

Coral Cay Conservation Proposed Marine Reserve Report



Nueva Estrella Norte

Pintuyan, Southern Leyte, The Philippines

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EXECUTIVE SUMMARY

- Coral Cay Conservation (CCC) conducted an assessment of the reef fish, invertebrates, substrates and anthropogenic impacts at the Barangay Nueva Estrella Norte in the Municipality of Pintuyan. The site is proposed as a potential Marine Protected Area.
- An enhanced Reef Check methodology was used to survey eight 100m transects, each containing four 20m replicates. The transects were equally divided between 6m and 12m depths.
- Abundance and diversity of fish families and species did not vary significantly between transects. Fish diversity was highest at transects seven and five. The only significant relationship was between transect seven (more abundant) and three (less abundant).
- Snappers and groupers across all transects were observed in low abundances and small sizes. Parrotfish were the most abundant commercially important fish family observed throughout the survey but large adults were low in abundance.
- Abundance and diversity of invertebrate species varied significantly between transects. Transects two and seven had significantly higher diversity than all other transects. Transects three and four had the lowest abundances but this was only significant against transects two, six and seven.
- Hard coral was the most commonly recorded substrate across the survey area followed by rock and sand. Hard coral cover did not differ significantly between transects but was highest at transects five, seven and eight. Transects three and four had significantly more sand cover than all other transects.
- Instances of damaging impacts such as trash and discarded fishing gear were present in high instances throughout the survey site with general trash being the most abundant.
- The reef appears in moderate health although lack of commercially important fish and invertebrate species indicates that overfishing is a threat to the area.
- It is recommended that consultation be started between the local community, municipal and provincial government and CCC on the creation of a marine protected area. Three options have been given within report and all would benefit from the inclusion of marine reserve buffer zones restricting all but hook and line fishing.

ACKNOWLEDGEMENTS

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LIST OF ACRONYMS AND ABBREVIATIONS

CCC	: Coral Cay Conservation
CoTs	: Crown of Thorns Seastars (<i>Acanthaster planci</i>)
IEC	: Information and Education Campaign
IUCN	: International Union for the Conservation of Nature
LGU	: Local Government Unit
MAO	: Municipal Agricultural Office
MR	: Marine Reserve
MPA	: Marine Protected Area
MPA MEAT	: MPA Management Effectiveness Assessment Tool
NIA	: Nutrient Indicator Algae
NIPAS	: National Integrated Protected Area System
PENRMO	: Provincial Environmental and Natural Resource Management Office
PGSL	: Provincial Government of Southern Leyte
PMR	: Proposed Marine Reserve
PRRCFI	: Philippines Reef and Rainforest Conservation Foundation Inc.
PRRP	: Philippines Reef and Rainforest Project
RKC	: Recently Killed Coral
SE	: Standard Error
SLRCP	: Southern Leyte Reef Conservation Project

CORAL CAY CONSERVATION

Initially founded in 1986, CCC is an internationally renowned, not for profit organisation, which provides host countries with appropriate resources for the protection and sustainable use of tropical ecosystems. This protection is established to enable future generations the continued use of local ecosystem resources. These goals are outlined in CCC's mission statement:

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

CCC achieves its mission via the formation of long-term programmes of collaborative research with local institutions and governments. Such research programmes require technical support from CCC, in the form of scientific data collection, data analysis and the production of reports and integrated coastal zone management plans. CCC also provides communities with education, training and alternative livelihood opportunities to strengthen local human resources to the point where research can be continued independently by the host country.

CCC has carried out conservation projects all over the world, including the Philippines, the Caribbean, Belize, Honduras, Malaysia, Cambodia and Fiji. CCC has successfully set up numerous Marine Protected Areas (MPAs) throughout these regions and provided essential scientific data for the management of their local marine resources. Successfully established areas in the Philippines are a result of the Philippines Reef and Rainforest Project (PRRP). CCC established PRRP in collaboration with the Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and the World Land Trust in 1995. Such protected areas include the coastal regions of the Southern Negros Occidental, Anilao, Palawan, Danjungan Island, the forests of North Negros and Padre Burgos.

In 2002, the PGSL invited CCC and the PRRCFI to conduct research in Sogod Bay. This resulted in the formation of the Southern Leyte Reef Conservation Project (SLRCP). The SLRCP utilises trained volunteers to survey the region's coral reefs and provide training and conservation education opportunities for project counterparts. The aim of this is to develop local capacity and ensure the long-term protection and sustainable use of marine resources throughout Southern Leyte. Between 2002 and 2013, CCC focused on implementing baseline surveys throughout Sogod Bay to obtain information on the distribution of fish and invertebrate populations, benthic cover and reef health. In 2013, having surveyed much of the accessible area in the Bay, CCC shifted its focus to concentrate on MPA monitoring surveys. Under this new protocol surveys are implemented inside and outside of existing MPAs to evaluate their efficacy and in unprotected areas to assess their potential for MPA installation.

1. INTRODUCTION

1.1 Marine Protected Areas (MPAs) and Marine Reserves (MRs)

Marine resources are under increasing pressure from an ever growing global population (Jackson *et al.* 2001). Strong declines in catch from worldwide fisheries, such as the North Atlantic Cod (Myers 1997) and Caribbean reef fisheries (Hardt 2009), have illustrated that biological marine resources are limited and highly vulnerable to overfishing (Jackson *et al.* 2001; Pauly *et al.* 2002). Additional pressures such as pollution, coastal development and climate change exacerbate this vulnerability. As a result, there is an increased drive for conservation efforts and resource management in the marine environment (Wood *et al.* 2008; CBD 2010). The protection of marine areas can achieve conservation and resource management targets simultaneously and are therefore considered instrumental to sustainable ocean utilisation (Pauly *et al.* 2002). The International Union for the Conservation of Nature (IUCN) defines an 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.”

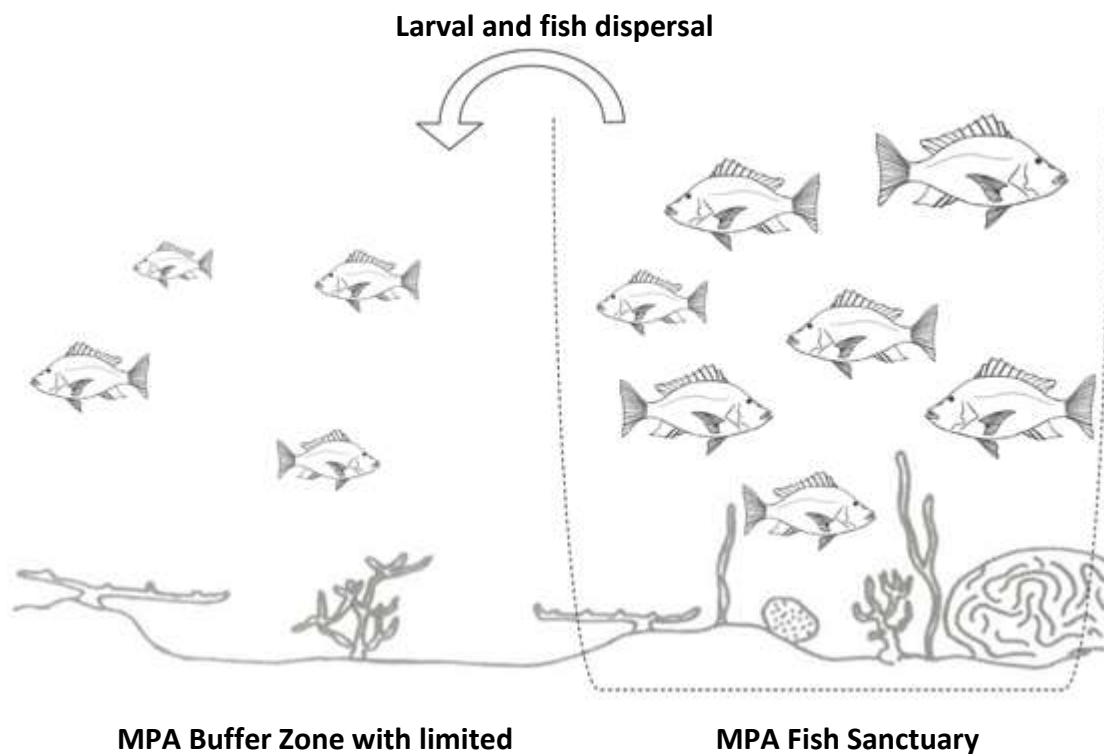


Figure 1. Schematic diagram of MPA functioning. Protected fish within the MPA fish sanctuary grow and produce offspring. This leads to ‘overspill’, increasing fish numbers inside and outside of the MPA. In addition, the corals inside the MPA are not disturbed by destructive fishing methods.

MPAs have become vital tools in protective management for the conservation of marine resources. MPAs in the Philippines encompass “no take” areas (min. 5 hectares), within which no form of extraction is permitted. These no take areas are surrounded by 50m “buffer zones” where only non-destructive fishing methods, such as hook and line fishing, are permitted (Figure 1). These large areas of no extraction combat resource exploitation by providing local communities with a sustainable supply of goods; such as fish and invertebrates; and services, such as shoreline protection and tourism (World Bank, 2005).

Generally, the most desired benefit of an MPA is increased fish production. This occurs as a result of overspill and larval export from the “no take” area into surrounding waters (Figure 1). Over time, the displacement of fishing effort from the MPA results in an increase in adult fish biomass and fecundity. This results in adult fish and larvae being exported to the buffer zone and its surrounding waters. Local fishery yields subsequently increase because they have a continual and sustainable supply of stock (Maliao *et al.* 2004). In areas where there is the potential for increased tourism and 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.

Marine Reserves (MRs) are areas of the marine environment where fishing is restricted to non-destructive methods, such as hook and line fishing. This reduces habitat damage often caused by destructive fishing methods, such as dynamite fishing, net fishing or trawling. MRs are preferable to areas of no protection but are not as effective as MPAs because fishing pressure remains present and is unselective. All sizes, ages and species of fish and invertebrates within an MR can still be extracted. Juveniles are often removed before they can reach reproductive age or size, causing populations to decline. Environmentally important species, such as algae-grazing parrotfish, are also removed, potentially allowing algae to proliferate and smother vital coral habitat.

The success of a protected area is entirely dependent upon the cooperation of local stakeholders. Research has shown that the involvement of resource users in the planning, implementation and management of their own MPA increases their sense of ownership and pride. Only when local stakeholders feel they are adequately considered and regularly consulted on their MPA’s management, will it be possible for the full potential of the MPA to be attained (Green *et al.* 2009, Human and Davies 2010). It is, therefore, essential that the local community is involved with the entire process of protected area establishment. Stakeholders must be consulted about key aspects of the MPA establishment process, such as size and location and directly involved in their management e.g. via community Bantay Dagats (marine guards).

1.2 Coral Reefs & Marine Conservation in the Philippines

The Philippines lies within a region known as the Coral Triangle, which also includes Indonesia, Malaysia, Papua New Guinea, Timor-Leste and the Solomon Islands. It is recognised as the global centre of marine biodiversity as it is home to the oldest coral reefs and the largest expanses of mangrove forest in the world (Roberts *et al.* 2002). More than 75% of the world's known coral species and over 30% of the world's coral reefs are found in the Coral Triangle (Veron *et al.* 2009). The same extraordinary diversity is also found in other types of marine organisms; 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 within 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 characterised 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 within the Philippines. Jacinto *et al.* (2000) stated that legislation concerning marine conservation in the Philippines is some of the most advanced within the Coral Triangle. Important laws currently instigated in the Philippines include:

- 1998 Fisheries Code (Republic Act 8550): 15% of municipal waters should be within an MPA.
- Marine and Coastal Resource Protection Act 2011: 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 roughly 1,640 MPAs in the Philippines. Of these MPAs, 33 have been declared at national level as National Integrated Protected Area System (NIPAS) sites and the remainder are managed by Local Government Units (LGUs) (DENR-CMMO presentation, March 19th 2013). Box 1 highlights two case studies 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 an MPA is given the chance to recover (Figure 2). Results 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 fish sanctuary make it likely that the MPA is a source for net larval export that aids the recovery of fish stocks in the area. Indirect positive effects of the effective management of these MPAs include increased tourism income and the elimination of unsustainable fishing practices such as dynamite fishing (Russ and Alcala, 2004).

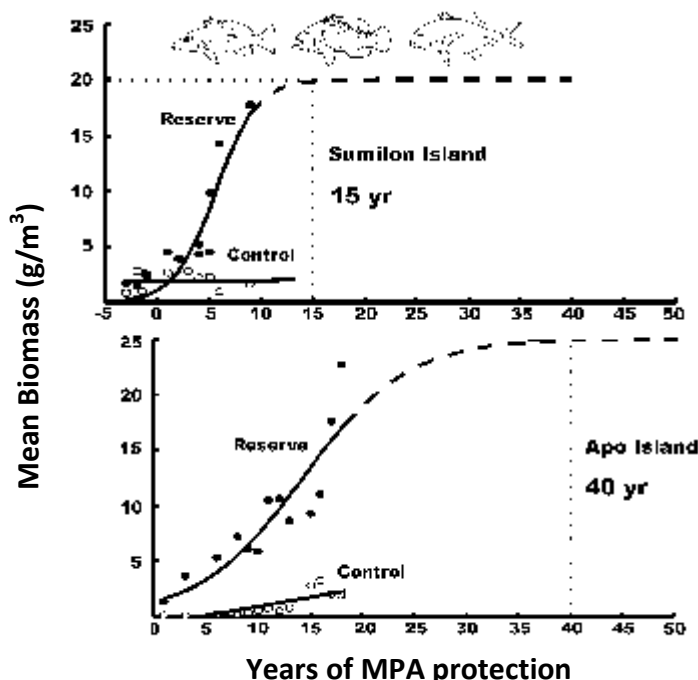


Figure 2. Observed and projected increases in mean biomass of commercially important fish species inside Apo Island and Sumilon Island MPAs (Russ and Alcala, 2004).

1.3 Characterisation of Study Region

1.3.1 Southern Leyte and Sogod Bay

The coral reefs of Southern Leyte remain some of the least disturbed habitats in the Philippines. The coastal regions that include Canigao Channel in the west, Sogod Bay, Cabalian Bay, the northeastern Pacific coast and the Surigao Strait are rich in marine life and are important fishing grounds for local communities. The area is rich in tuna, flying fish, herrings, anchovies, shellfish and Spanish mackerel. Sogod 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). The region is also a feeding ground for attractive mega-fauna such as pilot whales, melon-headed whales, dolphins, manta rays and whale sharks. The coast is characterised by naturally limited mangrove areas, narrow fringing coral reefs, limited seagrass beds and narrow intertidal areas and beaches (Calumpong *et al.* 1994).

Currently there are ~25 established MPAs within Sogod Bay covering an estimated 292 hectares. These figures will increase in the coming years as more MPAs are set up. Sizes of MPAs range from 3.5 hectares (Maujon/Juangon Fish Sanctuary) to 55 hectares (Limasawa Fish Sanctuary), with a mean average size of 11.7 hectares (± 2.2 SE) and a median average of 7.9 hectares (PENRMO-CFRU, 2014). The sizes for several MPAs are not known, as accurate GPS coordinates are not available.

1.3.2 Nueva Estrella Norte, Proposed MPA Site

By the request of the Pintuyan MAO CCC surveyed the coral reefs located 75-100m from the shore of the Barangay Nueva Estrella Norte, on the eastern side of Sogod Bay. The surveyed area lies in a north south orientation. The bay affords some protection from prevailing weather systems coming across the Pacific, however, the sites location toward the southern entrance of the bay leaves it open to weather system coming from the Bohol Sea. The Barangay has a population of 600 people, all living within close proximity to the coast. A river mouth of <10m is located approximately 300m away from the proposed site. The survey request comes as the Pintuyan MAO are expending efforts to meet the requirements of the aforementioned 1998 Fisheries Code (Republic Act 8550), which states that 15% of municipal waters should be within an MPA. The area surveyed is not considered to be the best reef in the area, although transects two and eight are.

2. METHODS

2.1 Survey Site

CCC's assessment of Nueva Estrella Norte's (Figure 2) Proposed MPA was conducted between the 21st August and the 11th September 2014 by trained volunteer survey teams. Weather throughout the survey period was sunny, with no major weather systems moving through the region. Mean air temperature during surveys was 30.5°C. Mean water temperature was 29.4°C at the surface and 29°C at a depth of 3m and 10m. Mean estimated horizontal visibility during the survey was 23.5m.

It was observed that anthropogenic pressures in the area were high. These are posed mainly from medium levels of commercial and artisanal fishing, medium levels of invertebrate harvesting, low levels of poison fishing and compressor fishing during habagat. Few divers currently visit the area and the site is not considered popular or known by local dive operators. No protection is currently afforded to the site. The presence of these stressors indicates a strong need for protecting the area.

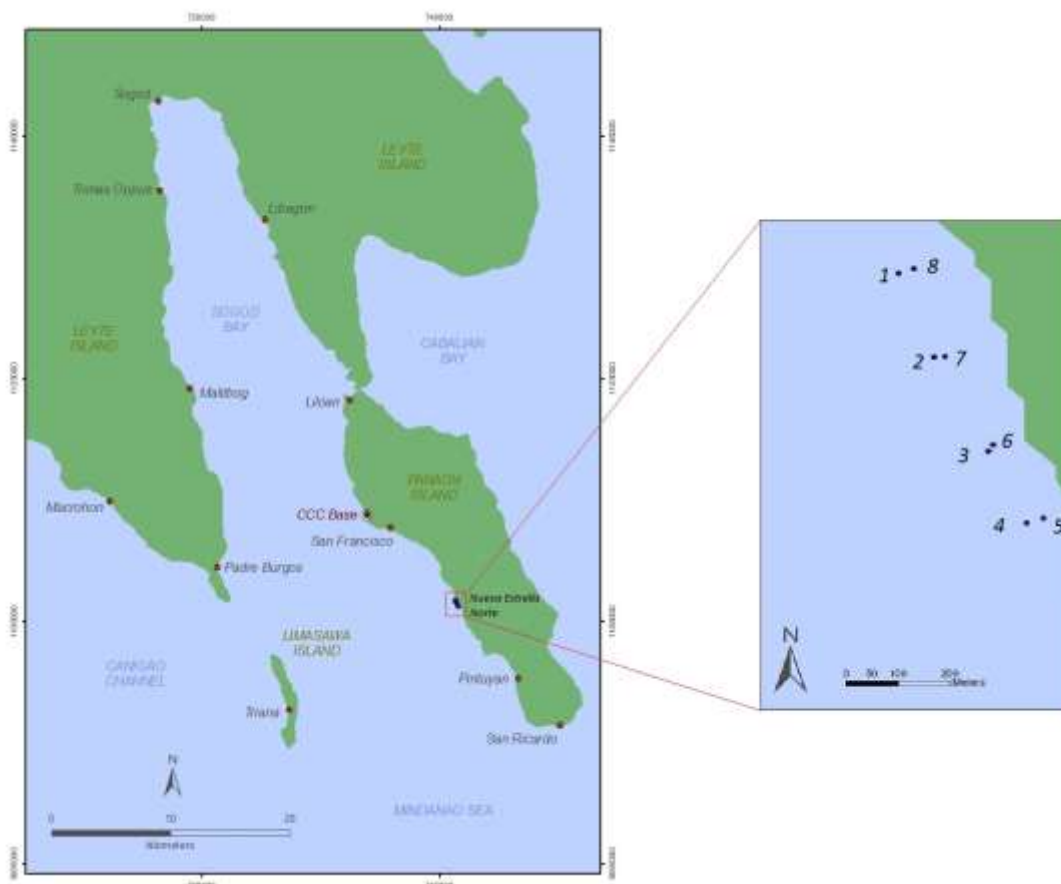


Figure 2. Locations of the eight transects surveyed in Nueva Estrella Norte, Pintuyan. Transect numbers correspond to those listed in table

2.2 Biophysical Survey

Assessment of the proposed MPA was conducted using an enhanced Reef Check methodology. The Reef Check methodology is widely recognised and 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). Data from around the world is analysed on a yearly basis to enable the production of global coral reef status updates. Reef Check surveys produce a representation of the ecological status of a reef and its human impacts. CCC has augmented the methodology in order to reflect the high biodiversity of the area by adding additional target species of fish, coral and invertebrates (Appendix A).

Transects were laid along the reef, parallel to the shore, on a north to south bearing. Four transects were situated at a depth of 6m and four transects were situated at a depth of 12m (Table 1). Each 100m transect was divided up into four 20m replicates, separated by 5m gaps in which no data was collected. This produced a total surveyed length of 80m. A distance of 100m was left between each whole transect. This survey design allowed for robust statistical analysis of the collected data.

Table 1. Depths and coordinates for the eight transects surveyed along the coast of Nueva Estrella Norte.

Transect Number	Depth (m)	Easting (UTM)	Northing (UTM)
1	12	741320	1106755
2	12	741389	1106563
3	12	741494	1106346
4	12	741567	1106181
5	6	741600	1106191
6	6	741503	1106361
7	6	741409	1106564
8	6	741349	1106766

2.2.1 Fish

Fish diversity and abundance data was collected using Underwater Visual Census. Selected fish families and species recognised as being good indicators of fishing pressure, aquarium collection and reef health were recorded. Three commercially important fish families: groupers (lapulapu, *Serranidae*), parrotfish (mulmul, *Scaridae*) and snappers (mayamaya, *Lutjanidae*); were also classified into the size classes 0-10cm, 11-20cm, 21-30cm, 31-40cm, 41-50cm, 51-60cm and >60cm (Appendix A).

Data was recorded using 'belt' transects, where fish were observed along each replicate of the 100m transect within an imaginary 5x5x20m (WxHxL) box (Figure 3). Surveys were conducted by two surveyors swimming slowly along replicates, each counting indicator fish species 2.5m

either side of the central transect line. Divers paused at five metre intervals along each replicate to wait one minute for fish to acclimatise to surveyor presence. Data collection continued during this one minute pause.

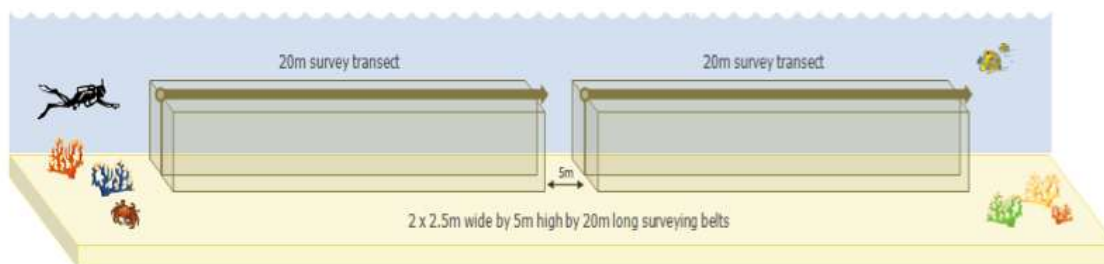


Figure 3. Survey method for recording fish. Diagram shows two of the four 20m replicates within a 100m transect. Fish were recorded within a 5x5x20m imaginary box.

2.2.2 Invertebrates

The diversity and abundance of selected invertebrate families and species were recorded along the same belt transect used for fish. Recorded species are typically targeted for food, collected as curios or important to the ecological balance of the reef (Appendix A). Giant clams (*takubo*, *Tridacna gigas*) were recorded into the size classes 0-10cm, 11-20cm, 21-30cm, 31-40cm, 41-50cm, 51-60cm and >60cm. Two divers each recorded invertebrates 2.5m either side of the transect line while swimming in a U-shaped search pattern (Figure 4). Divers looked in holes and under overhangs to find cryptic organisms such as lobsters and sea urchins.

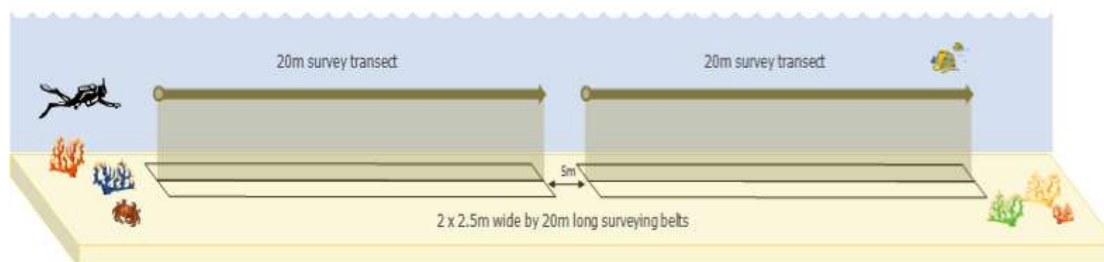


Figure 4. Survey method for recording invertebrates. Diagram shows two of the four 20m replicates within a 100m transect. Invertebrates were recorded within a 5x20m benthic rectangle.

2.2.3 Substrate

Benthic diversity was measured by recording living and non-living substrate categories along a 'point-intercept' transect using a plumb line to minimise bias. Benthic organisms and substrate types directly underneath the transect line were recorded at 50cm intervals along each 20m replicate (Figure 5). Every 20m replicate contained 40 benthic points. Benthic categories included: sand (SD), rock (RC), rubble (RB), silt/mud (SI), nutrient indicator algae (NIA), sponge (SP), recently killed coral (RKC), soft coral (SC), hard coral (HC) and any other sessile organisms. All hard corals were recorded to life form and genus level, with targets being recorded to species level (Appendix A).

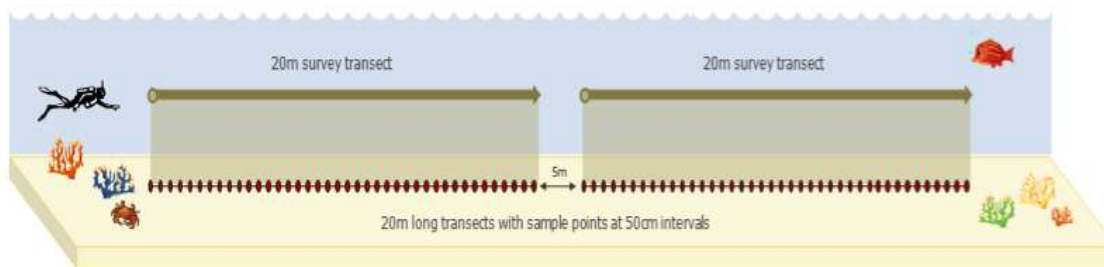


Figure 5. Survey method for recording substrate data. Diagram shows two of the four 20m replicates within a 100m transect. Substrates were recorded along a 'point intercept' line of each 20m replicate

2.2.4 Impacts

Within the same area assessed for invertebrates, divers recorded impacts on the reef. The total percentage of bleached coral cover was estimated together with the percentage of each individual bleached coral colony. Coral diseases were identified where present and recorded as a percentage of the colony infected. 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). The impact of trash was recorded on the same scale and separated into general and fishing nets/traps.

2.3 Data Analysis

Each 20m belt transect was treated as an independent replicate. This produced $n=16$ at 6 metres and $n=16$ at 12 metres. Data analysis was undertaken to establish which areas of the reef were particularly healthy and which were not, with the view of being able to recommend suitable areas for protection. 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 so a Mann-Whitney U test was used to determine any statistically significant differences between transect depths and sites.

Species diversity of fish and invertebrates was calculated using the Fisher's α index, which incorporates number of species and number of individuals observed at each transect. Results were also submitted to the Mann-Whitney U test.

Gobies and fusiliers were removed from statistical analyses of fish abundance as they were often found in large groups, which skewed overall abundance data. Gobies are not a key indicator species of reef health and therefore will not affect protected area recommendations. Fusiliers are an economically important fish species and were analysed separately.

3. Results

3.1 Fish

Fish abundance across the eight transects at Nueva Estrella Norte ranged between 26 ± 2.9 per 500m^3 at transect three and 41.8 ± 8.9 per 500m^3 at transect seven (Figure 6). Transect seven was significantly higher than transect three only ($p=0.04$) (Figure 7). There was no other significant difference between fish abundance across the eight transects. Fish diversity (fisher's α) ranged from between 3.8 ± 1.2 at transect four and 6.1 ± 0.9 at transect three (Figure 6). There was no significant difference between fish diversity. Transect seven and five recorded the highest abundance (five = 36.5 ± 7.8) and had similarly high diversities, 5.5 ± 1 and 5.6 ± 0.5 respectively. Although transect three had the highest diversity it recorded some of the lowest abundances of fish at 26 ± 2.9 per 500m^3 .

The occurrence of a school of 25 barracuda contributes to the higher fish density at transect seven. No other barracuda were recorded throughout the survey.

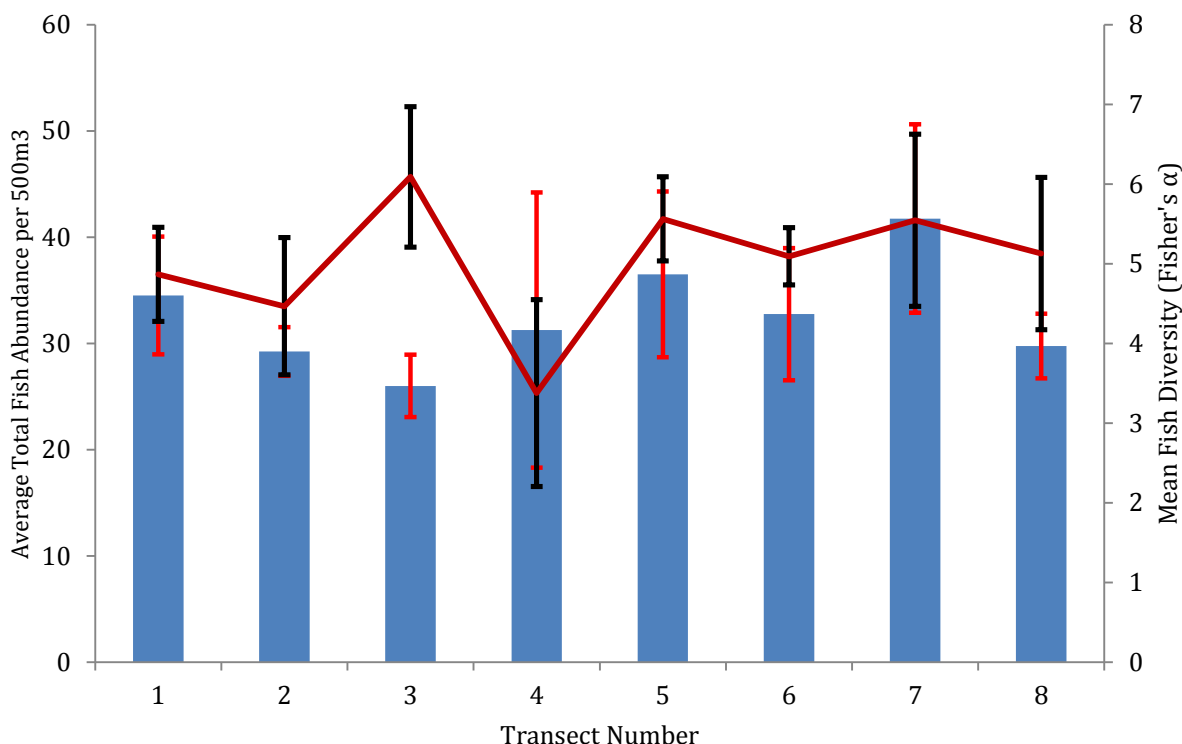


Figure 6. Average fish abundance (without gobies or fusiliers) and diversity (with gobies) per transect at 12m and 6m depths. Blue bars represent mean fish abundance per 500m^3 , black error bars denote standard error from the mean. Red line graph portrays mean fish diversity per 500m^3 using the Fisher's α index, black error bars denote standard error of the mean.

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

Figure 7 - Matrix showing significant differences in mean fish abundance between transects. A green '+' indicates that abundance was significantly higher at the transect in the left column compared to the transect in the top row ($p < 0.05$). A blue '-' indicates that abundance was significantly lower at the transect in the left column compared to the transect in the top row ($p < 0.05$). Blank cells indicate no significant difference.

Fusiliers were removed from statistical testing as they tend to be found in schools and so can skew the data. Two schools of fusiliers were recorded at transects two and four, 52.3 ± 20.6 and 42.5 ± 36 respectively (Figure 8). Individual fusiliers were also recorded at some of the other transects, although in low abundance (Figure 8).

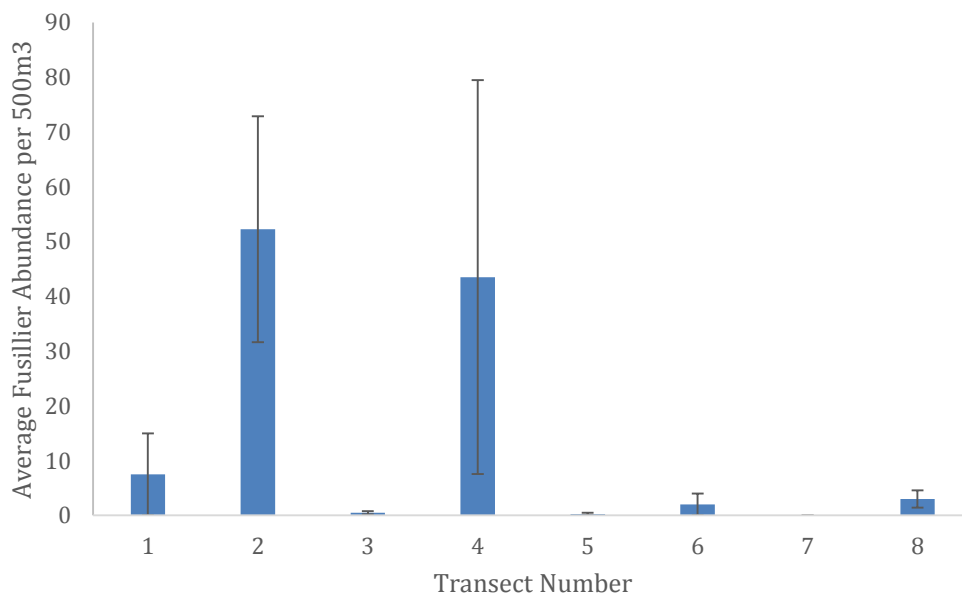


Figure 8 - mean abundances of fusiliers per transect at 12m and 6m depths, black error parts denote standard error from the mean.

Very low densities of commercially important fish species including parrotfish, snapper and grouper were recorded (Figure 12). Of the three species parrotfish were recorded the most

with average abundances of 4.8 ± 1.6 per 500m^3 , whereas snapper and grouper were only found in average abundances of 0.25 ± 0.1 and 0.6 ± 0.4 per 500m^3 respectively (Figure 9). Average biomass for the recorded fish species were also low (Figure 10). Snapper and grouper recorded very low biomass of 0.03 ± 0.02 and 0.04 ± 0.04 per 500m^3 respectively. The average biomass of parrotfish was 0.5 ± 0.2 with the greatest biomass occurring at transect eight where 0.9 ± 0.5 was recorded.

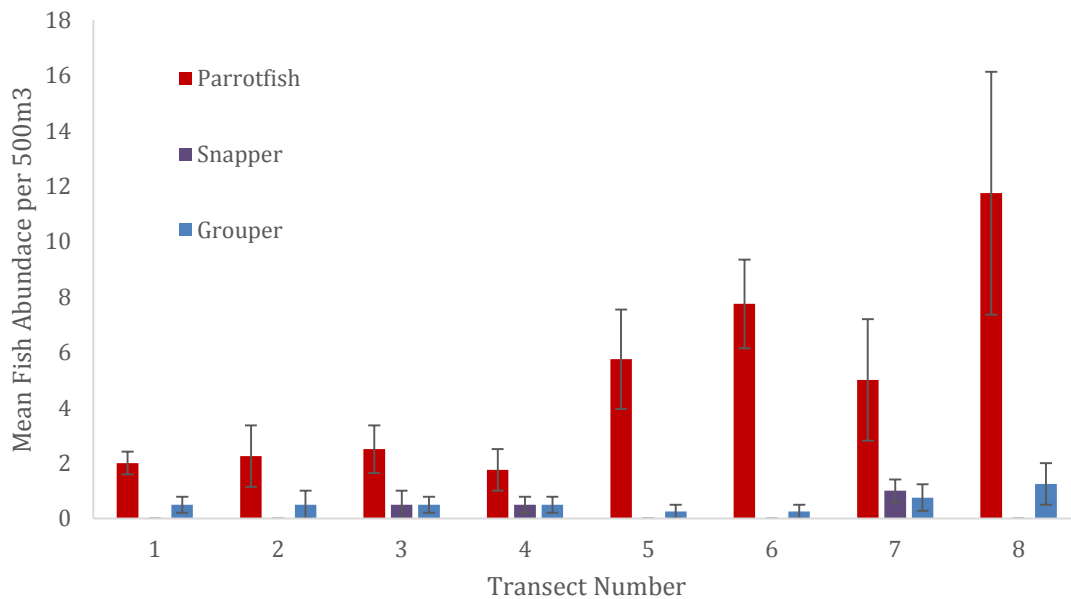


Figure 9 – Average abundances of Snapper, Parrotfish and Grouper observed at each site. Data are mean number of individuals per replicate, error bars are standard error of the mean.

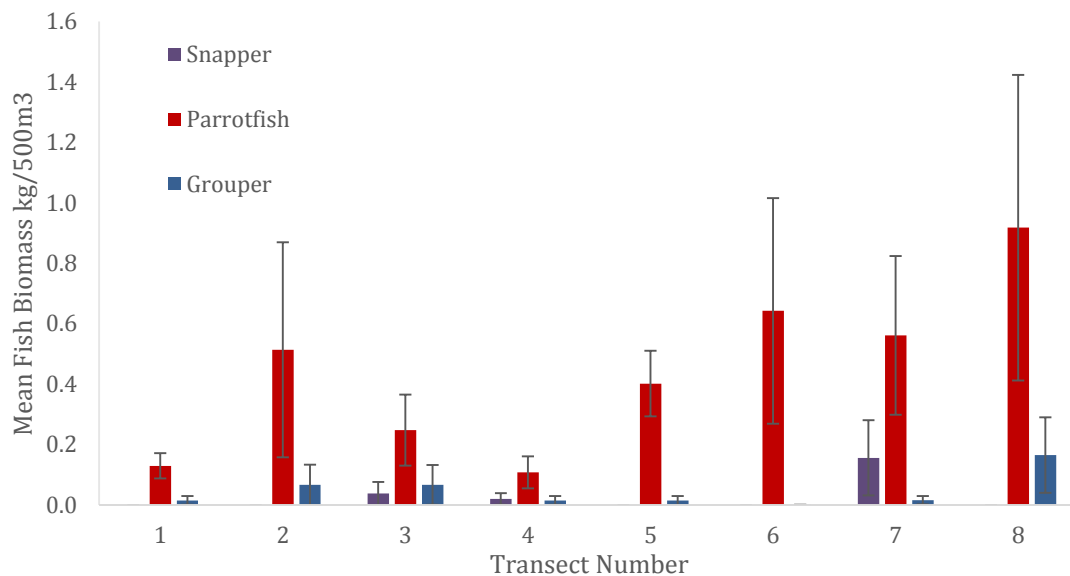


Figure 10 - Biomass of Snapper, Parrotfish and Grouper observed at each site. Data are mean number of individuals per replicate, error bars are standard error of the mean.

In total only 17 grouper were recorded across the eight transects, with transect eight holding the largest count of four groupers. Only eight snapper were recorded, four at transect eight and two at transects three and four. Parrotfish occurred in greater numbers with a total of 115 individuals (Figure 11). Transect eight contained the most with 47 individuals and transect three the least with only seven individuals (Figure 11).

The commercially important fish that were present were all small in size. All snapper were less than 21cm in length and all grouper were less than 31cm in length. Parrotfish had more of a range but all were less than 41cm with 89% falling evenly into the 0-10cm and 11-20cm category (Figure 11).

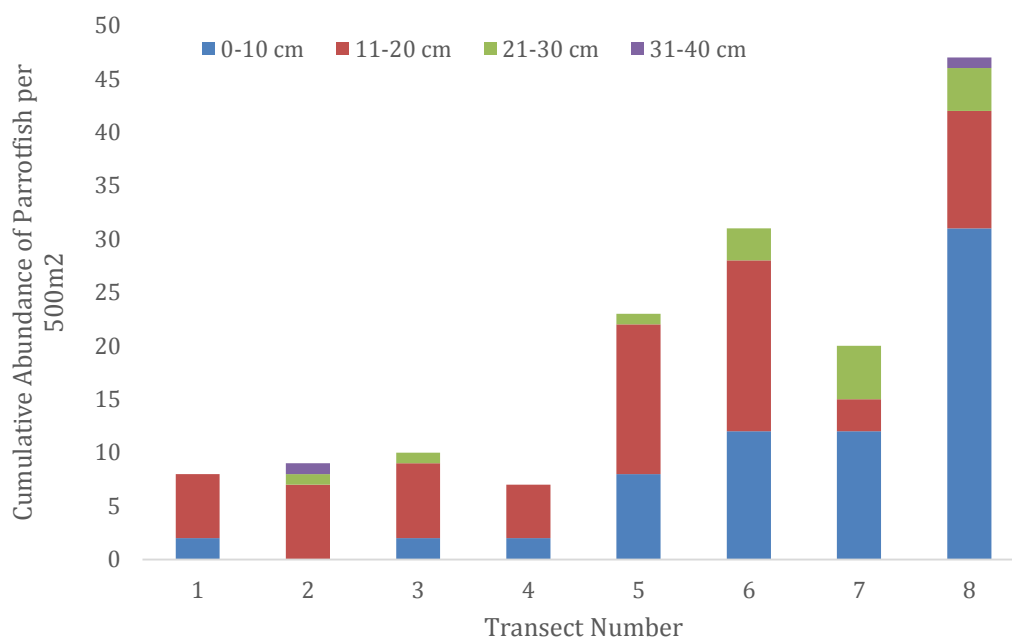


Figure 11 – cumulative abundance of parrot fish in size categories 0-10cm, 11-20cm, 21-30cm and 31-40cm across the eight transects at 6m and 12m depths

One manta ray was spotted from the survey boat near transect two. Other rare fauna sighted included one banded sea krait, one mantis shrimp and three mandarin fish.

3.2 Invertebrates

Invertebrate abundance ranged from between 97.8 ± 30.2 per 100m^2 on transect four and 225 ± 12.6 per 100m^2 on transect two (Figure 12). Transect seven was similarly high with 221 ± 8.4 mean invertebrate abundance per 100m^2 . Transect two and seven were significantly more abundant than all other transects ($p \geq 0.03$) (Figure 13). Transect six was significantly more abundant than transects three ($p=0.02$) and four ($p=0.04$). Species richness ranged from between 11.3 ± 2.5 on transect four and 13 ± 4 on transect three (Figure 12). Although transect three had the highest species richness it had the second

lowest abundance of invertebrates recording 101 ± 9.5 per 100m^2 . Transect four had a similar abundance of invertebrates to transect three (97.8 ± 30 per 100m^3) but had the lowest species richness (11.3 ± 2.5).

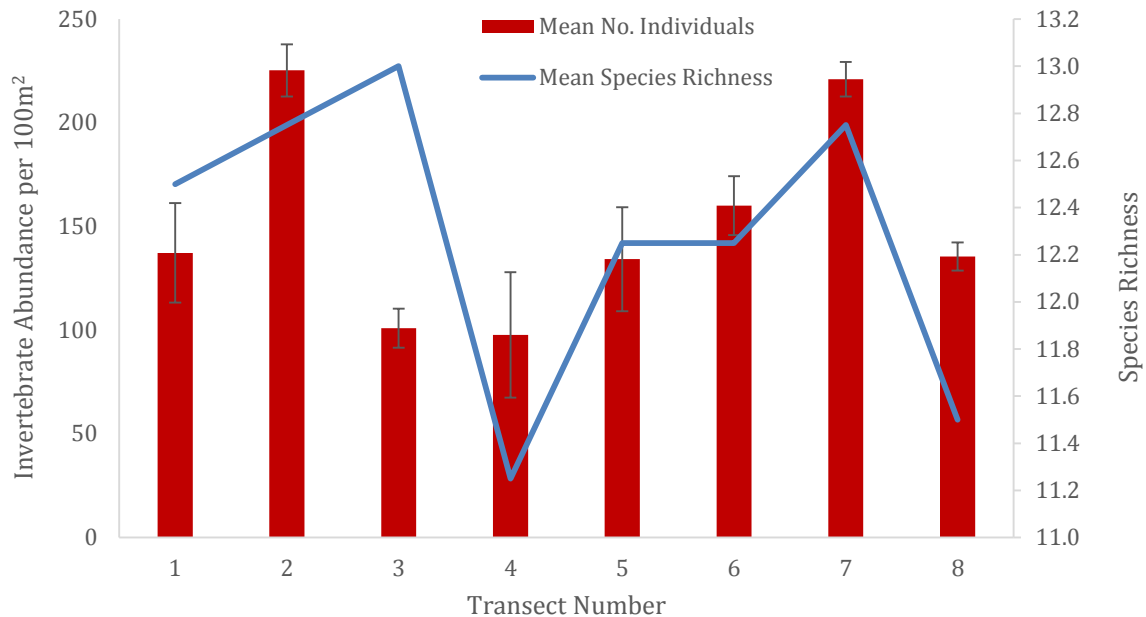


Figure 12– Average invertebrate abundance at each transect. Data are mean number of individuals per replicate, error bars are standard error of the mean.

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

Figure 13 - Matrix showing significant differences in invertebrate 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.

Increased amounts of brittle stars account for the higher number of invertebrates at transect four. 97.5 ± 10 brittle stars were recorded at transect four compared to an average

of 48.5 ± 8.9 . There is only a significant difference in abundance of brittle stars between transect four and two ($p=0.02$) and six ($p=0.03$). Other gastropods account for the high invertebrate abundance at transect seven.

Invertebrate diversity (Fisher's α) ranged between 2.9 ± 0.1 at transect two and 4 ± 0.2 at transect three (Figure 14). Transect three was significantly more abundant than two ($p=0.03$) and transect four was significantly more abundant than two ($p=0.04$) and seven ($p=0.04$) (Figure 15). Again transect three showed low abundance but high diversity of creatures. Rarer invertebrates such as banded coral shrimp, Cowrie, pencil urchins, and giant clams were not present or found in very low numbers throughout the survey.

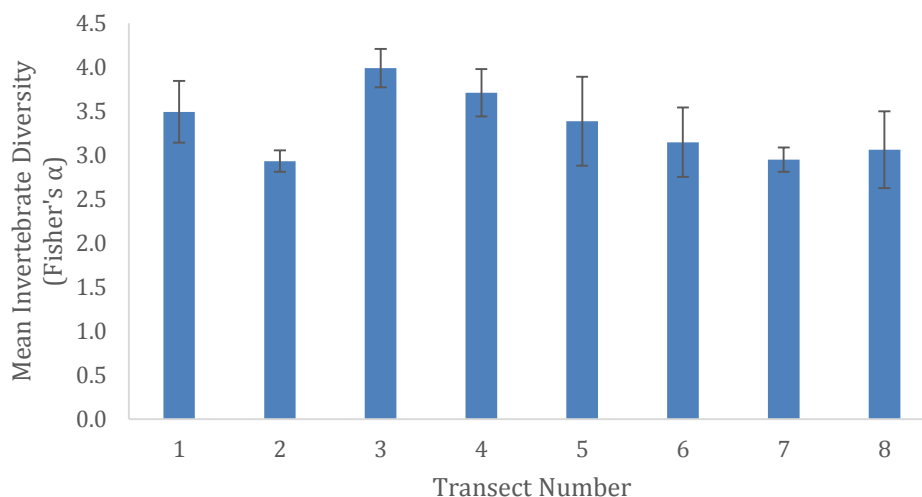


Figure 14 – Average invertebrate diversity (Fisher's α) at each transect. Data are mean number of individuals per replicate, error bars are standard error of the mean.

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

Figure 15 - Matrix showing significant differences in invertebrate diversity between transects. '+' significantly higher at transect on the left compared to transect at the top ($p<0.05$). '-' significantly lower at transect on the left compared to transect at the top ($p<0.05$). Blank cells indicate no significant difference.

Commercially important species, such as lobster (*Nephropidae*), abalone (*Haliotidae*), triton's trumpet (*Charonia tritonis*), squid (*Teuthida*), prickly redfish sea cucumber (*Thelenota ananas*), greenfish sea cucumber (*Stichopus chloronotus*) or pinkfish sea cucumber (*Holothuria edulis*) were entirely absent from the survey. Crown of Thorn Seastars (*Acanthaster planci*, CoTs) were recorded on one occasion only and sea snails in the *Drupella* genus were observed in low abundances across the survey apart from at transect two where 51 individuals were recorded.

3.3 Substrate

Hard coral was the most abundant substrate in the area covering an average of 39.1% of the total surveyed area (Figure 16). The second most abundant substrate was rock (26.2%) followed by sand (15.2%). Transect five recorded the highest abundance of hard coral at 58.8%. Transects seven and eight recorded similarly high abundances of hard coral at 47.5% for both sites, and transect one and six had 39.4% covering each site. Transect three recorded the most sand (48.7%) and least hard rock cover (16.3%). Transects two, five, six and eight all had significantly more hard coral cover than site three (Figure 17.B). The highest abundance of rock was recorded at transect six (42%). Transects two and four had significantly more sand cover than any other ($p = <0.03$) (Figure 17.A). Transect one had significantly more rubble than transects four, five and six ($p = <0.03$) (Figure 17.C).

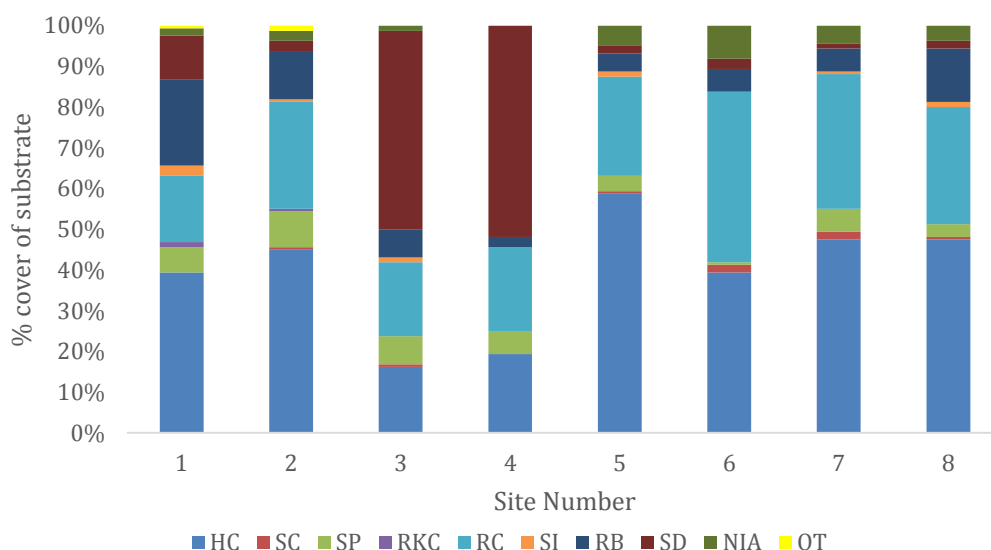


Figure 16 - Mean substrate percentage cover at each transect. Data are mean average per replicate. HC – Hard coral; SC – Soft coral; SP – Sponge; RKC – Recently killed coral; RC – Rock; RB – Rubble; SD – Sand; SI – Silt/mud; NIA – Nutrient indicator algae; OT – Other living organisms.

Non-*acropora* branching and massive coral contributed to 46.7% of hard coral cover. A total of 24 target hard coral species were recorded at contributing to 63.1% of hard coral cover. Massive *Porities* contributed to 27% of hard coral cover and *Porites cylindrica* and *Porites nigrescens* contributed to 17% and 13% of total hard coral respectively. At transect five 40% of the hard coral cover was Massive *Porities*. At transects seven and eight *Porites cylindrical*

and *Porites nigrescens* made up 31.6% and 40% of the total hard coral respectively. Transect five had the highest diversity of target hard coral with 16 individual species. Transects one, seven and eight all contained 13 species of hard coral. The lowest diversity was at transect two where only nine species of hard coral were recorded. *Acrpora* contributed to only 6.4% of total hard coral cover.

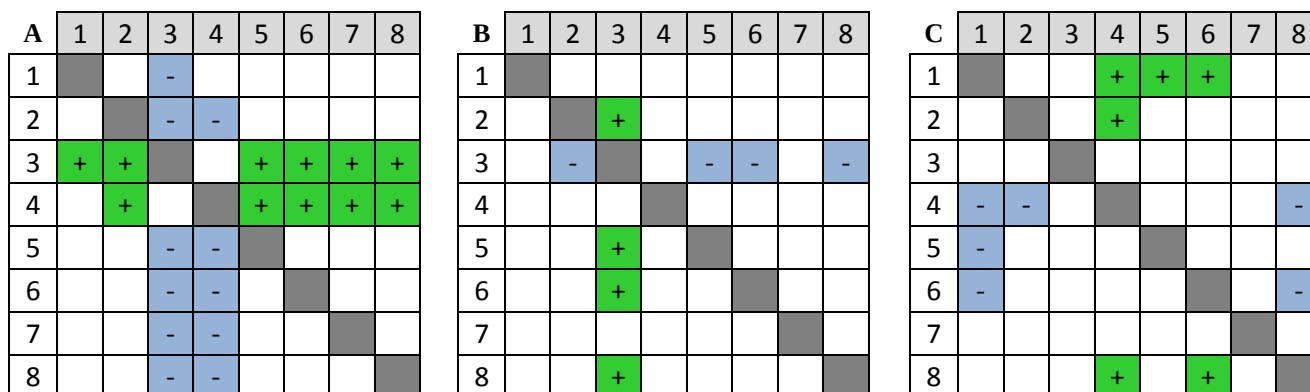


Figure 17 - Matrix showing significant differences in percentage of sand (A), hard coral cover (B) and rubble (C) between sites. '+' significantly higher at transect on the left compared to transect at the top ($p < 0.05$). '-' significantly lower at transect on the left compared to transect at the top ($p < 0.05$). Blank cells indicate no significant difference.

3.4 Anthropogenic Impacts

The reefs at Nueva Estrella Norte showed high levels of anthropogenic impacts. No damage from anchors or dynamite fishing was observed on any of the survey transects, however coral damage was high with 23 observed cases. Predation was equally high with 33 observed cases. General trash levels were high with a total of 110 observations across Nueva Estrella Norte. Transect five showed the highest levels of general trash with 38 observations in 100m², transect eight was the second highest with 21 observations in 100m². Transects three and six also showed high levels of general trash with 12 and 18 occurrences observed per 100m². Fishing related trash was lower with only 21 occurrences and none found at transects six, seven or eight. Transect four had the highest levels of fishing trash with 11 observations recorded per 100m².

4. Visual Assessment

Images taken by CCC staff and volunteers at the Nueva Estrella Norte Survey Site.



Figure 18 – Healthy acropora tabulat at Nueva Estrella Norte



Figure 19 - Chromodoris magnifica Nudibranch



Figure 20 - Healthy substrates showing an array of hard coral, soft coral and sponge



Figure 21 - Bluespotted ribbontail ray (Taeniura lymm) hiding under a coral outcrop



Figure 22 – Beautiful coral outcrop



*Figure 23 – A Jorunna funebris (Funeral Jorunna)
Nudibranch*

5. DISCUSSION

CCC's assessment of the reefs at Nueva Estrella Norte revealed that the reef itself appears to be in a moderate condition but that the anthropogenic impacts are high. Overfishing is a threat and there is a high instance of pollution and coral damage. Low abundances of commercially important fish and invertebrate species are also a cause for concern. Trends observed on the reefs of Nueva Estrella Norte are discussed in relation to management strategies in the following sections.

5.1 Fish

The only significant differences found for abundances of fish were between transects seven and three where seven had significantly more fish. Although transect seven did display the largest abundance, the range of abundance between transects was low which is why the difference between the other sites is not significant. The school of barracuda recorded at transect seven is encouraging as it represents a healthy population of one of the few commercially important fish species found within the survey.

The only other commercially important schooling fish recorded was fusiliers which were found in large (42-52 individual) schools on two of the 12m transects. Fusiliers were not included in the main analysis of fish abundance as they are often observed in large mobile schools capable of moving between transects and this can misrepresent the data. That two large schools were recorded is positive however on a healthy reef system large schools of fusiliers would be expected to occur at multiple transects.

Incredibly low abundances and small sizes of both snapper and grouper across all transects indicate that these commercially important families are being overfished. Individuals larger than 30cm were completely absent from the survey. Large individuals of these families are highly valued as a food fish and easily targeted by spear fishing, hook and line fishing and net fishing when they aggregate in large numbers to spawn (Hodgson and Liebel, 2002). Snappers and groupers take many years to increase in size, reach sexual maturity and typically change sex. Snappers have been shown not to reach sexual maturity until they are approximately 54.6 cm in length, suggesting that a population with no individuals larger than 40cm will not be able to replenish itself (Froese and Pauly, 2001). The fecundity (or reproductive output) of these families also exponentially increases with size. One 12.5 kg female snapper can produce the same number of eggs as 212 1.1kg snappers (Bohnsack, 1990). Overfishing of large individuals from a reef will, therefore, remove the most reproductively active individuals and create a population with a highly skewed sex ratio, which will inhibit future growth of the population.

Parrotfish over 21cm were also low in abundance, also indicating overfishing. Although large specimens were not abundant small parrotfish (0-10cm) represented 44.5% of the total recorded population which suggests some recruitment has been successful. However, for the population to grow larger, sexually active specimens are needed. That the majority of parrotfish

were found at transects five to eight indicates a preference of the reefs here. This is likely due to the greater abundances of hard coral found at these transects. Parrotfish are an ecologically important species because they are the largest herbivorous fish found on coral reefs. They graze on large quantities of algae, which would otherwise compete with coral for space.

Zero observations of humphead wrasse or barramundi cod and low abundances of sweetlips (only 5 were recorded throughout the whole survey) also indicate overfishing of these species targeted for food. The humphead wrasse is the most desirable and highly priced fish in the live fish trade, with one large individual capable of selling for as much as \$10,000 (Lau and Parry-Jones, 1999). Barramundi cod are also targeted by fishers because juveniles are highly valued in the aquarium trade and adults are valuable in the Chinese live food fish market (Hodgson and Liebeler, 2002). Low abundances of poison fishing, used for the live food fish market, are known to occur throughout the site. This should be completely restricted in an attempt to allow these populations to recover.

That one manta ray was spotted from the survey boat is a positive sign. Nueva Estrella Norte is towards the entrance of Sogod Bay and near to known whale shark feeding grounds. That a manta ray was spotted is evidence that they travel up into the mouth of the bay. Mantas and whale sharks are a big attraction for scuba divers but the divers are unlikely to come unless the surrounding waters are clean and healthy. There is good potential to promote Nueva Estrella Norte as a protected dive site that offers the opportunity to spot these incredible creatures. The manta ray was spotted near transect two, in the deeper waters of the survey and so this and other deep water sites should be included in the MPA if possible. If properly promoted diving and snorkelling fees could make a healthy contribution to the economy of the local barangay.

The analysis did not show significant differences between fish abundance throughout the transects. For the commercially important fish species protection of any of the transects is extremely important to enable recovery at Nueva Estrella Norte. The shallower sites (five, six, seven and eight) did hold greater abundances of parrot fish it would therefore be preferable to protect an area that includes at least some of these transects. By ensuring site eight, which held 30% of the total recorded population, including 45% of 0-10cm parrotfish, is protected the opportunity for these fish to grow to sexual maturity and produce young will be afforded. By allowing this process a higher abundance of juveniles will occur and will eventually spillover to surrounding waters.

5.2 Invertebrates

Invertebrate abundance was significantly higher at transects two and seven than any another. Transect three exhibited the lowest abundance and a particularly high Fisher's α value of diversity. This peak in invertebrate diversity was caused by a lower number of individuals being divided by a higher number of species. There were no species, however, that only occurred on transect 3 and were not observed elsewhere. Based on the significantly higher abundance of

invertebrates found at transects two and seven it would be beneficial to include these in the protected area.

The conspicuous absence of commercially important invertebrate such as lobster, abalone, squid, triton's trumpet, prickly redfish sea cucumbers, greenfish sea cucumbers and pinkfish sea cucumbers indicates high levels of overfishing.

Lobsters are a highly prized food item throughout the world. They can be quickly removed from areas as they are easily caught in traps and nets. As with many fish species, larger lobsters sell for a higher price in the live food trade. The targeting of large individuals removes the most fecund (reproductively successful) females from the community, resulting in population decline.

Prickly redfish, greenfish and pinkfish are all edible species of sea cucumber regularly targeted by humans as a food substance (Hodgson and Liebel, 2002). They are easily extracted from the reef by free divers or by fishers at low tide. A complete absence of these species from the reefs at Nueva Estrella Norte indicates severe overfishing. Their presence on the reef is also ecologically significant because they filter and digest sand, producing pellets that aid in reef formation.

Triton's trumpets are an ecologically important invertebrate species on Indo-Pacific reefs because they are one of the few predators of CoTs, which in turn feed upon live coral. If top predators such as the triton's trumpet are removed from an ecosystem, the risk of a CoTs outbreak is increased. They are targeted by humans because of their high value as a curio item and easily completely removed from a reef because of their conspicuous appearance and large size.

Low levels of CoTs (only one was recorded) from the survey area is a positive sign for the health of the reefs at Nueva Estrella Norte. High abundances of CoTs indicate that populations could be approaching outbreak levels where they are capable of causing large-scale damage to the reef. They can predate live coral at such a fast rate that they can trigger phase shifts from healthy, coral-dominated reefs to algae-dominated reefs, with little habitat for fish. After a reef has been exposed to an outbreak population of CoTs it can take in excess of 15 years to recover, depending upon the reef's herbivore population and coral larval supply (CRC Reef Research Centre, 2003). The high levels of *Drupella* snail recorded at transect two are not a point for concern, they are a natural part of the reef and their predation is not considered threatening.

5.3 Substrates

Mean percentage cover of hard coral did not differ significantly between transects. Transects three and four held significantly more sand than all the other transects. Transect one had significantly more rubble than four, five and six and transect eight had significantly more than four and six.

Research implemented by Reef Check between 1997 and 2001 showed that coral reef systems throughout the Indo-Pacific averaged around 40% hard coral cover (Hodgson and Liebel, 2002). Compared to this the reefs at Nueva Estrella Norte appear to have a good/average to low percentage cover of hard coral but there is potential for this to increase.

All surveyed transects, excluding three and four are characterised by a high abundance of rock (the second most abundant substrate after hard coral) and a low percentage cover of NIA, which indicates potential for the area to be colonised by new coral recruits. In a reef ecosystem, the presence of hard coral is essential because it provides the main habitat utilised by fish and invertebrates for shelter, spawning and food.

The presence of massive *Porites*, *Porites cylindrica* and *Porites nigrescens* across all transects at Nueva Estrella Norte shows that the area is colonised by both slow-growing and fast-growing species of coral. This indicates that the area is not exposed to high wave action because slow-growing species have been able to settle and grow without being destroyed. New recruits should, therefore, be able to colonise the rocky substrate.

As hard coral percentage cover did not differ significantly between transects, the protection of any area of hard coral within the survey site would benefit the entire ecosystem. However, almost half of the substrate at transect five consisted of hard coral and so we suggest, if possible, that this be included in the protected area to allow the colonies to spread to the remaining rock in the site. Similarly transects seven, eight, one and two all hold greater than 39% hard coral cover representing (according to Reef Check) average colonies that should be protected. Including as many of these transects as possible in the proposed MPA would be beneficial.

5.4 Impacts

The Coral Reef at Nueva Estrella Norte appeared relatively healthy, showing no signs of disease and very low levels of coral bleaching. However, there was a lot of coral damage observed, and high levels of general and fishing related trash. The high levels of trash and damage are a concern, however, if protection were enforced upon the reef then these levels could be expected to diminish or even disappear. For the site to become used for recreational diving trash levels will need to be greatly reduced.

The local community may be unaware that the improper disposal of general waste negatively affects the health of the reefs at Nueva Estrella Norte. It is extremely important, therefore, that people are educated about the consequences of improper waste disposal and given the right facilities to safely dispose of their waste. The installation of covered bins throughout the barangay and above the high tide line of its beaches would prevent people from dropping their waste where it will eventually end up in the sea. It is essential that any bins provided to the community are emptied regularly by the municipality's waste disposal team to encourage their continued use. With such close proximity to a river it is likely that a lot of the non-fishing

related trash enters this way. Again educating the community on better waste disposal techniques could have a huge benefit to the ecosystem.

Other impacts such as high fishing pressure were also evident in the data. As mentioned in previous sections, several species of fish and invertebrates targeted for human consumption were observed in low numbers or completely absent. The most concerning aspect of these findings is that several of these species are known keystone species. This means that these

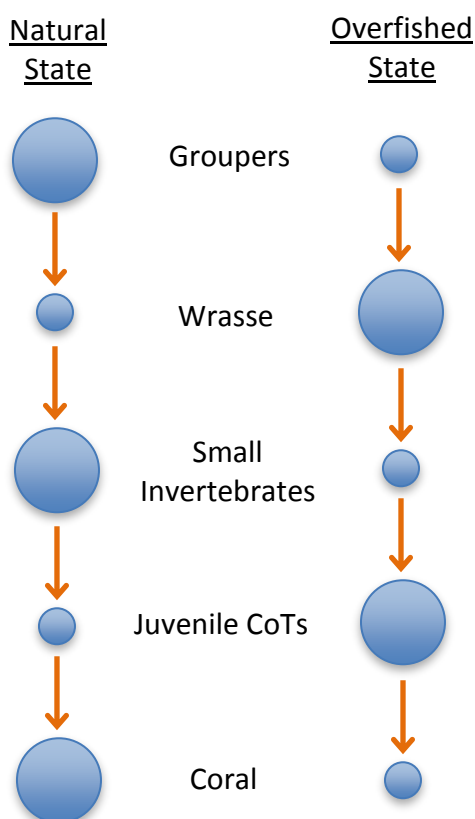


Figure 24. Representation of the indirect effects that overfishing of predatory fish, in this example Groupers can have on the entire coral ecosystem. The size of the circle represents the relative abundance of that organism or trophic level.

organisms play a vital role in the reef system and if removed could seriously affect the stability of the entire ecosystem. This can happen in two ways: (1) direct effects or (2) indirect effects.

Direct effects occur when predators are removed from an ecosystem and facilitate the ecological release of prey species. For example the removal of predators such as humphead wrasse (*Chelinus undulatus*), which are known to feed on CoTs can result in an expansion in CoTs numbers through a lack of predation pressure. Indirect effects are more complex as they often involve many species of families and cascade down through trophic levels. In severe cases this can lead to phase shifts and alter ecosystem dynamics (Figure 24).

The removal of apex predators such as groupers causes a decrease in the predation of species such as wrasse, allowing prey populations to increase. Many wrasse species feed on benthic invertebrates that in turn predate juvenile settlement stage CoTs. With an increase in wrasse numbers there is a corresponding decline in these invertebrates and thus an increase in juvenile CoT survivorship (Figure 28). 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 reefs at Nueva Estrella Norte have a good potential to recover and support good abundances of economically and culturally important fish species, however, in their current state they are in danger of declining further. If protection is not afforded fish densities may become very low and go beyond a point from where they can recover. Data suggests that fishing pressure is high and unsustainable at current levels. The implementation of an MPA at Nueva Estrella Norte could reverse these trends and allow the reef to fully recover.

6. Recommendations

CCC strongly recommend Nueva Estrella Norte to be given some level of protection. Considering the levels of overfishing suggested from the survey an MPA, that bans all fishing on at least some of the reef is the recommended course of action. Ideally this would be buffered with designated MR areas allowing some restricted (hook and line only) fishing in the area. The no-take zone created by an MPA would provide a sanctuary for economically important fish species to begin to repopulate the area. By allowing fish and invertebrates to grow to larger sizes within MPA they would produce more offspring and replenish fish stocks more quickly than an MR.

A recent study by Edgar *et al.* (2014) argues that the effectiveness of MPAs relies on five criteria: that they should be no-take zones and well enforced, that they should be both large and old (>10 years), and that they should be isolated by deep water or sand. This is an ideal, but something that should be considered in the process of setting up an MPA at Nueva Estrella Norte. MPAs throughout the Philippines are characteristically small and this size restriction will dictate the length of time it takes stocks to recover. Local fishers must be considered and it is unreasonable to suggest the designation of large MPAs restricting a local barangay of any fishing in the area. By zoning the area, allowing some restricted level of fishing in buffer zones surrounding the MPA local fishers can continue to benefit from subsistence fishing whilst allowing their reef to recover for future generations.

That successful MPAs should be old (Edgar *et al.*, 2014) is something that needs to be considered when setting up this reserve. Response times can be slow and it may be a number of years before fishers see the benefits of a no-take zone. To ensure this is understood and realistic expectations are set a consultation and presentation of data is recommended to inform the local barangay of the health of their reef and expected timeframe of results if an MPA is created.

Perhaps the most important criteria ensuring the success of an MPA is that it is well enforced. If an MPA is designated without anyone taking notice the process becomes useless and further degradation will occur. For this CCC advise the creation of a management committee to oversee the effective running of the MPA. The committee would coordinate the collection of MPA fees for possible dive and snorkel sites, provide training and support to Bantay Dagats, oversee the enforcement of the MPA and be a link to the Municipal Government for matters concerning the MPA. 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. CCC can offer support throughout this process, and can assist in training local Bantay Dagats, at the request of Nueva Estrella Norte.

6.1 Recommended Site for Nueva Estrella Norte's MPA

The final designated MPA site for Nueva Estrella Norte must be decided in consultation with the local Barangay, the local fishers and the municipal government of Pintuyan. Outlined here are the best recommendations, and alternative options.

Transects eight, seven, five and two held the greatest abundances of either fish, invertebrates or hard coral throughout the survey and should ideally be included in the protected area. These include the transects where a manta was spotted nearby (two), where the school of barracuda were recorded (seven) and where one of the large schools of fusiliers were spotted (two). For chances to promote the site as a manta and whale sharks diving spot, and also to promote the proliferation of large economically important fish it would be beneficial to include some of the deeper transects (one, two, three and four) in the MPA.

The ideal MPA would cover 15.39 hectares and include all eight survey sites within its boundaries (Figure 25.A). The reef is showing considerable signs of overfishing and pollution and including all the surveyed area would allow the best chances of a full recovery. Transects three and four held the least amount of hard coral and lower abundances of fish and invertebrate species. Figure 25.B provides an alternative option that covers 13.0 hectares of reef and does not include these transects, but benefits from the inclusion of transect five which held the greatest abundance of hard coral. The final option (Figure 25.C) additionally does not include transects five and six and would protect a total area of 9.7 hectares. This option is not strongly recommended as transect five represents an important area for hard coral proliferation, which will in turn support greater numbers of fish species.

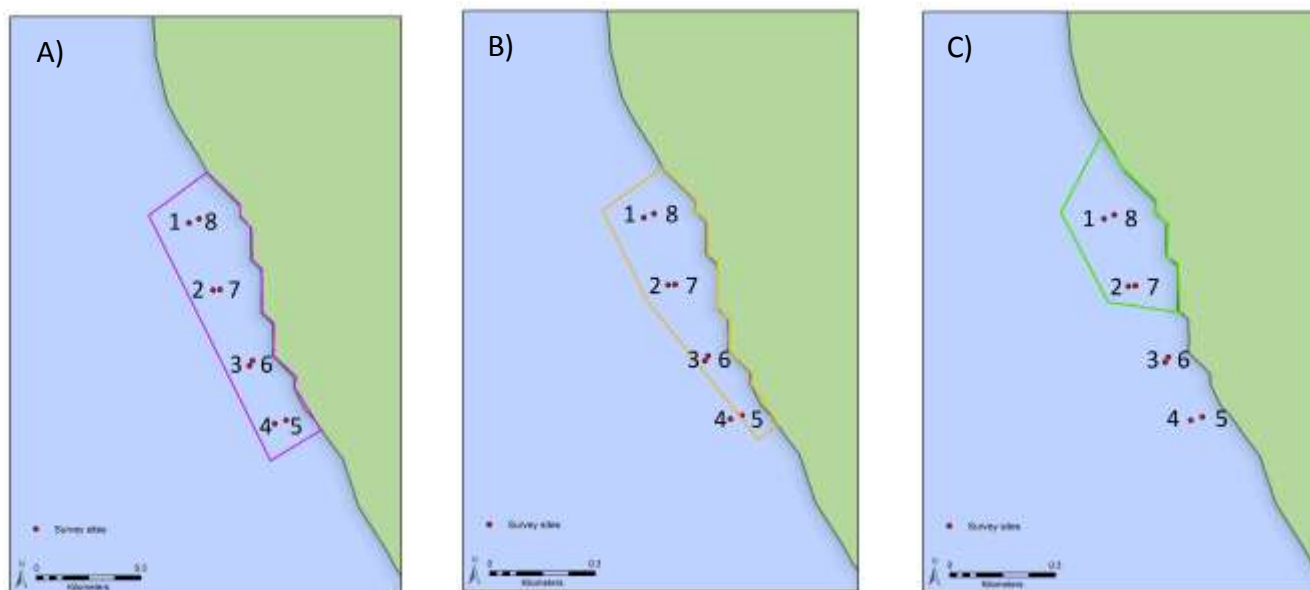


Figure 25 - Visual representation of three options for MPA designation at Nueva Estrella Norte. A represents the preferred options, B the next best and C the least preferred.

All suggestions would benefit additionally by having buffer zones which restrict all but hook and line fishing. Compressor fishing and poison fishing should be restricted throughout Nueva Estrella Norte as both are extremely damaging to the reef. In the case of option C we would strongly recommend including transect five in a buffering MR.

All three recommendations are flexible and the final designation will come down to what is decided in collaboration with the local community and local fishers. CCC provide suggestions on what is the ecological ideal, but understand that there are other factors to think about when going through this process.

This recommendation should be used as the initial step in opening dialogue between all relevant members of the local community, Municipal and Provincial Governments, and CCC. Extensive consultation will be essential within the local community to enable compliance with the MPA. The livelihoods of many local fishers may be affected by the designation of an MPA so their agreement is essential to the success of an MPA. Many studies (e.g. Pollnac *et al.*, 2001) from existing MPAs have shown that without the involvement of the local community the effectiveness of a MPA is greatly reduced. If individuals from the community are involved in the planning processes 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 to the community with information on how and why MPA can be successful.

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 in Nueva Estrella Norte it will be important to ensure that monitoring 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 a protected area at Nueva Estrella Norte should be reviewed with consultation between all stakeholders involved. The site is in high need of protection but this 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**:		
<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 heliophora</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>Herpolithalimex</i>	<i>Hydnophora</i>	<i>Lobophyllia</i>
Massive <i>Porites</i>	<i>Montipora</i> digitate	<i>Mycedium</i> elephantotus
<i>Pachyseris</i> rugosa	<i>Pachyseris</i> speciosa	<i>Pavona</i> clavus
<i>Pectinialactuca</i>	<i>Plerogyra</i>	<i>Pocillopora</i> small
<i>Pocillopora</i> medium	<i>Pocillopora</i> large	<i>Polyphyllia</i> talpina
<i>Porites</i> cylindrica	<i>Porites</i> nigrescens	<i>Porites</i> rus
<i>Seriatopora</i> hystrix	<i>Tubastrea</i> micrantha	<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</i> laevigata	<i>Culcitanoa</i> guineae	<i>Protoreaster</i> nodosus

<i>Choriastergranulatus</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	Dalagangbukid
Goatfish	Mullidae	Timbongan
Goby	Gobiidae	
Groupers	Serranidae	Lapu-lapu
Flagtail Grouper	<i>Cephalopholisurodeta</i>	
Honeycomb Grouper	<i>Epinephelus</i> sp.	
Humpback Grouper	<i>Cromileptesaltivelis</i>	
Lyretail Grouper	<i>Variolalouti</i>	
Peacock Grouper	<i>Cephalopholis argus</i>	
Jack/Trevally	Carangidae	Talakitok
Lionfish	Scorpaenidae	
Lizardfish	Synodontidae	
Moorish Idol	<i>Zancluscornutus</i>	Sanggowanding
Moral Eel	Muraenidae	
Parrotfish	Scaridae	Mulmul
Pipefish	Syngnathidae	
Porcupinefish	Diodontidae	
Pufferfish	Tetraodontidae	
Rabbitfish	Siganidae	Kitong
Virgate rabbitfish	<i>Siganusvirgatus</i>	
Ray	Rajiformes	
Sandperch	Pinguipedidae	
Scorpionfish/Stonefish	Scorpaenidae	
Snapper	Lutjanidae	Maya-maya
Black and White Snapper	<i>Macolormacularis</i>	
Checkered Snapper	<i>Lutjanusdecussatus</i>	

Two Spot Snapper	<i>Lutjanusbiguttatus</i>	
Spade/Batfish	Ephippidae	
Spinecheeks	Nemipteridae	Silay
TwolineSpinecheek	<i>Scolopsisbilineatus</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>Thalassomalunare</i>	
Humphead Wrasse	<i>Cheilinusundulatus</i>	
Red Breasted Wrasse	<i>Cheilinusfasciatus</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	HighfinCoralfish	Reticulated Butterflyfish
Ornate Butterflyfish	Two-Eyed Coralfish	Saddled Butterflyfish
Meyer's Butterflyfish	Brown Banded Butterflyfish	Spotted Butterflyfish
Speckled Butterflyfish	OcellateCoralFish	Yellowtail Butterflyfish
Pacific Double-Saddle Butterflyfish		