

Justification for Marine Protected Area establishment in Hinoba-an municipality, Negros Occidental, Philippines

An assessment of baseline survey data of the reefs of Hinoba-an



Report submitted to the Mayor of Hinoba-an and
The Philippine reef and Rainforest Conservation Foundation Inc.
(PRRCFI)

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



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Executive Summary

Negros Island, as part of the Visayas, Philippines, supports significant areas of coral reef and tropical forest, two of the most diverse ecosystems on earth. The region lies in one of the most biodiverse areas on Earth and its reefs and rainforests support a large number of endemic species. These ecosystems also provide an important source of food and revenue for local communities. However, both the reefs and forests of Negros are under increasing threat from a range of anthropogenic activities.

The Southern Negros Coastal Development Programme (SNCDP) is an initiative of the regional government to encourage the conservation and sustainable use of their natural resources. The Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and Coral Cay Conservation (CCC), have been collaborating within this programme to provide an accurate baseline assessment of the coral reefs in the region. The project also obtains monitoring data from reefs and forests and provides community organising and training, conservation education opportunities for Filipino counterparts and alternative livelihoods at the local community level.

From March 2000 until June 2001, CCC conducted baseline surveys in the region of the municipality of Hinoba-an. Fringing reefs and offshore patch reefs were surveyed in order to describe benthic community classes, identify fish communities and gross anthropogenic impacts. Data were used to establish a GIS-compatible database and a detailed qualitative and quantitative data analysis is presented in this report where distribution of different habitats, motile invertebrate and fish communities are presented. Analysis showed that habitats were physically and biologically diverse and in 'good' to 'fair' health compared to many reefs of different sections of the Negros coast, and wider Philippine region. This report also distinguishes areas that have been impacted by both anthropogenic and natural disturbance.

The most significant anthropogenic impacts appeared to be sedimentation and over-fishing. Sedimentation has affected the reefs in areas adjacent to rivers and in areas with poor circulation. Important commercial fish communities appeared to be similar across all habitats and were of small size, although areas of greater benthic diversity exhibited similarly diverse fish communities. It appears that Hinoba-an reefs were affected by the 1998 coral bleaching event to different degrees at different locations. We provide evidence that certain coral areas have better survived this periodic stress.

As a result of the analysis, possible sites for marine protected areas in the region were identified (three distinct areas). It is recommended that the SNCDP should continue its education and training initiative to inform local communities of the importance of these diverse and relatively healthy areas. Establishment of an Integrated Coastal Zone Management Plan for Southern Negros is recommended, which should encompass forests, mangroves and coral reefs. Key supporting activities should include the strengthening of conservation education opportunities within local schools and communities and provision of further skills training programmes to establish a Filipino-led team capable of carrying out long-term surveys and monitoring programmes.

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1.0 Introduction

1.1 Introduction and background to Marine Protected Areas (MPAs)

The science surrounding the development of Marine Protected Areas (MPAs) for coral reefs has become more sophisticated and community orientated over the last 10-15 years (Mascia, 2001; Roberts and Hawkins, 2000, Alcala and Russ, 1996). MPAs have in the past, been drafted and passed without consideration of the implications and effect on local fishers and commercial developments in upland areas. The recognition of the importance of engaging the stakeholder community has been addressed in the recent past, and is highlighted in recent community-based MPA development strategies (Beger *et al.*, 2000, Gladstone, 2000).

As a result of poor long-term involvement of stakeholder communities in MPA development, the Philippines has a large quantity of 'paper parks' where coral reefs are not protected in the long term, and where community involvement is negligible after the initial start up phase. Philippine MPAs have been established, and in many cases, initiated through the backing of small local communities (eg. 'Barangays' in the Philippines). This smallest level of local (village) authority has responsibility and holds respect over the local community and is the key to the ongoing success of the MPA. By establishing parks without carefully thought out planning and discussion between the implementing agency and the stakeholders, there will be no successful application of recommendations of the MPA by local, or outside resource users.

The problem of creating an MPA without successful and determined thought and through-put of ideas, training and education, and without facilitating alternative livelihoods for fishermen, will leave the area bereft of ideas and a positive legacy for the future sustainability of its resources. By leaving an area as a 'paper park' without practical programmes in place to protect marine resources, outsiders and local stakeholders will imagine that the area will always be in a 'healthy' state as it is termed a park, regardless of continuing unsustainable extraction of its resources. The danger of this situation within the Philippines cannot be understated. One need only look at the level of enforcement of coastal areas within the Philippines in order to see the different levels of protection for marine protected areas (Fig. 1).



Figure 1. Philippines MPAs. Location and level of protection of marine protected areas in the Philippines (source: Haring Ibon, vol 3, 2001)

1.2 Justification for Marine Protected Areas (MPAs) in the Philippines

Philippine reefs are amongst the most diverse coral reefs in the world (there are over 70 genera of coral on Danjungan Island, Negros Occidental (Gill *et al.*, 1996)). However only 4.3% of Philippine reefs are now in excellent condition with at least 75% hard coral cover. This leaves an overall hard coral cover figure for the Philippines of 32.3 % (Licuanan and Gomez, 2001). Total reef fish landings in the Philippines have increased dramatically by 51% from 1976 to 1997 (Coastal Resources Management Programme, 1999). However, the population of fishermen causing this increase in supply has resulted in a phenomenal reduction in catch per unit effort over this period. This is markedly demonstrated by the figures in the increase of tonnage of the Philippine commercial fishing fleet which rose by 43.8% between 1988 and 1994 to 216,090 tonnes. In this period, the fishery of the country produced a net loss in landings (Coastal Resource Management Programme Report, 1999). This shows that as a whole, the fisheries of the country are severely over-exploited, and alternative livelihoods and protection for remaining stocks is a high priority.

1.3 Selection criteria for Marine Protected Areas

Designs of MPAs in size, location and management level are often chosen in considering biodiversity, level of threat and social criteria (Salm and Clark, 1989) or in accordance with habitats present in the area, depending on the management aims. Selection criteria for MPAs in the Philippines have been identified as follows (Chou, 1998):

(a) Social suitability

The MPA is accepted and supported by the local community.

Remaining fishing grounds can still provide income to fishermen (particularly for the phase immediately after establishment).

(b) Economic suitability

The local economy is not significantly disturbed by removal of part of the fishing grounds.

The selected area is suitably accessible for generation of income through tourism.

(c) Ecological and social suitability

- *species diversity*

High diversity of corals, fish and marine plants ensure high conservation value.

- *naturalness*

Low level of adverse human impacts, natural status of the reef.

- *dependency*

Adjacent areas depend on the MPA area as a source for larvae, nursery areas for juveniles and food supply (nutrients, plankton, organisms).

- *representativeness*

The MPA area represents a typical reef natural to the region, or represents one of the remaining healthy spots which still retained high species diversity.

- *uniqueness*

The MPA contains features, which are unique and could not equally be conserved on a different site.

- **integrity**

The size of the MPA is appropriate to provide integrity of the reserve.

- **productivity**

The reef contains a high level of features supporting a high productivity, such as topographic variety (hiding places, crevasses, walls, caves) and a high species diversity to support a multitude of organisms (for example selective corallivores), and has the potential to support more fish biomass than surrounding adjacent reef areas.

- **vulnerability (natural impacts, anthropogenic impacts)**

(i) natural impacts

Natural resistance to coral bleaching – MPA has good water exchange to minimize likelihood of raised seawater temperatures.

Crown of thorns – numbers are low enough not to be a threat to the existing live coral reef.

(ii) anthropogenic impacts

Sedimentation – MPA is located in area less exposed to sediment carried by rivers or entering from coastal erosion.

Coastal development – Building and operation of coastal development (resorts, road construction, ports) are located a considerable distance away from the MPA. If these activities exist, they are properly planned, approved and managed.

Sewage – The MPA is located a significant distance away from existing sewage disposal units (for example outlet pipes), such that eutrophication levels are negligible. New facilities/developments in the vicinity of the MPA are adequately planned and managed to widely accepted water disposal standards.

1.4 Overview of the inland geography and coastal resources of the Philippines and Negros Occidental

Coral reefs of the Philippines cover approximately 25,000 km² of the whole archipelago (over 7000 islands) (Fig. 2). Within these reef systems are upwards of 499 coral species (Chou, 1998), and well over 2500 fish species (Lieske and Myres, 2001).



Figure 2. Map of the Philippines, showing the location of Negros Island in the central Visayas.

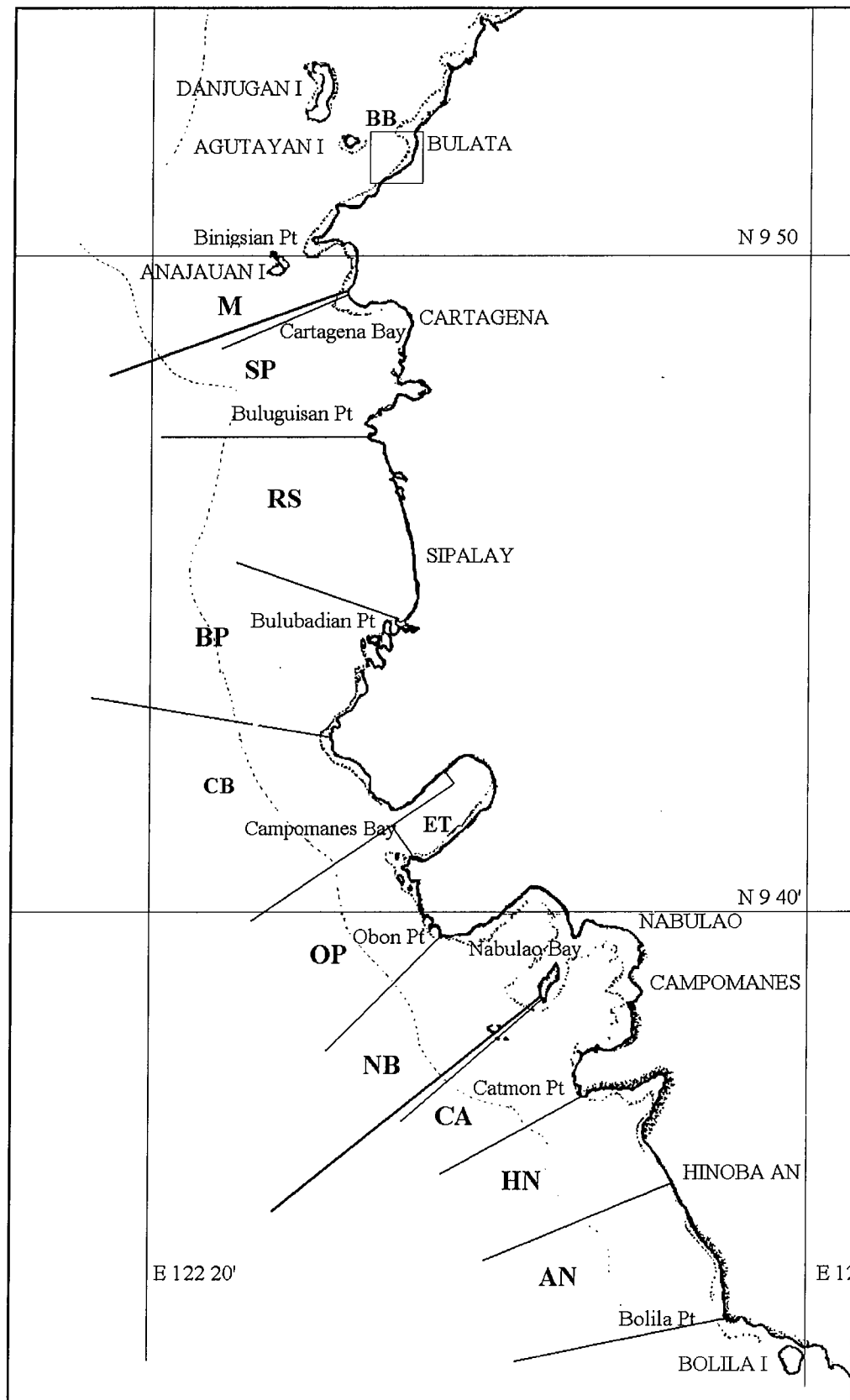


Figure 3. Map of south west Negros Island (site of the Southern Negros Coastal Development Programme), showing the location of Danjugan Island, Campomanes Bay and Hinoba-an. CCC baseline survey sectors are shown in capitals.

Along the western seaboard of Negros Island (Negros Occidental) there are coral reefs, mangroves and seagrass beds. Coral reefs dominate in the south west coast of Negros Occidental (especially south of $N 9^{\circ} 60'$) in the region of coast stretching between Batas (municipality of Cuauayan) and Bolila Island (municipality of Hinoba-an) (Fig. 3). North of this region, there is freshwater input between Ilog and Silay from the mountainous region of Mandalagan and The Kanlaon volcano. Extensive input of freshwater restricts coral recruitment and growth around central western coasts due to low salinities and heavy sedimentation.

1.5 Threats to the coral reefs of Negros Occidental

1.5.1 Sedimentation and nutrification

The freshwater input to the coast in this region is coupled with fertiliser run-off from the extensive sugar cane industry, which is predominant in the plains between Ilog and Silay on the western coast. The rich volcanic soils of the mountains coupled with high precipitation has led to massive agricultural growth which has considerably altered the natural landscape of the island over the last 100 years (Heaney and Regalado, 1998). Deforestation of Negros in order to gain foreign currency from hardwoods, provide space for the crop farming of sugar cane and maize for the local population has exacerbated down stream impacts on local coral reefs. Negros now has less than 5% of its original forest cover remaining in areas inaccessible to loggers (in the mountains of Mandalagan and Cuernos de Negros in the south east). Much of the rainfall and associated nutrients in Negros run straight to the coast, and don't become locked by the root system of the original forest trees due to logging. This causes the soil of the denuded landscape to be shifted out to the coastal areas through the extensive estuaries of the mainland. Sedimentation smothers coral polyps and reduces the light attenuation of the water. This restricts the photosynthetic capability of the coral symbiont (zooxanthellae) within the tissues of the coral host, thus significantly stressing the coral host. It is estimated that sedimentation is the most serious problem affecting the health of coral reefs in many parts of the Philippines (Hodgson, 1997). A recent study in El Nido, Palawan linked the increase in sedimentation, subsequent death of corals, and reduction of coral reef fish numbers to the logging upland in the Bacuit Bay region (Hodgson, 1997). Here, the author highlighted 4 key statistics related to increased sediment load on the coral reefs of Bacuit Bay:

1. He found an annual decrease in coral cover of 1% for every additional 44tons/km² of annual sediment deposition in Bacuit Bay.
2. The above sedimentation rate results in the local extinction of one coral species per year.
3. Fish biomass decreased by 2.43% for every 1% reduction in coral cover in Bacuit Bay.
4. For each annual loss of one coral species, associated with coral cover loss, the annual fish biomass decreased by 0.8%

Deforestation of the forest of Negros has not been the only threat to its marine resources. The associated decrease in fish stocks related to the poorer coral environment has been further threatened by the massive increase of the Philippine population. The Philippines population growth rate of the last 30 years has decreased

from 3.3. to 2.3%, but this still means that the population will double to around 128m people by 2025. At the moment, approximately 60% of this population is dispersed around 60 coastal barangays (Jacinto *et al.*, 2000) in the country, putting excessive pressure on fringing coral reefs.

1.5.2 Overfishing

The population of Negros Island has at least quadrupled in the last century from around 500,000 to over 2m people today (Heaney and Regalado, 1998). Large numbers of these people live along the coastal fringe and have been fishing the waters of south west Negros for many years. The intensity of fishing pressure has put the marine resources of this coastline under severe threat.

The small-scale coral reef fishery is the most obvious artisanal fishery in Negros. Many fishing bancas in the area are only large enough for one or two individuals to sit in the boat and either spear fish, use simple hook and line, or small wall nets. These fishermen with conventional gear types, and limited use of motor engines were increasingly extracting predator fish from the coral reefs. This predator-fish extraction has occurred to such an extent that many species are now locally extinct (such as *Cheilinus undulatus*), and those that do occur are seen at very small size classes (Russ and Alcala, 1989). Because of the limited power and seaworthiness of these small vessels, and the nature of the narrow fringing reef of south-west Negros, fishing effort has historically impacted onto a small area of fringing coral reef. The deleterious impact of a large artisanal fishing fleet on fish populations of narrow fringing reefs has been seen on the north coast of Jamaica (Munro 1969, Sary *et al.*, 1997). This effect is being echoed on Negros reefs.

Since the advent of larger vessels, the gear type and technology within the artisanal and commercial fishing industry has increased whereby boats man larger numbers of crew in order to deal with greater net size (muro-ami, seine nets). These gear types, and the subsequent reduction in fish available to artisanal fisherman, has led (in part) to the advent of destructive fishing practices. Here, methods used to gain the necessary biomass of fish to support coastal communities include the use of dynamite, poison (cyanide), night compressor fishing and muro-ami fishing (Licuanan and Gomez, 2000). All these methods rapidly remove the remaining fish biomass, but also the important and slow-growing corals (fish habitat) of coastal waters. Therefore, the advent of these fishing practices has led to vast destruction, and long-term problems of re-generation of these fisheries. Some of the large coral heads (such as *Porites lobata* and *Diploastrea heliopora*) take thousands of years to grow to the size of large houses (up to 3 metres tall). These colonies can be destroyed by a single dynamite blast, destroying the habitat for a multitude of other invertebrate and vertebrate species.

Clearly, it is the aim of the Southern Negros Coastal Development Programme (SNCDP) to eliminate destructive fishing practices, and eradicate overfishing from particular areas that still remain biodiverse – in order to protect the remaining 35% of Philippine reefs that are in good in condition (Gomez *et al.*, 1994). Here, the baseline surveys of CCC can distinguish healthy reef areas from areas that are beyond the likelihood of medium-term (10-15 years) recovery.

1.5.3 Other threats

1. Mangrove clearance – some local populations are not aware in that mangroves stabilise the sediments flowing out of estuaries, filter the water of fertilisers and provide a natural nursery for juvenile fish.
2. Discharge of untreated domestic and industrial waste.
3. Infestations of crown of thorns starfish and *Drupella* sp. invertebrates that both are able to feed on large tracts of live hard corals, and therefore significantly reduce localised coral cover.
4. Continued bleaching events (caused by considerable warming of surface waters). A world-wide bleaching event in 1998 (Wilkinson, 2000) severely affected reefs of western Negros, and killed large swathes of hermatypic corals (Solandt *et al*, 2000).

1.6 Aims

The aims of the surveys undertaken by CCC volunteer divers, and PRRCFI were to:

1. Undertake assessments of the coral reefs of Hinoba-an district and recommend areas of high biodiversity of coral reef associated organisms, in particular hard coral species, fish species that indicate diversity, and fish species that are important to the local fishery and biodiversity. Also, to recommend those areas that are more likely to succeed as protected areas, and have less associated threats than the rest of the coastline.
2. Help to integrate a training programme that allows both student, and agricultural/fisheries managers to be take part in the coral reef survey effort, and lead them to become facilitators and spokespersons on behalf of the local coral reef ecosystem.
3. Undertake and participate in education and field course programmes for local schools of Negros to allow the future generations of Negros to respect the marine environment, and understand the importance of sustainability.
4. Provide adequate infrastructure for a training and education programme (this is being achieved through the construction of an education centre near Danjugan Island).
5. Provide alternative livelihood mechanisms that take pressure away from the coral reef fishery.
6. Provide recommendations and reports to facilitate the smooth transition from open access fishing policy to harmonious municipal-led, community-enforced governance of MPAs in Cuauyan, Sipalay and Hinoba-an.

2. Methods

The following survey assessment methodologies were utilised during the survey period:

- Coral Cay Conservation (CCC) baseline marine surveys for reef assessments of fauna and flora (Mumby *et al.*, 1996)
- Taxonomic recording (species lists) of important fish and coral species.
- Qualitative reporting from the field site to CCC-UK on a weekly basis in order to facilitate fast information flow after initial data collection.

The Southern Negros coastline, including the Municipality of Hinoba-an, was divided into distinct survey sectors (Fig. 3). Borders of survey sectors were established using major features in the landscape such as river estuaries or conspicuous headlands.

Following an intensive training programme, CCC's techniques have been shown to generate precise and consistent data appropriate for baseline mapping (Mumby *et al.*, 1995). All surveys are co-ordinated by marine biology qualified Project Scientists and Science Officers to ensure accurate and efficient data collection by the volunteer divers.

2.1 Volunteer training

Prior to assisting with data acquisition, CCC volunteers were required to undertake an intensive nine-day training course in marine life identification and survey methods (Table 1). The training programme included assessments of volunteers' identification skills and their competence at undertaking reef surveys. Assessments were in the form of written tests to determine the level of competence of each volunteer in marine life identification. Only those volunteers who passed the assessments satisfactorily (score of greater than 80%) were permitted to gather data.

Table 1. CCC science training programme schedule.

DAY		AM	PM	EVENING
1	📖 🏊	- -	Lecture 1. Introduction Familiarisation snorkel and buoyancy checks.	-
2	📖 🏊	Lecture 2. Introduction to coral biology and reefs. Identification of hard coral life forms. Snorkel and dive to 12 m – reef orientation	Lecture 3. Identification of target hard coral species. 6m dive – reef orientation.	Knowledge review & coral slide show. -
3	📖 🏊	Lecture 4. Identification of hard coral species. Morphotypic variation. 18 m dive – coral ID.	Lecture 5. Knowledge review of coral identification. 15 m dive – coral ID	Knowledge review. -
4	📖 🏊	Lecture 6. Introduction to fish and fish identification. Major families and species. 24 m dive – fish ID	Lecture 7. Further reef fish identification. 18 m dive – fish ID	Knowledge review -
5	📖 🏊	Lecture 8. Invertebrate identification and soft coral growth forms. 24 m dive – invertebrate ID	Lecture 9. Marine plants and algae identification. 18 m dive / snorkel - algal ID.	Study of algal reference collection. -
6	📖 🏊	Lecture 10. Overview and practice of survey methods (beach dry-run). Completion of boat forms. 18 m dive – practical survey technique.	Lecture 11. Physical and biological forms. Concept of ordinal scale and habitats. 15 m dive – practise survey and form completion.	-
7	📖 🏊	- 24 m dive – general identification.	- 15 m dive – coral ID trail.	Coral knowledge test. -
8	📖 🏊	- General identification snorkel / snorkel trail.	- General identification snorkel.	Fish knowledge test. -
9	🏊	Validation	Validation	

📖 - theory session (lecture/classroom activity)

🏊 - practical session – (dive/snorkel, demonstration)

2.2 Baseline surveys

The principle aims of the baseline surveys carried out within the Municipality of Hinoba-an were to:

- map and describe the topography and habitat types of the reefs.
- collect basic oceanographic data.
- assess the extent of anthropogenic disturbance to the reefs.
- establish a data set that can be used to recommend key areas for MPA status.

In order to achieve these aims, the standard baseline survey technique developed by CCC was utilised. The CCC baseline marine survey method facilitates the rapid and accurate assessment of biological and physical characteristics of reef communities by trained volunteer divers (Harborne *et al.*, 1996).

2.2.1 Field methodology

The CCC transect survey method uses a series of plotless transects, perpendicular to the reef, starting at a depth of 28 m and terminating at the reef crest to map zonation across a reef profile. Benthic and fish surveys are focused on a pre-selected number of species and standardised life forms that are either abundant, easily identifiable or ecologically or commercially important (appendix).

During the course of each survey, oceanographic data (e.g. salinity, temperature, vertical turbidity, current strength) and observations on obvious anthropogenic impacts and activities (e.g. litter and presence and activity of boats) were recorded at depth (deepest point of each dive) and from the surface support vessel.

Since most transects required two or more dives to complete, surveys were usually divided up into sections (or “sub-transects”) with surveys of each sub-transect carried out by a team of four trained divers which is divided into two buddy pairs (A and B) (Fig. 4). At the start point of each sub-transect, Buddy Pair B remained stationary with Diver 3 holding one end of a 10 m length of rope, whilst Buddy Pair A swam away from them, navigating up or along the reef slope in a pre-determined direction until the 10 m line connecting Divers 1 and 3 became taught. Buddy Pair A then remained stationary whilst Buddy Pair B swam towards them. This process was repeated until the end of the planned dive profile, when a surface marker buoy (SMB) carried by Diver 2 was deployed to mark the end of that sub-transect. The SMB functioned as the start point for the next survey team and this process was repeated until the entire transect was completed. The position of the SMB at the start and end of each dive were recorded using a Global Positioning System (GPS).

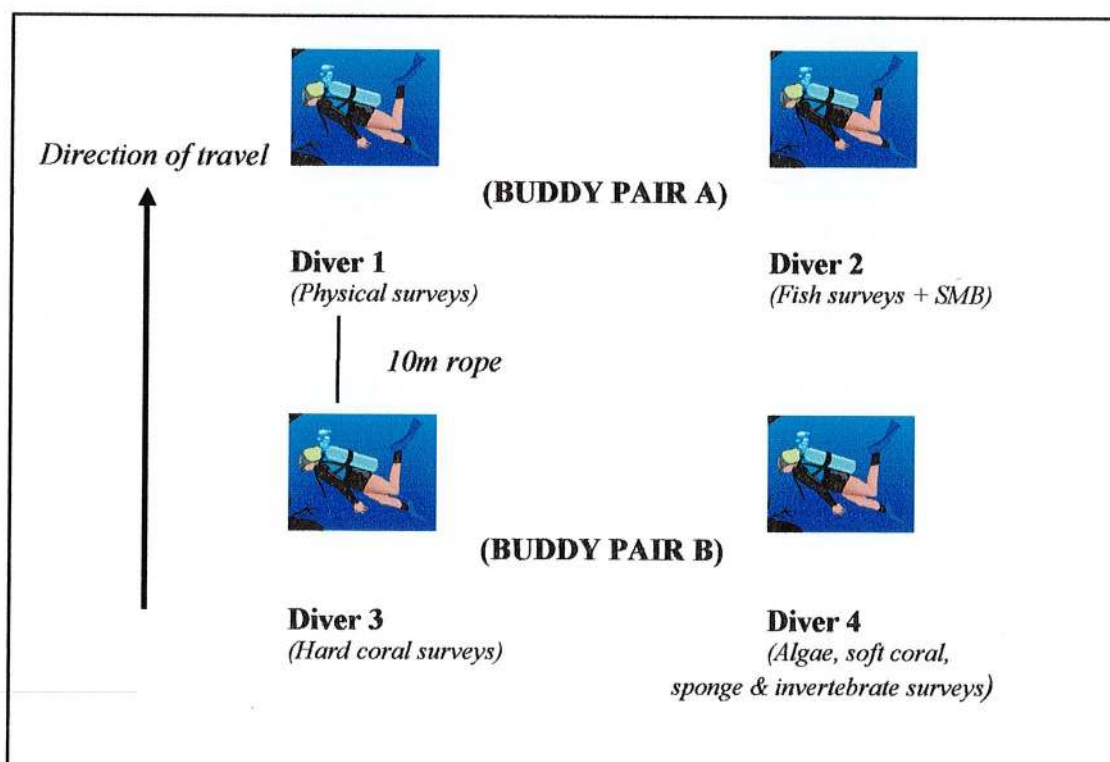


Figure 4. Diagram of a baseline survey dive team showing the positions and data gathering responsibilities of all four divers.

Diver 1 was responsible for leading the dive, taking a depth reading at the end of each 10m interval, and documenting signs of anthropogenic impact such as broken coral or fishing nets. Diver 1 also recorded the direction and strength of the current (none(1), weak(2) or strong(3)) and took the temperature reading at the start of the sub-transect along with a water sample for subsequent salinity measurements. Diver 1 also described

the substratum along each sub-transect by recording the presence of five substrate categories (dead coral, bedrock, rubble, sand and mud).

Fish were normally recorded at a family level by Diver 2 with the exception of a number of important target species which were recorded to the species level. Hard corals were recorded by Diver 3 using the life forms described by English *et al.* (1997) along with additional target coral species. Sponges and octocorals were recorded in various life form categories by Diver 4 who also identified the marine flora which was classified into three groups (green, red and brown algae) with selected target species recorded (appendix).

Diver 3 surveyed an area of approximately 1 metre to each side of the transect line whilst Divers 1, 2 and 4 surveyed an area of approximately 2.5 metres to either side of the line.

During the course of each sub-transect survey, divers may have traversed two or more apparently discrete habitat types, based upon obvious gross geo-morphological or biological differences (e.g. dense coral reef, sand or rubble). The data gathered by each diver from each habitat type were recorded separately for subsequent analysis.

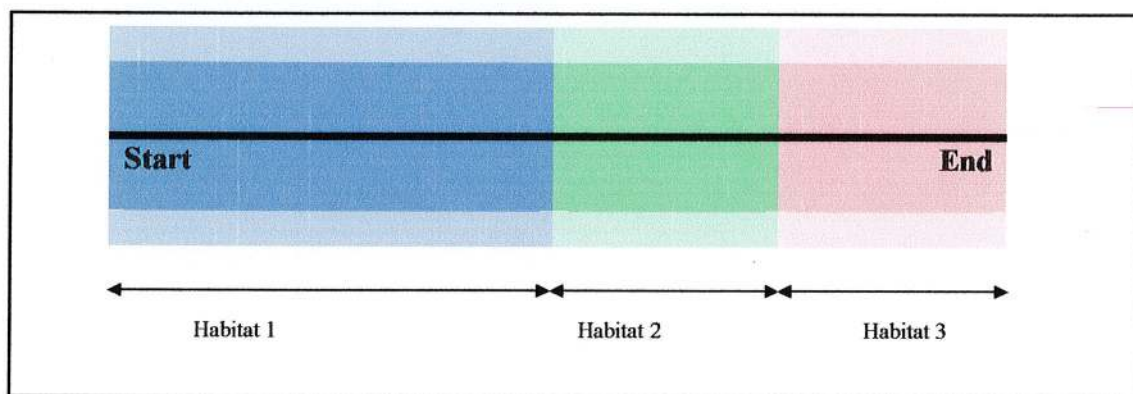


Figure 5. Diagram (aerial aspect) of an example of a reef area mapped by divers during the sub-transect survey. Solid line represents imaginary sub-transect line. Benthic data from habitats 1, 2 and 3 (e.g. reef, sand and rubble) were recorded separately.

Each species, life form or substratum category within each habitat type encountered were assigned an abundance rating from the ordinal scale shown in Table 2.

Table 2. Ordinal scale assigned to life forms and target species during baseline surveys.

ABUNDANCE RATING	CORAL AND ALGAE	FISH AND INVERTEBRATES (NUMBER OF INDIVIDUALS)
0	None	0
1	Rare	1-5
2	Occasional	6-20
3	Frequent	21-50
4	Abundant	51-250
5	Dominant	250+

During each dive, data on surface water temperature and salinity, vertical turbidity (secchi disc reading) were collected by the Boat Marshall on board the surface support vessel. The Boat Marshall also recorded the numbers and activities (classed as fishing, diving, commercial or pleasure) of any boats observed during the course of the survey dive.

Data collected from each sub-transect survey were transferred to recording forms routinely used by CCC for data recording (appendix), prior to incorporation into CCC's GIS-compatible database.

2.2.2 Reporting

Updated reports came from the field to the CCC-UK office when a new 'survey sector' was started. Initially, a Rapid Reef Assessment (RRA) report was written by the science staff on site. This involved up to 10 dives that occur on a particular survey sector and described broad outlines of the most important and obvious habitat types, fish and other invertebrates that were resident on the reefs. These reports focused the consequent baseline survey effort on areas that were important in terms of coral diversity or fish biomass.

Once the baseline surveys were completed from a particular survey sector, the Programme Scientist/ Science Officer on site wrote a qualitative science report. This allowed the head scientist at CCC-UK and local partners in the Philippines to be able to read a concise appraisal of the reefs of a discrete section of coastline. This report also highlighted the areas that should be considered important for MPA development on a biological level (before data analysis was conducted). Detailed data analysis of habitats and organism populations at different geographical locations was carried out after the complete section of coastline had been surveyed. [Both templates for the RRA and Qualitative Report can be seen in the appendix of this report].

2.2.3 Data analysis

[Semi-quantitative abundance values were used from three potential MPA areas of intrinsic biological value, Nabulao Bay Patch reef (NBP); Catmon Point (CA) and Palm Reef (ANP) with 2 non-MPA areas, Catmon Bay (other) and Bolila Point (other) analysed as control sites. For statistical comparisons, data from the two non-MPA areas were pooled.]

Data analysis involved:

1. Production of habitat map: a habitat map for the coast of south west Negros occidental was produced in order to visualise the key habitats of Negros Occidental. (Stephens, 2000). Data from over 800 baseline survey transects was analysed with the use of multivariate statistics (PRIMER) in order to assign a label (habitat class) for each transect which were previously clustered into separate habitat types using a dendrogram. The map gives an impression of the location of particular benthic classes of habitat along the southern Negros coast from Cuauyan in the north to Bolila in the south (Fig. 6). This was followed by analysis of the major benthic physical features in particular coastal sections of Hinoba-an. Mean habitat type

abundance (semi-quantitative scale) was represented by proportion to indicate relative dominance of different substrate types within each coastal MPA and non-MPA area.

2. Coral diversity inside and outside potential MPA areas. Data were again pooled from the two non-MPA areas and tested using univariate (ANOVA) techniques to indicate areas of highest diversity. Post-hoc multiple comparison testing was done on mean species diversity between different sites using Tukey's test.
3. Abundance and distribution in key recommended MPA areas of reef fish assemblages (butterflyfish) that are indicators of habitat diversity (Roberts *et al.*, 1992). Also to count commercially important reef fish using non-parametric and parametric statistics (t-test, Kruskal-Wallis test). Diversity and abundance of eleven commercially important fish families was compared to location and depth of the reef.
4. Similar comparisons (KS test) were made with key invertebrate taxonomic guilds between different coastal locations.
5. Assessments of physical parameters at different coastal locations.

3. Results

3.1 Habitat map of the south-western Negros coast

A map was generated from the analysis of benthic habitats between Danjungan Island in the north, and from surveys conducted to the south of Campomanes Bay. Only sites shallower than 20m were used in the analysis, as deeper surveys were too deep for accurate assessment of habitat type due to low light attenuation in coastal Negros (partly due to high sedimentation).

Table 3. A number of habitats were determined (classified) from the original dataset by SIMPER analysis. These were:

Classified habitat type	Number of transects
Bedrock and foliose corals	21
Bedrock and soft corals	16
Dense hard coral	12
Medium density corals	50
Mud	19
Non- <i>Acropora</i> branching corals	8
Rubble	9
Sand, dead coral and coral heads	21
Sand and coral patches	15
Sand and algae	11
Sand, algae and sparse coral	16
Seagrass and coral	6

All these predominant habitat types were then geographically referenced to the Landsat 7 image that was acquired. The image processing was undertaken on Imagine™ software (see Figure 6 for results).

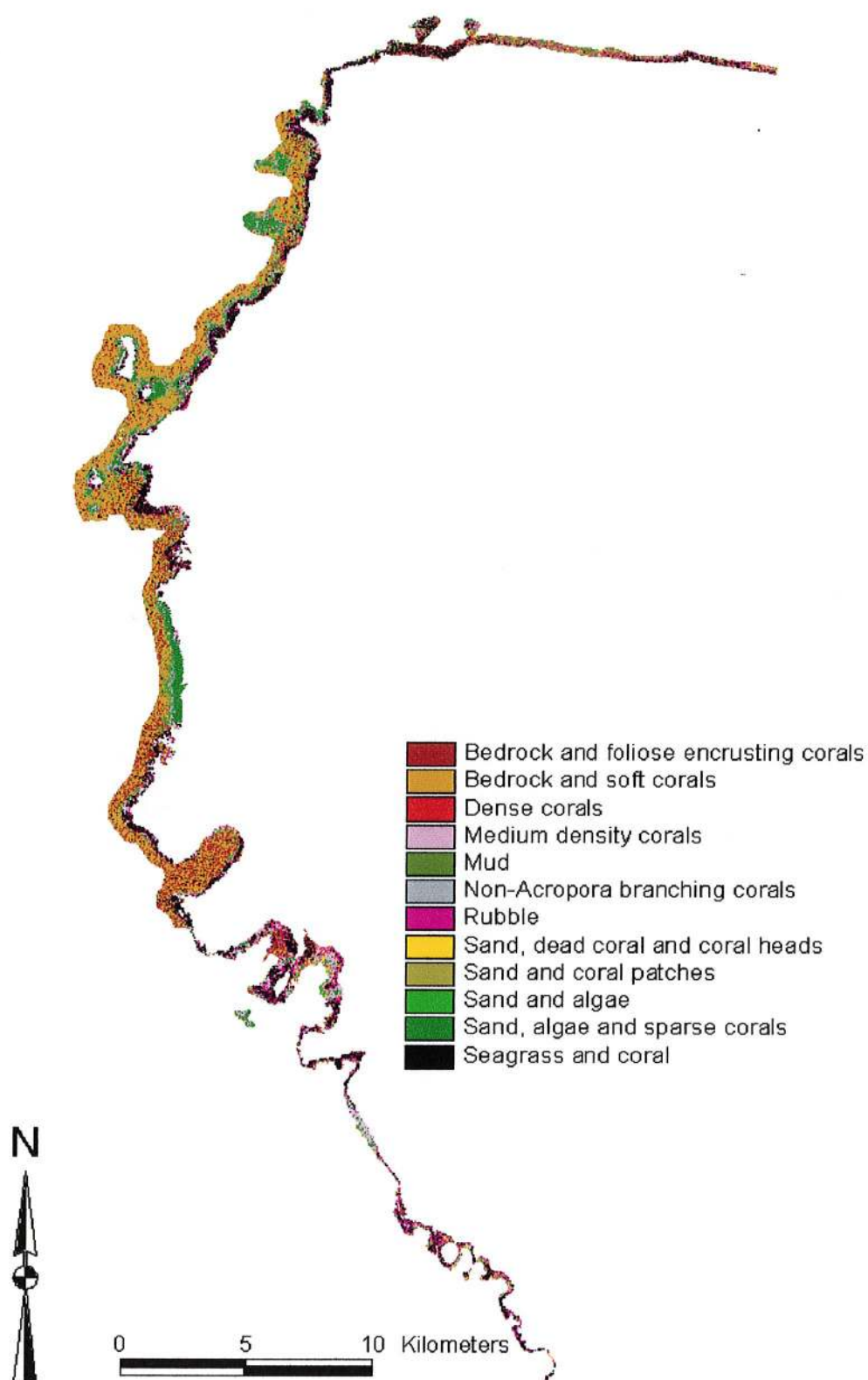


Figure 6. Classified habitat map of the southern Negros coastline from Sojoton Point in the north to Bolila Island in the south (image from Stephens, 2000).

3.2 Potential MPA locations in the municipality of Hinoba-an

Three locations were decided upon for the establishment of MPA status in the municipality of Hinoba-an. They are Nabulao Bay Patch Reef (NBP) and adjacent Pitogo Island, Catmon Point (CA) and Palm Reef (ANP) (a submerged patch reef west of the town of Hinoba-an). These areas were first outlined by the survey using a rapid reef assessment followed by detailed qualitative reports of the main invertebrate and vertebrate organisms that serve to make the area important in terms of biodiversity, and for the state of its fishery. All other areas analysed in this report will not be recommended for MPA status. These are at Catmon Bay and Bolila Point (from this point forward, termed 'Other').

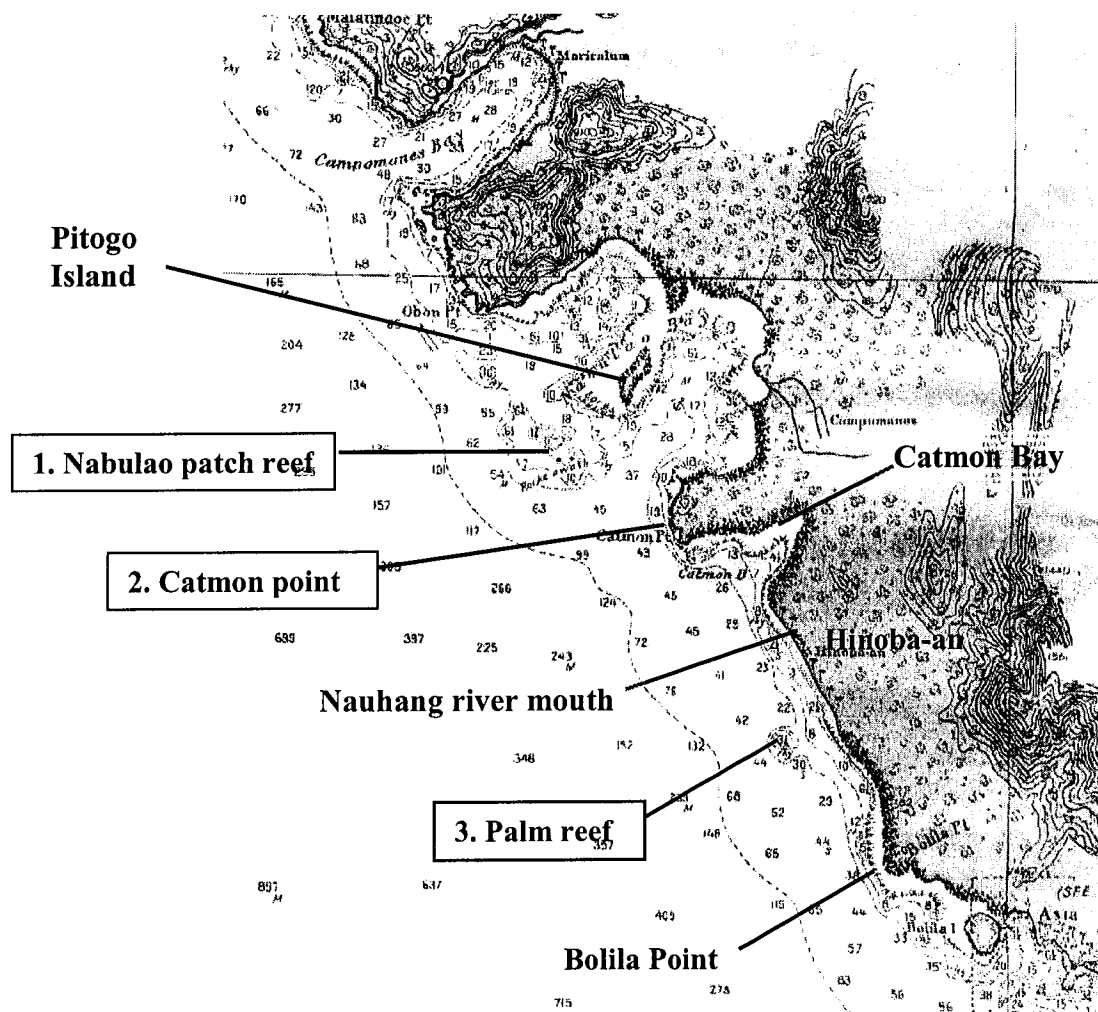


Figure 7. The location and composition of habitats in and around three recommended Marine Protected Areas (Palm Reef, Catmon Point and Nabulao Patch reef). (For a qualitative breakdown of the three areas, and summation of the reasons for their choice, refer to Solandt, 2001). 'Other' areas designate control areas adjacent to the potential MPAs (Catmon Bay and Bolila Point). The location of the Nauhang river mouth estuary is shown for reference.

3.3 Biological criteria for selection of potential MPAs

3.3.1 Key habitats at different locations along the Hinoba-an coast – relative abundance of substrate cover at different potential MPA and other locations

3.3.1.1 Northern Hinoba-an (Nabulao Patch Reef, Catmon Point and Catmon Bay (other))

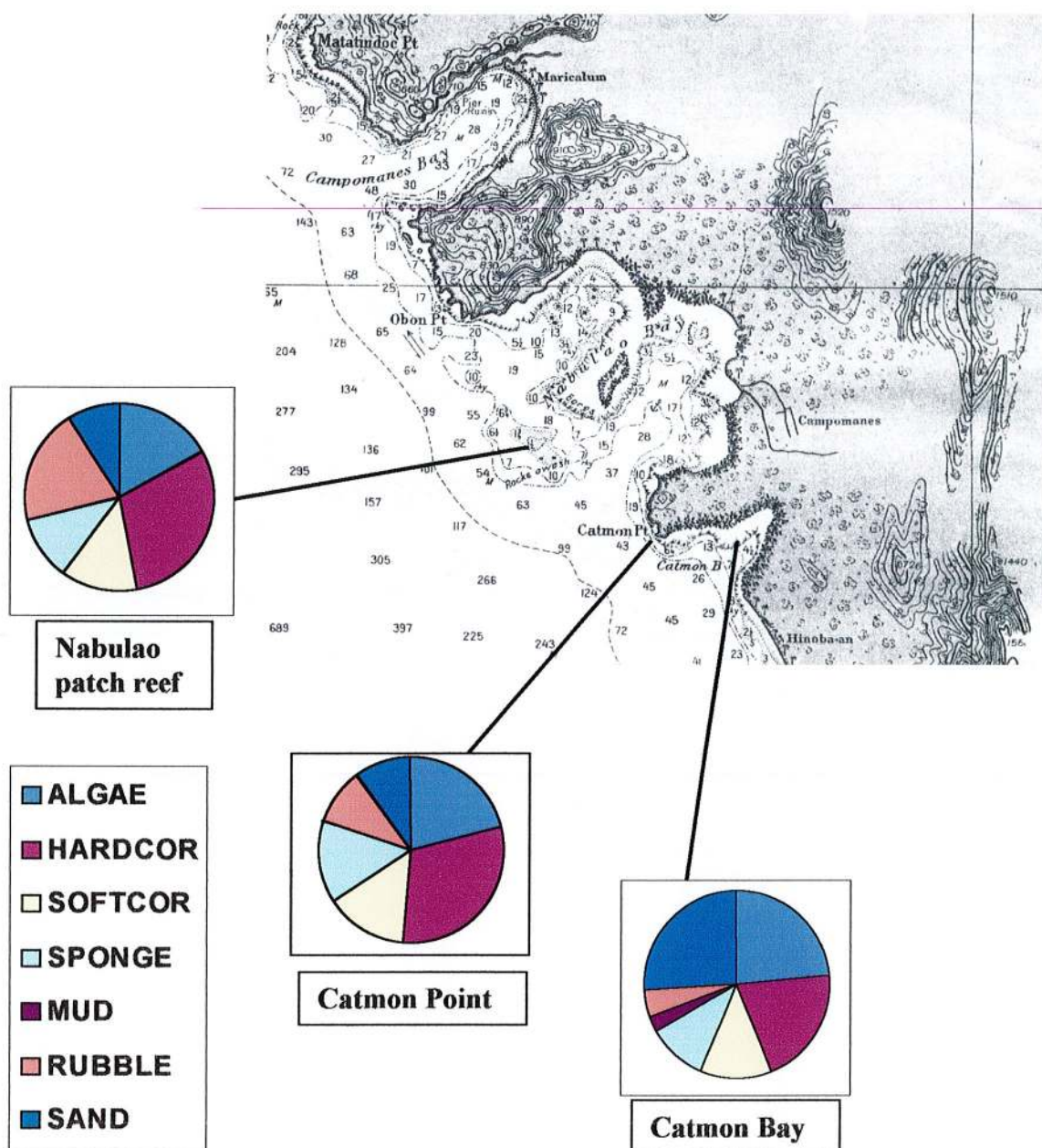


Figure 8. Major benthic habitat types at Nabulao patch reef, Catmon Point and Catmon Bay. The data is derived from mean semi-quantitative counts from all transects from these three locations. Pie charts represent the relative proportions of the seven habitat types from each area.

Reefs around Nabulao Bay Patch Reef were dominated by live hard coral and rubble (Fig. 8). These reefs had rubble in deeper areas, rising to shallows dominated by hard coral and in many areas bottlebrush and branching *Acropora* spp.. This genus was uncommon at other reef locations in Hinoba-an. Filamentous algae was prevalent on the rubble pieces, especially in the 10-8 metre depth zone.

Catmon Point was dominated by hard and soft corals with high coral diversity on the steep wall between 15 and 5m. The coral wall lies at an angle of approximately 70° to the horizontal and can be characterised by a considerable amount of filter feeding soft coral and sponges. *Sarcophyton* spp. in particular dominates the upper reef zone. The steep nature of the wall around Catmon creates a distribution of lighter sediments and rubble that settle in deeper waters (>15m) at the base of the wall.

Catmon Bay has far more algae associated with its reefs than at Catmon Point (Fig. 8). There is considerable influence of the Nauhang river that feeds in to the north Catmon Bay sector. Considerable sediment outflow from this river mouth has been observed in the rainy season. As one moves westerly towards Catmon point from Catmon Bay, the influence of river-borne sediments are less apparent, coral cover increases, as does vertical water clarity. At Catmon Bay, mud was observed that was not seen at Catmon Point, further indicating the influence of calm water and the close proximity to the river mouth (ideal conditions for sediment deposition).

3.3.1.2 Southern Hinoba-an coast – Palm reef and Bolila Point (other)

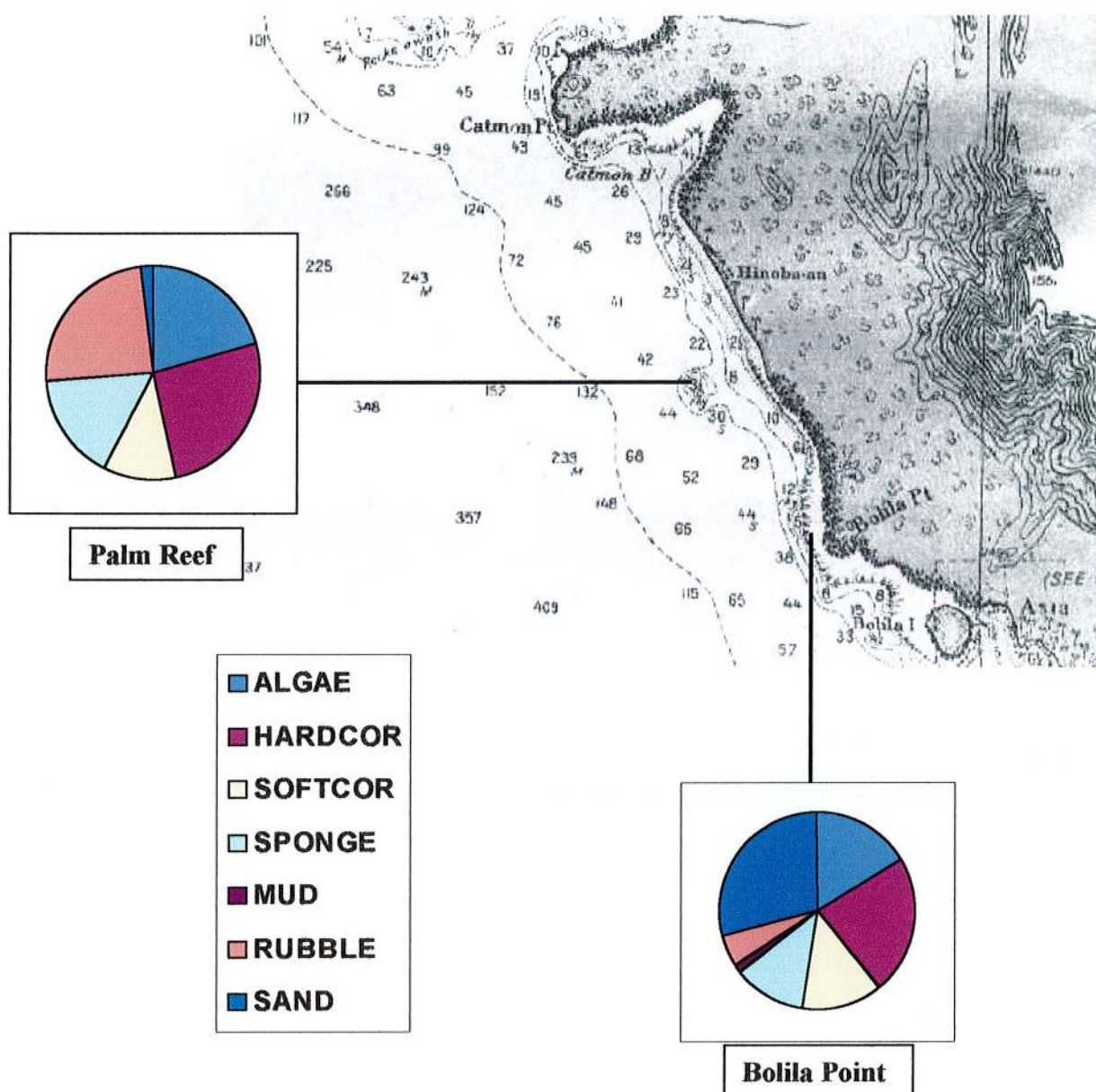


Figure 9. Major benthic habitat types at Palm Reef and north Bolila point. The data is derived from mean semi-quantitative counts for transects from these two locations. The pie charts represent the relative proportions of the seven habitat types from each area.

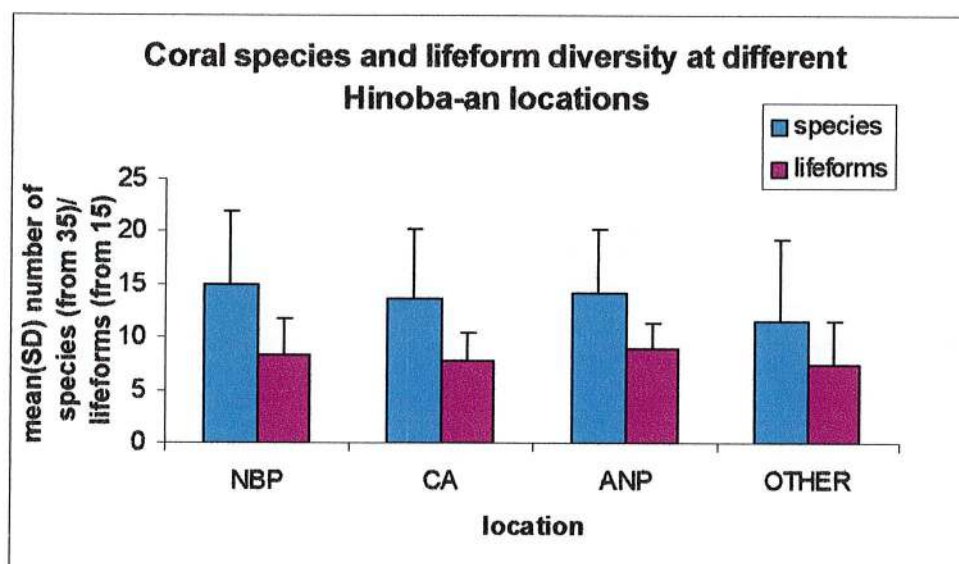
Coastal habitats to the south of Hinoba-an were dominated by mud and sand habitats due to currents pushing sediment derived from the Nauhang river to the south (Fig. 9). The depth soundings (in fathoms) of the admiralty chart below shows that up to 0.5 km from the coast, the depth can be as little as 20m. The outflow of sediments at the Nauhang river mouth account in some way for this high proportion of settled sand and mud which creates an environment of depauperate coral. The CCC baseline technique only allows for volunteers to record epi-fauna and flora. Therefore, biotic abundance associated with sand-dominated habitat is poor, with occasional counts of algae and cyano-bacteria along the coast. As one moves further to the south of this coastline, the habitat around Bolila Point becomes a mix of coral patches (*Diploria strigosa*, massive *Porites*, *Porties cylindrica*, *Favia* sp. and *Favites* sp.) These coral genera are well adapted to higher sediment levels unlike the *Acroporidae*. There is also a dominance of algal mats with blue-greens and algal turfs dominating the sand-dominated substrate. Sponges were represented by encrusting and lumpy growth forms, and only occurred where there was sessile bedrock to attach to (Bolila Point). *Halimeda* sp. and *Galaxaura* sp. were the most commonly associated macoralgal forms, attached to a rocky substrate.

Palm reef was considerably different in the proportion of sand to bedrock habitat types. It lies one kilometer off the coast from the town of Hinoba-an, but is almost devoid of sand and silt down to 20 metres depth (Fig. 9). Here, the habitat is dominated by bedrock and rubble, with the upper reef area almost entirely composed of living coral. The abundance of *Pocillopora eydouxi* was considerable on the shallow (6m) reef table at the top of this large patch reef. A large proportion of the substrate of palm was composed of rubble, especially below 15m depth. This has probably been caused initially by the use of dynamite, and more recently by the effects of high winds during the monsoon periods pushing the broken coral rubble in to deeper water. The deep reef on the eastern side of Palm reef is dominated by sand which may be settling as a result of low proximate current and discharge from the Nauhang river.

3.3.2 Coral species and lifeform diversity at Hinoba-an

Coral species diversity was higher at the three potential MPAs from other coastal locations (ANOVA $F_{(3,249)} = 2.55$ $P < 0.057$) (Fig. 10). The biggest difference in coral diversity was seen between Nabulao Bay and Bolila Point (Tukeys test = 14.88, $P < 0.031$). Coral species at Bolila Point were dominated by *Porites*, *Favia* spp., *Favites* spp. and *Diploastrea heliophora* (massive and submassive lifeforms). Nabulao Bay patch reef was unique as it was the only location to have substantial stands of both bottlebrush and other branching species of *Acropora*.

Corals on the southern part of Catmon Point show considerable diversity with counts of almost all the coral species that are on the CCC-baseline survey list. Further east towards the inner part of Catmon Bay, the coral diversity drops, with sand and algae become more common in their dominance of the reef. This trend continues as one moves south past the town of Hinoba-an near to the Nauhang river (refer to Fig. 9).



(NBP – Nabulao Bay patch reef; CA – Catmon Wall; ANP – palm reef; Other – Catmon Bay and Bolila Point)

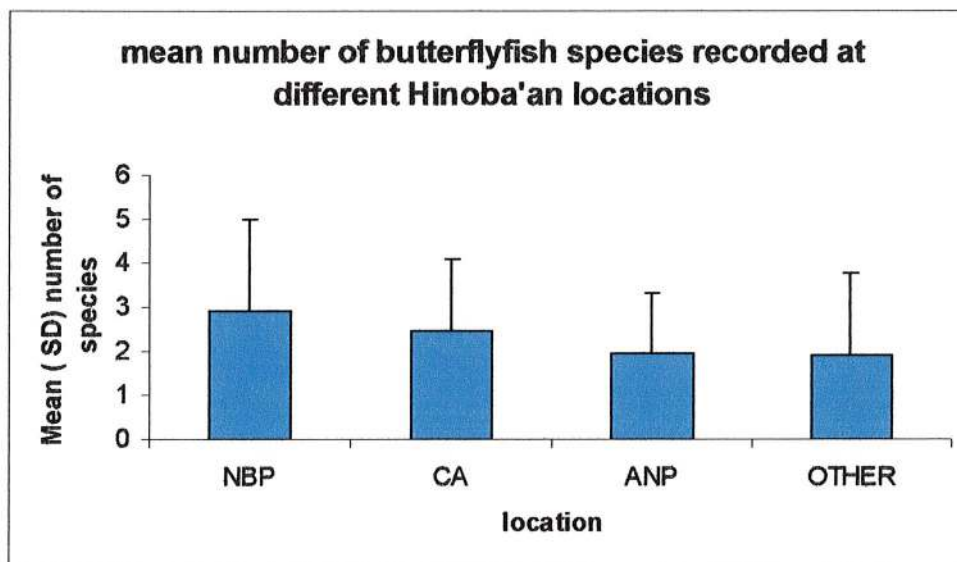
Figure 10. Mean number of different coral species/ lifeforms at four different Hinoba-an locations. Coral species diversity was higher at the three potential MPAs from other coastal locations (ANOVA $F_{(3,249)} = 2.55$ $P < 0.057$). Multiple comparisons of means show that commercial fish diversity was significantly greater at NBP than at 'other' coastal locations (Tukeys test = 14.88, $P < 0.031$).

3.3.3 Fish species diversity and abundance

There was a significant difference in the number of butterflyfish species seen at the different locations along the coast of Hinoba-an (KS test, $H = 12.92$, $P < 0.02$, $N = 252$). The number of species of butterflyfish species seen at Nabulao Bay patch reef was considerably more (a mean of 2.92 species per transect ± 2.06) than at other sites adjacent to the mainland (1.93 species per transect ± 1.84). Dispersal between butterflyfish appeared to be substantial indicating that they were restricted in the foraging ranges.

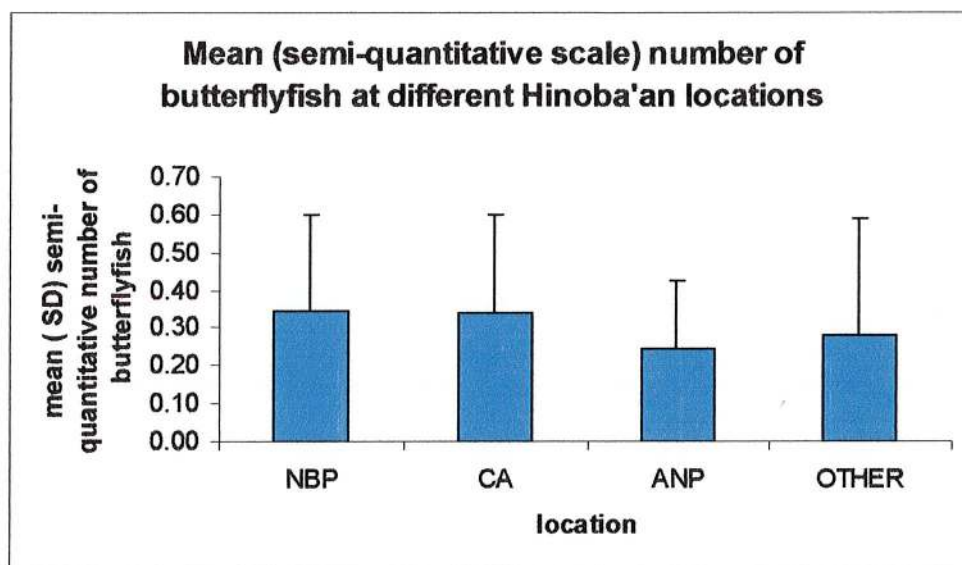
The major species that were counted in most areas were the longfin butterflyfish, *Forcipiger flavissimus*, the redfin butterflyfish, *Chaetodon trifasciatus* (an obligate corallivore) and the Kleins butterflyfish, *Chaetodon kelinii* (Table 4). These species were seen as solitary individuals or as mated pairs. *C. trifasciatus* occurred predominantly on shallow coral dominated areas. The other two species were more evenly distributed amongst coral and other areas dominated by bedrock.

There was no significant difference between the abundance of butterflyfish species observed between the different Hinoba-an locations (KS test, $H = 5.22$, $P < 0.16$, $N = 252$). However, the mean abundance of butterflyfish per transect at Nabulao Bay Patch reef (0.35 ± 0.26) was more than that of the abundance at the other sites on the coast (0.28 ± 0.31). Large standard deviations show the patchiness of the distributions of this family (as relates to the patchiness of the coral distributions for the corallivorous butterflyfish species). The relatively high abundance of butterflyfish species at all sites may be because high numbers were seen adjacent to the proposed MPA at Catmon Point, as there was similarity in reef types and hence fish assemblages between Catmon Point and the outer part of Catmon Bay.



(NBP – Nabulao Bay patch reef; CA – Catmon Wall; ANP – palm reef; Other – Catmon Bay and Bolila Point)

Figure 11. Number of butterflyfish species at different Hinoba-an locations. There was a significant difference between species diversity at NBP than at the 'other' coastal sites (KS test, $H = 12.92$, $P < 0.02$, $N = 252$).



(NBP – Nabulao Bay patch reef; CA – Catmon Wall; ANP – palm reef; Other – Catmon Bay and Bolila Point)

Figure 12. Mean abundance of butterflyfish (semi-quantitative scale) at different Hinoba-an locations. There was no significant difference in mean semi-quantitative abundance between any of the above sites (KS test, $H = 5.22$, $P < 0.16$, $N = 252$).

Table 4. Mean ($\pm$ SD) semi-quantitative abundance of the three most frequently occurring butterflyfish species at different Hinoba-an locations. Highlighted counts are those that were most dominant at that particular location.

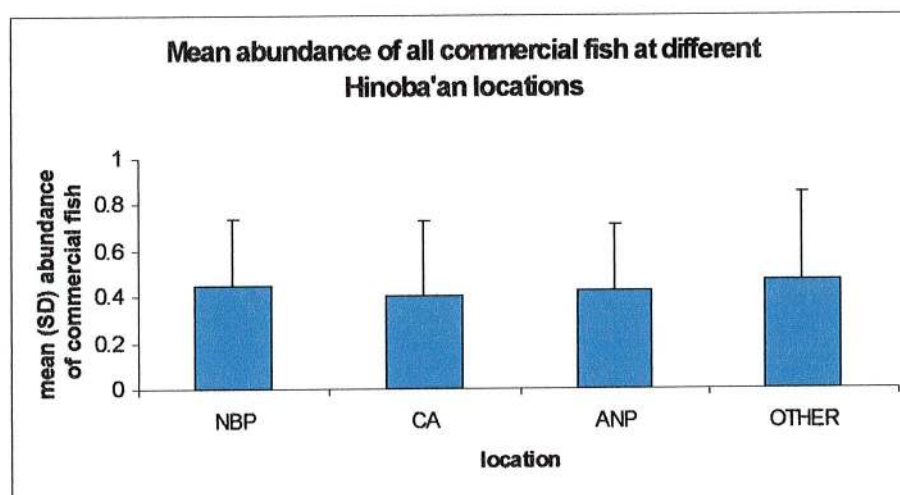
Butterflyfish species (common name)	NBP	CA	ANP	OTHER
Kleins	1.04±0.85	0.95±0.74	0.44±0.63	0.65±0.78
Long-nose	0.39±0.54	0.68±0.76	0.57±0.63	0.40±0.66
Redfin	0.57±0.69	0.49±0.68	N/a	0.37±0.58
Vagabond			0.28±0.49	

3.3.4 Commercial fish family diversity and abundance

Commercial fish families did not significantly differ in overall diversity (KS test, $H = 5.02$, $P < 0.17$, $N = 252$) and abundance (KS test, $H = 1.89$, $P < 0.60$, $N = 242$) between potential MPA locations and other sites along the coast (Fig. 13 and 14).

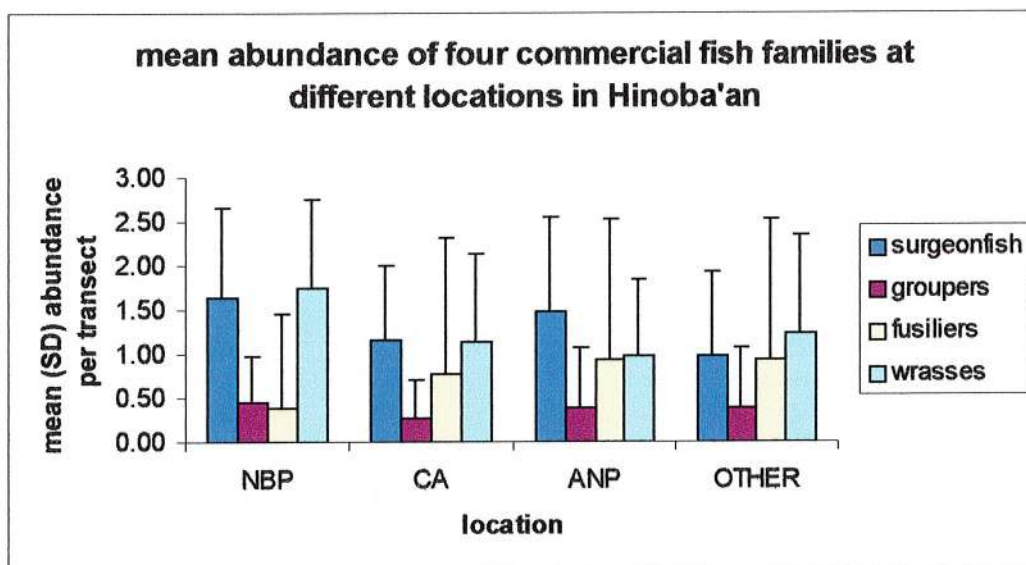
However, the populations of individual families within these locations differed between locations with important herbivore groups such as surgeonfish (*Acanthuridae* spp.) and the omnivorous wrasse (*Labridae* spp.) family being more abundant at Nabulao Bay patch reef than at the other coastal locations (Fig. 14). The abundance of groupers (*Epinephalidae* spp.) appeared to be low at all sites (Fig. 11). Groupers were often small individuals that were frequently dominated by the peacock grouper (*Cephalopholis argus*). These groupers at a juvenile – sub-adult stage (<20cm) were seen frequently in shallow waters in amongst crevices in the reef.

Difference in commercial fish species diversity between deep (>13m) and shallow (<13m) reefs was evident at Palm reef (T -test, $t = 1.30$, $P < 0.05$) (Fig. 15). Commercial fish were distributed around the higher coral cover of the shallow Palm reef areas.



(NBP – Nabulao Bay patch reef; CA – Catmon Wall; ANP – palm reef; Other – Catmon Bay and Bolila Point)

Figure 13. Mean abundance of commercial fish at different Hinoba-an locations. There was no significant difference between abundance between the locations (KS test, $H = 1.89$, $P < 0.60$, $N = 242$).



(NBP – Nabulao Bay patch reef; CA – Catmon Wall; ANP – palm reef; Other – Catmon Bay and Bolila Point)

Figure 14. Abundance of four families of commercially important reef fish at different Hinoba'an locations. The difference in the surgeonfish and wrasse distributions between Nabulao Bay patch reef and the 'other' coastal locations was significant (Mann-Whitney $U = 1001$, $P < 0.05$, $N = 110$).

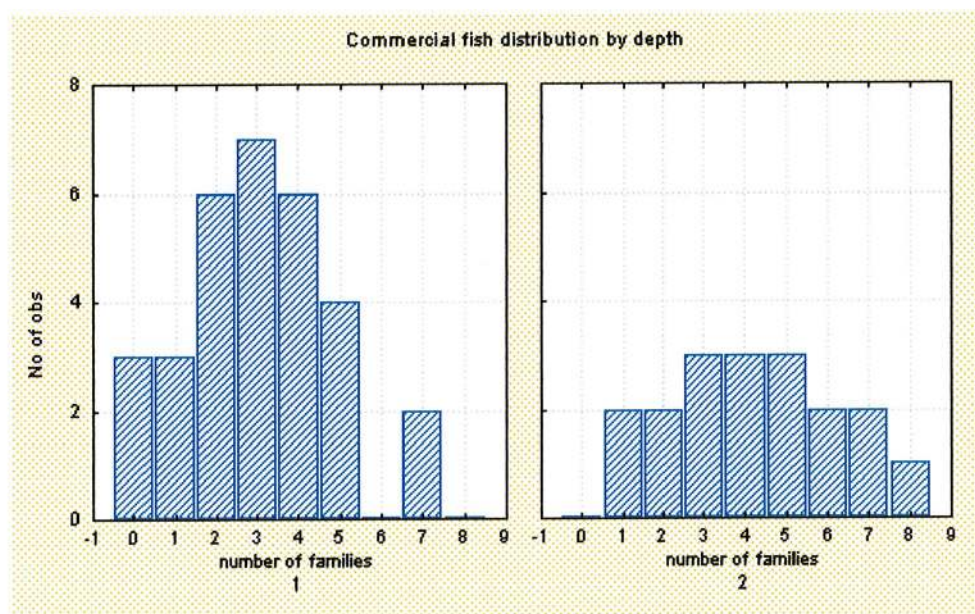


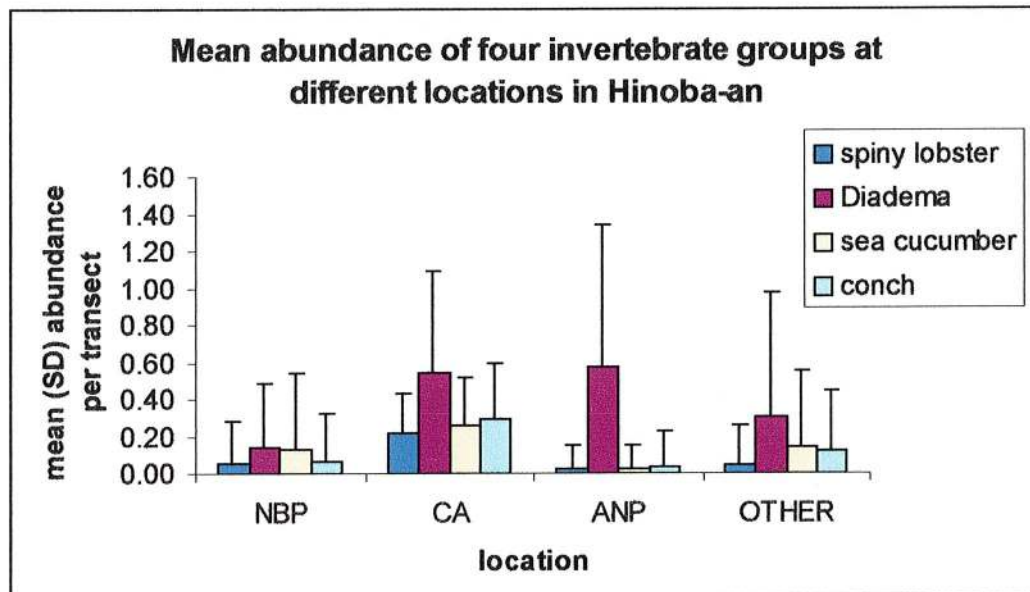
Figure 15. Commercial fish families above and below 13m depth at Palm Reef. Mean number of families $>13\text{m} = 3.032 \pm 1.816$. Mean numbers of families $<13\text{m} = 4.220 \pm 2.074$. There was a significant difference between the number of commercial fish families between shallow ($<13\text{m}$) and deep waters ($>13\text{m}$) ($t = 1.304$, $P < 0.042$).

3.3.5 Invertebrate species on the coral reefs of Hinoba-an

Crown of Thorns starfish were low in abundance on all Negros reefs (mean abundance per transect was <0.10). Edible sea cucumbers (*Holothuria* spp.) were also at low abundances at all habitats (<0.25 per transect, Fig. 16). Highest abundance amongst the invertebrate groups was seen in long-spine urchin (*Diadema* spp.) populations. These animals were regularly seen sheltering in crevices within the reefs. They were more prevalent in shallower waters nearer to the reef crest and reef flat than in the deeper forereef waters. Those that were seen in the deeper areas were more cryptic in behaviour, whilst in some shallow areas, especially where numbers were higher, echinoids were seen to exhibit aggregating behaviour as they fed on algal turfs.

Sea cucumbers were dominated by the species *Bohadschia graffei* and *Synaptia* spp.. *B. graffei* is a detritivore that feeds on algae, sediments and organic matter that are found on dead corals. They were frequently found underneath the dead skeletons of *Acropora hyacinthus* and in other areas where sediments and organic detritus had gathered.

Conch (*Strombus* spp.) are an important food shellfish. Many species inhabit sand and rubble areas after maturation with an initial juvenile stage commonly resident in seagrasses in shallow reef areas. Conch were found in the Catmon Point area both at the bottom of the wall, and on the seagrass beds in the shallow forereef areas.



(NBP – Nabulao Bay patch reef; CA – Catmon Wall; ANP – palm reef; Other – Catmon Bay and Bolila Point)

Figure 16. Key invertebrate groups at different locations in and around the municipality of Hinoba-an. The only significant difference between the sites was in the density of *Diadema* spp. echinoids (KS test, $H = 17.26$, $P = < 0.001$, $N = 252$) between Palm reef, Nabulao Bay patch reef and 'other' coastal locations.

3.4 Physical factors

All sectors showed similar physical/oceanographic characteristics due to the close proximity of all sites (Table 4). All Hinoba-an surveys were conducted between February 2001 and June 2001 during the NE winds period (in the Philippines, this period of weather is between December and June). The first six months of the year is relatively dry in Negros with mild winds from the north. Therefore, regional conditions effectively remained the same at all survey sites.

There was a consistent difference in the salinity and temperature levels between deep and shallow waters. Surface water temperatures were slightly higher than those at 28m. Divers did not describe experiencing a distinctive thermocline between these depths. Evaporation and still conditions likely increased surface temperatures relative to deeper waters, but only to a small extent.

Secchi disc (vertical visibility) readings gave interesting results with the coastal survey areas of Catmon Point (20.63m) and Bolila/Catmon Bay (16.63m) showing the greatest vertical visibility. Palm reef and Nabulao patch reef gave lower results with limited vertical visibility of just over ten metres at Palm reef. It is likely that because surface currents during the survey period travelled north to south, sediments were placed from the Nauhang river on to the reef of Palm (Fig. 7) and therefore reduced water clarity at this location. Currents were not significantly different between sites, and were extremely low. The currents during the SW monsoons that would be different in direction and strength due to the winds impinging directly on to the SW facing coast of southern Negros. This would likely have a different impact on the visibility and other oceanographic factors around Hinoba-an. Without data loggers and consistent year-round monitoring, these seasonal factors could not be monitored.

Aesthetic and biological values give readings of over 2 for many of the sites. The values for all sites are almost identical. They fall for Palm reef. This may be attributed to the rubble fields that lie at the 15 metre depth zone which have little associated biological cover apart from filamentous and coralline algae.

Table 5. Physical attributes of different survey locations in Hinoba-an. (refer to Fig. 13 and 14 for locations). Temperature measurements are in degree Celsius. These were taken at 28m (start depth of transect) and on the surface. A similar method was used for the salinity measurements. Current was estimated by the effort required for the divers to move through the water. Aesthetic and biological values were assessed on a relative scale of 1-poor, 2-average and 3-good.

Factor/ Location	NBP Nabulao Patch reef	CA Catmon Point	ANP Palm reef	Other sites (Bolila and Catmon Bay)
Salinity $^{\circ}/_{00}$ (surface)	30.99 $\pm$ 0.25	30.74 $\pm$ 0.43	29.90 $\pm$ 6.40	29.80 $\pm$ 3.02
Salinity $^{\circ}/_{00}$ (28m)	30.20 $\pm$ 0.53	30.83 $\pm$ 0.84	31.00 $\pm$ 2.10	30.50 $\pm$ 3.33
Temp $^{\circ}$C (surface)	28.50 $\pm$ 0.70	28.64 $\pm$ 0.69	28.40 $\pm$ 0.79	29.50 $\pm$ 1.12
Temp $^{\circ}$C (28m)	28.60 $\pm$ 0.50	27.89 $\pm$ 0.19	27.60 $\pm$ 0.81	27.80 $\pm$ 0.98
Secchi disc (m)	11.48 $\pm$ 1.45	20.63 $\pm$ 4.68	10.74 $\pm$ 1.41	16.63 $\pm$ 5.75
Current (1-low, 2-moderate, 3-strong)	0.88 $\pm$ 0.35	0.59 $\pm$ 0.21	0.96 $\pm$ 0.83	0.72 $\pm$ 0.71
Aesthetic value (1-poor, 2-average, 3-good)	2.54 $\pm$ 0.16	2.23 $\pm$ 0.29	1.83 $\pm$ 0.76	2.19 $\pm$ 1.41
Biological value (1-poor, 2-average, 3-good)	2.42 $\pm$ 0.27	2.16 $\pm$ 0.23	1.90 $\pm$ 0.69	2.09 $\pm$ 2.83

4.0 Discussion

4.1 Coastline outlined by the habitat map

Distribution of habitats along the southern Negros coast (habitat map) indicates that the marine benthos around the municipality of Hinoba-an is principally dominated by rubble and medium density coral reefs. The dominance of coral classes at Hinoba-an makes this section of coast extremely important to Negros Occidental as most of north-west and west Negros is dominated by mud. Below 15 metres, most of the Hinoba-an coast was dominated by either sand and rubble, and in some areas near rivers, by mud and fine silt. This is demonstrated in Sipalay by the habitats surrounding the Sipalay river being dominated by mud (Fig. 6), and in Hinoba-an by mud and sand habitats being dominant near to the Nauhang river mouth (Fig. 9). This is not unusual for the Philippines as a whole, as reef accretion and productivity is generally less below 15-20m due to the lower light levels in deeper waters. Reduced light restricts photosynthesis in the zooxanthellae of scleractinian corals, thus reducing coral productivity and growth.

4.2 Effects of sedimentation

Sedimentation, which is a predominant feature of much of the Negros coast, exacerbates negative impacts on hard coral growth and metabolism as much of the material flowing out from the rivers will settle in calmer reef waters, and on to corals. Corals become stressed as they produce increased amounts of mucous in order to slough off the sediments that fall on colonies (Hodgson, 1993). Some coral species are better at dealing with increased sediment levels than others. For example, the genus *Acropora* spp. is more detrimentally affected than the genus *Porites* spp. (Rogers, 1990). This explains the dominance of hard coral forms such as *Porites* spp. and *Favia* spp. in shallow coastal reef areas such as inner Catmon Bay and Bolila Point. Sediments that fall in shallow waters can be removed fairly rapidly by wave action in exposed locations (such as at Catmon Point). These sediments then settle in calmer and deeper waters away from coral-dominated locations. This further reduces coral cover in deeper areas where sediments settle out. Alternatively, many habitats associated with shallow waters of the coastal fringe have a lower diversity of coral species and lifeforms (such as at inner Catmon Bay), as they tend to be in areas near to river mouths (within 500m of the Nauhang river). Areas near to river mouths tend to accrue sediments at a high rate due to deforestation of the south-west Negros interior causing chronic run-off of surface sediments. This distribution of sedimentation in and around the Nauhang river has a large influence on the low diversity of coral species that are found at Bolila Point compared to more exposed locations such as Catmon Point and Nabulao Bay patch reef.

4.3 Coral bleaching

The coral bleaching event of February and March 1998 along the coast of Hinoba-an (Solandt, 2000) had a deleterious impact on live coral cover in this region. This resulted in the death of many acroporid species, some foliose species (such as *Pachyseris speciosa*) and even some shallow-water massive species such as *Physogyra lichtensteini* at Danjungan Island. This event has probably altered the coral cover of Hinoba-an reefs to a significant extent in comparison to coral structure and species composition prior to 1998. Therefore, it is of paramount importance to protect those areas of reef that are still relatively healthy since this bleaching event, as further and more frequent bleaching events are likely to impact global coral reefs in the future (Hoegh-Guldberg, 1999).

Areas of *Acropora* spp. That survive bleaching events need to be considered for MPA status as they have been shown to be susceptible to coral bleaching in previous studies (Marshall and Baird, 2000). The branching and bottlebrush *Acropora* species that are seen at Nabulao, have obviously survived the 1998 bleaching due to their extensive growth that precedes the date of the 1998 bleaching event. This demonstrates that the physical conditions of this reef may mean that corals at this location are less prone to bleach than in surrounding coastal areas.

4.4 Physical factors of reef geomorphology: Effects on benthic fauna and flora

Catmon Point reef has sessile invertebrate species at high abundance and diversity, particularly represented by filter feeding hard and soft corals, which benefit from the currents that drift past this wall. As can be seen from the chart (Fig. 13), the reef structure of Catmon Point is very different to that of Nabulao Bay patchreef and Palm reef. There is a steep wall around the western edge of the point with a depth of 80 metres only 50 metres from the shore. This wall tapers off to become a gentle slope with a more extensive shallow shelf towards Catmon Bay (to the east). Catmon Point is unique in reef geomorphology from the other two potential MPAs (Nabulao Bay patch reef and palm reef).

This section of coastline also lacks considerable rubble development. It appears that topographically flatter patch reefs act as settlement locations for rubble. Again, this may be a function of increased wave action impinging on the shore, driving the rubble in to deeper waters, beyond the 28m depth of the CCC baseline surveys. On patch reefs, the slope is more gradual from the deeper waters than at Catmon, and therefore has more rubble in shallower (20-10m depth) waters. The southern side of Palm reef is almost totally comprised of rubble between 20 and 15m.

Rubble fields may be linked to the historical use of dynamite in the region. Dynamite shatters the living coral to produce the shards of dead coral. This fishing method appears to be very rare in Hinoba-an itself (practically no blasts were heard by the CCC survey programme for the duration of the survey work at Hinoba-an). The depth of the rubble fields (generally >15m) on the reefs of Hinoba-an is not related to the depth at which the dynamiting of the reefs occurred, but is more closely associated with the impact of surge that washes rubble and sand in to deeper waters. What is of concern to the sustainability and regeneration of the reefs after the use of dynamite, is the

colonisation of the rubble by filamentous algae rather than coralline algae. The latter is extremely effective at cementing the broken pieces of coral together, which then allows a solid substratum for coral recruitment and subsequent accretion. Filamentous algae colonises in areas where sedimentation and nutrification is fairly high, coral colonisation is low, herbivory is low. The deeper reefs of Hinoba-an have rubble that is colonised by filamentous rather than calcareous algae. Very little evidence was seen of herbivores such as *Diadema* spp. echinoids, *Naso* spp. and other *Acanthuridae* that are extremely effective at removing filamentous algae, thus promoting calcareous algal growth (Steneck, 1993).

The reefs of Hinoba-an differ spatially in the amount of hard coral and the different coral lifeforms that structure the reef. The small spatial scale of metres that is observed by using transects at every 100m of coast reveals the distribution of smaller sight-attached motile species (such as butterflyfish). This level of scale can elucidate the distribution of reef fishes because distinct differences in associated benthic fauna and physical conditions between bays and headlands are revealed at this scale (Roberts *et al.*, 1992). Numbers of butterflyfish were fairly similar between sites, although Nabulao patch reef attracted the highest diversity of species. Many of the individuals on this reef were made up of the redfin butterflyfish (*Chaetodon trifasciatus*) which is an obligate corallivore. This species feeds solely on coral polyps, and its greater abundance at Nabulao compared to other sites can be attributed to the greater amount of hard coral at this location (Table 4 and Fig. 8). An average transect on this patch reef also had a high number of coral species (from the CCC species list) which would encourage greater fish diversity, due to the variety of associated habitats linked to a greater abundance of different coral lifeforms (Roberts *et al.*, 1992).

4.5 Commercial fish populations and distributions

Commercial fish abundance and diversity did not differ significantly as a whole between the various locations in Hinoba-an. The important surgeonfish (*Acanthuridae*) family (which is responsible for cropping small amounts of ephemeral and filamentous algae off the substrate) was seen to be more abundant on the patch reefs (Nabulao and Palm) than in areas closer to shore. Algal abundance was considerable at this location (Fig. 8 and 9), and the flat profile of the reef table allowed epilithic algal turf to grow rapidly every day. Also, abundance of light and appropriate rocky benthos provided suitable conditions for rapid filamentous plant growth. These factors have a distinctive effect on the distribution of larger numbers of herbivorous fish on the patch reefs. Also the fishing gear used in these locations tended to be dominated by hook and line which freed herbivorous fish from the threat of large-scale overfishing.

The groupers (*Serranidae*) were at very low abundances at all sites. This is because they are the most valuable food fish and are easily taken by spear and hook and line. There is little coral structural diversity for these fish to hide in at the patch reef locations, and they can easily be taken by spear fishermen down to a depth of 15 metres. A considerable reduction in fishing effort needs to be encouraged in order to increase the numbers of these fish on all reefs of Hinoba-an.

Distributions of commercial species of reef fish were again demonstrated to be dependent on the coral cover of the reef (Fig.12). Fish need both high rugosity of habitat with which they can use to find a variety of prey, and for shelter from predators and wave action during the night. The shallow reef of Palm reef provides these niche requirement where the sand and rubble dominated deeper waters provides very little suitable resources for most commercial reef fish families. A sustained effort needs to be made to allow coral to re-emerge as the dominant substrate at all locations so that there is sufficient habitat to support important reef fish families.

4.6 Justification for selection of three Marine Protected Areas (MPAs) within the municipality of Hinoba-an

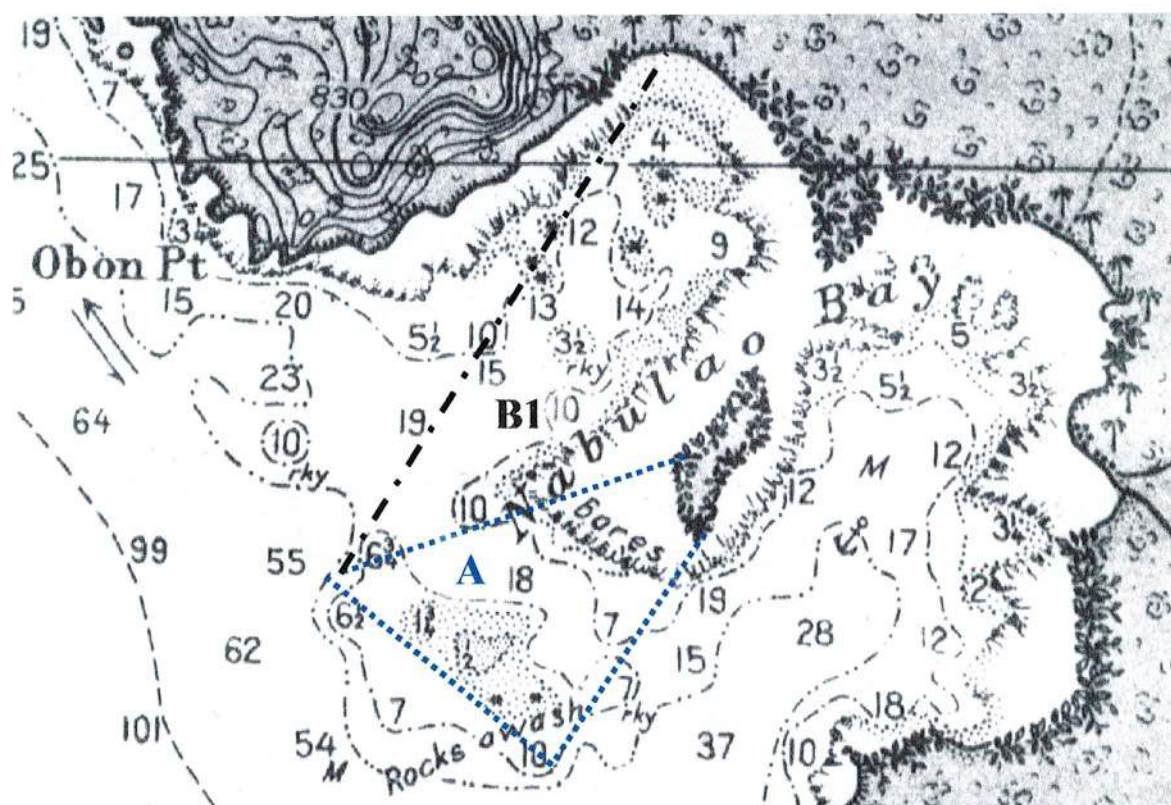
4.6.1 Nabulao Bay patch reef and Pitogo island

Nabulao Bay patch reef was unique in that it had the highest diversity of fish and corals in this location, and was dominated by dense stands of *Acropora* spp. (bottlebrush and digitate lifeforms) corals on the shallow (<8m) shelf. Branching *Acropora* spp. stands were interspersed with sponge (mainly encrusting), soft corals (*Sarcophyton*, *Lobophyllia* and some *Sinularia* sp.) and scattered massive coral species. Areas of bottlebrush and other species of *Acropora* spp. need to be strongly considered for MPA status as they have been shown to be prone to coral bleaching in previous studies (Marshall and Baird, 2000). As it appears that the shallow water corals of Nabulao Bay patch reef have obviously survived the 1998 bleaching, it seems that this patch reef may have higher associated currents and reduced stresses that allow good conditions for survival of bleaching episodes. Nabulao Bay patch reef has various diverse associated habitats including steep wall on the north eastern side down to 35 metres. Wall reefs provide good currents for fusiliers (*Caesio* spp.) and some surgeonfish (*Acanthuridae* spp.) species to feed on passing zooplankton. Reefs with a diverse array of benthic species and geo-morphologies are advantageous as marine protected areas, as their topography and diverse associated fauna generally provides a healthy diversity of life (Roberts and Ormond, 1987) which protects the food web against disturbance better than a species-poor area. Also, seaward patch reefs off Negros are surrounded by deeper waters that provides good current and flow over the reef, and from different directions. Nabulao Bay patch reef can be considered to be a species-rich oasis in an otherwise depauperate sand and mud-dominated bay (Fig. 18).

There are seagrass beds and lagoon environments on the shoreward side of the patch reef between Pitogo island and the patch reef itself (Fig. 18). Seagrass beds are extremely productive, act as nurseries for juvenile fish, and soak up excess nutrients that can be washed down stream from the coastal fringe.

The patch reef is also adjacent to the largest mangrove stand in Hinoba-an which stretches from north Nabulao Bay to the north coast of Pitogo Island. This mangrove supplies recruiting fish from their nursery grounds in amongst the roots of the trees. One of the initial settlement areas for sub-adult fish would be the patch reef itself, so the importance of the mangrove at Nabulao Bay cannot be understated. This ecosystem is also extremely diverse (with over 12 mangrove tree species in the local area). Mangroves clear sea water of nutrients and sediments by extracting nitrates and

This particular area lies on the border between the municipality of Sipalay and Hinobanan, but should be considered for MPA status as it is extremely important to the reefs of both Catmon Point and Nabulao Bay patch reef, both of which have important diverse coral reef habitats. Within any subsequent management plan that may emerge from this work consideration must be made as to the importance of the mangroves, seagrass beds and reefs to the local coastal environment. This is why the buffer zone of this area has been made so large, so as to encompass ecosystems from the land to the patch reef itself.



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4.6.2 Catmon Point

This is a completely different ecosystem from the patch reef MPAs that are recommended in this report. On the wall of Catmon Point there is considerable diversity and abundance of soft coral, sponge and hard coral lifeforms in a limited reef slope area. The unique nature of this slope makes it particularly important, as at certain times of year the nature of the slope means that it may be a significant spawning point for broadcast spawning fish. Many of the corals that occur on this reef will also widely disperse their gametes due to the exposed nature of this headland. Other qualitative observations and direct advantages of this location are that it is not heavily fished during the SW monsoon period as the wave action impinging on this area is considerable. This gives some relief to the fish populations during this rough period (June to November).

Although the recommended area of the reserve is rather small, the adjacent buffer zone which is recommended as a line and net fishing area only will reduce the 'edge' effects of fishing very close to the no-take zone (see Fig. 17).

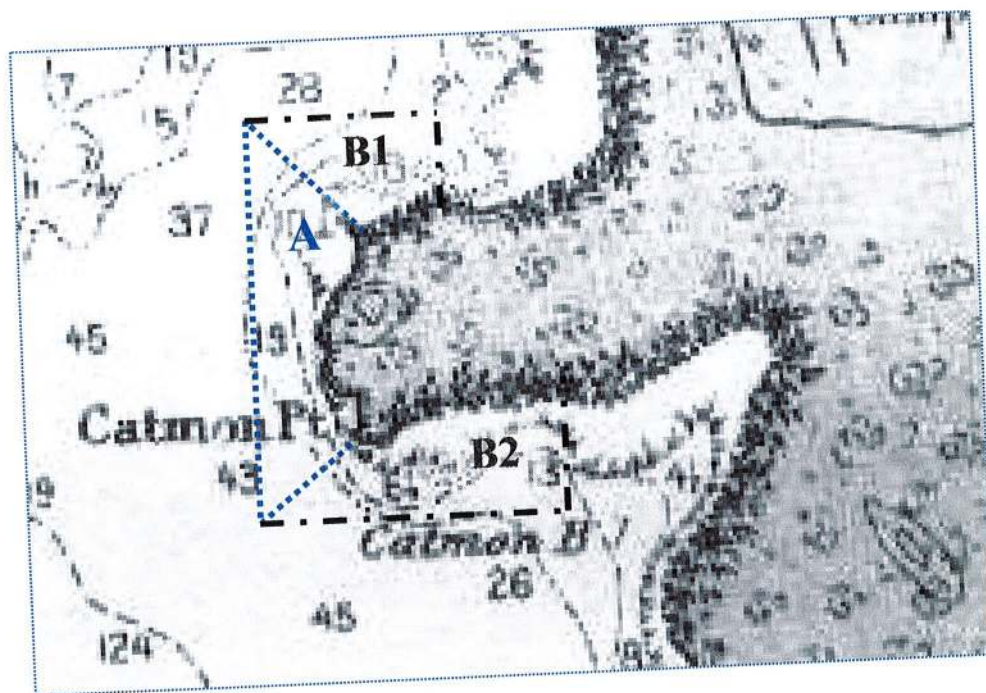


Figure 18. Location of no-take zone (A) and north (B1) and south (B2) buffer zones of Catmon Point proposed MPA. (See section 4.7 for definition of zones).

4.6.3 Palm reef

Palm Reef is unique as volunteers witnessed more megafauna observations during surveys than at any other location along the Hinoba-an coastline. Frequent sightings of jacks (*Carangidae* spp.), narrow-banded king mackerel (*Scomberomorus commerson*), dogtooth tuna (*Gymnosarda unicolor*) and the occasional elasmobranch such as the baktip reef shark (*Carcharhinus melanopterus*) indicated that this is an important feeding area for large predator fish. There were frequent observations of hawksbill turtles (*Eretmochelys imbricata*) feeding at this site. Also, its location in an otherwise barren seascape provides an important alternative habitat that is coral dominated whilst being surrounded by sand and silt conditions. At the top of the reef (between 8 and 6 metres), there appears to have been a strong recovery of scleractinian corals since coral bleaching, particularly with corals of the species *Pocillopora eydouxi* and *Pocillopora verrucosa* predominating on this shallow (<8m) reef flat. The currents during the SW monsoons on this reef are significant which could make it an important area for the distribution of gametes during benthic or fish broadcast spawning events.

As Palm reef is a fairly unique patch reef in an area where the nearest coral dominated areas are Catmon Point (to the north) and small areas of patchy reef at Bolila Point (to the south), this location again can be considered an ecological 'oasis'. Surrounding the reef are areas of silt and sand as a result of the discharge of sediments from the Nauhang river, and the re-suspension of sand caused by the heavy south west monsoon winds which restricts coral growth along the intertidal. It lies at the only coral-dominated point between Catmon Bay to the north and Bolila Island to the south (approximately 10 km of coastline).

This area is, unfortunately, heavily fished at present, and serious consideration and communication must be made between the local municipality (implementing agency) and the fishermen who use Palm reef as to the restrictions for fishing that would be put in place. Palm reef consistently had at least four fishing boats on it at all times of day during the surveys, using line or net with the average number of crew numbering two persons. Numbers of fishing vessels fell at Palm during the south-west monsoon period due to exposure to high winds making conditions, at best, impractical, and at worst, dangerous for fishing.

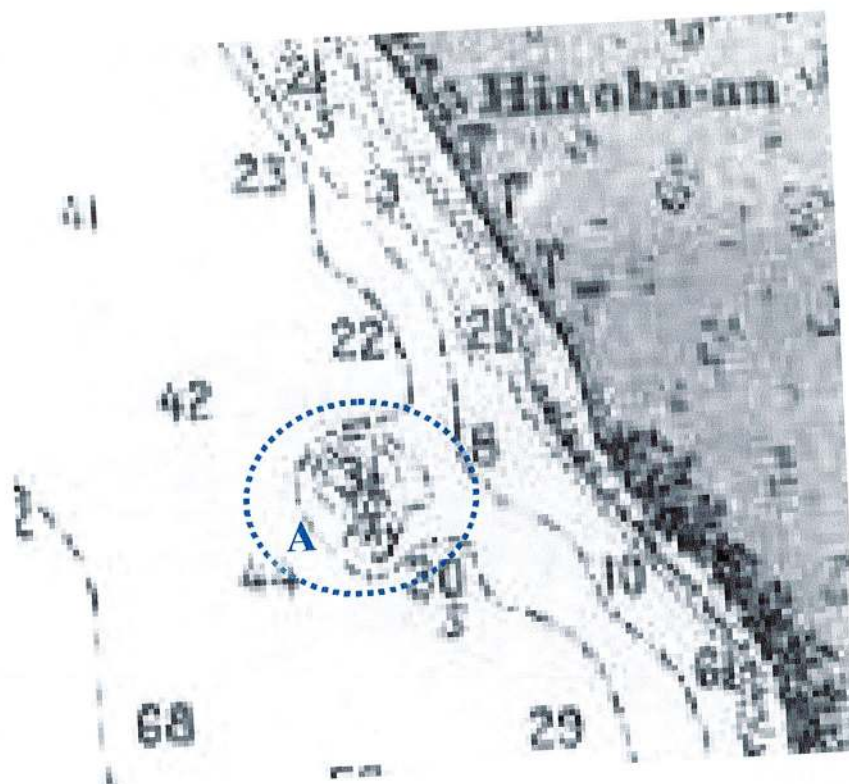


Figure 19. Location of no-take zone **A** that should be incorporated in the Palm reef Marine Protected Area. (See section 4.7 for definition of zones). No buffer zone is recommended for this location.

4.7 Recommended zoning scheme for Marine Protected Areas (MPA), Nabulao Bay patch reef, Catmon Point and Palm reef

1. The blue zone represents a no take zone where no fishing/collecting of any sort will be allowed at any time. These areas should be marked by clear surface buoys.
2. The black hashed lines denoting B1 and B2 represent the buffer zone around the recommended no-take zone (MPA) of each location. Here fishing will only be allowed during the SW monsoon season months (between May and December). At all other times of year, there can be no fishing activity of any kind in these buffer areas. This will mean that fishing is both restricted in time and space. Also, the SW monsoon winds will restrict the ability of fishermen to go out only during times of calm weather.
3. No destructive fishing practices to be allowed anywhere within each MPA. This includes the use of; (1) dynamite fishing; (2) cyanide (or any other toxin); (3) compressor fishing; (4) muro-ami fishing and (5) trap fishing.
4. Fishing gear types in the buffer zones should be restricted to hook and line and fishing net (no net to be set over night), and the minimum mesh size should be no less than 10 cm for all fishing nets.
5. Minimum craft size allowed in the buffer zones should be no greater than 10 metres in length.
6. Maximum crew size on any one vessel will be restricted to 3 individuals.
7. Boats passing any MPA area in transit should not encroach within the buffer or no-take zones in any of the three recommended MPAs.

4.8 Monitoring/enforcement and education scheme

1. Rangers should be designated from the local bantay dagat in order to patrol the area, and paid for by the local municipality in order to restrict fishing activity within the area.
2. Rangers should receive education from The Philippine Reef and Rainforest Conservation Foundation Inc. in the reasons behind the efficacy of a reserve, and the benefits to the local community of establishing an MPA.
3. Local schools should be involved in the monitoring and biology of the coral reef at Catmon Point. They should be taken on snorkels by local environment groups in order to be made aware of the unique nature of these reefs.
4. Workshops involving all local stakeholders should be carried out 6 months before, 1 month before, 1 month after, 6 months after and 9 months after the MPA is put in working order.
5. Fines should be imposed at the discretion of the local municipality in order to give incentive to the fishermen to avoid the area.
6. Signs should be placed in all the local fishing villages in order to allow local people to realise the importance and zoning scheme of the MPA. All the above restrictions and important restrictions of fishing practices should be incorporated in to the signs and any leafleting that is produced.
7. People should be made aware of the worth of the reserve by communicating with Siliman University and PRRCFI scientists so that they can monitor this area on a yearly basis to monitor the recovery of local fish populations.

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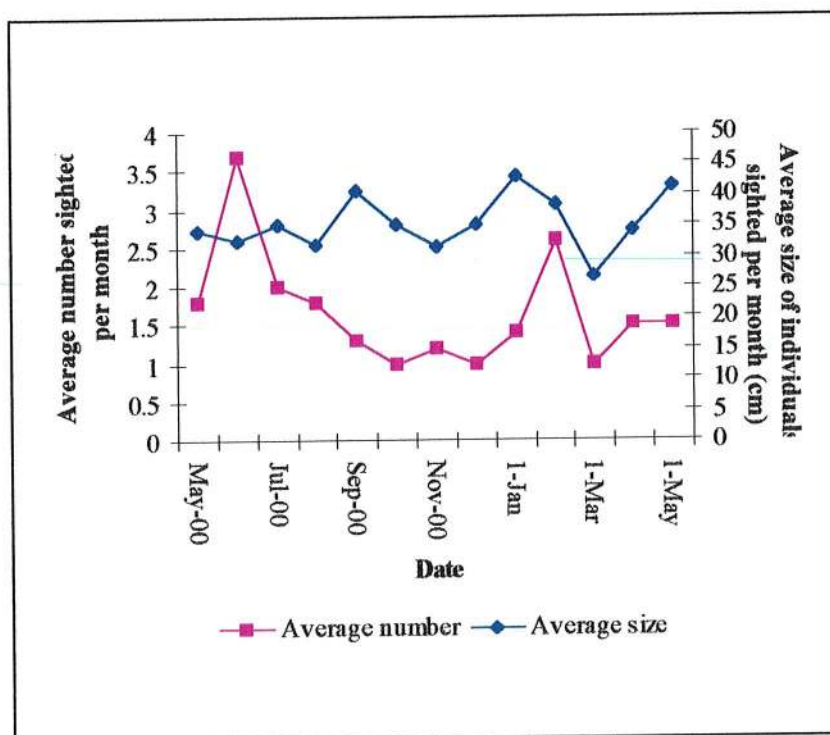
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Appendices

Appendix 1. Megafauna observations. Observations demonstrated are not quantitative per unit time or space.

Species/ Location	NBP	CA	ANP	Other
<i>Carangidae</i> spp. (Jacks)			6	
<i>Scrombridae</i> spp. (Mackerel and Tuna)		2	16	
Marlin (<i>Makaira mazara</i>)			1	
Barracuda (<i>Sphyraenidae</i> spp.)			1	
Large snapper (<i>Lutjanidae</i> spp.)			9	
Bumphead parrotfish (<i>Bolbometopon muricatum</i>)				1
Humphead wrasse (<i>Cheilinus undulatus</i>)		4		
Manta ray (<i>Mobula japonica</i>)		3		
Bottlenose dolphins (<i>Tursiops truncatus</i>)				28
Turtles (all species)	1	8	8	1

Appendix 2 – Crown of Thorns observations (from all reefs from all dives between March 2000 and June 2001).



Appendix 3. Fish species list from Negros Occidental at the sites of all SNCDP project locations (Danjungan Island, Campomanes Bay and Hinoba-an).

SHARKS AND RAYS - ELASMOBRANCHIDAE

STINGRAYS- DASYATIDAE

<i>Taeniura</i>	<i>lymma</i>	Bluespotted ribbontail ray
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MANTA RAYS- MOBULIDAE

<i>Mobula</i>	<i>japonica</i>	Devil Ray
<i>Manta</i>	<i>birostris</i>	Manta ray

SHARKS- CARCHARHINIDAE

<i>Carcharhinus</i>	<i>melanopterus</i>	Balcktip reef shark
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EAGLE RAYS- MYLIOBATIDAE

<i>Aetobatus</i>	<i>narinari</i>	Spotted Eagle Ray
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MORAY EELS- MURAENIDAE

<i>Scuticaria</i>	<i>tigrinus</i>	Tiger snake moray
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EEL CATFISHES- PLOTOSIDAE

<i>Plotosus</i>	<i>lineatus</i>	Striped catfish
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LIZARDFISHES- SYNODONTIDAE

NEEDLEFISH- BELONIDAE

<i>Strongylura</i>	<i>incisa</i>	Reef needlefish
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SOLDIERFISHES & SQUIRRELFISHES- HOLOCENTRIDAE

TRUMPETFISHES- AULOSTOMIDAE

<i>Aulostomus</i>	<i>chinensis</i>	Trumpetfish
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CORNETFISHES- FISTULARIIDAE

<i>Fistularia</i>	<i>commersonii</i>	Cornetfish
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SHRIMPFISHES - CENTRISCIDAE

*Aeoliscus**strigatus*

Shrimpfish

PIPEFISHES & SEAHORSES- SYNGNATIDAE**Dorhyramphus***dactyliophorus*

Ringed pipefish

FLATHEADS- PLATYCEPHALIDAE**SCORPIONFISHES- SCORPAENIDAE****Scorpaenopsis***diabolus*

Devil Scorpionfish

GROUPERS, ANTHIASES, PERCHLETS, BASSLETTS & SOAPFISHES- SERRANIDAE**ANTHIASES- ANTHIINAE****GROUPERS- EPINEPHELINI***Epinephelus**merra*

Honeycomb grouper

*Epinephelus**fasciatus*

Blacktip grouper

*Cephalopholus**argus*

Peacock grouper

*Cephalopholis**urodeta*

Flagtail grouper

*Epinephelus**caeruleopunctatus*

Whitespotted grouper

*Variola**louti*

Lyretail grouper

SOAPFISH- GRAMMISTINI*Diplorion**bifasciatum*

Two-banded soapfish

PRETTYFINS- PLESIOPIDAE*Calloplesiops**altivelis*

Comet

DOTTYBACKS- PSEUDOCHROMIDAE**HAWKFISHES-CIRRITIDAE***Cirrhitichthys**falco*

Dwarf Hawkfish

CARDINALFISHES- APOGONIDAE**BARRAMUNDI- CENTROPOMIDAE****TIGER PERCHES; GRUNTERS- THERAPONIDAE****FLAGTAILS- KHULIIDAE****BIGEYES- PRIACANTHIDAE****Priacanthus***blochii*

Bloch's Bigeye

MOJARRAS- GERREIDAE**SAND TILEFISHES- MALACANTHIDAE****REMORAS- ECHENEIDAE***Echeneis**naucratus*

Sharksucker

JACKS & TREVALLYS- CARANGIDAE

Caranx	<i>melampygus</i>	Blue fin trevally
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SNAPPERS- LUTJANIDAE

<i>Lutjanus</i>	<i>biguttatus</i>	Two-spotted snapper
<i>Lutjanus</i>	<i>decussatus</i>	Checkered snapper
<i>Macolor</i>	<i>macularis</i>	Black-and-white snapper

FUSILIERS- CAESIONIDAE**SWEETLIPS- HAEMULIDAE**

<i>Plectorhinchus</i>	Harlequin sweetlip
<i>chaetodonoides</i>	

MONOCLE BREAMS & SPINECHEEKS- NEMIPTERIDAE

<i>Scolopsis bilineatus</i>	Twoline spinecheek
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EMPERORS- LETHRINIDAE

Monotaxis	<i>grandoculis</i>	Bigeye Emperor
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GOATFISHES- MULLIDAE

<i>Parapeneus</i>	<i>barberinoides</i>	Half and half goatfish
<i>Parapeneus</i>	<i>barberinus</i>	Dash and dot goatfish
<i>Parapeneus</i>	<i>multifasciatus</i>	Multibarred goatfish
<i>Upeneus</i>	<i>tragula</i>	Blackstriped goatfish

SWEEPERS- PEMPHERIDAE

<i>Pempheris</i>	<i>varicolensis</i>	Vanikoro sweeper
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RUDDERFISHES- KYPHOSIDAE**SPADEFISHES – EPHIPPIDAE**

Platax	<i>batavianus</i>	Hump-headed spadefish
Platax	<i>pinnatus</i>	Pinnate spadefish
Platax	<i>orbicularis</i>	Circular spadefish

BUTTERFLYFISHES- CHAETODONTIDAE

<i>Chaetodon</i>	<i>adiergastos</i>	Panda butterflyfish
<i>Chaetodon</i>	<i>baronessa</i>	Eastern triangle butterflyfish
<i>Chaetodon</i>	<i>kleinii</i>	Klein's butterflyfish
<i>Chaetodon</i>	<i>lunula</i>	Raccoon butterflyfish
<i>Cheatodon</i>	<i>trifascialis</i>	Chevroned butterflyfish
<i>Chaetodon</i>	<i>trifasciatus</i>	Redfin butterflyfish
<i>Chaetodon</i>	<i>vagabundus</i>	Vagabond butterflyfish

<i>Forcipiger</i>	<i>flavissimus</i>	Long-nosed butterflyfish
<i>Forcipiger</i>	<i>longirostris</i>	Big long-nosed butterflyfish
<i>Coradion</i>	<i>chrysozonus</i>	Orange-banded coralfish
<i>Hemitaurichthys</i>	<i>zoster</i>	Pyramid butterflyfish
<i>Chaetodon</i>	<i>auriga</i>	Threadfin butterflyfish
<i>Chaetodon</i>	<i>bennetti</i>	Bennett's butterflyfish
<i>Chaetodon</i>	<i>ulietensis</i>	Pacific double-saddle butterflyfish
<i>Chaetodon</i>	<i>rafflesi</i>	Latticed butterflyfish
<i>Chaetodon</i>	<i>punctatofasciatus</i>	Spot-banded butterflyfish
<i>Chaetodon</i>	<i>citrinellus</i>	Speckled butterflyfish
<i>Chaetodon</i>	<i>ornatissimus</i>	Ornate butterflyfish
<i>Chaetodon</i>	<i>mertensii</i>	Merten's butterflyfish
<i>Chaetodon</i>	<i>unimaculatus</i>	Teardrop butterflyfish
<i>Chaetodon</i>	<i>guentheri</i>	Gunther's butterflyfish
<i>Chaetodon</i>	<i>ephippium</i>	Saddled butterflyfish
<i>Heniochus</i>	<i>pleurotaenia</i>	Phantom bannerfish (??)
<i>Heniochus</i>	<i>singularis</i>	Singular bannerfish
<i>Heniochus</i>	<i>acuminatus</i>	Longfin bannerfish
<i>Heniochus</i>	<i>chrysostomus</i>	Pennant bannerfish
<i>Heniochus</i>	<i>varius</i>	Humphead bannerfish

ANGELFISHES- POMACANTHIDAE

<i>Centropyge</i>	<i>vrolikii</i>	Pearlscale angelfish
<i>Centropyge</i>	<i>nox</i>	Midnight angelfish
<i>Pygoplites</i>	<i>diacanthus</i>	Regal angelfish
<i>Pomacanthus</i>	<i>imperator</i>	Emperor angelfish
<i>Pomacanthus</i>	<i>narvarchus</i>	Blue-girdled angelfish
<i>Centropyge</i>	<i>bispinosus</i>	Two-spined or Dusky angelfish
<i>Centropyge</i>	<i>tibicen</i>	Keyhole angelfish
<i>Centropyge</i>	<i>multifasciatus</i>	Multibarred angelfish
<i>Genicanthus</i>	<i>lamarcki</i>	Lamarck's angelfish
<i>Apolemichthys</i>	<i>trimaculatus</i>	Three-spot angelfish
<i>Centropyge</i>	<i>bicolor</i>	Bicolor angelfish

DAMSELFISHES- POMACENTRIDAE

<i>Amphiprion</i>	<i>polymnus</i>	Saddleback anemonefish
<i>Amphiprion</i>	<i>sandaracinos</i>	Orange anemonefish
<i>Amblyglyphidodon</i>	<i>curacao</i>	Staghorn damsel
<i>Amblyglyphidodon</i>	<i>leucogaster</i>	White-belly damsel
<i>Dascyllus</i>	<i>aruanus</i>	Humbug dascyllus
<i>Dascyllus</i>	<i>reticulatus</i>	Reticulated dascyllus
<i>Dascyllus</i>	<i>trimaculatus</i>	Three-spot dascyllus
<i>Neoglyphidodon</i>	<i>melas</i>	Black damsel
<i>Neoglyphidodon</i>	<i>nigroris</i>	Behn's damsel
<i>Neoglyphidodon</i>	<i>oxydon</i>	Javanese damsel
<i>Pomacentrus</i>	<i>coelestis</i>	Neon damsel
<i>Chromis</i>	<i>retrofasciata</i>	Black-bar chromis

WRASSES- LABRIDAE

<i>Anampses</i>	<i>meleagrides</i>	Yellowtail wrasse
Bodianus	<i>diana</i>	Diana's hogfish
<i>Bodianus</i>	<i>mesothorax</i>	Mesothorax hogfish

<i>Cheilinus</i>	<i>fasciatus</i>	Red-banded wrasse
<i>Cheilinus</i>	<i>undulatus</i>	Humphead wrasse;
		Napoleonfish
<i>Coris</i>	<i>gaimard</i>	Yellowtail coris
<i>Gomphosus</i>	<i>varius</i>	Bird wrasse
<i>Halichoeres</i>	<i>prosopeion</i>	Twotone wrasse
<i>Hemigymnus</i>	<i>melapterus</i>	Blackedge thicklip wrasse
<i>Labroides</i>	<i>dimidiatus</i>	Bluestreak cleaner wrasse
<i>Thalassoma</i>	<i>hardwicke</i>	Sixbar wrasse
<i>Thalassoma</i>	<i>janseni</i>	Jansen's wrasse
<i>Thalassoma</i>	<i>lunare</i>	Crescent wrasse

PARROTFISHES- SCARIDAE

<i>Bolbometopon</i>	<i>muricatum</i>	Bumphead parrotfish
<i>Cetoscarus</i>	<i>bicolour</i>	Bicolour parrotfish

BARRACUDAS- SPHYRAENIDAE

<i>Sphyræna</i>	<i>barracuda</i>	Great barracuda
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MULETS- MUGILIDAE**SANDPERCHES- PINGUIPEDIDAE****JAWFISHES- OPISTOGNATHIDAE****STARGAZERS- URANOSCOPIDAE****SAND-DIVERS- TRICHONOTIDAE****TRIPLEFINS- TRIPTERYGIIDAE****BLENNIES, FANGBLENNIES & COMBTOOTH BLENNIES- BLENNIIDAE****CONVICT BLENNY- PHOLIDICHTHYIDAE****DRAGONETS- CALLIONYMIDAE****DARTFISHES- MICRODESMIDAE**

<i>Nemateleotris</i>	<i>magnifica</i>	Fire dartfish
<i>Ptereleotris</i>	<i>evides</i>	Blackfin dartfish

GOBIES- GOBIIDAE**MOORISH IDOL- ZANCLIDAE**

<i>Zanclus</i>	<i>cornutus</i>	Moorish idol
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SURGEONFISHES & UNICORNFISHES- ACANTHURIDAE

<i>Acanthurus</i>	<i>lineatus</i>	Striped surgeonfish
<i>Acanthurus</i>	<i>triostegus</i>	Convict surgeonfish
<i>Acanthurus</i>	<i>pyroferus</i>	Mimic surgeonfish
<i>Paracanthurus</i>	<i>hepatus</i>	Palette surgeonfish

<i>Acanthurus</i>	<i>olivaceus</i>	Orangeband surgeonfish
<i>Acanthurus</i>	<i>thompsoni</i>	Thompson's surgeonfish
<i>Naso</i>	<i>minor</i>	Blackspine unicornfish
<i>Naso</i>	<i>lituratus</i>	Orangespine unicornfish
Naso	<i>caeruleacauda</i>	Bluetail unicornfish
Zebrasoma	<i>scopas</i>	Brushtail tang

RABBITFISHES- SIGANIDAE

<i>Siganus</i>	<i>virgatus</i>	Virgate rabbitfish
<i>Siganus</i>	<i>vulpinus</i>	Foxface rabbitfish

TUNAS & MACKERELS- SCOMBRIDAE

<i>Gymnosarda</i>	<i>unicolor</i>	Dogtooth tuna
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FLATFISHES- PLEURONECTIFORMES

<i>Pardachirus</i>	<i>pavoninus</i>	Peacock sole
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TRIGGERFISHES- BALISTIDAE

<i>Balistoides</i>	<i>viridescens</i>	Moustache triggerfish
<i>Melichthys</i>	<i>vidua</i>	Pinktail triggerfish
<i>Rhinecanthus</i>	<i>verrucosus</i>	Blackbelly picassofish
<i>Sufflamen</i>	<i>bursa</i>	Scythe triggerfish
<i>Sufflamen</i>	<i>chrysopterus</i>	Halfmoon triggerfish
<i>Balistoides</i>	<i>conspicillum</i>	Clown triggerfish
<i>Balistapus</i>	<i>undulatus</i>	Orangestriped triggerfish
<i>Abalistes</i>	<i>stellatus</i>	Starry triggerfish
<i>Odonus</i>	<i>niger</i>	Redtooth triggerfish

FILEFISHES- MONOCANTHIDAE

<i>Aluterus</i>	<i>scriptus</i>	Scribbled filefish
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TRUNKFISHES- OSTRACIDAE

<i>Ostracion</i>	<i>solorensis</i>	Striped boxfish
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PUFFERFISHES- TETRAODONTIDAE

<i>Arothron</i>	<i>stellatus</i>	Star puffer
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PORCUPINEFISHES- DIODONTIDAE

<i>Diodon</i>	<i>liturosus</i>	Blackblotched porcupinefish
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OTHER FISHES**BILLFISHES- ISTIOPHORIDAE**

Makaira	<i>mazara</i>	Indo-Pacific blue marlin
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Appendix 4. Baseline survey forms

Appendix 5. Qualitative report from the field base at Hinoba-an (example – Palm reef).

Ade Lambo (Science Officer SNCDP/Nov-Mar 2000)

Qualitative Report on Palm Reef (ANP Sector), Southern Negros Coastal Development Project (SNCDP), Hinoba-an.**Introduction**

This report pertains to Palm patch reef in the AN sector of which the central location of the reef is situated at the GPS point 09 35 40 latitude and 122 28 10 longitude. The reef is situated 1.05 km from the CCC base camp at a bearing of approximately 210°. Coral Cay Conservation volunteers surveyed the reef from the 9th November 2000 until the 3rd January 2001. A total of 55 survey dives were carried out on the 12 separate transects on Palm. Palm Reef is classic patch reef with a shallow reef flat (7-10 meters) and gently sloping slides down to 70+ meters. The topography of the reef is such that transects were started at 28 meters and teams worked in towards the central marker buoy (8 meters) on a pre prescribed bearing according to the 'spoke and wheel system'.

Survey Methodology

Because of the nature and shape of the reef the spoke wheel system was needed to get an accurate and sufficient coverage of the whole reef. The reef was divided into 12 separate transects (AN 28-39) each 30° apart from each other and running towards the central buoy from an initial depth of 28 meters.

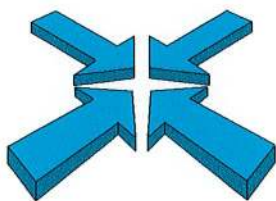


Figure 1. This represents the basis of the spoke and wheel system in that 12 arrows (transects) move towards the central marker buoy on a prescribed bearing

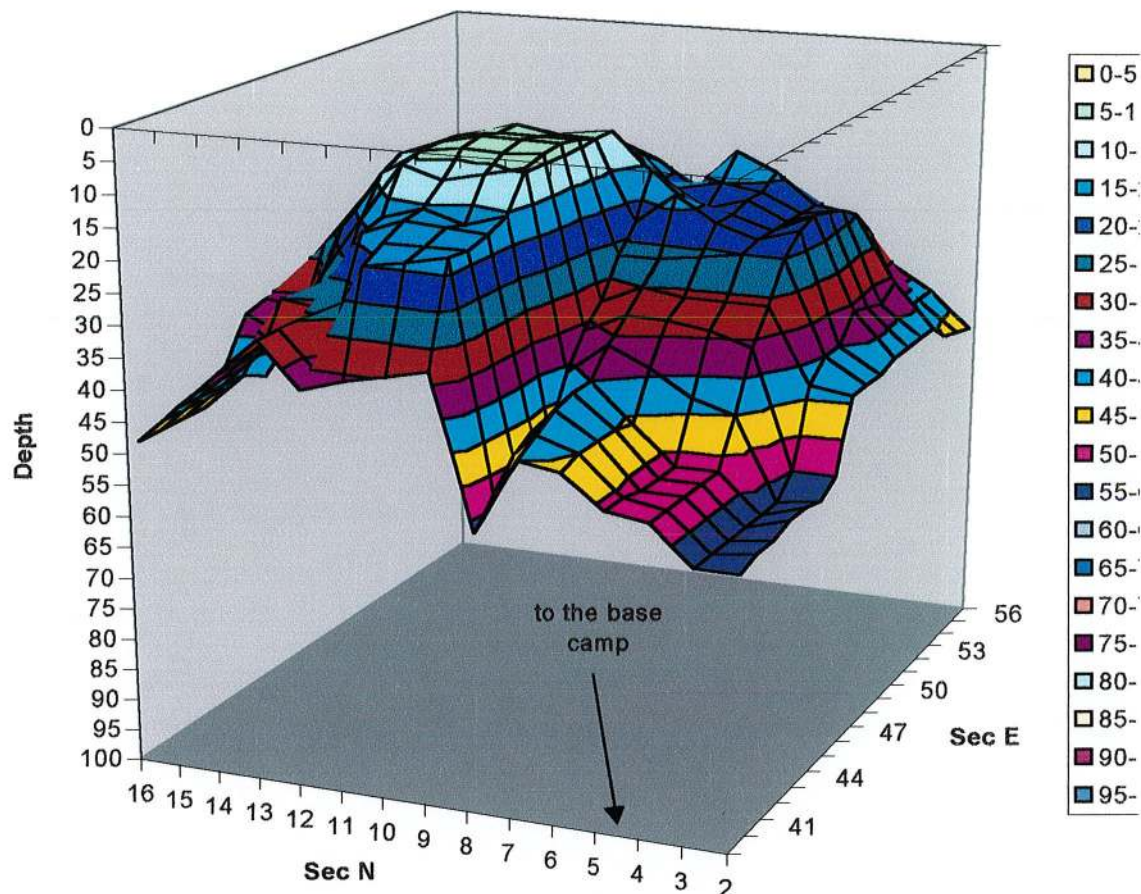
The survey was considered completed when the divers had reached the central marker buoy at 8 meters. Generally it was necessary to undertake three or four surveys dives to complete one transect.

General Topography of the Reef

Unlike many of the coastal reefs in the Philippines Palm reef is a patch reef and not a fringing reef hugging the coastline. Thus the topography of the reef is somewhat more complicated than a normal fringing reef wall. As is shown by this 3-D diagram of Palm reef, created using GPS points and depth sounders, it raises from the sea bed like a sea

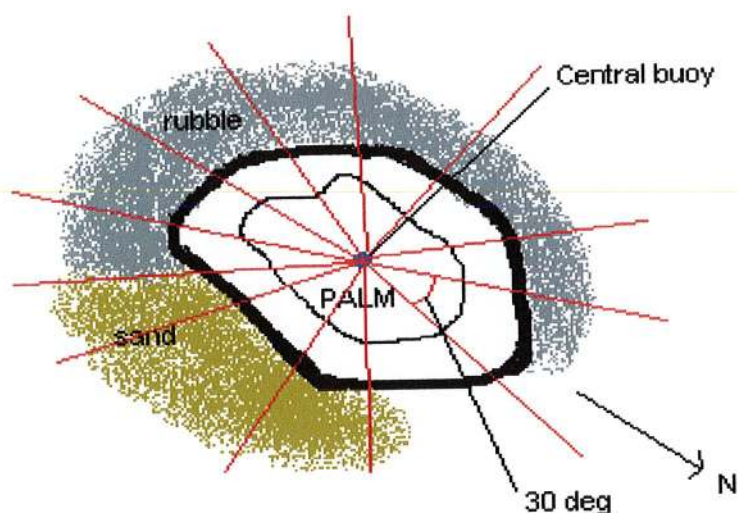
mountain from a depth of about 70+ meters and reaches a minimum depth of about 6-7 meters on the reef front.

Palm Reef



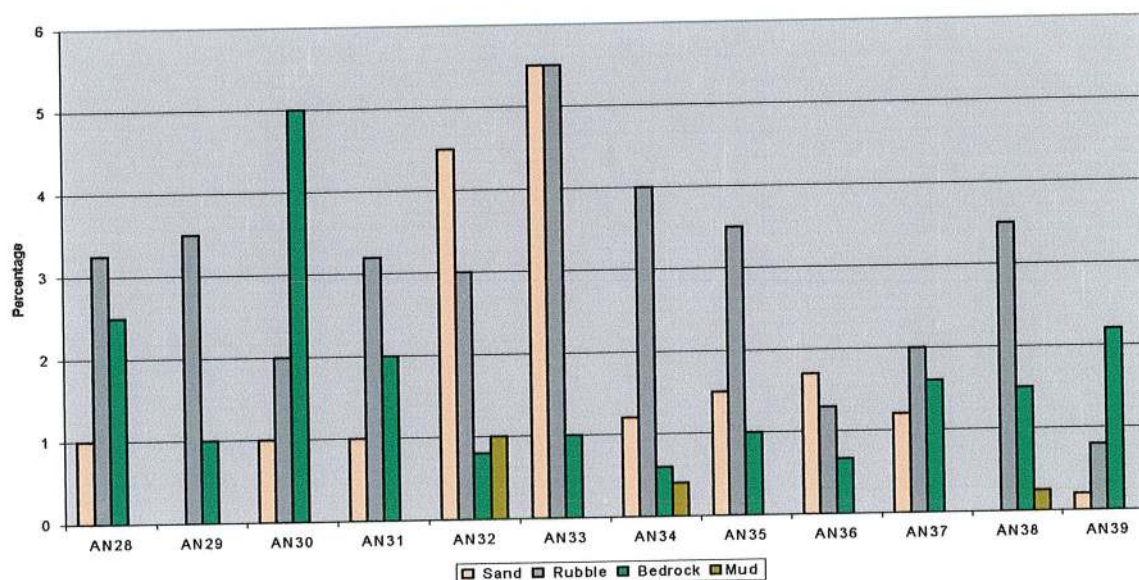
The Northern side of Palm slopes gently down from 15 meters to 22 meters before it drops off more steeply to 40+ meters. On the other hand, the other sides of Palm drop away quite quickly, within approx. 100-150 meters from the central buoy. This change in depth and topography is extremely important when relating it to the biological data from the survey because as will be highlighted later in the report the biological diversity in terms of fish, hermatypic & ahermatypic corals and invertebrates (of which include Sponges, Cephalopods, Molluscs, Crustaceans and Echinoderms). The depth gradients directly correlate to diversity and abundance. The Reef flat (7-10m) consists of a limestone bed rock structure with relatively high hard and soft coral cover and diversity. The gradual increase in depth into what is effectively the upper reef slope brings an extremely abrupt change in topography and biological cover. This is due to the widespread and almost total devastation of destructive fishing practices. The lower and upper reef slopes (28-18 meters) are almost entirely comprised of large rubble fields, the result of extensive dynamite fishing practices. These areas are almost devoid of any hard coral growth except for occasional small coral bommies. Likewise even the relatively undamaged reef front is peppered with craters and gullies which could be attributed to the use of dynamite in the past. An interesting point about the location of these rubble fields is that they start almost exclusively at 14 meters and extended to well below 28 meters. The reason why this pattern exists has not been found. The

eastern side of Palm (transects 220°, 250° and 280°) exhibits a slightly different pattern in that the coral rubble fields are absent and instead sand flats with large isolated coral bommies exist.



Because of this, the area has escaped any widespread damage and the coral bommies appear to be in relatively good health. The sand flat gently slopes from 28m and reaches the main reef structure 50-100m from the start of the transect. Closer towards the reef the more apparent the damage is, as rubble again becomes the dominant substratum.

Percentage Substratum in Each Transect



Biological Descriptions and Observations

For the purpose of this section the biological descriptions shall be divided according to reef zonation along each of the transects. Hard Corals, Invertebrates and Fish will be discussed separately.

Hard Corals

Lower Reef Slope (28-10m)

As previously stated in the topographical section Palm exhibits a very distinctive change in diversity and coverage that is strongly correlated to the zonation of the reef. At this depth all the surveys except for the eastern transects portray widespread coral rubble fields where diversity and abundance of hard coral is extremely poor. All the transects except for AN32 and AN35 portray a total hard coral cover of 10% or less. With the main substratum being rubble with algal overgrowth (*filamentous*, *Halimeda*, *Neomeris*). The lack of hard coral coverage can be attributed to long-term and intensive destructive fishing activities. Regardless, some species have started to take a foot hold and isolated bommies or coral heads have persisted. These coral bommies, though isolated, do demonstrate limited diversity even though coverage is very low. Encrusting forms of *Favia* and *Favities* tend to be one of the species that persists. *Pachyseris speciosa*, *Montipora foliose* and occasional massive *Porites* heads are encountered on these isolated bommies. Nevertheless, the lower reef slope on Palm demonstrates widespread destruction with almost 90% rubble coverage in certain areas. In keeping within Coral Cay diving regulations no data or observations can be collected from deeper down the reef slope but one would imagine that the same trend exists. The topography in some areas is such that the rubble fields slope very gently from 28m to 14-15m where the diversity increases. Thus often whole survey dives on a transect have been solely on rubble fields.

Again, it has yet to be established why this depth zone on Palm is subject to such devastation as opposed to zone higher up the reef.

Upper Reef Slope (10-20m)

This is the zone on Palm where the most apparent change in diversity and abundance of corals exists because this zone contains the end of the rubble fields and the beginning of the main reef structure. From about 14-15m the main rubble fields cease and the main part of the reef starts to become dominant. Along with this change in substratum comes a distinct change in the diversity and abundance of the hard corals. In this zone all the target families (*Pocilloporadae*, *Acroporidae*, *Poritidae*, *Agariciidae*, *Fungiidae*, *Oculinidae*, *Pectiniidae*, *Mussidae*, *Faviidae*, *Caryophylliidae*, *Milleporidae*, and *Platygyra sp.*) have been regularly recorded. While abundance for individual target species, as far as utilizing the quantitative abundance scale, (0-5) may still be 1 (0-10%) the total hard coral coverage increases dramatically and much more non target species occur (encrusting species especially). Coverage of up to 30% (3 on the quantitative

scale) has been recorded. Rubble does still exist, however this is only in patches and not as fields as has been recorded for the lower reef slope. Certain areas are dominated by large mono-specific stands, such as the fast growing branching *Acropora* sp. The shallower one gets on the reef the higher the abundance of both the *Milleporidae* sp. With *M. intricata* especially dominant at 7-9m. The other common family on the reef front are *Pocilloporidae* with example of small, medium and large individuals quite widespread. Numerous encrusting species on the actual bedrock include non-target *Montiopora* sp and *Galaxea* which is very common even though coverage is low because of the small size of the colonies. Encrusting *Favities* and massive *Favia* are again quite common place on the shallower parts of the upper reef slope. Encrusting *Mycedium elephantotus* does occur but coverage is relatively low (1 on the abundance scale) and tends to occur encrusting on the sides of gullies or shallow trenches in the reef.

There is a definite trend that portrays an increase in diversity and coverage, of target and non-target species, with depth. One main observation is the relative amount of dead coral with algae in proportion to the amount of living hard coral. The dead coral is either whole colonies or parts of colonies. *Drupella* sp. seems to be a main culprit of a lot of dead *Acropora* spp. table colonies where up to half of the table has died off.

Reef flat (6-10m)

The reef flat on palm is a relatively small flat area of reef but exhibits very large diversity and coverage of target species. The first thing that is apparent is the numerous large *Acropora* tabulates that occur randomly on the reef. Likewise *M. intricata* tends to dominate the area. *Pocillopora* small and medium are also quite abundant. Unlike the other two zones branching species like *Stylophora pistillata*, *Porites nigrescens* and *P. cylindrica* are more abundant. Several extremely large mounds of *Millepora platyphylla* exist. One of which the central buoy is attached to. The reef flat is intermitted with deeper gullies and large craters which are rubble covered and so point towards the use of dynamite. However, these are not common place and the percentage of rubble cover is significantly reduced to that of the other two zones. It is almost exclusively in this area that we encounter the azooxanthalle *Caryophyllidae* sps. (*Euphyllia* and *Plerogyra*). Although relatively uncommon on the reef front they almost solely inhabit shallow reef areas as the data collected can verify. Of the *Fungiidae* species encountered the higher proportion tends to be of non-target species other than the four target species (*H. Limax*, *C. echinata*, *P. talpina* and the upside down bowl). These are mostly encountered on the reef front on the underlying bedrock.

Invertebrates

Lower Reef Slope (28-20m)

The invertebrates section includes the sponges (Phylum *Porifera*), Soft corals (Order *Octocorallia*), Gastropods (Phylum *Mollusca*), Sea stars (Phylum *Echinoderm*), Crustaceans (Phylum *Arthropoda*), Worms (Phylum *Annelida*), Tunicates (Phylum *Chordata*), Bryozoans and all the Algae. As described in the topographical and hard coral sections the lower reef slope of Palm is entirely dominated by large rubble fields. Hence, there is a marked absence of many of the invertebrates. As is to be expected the rubble field is subjected to widespread algal overgrowth. The dominant group being the

chlorophyta (green algae). Of this group, green filamentous had a very widespread coverage along with *neomeris*. Surprisingly, the very common coralline algae *Halimeda* was not common on the rubble fields. Occasional *Galaxaura* and *Jania* were also encountered. The coverage of any of the other invertebrates was extremely poor, except in a few cases. Hardly any echinoderms were recorded except for occasional brittle and feather stars that inhabited the rare coral bommies that escaped destruction. Gastropods were rarer still. No gastropods except nudibranchs were recorded from 28-25m and only then only a few records of cowries and the occasional cone shell were every seen. No crustaceans were ever recorded on the lower reef slope. This supposedly has to do with the fact that on the rubble fields there isn't sufficient habitat for these animals to shelter in. One can probably assume that there are some crustaceans in this zone but the cryptic nature of shrimps and other species make them very hard to observe. The tunicates which are so common on the upper reef slope and reef front and almost entirely absent from this area. Again only where a coral bommie exists will the occasional colony of tunicates be sited. Likewise the bryozoans tend to be virtually absent in this zone. One of the most striking sights on these rubble fields is the existence of very large individual barrel sponges that sit completely isolated in the rubble. However, apart from these examples the abundance of sponges in general is very low with only occasional lumpy and encrusting species being seen on coral bommies. In keeping with this pattern soft corals are not very abundant. There are occurrences of small juvenile *Sacrophyton* and *Lobophyton* that are taking hold in the area but generally diversity and coverage is low. However there is an exception to this rule, in that there tends to be large areas that are completely covered in tree soft corals (*Dendronephthya* sp.) these patches can be up to 20m long and 10 m wide and are found from 28-20m on the rubble fields.

Upper reef slope (10-20m)

The upper reef slope contains a far higher diversity and abundance of all the invertebrates. Algae is again common but now there also tends to be a higher abundance of *Rhodophyta* algae with *Jania*, *Galaxaura* and *Amphiora* all becoming more conspicuous. At this depth we also get *halimeda*, *valonia*, *neomeris* and *filamentous* quite frequently.

Echinoderms such as *Linkia Laevigata*, *Culcita Novaguinea* and *Choriaster granulatus* become common place. Feather stars (*Comasteridae*) become extremely common, perched on top of coral heads extending their tentacles to filter feed. Even in this zone the gastropods are extremely hard to find they tend to inhabit the gullies and crevices in the bedrock and this makes them hard to spot. Tunicates such as the *Didemnum* and *Guerrero* are frequently found encrusting on coral heads, tables or sea whips forming dense colonies. Bryozoans are notoriously misidentified because of their small size and the fact that they look like algae. For this reason there have been almost no bryozoans recorded, however I feel that this is due to a lack of identification rather than absence. This is the zone that the soft corals really start to dominant. Leather (*Sacrophyton*) as well as Dead Man's Fingers soft coral (*Sinularia* and *lobophyton*) are common, competing with other corals for space. Flower and Pulsing (*Xenia*) are found in large bushes on the reef structure. With much more varied topography and bedrock there tends to many more crustaceans in this zone with shrimps and the occasional spiny lobster being recorded. Sponges are probably the most common invertebrate on the upper reef slope with tube and rope sponges being the most common out of these.

Encrusting and lumpy sponges are found on or around coral bommies encrusting on the bedrock.

In my opinion the upper reef slope has the best overall abundance and diversity of invertebrates because the competition for space and light availability isn't as intense as that in the reef front where the hard coral coverage can get up to 50% and thus space is very limited for colonization and growth. Another issue is that many of the invertebrates are azooxanthalle and so light availability isn't a limiting factor in their location on the reef. A more important factor is to be situated in areas that can take advantage of any currents that would bring along the plankton and detritus that they need to feed. Green filamentous algae again seem to be the most common algae along with *Valonia sp.*

Reef flat (3-10m)

The reef flat of Palm is dominated by living hard coral and dead coral with algae therefore the abundance of soft corals and sponges is lower than in the upper reef slope where the competition of space is less intense. Still, leather and dead man's fingers are both seen frequently at this depth. However, the most common soft coral would be the flower (*Xenia*) soft coral. Sea stars have their highest abundance in this zone and of the target species *Linkia Laevigata* is by far the most common. The only sea star that seems quite rare is the *Protoreaster nodosus*. Of the sponges, rope and encrusting sponges which are strewn randomly on the bedrock are the most common. There is a conspicuous absence of any the large sponges that you encounter at lower depths but that may be due to competition with corals. Virtually every coral head (especially dead coral with algae) is covered with colonies of tunicates. Again crustaceans are rarely encountered, except for the resident spiny lobster, and for anemone shrimps that are found in anemones.

Fish

Lower reef slope (20-28m)

The continuing trend of a decrease in diversity with an increase in depth is most apparent in the fish data and observations. The lower reef slope which is almost completely devoid of any living hard coral presents a new habitat for some fish species but the majority of fish are excluded from this zone by lack of appropriate habitat. The rubble fields contains very low abundance for fish species even though the diversity of fish is quite varied. There are some fish that thrive in this type of environment. One is almost always sure to see numerous goatfish on the rubble fields rummaging in the rubble and sand for food. Generally the rubble fields, when compared to the other zones on the reef, have extremely low fish abundance. One thing that is interesting is that often juvenile butterfly and angelfish are found in and amongst the rubble. This could be due to the ready availability of food (algae overgrowth). Even mid-water fish, such as fusiliers, are quite sparse in this zone. Where there is an isolated bommie or coral head the fish will congregate and this tend to be the usual fish found on the reef such as the damsels, butterfly, surgeons and angelfish.

Upper reef slope (10-20m)

The increase in diversity and abundance of fish in the upper reef slope is immediately obvious to the surveyor as he/she enters the upper reef slope. With the existence of healthy living coral numerous fish have their appropriate habitats and thus we see much more diversity. Throughout the whole reef the one group of species that stands out as being the most abundant are the damselfish. The diversity and abundance of these reef fish is enormous. The reticulated damsel, the black bar chromis, bi-color chromis and the various other chromis sp. are dominant close to the reef. However, all the target species have been encountered in this zone in relatively high numbers. Butterfly and damsel fish regularly record 3 and above in the abundance scale. Surgeonfish, both target and non-target are also very common place on the upper reef slope reef. This is also the zone where one tends to encounter the large schools of fusiliers that appear regularly. Jacks, Mackerel and Tuna have all been observed in this area.

Reef flat (3-10m)

As with the invertebrates I feel that varied topography that is encountered on the upper reef slope results in a multitude of habitat opportunities and thus results in high diversity. While the reef flat does have a high diversity and coverage of hard corals the topography is quite uniform and so the diversity of fish may be a little lower even if the overall abundance is higher. Fish do not have a barrier to dispersal on the reef and so you tend to encounter all the same fish in both zones but with a few exceptions. Some species of fish, damselfish for example, live in very close association with certain corals and so an increase in the coral coverage almost invariably results in an increase in their numbers.

Anthropogenic issues

On and around Palm reef has always been the main fishing area for the Hinoba-an local fishermen. The past human impacts on the reef are there for everyone to see. The amount of dynamite damage on the reef is very high. While this type of destructive fishing practice is not really used on Palm any more the effects are still being felt and are reflected in the diversity of the dynamited areas as opposed to the areas that escaped damage. Widespread fishing still does occur on Palm and this tends to be individual fishermen skin diving with spear guns. Occasionally, we have suspected some illegal fishing activities being carried out but haven't got the proof or means to question or stop it. The main catch on the reef seems to be of the pelagic reef needlefish which live near the surface and are caught by the use of scare lines and nets with very small mesh sizes. An interesting point to add is the rubble and destruction on Palm isn't necessarily from dynamite as I have frequently found boulders with attached rope on the reef, which is a clear sign of Muro-ami fishing being carried out in the past. Occasionally nets are found on the reef but these tend to be old and have now been encrusted over with algae and coral so don't pose much of a problem. Sewage is a frequent problem in these waters and often sewage is encountered around the reef area. However, the

amount in question is not that substantial and so I don't feel that it makes an impact on the reef itself. Most of the fishing activity tends to occur at night and so it is hard to gauge the numbers and types of activity that are going on.

General comments and conclusions

Palm is a very nearby reef to the large fishing population of Hinoba-an and Vasques and it seems to be the main source for subsistence and small scale commercial fishing activities. The general reef condition of Palm is very varied. As is continuously stated in this report the lower reef zone is an area of almost total devastation and in terms of coral, invertebrate and fish diversity/abundance it is very poor. However, this trend reverses as we get higher on the reef where the amount of live coral coverage increases dramatically. The diversity and abundance of fish seem to be quite high when compared to other sites in the area (Bolila, Nabulao and Catmon Bay). The one thing that is obvious is the small size of all the fish, even relatively large species like groupers, snappers and parrotfish are relatively small. This could be due to selective fishing by fishermen for larger fish or an adaptation by the fish to the area. Palm along with the other reefs in the area should be prime targets for further protection from destructive and intensive fishing. Its relative accessibility could be used in its favor with the introduction of eco-tourism in the area and the possibility of diving operations working in the area. Coral reefs, even though they are relatively sensitive, have a remarkable ability for regeneration and given time and protection Palm could regain back some of its former glory and prove to be an excellent site.