

Coral Cay Conservation

Proposed Marine Protected Area Report



Himayangan

Municipalty of Liloan, Southern Leyte, Philipines

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EXECUTIVE SUMMARY

- Coral Cay Conservation (CCC) conducted an assessment of the reef fish, invertebrates, substrates and anthropogenic impacts in the waters of Barangay Himayangan in the Municipality of Liloan. The site has been proposed as a potential Marine Protected Area (MPA).
- After consultation with the Barangay Council of Himayangan two sites were selected to the North and to the South of Himayangan beach. For the purpose of this report, the sites are differentiated as Himayangan North and Himayangan South.
- An enhanced Reef Check methodology was used to complete formal biophysical surveys of four 100m transects at each site, each containing four 20m replicates. Transects were equally divided between depths of 6m and 12m.
- Fish abundance was significantly higher in Himayangan North than in Himayangan South. Fish diversity (Fishers α) did not differ significantly between sites.
- The abundance of commercially important species of Parrotfish, Grouper and Snapper was low across both sites with zero individuals recorded on two out of eight transects. The majority of fish (58.44%) were observed to be less than 10cm in length with no individuals greater than 40cm. The abundance of commercially important fish did not differ significantly between sites.
- Invertebrate abundance was significantly higher in Himayangan North than in Himayangan South. The majority of invertebrates recorded (82.94%) belonged to the Phylum Echinodermata. Invertebrate diversity (Fishers α) did not differ significantly between sites.
- There was a great variation in substrate composition between sites; rock was the most prevalent substrate in Himayangan North while the reefs of Himayangan South were dominated by sand and silt. Hard coral cover was low in both sites however significantly higher in the Himayangan North in comparison to Himayangan South.
- Anthropogenic impacts were observed to be present in moderate to high levels. A high abundance of general household trash and fishing-related trash was observed across both sites. Coral damage was also recorded on several occasions.
- The low abundance and complete absence of some commercially important fish and invertebrate species indicates that fishing pressures are too high to sustain a healthy population. Sightings of rare marine organisms across the surveyed area included one hawksbill sea turtle *Eretmochelys imbricate* and five blue-spotted ribbontail rays *Taeniura lymma*.
- Based on the results of this survey, CCC has outlined their recommendations for the location and implementation of a new Marine Protected Area in Himayangan. Coordinates and boundaries are provided in this report.
- 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.

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), the Provincial Tourism Office and other members of the PGSL.

We would also like to thank the Barangay Council of Himayangan and the Municipality of Liloan for facilitating the MPA assessment. In particular we would like to acknowledge the cooperation of Ma'am Benita Dipay, Liloan Municipal Agricultural Technician and the honourable Captain Euginio C. Montajes, Barangay Captain of Himayangan. We would also like to thank our trained volunteers, staff and scholars who collected vital data during this proposed MPA assessment; Ruth Avery, Leandra Kornau, Oliver McGuinness, Josh Milne, Zachary Parkes, Charlotte Riddick, Joseph Roche, Jason Tuang-Tuang, Elena Wagner and Phoebe Wilson.

LIST OF ACRONYMS AND ABBREVIATIONS

CCC	: Coral Cay Conservation
CoTs	: Crown of Thorns Seastars (<i>Acanthaster planci</i>)
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
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.”

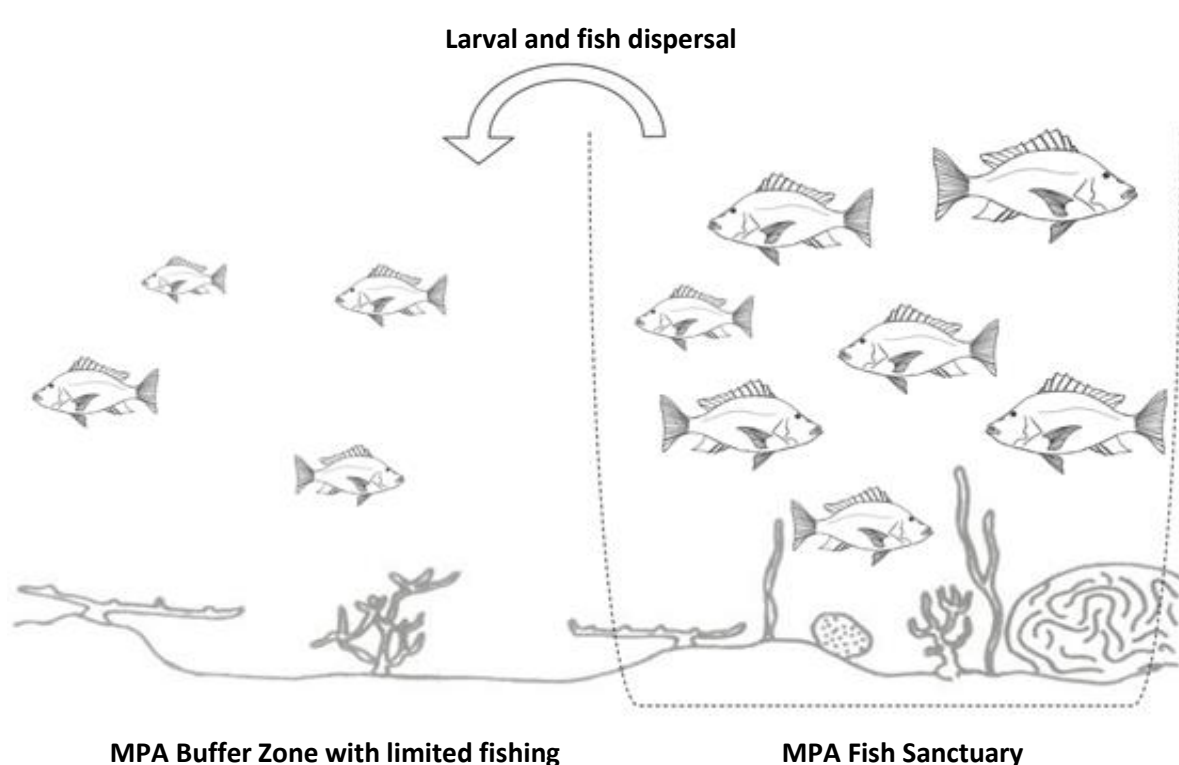


Figure 1. Schematic diagram of MPA functioning. Protected fish within the MPA fish sanctuary grow and produce offspring. This leads to ‘overspill’, increasing fish numbers inside and outside of the MPA. In addition, the corals inside the MPA are not disturbed by destructive fishing methods.

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 and 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).

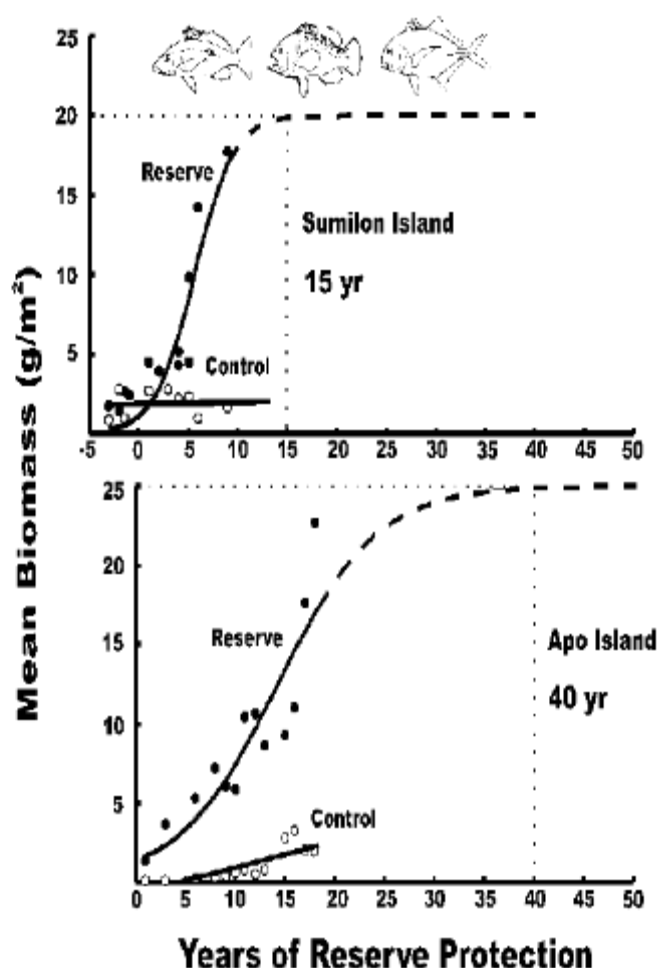


Figure 2. Observed and projected increases in mean biomass of commercially important fish species inside Apo Island and Sumilon Island MPAs (Russ and Alcala, 2004).

1.3 Characterisation of Study Region

1.3.1 Southern Leyte

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. 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).

CCC generally works alongside the municipalities with waters lying within Sogod Bay. Currently there are ~25 established MPAs within the bay covering an estimated 292 hectares. These figures will increase in the coming years as more MPAs are established. 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 Himayangan, Liloan: Proposed MPA Site

This survey was requested by the Liloan MAO as they aim to meet the requirements of the aforementioned 1998 Fisheries Code (Republic Act 8550) which states that 15% of all municipal waters should be within an MPA. CCC surveyed the coral reefs located between 50-150m from the shoreline of the Barangay Himayangan, on the eastern side of Sogod Bay. Two sites were selected to the North and South of Himayangan beach in order to determine the best location for a Marine Protected Area (Figure 2). For the purposes of this report, from this point forth these will be referred to as Himayangan North and Himayangan South. Himayangan North is overlooked by a large, grassy hill while the reefs of Himayangan South lie adjacent to a small area of mangrove forest. Both areas were surveyed in a North to South orientation.

Due to the semi-enclosed structure of the bay, the reefs of Himayangan are sheltered from prevailing weather systems coming across the Pacific. However during the monsoon season of Habagat, Southwest winds leave the East Coast of Sogod Bay exposed to moderate to high wave action. The Barangay has a population of approximately 2100 people, all of which live within close proximity to the coastline. A river mouth of <10m is located approximately 300m away from the proposed site.

2. METHODS

2.1 Survey Sites

CCC's assessment of the proposed MPA site at Himayangan North was conducted between August 25th and September 15th 2015 by trained volunteer survey teams. The weather varied between sunny and overcast/raining during this time with no major weather systems moving through the region. Mean air temperature during surveys was 27.75°C. Mean water temperature was 29.25°C at the surface, 28°C at a depth of 3m and 28°C at 10m. The mean estimated horizontal visibility throughout the survey was 12.5m.

The assessment of the proposed site at Himayangan South was conducted between September 17th and October 14th 2015. The weather was sunny during this time with no major weather systems moving through the region. Mean air temperature during surveys was 29.25. Mean water temperature was 29.75°C at the surface, 28.75°C at a depth of 3m and 28.25 at 10m. The mean estimated horizontal visibility throughout the survey was 11.25m.

From discussions with the Barangay Council of Himayangan it was gathered that there is currently a low level of anthropogenic pressure in the area in the form of sewage pollution and the harvest of invertebrates for food. Siltation is prevalent during and after heavy rainfall.

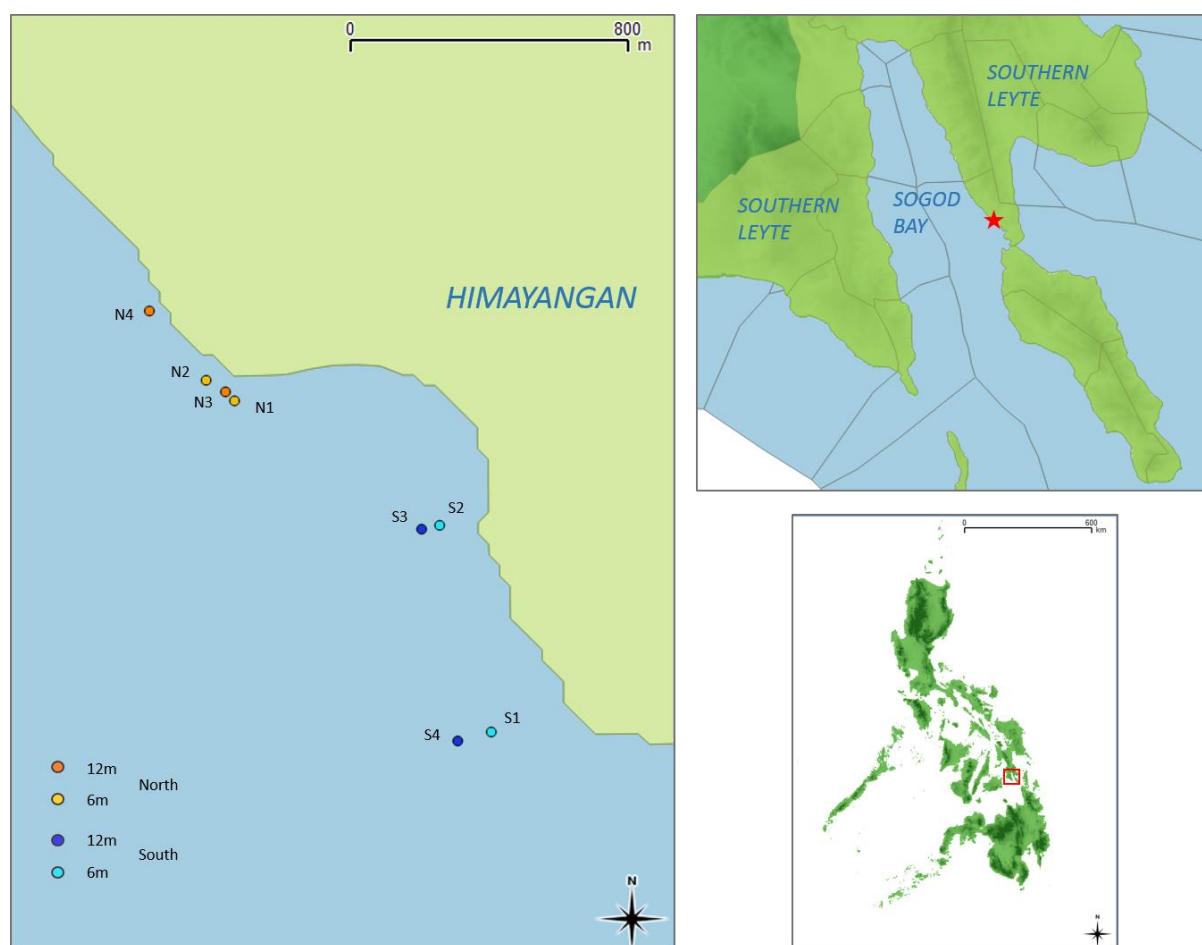


Figure 2. Map of survey sites in Barangay Himayangan

2.2 Biophysical Survey

Assessment of the proposed MPA site as conducted using an enhanced Reef Check methodology which 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 with the addition of extra target species of fish, coral and invertebrates (see Appendix).

Transects were laid along the reef, parallel to the shore, on a north to south bearing. At Himayangan North, two transects were situated at a depth of 6m and two transects were situated at a depth of 12m (Table 1: N1-N4). The same methodology was applied to Himayangan South (Table 1: S1-S4). 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 approximately 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 four transects surveyed along the coast of Barangay Himayangan.

Transect Number	Depth (m)	Easting (UTM)	Northing (UTM)
N1	6	730519	1127343
N2	6	730437	1127403
N3	12	730494	1127368
N4	12	730275	1127605
S1	6	731262	1126382
S2	6	731110	1126982
S3	12	731059	1126969
S4	12	731165	1126357

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: Parrotfish (mulmul, *Scaridae*); Groupers (lapulapu, *Serranidae*) and Snappers (mayamaya, *Lutjanidae*) and were also classified into the size classes 0-10cm, 11-20cm, 21-30cm, 31-40cm, 41-50cm, 51-60cm and >60cm (see Appendix).

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.

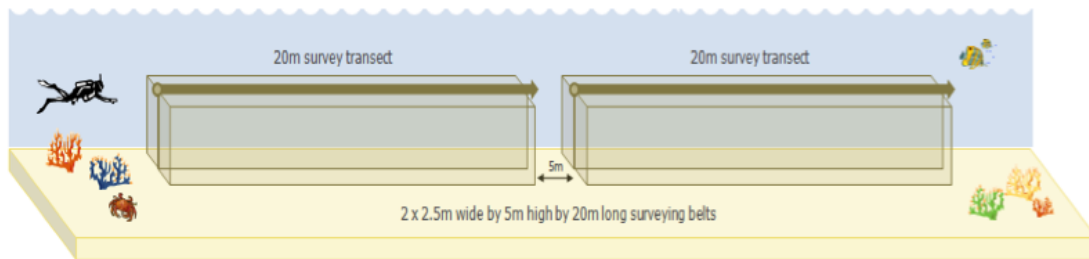


Figure 4. Survey method for recording fish. Diagram shows two of the four 20m replicates within a 100m transect. Fish were recorded within a 5x5x20m imaginary box.

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 (see Appendix). 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.

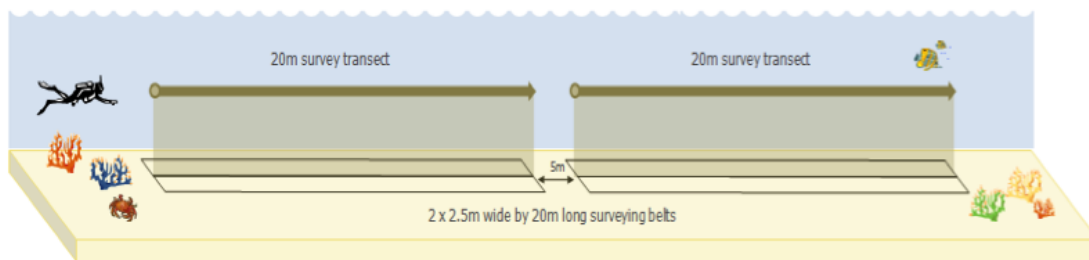


Figure 5. Survey method for recording invertebrates. Diagram shows two of the four 20m replicates within a 100m transect. Invertebrates were recorded within a 5x20m benthic rectangle.

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 minimize 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 (see Appendix).

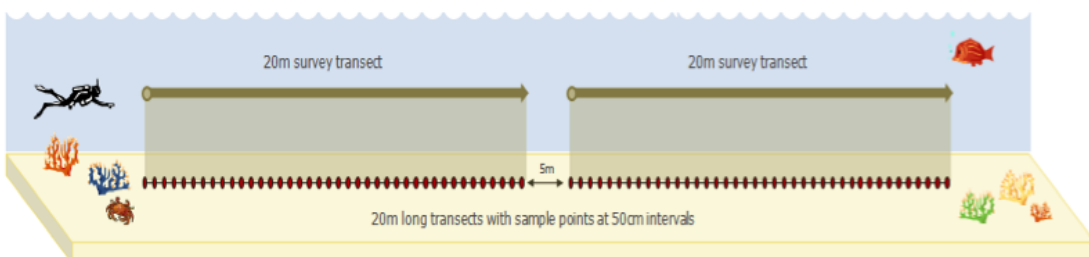


Figure 6. Survey method for recording substrate data. Diagram shows two of the four 20m replicates within a 100m transect. Substrates were recorded along a 'point intercept' line of each 20m replicate.

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 bleaching on 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 surveyed 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 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.

3. RESULTS

3.1. Fish

Mean fish abundance ranged between 29 ± 4.02 and 65.75 ± 12.66 in Himayangan North; and between only 12 ± 2.71 and 29.5 ± 10.69 in Himayangan South (Figure 7). Overall, the fish abundance recorded in Himayangan North was significantly higher than that of Himayangan South ($p < 0.05$). Similarly, the diversity of fish species (fishers α) was significantly higher in the Northern site ($p > 0.05$).

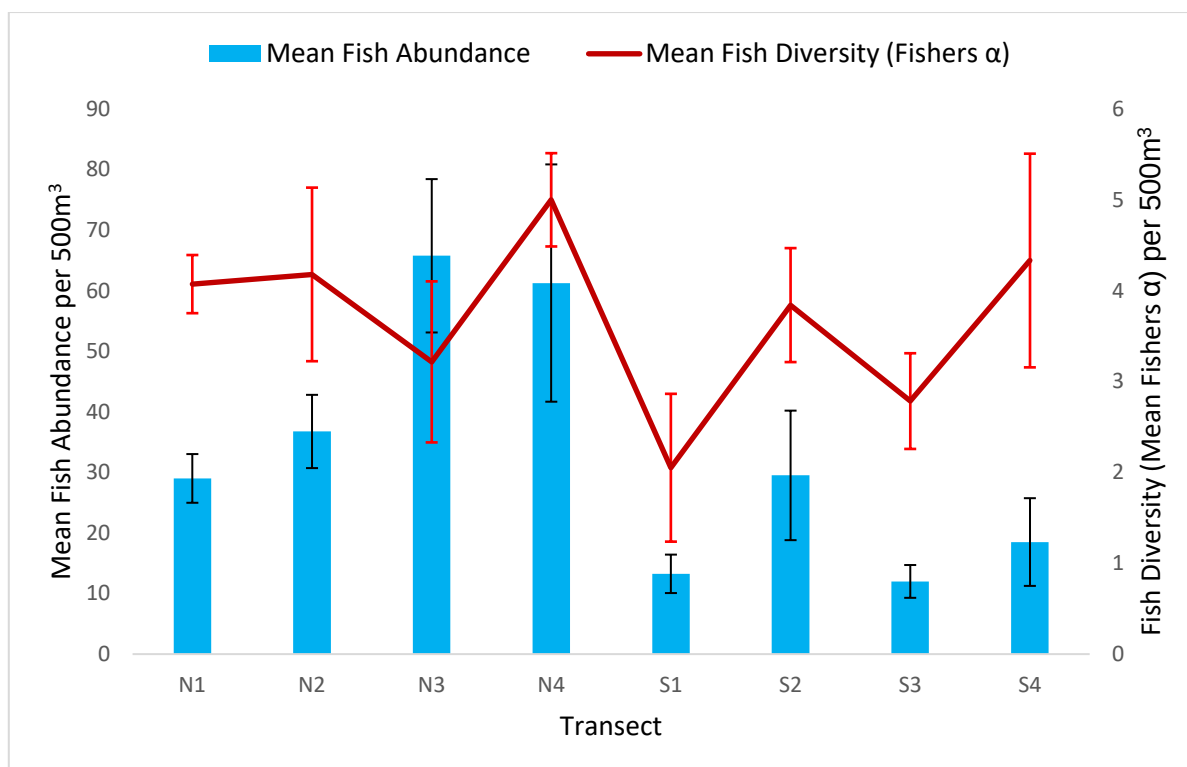


Figure 7. Average fish abundance and diversity at each transect. Blue bars represent mean fish abundance per 500m³, black error bars denote standard error from the mean. Red line represents mean fish diversity (fishers α) per 500m³, red error bars denote standard error from the mean.

The abundance of the commercially important fish families Parrotfish, Grouper and Snapper were recorded in low numbers with a total of only 77 individuals across both sites; overall abundance of the three families combined ranged between 0 and 2.25 ± 0.85 individuals per 500m³ (Figure 8). Of these, 61.04% were Parrotfish, 27.27% were Snappers and a mere 11.69% were Groupers (Figure 9). Transect N4 yielded the highest number of commercially important fish species while zero individuals were recorded at both transects S1 and S3 (Figure 8). Nevertheless, the abundance of commercially important fish species did not vary significantly between sites ($p > 0.05$).

Of the Parrotfish, Grouper and Snapper observed in Himayangan, all were relatively small in size. The length of each fish was recorded to the nearest 10 centimetres with 58.44% falling in to the 0-10cm category, 32.47% within 11-20cm, 7.79% within 21-30cm and only 1% of individuals within 31-40cm in length (Figure 10). No commercially important fish were observed to be greater than 40cm in length.

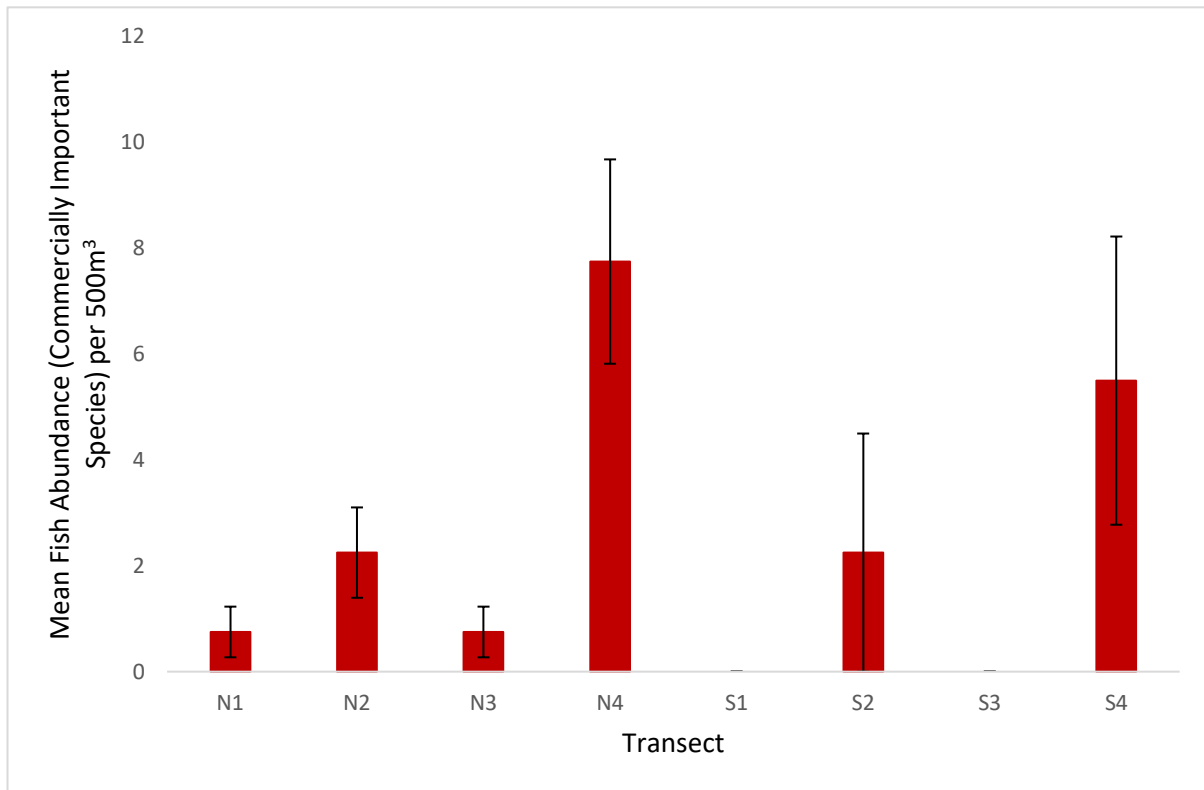


Figure 8. Average abundance of commercially important fish species observed on each transect. Data are mean number of individuals per replicate, error bars denote standard error from the mean.

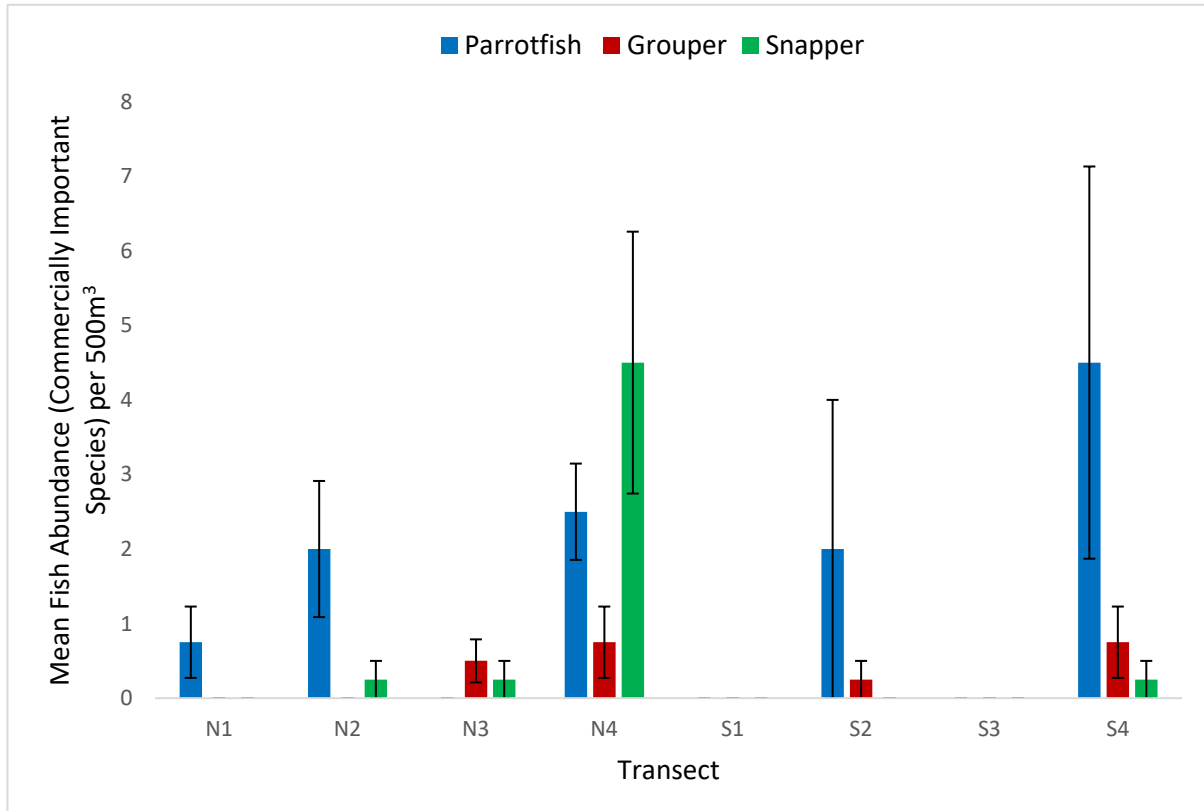


Figure 9. Average abundance of Parrotfish, Grouper and Snapper observed on each transect. Data are mean number of individuals per replicate, error bars denote standard error from the mean.

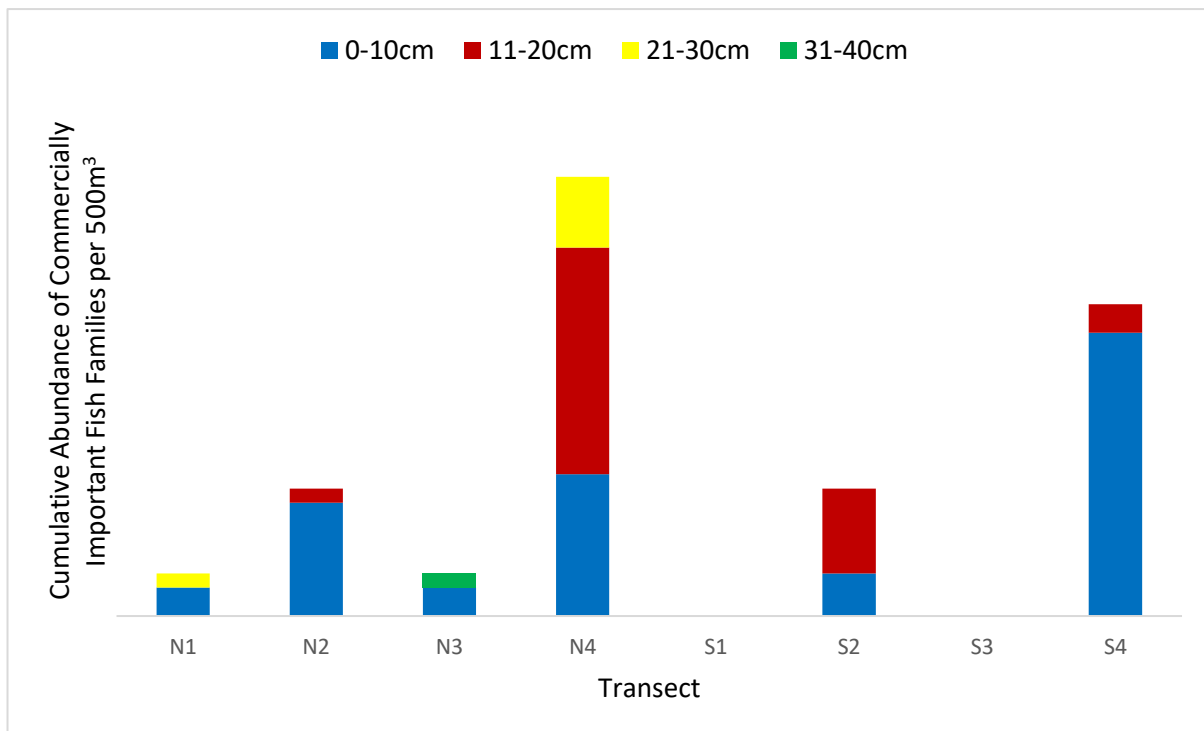


Figure 10. Cumulative abundance of Parrotfish, Grouper and Snapper in size categories 0-10cm, 11-20cm, 21-30cm and 31-40cm across eight transects.

Other commercially important fish species including Bumphead Parrotfish, Humphead Wrasse and Sweetlips were completely absent from the survey area. However, a number of rare marine organisms were sighted including one hawksbill sea turtle *Eretmochelys imbricate* and two blue-spotted ribbontail rays *Taeniura lymma* at transect N3 and a further three *T. lymma* at transects N4, S3 and S4.

3.3 Invertebrates

Mean invertebrate abundance across throughout the survey ranged between 35.75 ± 2.25 and 127.25 ± 27.57 at Himayangan South and between 141.5 ± 29.49 and 285.75 ± 44.45 at Himayangan North (Figure 11); the Northern site yielded a significantly higher abundance ($p < 0.05$). There was no significant difference in invertebrate diversity between sites ($p > 0.05$). 82.94% of individuals recorded across both sites belong to the Phylum Echinodermata of which brittle stars, long spine urchins and feather stars accounted for 21.49%, 37.06% and 40.01%, respectively.

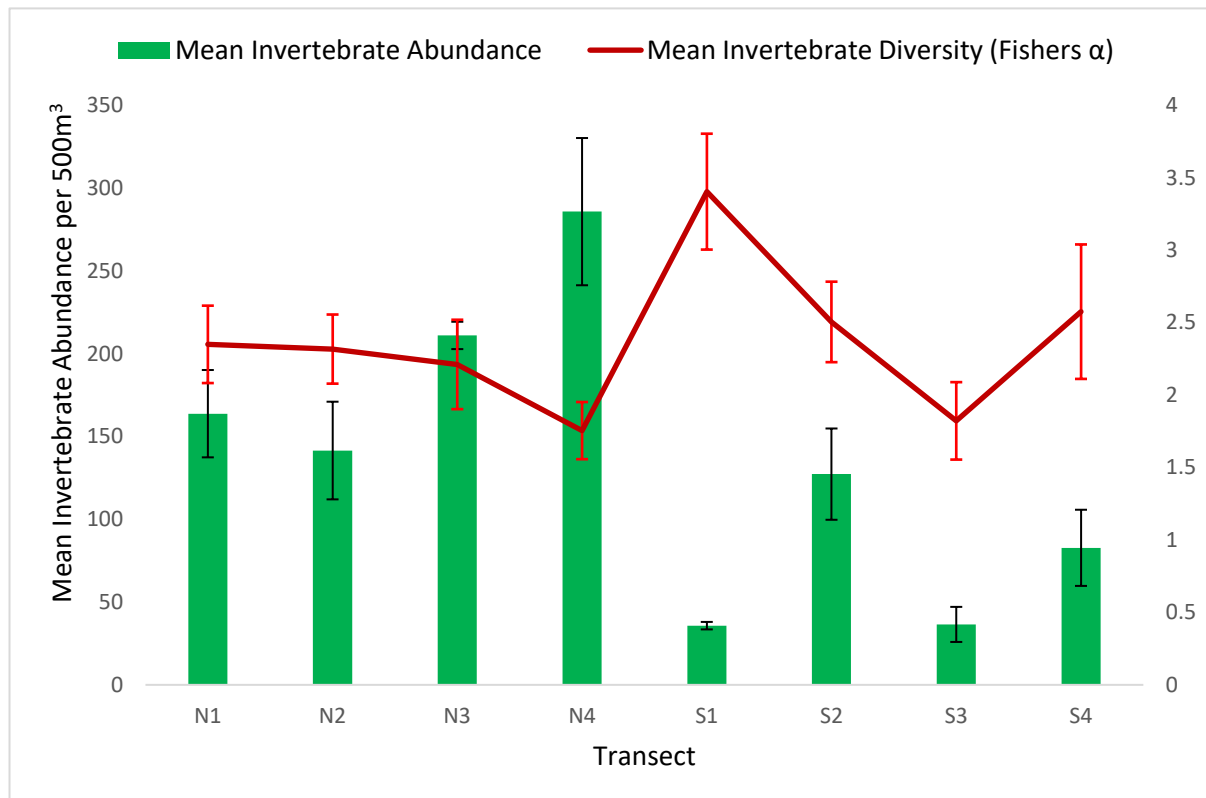


Figure 11. Average invertebrate abundance and diversity at each transect. Blue bars represent mean invertebrate abundance per 500m³, black error bars denote standard error from the mean. Red line represents mean invertebrate diversity (fishers α) per 500m³, red error bars denote standard error from the mean.

Commercially important invertebrate species including lobster (*Nephropidae*), abalone (*Haliotidae*), triton's trumpet (*Charonia tritonis*), squid (*Teuthida*), prickly redfish sea cucumber (*Thelenota ananas*), greenfish sea cucumber (*Stichopus chloronotus*) and pinkfish sea cucumber (*Holothuria edulis*) were entirely absent from the survey.

3.4 Substrates

In Himayangan South sand was the most common substrate covering an average of 38.28% of the total area surveyed, followed by silt with 27.5% and rock with 14.38% mean coverage. Hard coral accounted for only 4.37% of the area surveyed at this site (Figure 12).

In Himayangan North the most prevalent substrate was rock (RC), covering an average of 36.56% of the surveyed area. This was followed by sand (SD) with 19.22%, hard coral (HC) with 15.94% and rubble (RB) with 15.31% coverage (Figure 12). Both hard coral and rock were significantly more abundant at this site than at Himayangan South.

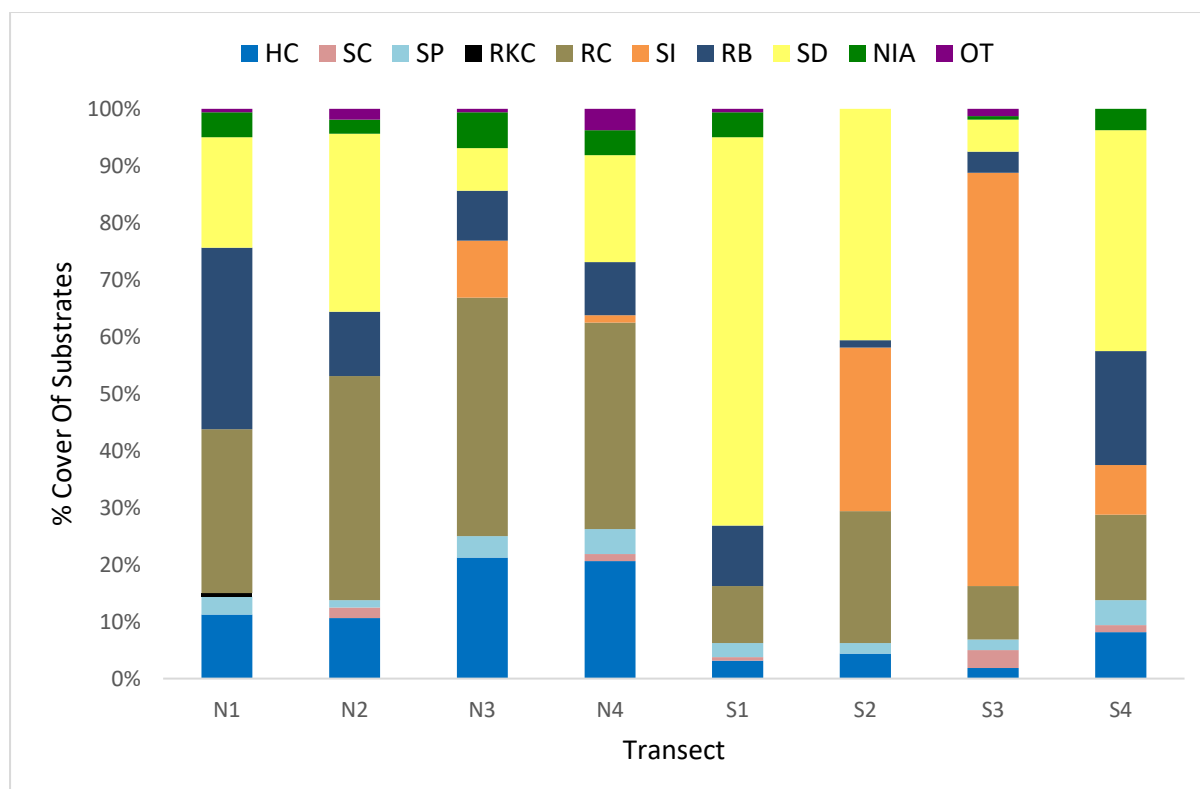


Figure 12. Mean substrate percentage cover at each transect. HC – Hard coral; SC – Soft coral; SP – Sponge; RKC – Recently killed coral; RC – Rock; RB – Rubble; SD – Sand; SI – Silt; NIA – Nutrient indicator algae; OT – Other living organisms

3.2 Anthropogenic Impacts

During the survey period the reefs of Barangay Himayangan showed evidence of moderate to high levels of anthropogenic impact. Trash was recorded on each transect with instances discarded fishing gear on all Northern transects and transect S3. There were no obvious signs of boat or anchor damage however low levels of undetermined coral damage were observed on transects N1, N2, N3, S1 and S4.

At Himayangan North low levels of coral bleaching were recorded on three out of four transects. Less than 1% of the population were affected with an average of 60% bleaching on individual colonies. In Himayangan South low levels of bleaching were recorded on two out of four transects. Approximately 2.75% of the population were affected with an average of 71% bleaching on individual colonies. Coral colonies on both transects N2 and S1 showed signs of predation however no colonies within the surveyed area were affected by disease.

4. VISUAL ASSESSMENT

Images taken by CCC volunteers on the reefs of Himayangan.



Figure 13-16 (clockwise from top left): False clown anemonefish *Amphiprion ocellaris*; Panda anemonefish *Amphiprion polymnus*; Ringed pipefish *Dunckerocampus dactyliophorus* and White-eyed moray eel *Gymnothorax thyrsoideus*.



Figure 17-23 (clockwise from top left): Blackspotted sea cucumber *Bohadschia graeffei*; Granular seastar *Choriaster granulatus*; Giant clam *Tridacna gigas*; Crown of Thorns seastar *Acanthaster planci*; Batangas Halgerda nudibranch *Halgerda batangas*; Creamy chromodoris nudibranch *Chromodoris fidelis* and Bennett's feather star *Oxycomanthus bennetti*.



Figure 24. Sand is the prevalent substrate in Himayangan South with rock, rubble and hard coral interspersed.



Figure 25. General household trash was recorded on all transects and across both sites.



Figure 26. A hard coral colony shows signs of bleaching.

5. DISCUSSION

CCC's assessment of the reefs in Himayangan North and South revealed that there is a vast difference in fish, invertebrate and substrate composition between the two sites. Both sites suffer from moderate to high levels of anthropogenic impact and low levels of predation and bleaching. Overfishing is a major threat to both areas and high levels of general and fishing trash are a cause for concern. Nevertheless, the reefs of Himayangan show potential for recovery which could be instigated by the implementation of an MPA. Trends observed across the survey site are discussed in relation to management in the following sections.

5.1 Fish

Fish abundance was found to be significantly higher in Himayangan North than in Himayangan South ($p < 0.05$) with transects N1-N4 all yielding a higher abundance of fish than S1-S4. The highest abundance of fish was recorded at transect N4 which yielded 61.25 ± 19.58 individuals per 500m^3 . This can mostly be attributed to the presence of a large number of fusiliers observed in this particular area. Rather than a large school of fish, as in which fusiliers are generally sighted, low to moderate numbers (4-70) fusiliers were sighted on all four replicates of transect N4. This suggests that fusiliers are common in this area, rather than a single school simply passing through.

Fish diversity (Fishers α) did not differ significantly between sites; ranging between 2.05 ± 0.81 and 4.33 ± 1.18 in Himayangan South and 3.21 ± 0.89 and 4.33 ± 1.18 in Himayangan North. Although the number of fish recorded was much higher in the Northern site, the number of fish species present on the reef is similar at both sites. This suggests that while the reefs at both sites are suitable to accommodate the same types of fish the population in Himayangan South may be limited by other factors.

Commercially important fish families Parrotfish, Grouper and Snapper were recorded in low numbers across the entire area surveyed, with no significant difference in abundance between Himayangan North and South. A combined total of only 77 individuals were recorded across both sites of which 61.04% belonged to the Parrotfish family (Scaridae), 27.27% the Snapper family (Lutjanidae) and 11.69% the Grouper family (Serranidae). The highest abundance of commercially important fish was observed at transect N4 (7.75 ± 1.93 per 500m^3) and the lowest at transects S2 and S4 where they were completely absent.

Of the Parrotfish, Grouper and Snapper which were recorded in Himayangan, all were relatively small in size. The majority of fish (58.44%) were recorded in the smallest category of 0-10cm and no individuals were greater than 40cm in length. This strongly suggests that the reefs of Himayangan suffer from overfishing, with the largest members of the population having already been extracted. These commercially important fish families take many years to increase in size and reach sexual maturity; Snappers have been shown not to mature until they are approximately 54.6 cm in length. As such, a population with no individuals larger than 40cm is incapable of replenishing itself (Froese and Pauly, 2001). The fecundity (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 the largest individuals from a reef removes the most reproductively active individuals, inhibiting future growth of the population.

There were no observations of other commercially important species including Bumphead Parrotfish, Humphead Wrasse or Barramundi Cod. This supports the suggestion that these desirable food-fish species have been overfished in the area. The Humphead Wrasse is the most sought after 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).

Blue-spotted ribbontail rays, *Taeniura lymma*, are a common sighting in Himayangan, with five spotted by volunteer divers throughout the survey. A hawksbill sea turtle, *Eretmochelys imbricate*, was also observed feeding in the area. Such rare marine creatures are a desirable attraction for SCUBA divers and may serve to establish the waters of Himayangan as a dive site. If this area were protected and properly promoted, diving and snorkelling fees could make a healthy contribution to the economy of the local Barangay.

5.2 Invertebrates

Invertebrate abundance was found to be significantly higher in Himayangan North than in Himayangan South ($p < 0.05$) with transects N1-N4 all yielding a higher abundance of invertebrates than each of the Southern transects S1-S4. The majority (82.94%) of invertebrate organisms recorded across both sites were Echinoderms, largely feather stars, long spine urchins and brittle stars. These families are all indicators of a healthy and diverse reef system. Indeed long spine urchins are important for the control of macro algae and preventing a shift to algal dominated reefs. This is particularly important on reefs which have suffered overfishing of herbivorous fish. Invertebrate diversity (Fishers α) did not differ significantly between sites.

The absence of commercially important invertebrate including lobster, squid, triton's trumpet and prickly redfish, greenfish and pinkfish sea cucumbers from Himayangan indicates high levels of overfishing in the area. Each of these species is highly sought after as a food product.

Lobsters are highly prized 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. Their presence on the reef is ecologically significant because they filter and digest sand, producing pellets that aid in reef formation. However they are easily extracted from the reef by free divers or fishers at low tide and, as such, are regularly targeted by humans as a food substance (Hodgson and Liebel, 2002).

Triton's trumpets 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. They are an ecologically important invertebrate species on Indo-Pacific reefs as one of the very few predators of CoTs (Crown of Thorns Starfish). If top predators such as the triton's trumpet are removed from an ecosystem, the risk of a CoTs outbreak is increased.

Nonetheless, only six individual CoTs were recorded throughout the survey site; a positive sign for the health of the reefs in Himayangan. 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 on 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).

5.3 Substrates

The composition of substrates varied significantly between Himayangan North and South. The prevalent substrate in the South was sand, which covered 38.28% of the surveyed area followed by silt with 27.5%. 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 Liebeler, 2002). However, hard coral cover was extremely low in Himayangan South and accounted for only 4.38% of the substrate. In a coral 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. As such, the low abundance of hard coral in Himayangan South reduces this areas ability to support a healthy population of marine life.

The substrate in Himayangan North yielded a significantly higher proportion of hard coral ($p < 0.05$) which accounted of 15.94% of the surveyed area. Although this is still low in comparison to the Indo-Pacific average of 40%, there is potential for this site to recover. The most prevalent substrate here was rock, covering an average of 36.56% of the substrate. Unlike the sand-dominated sea floor of the Southern site, the rocky surfaces here provide a suitable area for attachment of new coral colonies and creates opportunity for the hard coral community to increase. In order to achieve this, the reefs should be protected against destructive fishing practices including dynamite, cyanide and trawling.

5.4 Anthropogenic Impacts

The Coral Reefs in Himayangan appeared relatively healthy, showing no signs of disease and low levels ($< 1\%$) of coral bleaching. However, signs of moderate to high levels of anthropogenic impact were observed. Coral damage and discarded fishing gear were observed on five out of eight transects, while general household trash was present across all transects. 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 disappear over time. The presence of such trash tends to deter divers from visiting or returning to a site, therefore to improve the site for recreational diving trash levels should be greatly reduced.

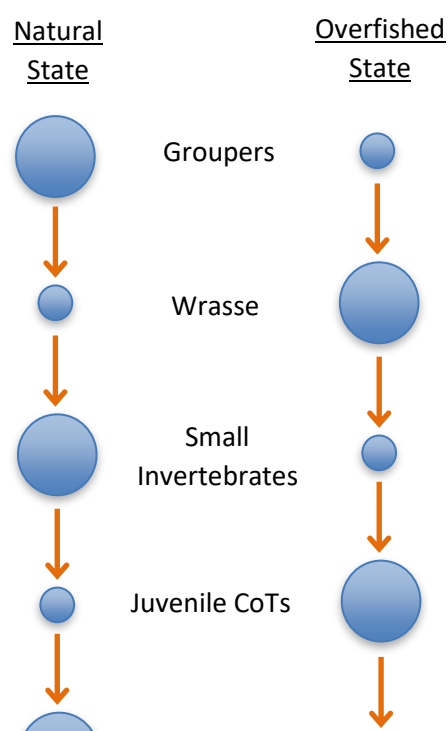


Figure 27. Representation of indirect effects that overfishing of predatory fish, Groupers can have on the entire coral ecosystem. The size of the circle represents the relative abundance of that organism or trophic level.

The local community may be unaware that the improper disposal of general waste negatively affects the health of reefs. 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.

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 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 17). 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 of Himayangan currently appear to be in decline, with low coral cover, low abundances of small, commercially important fish and moderate to high levels of anthropogenic impact. However Himyanagan North, in particular, exhibits excellent potential to increase in hard coral cover and fish abundance. This is also known to be habitat for rare species which are highly attractive to divers thus providing a major selling point for eco-tourism. In their current state the reefs are in danger of declining further and if protection is not afforded fish densities may decrease 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 could reverse these trends and allow the reef to fully recover, with lasting benefits for the community of Barangay Himayangan.

6. RECOMMENDATIONS

CCC strongly recommend for the waters of Himayangan 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 zones 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 within the waters of Barangay Gudan. 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 Himayangan.

6.1 Recommendation for the Establishment of a Marine Protected Area in Himayangan

Of the two sites surveyed in the Barangay of Himayangan, North and South, the data suggests that reef was superior in terms of fish, invertebrates and substrates in Himayangan North. Protecting this area would allow the hard coral cover to increase, allow fish stocks to recover and potentially create funding in the form of eco-tourism. Taking this in to consideration, Coral Cay Conservation recommends that a new Marine Protected Area be established in the area encompassing transects N1-N4 (Figure 28).

This would additionally benefit by having Marine Reserve buffer zones of 50m which restrict all but hook and line fishing.

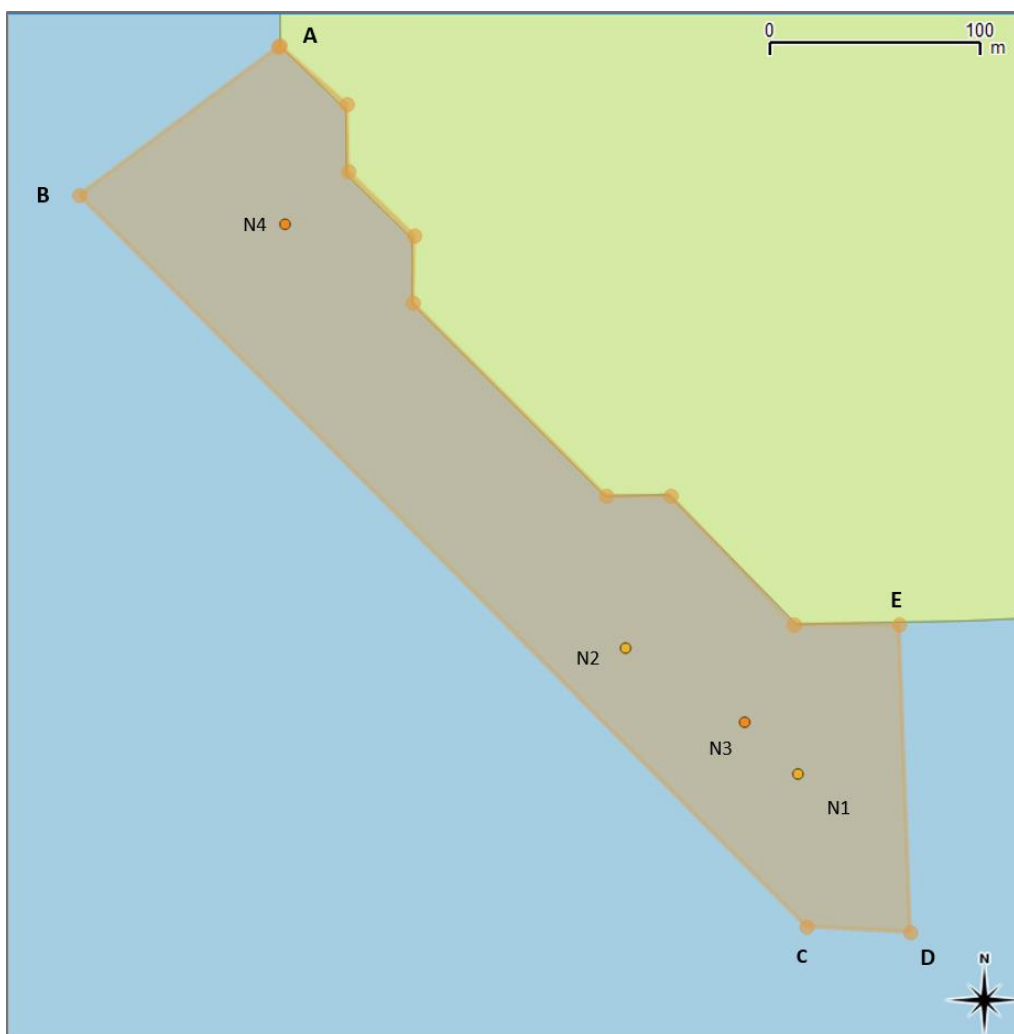


Figure 28. Proposed boundary location for Barangay Himayangan Marine Protected Area.

Table 2. Boundary coordinates for proposed Marine Protected Area in Barangay Himayangan

Boundary Point	Easting (UTM)	Northing (UTM)
A	730272	1127690
B	730177	1127618
C	730523	1127271
D	730572	1127268
E	730272	1127415
Total MPA area:		4.73 ha

All recommendations are flexible and the final designation will be the result of a collaboration of CCC with the Municipality of Liloan and the local community of Himayangan, in particular the local fisherfolk. CCC provide suggestions on what is the ecological ideal, but understand that there are other factors to consider during the decision making process. As such, the scenarios outlined here should be

used as the initial step in opening a dialogue between all relevant aforementioned stakeholders in order to come to the best possible conclusion for all parties.

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 its success. 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 Gudan 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 in Himayangan 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: TARGET SPECIES LIST

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		

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	

Common Name	Latin Name	Visayan Name
Angelfish	Pomacanthidae	Adlo
Barracuda	Sphyrnidae	
(Butterflyfish)	Chaetodontidae	Alibangbang
(Big) Longnose Butterflyfish	Forcipiger flavissimus	
Eastern Triangle Butterflyfish	Chaetodon baronessa	
Humphead Bannerfish	Heniochus varius	
Kleins Butterflyfish	Chaetodon	
Raccoon Butterflyfish	Chaetodon lunula	
Redfin Butterflyfish	Chaetodon lunulatus	
Vagabond Butterflyfish	Chaetodon vagabundus	
Cardinalfish	Apogonidae	
(Damselfish)	(Pomacentridae)	
Anemonefish	<i>Amphiprion</i> sp.	

Sergeant Damselfish	Pomacentridae	
Emperor	Lethrinidae	Katambak
Fusilier	Caesionidae	Dalagangbukid
Goatfish	Mullidae	Timbongan
Groupers	Serranidae	Lapu-lapu
Jack/Trevally	Carangidae	Talakitok
Lionfish	Scorpaenidae	
Lizardfish	Synodontidae	
Moorish Idol	<i>Zancluscornutus</i>	Sanggowanding
Moray Eel	Muraenidae	
Parrotfish	Scaridae	Mulmul
Pufferfish	Tetraodontidae	
Rabbitfish	Siganidae	Kitong
Ray	Rajiformes	
Sandperch	Pinguipedidae	
Scorpionfish/Stonefish	Scorpaenidae	
Snapper	Lutjanidae	Maya-maya
Spinecheeks	Nemipteridae	Silay
Squirrelfish/Soldierfish	Holocentridae	
Surgeonfish	Acanthuridae	Indangan
Unicornfish	<i>Naso</i> sp.	
Sweetlips	Haemulidae	Lipti
Toby	Tetraodontidae	
Triggerfish	Balistidae	Pakol
(Wrasse)	(Labridae)	
Crescent Wrasse	<i>Thalassomalunare</i>	
Humphead Wrasse	<i>Cheilinusundulatus</i>	
Red Breasted Wrasse	<i>Cheilinusfasciatus</i>	