patches of sand and coral rubble. The combination of hard coral with large areas of sand and smaller patches of coral rubble could potentially mean that a more diverse range of habitats is available inside the MPA.

Indicators of hard coral health, such as Nutrient Indicator Algae, signs of recently killed coral, bleaching and coral disease were either not observed at all or only in a few instances. From these observations it can be concluded that as far as hard corals are concerned, the reef inside the MPA as well as in the area around it is in good condition.

5.4 – Impacts

Although anthropogenic impacts such as anchor damage and trash were very low, signs of high fishing pressure were evident. As mentioned in previous sections, several species of fish and invertebrates that are known to be popular for consumption were only

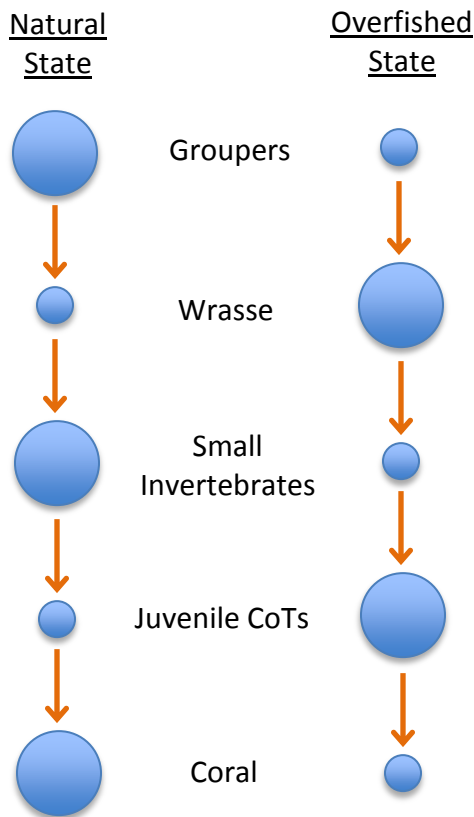


Figure 24 – Representation of the indirect effects that overfishing of predatory fish, in this example Groupers can have on the entire coral ecosystem. The size of the circle represents the relative abundance of that organism or trophic level.

observed in low numbers or were absent from the surveyed area entirely. The most concerning aspect of these findings is that several of these species are known keystone species. This means that these organisms play a vital role in the ecosystem which if removed can seriously affect the stability of the entire ecosystem. This can happen in two ways: (1) direct effects or (2) indirect effects.

In relation to CoTs, direct effects occur when their natural predators are removed and mortality through predation is reduced. Natural predators of CoTs include Humphead Wrasse, Titan Triggerfish and invertebrates such as Triton's Trumpet, species of shrimp and the Giant Clam, which feeds on larval CoTs. Indirect effects that can lead to increased numbers of CoTs include removal of predatory fish, such as Groupers. When unsustainably high fishing pressure has removed most of these predatory fish this can lead to a trophic cascade, which is a change in the dominant trophic level that can have to ecosystem wide impacts. Groupers feed on smaller fish, which in turn feed on small invertebrates that eat tiny juvenile CoTs. By removing the Groupers the smaller fish will become more numerous, which will lead to increased predation on the small invertebrates that eat the tiny CoTs (Figure 24). This means that more juvenile CoTs will be able to grow into adulthood and hard coral predation increases (Sweatman 2008). This same principle is likely to hold true for other piscivorous species of Emperor, Snapper and Jacks. Indirect top-down effects from depletion of apex predators have been shown to have wide spread impacts on ecosystems around the world (Myers et al. 2007).

The high numbers of Long Spine Urchins observed inside the Santa Paz MPA and the surrounding area may be another sign of overfishing. Similar to the removal of apex

piscivorous fish leading to increased numbers of CoTs, overfishing of herbivorous fish such as Parrotfish, Rabbitfish and Surgeonfish, can lead to increased abundance of Long Spine Urchins (McClanahan et al. 1996). By fishing down the populations of herbivorous fish, the Long Spine Urchins have more algae to feed on and increase in numbers to become the dominant grazers on the reef (similar situation as in Figure 24). This in itself is not a direct problem as the urchins fill the same ecological niche, or role, on the reef but it has been shown that high abundance of Long Spine Urchins are vulnerable to mass death due to outbreaks of diseases (Lessios et al. 1984). If Long Spine Urchins were to suffer massive death from a disease outbreak and fishing pressure on the herbivorous fish was to remain at current levels, there would not be enough grazing pressure to keep the algal growth on the reef down. Corals are easily outcompeted by the fast growing algae and what will ensue is a phase shift from a coral dominated to an algae dominated reef (Bellwood et al. 2004). This trend has been observed in many reefs all over the world and reversing this phase shift, i.e. going from an algal dominated reef back to a coral dominated reef, is notoriously difficult (Lotze et al. 2006).

Signs of unsustainable fishing pressure observed inside the Santa Paz MPA mean that it is unlikely that the local citizens will be able to reap the benefits that it was originally put in place for, to provide a sustainable source of food and income for the future generations. Only if the fisherfolk who operate in the area adhere to the rules and stop fishing inside the MPA, will it start to recover from its current overfished state. As shown in the case studies of Apo Island and Sumilon Island (Box 1), full recovery of certain species will take a substantial period of time, especially Groupers, but species with quicker reproductive rates, such as Emperors, may recover faster (McClanahan and Kaunda-Arara 1996; Russ and Alcala 2004). It is also relevant to note that recovery will be quicker if overfishing is halted before the population reaches critically low levels (Russ and Alcala 2004). When the abundances of fish and invertebrates begin to rise and people start to notice, enforcement of the MPA should be extra vigilant as poaching inside the MPA can destroy years of recovery in a short time (McCook et al. 2010).

6. RECOMMENDATIONS

Increasing compliance of the fisherfolk with the rules of the Santa Paz MPA can be accomplished by (1) effective enforcement and (2) broadening understanding of what the MPA can do for their livelihoods, and that of their children, in the long-term. Effective enforcement is currently lacking in the Santa Paz MPA. There is virtually no infrastructure in place and no trained personnel. Coral Cay Conservation is aiming to train several Bantay Dagats in the near future to help increase the enforcement capacity but further steps should be taken to increase the institutionalization of the Santa Paz MPA. These include the construction of a guardhouse and providing the Bantay Dagats with equipment such as flashlights, megaphones and a patrol boat. Anecdotal evidence from the Barangay Captain about illegal fishing taking place inside the MPA and the observations of CCC staff confirming these violations, illustrate that effective enforcement is needed. Prosecution of violators of the MPA rules stands central in this matter.

The placement of demarcation buoys is an excellent start to making the MPA more visible to fisherfolk operating the area. However, when compliance of the fisherfolk with the rules of the MPA is high, enforcement may not need to be as stringent. By conducting an 'Information, Education and Communication' campaign in the Santa Paz Sur Barangay, the citizens would be more aware of the state of their natural resources and increase local support of the MPA. Increased support from the local stakeholders leads to an increased sense of ownership of the MPA and people take on a stewardship role whereby compliance with the MPA does not need to be enforced but is simply a given. Until this level of support and sense of stewardship for the MPA has been reached enforcement of the MPA needs to be effective.

The MPA Management Effectiveness Assessment Tool (MPA MEAT) was designed by the Philippines government and allows local stakeholders and managers to identify areas of MPA management that are good as well as aspects that need improving. The MPA MEAT uses simple criteria to outline the current management situation regarding the MPA and can be used to plan steps to improve the management. The methodology and more information can be obtained from the CCC Project Scientist. Only when the coral reef ecosystem inside the MPA is given a proper chance to recover from unsustainable fishing pressure, will the benefits of protection become evident. Action towards achieving this is needed in the near future in order to avoid the damage to the ecosystem to reach such an extent that recovery will take decades rather than years.

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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**:		
<i>Acropora</i> branching	<i>Acropora</i> encrusting	<i>Acropora</i> submassive
<i>Acropora</i> 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/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	Raccoon 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: Target Fish Family Abundance

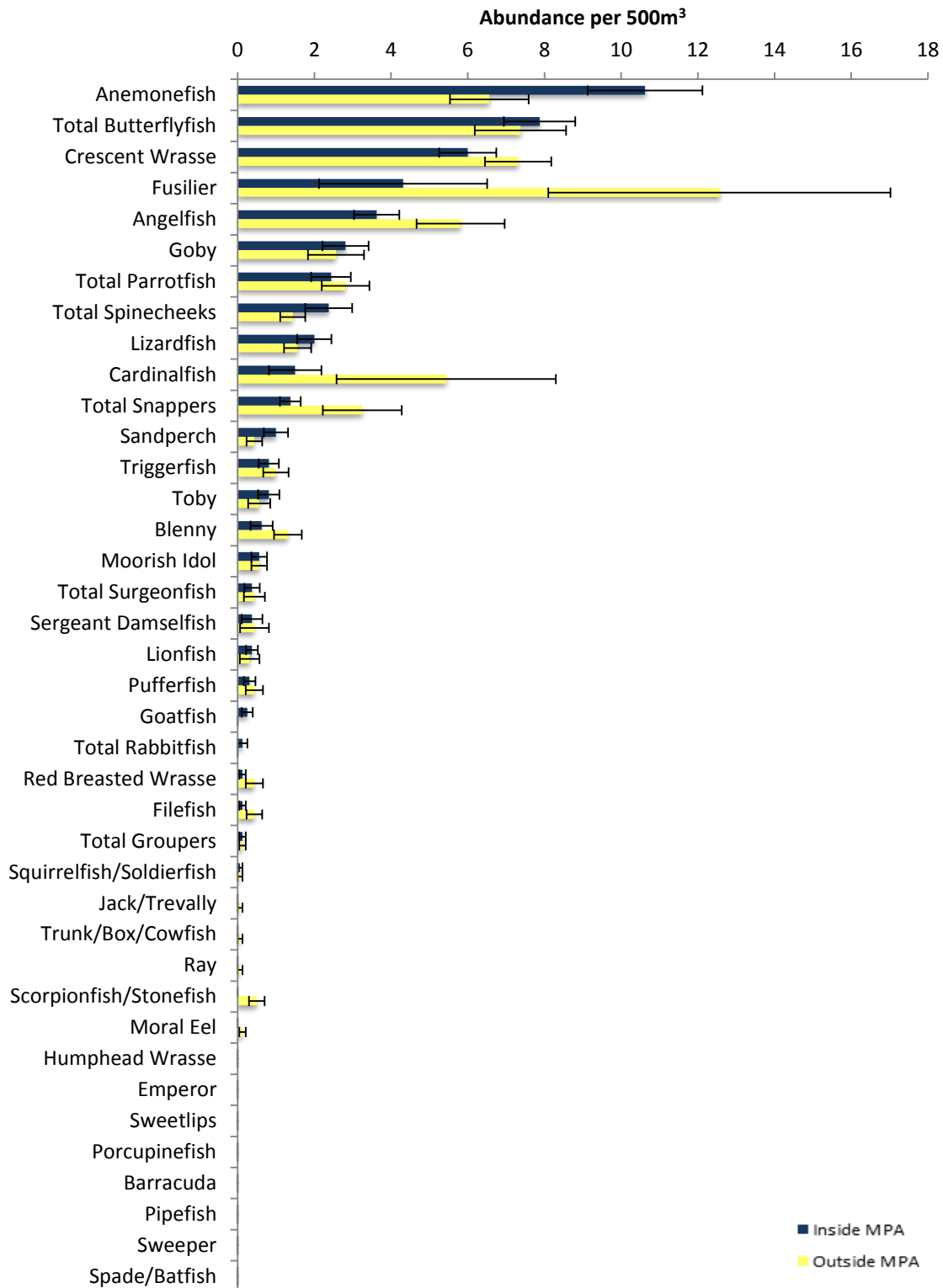


Figure 25 – Average abundance of target fish families. Data are mean average per replicate, error bars indicate Standard Error of the Mean.

APPENDIX C: Target Invertebrate Abundance

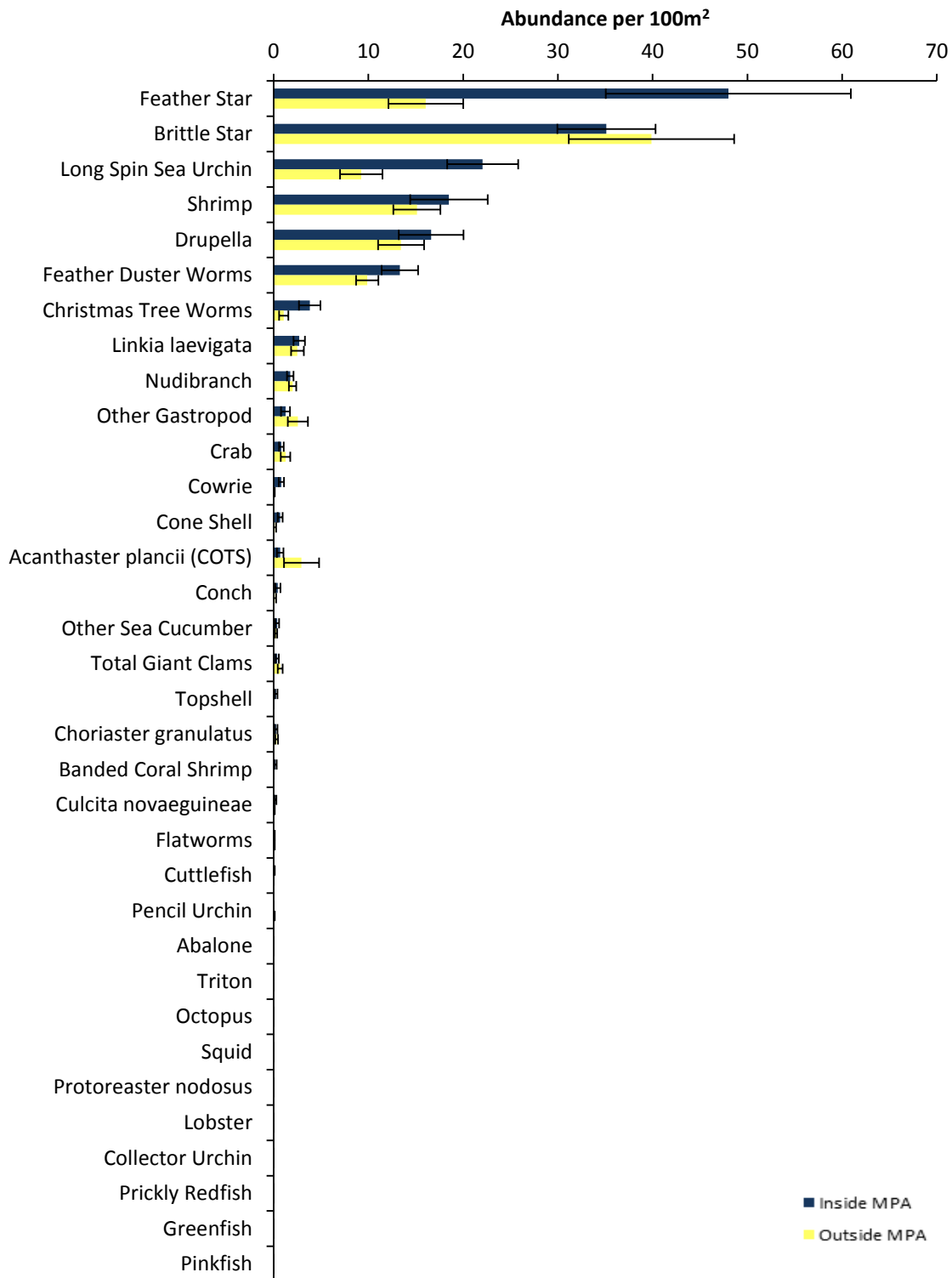


Figure 26 – Average abundance of target invertebrate species and families. Data are mean average per replicate, error bars indicate standard error of the mean.

APPENDIX D: Target Substrates Abundance

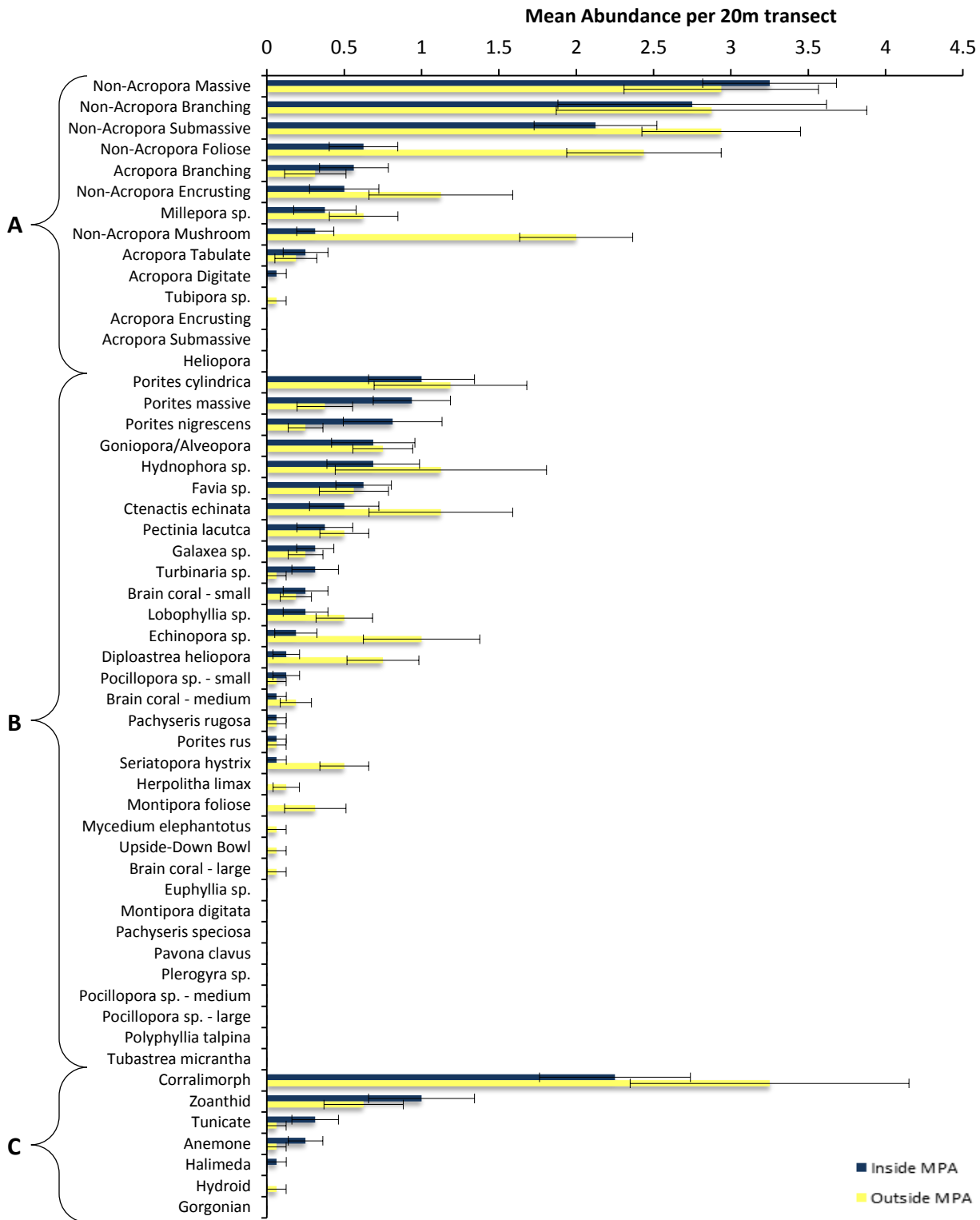


Figure 27 – Average abundance of hard coral life form categories (A), target coral species and families (B) and benthic organism classed under substrate category “Other” (C). Data are mean average per replicate, error bars indicate Standard Error of the Mean.