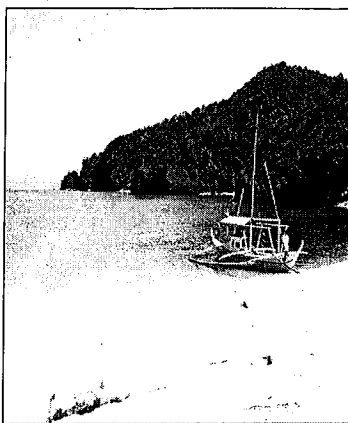


MABINI-TINGLOY MARINE BIODIVERSITY CONSERVATION PROJECT

FINAL REPORT



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February 2003



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ACKNOWLEDGMENTS

The success of *The Mabini-Tingloy Marine Biodiversity Conservation Project* would not have been possible without the vision, guidance and support provided by the following:

The Philippines Reef and Rainforest Conservation Foundation, Inc. (PRRCFI);
WWF-Philippines, and in particular members of the local WWF office in Bagalangit, the Bantay Dagat, Romy Trono (Director, Sulu-Sulawesi Marine Ecoregion Programme, WWF-Philippines), and members of the GIS department of WWF-Philippines;
The local community of Bagalangit;
The Mayors of Tingloy and Mabini;
The Friends of Balayan Bay (FOBB) including Ton Francisco and Boy Venus;
The British Embassy Manila for generously making available a grant of £10,000 towards project implementation costs.

The authors would also like to thank the following additional members of the CCC project staff:

Keith Lawrence (Expedition Leader)
Steve Box (Expedition Leader)
Harry Goudge (Science Officer)
Phil Molloy (Science Officer)
David McCullagh (SCUBA Instructor)
Chris Slater (SCUBA Instructor)
Rebecca Graves (Medical Officer)
Karren Bisset (Medical Officer)
Keith Mann (Medical Officer)
Christian Jung (Medical Officer)
Andy Maloney (Volunteer photographer)

We are also extremely grateful to the local field staff for their extensive effort and the large number of international CCC volunteers who worked tirelessly to help gather the survey data presented in this report.

EXECUTIVE SUMMARY

The coastal and marine resources of the Municipalities of Mabini and Tingloy (Southern Luzon, Philippines) are considerably diverse and provide livelihoods for multiple stakeholders including petrochemical refineries, fishers, recreational divers, hoteliers, ferry operators, etc.

Various significant anthropogenic impacts threaten the intricate diversity of the coral reefs of this area. These include overfishing, blast fishing, aquaculture, ship groundings, oil-spills, nitrification, pollution and sedimentation.

Between January and August 2002, teams of international CCC volunteers carried out more than 200 survey dives to gather the information presented in this report, which includes analyses of data from over 13 000 species records.

Survey work carried out by the CCC dive teams in the *Mabini-Tingloy Marine Biodiversity Conservation Project* (MTMBCP) has revealed a considerable degree of both benthic habitat and coral diversity. However, overall, the area appears to be heavily over-fished.

Currents and the unique lie of the Sepoc headland, and considerable variation in the coastline at this area, facilitates a variety of depositional and accretive marine habitats (from exposed spur-and-groove to sheltered large *Porites* mounds). This has, in turn, developed a considerably varied number of marine habitats along the 1 km of coastline surrounding the area of Sepoc Point.

Sepoc Point (north and south) surveys identified eight different benthic habitats and an overall coral cover of 31%. By contrast, only three habitats were recorded on Caban Island. Sombrero Island appears to have medium density of coral cover on the easterly side. However, the west and north-west coast appears to be rubble dominated, suggesting previous storm or blast fishing damage to this part of the island.

The south-west Calumpan peninsula (within the 1991 designated Mabini reserve area) has a varied number of habitats with a patchy distribution. There are also pockets of extremely high coral cover; for example, to the north of Eagle Point Resort, and in the region shoreward of Cathedral Rock (a fish sanctuary).

Fish populations within the Mabini reserve area, and especially within the sanctuary of Cathedral Rock, appear to be healthy in terms of biomass and diversity of fish compared to adjacent areas. Deeper waters in this survey sector appear to be dominated by fusiliers, damselfish and *Naso* species.

Given the high biodiversity of coral populations of the Mabini-Tingloy area, serious consideration should be made to increasing the number and range of marine protected areas within the region. The area of Sepoc Point is recommended for establishment of a fish sanctuary and MPA.

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LIST OF ABBREVIATIONS

ANOSIM	Analysis of Similarity
BC	Benthic Class
CCC	Coral Cay Conservation
COT	Crown of Thorns (Starfish)
DIMRS	Danjungan Island Marine Reserve and Sanctuaries
ESI	Environmental Sensitivity Index
FOBB	Friends of Balayan Bay
GIS	Geographic Information System
GPS	Global Positioning System
GO	Government Organisation
GPS	Global Positioning System
ID	Identification
IMO	International Maritime Organisation
KKP	Kabang Kalikasan ng Pilipinas (WWF-Philippines)
MPA	Marine Protected Area
MOU	Memorandum of Understanding
MTMBCP	Mabini-Tingloy Marine Biodiversity Conservation Project
NGO	Non-Governmental Organisation
p	Percent (significance value in statistics)
PADI	Professional Association of Diving Instructors
PRIMER	Plymouth Routines in Multivariate Ecological Research
PRRCFI	Philippines Reef and Rainforest Conservation Foundation Inc.
PS	Project Scientist (CCC staff position)
SCUBA	Self Contained Underwater Breathing Apparatus
SIMPER	Similarity Percentage
SMB	Surface Marker Buoy
SO	Science Officer (CCC staff position)
SSMECP	Sulu-Sulawesi Marine Ecoregion Conservation Programme
UNDP	United Nations Development Programme
WWF	World Wide Fund for Nature

1. INTRODUCTION

Philippine coral reefs are believed to contain at least 499 coral species (Chou, 1998) and more than 2500 fish species (Collins, 2001), making the region (along with Indonesia and Papua New Guinea) the most biodiverse marine realm in the world. Coral reefs cover approximately 25 000 km² of the Philippines coastline, equivalent to approximately 10% of the land area of the whole archipelago (Spalding *et al.*, 2001).

Coral reefs of the Philippines are intrinsically diverse ecosystems that require a considerable degree of environmental stability as a result of the narrow band of physical tolerance limits that govern the life of most scleractinian corals.

Coral reefs provide Filipinos with invaluable income from both fisheries and tourism. Approximately 60% of the Philippine population (70 million people) is dispersed around the coastal barangays (Jacinto *et al.*, 2000). This putting excessive pressure on fringing coral reefs, with fishing, coastal development and run-off all affecting coral communities. Millions of pesos are generated each year from the fish/shellfish and invertebrates that are harvested from Philippine reefs and sold both locally and internationally. Tourism in the Philippines has unfortunately suffered over the past 2-3 years with the insurgency in Mindanao, and some negative international press related to isolated and rare kidnapping events (such as that at Honda Bay, Palawan). Therefore, considerable regional income from tourism has diminished in recent years, leading to severe economic problems for many coastal communities. Often, this regrettably has the effect of driving some workers back to subsistence fishing and gleaning in coastal areas.

Reefs also serve as an important natural breakwater for many coastal areas of tropical countries. Without such protection these coastlines would be under considerable threat from both erosion and storm damage. It is estimated that the cost of providing artificial breakwaters in place of reefs would run into billions of dollars, particularly in areas where the coastline is low-lying and prone to flooding.

1.1 Threats to the coral reefs of Mabini-Tingloy, Luzon

It has been predicted that 97% of the reefs across the Philippines are at risk (Spalding *et al.*, 2001). A variety of factors, exacerbated by a rapidly expanding population, have caused serious degradation of coral reefs, which many people depend upon for their livelihoods.

1.1.1 Sedimentation

Over much of South East Asia, extensive deforestation has resulted from the harvesting of tropical hardwoods (Hodgson, 1997) and land clearance for agriculture. In the area of Mabini-Tingloy itself, downstream effects of sedimentation are clearly visible on the southern Calumpan peninsula when extensive tidal movements shifts water from the east (Batangas Bay) to the west (Balayan Bay) via the Maricaban channel. Similarly, the recent spate of typhoons between June and July 2002, has caused considerable run-off in the area of Bagalangit Bay. There has been considerable urban and industrial development on the east side of the Calumpan peninsula where there has been clearance of forests for many human-based activities. Sediments that are stirred up in the strong currents running between the Calumpan peninsula and the island of Tingloy (Maricaban) are also marine derived. That is, the sediments that are welled up and settle during each tidal cycle, are likely to arise from the movement of natural marine-derived limestone deposits.

Siltation has been cited as being the single most important impact influencing coral reef health in the Philippines (Jacinto *et al.*, 2000). Corals rely on a high amount of light irradiance to survive. Increased sediment loading in the water may cause smothering of coral colonies, restricting the photosynthetic capability of the microscopic dinoflagellate algae (zooxanthellae) that live within the coral host. Sedimentation also clogs coral polyps, reducing the feeding efficacy of the colonies. Production of large amounts of mucous, secreted by the coral host in order to slough off sediments, further stresses the coral as significant energy is required to produce large amounts of mucous. Furthermore, considerable mucous production by corals over long time periods is only effective in certain species.

Sedimentation causes coral death and decreased accretion and growth rate of coral reefs, resulting in an overall degradation in habitat quality. This, in turn, affects the rest of the reef community and may have knock-on effects by reducing the diversity of invertebrate and fish fauna.

1.1.2 Pollution and nutrification

Coral reefs are generally nutrient poor environments (oligotrophic) and anthropogenically-induced increases in nutrient levels can significantly alter their water chemistry. Nutrient pollution can lead to phase shifts on coral reefs when combined with other factors such as reduced herbivory (McCook, 1999). Nutrients often enter the coastal environment via the discharge of untreated effluent or through groundwater seepage. Other significant sources are the use of fertilisers for agriculture and effluent from finfish aquaculture. Many villages and towns adjacent to the seas and coastal watersheds are devoid of even primary sewage facilities with direct discharge on to beaches, and also considerable leaching of pollutants through ground water via permeable rock (much of it limestone). Many Philippine villages rely on artisanal fishing as a main source of income and so are based on the coast. The discharge of untreated sewage directly into the sea results in poor water quality and can pose a health threat to local human populations, which use seawater for bathing.

Pollution may be a particular problem in bay areas where flushing rates are slow so that nutrients are not quickly dispersed. Elevated nutrient concentrations can persist within particular areas of reef for considerable lengths of time. Similarly, the geo-morphological structure of the coast can create eddies within coral reef areas. Cyclical patterns of water circulation can prevent or reduce dilution, thus resulting in localised concentrations of nutrient enrichment. It is postulated that one of the possible reasons for red tides and algal blooms is caused by excessive run-off of fertilizer, industrial pollutants and chemicals. Unfortunately, the Philippines appear to have been beset by a considerable number of these blooms in the past. Such blooms can have serious deleterious consequences by causing mass-mortalities of fish and some invertebrate species on coral reefs (Brown, 1996).

Nutrification caused by elevated levels of nitrogen and phosphorous allows algae to increase in dominance (as many marine algae are nutrient limited in their growth), which is often to the detriment of coral, as they become overgrown by faster growing algae. Nutrification through organic, human-derived waste can seriously reduce water quality, and stimulate the rapid growth of macroalgae (*Turbinaria* spp.) and filamentous algae (*Chaetomorpha* spp.) during calm summer periods. The nature of the algal community also changes, as these nutrients can provide the correct chemical building blocks to promote the growth of rigid tissue that is found in macroalgae (such as *Lobophora* and *Dictyota*). These lifeforms often contain toxic secondary metabolites that are not easily broken down by herbivores, and can therefore lead to a significant reduction of herbivory on coral reefs (Hay *et al.*, 1996).

Nutrification often occurs along with sedimentation in surface water runoff. Mangrove clearance has exacerbated the problems of sedimentation and pollution. Mangroves retain particulate matter and filter out nutrients from sediments, as well as providing nursery grounds for juvenile reef fish. The loss of considerable areas of mangrove forests through unregulated coastal development in the Mabini area in particular, has drastically reduced this natural filtering and sedimentation capability whilst also removing a highly useful habitat.

A major potential impact within the area of Balayan Bay and principally, Batangas Bay, is the oil business. There are two large companies that have refineries on the northern part of Batangas Bay near to Batangas itself. Each quarter, approximately 320,000 tonnes of crude oil is shipped to these refineries (2001 figures, WWF website). WWF-Philippines recently conducted an Environmental Sensitivity Index of the area of Calumpan peninsula to investigate the threat of oil spills within Batangas Bay. This was finalised in September 2001 with production of a base map showing the critical habitats of the bay. The push for total stakeholder awareness and accountability led to the ratification of environmentally clean policies within local industries with the formal signing of a Memorandum of Understanding (MOU) between the leading industries, shipping vessel contractors, resort owners, non-governmental organisations, national and local government agencies and KKP.

1.1.3 Fishing

The Philippines is comprised of thousands of small islands. A large proportion of coastal-dwelling communities are highly dependent on coastal resources for their livelihood, as is the case in the Mabini-

Tingloy area. Traditionally, these communities have sustainably harvested reef resources without causing significant impacts. However, a rapid increase in population growth over the last 20-30 years has led to unsustainable fishing levels (Courtney *et al.*, 1999).

Increased fishing pressure is a major threat to the integrity of coral reefs, a threat greatly exacerbated by the use of destructive fishing techniques. Cyanide, blast-fishing, night compressor fishing and muro-ami fishing (Spalding *et al.*, 2001) are all carried out in the Philippines. Such practices are very damaging to the reef both in the short and long-term as they can kill both target and non-target fish indiscriminately as well as invertebrate and hard coral species that are often extremely slow growing. In addition destructive fishing practices, as their name suggests, can also destroy the habitat, which the fish communities depend upon.

The live fish trade has expanded in recent years and is particularly detrimental to large (generally predatory) fish species. These are highly sought after for the restaurant trade but have low reproductive outputs and therefore slow recovery rates from population collapse (Roberts and Hawkins, 2000). Many of the larger species of fish targeted for this trade are slow growing, and are sequential hermaphrodites. They begin life as one sex but change into the other later on. For example many grouper (serranids) and parrotfish (scarids) are protogynous hermaphrodites, changing from a female to male at a given size and age. By harvesting serranids at a particularly small size, the population lacks significant numbers of male fish, which can have serious implications for broadcast spawning, where large quantities of egg and sperm are needed for successful fertilization.

Fisheries in the Mabini-Tingloy area have been comprehensively studied in the past. A recent report funded by the UNDP International Maritime Organisation highlighted the fisheries resources of Batangas Bay (UNDP-IMO, 1999). This report expressed the view that the pelagic fisheries of the bay (mainly for Tuna (*Auxis* sp.)) were highly overexploited with annual catches of approximately $1.97 \text{ mt km}^{-2} \text{ yr}^{-1}$. Many pelagic fisheries within the area, and landed at Batangas and Anilao, are supported by considerable off-shore catches from outside the bay. Many of the registered fishing vessels within the port of Anilao are clearly over the 3 ton limit for subsistence fishing, and are therefore restricted to fishing in waters more than 15km from the municipal coasts of Mabini and Tingloy. The small vessels that are left are usually comprised of bancas with inboard engines that patrol local reefs and carry out line and net fishing. The majority of these boats are small (around 10-15 ft) with usually one fisherman onboard who uses (in the majority of cases) squid bait on a line to catch tuna. Others spearfish for reef-associated species such as fusiliers, grouper and snapper. During the CCC surveys, nets were rarely observed being used over reef areas. The majority of fishing in the more populated areas of Mabini was with hook and line, fishing in depths greater than 100m for pelagic species. Most fish caught by small-scale fishers are landed at Anilao beach, where they are immediately sold to stall holders and market traders.

The recent UNDP-IMO report suggests that the Mabini-Tingloy reef fishery was probably under-exploited in 1999. The report stated that the potential landings for the Batangas Bay area could reach $5 \text{ mt km}^{-2} \text{ yr}^{-1}$. However, the report noted that the absence of top predators (such as jacks, snappers, grunts and emperors) was evidence that, in non-reserve areas, families susceptible to the hook and line fishery were already over-exploited.

Many of the more destructive fishing methods associated with over-exploited fisheries, of which the Philippines is a prime example, have become rare in the municipality of Mabini. Here, there are at least three established fish sanctuaries within the Mabini reserve (Cathedral Rock, Arthurs and Twin Rocks) where fishing has been restricted with some degree of success (White, 2001). The prevalence of the diving industry within this area, and of the push for environmental awareness to counteract habitat degradation in the 1970's and 1980's, has led to a significant decrease in the incidence of destructive fishing. Also, the dive industry in Mabini (a major stakeholder in the area) has positively influenced a more sympathetic attitude to preserving the coral reefs. The municipality of Tingloy is a major residence for local and municipal fishers, and the benefits associated with the establishment of resorts on the Calumpan peninsula has not yet been fully realised by those living on Maricaban Island. Therefore, the fishers in Tingloy have perceived little change in their livelihood options, unlike their neighbours in Mabini. An adjustment towards income opportunities associated with the dive industry may influence the local fishermen from Tingloy to become more able to switch livelihoods in the future, and thereby take the strain off the over-exploited marine resources.

1.1.4 Coral Bleaching

A further impact affecting coral reefs across the world is coral bleaching, which occurs across all tropical seas as a result of increases in surface water temperature (Hoegh-Guldberg, 1999). Corals either temporarily or permanently disassociate from the photosynthesising zooxanthellae, which they depend upon for 80% of their nutrition, leaving only the white coral skeletons remaining. It is feared that bleaching could become more frequent as global warming increases the incidents of high sea surface temperatures. It appears that corals in the Mabini-Tingloy area have been spared the worst impacts of the 1998 bleaching event, possibly as a result of the strong considerable currents that run through this area, which keep the water column mixed, and hence reduce considerable temperature extremes.

1.1.5 Tourism

Tourism has been developing in the Mabini-Tingloy area since the 1970's both in terms of local and foreign visitors. The region is highly popular for recreational diving. Its close proximity to Manila (three hours by road) ensured that it became the primary destination for recreational divers on weekend trips. During peak times up to 400 dives can be undertaken in the region (Trono, personal communication). The growth of hotel and dive businesses has also occurred with associated issues of both solid and liquid waste management, coastal front development and diving related reef damage. There is massive interest in further development of both the dive tourism and hotel industry in the Mabini-Tingloy region. Thankfully, these two tourism industries are very responsive to environmental advice and are keen to adopt a series of guidelines in order to sustainably manage the coral reef environment.

1.2 Marine Protected Areas

The establishment of Marine Protected Areas (MPAs) has proved to be an effective methods for conserving coral reefs and their fish populations (Mosquera et al., 2000). In the Philippines areas have been targeted where there has either been a local reduction in fish catch and coral cover, such as Apo Island off Negros Oriental (Russ and Alcala, 1996) and Danjungan Island in Negros Occidental (Harborne et al., 1996), or where there is considerable interest in globally significant marine biodiversity of an area, such as Tubbataha atoll in the Sulu Sea (White and Palaganas, 1991). Projects that have been successful after the initial establishment of an MPA are those where when there is often prior scientific assessment of resources before reserve boundaries are set, combined with contemporary capacity building, and the implementation of a significant long-term strategy and management of the protected area.

Apo Island in Negros Oriental was initially set up as a marine reserve with the full commitment and backing of the local community. The initial plan was to preserve one section of the reef as a no-take zone (Russ and Alcala, 1989). Although this area was extremely small (~250 x 50 metres), the reserve location was decided as being an effective area (<25% of the islands reef area above 30m depth) to restrict fishing to the rest of the island (with a circumference of approximately 1.5 km) whilst preserving reef fish populations within the no-take zone. Monitoring dives were undertaken to record the recruitment and increase of the commercial fish population inside and outside the no-take zone. These surveys proved that jack and grouper populations (large, easily caught reef-associated predator fish) increased dramatically in biomass and abundance within 5 years of the reserve area being established, both within, and outside the fish sanctuary (Russ and Alcala, 1996). A local education programme was combined with the surveys, which enabled the borders of the reserve to be respected by the fishing community of the island. The reserve has successfully been managed to this day and provides a considerable spill-over of fish from the no-take area to the other areas of the island for the local fishers, whilst maintaining the population within the no-take zone (see Roberts 2000 and Roberts and Hawkins, 2000).

Tubbataha reef protection is on a larger (financial, logistical and spatial) scale, and is managed by the global NGO The World Wide Fund for Nature (WWF). WWF and other researchers from the Philippines gained the interest of the international scientific and national political world to establish this area as a United Nations World Heritage Site in 1993.

The Danjungan Island Marine Reserve and Wildlife Sanctuaries (DIMRS) in Negros Occidental is another case study in effective marine reserve management. The Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) has been managing Danjungan Island since 1994, with assistance from the UK-based Non Governmental Organisation (NGO), Coral Cay Conservation (CCC) (Solandt et al., 2000; Harborne et al., 1996). CCC recruited volunteer divers in order to carry out biological surveys of both the

marine and terrestrial resources of the island between 1996 and 2001. PRRCFI and CCC also provided training of local fishermen and other community members in marine identification and survey skills, such that the local community is now successfully monitoring reefs themselves. Alternative livelihoods have also been initiated in the area of Bulata (the coastal village adjacent to the island) in order to take the pressure off the natural resources of the area. These include, but are not limited to; the development of a mud-crab fishery and mangrove replanting scheme; basket weaving and employment as terrestrial guides, dive guides and reef surveyors.

As a result of the success of the scientific and socio-economic management of the area, the DIMRS was officially sanctioned by Philippine provincial law in February 2000. In 2002 the reserve was voted the 'Best Managed Reef' in the Philippines (by a committee consisting of members of the Department of the Environment and Natural Resources; PhilReefs – the newsletter of the University of the Philippines; The Philippine Council for Aquatic and Marine Research and Development, and The Department of Agriculture).

These projects are beacons that stand out as the success stories of Philippines Marine Protected Areas. It has to be the aim of a sustainable development initiative within the Philippines that more success stories such as those from Apo Island, Danjungan Island and Tubbataha are seen in different areas of the Philippines. This will help alleviate the poverty due to the destruction of marine natural resources, and help to accommodate factors such as large coastal populations and the dominance of farming and fishing industries that glean marine resources.

1.3 Project Background

'Anilao' (named because of the main fishing village commonly associated with the Mabini-Tingloy dive area) is the most famous and historically rich of the Philippine dive areas. It is only 3 hours by road from Manila, and since the 1970s, began to emerge as the area where most people from the Manila area went to carry out recreational dives. Filipinos use this area for weekend dive trips, with around 400 dives carried out in the area during peak periods (Trono, pers. comm.).

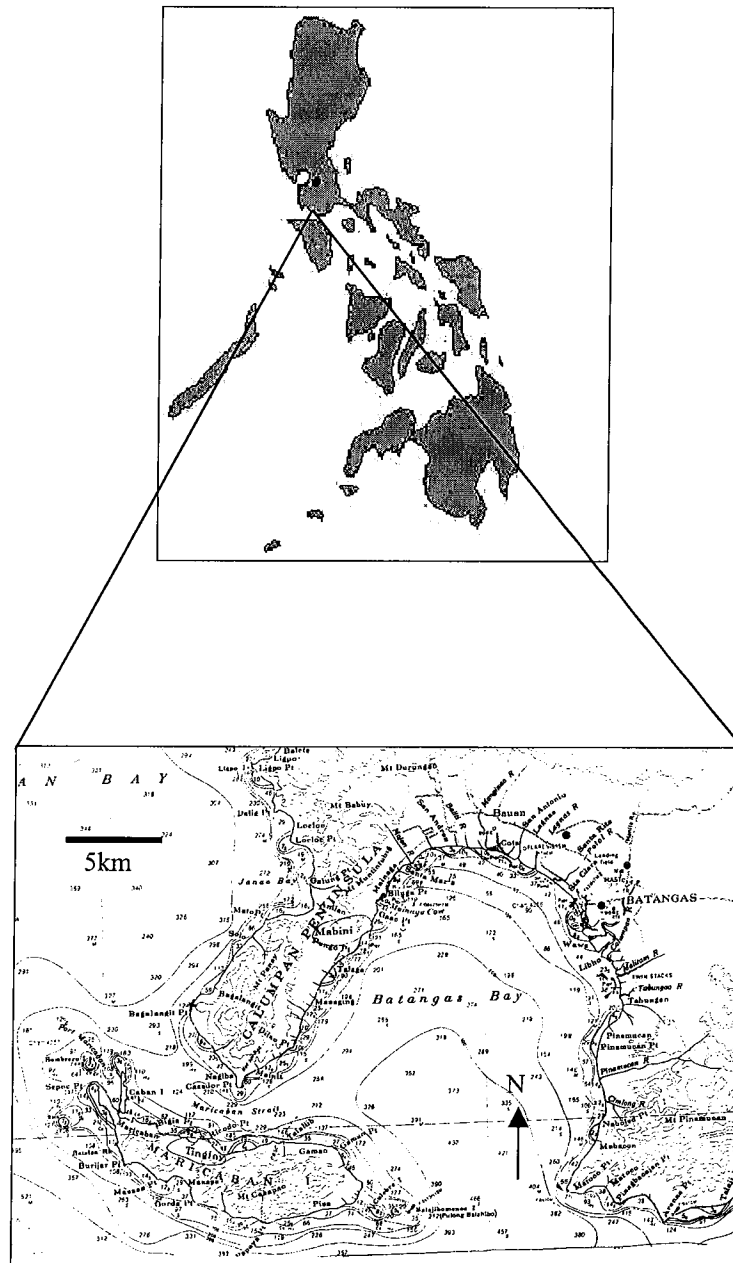


Figure 1. Location of the Anilao area (Mabini-Tingloy Municipalities) in southern Luzon, Philippines

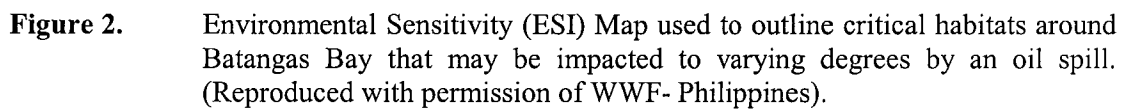
1.3.1 A Brief History

Between the late 1970's and 1980's considerable efforts were made by the National Environment Protection Council to create marine parks around Sombrero Island, Sepoc and Layag-Layag within the waters of Mabini and Tingloy. These initiatives were unsuccessful, and the areas remain open to access for all stakeholders and resource users to this day. The Haribon Foundation affected a community based conservation project along the shores of San Teodoro and Bagalangit barangays in Mabini from 1990 (White, 2000). These led to the creation of the first fish sanctuaries by municipal (Mabini) ordinance in 1991 in the areas of Cathedral Rock, Arthurs Reef and Twin Rocks. All these sanctuaries lie on the south-westerly facing coast of the Calumpan peninsula (Fig. 1). They have been relatively successfully protected by a local bantay dagat, and through the conservation efforts of the resorts that abut that section of coast. During the mid 1990s, The Sulu Fund for Marine Conservation Foundation Inc. (Earthwatch funded) began a series of surveys at the sanctuaries and surrounding reefs of the Anilao dive area. These surveys have carried on throughout the 1990's with the most recent survey in 2001 (White *et al.*, 2001). The Biodiversity Conservation Network supported the Haribon Foundation in planning a major conservation programme and conducted a socio-economic study of the area in 1988. In 1997, WWF-Philippines (KKP - Kabang Kalikasan ng Pilipinas) became actively involved in the area, and promoted the area as one of its key sites within the Sulu-Sulawesi Marine Eco-Region programme. Work initiated by WWF, The Centre for Empowerment and Resource Development and the Sulu Fund for Marine Conservation Foundation led to the inception of The Mabini Tingloy Coastal Area Development Council in 1997 (White, 2000). This legislative council was formed in order to discuss trans-boundary issues related to conservation in the waters of Batangas and Balayan Bays, and around the island of Maricaban (Tingloy municipality). WWF also initiated a resorts' NGO called The Friends of Balayan Bay in 2000 in order for diver and resort stakeholders to have a single voice related to environmental issues. In September 2001, an MOU was signed between NGOs, Governmental Organisations, local businesses, oil and shipping companies of the area in order to agree to preserve the environment in the area of Batangas. This was as an offshoot of the production of the Environmental Sensitivity Map (see Fig. 2) through the efforts of WWF-Philippines.

The Mabini-Tingloy Marine Conservation Project was initiated in order to facilitate the massive commercial dive interest there is in the Anilao dive area. Recently, the members of the two municipalities along with implementation from WWF set up a local bantay dagat to patrol the waters of the project area, enforcing the 'Environmental Protection crusade' that is part of the programme of activities. WWF has a staff house and office in Bagalangit on the south-west shore of the Calumpan peninsula (see Fig. 3), where community meetings, training of bantay dagat members, and stakeholder assemblies are facilitated.

Whilst there is a considerable history behind the efforts of marine conservation of the area, biological resource surveys have been fairly limited in the past (monitoring by the Sulu Fund for Marine Conservation Foundation, and some assessments of the resources by WWF), such that PRRCFI/CCC have been invited to undertake a more comprehensive assessment of these resources.

WWF approached the Philippines Reef and Rainforest Conservation Foundation Inc., in the summer of 2001 in order to investigate the possibility of Coral Cay Conservation undertaking comprehensive marine resource assessments in the area of the Mabini-Tingloy Marine Conservation Project waters. Thus was borne the Mabini-Tingloy Marine Biodiversity Conservation Project (MTMBCP), where an MOU was signed in late 2001 in order to bring these three NGOs together to plan to survey the reefs of Mabini-Tingloy, and provide a dataset and habitat map that could be effectively used alongside the management plan for the project area.



2. METHODS

2.1 Survey strategy

Since the area encompassed by the MTMBCP is extensive (approximately 400km²), the survey strategy focused on gathering data from a wide range of reef habitats that represent most reef types of the area and hence provide preliminary comparisons and guidance for future research and management decisions. Areas to be surveyed were chosen based on local knowledge, popular dive sites and reconnaissance dives.

Planning of survey dives was also motivated by the interest from all stakeholders in the reefs of Sombrero Island, and the potential for this area to become a marine reserve and fish sanctuary, as it lies in the middle of the Maricaban channel, between Maricaban Island (Tingloy municipality), and the Calumpan Peninsula (Mabini municipality) (see Fig. 2), and is one of the most important dive areas of Anilao. Other surveys were effected on the area around Sepoc Point (SE and BA), southern Calumpan peninsula (SO and NA), and Caban Island (CI). These areas all appeared to have completely different oceanographic conditions mainly associated with the impact of the tidal current movement within the Maricaban Strait.

Table 1. A description of the fourteen survey sectors delineated during the MTMBCP.

Survey sector	Description of extent
Sombrero Island (SI)	Reef surrounding the island in the Maricaban channel (baseline surveys and rapid assessment)
Sepoc north (SE)	Northern Sepoc Point – fringing reefs with drop-off on the north side (baseline and rapid assessment)
Burijar (BA)	Southern Sepoc Point to Gorda Point encompassing south-westerly facing reefs (baseline and rapid assessment)
Rock (RO)	Exposed rock to the west of Maricaban Island. No surveys carried out due to extensive currents
Papaya (PA)	Southerly facing coast from Maricaban Island. No surveys carried out due to distance from expedition base at Bagalangit
Culebra Island (CA)	Islands to the east of Maricaban Island. No surveys carried out due to distance from expedition base at Bagalangit
Gamao (GA)	Coast of Maricaban Island facing the north east. Only rapid assessment dives carried out in this sector
Tingloy (TI)	Northern fringing reef of Maricaban Island. Only rapid assessment dives carried out in this sector.
Caban Island (CI)	Island to the east of Sepoc Point with east and westerly facing reefs. Extensive rapid assessment and baseline survey dives carried out at this location
Mainit (MA)	South easterly facing coast of southern Calumpan peninsula. No dives carried out here due to potential undertow currents
Nagiba (NA)	South west facing Calumpan peninsula encompassing a marine reserve and three fish sanctuaries. Extensive rapid assessment and baseline surveys carried out in this location
Survey sector	Description of extent
Solo (SO)	North west facing coast of west Calumpan peninsula between Cathedral rock and Mato Point. Extensive rapid assessment and baseline surveys carried out in these locations.
Locloc Point (LO)	Northern Balayan Bay. No dives carried out here due to logistical and time constraints
Ligpo Point (LI)	Northern Balayan Bay. No dives carried out here due to logistical and time constraints

Work carried out during the MTMBCP area encompasses data derived from two survey techniques – firstly, between February and March, the *CCC Reef Survey Technique* was used to collect semi-quantitative data to describe relative abundances of key biological and physical information. Between April and July an adapted form of the global reef survey technique ‘Reef Check’ was used to add quantitative reef and fish population health data to the *CCC Reef Survey Technique* data. This report summarises results from data derived from both techniques.

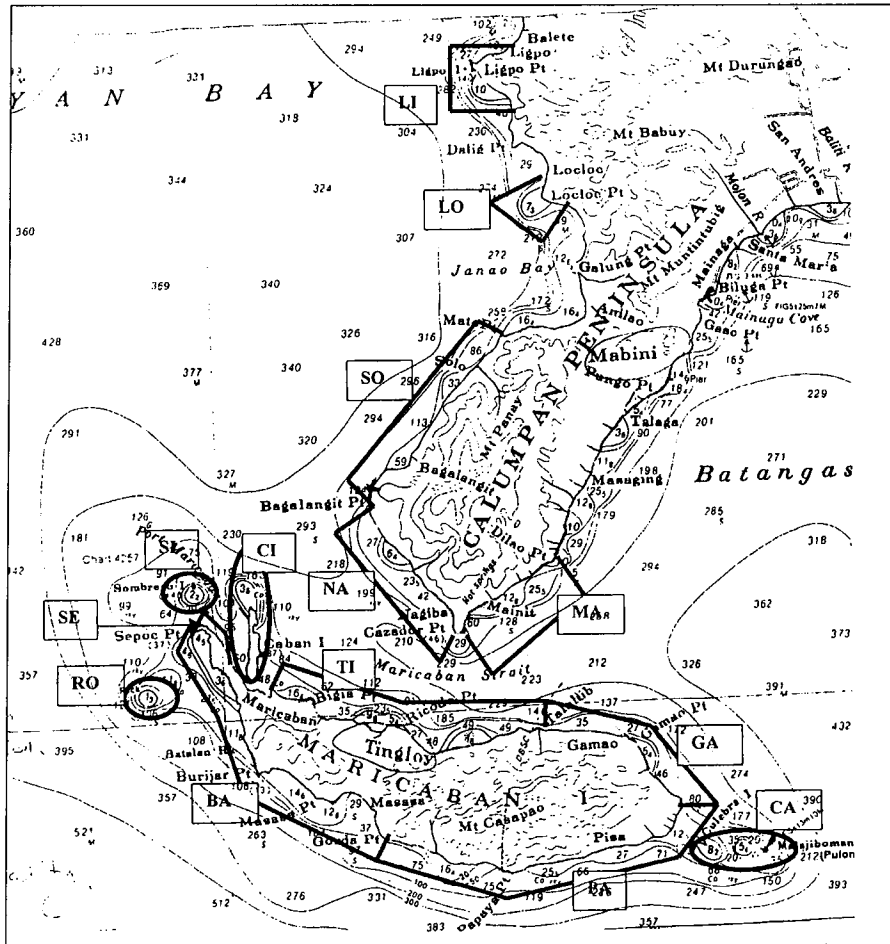


Figure 3. Diagrammatic representation of the fourteen survey sectors delineated for the MTMBCP.

2.2 Volunteer training

Efficient and effective training is a vital component of any volunteer programme in order that participants quickly gain the required identification and survey skills that allow them to collect accurate and useful data. During the MTMBCP, CCC used an intensive 12-day training programme, plus two days of validation, which is outlined in Table 3. The programme has been designed to provide volunteers, who may have no prior biological knowledge, with the skills necessary to collect useful and reliable data. The primary aim of the lecture programme is to give volunteers the ability to discern the specific identification characteristics and relevant biological attributes of the species that they encounter during their diving surveys. The training programme is co-ordinated by the Project Scientist (PS) and Science Officer (SO) and involves two lectures and two dives each day along with de-briefings and evening audio-visual presentations. Volunteers are also encouraged to snorkel and utilise identification guides to ensure a thorough understanding of the information provided in the lectures.

An important component of the training schedule is a series of testing procedures to ensure that each volunteer reaches a minimum acceptable standard. These tests use both 'flash-cards', slide and in-water identification exercises for corals and fish. Furthermore, to assess the quality of data collected by CCC volunteers during actual survey work, two validation exercises are undertaken. The benthic validation exercise uses transect survey set up and thoroughly surveyed by the PS and SO to collate a reference data set. Test transects are subsequently conducted in buddy pairs with one person recording coral and the other soft corals, invertebrates and algae (as performed by Divers 3 and 4 during surveys; Section 3.3). Data are then transferred to recording forms and entered into a spreadsheet where the results from each pair are compared to the reference (science staff results) using the Bray-Curtis similarity coefficient (Equation 1; Bray and Curtis, 1957).

Equation 1:

$$\text{Bray - Curtis Similarity, } S_{jk} = \left[1 - \frac{\sum_{i=1}^p |X_{ij} - X_{ik}|}{\sum_{i=1}^p (X_{ij} + X_{jk})} \right]$$

Where X_{ij} is the abundance of the i th species in the j th sample and where there are p species overall.

Since it is impossible to compare volunteer fish data to a reference, validation of fish surveys are conducted by measuring the consistency between pairs of surveyors. It is then assumed that if surveyors are consistent they are also accurate. Therefore, both divers within a buddy pair independently survey the whole fish list and each surveyor fills out their own survey form and enters it onto a spreadsheet. As with the benthic validation, the pairs of results are compared using the Bray-Curtis similarity coefficient. These assessments are similar to the critical assessment conducted by CCC in 1993 to test the accuracy of volunteer divers conducting baseline transect surveys (Mumby *et al.*, 1995).

Table 2. CCC Skills Development Programme timetable for CCC volunteers during the MTMBCP. ID = identification

	Day +1 (Wed)	Day +2 (Thur)	Day +3 (Fri)	Day +4 (Sat)	Day +5 (Sun)	Day +6 (Mon)	Day +7 (Tue)	Day +8 (Wed)	Day +9 (Thur)	Day +10 (Fri)	Day +11 (Sat)
↕ AM	Transfer New vols (i.e. trained scuba divers) to Bagalangit	Lecture 2 ▶ Dangerous animals! Safety briefs ▶ PADI MFA: Ac mods 1+2 ▶ O ₂ therapy ▶ PADI tables & quiz (OW mods 4+5) ▶ CCC dive standards ▶ Radio use ▶ Emergency procedures Practical ▶ Scuba kit allocation ▶ PADI AOW Elective Dive: PPB (6m)	Lecture 3 ▶ Intro to coral reef ecology Practical ▶ Reef orientation (scuba-18m) ▶ Scuba tune-up (if required) Safety briefs ▶ Boat safety ▶ Boat marshalling ▶ Use of boat safety kit	Lecture 6i ▶ Hard coral ID – target grps Practical ▶ Hard coral ID (scuba-24m) Lecture 6ii ▶ Hard coral ID	No scuba day Lecture 10 ▶ Marine plants & algae Practical ▶ Marine plants & algae ID (snorkel) ▶ Specimen ID – reference collections	Lecture 11ii ▶ Fish ID – target species Practical ▶ Fish ID – target species (snorkel only) Review ▶ Fish ID – target species	Lecture 13 ▶ Invert. ID Practical ▶ Invert. ID (scuba-18m) Review ▶ Invert. ID	Lecture 15 ▶ Intro to CCC Reef Survey Technique Practical ▶ CCC Reef Survey methods (dry run) ▶ CCC Reef Survey methods practice (scuba-18m) Review ▶ CCC Reef Survey technique	Review ▶ ID – coral, fish, inverts & algae Skills refresher ▶ Benthic validation (scuba-18m) ID skills evaluation ▶ Inverts & algae (slides & samples) ▶ Inverts & algae (snorkel) or (b) Practical ▶ CCC Reef Survey Technique	Review ▶ ID – hard & soft corals Options: (scuba-28m) (a) Skills validation ▶ Coral trail (16m)	Skills validation Retakes if required (fish or coral) review Coral and soft coral ID
			PADI DM* ▶ Rescue As; CW As.								
↕ PM	Orientation ▶ Welcome & tour of facilities ▶ Expedition life & duties ▶ General health & safety ▶ CCC rules & regulations	Safety briefs ▶ PADI RD: Ac mods 1+2 Practical ▶ PADI RD: OW exc. 1 (surface only) ▶ OW exc. 2 (3m)	Lecture 4 ▶ Introduction to hard coral biology Practical ▶ ID - coral life forms (scuba-16m) Review ▶ Coral life forms	Lecture 7 ▶ Soft coral and sponge ID Practical ▶ Hard/soft coral ID (scuba – 16m) Review ▶ Hard/soft coral ID	Lecture 11i ▶ Fish family and species ID Practical ▶ Fish ID – Families (snorkel only) Review ▶ Fish ID – Families	Lecture 11iii ▶ Fish ID – target species Practical ▶ Fish ID – target species (scuba-28m) Review ▶ Fish ID – target species	Review ▶ ID – coral, fish, inverts & algae Practical ▶ ID – coral, fish, inverts & algae (scuba-16m) Self-revision ▶ ID – coral, fish, inverts & algae	Lecture 16 ▶ Intro to CCC Reef Survey forms, habitat classifications and the use of abundance scales Practical ▶ Practice survey (scuba-16m) ▶ Data entry onto CCC forms	Lecture 17 ▶ CCC data validation Skills validation ▶ Fish (scuba-10m) Review ▶ Validation assessment s	Review ▶ ID – fish & soft corals Options: (scuba-28m) (a) Skills validation ▶ Coral trail (16m) or (b) Practical ▶ CCC Reef Survey Technique	Practice CCC Reef Survey dive from boat Lecture 19 ▶ Data entry to CCC computer database – (groups of 4) Safety brief ▶ Night-diving procedures

EVE	Lecture 1 ▶ The Philippines + CCC/PRRCFI Review ▶ Expedition Skills Training schedule	Review quiz ▶ CCC health & safety regulations ▶ CCC dive standards ▶ Emergency procedures ▶ Local culture & customs	Lecture 5 ▶ Coral biology and taxonomy	Lecture 8 ▶ Intro to fish ecology & behaviour Lecture 9 ▶ Intro to GPS	Review ▶ Coral & fish ID (pictionary) Lecture 12 ▶ Ropes & knots	Review ▶ Coral, fish and algae ID (pictionary) Review ▶ GPS & knots	ID skills evaluation ▶ Corals Lecture 14 ▶ CCC data: analysis & use	Review ▶ Data entry onto CCC forms (group w/shop)	ID skills evaluation ▶ Fish (slides)	ID skills evaluation ▶ Re-takes (if required) Lecture 18 ▶ Other survey methods	Practical ▶ Optional night-dive (12m)
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Day +12 (Sun) No scuba day	Day +13 (Mon)	Day +14 (Tue)	Day+15(Wed) End of training
Review ▶ CCC dive standards ▶ PADI tables & quiz ▶ Boat safety ▶ Boat marshalling Skills tests ▶ Radio use ▶ O ₂ therapy ▶ Boat safety equipment – demonstration of use	Skills assessment – practice CCC survey dive (shore or boat dive) Followed by Data entry	Data collation – practice CCC Reef Survey dive Validation retake if required ID skills evaluation if required	Departures ▶ 2 week volunteers start <u>conservation weeks</u> Survey dive + Data collation PADI DM* ▶ Topic 1
Skills tests ▶ Emergency procedures Practical ▶ Marine ID skills (ID trail – snorkel only) ▶ GPS use	Skills assessment - practice CCC Reef Survey - shore/boat dive Followed by Data entry PADI MFA* ▶ Mods 3+4	Practice CCC Reef Survey dive Validation retake if required PADI MFA* ▶ Mods 5+6	Survey dive + Data collation PADI DM* ▶ Topic 2–pt1
Lecture 20 ▶ Coastal Zone Management	Lecture 21 ▶ Marine reserves retakes of ID evaluation if required	Graduation! Congratulations – you have completed the CCC Skills Development Programme	Lecture 22 ▶ mangrove ecology Data entry

2.3 CCC Reef Survey technique

The initial phase (February to March) of the MTMBCP utilised the CCC Reef Survey Technique developed by CCC for the rapid assessment of biological and physical characteristics of reef communities by trained volunteer divers. 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 were co-ordinated by the PS and SO to ensure accurate and efficient data collection. Prior to carrying out reef survey technique dives, CCC volunteers carried out several (between 3 and 10) dives within each survey sector to give a rapid assessment of each survey sector. These dives served two purposes; firstly, they allowed science staff to send to CCC-UK an assessment report of species and habitat types within each sector, which was subsequently essential for describing subsequent results, and secondly, it provided the field staff team with the ability to logistically plan surveys into the future of the survey programme (knowing distances to sites, fuel budgets, wave and current conditions for divers) prior to starting CCC Reef Survey Technique dives.

The CCC Reef Survey Technique utilises a series of plot-less transects, perpendicular to the reef, starting from the 18 metre contour and terminating at the reef crest or in very shallow water. Benthic and fish surveys are focused on life forms or families along with a pre-selected number of target species that are abundant, easily identifiable or ecologically or commercially important. Stony corals are recorded as life forms as described by English *et al.* (1997) and selected corals are identified to species level. Fish are generally identified to family level but in addition, important target species are identified. Sponges and octocorals are recorded in various life form categories. Seaweeds are classified into three groups (green, red and brown algae) and identified to a range of taxonomic levels such as life form, genera or species.

Since most transects require two or more dives to complete, transect surveys are divided up into sections (or 'sub-transects') with surveys of each sub-transect carried out by a team of four trained divers divided into two buddy pairs (A and B) as shown in Figure 4. At the start point of each sub-transect, Buddy Pair B remains stationary with Diver 3 holding one end of a 10 m length of rope, whilst Buddy Pair A swims away from them, navigating up or along the reef slope in a pre-determined direction until the 10 m line connecting Diver 1 and 3 becomes taught. Buddy Pair A then remains stationary whilst Buddy Pair B swims towards them. This process is repeated until the end of the planned dive profile, when a surface marker buoy (SMB) carried by Diver 2 is deployed to mark the end of that sub-transect. The SMB acts as the start point for the next survey team and this process is repeated until the entire transect is completed. The positions of the SMB at the start and end of each dive are fixed using a Global Positioning System (GPS).

Diver 1 is 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 describes the substratum along the sub-transect by recording the presence of six substrate categories (dead coral, recently killed coral, bedrock, rubble, sand and mud). Divers 2, 3 and 4 survey fish, hard corals and algae, soft corals, sponges and invertebrates respectively. Diver 3 surveys an area of approximately 1 metre to each side of the transect line whilst Divers 1, 2 and 4 survey an area of approximately 2.5 metres to either side of the line.

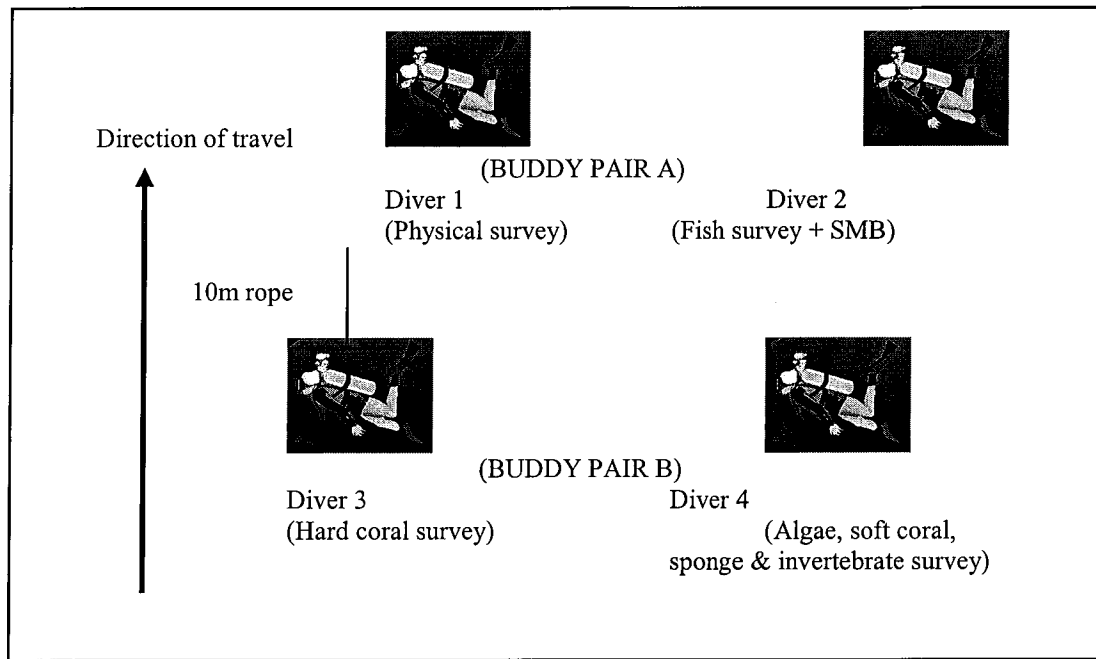


Figure 4. Schematic diagram of a CCC Reef Survey Technique dive team showing the positions and data gathering responsibilities of all four divers. Details of the role of each diver are given in the text

During the course of each sub-transect survey, divers may traverse two or more apparently discrete habitat types, based upon obvious gross geo-morphological (e.g. forereef, escarpment or lagoon) or biological differences (e.g. dense coral reef, sand or rubble; Figure 5). Data gathered from each habitat type are recorded separately for subsequent analysis.

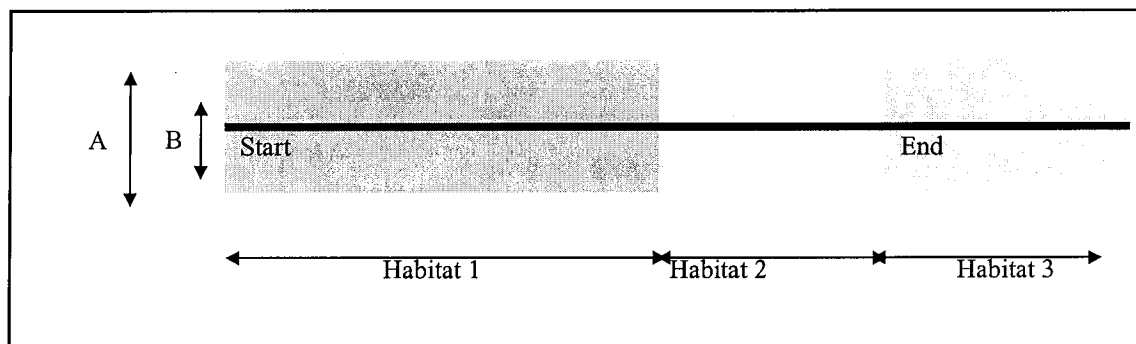


Figure 5. Schematic diagram (aerial aspect) of an example of a reef area mapped by divers during a sub-transect survey. Solid line represents imaginary sub-transect line. Dashed lines and shaded areas represent areas surveyed (A = 5m wide swathe surveyed by Divers 1, 2 and 4; B = 2 m wide swathe surveyed by Diver 3). Benthic data from habitats 1, 2 and 3 (e.g. reef, sand and rubble) are recorded separately

Each species, life form or substratum category within each habitat type encountered is assigned an abundance rating from the ordinal scale shown in Table 3.

Table 3. Ordinal scale assigned to life forms and target species during CCC Reef Survey Technique surveys.

Abundance rating	Coral and algae and sessile inverts	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 the course of each survey, certain oceanographic data and observations on obvious anthropogenic impacts and activities are recorded at depth by the divers and from the surface support vessel. Water temperature readings ($\pm 0.5^{\circ}\text{C}$) are taken from the survey boat using a bulb thermometer at the sea surface. The survey team also takes the temperature at the maximum survey depth (i.e. at the start of the survey). Similarly, the salinity is recorded using a hydrometer and a water sample taken from both the surface and the maximum survey depth. Water visibility, a surrogate of turbidity (sediment load), is measured both vertically and horizontally. A secchi disc is used on the survey boat to measure vertical visibility through the water column (Figure 6). Secchi disc readings are not taken where the water is too shallow to obtain a true reading. Horizontal visibility through the water column is measured by divers' estimates while underwater. Survey divers qualitatively assess the strength and direction of the current at each survey site. Direction is recorded as one of eight compass points (direction current was flowing towards) and strength is assessed as being 'None', 'Weak', 'Medium' or 'Strong'. Similarly, volunteers on the survey boat qualitatively assess the strength and direction of the wind at each survey site. Direction is recorded as one of eight compass points (direction wind was blowing from) and strength is assessed using the Beaufort Scale.

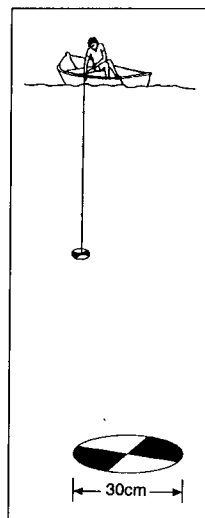


Figure 6. The use of a secchi disc to assesses vertical water clarity. The secchi disc is lowered into the water until the black and white quarters are no longer distinguishable. The length of rope from the surveyor to the disc is then recorded.
Source: English et al. (1997)

Natural and anthropogenic impacts are assessed both at the surface from the survey boat and by divers during each survey. Surface impacts are classified as 'litter', 'sewage', 'driftwood', 'algae', 'fish nets' and 'other'. Sub-surface impacts are categorised as 'litter', 'sewage', 'coral damage', 'lines and nets', 'sedimentation', 'coral disease', 'coral bleaching', 'fish traps', 'dynamite fishing', 'cyanide fishing' and 'other'. All information is assessed as presence / absence and then converted to binary data for analysis. Any boats seen during a survey are recorded, along with information on the number of occupants and its activity. The activity of each boat is categorised as 'diving', 'fishing', 'pleasure' or 'commercial'. Finally the divers record a general impression of the site during each survey. These ratings are completed for biological (e.g. benthic and fish community diversity and abundance) and aesthetic (e.g. topography) parameters. Both parameters are ranked from a scale of 5 (excellent), 4 (very good), 3 (good), 2 (average) or 1 (poor).

Data collected¹ from each sub-transect survey are transferred to recording forms prior to incorporation into CCC's database, which is compatible with a range of Geographic Information System (GIS) software used for spatial analysis. The recording forms consist of a 'Boat Form', 'Physical Form' and 'Biological Form'. Each form is completed for each individual dive, although there may be more than one biological form depending on the number of habitats observed. The Boat Form holds data on the GPS co-ordinates of the dive along with oceanographic and climate data such as winds, currents, temperatures and salinities. The Physical Form holds data on the maximum and minimum depths of the dive, the aesthetic and biological ratings and also a reef profile drawn from the depths collected every 10 m. Finally the Biological Form(s) contain data on the reef zone, the major biotic and substratum features of the habitat and the ordinal ratings of each life form and target species.

2.4 Habitat mapping

In order to produce a preliminary habitat map (Environmental Sensitivity Index Map – Figure 2) for the project area, a flight was chartered by KKP in order to take a digital video mosaic of the coral reefs of the Balayan and Batangas Bay areas. The image resolution provides a pixel size of approximately 4x4m on the ground. This type of remotely sensed image is therefore extremely useful at classifying habitats down to reef communities with very intricate species descriptions.

CCC within this report has utilised two of the screen grabs (.jpg) files in order to superimpose the relative locations of the different habitats on the location of the different areas of the aerial image¹.

1 - In the future, it is the aim of the project, and all project partners to use the raw data of the image to superimpose the habitat information gained from the surveys, such that a full habitat map will be made for the whole Mabini-Tingloy project area.

2.4.1 Generation of habitat information

In order to describe the reef habitats within the project area, benthic and substratum data were analysed using multivariate techniques within PRIMER (Plymouth Routines in Multivariate Ecological Research) software. Data from each Biological Form (which represents a 'snap-shot' of the benthic community from either part or all of a habitat type distinguished by the survey team) are referred to as a Site Record. Multivariate analysis can be used to cluster the Site Records into several groups, which represent distinct benthic classes. Firstly, the similarity between benthic assemblages at each Site Record was measured quantitatively using the Bray-Curtis Similarity coefficient without data transformation (Equation 1; Bray and Curtis, 1957). This coefficient has been shown to be a particularly robust measure of ecological distance (Faith *et al.*, 1987).

Agglomerative hierarchical cluster analysis with group-average sorting was then used to classify field data. Cluster analysis produces a dendrogram grouping Site Records together based on biological and substratum similarities. Site Records that group together are assumed to constitute a distinct benthic class. Characteristic species or substrata of each class were determined using Similarity Percentage (SIMPER) analysis (Clarke 1993).

To identify characteristic features, SIMPER calculates the average Bray-Curtis similarity between all pairs of intra-group samples (e.g. between all Site Records of the first cluster). Since the Bray-Curtis similarity is the algebraic sum of contributions from each species, the average similarity between Site Records of the first cluster can be expressed in terms of the average contribution from each species. The standard deviation provides a measure of how consistently a given species contributes to the similarity between Site Records. A good characteristic species contributes heavily to intra-habitat similarity and has a small standard deviation. The univariate summary statistics of median abundance of each species, life form and substratum category were also used to aid labelling and description of each benthic class.

Finally, the benthic class of each Site Record was combined with the geo-morphological class assigned during the survey to complete the habitat label. The combination of a geo-morphological class and benthic class to produce a habitat label follows the format described by Mumby and Harborne (1999).

2.5 Reef Check

Reef Check provides the opportunity for local stakeholders to be trained and involved in the survey effort alongside the CCC volunteers. It is a methodology that was designed in 1997 in order to allow volunteers to gather much needed wide-scale data on the status of coral reef health, and fish numbers. The method is designed to be repeated over years such that a continuous database can be built up of information from a number of different sites.

During the MTMBCP the standard Reef Check protocol was modified to collect more detailed data (e.g. via greater taxonomic resolution) and hence provide a better assessment of reef health. Such modifications are possible because all CCC volunteers on the MTMBCP received more intensive training than regular sport divers. Each Reef Check site is located close to a CCC Reef Survey Technique transect in order that the data sets are able to be spatially linked together and hence analysed in conjunction.

The standard Reef Check survey protocol utilises two transects at depths of approximately 3 and 10 m and these depths are surveyed for this project, as this is where the greatest coral reef diversity and cover occurs on most coral reefs. Along each depth contour a 100 m transect is deployed, and along it four 20 m long replicate transects surveyed. The replicate transects follow the designated depth contour in sequence but the start and end points are separated by a 5 m space (Figure 7) i.e. the distance between the start of the first transect and end of the last transect is $20 + 5 + 20 + 5 + 20 + 5 + 20 = 95$ m. By collecting data from each of the four 20 m sections, four replicates are collected per survey allowing the calculation of a mean per replicate and hence more powerful statistical analysis.

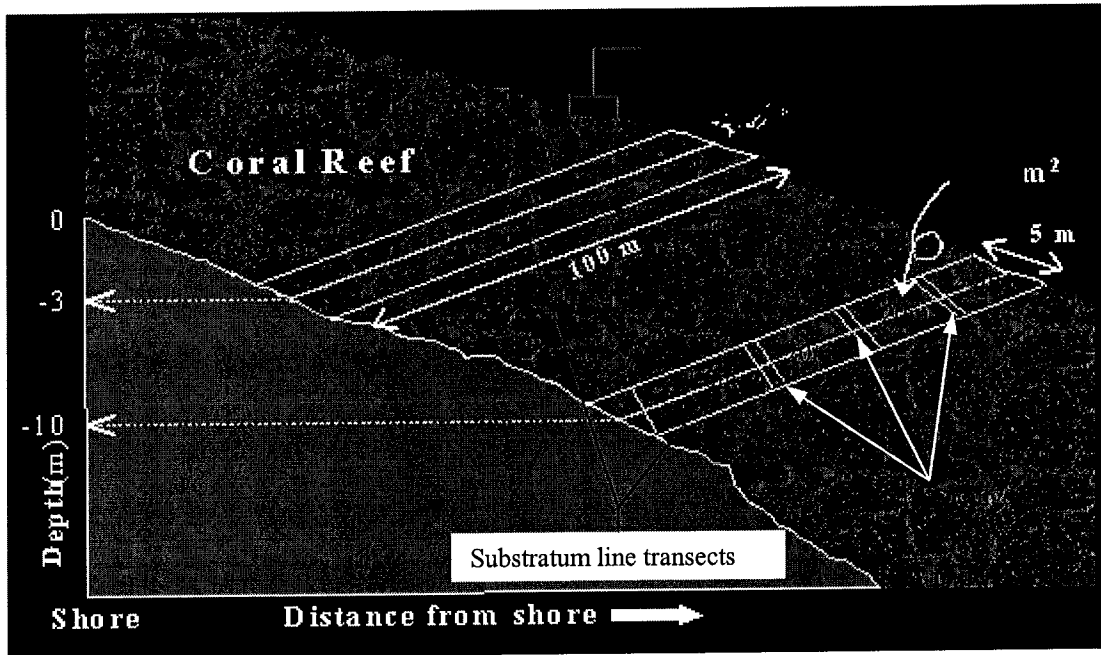


Figure 7. Schematic diagram showing the position of the transect lines during a Reef Check survey. 100 m transect is divided into four 20 m replicates so the area of each belt transect is $20 \times 5 \text{ m} = 100 \text{ m}^2$. *Source:* modified from figures on www.reefcheck.org

Five types of data are recorded via three surveys along each transect line at each depth. Firstly, a site description sheet is completed which includes anecdotal, observational, historical, locational and other data. Secondly, four 5 m wide by 20 m long transects (centred on the transect line) are sampled for commercially important fish, for example those typically targeted by fisherfolk and aquarium collectors. Fish are counted if they are less than 5 m above the transect line, giving a survey area for each transect replicate of $20 \times 5 \times 5 \text{ m} = 500 \text{ m}^3$. CCC volunteers in The Philippines record data on more fish species than specified by the standard Reef Check protocol. Divers assigned to count fish swim slowly along the transect and then stop to count target fish every 5 minutes and wait three minutes for target fish to come out of hiding before proceeding to the next stop point. Thirdly, four 5 m wide by 20 m long transects (centred on the transect line) are sampled for invertebrate taxa typically targeted as food species or collected as curios. Quantitative counts are made of each species. In addition, invertebrate surveyors note the presence of coral bleaching or unusual conditions (e.g. diseases) along transects.

Finally, four 20 m long transects are point sampled at 0.5 m intervals to determine the substratum types and benthic community of the reef. The diver looks at each point and notes down what lies under each of the points. The standard Reef Check protocol specifies that categories recorded under each 50 cm point are: hard coral, soft coral, recently killed coral, dead coral, fleshy seaweed, sponge, rock, rubble, sand, silt / clay and 'other'. However, CCC volunteers record hard corals to life form level (along with target species), and five categories of algal cover (mixed assemblage, coralline, *Halimeda*, 'macro' and 'turf'). Finally, substratum surveyors record coral damage from anchors, dynamite, or 'other' factors and trash from fishing nets or 'other'. Divers rate the damage caused by each factor using a 0-3 scale (0 = none, 1 = low, 2 = medium, 3 = high). All data are transferred to specially designed recording forms.

Following the completion of the MTMBCP, data from the Reef Check surveys will be made available to the global and national databases, hence increasing the impact of the project.

Reef Check surveys are completed in conjunction with local counterparts. Involving the local stakeholder community in the scientific surveys provides a baseline and incentive for community members to become aware of the continuing health of their reef in the medium to long-term. Hopefully these surveys will be carried out at annual intervals by local KKP staff members at Bagalangit, and other community representatives.

3. RESULTS

3.1 Anthropogenic factors

3.1.1 Boat activity

An obvious difference between the number and activity of boats can be seen in the project area (Fig. 8). There is a clear dominance in fishing activity in the Mabini and Tingloy areas, as can be seen from the proportion of fishing boats compared to boats carrying out other activities. Most surveys were carried out at Caban Island and in the Mabini marine reserve (south west Calumpan peninsula). Here, the boats were dominated by fishing vessels, but there also was evidence of pleasure craft (diving) and commercial vessels (ferries running between Anilao and Tingloy) frequently passing through these areas.

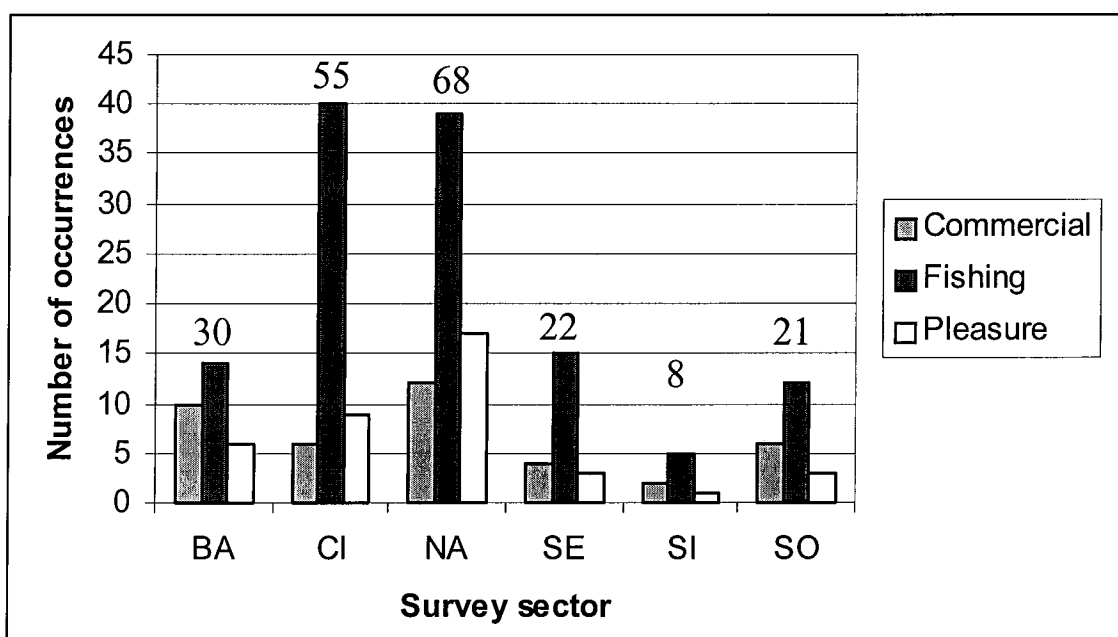


Figure 8. Summary of boat activity observed at different survey locations. Numbers above the sectors represent the total number of observations.

3.1.2 Surface Impacts

Number of surface impacts and location information revealed that litter was the most frequent impact on the surface waters of the area, and as jetsom on the beaches of Maricaban and the Calumpan peninsula (Fig. 9). There is evidence that the village to the south of Caban Island is influencing the quantity of other surface impacts near to Caban Island, as sewage, driftwood and nets were all seen in the western part of Caban. This also highlights the possible influence of the eddies that occur in this area which create a whirlpool effect, concentrating water within this sheltered location. However, only further detailed oceanographic measurements can establish this as fact.

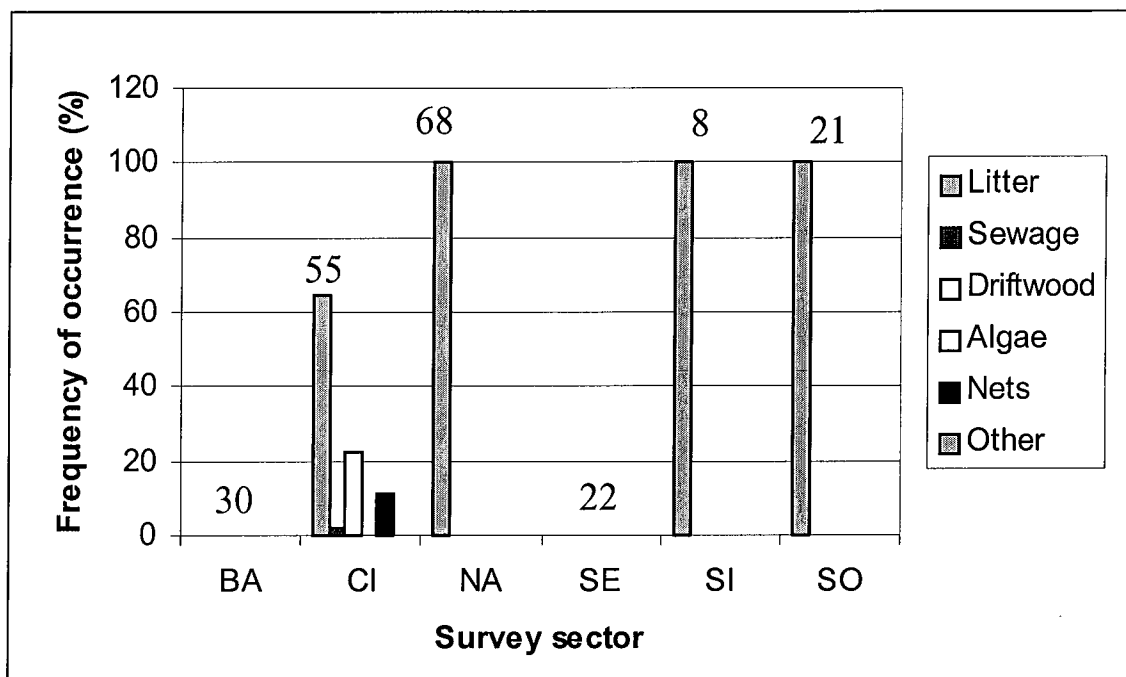


Figure 9. Frequency of occurrence of surface anthropogenic impacts observed during baseline surveys (CCC Reef survey Technique). Additional figures show sample size.

3.1.3 Underwater impacts

A wide range of underwater impacts were observed on all dives. The most serious of which was coral damage by blast fishing (Fig. 10). It can be clearly seen that the influence of dynamite, or evidence of coral damage by anthropogenic means occurred in southern and western Sepoc, Caban Island, the south-west Calumpan peninsula, and western Calumpan peninsula. Algal overgrowth is also of concern, possibly as a result of nutrient enrichment, or overfishing of herbivores. Algal overgrowth can be seen in sectors SO, NA and BA more significantly than other areas. Broken coral can be clearly seen in sector SO and SI, but cannot significantly be attributed to one causal factor over another (bomb fishing, anchor or typhoon damage). The amount of broken coral rubble at Sombrero appears (from algal and sponge encrustation) to be considerably old and persistent, and the large area may be attributable to storm damage, or vast areas of blast fishing.

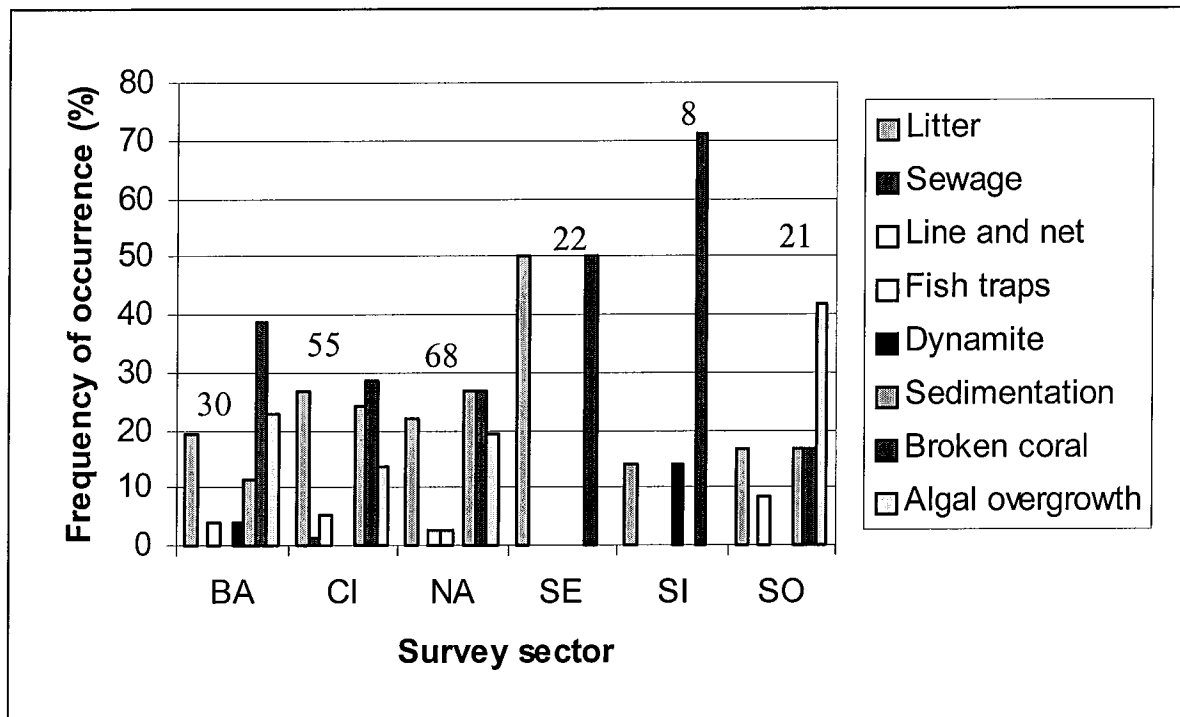


Figure 10. Frequency of occurrence of sub-surface impacts observed during baseline surveys (CCC Reef survey Technique). Additional figures show sample size.

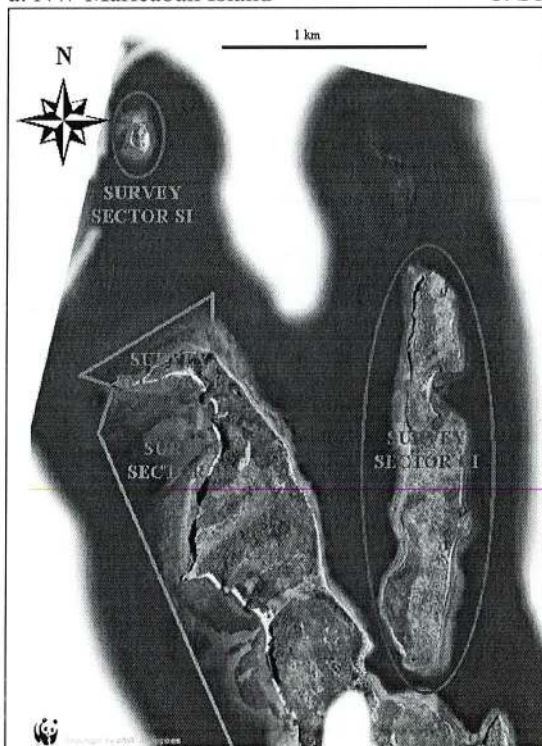
3.2 Habitat mapping

The CCC Reef Survey Technique data included in this report of the Mabini-Tingloy program area was split into six discreet survey sectors as outlined in Table 4 and Figure 11a+b.

Table 4. Sectors mapped during the MTBCP baseline survey programme (using The CCC Reef survey Technique).

Survey sector	Name	Location
BA	Burijar Point	North West coast of Maricaban, Tingloy
CI	Caban Island	Caban Island off North East coast of Maricaban, Tingloy
NA	Nagiba Point	South-West facing shore of Calumpan Peninsular, Mabini
SE	Sepoc Point	Extreme North facing coast of Maricaban, Tingloy
SI	Sombrero Island	Approximately three kilometers North of Maricaban, Tingloy
SO	Solo	Extending from Bagalangit Point north to Mato Point on the North-West facing coastline of the Calumpan Peninsular, Mabini

a. NW Maricaban Island



b. South-west Calumpan peninsula

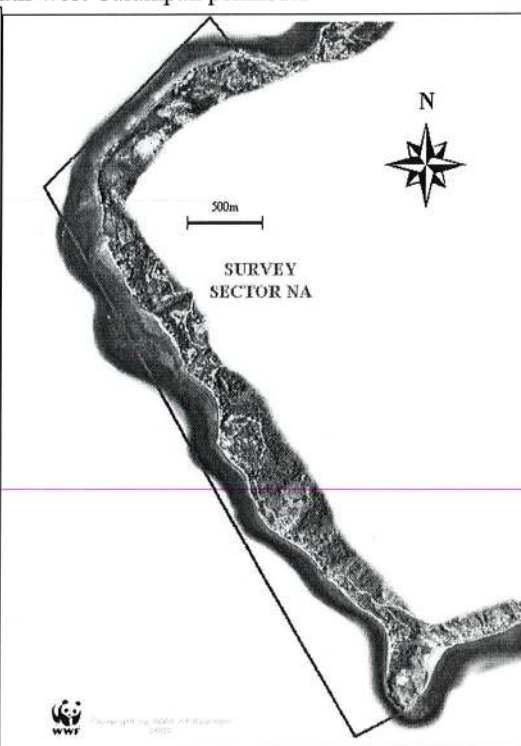


Figure 11a+b. Location of survey sectors in the Mabini-Tingloy project area from which CCC Reef Survey Technique data was collected for habitat analysis. For mapping, sector NA and SO were combined within sector NA.

3.2.1 Multivariate statistical analysis to generate habitat information

The data analysed for generation of habitat information was collected between January 2002 up to and including the 19th March 2002. Summary statistics of survey effort by sector reveal patterns are included in Table 5. During this period a total of 137 survey dives were conducted on a total of 44 transects. On average each transect consisted of data collected on three dives. During each dive, an average of just over two ten-meter sections was analysed. In total during this period 260 site records were taken. The data produced during this period included over 13 000 species records, and over 5000 records on oceanographic data, data on substrate abundance and anthropogenic activities.

Table 5. Summary statistics of survey effort by survey sector during the MTMBCP.

Survey sector	Number of Transects	Number of dives	Number of site records
BA	8	30	85
CI	11	40	57
NA	13	42	73
SE	4	9	19
SI*	5	13	20
SO	5	10	19
TOTALS	46	144	273

* Includes 2 transects, 7 dives and 13 site records collected between 18th–22nd March but not included in the data analysis presented in this report

The dendrogram resulting from a cluster analysis of Bray-Curtis similarities of the CCC Reef Survey Technique data collected during the Mabini-Tingloy conservation project resulted in the formation of the data into 13 major habitats. The Bray-Curtis similarity derived dendrogram is shown as a cluster chart (Fig. 12). Of the 260 complete data sets collected, 8.8% or 23 data sets were discarded because they represented either erroneous data sets or separable habitats in which there were not enough replicates to make them statistically discernable from other data sets.

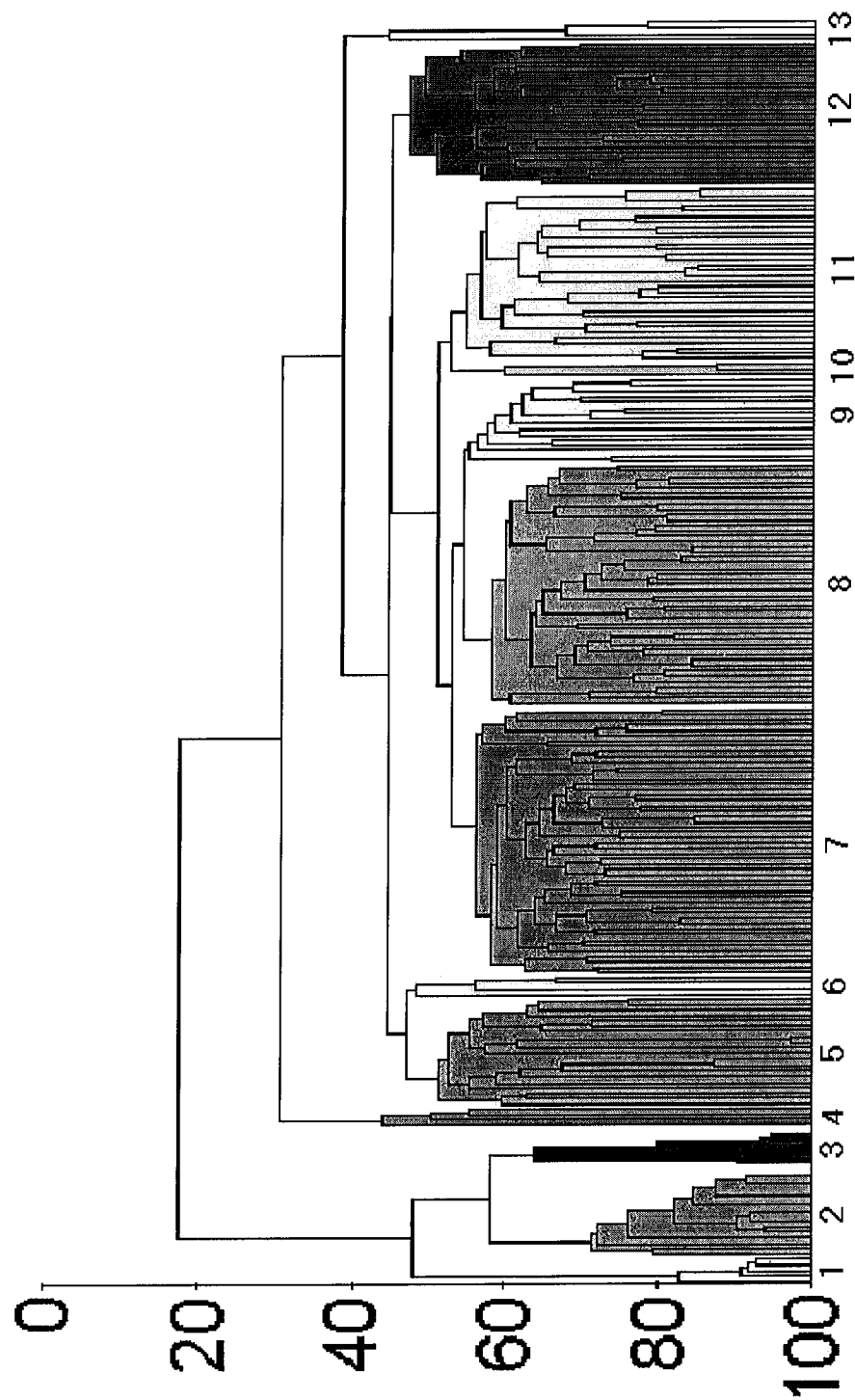


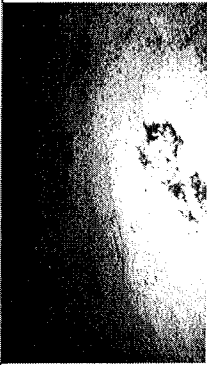
Figure 12. Dendrogram resulting from Bray-Curtis assessment of the similarity between all survey dives (10m sections) from within the Mabini-Tingloy project area. The similarity of the different dives is represented by the percent level of similarity (Y-axis) of where adjacent records split off from each other. 13 discrete habitat types were be discerned from the final analysis.

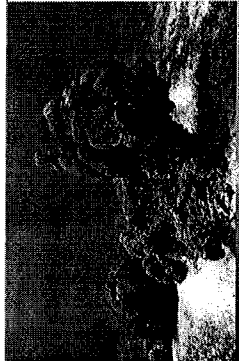
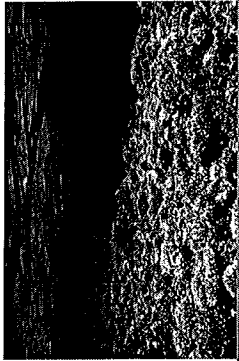
Using SIMPER analysis in PRIMER, each of these habitats has been fully quantitatively described. A summary description of each habitat is included below and a more detailed description is given in later in this section (Table 6).

Benthic class 1	Sand with dense algal cover
Benthic class 2	Sand with mixed algae and <i>Halophila sp.</i>
Benthic class 3	Sand with mixed seagrass community and occasional algae
Benthic class 4	Rubble dominated lower reef slope
Benthic class 5	Sand dominated lower reef slope
Benthic class 6	Sand and rubble dominated upper reef slope with low coral cover
Benthic class 7	Sand dominated upper reef slope with algae and soft-corals
Benthic class 8	Upper reef slope with dense coral cover
Benthic class 9	Bedrock and sand patches with medium density hard corals
Benthic class 10	Rubble and bedrock with frequent algae and a medium density of hard corals
Benthic class 11	Sand, rubble and dead standing coral dominated by algae
Benthic class 12	Sparsely inhabited sand with occasional macroalgae and soft corals
Benthic class 13	Soft coral dominated bedrock

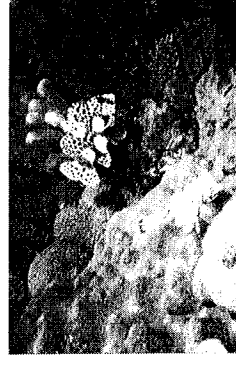
Univariate statistics of the abundance of each of the recorded benthic organisms in each habitat is outlined in the Appendix. A list of survey records encountered in each habitat is also given in the Appendix.

Table 6. Major characteristics of the thirteen discriminated habitats from the CCC Reef Survey Technique data set collected in the Municipalities of Mabini and Tingloy, Luzon, Philippines.

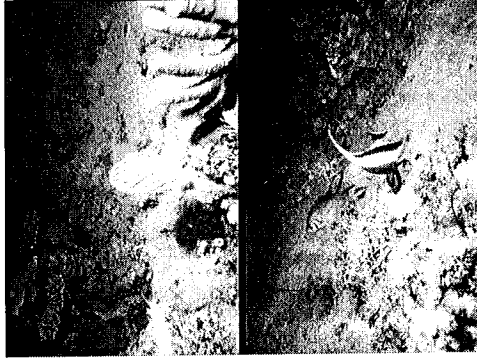
Benthic class	# surveys	Average depth	Substratum	Hard corals	Octocorals	Sponges	Algae/ seagrass	Photo
BC 1 Sand with dense algal cover	5	7.6m	Sand (5)	Favites sp. (0.2), Non-Acropora submassive (0.2)		Branching (0.2)	Filamentous green (5), Gelidium sp. (2), Dictyota sp. (1.8),	
BC 2 Sand with mixed algae and seagrass cover	16	7.3m	Sand (5)				Halophila sp. (2.3) Filamentous green (1.8), Mixed seagrass species (2.4), filamentous green algae (1.8)	No picture available
BC 3 Sand with seagrass and occasional macroalgae	8	11.3m	Sand (5)					
BC 4 Lower reef slope, rubble dominated	4	26.6m	Rubble (4), Sand (3)	Total hard coral cover (1.75), Herpolitha limax (1), Ctenactis echinata (0.75)	Total soft coral cover (1), Dendronephthia sp. (0.75), Xenid sp. (0.5)	Total sponge cover (0.5), Lumpy (0.5), Encrusting (0.25)	Total algae cover (1.5),	
Benthic class	# surveys	Average depth	Substratum	Hard corals	Octocorals	Sponges	Algae/ seagrass	

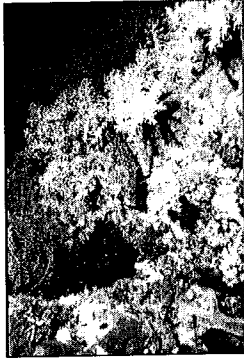
BC 5 Lower reef slope, sand dominated	20	21.6m	Sand (3.5), Rubble (1.8)	Total hard coral cover (1.25), Mushroom corals (1), Branching Acropora (1)	Total soft coral cover (0.9), Dendronephthia sp. (0.35), sea fan (0.35)	Total sponge (1), 'Elephant ear' (0.7), Encrusting (0.6)	Total cover of algae (1.8), Filamentous green algae (1.1)	
BC 6 Reef slope, sand and rubble dominated, low coral cover	4	14.4m	Rubble (2.3), Sand (2.25)	Total hard coral cover (1.5), Dead coral with algae (1.25), Total mushroom corals (2), Lobophyllia sp. (1), Millepora intricata (1)	Total soft corals (0.5), Sea whip (0.5)	Total sponge (0.75), Encrusting (0.75)	Total cover of algae (1.5), Sargassum sp. (0.5), Brown and green filamentous (0.5, 0.5)	
BC 7 Sand dominated upper reef slope, dominated by algae and soft coral	50	8.14m	Sand (4.2), Bedrock (1.1)	Total hard coral cover (1.7), Branching Acropora (1.5), Dead coral with algae (1.4), Mushroom corals (1.2) Porites sp. (1), Lobophyllia sp. (1)	Total soft coral cover (2.7), Xenid sp. (2.2), Xenia sp. (1.5)	Total sponge cover (1.3), Encrusting (1.1)	Total algae (3.1), Dictyota sp. (2.2), Filamentous green algae (1.2)	
BC 8 Upper reef slope/ reef flat with dense, mixed hard corals	# surveys 45	Average depth 7.9m	Substratum Bedrock (3.8), Sand (2)	Hard corals Total cover of hard coral (4.3), Branching Acropora (2.5), Non-Acropora encrusting (2.7), Non-Acropora massive (2)	Octocorals Total cover of soft coral (1.7), Xenid sp. (1), Dendronephthia sp. (0.7)	Sponges Total cover of sponge (2), Encrusting (1.2), Lumpy (1.2)	Algae/ seagrass Total cover of algae (2.7), Dictyota sp. (1.5), Filamentous green (1.6)	

massive (3),
Mushroom
corals (2.5),
Massive Porites
sp. (2.7),
Galaxea sp.
(1.7), Favites sp.
(2.3), Favia sp.
(1.8),
Lobophyllia sp.
(1.7), ,
Seriatopora
hysterix (1.6),
Small brain coral
(1.4)



Benthic class	# surveys	Average depth	Substratum	Hard corals	Octocorals	Sponges	Algae/ seagrass	Photo
BC 9 Bedrock and sand with medium density hard coral, occasional soft coral and sponge	16	13.4	Bedrock (3.4), Sand (2.4), dead coral with algae (1.8)	Total cover of hard coral (3.1), mushroom corals (2.6), non-Acropora encrusting (2.4), non-Acropora massive (2.1), Mycedium elephantotus (1.6), Favia sp. (2.1), Favites sp. (1.7)	Total soft corals (2.5), Dendronephthia sp. (2.1), Sarcophyton sp. (0.8)	Total sponge (2.7), Lumpy (1.8), 'Elephants ear' (1.4)	Total algae (1.5), Filamentous green (1.1), Caulerpa sp. (0.9)	

Benthic class	# surveys	Average depth	Substratum	Hard corals	Octocorals	Sponges	Algae/ seagrass	Photo
BC 10 Rubble and bedrock with frequent algae and a medium density of hard corals	3	13.9m	Bedrock (2.7), Rubble (2.7), Dead coral (1)	Total cover of hard corals (2.3), mushroom corals (2.3), massive Porites sp. (2), Favia sp. (1.7)	Total cover of soft corals (1.3), Simularia sp. (1)	Total cover of sponge (2), Plate (1), 'Elephants ear' (1)	Total cover of algae (3), Filamentous green (2.3), Caulerpa sp. (1.7), Dictyota sp. (1), Actinotrichium sp. (1),	
BC 11 Sand, rubble and dead standing coral dominated by algae with occasional sponge and soft coral	32	10.3m	Sand (3.9), Rubble (2.6), Dead coral and algae (2.3)	Total cover of hard coral (2), Branching Acropora (1.5), Branching non- Acropora (1.5)	Total cover of soft coral (2.2), Simularia sp. (1.3)	Total sponge (2.56), Encrusting (2.1), Plate (1.2)	Total algae (3.4), Corallina sp. (2.2),	
BC 12 Sparsely inhabited sand with occasional macroalgae and soft coral	27	10.7m	Sand (4.6), Dead coral with algae (1.3)	Total cover of hard coral (0.8), Massive Porites sp. (0.7), Favia sp. (0.3)	Total cover of soft coral (1.8), Xenid sp. (1.2), Xenia sp. (0.9), Simularia sp. (0.6)	Total cover of sponge (1.5), Encrusting (0.9), Lumpy (0.8)	Total cover of algae (2.4), Dictyota sp. (1.4), Galaxaura sp. (0.8), Green filamentous (1.9)	

BC 13 Soft coral dominated bedrock	4	5.2m	Bedrock substrate dead coral with algae (1.5)	Total cover of hard corals (1.5), Massive Porites sp. (1)	soft corals (3.8), Xenia sp. (3.3), Xenid sp. (2.8), Simularia sp. (2)	Total cover of sponge (0.5)	Total cover of algae (1.3), Filamentous green (1), Filamentous brown (0.8), Filamentous red (0.8)	
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3.2.2 Intra-habitat variability

To facilitate the pairwise comparison of Bray-Curtis similarities between survey sections within each habitat class, an array of Bray-Curtis similarities has been prepared (Table 7).

Table 7. Pairwise comparison Bray-Curtis similarity (corrected to two decimal places) measures of the abundance of benthic sessile organisms, substrate categories and cover of organisms present in survey sites characterised as each of thirteen benthic classes.

	1	2	3	4	5	6	7	8	9	10	11	12
1												
2	46.33											
3	52.59	68.20										
4	26.97	25.89	35.45									
5	28.32	25.72	30.19	56.66								
6	18.65	17.78	20.82	51.76	65.15							
7	19.39	16.33	19.05	45.54	70.02	64.62						
8	17.84	11.55	13.61	34.36	54.50	53.10	75.68					
9	16.37	12.35	14.18	39.28	59.37	53.81	74.29	74.14				
10	20.32	12.11	15.24	41.78	54.37	50.96	64.26	62.33	66.78			
11	27.12	17.94	20.92	40.98	62.88	52.64	73.36	70.43	74.19	67.55		
12	36.30	30.67	35.85	44.29	69.08	53.83	71.11	58.91	59.79	57.55	70.67	
13	21.00	16.03	18.56	37.12	49.36	40.50	50.91	44.37	52.71	46.12	50.97	57.05

Table 7 shows the Bray-Curtis similarities calculated using the average abundance of benthic organisms present, substrate categories and cover of organisms in surveys categorised into one of 13 benthic classes (BC). The lowest Bray-Curtis similarity and therefore the most different classes in terms of the variables analysed are classes two and eight, with a similarity of only 11.55%. In contrast, classes seven and eight are on average 75.68% similar across all variables examined. Despite this similarity, examination of the data confirms that these two classes are indeed separable and can be categorised independently of each other.

One measure of the richness in terms of the total number of habitats found in each survey sector is outlined in Table 8. Firstly, it compares the number of habitats found in each survey sector and then goes on to weigh this number according to the survey effort, measured in the number of dives.

Table 8. Occurrence of habitats by survey sector according to survey effort number of dives).

Survey sector	Total number of habitats found	Number of dives	Habitats found per unit survey effort
BA	7	30	0.23
CI	5	40	0.13
NA	8	42	0.19
SE	4	9	0.44
SI	2	13	0.15
SO	2	10	0.2

Whilst the surveys carried out in sector NA have identified the greatest number of habitats, the actual number of habitats identified per unit survey effort in this area is the third lowest. Only that of sectors CI and SI (0.13 and 0.15 habitats per unit survey effort respectively) are lower. The greatest number of habitats encountered per unit survey effort is found in sector SE (0.44). This indicates that whilst only four habitats have been encountered there at present, this survey area has the greatest homogeneity in terms of the spatial distribution of the habitats it contains.

To describe the biodiversity of each habitat classified using the multivariate analysis procedure, a range of univariate biodiversity measures have been calculated based on the species records of benthic organisms found in surveys within each habitat (Table 9).

Table 9. Univariate biodiversity measures calculated on the average species records of all sample records by benthic class.

Benthic class	Total species records	Total abundance ratings	Margalef species richness	Pielou's evenness	Log _e Shannon-Weiner index
BC1	11	11	4.2	0.69	1.66
BC2	16	8	7.3	0.63	1.74
BC3	8	4	5.2	0.82	1.71
BC4	31	13	11.6	0.95	3.25
BC5	85	29	25.1	0.93	4.13
BC6	50	28	14.7	0.96	3.74
BC7	102	48	26.1	0.93	4.30
BC8	101	75	23.1	0.91	4.19
BC9	90	62	21.6	0.91	4.09
BC10	55	48	13.9	0.96	3.85
BC11	95	58	23.1	0.92	4.19
BC12	88	31	25.1	0.90	4.03
BC13	42	28	12.4	0.91	3.39

On average, the largest number of species recorded in survey records comes from surveys in benthic class BC7- BC12, with BC8 coming a close second with only one less recorded species. BC5, BC9, BC11 and BC12 all have a similar number of species recorded in the surveys performed in these habitats (85, 90, 95 and 88 respectively). There is then a large drop in the number of species recorded to BC6, BC10 and BC13, each with 50, 55 and 42 species records respectively. The sand with macroalgae and seagrass habitats (BC1, BC2 and BC3) all have the lowest number of species records (11, 16 and 8 respectively).

The largest sum of abundances of all species encountered comes from surveys within benthic class BC8, with the second highest sum from surveys in BC 9. Despite having the highest number of species recorded, surveys in benthic class BC7 have a low total sum of abundances across all species recorded (48).

The highest value of Margalef species richness is found in BC7. BC5 and BC12 have the second highest value on the Margalef index (25.1). BC8 and BC11 have the same value on this index scale (23.1).

Pielou's evenness assesses the evenness of distribution of all individuals across all species encountered. BC6 and BC10 have the highest scores on this index (0.96), followed in descending order by BC4 (0.95), BC5 and BC7 (0.93), BC11 (0.92), BC8, BC9 and BC13 (0.91), BC12 (0.90) and BC3 (0.82). The highest evenness scores are reserved for the species records associated with the sand and macroalgae with seagrass classes- BC1 and BC2 (0.69 and 0.63 respectively).

The final diversity measure used Shannon-Wiener index, which combines both the species number recorded with the distribution of the individuals across the species identified. The highest Shannon-Wiener diversity statistic is found from data recorded within BC7 (4.3). This is followed by, in descending order, BC8 and BC11 (4.19), BC5 (4.13), BC9 (4.09), BC12 (4.03), BC10 (3.85), BC13 (3.39) and BC4 (3.25). The lowest Shannon-Wiener diversity index values are found in data collected from sites in BC1, BC2 and BC3 (1.66, 1.74 and 1.71 respectively).

3.2.3 Spatial dispersal of habitats within the project area

The locations of each habitat encountered along each transect is shown diagrammatically (Fig. 13 and 14). Transect locations are shown accurately on the map, although the scale on the length of transects is exaggerated to allow for clarity of interpretation. Each coloured bar showing the benthic class encountered represents one ten-meter section of transect. In instances where ten-meter sections were included in those data sets that did not cluster into a defined habitat during the multivariate habitat definition process, in these cases a blank bar is included to maintain the spatial integrity of the diagram.

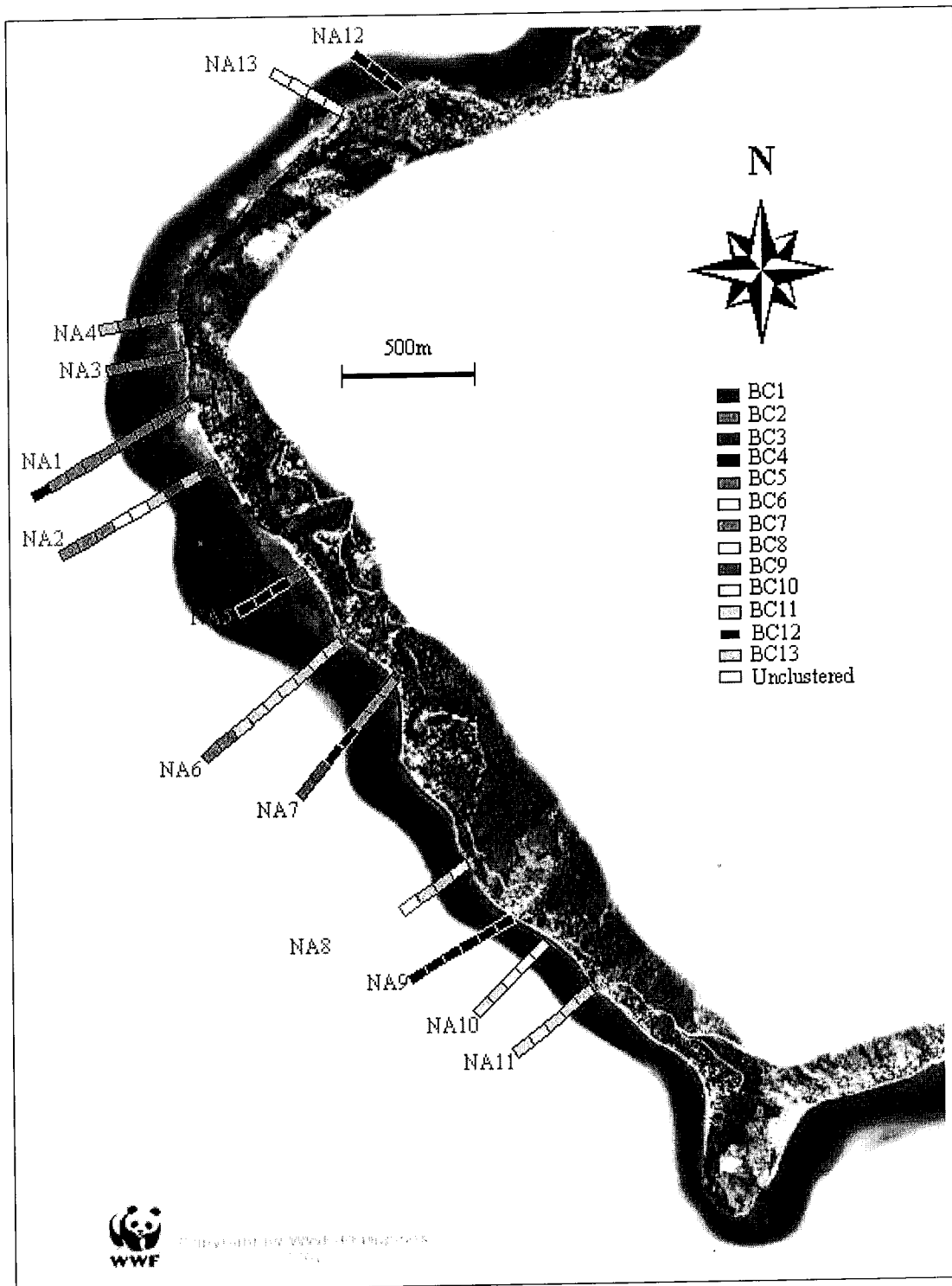


Figure 13. Location of different benthic classes along the south-western coastline of the Calumpan peninsula. The description of the exact location of the different benthic classes is not accurate in terms of depth. However, the bearing of the transect, and the orientation of the swim is accurate

Starting at the northern section of survey sector NA (NA 12 and 13), towards Bagalangit point (Fig. 13), there are two transects that have entirely different compositions from each other in terms of the habitats they contain. The first transect is comprised of sand, rubble and dead standing coral (BC12), with the second supporting a bedrock and dense coral cover habitat (BC8). This area, known locally as Cathedral Point, supports a very patchy and homogenous mix of substrates, with sand being dominant in some sites, yet bedrock dominating less than twenty metres further along the coastline.

Three transects run out from the western-most point on the Calumpan Peninsula (NA1, 3 and 4) are dominated by BC7, a sand dominated upper reef slope habitat. From the shore, the first forty meters of transect NA2 are composed of sand and rubble with dead standing coral with algae (BC 2 and 11). The next twenty meters have a dense cover of hard corals (BC8), before, with increasing depth, being superseded by a sandy lower reef slope. Transects NA 5 and NA 9 have BC12 as their main habitats, occupying thirty and sixty meters of the transect respectively. Transect NA 6 has a seventy meter section of sand, rubble and dead coral with algae (BC 11) before this becomes replaced with a sand dominated lower reef slope (BC 5) further down the reef profile. The presence of bedrock in the shallow thirty meters of transect NA 7 gives rise to the occurrence of a soft coral dominated habitat (BC13). Progressing down the reef profile the bedrock is replaced gradually by sandy habitats BC 12 and BC 7.

Excluding transect NA 9, the three remaining transects (NA 8, 10 and 11) identified along the southern section of the Calumpan Peninsular have an increased density of hard corals, with BC 11 (medium density corals) being present in all, and BC 8 (high density hard corals) being present in two of the three transects.

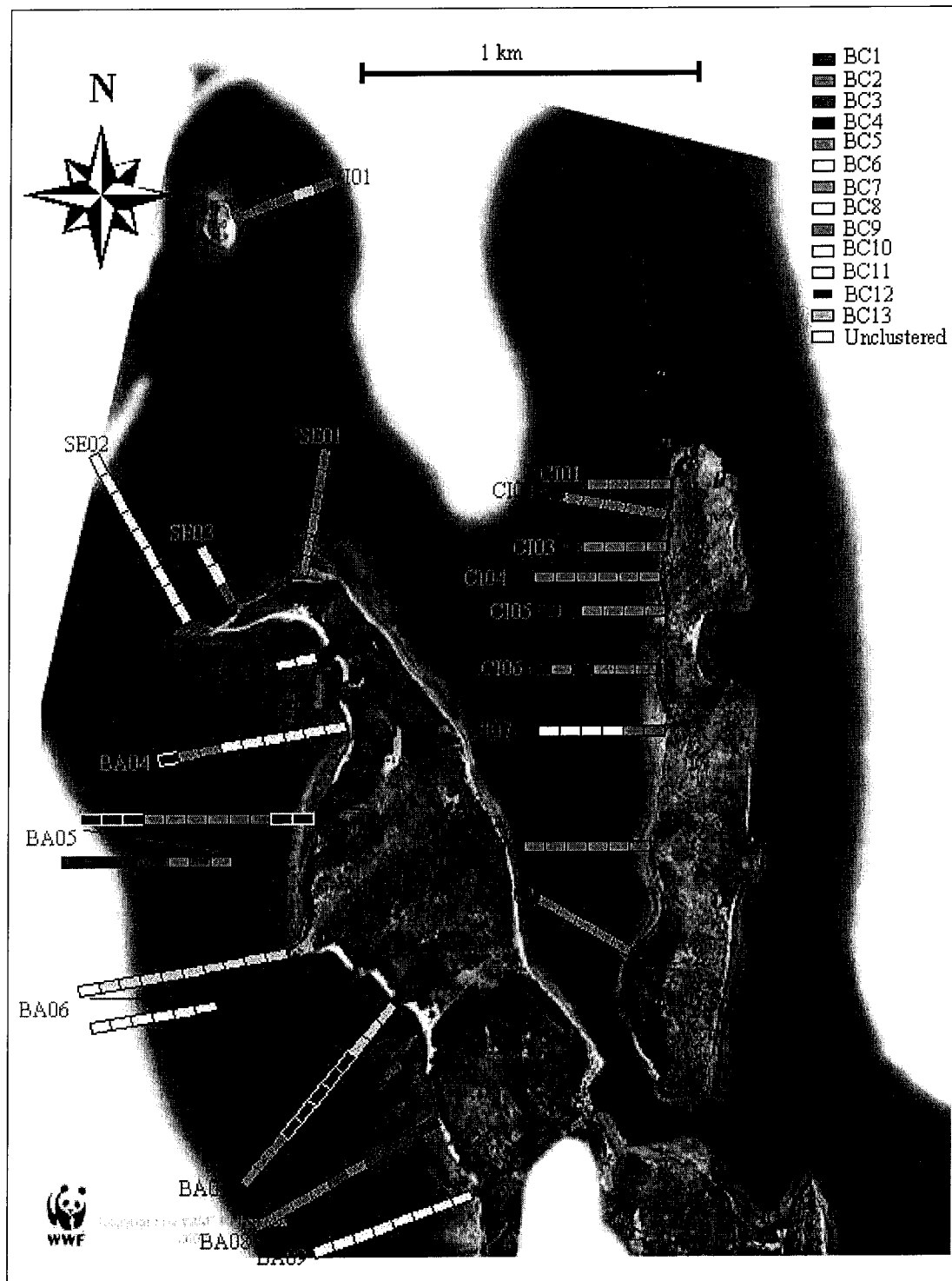


Figure 14. Location of different benthic classes within the north-western section of Maricaban Island. The description of the exact location of the different benthic classes is not accurate in terms of depth. However, the bearing of the transect, and the orientation of the swim is accurate

The transects illustrated on the west side of Caban Island (Fig. 14), are composed of only five different habitats. With the exception of transect CI01, all others along the coastline have at their shoreward margin an area categorised as BC7, (sand dominated upper reef slope with algae and soft coral). The length to which this band of habitat extends in the seaward direction varies from twenty meters on transect CI07 to fifty meters on transect CI04. Personal observation of the site may indicate that the categorisation of this area simply as a sand dominated upper reef slope may be an oversimplification. In this area, the live hard coral cover is very dense in places, although these patches are very homogenous in their distribution and the dominant substrate throughout the area remains sand. Amongst the hard corals found, branching growth form predominates. One exception to this is around transect CI07 where four of the ten-meter sections surveyed fall into BC6, (sand and rubble dominated upper reef slope with low coral cover). There is however a shift from branching *Acropora* sp. in the northern three transects to a non-*Acropora* sp. branching form in subsequent transects to the south of Caban. Below the upper reef slope, a sand dominated lower reef slope exists in all but two of the transects in the area. Finally, with increasing depth this sand dominated reef slope gives way in five of the nine transects present to BC4, (rubble dominated lower reef slope).

In survey sector SE on the northern most shore of Maricaban Island, hard corals predominate. In the case of transect SE02 there is one hundred meters classified as upper reef slope with dense coral cover. Whilst in this area, the depth ranges from five to over seventeen metres, and therefore the entire area is not truly an upper reef slope environment, the exceptionally high hard coral cover makes these areas fall within BC8. In the two remaining transects in sector SE, the habitats present include BC7, BC9 and BC10. Both habitat 9 and 10 characteristically have a medium density of hard corals. BC7 is limited to being present only on transect SE01 where it forms a thirty-meter band extending into the shore. The difference in aspect between this transect and those described previously in sector SE likely accounts for the presence of an increased quantity of sand, with this final transect being more sheltered than all others surveyed.

Within sector BA, the two most dominant habitat types are characterised by BC8, BC1, BC2 and BC3. Along this section of coastline a complex system of erosional and depositional environments exists in response to the degree of exposure. Within Sepoc Bay itself (transects BA03 and 04), the dominant habitat is BC8 (dense coral cover). Sand habitats BC12 and BC 7 exist only in deeper water along the transect where the degree of exposure is low enough to permit deposition of sand. Interestingly, BC7 (which is described as an upper reef slope habitat) and BC12 (sparsely inhabited sand), is found as the seaward ten-meter survey section on transect BA04. Transect BA05 is ~~characteristic of typical of a transect in~~ this area that is predominately a depositional environment. All of the benthic classes found on this transect are sand dominated (BC-1, BC2, BC3 and BC12). The next transect to the south (BA06) is situated on an exposed headland and the habitats it contains again fall into the erosional classes of medium to dense hard coral cover. In fact, the presence of a large amount of rubble and the well-defined spur and groove system on this transect, suggest that this site is highly exposed to wave action. The next bay contains two more transects (BA7 and BC8) dominated by sand habitats because of them being in a depositional environment. Finally, the last transect again reverts to being composed of hard coral cover dominated habitats.

Within this 2.5km stretch of coastline in survey sectors BA and SE, there is a range of environmental exposure. This gives rise to diverse range of habitats both in terms of their spatial distribution and actual quantity of habitats observed.

Only one complete transect was completed in sector SI at the time of writing this report. Along this transect, two benthic classes are present- BC9 and BC11. Bedrock and sand patches with medium density hard corals extends for fifty meters seawards, being disrupted only by one ten-meter section of sparsely inhabited sand with dead standing coral with algae.

3.2.4 Dispersal of habitats by depth

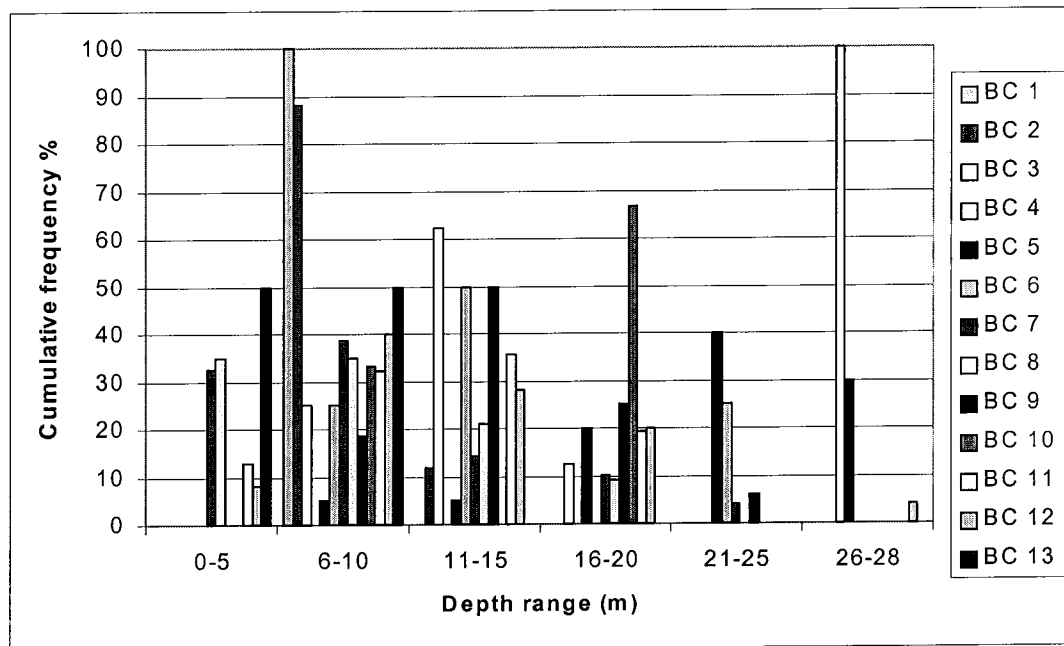


Figure 15. Cumulative frequency of occurrence of benthic classes within defined depth ranges.

Of the records from the two upper reef slope classes, benthic classes seven and eight, 33 and 35% respectively occur within the depth range 0-5 meters (Fig. 15). The remaining occurrences of these habitats occur in the depth range 6-10 and 11-15 metres. These habitats are therefore closely defined by the depth at which they occur. BC13 has fifty percent of its records within the depth range 0-5 meters. All of the records from BC1 (sand and macroalgae dominated class), occur within the depth range 6-10 meters. Similarly, the majority (88%) of BC2 records occur in this depth range. Twenty to forty percent of BC6, BC7, BC8, BC10, BC11, BC12 and BC13 records occur within the depth range 6-10 meters. Sixty percent of BC3 records occur within the depth range 11-15 meters, along with 50% of BC6 and BC9 records. Sixty-six percent of BC10 records occur between 16-20 meters. The lower reef slope habitat- BC12 is entirely limited in its distribution to depths from 26 to 28 meters.

3.3 Fish community analysis

3.3.1 Fish family abundance in different locations

Both the distribution and composition of fish community data collected was compared across all habitats identified in the survey data set collected (Fig. 16). Of the 237 data sets collected, 18 had no recorded fish present. For the analysis, these sites were removed. Of the 113 named species included in the survey recording forms, the following species were not recorded on any of the survey dives during the sampling period included in this report:

Blue-girdled angelfish (*Pomacanthus navarchus*), Bluestreak fusilier (*Pterocaesio tile*), Black bellied picassofish (*Rhinecanthus verrucosus*), Soapfish species, Virgate rabbitfish (*Siganus virgatus*), Two-spot snapper (*Lutjanus biguttatus*), Bluelined snapper (*Lutjanus kashmira*) and Dusky Surgeonfish (*Acanthurus nigrofusus*). In addition, the following species that were observed to be commercially important in the local area (pers obs/ comms. 2002) were not observed in any of the surveys conducted; Tuna/ Mackerel species, Humphead Wrasse (*Cheilinus undulatus*), Bumphead parrotfish, Humpback grouper (*Cromileptes altivelis*), Jack (*Carangoides sp.*). Finally, Barracuda (*Sphyrna sp.*) have been observed in the area (pers. obs. 2002), but not during survey dives and therefore they do not appear in the final data analysis.

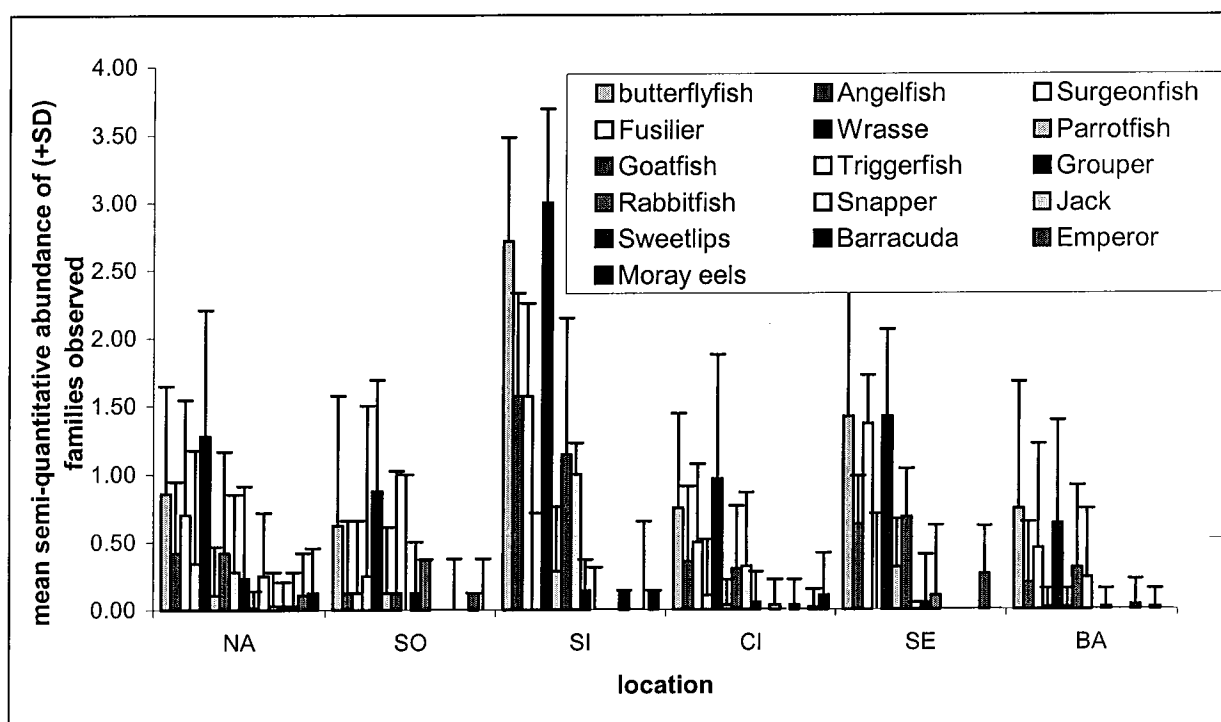


Figure 16. Relative mean abundances (semi-quantitative scale) of significant fish families on the reefs of Mabini-Tingloy. Abundance levels reveal that of the small number of dives analysed for Sombrero, this sector appeared to have the most abundant fish populations

3.3.2 Fish as a function of habitat – differences in assemblages of fish between different habitats.

ANOSIM analysis assumed that different benthic classes support different fish communities because of varied habitat requirements. In order to statistically prove this, the H_0 hypothesis stated that there were no differences in fish assemblages between benthic classes. Accordingly, for the H_0 hypothesis to be proven incorrect, a p-value of <0.05 is needed in the pairwise comparison of fish assemblages found associated with different habitats. (p-values are summarised in Table 10).

Table 10. p-values associated with a multivariate ANOSIM test comparing the fish assemblages found associated with each of thirteen benthic habitats identified during the initial survey phase (CCC Reef Survey Technique). Significant differences ($p < 0.05$) are indicated in grey

	1	2	3	4	5	6	7	8	9	10	11	12
1												
2	0.13											
3	0.01	0.07										
4	0.06	<0.01	<0.01									
5	<0.01	<0.01	<0.01	0.01								
6	0.03	0.01	0.01	0.14	0.40							
7	<0.01	<0.01	<0.01	<0.01	<0.01	0.22						
8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01					
9	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.65	0.10				
10	0.10	0.05	0.01	0.34	0.23	0.06	0.33	0.19	0.34			
11	<0.01	<0.01	<0.01	0.02	<0.01	0.18	0.01	<0.01	0.45	0.82		
12	<0.01	<0.01	<0.01	0.01	<0.01	0.27	<0.01	<0.01	<0.01	0.31	<0.01	
13	0.03	0.01	0.01	0.34	0.01	0.06	0.01	<0.01	0.01	0.86	0.03	0.06

Of the 78 pairwise comparisons made, the majority (68%) show that there is a significant effect of habitat in determining the fish assemblages present at sites within those habitats.

3.4 Invertebrate community

The invertebrate community around the separate locations of the Mabini-Tingloy area showed considerable abundances of filter feeding organisms (Fig. 17). Most dives were characterised by observation of a suite of sessile (feather duster and Serpulid worms) and motile (Feather star) species, seen feeding in the currents of the area. Long spined sea urchins (*Diademetidae* spp.) were also seen in considerable abundance within sector SO. Other commonly observed invertebrates were the Serpulid worms and nudibranchs. Commercially important invertebrates such as the lobster and octopus were absent and rare (respectively). Also, considerable pelagic fishing pressure exists within Balayan Bay on *Sepia* (squid) in the area. The corallivorous snail *Drupella* and Crown of Thorns (COT) were rare on the reefs of Mabini-Tingloy.

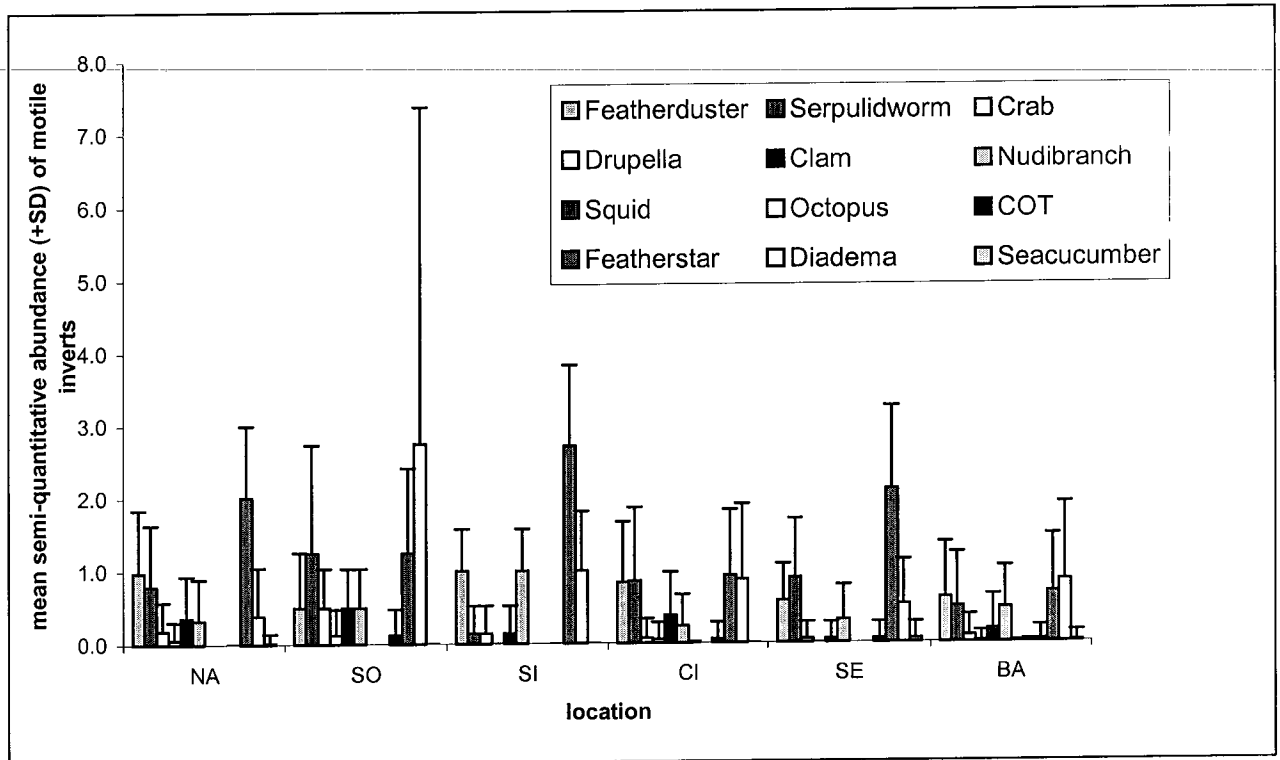


Figure 17. Relative semi-quantitative abundances of the most commonly observed invertebrates at different survey sites of the Mabini-Tingloy survey area.

3.5 Reef Check

Reef Check data was analysed between different survey sectors (as outlined in Fig 11a+b), and within one particular area – the Mabini reserve (NA). Data from the Mabini reserve was assessed for fish populations inside and outside three fish sanctuaries (Cathedral Rock, Arthurs and Twin Rocks that are within the boundaries of the Mabini reserve).

3.5.1 Sites surveyed

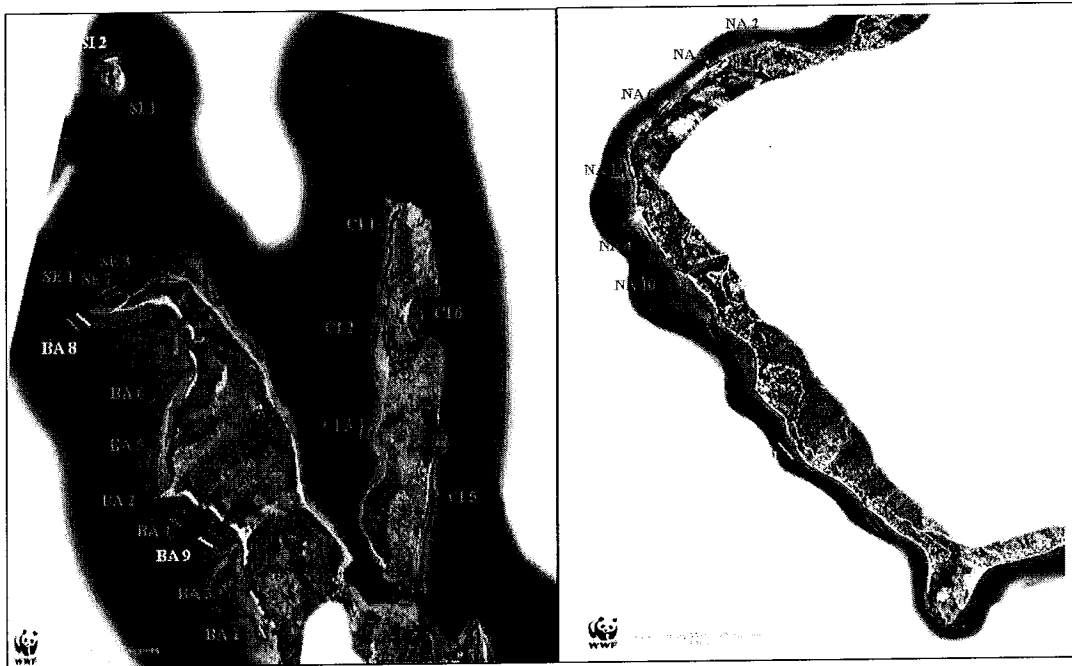


Figure 18. Location of Reef Check survey dives at north-west Maricaban and the Mabini reserve. Sites surveyed have two lines associated with them – one representing the location of the deep (10m) transect, and the other representing the shallow (6m) transect. BA09 deep, BA08 shallow, and NA11 deep were not surveyed.

3.5.2 Physical comparison between sites

Table 11. Different physical and anthropogenic impacts between the different survey sites (as in Fig. 18). Highest values for that particular variable are highlighted in grey.

	NA	SI	BA	SE	CI
Secchi disc (m)					
Vertical	10.5(4.61)	10.5(2.12)	15.71(7.81)	11.875(6.75)	12.25(7.91)
Horizontal	12(3.87)	18(2.83)	21(11.25)	16.9(5.88)	14.4(6.78)
Water temperature (°C)					
Surface	27.38(12.8)	28.25(1.06)	24.21(10.69)	29.31(13.17)	26.67(3.56)
Shallow	27.2(14.21)	29(0.00)	24.14(10.96)	29.25(16.05)	27.13(14.07)
Medium	26.3(13.30)	27(0.00)	23.14(10.22)	28.25(12.64)	28(14.47)
Salinity (‰)					
Shallow	31.53(15.92)	25.20(7.35)	30.74(11.67)	31.7(17.38)	31.03(17.03)
Medium	31.24(15.78)	31.70(0.00)	30.57(14.92)	31.67(17.38)	30.8(15.95)
Anthropogenic impacts					
Impact summary (0-3)	0.87(0.82)	1.75(0.35)	0.61(0.31)	0.72(0.53)	0.98(0.57)
Distance nearest population (km)	1.5(0.96)	5(0.00)	3.3(1.81)	2.5(1.41)	4.00(3.95)
Number of boats	1.65(0.92)	1.5(2.12)	2.71(0.64)	3.2(1.30)	2.50(1.20)
% Fishing	19.13(24.13)	50(70.71)	33.87(39.21)	45(44.72)	42.60(44.56)
%Diving	13.25(18.26)	0(0.00)	24.38(24.12)	37.5(43.66)	0.00(0.00)

There were no significant differences between any of the anthropogenic and physical factors between sites in the Mabini-Tingloy area. However, the highest vertical water visibility was seen at sector BA, the most south-westerly of the survey sectors (Fig. 18). There were some trends apparent in the anthropogenic data with a considerable difference in the impacts (compiled from bomb damage, net damage, bleaching and anchor damage) at Sombrero Island (mean impact ratio of 1.75(0.35) compared to the next highest 0.98(0.57) which was observed at Caban Island. Impact data for reef check is gathered from 3 different levels of perceived impact (0 = none; 1 = low; 2 = medium; 3 = high).

3.5.3 Fish numbers between different survey sectors

Fish numbers at different sites in the Mabini-Tingloy area were not particularly different from reef check survey data. Limited numbers of large reef species were seen at the sites visited (limited numbers of large groupers were seen and no barracuda or shark were observed during surveys). None of the fish synonymous with the live fish trade of mainland Far East Asia such as the humphead wrasse (*Chelinus undulatus*) and the bumphead parrotfish (*Bolbometopon muricatum*) were observed at any of the sites. However, fusiliers were significantly greater in numbers at Caban Island than at any of the other sites at shallow depths (ANOVA, $F = 3.76$, $P = 0.0153$). In general, the whole project area was dominated by planktivorous non-commercial species such as the damselfish and smaller members of the serranid family, the anthias.

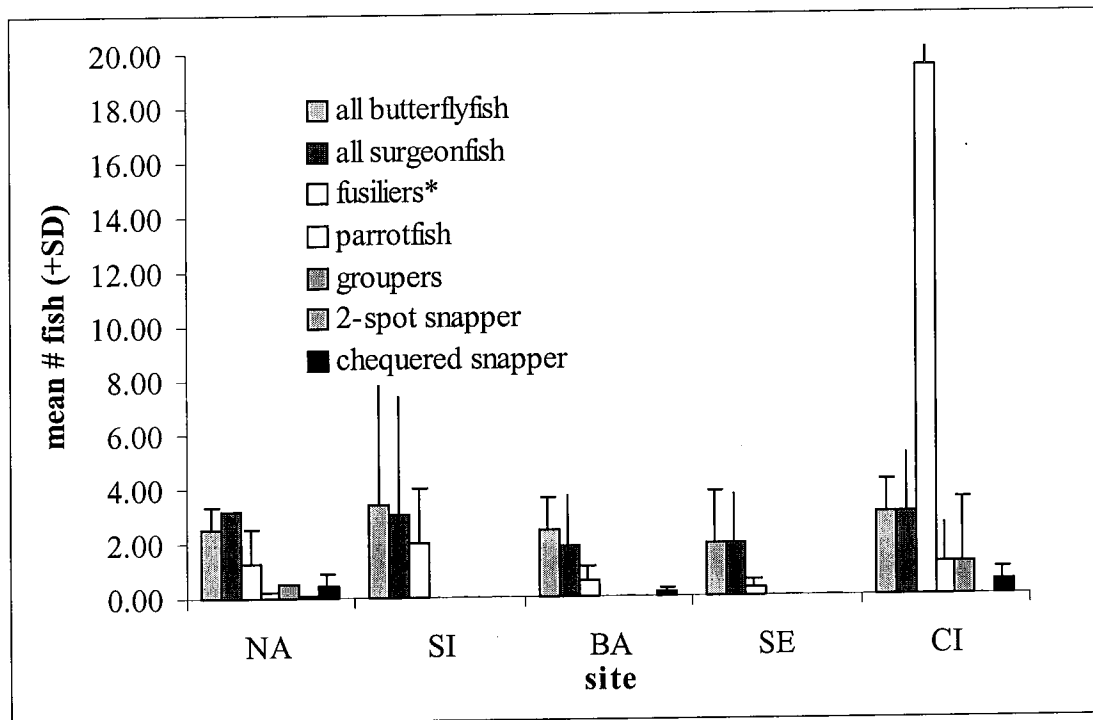


Figure 19. Mean abundance (+SD) of 7 commercially important fish groups in the Mabini-Tingloy area at shallow (6m) depths. There was a significant difference in the abundance of fusiliers between sites (ANOVA, $F = 3.76$, $P = 0.0153$).

There was a limited difference in the abundance of different reef fish between sites at the medium depths. Again, overall abundances were relatively low, however there was a significant difference between the abundance of chequered snapper between the sites (ANOVA, $F = 6.41$, $P < 0.01$). There was a significant difference between Sombrero Island, with this island having the only counts of this fish compared to other locations (Tukeys test, $SI > NA, BA, SE$ and CI), however it's abundance level on the island was very low (only one individual counted). The greatest fish abundances overall appeared to be the surgeonfish and butterflyfish families at Sepoc Point. BA (further to the south of Sepoc) was dominated by planktivorous fusiliers.

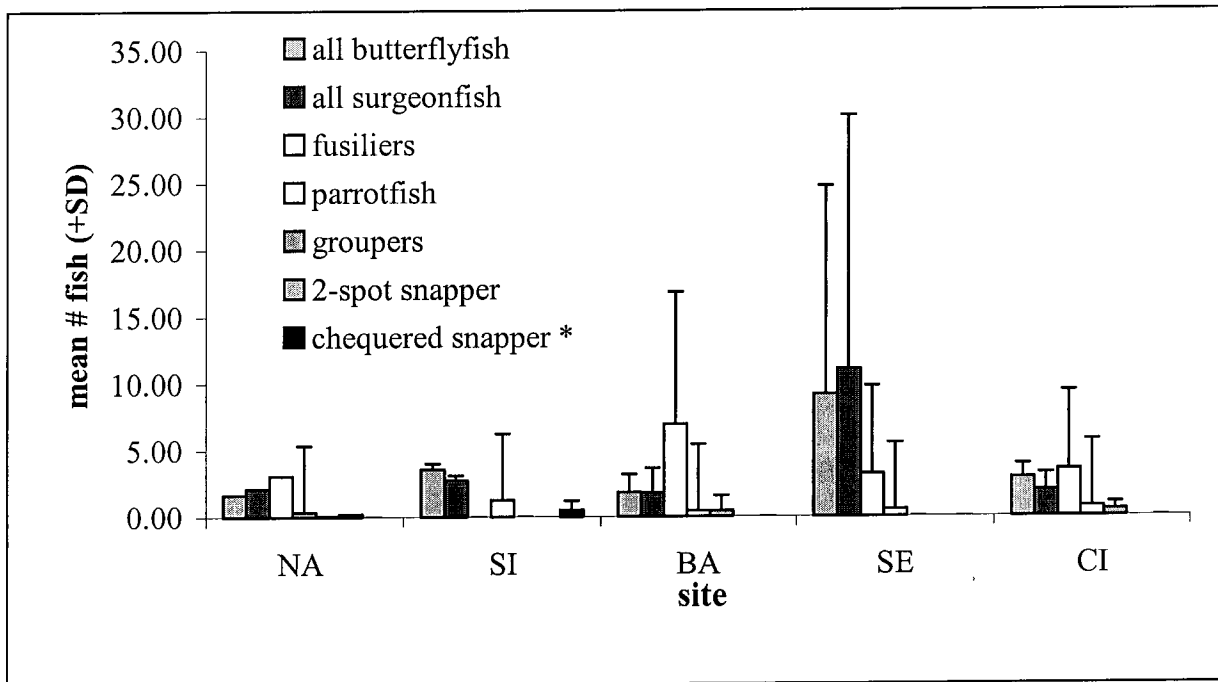


Figure 20. Relative fish abundances at different sites around the Mabini-Tingloy area at medium (10m) depths. Overall, abundances were low, however, chequered snappers were only seen at Sombrero Island, and therefore were significantly more abundant in this location than at other areas (ANOVA, $F = 6.41$, $P = 0.01$).

3.5.4 Fish numbers within sector NA

After analysing the data between the different survey sectors, data was analysed for fish populations between replicate transects inside and outside fish sanctuaries off the coast of southern Mabini, within the Mabini Marine Reserve (sector NA). The fish sanctuaries in this section of coast were Cathedral rock, Arthurs reef, and Twin Rocks (Fig. 21). This analysis was carried out, as there are a series of unlegislated fish-sanctuaries along this coastline. It is worthwhile investigating the data closely to see the effectiveness of sanctuaries in this area, and how the different areas compare for abundance of fish between and within different fish families.

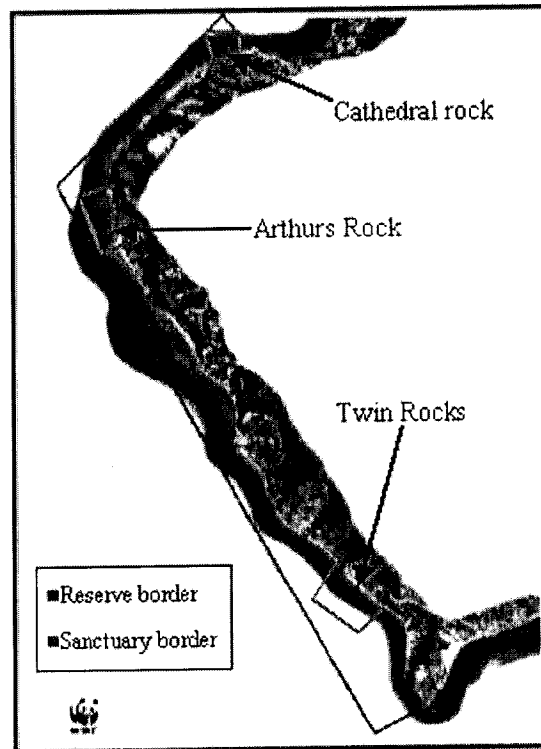


Figure 21. Location of Mabini reserve and three fish sanctuaries at the southern tip of the Calumpan peninsula.

Data was compiled within sanctuaries (one transect for Cathedral and Twin Rocks, two transects within Arthurs Rock) and outside sanctuaries (non-sanctuary), but within the border of the Mabini reserve.

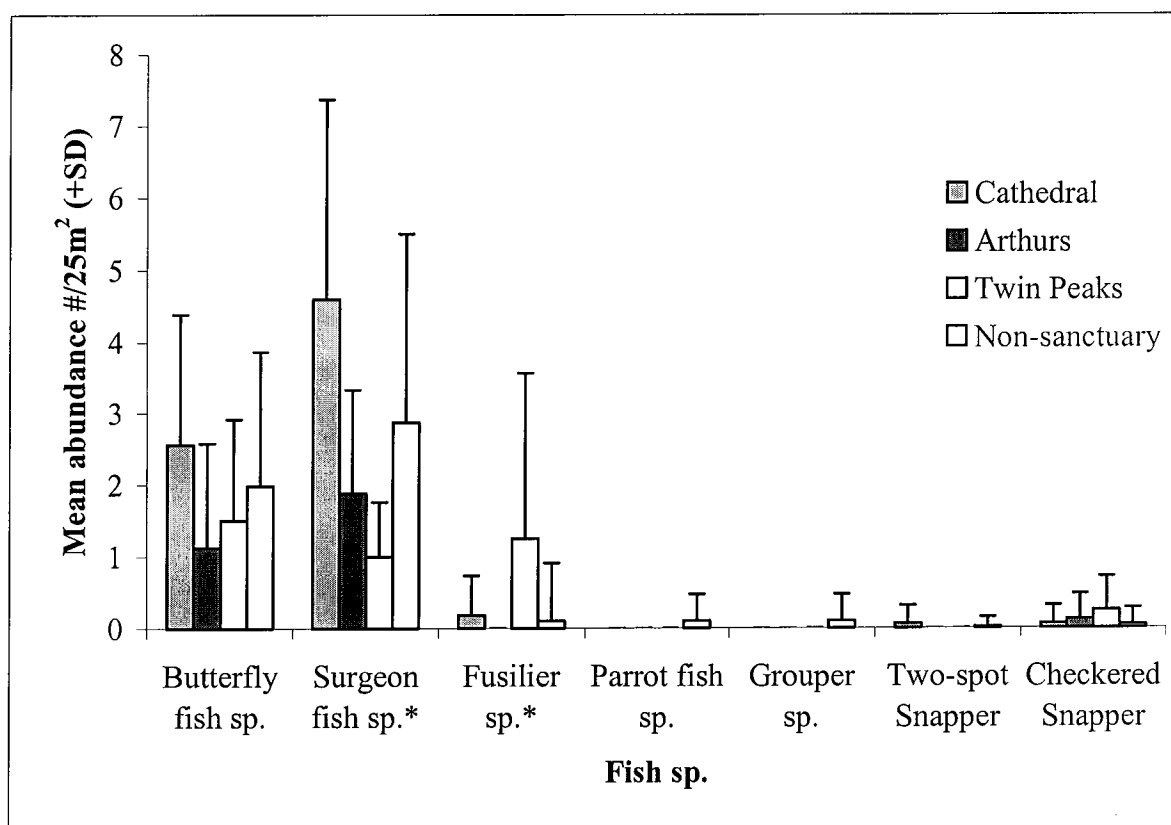


Figure 22. Mean abundance (+SD) of fish inside and outside a number of sanctuaries at shallow (6m) depths (sanctuary boundaries as described by White *et al.*, 2001) within the reserve area of southern Mabini. There was a significant difference in fish abundance in surgeonfish and fusilier numbers, with surgeonfish being greater in abundance at Cathedral, and fusiliers greater in abundance at Twin Peaks.

Fish populations were more abundant at shallow depth areas in Cathedral for butterflyfish and surgeonfish. It seems surprising that during surveys within the sanctuaries, the volunteer divers observed no grouper or parrotfish. This is more likely a result of observer error than a complete lack of families in these locations. Cathedral and Twin Rocks are very isolated and small sanctuaries; therefore, much of the data gathered at these locations may be from outside the sanctuary areas, resulting in reduced abundances of some families. Also, the shallow depth of the transect probably attracts more planktivores due to higher current in these waters, hence the larger numbers of surgeonfish and butterflyfish at these locations. Predator, and generally larger fish are more commonly found at medium depths on coral reefs. Fusiliers were seen to be more abundant at Twin Rocks than at any other site, and surgeonfish significantly more abundant at Cathedral compared to other sites.

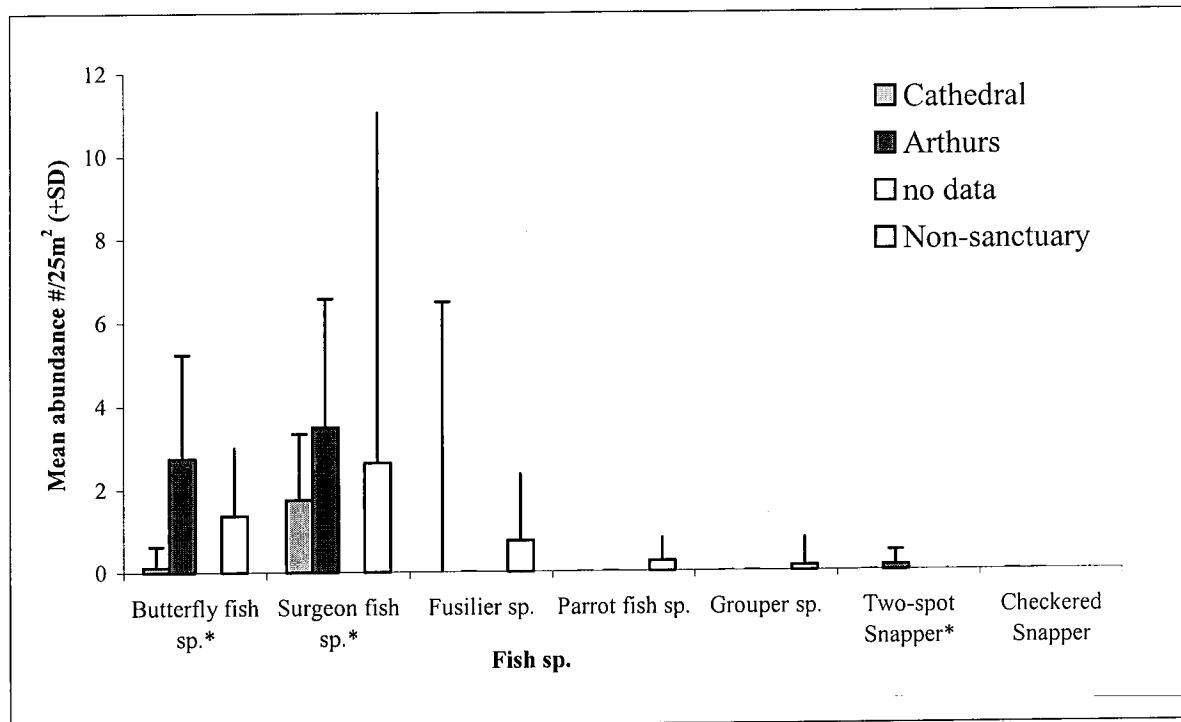


Figure 23. Mean abundance (+SD) of fish inside and outside a number of sanctuaries at medium (12m) depths (sanctuary boundaries as described by White *et al.*, 2001) within the reserve area of southern Mabini. **(there was no data collected for Twin Peaks at this depth).** There was a significant difference in fish abundance in butterflyfish and surgeonfish numbers, with both butterflyfish and surgeonfish greater in abundance at Arthurs than in other sanctuary and non-sanctuary areas.

At medium depth surveys, butterflyfish and surgeonfish numbers are reduced compared to abundances in shallow (6m) depths. This may be because these families tend to be in areas of higher coral cover (particularly the butterflyfish as many are corallivores), and the shallower depths are where the coral cover is higher in the Mabini reserve (Fig. 24). Again, large species were rare both within and outside sanctuaries, with no checkered snappers recorded at all at medium depths.

3.5.5 Benthic characteristics by site

Benthic comparisons were made between all sites around the Mabini-Tingloy survey area (Fig. 24). Coral cover was over double that of live coral cover in shallow waters (45%) in the Mabini reserve than at medium depths (20%). Algae cover was low at all sites and depths, never exceeding 5% cover in any of the areas surveyed. The relative dominance of coral compared to algal cover throughout the survey area stands out in the analysis.

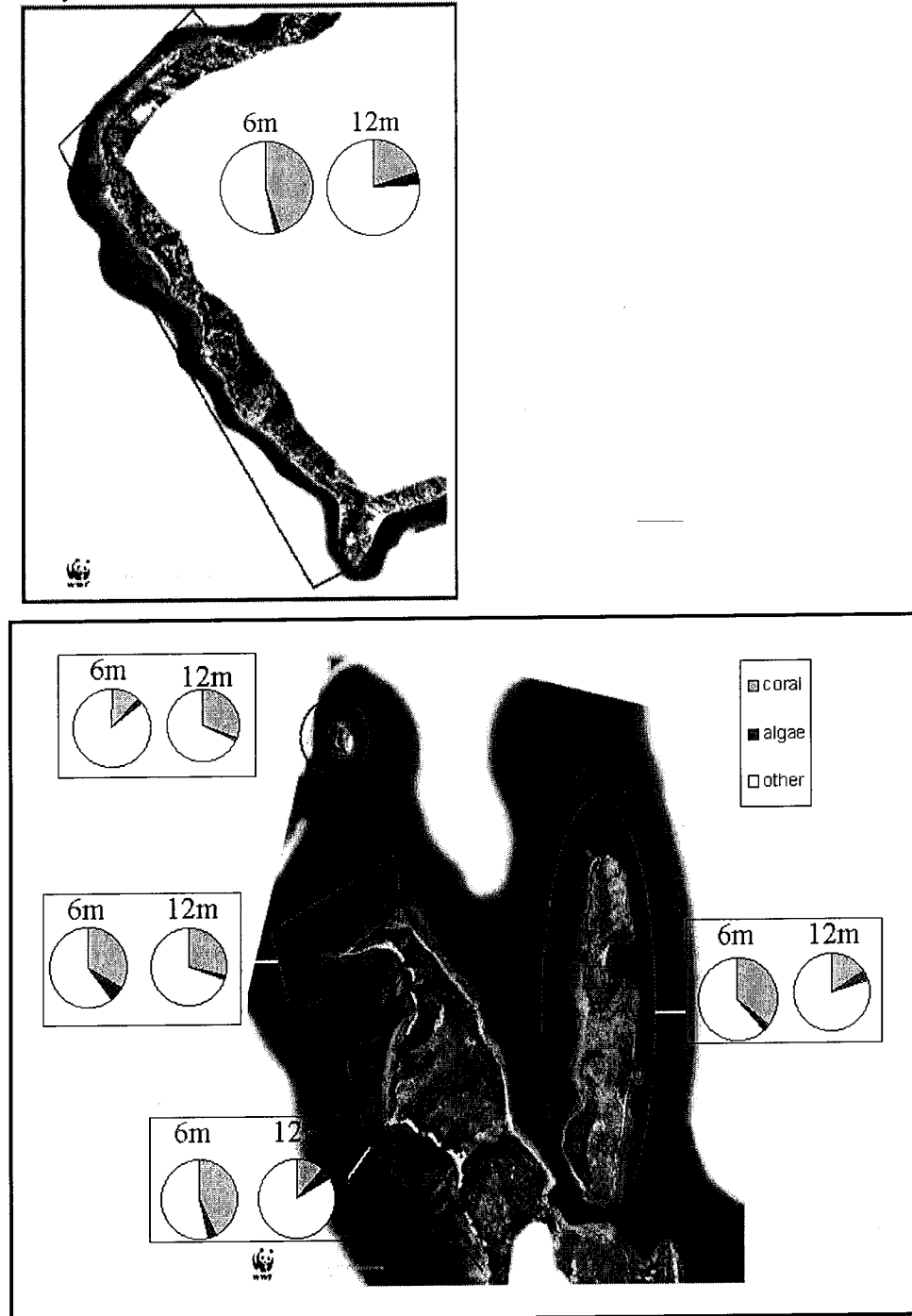


Figure 24. Coral, algae and other benthic cover at all reef check sites surveyed for shallow (6m) and medium (12m) depths in the Mabini-Tingloy area.

Both Caban Island and Burijar survey sectors showed coral-algal-other relative percentage cover similar to that of sector NA (Mabini) with shallow coral cover approximately 40%, and medium coral cover of 5-15%. This seems to reveal that many of these sites show considerable drop in overall coral cover at medium depths, as a feature of the area as a whole. Sombrero showed considerably low coral

cover with shallow reefs having <10% cover, and medium reefs a percent cover of approximately 30%. Sepoc has coral cover of between 30 and 35% for both shallow and deep depths, however the northern side of this point has coral cover in excess of 90% with *Acropora hyacinthus*, and numerous branching *Acropora* dominating the reefscape at a depth between 6 and 10m. This area is one of the most consistent areas of coral cover in the whole of the Mabini-Tingloy waters.

3.5.6 Live coral lifeform diversity by site

Assemblages of coral lifeforms between all the sites was fairly similar (Fig. 25). There was similar division of lifeforms between *Acropora* branching, branching, massive, encrusting coral lifeforms for all sites. These were the predominant lifeforms for most of the sites, however Caban Island was unusual where it had almost no branching *Acropora* coral. Instead, non-*Acropora* branching coral (*Porites cylindrica*, *Porites rus*, and some branching *Montipora* spp.) occurred in abundance in shallower water.

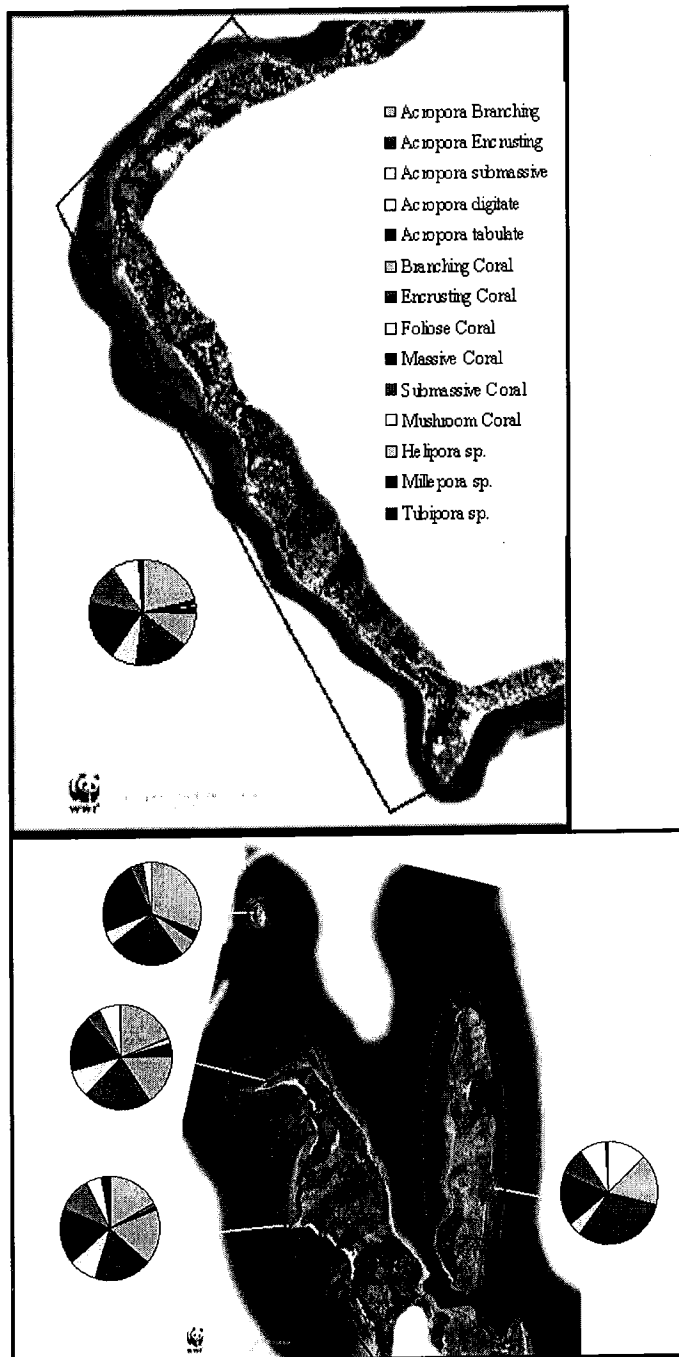


Figure 25. Relative abundance of different coral lifeforms from different survey sector areas in the Mabini-Tingloy project area.

3.6 Other observations/information during surveys

3.6.1 Red tide

A red-tide event on Thursday June 6th 2002 in northern Balayan Bay near to the area of Ligpo Point resulted in the death of thousands of reef fish. On Friday 7th June the bloom was concentrated in a focussed band approximately 5 km from the shoreline. The total length of shoreline affected was about 2 km, from Ligpo Island to Loc-Loc bay (Bauan municipality). The CCC Project Scientist, and Alan Silayan of WWF-Philippines liased with Dr Gill Jacinto (Marine Science Institute of the University of the Philippines) who looked at the samples and diagnosed an outbreak of *Phytoplankton gymnodinium* way above normal densities for this phytoplankton species. The bloom affected a considerable clam re-seeding project in the area, with 50 *Tridacna* clams dying in a project set up by the manager of Dive and Trek resort. The bloom peaked on Saturday 8th June with an expanse from Ligpo Island in the north to Barangay Solo-Mabini in the south, an approximate distance of 7km. At that time, the municipal fishery released a fishery advisory cautioning against consuming fish caught in the area. By Sunday 9th June, the bloom had broken up and was patchy in distribution.

3.6.2 Megafauna observations

A pod of pilot whales was observed within the bay on a number of occasions. Pygmy sperm whales were also spotted in the bay. Other megafauna observed were sharks (although rarely – one or two blacktip sharks). Commonly observed megafuana included pods of bottlenose and common dolphins, turtles, tuna and on one occasion, a marlin.

4. DISCUSSION

4.1 Anthropogenic factors

Anthropogenic factors around the Mabini Tingloy area indicate that fishing pressure and inadequate waste/sewage disposal services in the area were the most prominent factors underpinning stress on the marine community. Fishing activity (both non-destructive and destructive) accounts for the majority of the boating activity in the bay area. Other boats that can cause damage locally (by pollution and anchor) are predominantly dive boats, which in the absence of permanent moorings at dive sites, can cause physical damage to the reef environment.

Fishing boats in the majority of circumstances were fishing for pelagic tuna, and were therefore not directly influencing the health of the coral reefs. However, the reef spear, net and trap fishers can cause a trophic shift in the balance of the reef by extracting herbivorous fish, which in some survey sectors may have caused a phase-shift in the benthic community to one dominated by macroalgae. Algal overgrowth can be avoided if certain herbivorous fish were allowed to recover, such as parrotfish, surgeonfish and rabbitfish.

4.2 Habitats and Fish populations

4.2.1 Sepoc Point

Benthic habitat dispersal of the reefs of Mabini-Tingloy indicates that there are areas of extremely healthy coral cover in the medium to shallow waters (<15m) of the survey area. This is particularly evident within the surveys carried out in survey sector BA, which comprised a considerable number of habitats around the southern and western sections of Sepoc Point. In the south-west of Sepoc point, the environment comprised a massive reef table, gently sloping in a southwest direction to deeper water. The shallow bank of this reef opposite the area of Sepoc beach resembled a lagoonal environment with massive coral mounds of *Porites lobata*, interspersed with non-*Acropora* branching colonies and *Acropora* branching colonies. This area represents a unique habitat that is entirely different to those in the more south and easterly sections of Sepoc point. Habitats further to the south-east of the point resemble more exposed habitats one would associate (in a geo-morphological context) with shallow spur and groove, which is commonly associated with the coral reefs of the Caribbean region. Here, reefs are comprised by species of branching *Porites* (*nigrescens*, *rus* and *cylindrica*) as well as some *Montipora* branching species. The oceanographical conditions of the west side of Sepoc Point would suggest that this area is heavily impacted by the south-west monsoon waves, which would have a contributory effect on the spur and groove, and bedrock formations in the western side of the coastline from Batalan Rock up to Sepoc beach. The structure of the adjacent land with occasional depositional (sand) and accreting (rock) areas would make this location susceptible to different habitats in the adjacent marine environments.

The sheer variety and considerable health of the reefs in and around Sepoc make it a prime candidate for protective status within the reefs of the Mabini-Tingloy area. The adjacent land mass is not colonised by human population until one reaches the town of Maricaban, approximately 1.5 km to the south-east of this area. There is cabana-style structure on the south-facing beach at Sepoc Point, and this facility is owned by Eagle Point Resort on the Calumpan peninsula (to the northern part of sector NA). This facility on Sepoc beach is only used as a resting point for tourists who have ventured across the Maricaban straight, and use it for shelter. It is, however, permanently manned by employees of the resort, and as such, acts as a deterrent to the activities of illegal fishers who may encroach into the waters of the bay. It therefore causes low terrestrial impact (negligible human impact), acts as a snorkel site for tourists visiting a local resort, and is to an extent, locally protected by employees of the resort. Dives carried out at sector BA03 also revealed a considerable number of coral and fish recruitment in the area. Therefore, this location may act as a sink for considerable volumes of juveniles of both corals and fish.

A similarly important location would appear to be the shore and associated corals on the northern side of Sepoc Point. This location (particularly near to the point itself) is dominated by high (almost 100%) cover of *Acropora* branching and table corals (possibly *Acropora hyacinthus*). The massive extent (at least 0.3 x 1 km) of this exceptional area reveals the lack of disturbance to the reef for a considerable amount of time (since at least before the mid 1990s in the area of Sepoc Point). This can be deduced from the size and growth rates of the particular coral colonies that are present. It appears from the species composition of the reef at Sepoc Point (being dominated by branching and table *Acropora* colonies), that the global bleaching event in 1998 that considerably affected many corals in the Asia-Pacific region, appears to have had little impact at this location. Moreover, Sepoc Point is dominated on the north side by branching *Acropora* corals that are normally particularly associated with being readily bleached during periods of increased sea surface temperatures (Marshall and Baird, 2000). We postulate that the considerable currents that run in the Maricaban Strait reduce the likelihood of the water within the Tingloy area to increase in temperature to that point at which corals (especially of the *Acropora* family) easily bleach.

Fish and invertebrate populations recorded by the volunteer divers appear to be rather depauperate in terms of abundance. The diversity of many of the fish families seen on the reefs appears to be healthy, but the abundance of commercial families in particular is low. The numbers of jack, barracuda and emperor are fairly low. Snapper populations are a little more robust. The most apparently unique area of fish appears to be adjacent to Sepoc beach (survey BA 03) where there were an abundance of juvenile surgeonfish, parrotfish and emperors in the shallow bedrock dominated rocks (< 5m depth).

4.2.2 Caban Island

Habitats of Caban Island appear to be dominated by sand, algae and soft corals. The condition of the coral reef appears to slowly deteriorate from the north of the island, around Layag-Layag dive site, to the south, near to the Bangus fish farm (Fig. 26). This may be a direct result of the fish farm, coupled with the increasing proximity of Maricaban village that lies on the island of Maricaban, just to the south west of Caban Island. It may be that anthropogenic pollutants such as untreated sewage from the village, coupled with the deleterious effects of waste from the 'bangus' fish farm, could potentially be affecting the water chemistry in this more sheltered part of northern Maricaban Island. The overfeeding of bangus could seriously impact on the water chemistry of the area, by causing food particles that are not picked up by the fish to drop below the cages, and decay on the sea floor. Uneaten food from the fish pens is converted by bacteria to nitrates and phosphates that, can, in turn, provide the adequate inorganic nutrient base for rapid growth of macroalgae. Macroalgal proliferation can cause increased competition with live hard corals, and can lead to the degradation of the coral reefs in terms of decreasing live coral cover. Indeed, some of the corals along the western side of Caban Island appeared to be overgrown by green filamentous algae in pockets (4m²) in waters less than 5 metres deep. These pockets could be symptomatic of stresses to coral reefs associated with degradation of the coral reef waters in this part of Tingloy.

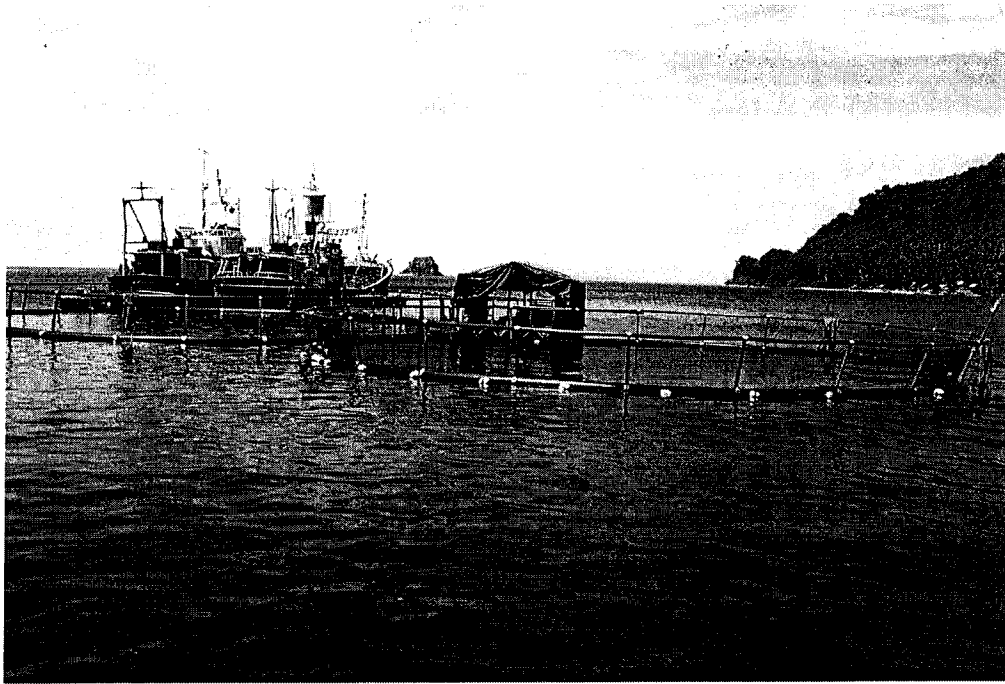


Figure 26. Bangus fish farm, south-west Caban Island.

4.2.3 Sombrero Island

Sombrero Island has attracted much attention from the local stakeholders of the bay. It has been proposed as a marine reserve since the 1980's and supports the majority of dives carried out in the Anilao area at the weekends. It lies at one end of the Maricaban Strait, and as such, is exposed to considerable currents (up to 3-4 knots, pers. obs.). This hydrodynamic state considerably influences the species composition and growth forms of sessile benthic invertebrates such as hard corals and sponges, which can also influence the reef fish community present. This area seemed to be particularly rich in benthic composition of bedrock, sand and medium density of corals, particularly on the west side of the island. The east side at medium (15-5m) depths is dominated by *Xenia* sp. soft corals on a rubble base. Many areas on the west side are also associated with high densities of mushroom corals (Fungiidae). This section of the reef from the middle of the western coast up to the north west tip of the island appears to have seen considerable amounts of blast fishing in the past. Slightly to the south west of the island, lies an area of vast, dense coral cover (>80%) which is dominated by branching and table *Acropora* corals. It appears that this particular section of reef has completely avoided blast-fishing or storm damage, whereas the adjacent reef slightly to the north has been severely impacted.

Fish populations in this area were limited to a certain extent by depth, and the frequency of coral-dominated habitats. A wide range of fish families occupied shallow reefs, with no particular overall dominance of any one species over another, although the damselfish family (Pomacentridae) was well represented in all areas.

Two other shallow reef platforms occur close to the reefs of Sombrero and Caban Island – these are the submerged reefs of Beatriz Rock and Bahura. These reefs are apparently associated with relatively large commercial (piscivore) fish populations and are subject to strong currents. They were not surveyed on this expedition, as the conditions of the diving in these areas were considered too difficult for volunteer divers.

4.2.4 South West Calumpan Peninsula

The south-western Calumpan peninsula was designated as a marine reserve in 1991. It has three fish sanctuaries where no fishing has been allowed in the vicinity of Cathedral Point, Arthurs and Twin Rocks (near to Mainit Point). This section of coast appears similar to the coastline at Sepoc, in terms of deep reef habitats, with large amounts of sand and rubble dominated substratum. The shallower reef area consists of a patchy mosaic habitat. Some areas are particularly well defined by good hard coral growth. Eagle Point (NA 13); is comprised of densely packed hard corals in the shallow waters, mainly composed of *Porites cylindrica* (and other non- *Acropora* species). As one moves around to the south-west facing coast, the diversity of habitats is quite variable within transects from deep to shallow waters. There is a considerable current from south-east to the north-west that has a major influence on structuring the benthic community in this area. Many of the corals that occur in the area of Arthurs (NA1 and 2) have a considerably stunted growth that may be as a result of the fast current environment. Many planktivorous associated invertebrates such as feather stars and basket stars also occur in association with the coral dominated habitats of this area.

Reefs in this part of the Mabini area have benefited from protection from local fishing effects. The twin pinnacles associated with Cathedral Rock (survey sector northern NA/SO) have considerable numbers of schooling fish. This small area (<1 km²), and much of the adjacent shoreline has abundant planktivorous surgeonfish *Naso minor*, and the eyestripe surgeonfish *Acanthurus dussumieri*. In particular the former *Naso* species were seen in large schools in this area. It is likely that they thrive on the rich planktonic upwellings in this part of the bay, combined with the limited fishing pressure around the fish sanctuary. Indeed, many other families in this area, rare on fished reefs, appear to be in greater abundance more abundant than in adjacent areas outside the sanctuary. This can be said for scarids, lutjanids, lethrinids, balistids and even small (<30 cm) serranids.

ANOSIM analysis comparing the fish assemblages, found that there was a close correlation between the benthic organisms and associated fish assemblages. Of the pairwise comparisons made, 68% showed significant interaction between the habitat and the fish assemblages present. This indicates the importance of the interaction between the distribution of habitat types and fish assemblages, which has implications for managing reefs, not only from the occurrence and distribution of fish, but also of habitat types.

A total of fourteen target species of fish were not recorded on any survey dives. This group contained six local commercially important species. These figures are likely to be related to the high fishing pressure observed within the study area (generally outside the fish sanctuary areas).

4.3 Reef Check data

All areas surveyed showed fundamentally similar fish and benthic populations. There were no large differences in benthic and fish communities between survey sectors. However, subtle differences in coral and fish populations reveal patterns possibly related to the distribution of different habitats in different oceanographic and geological locations, which lends themselves to a different suite of physical disturbances. A well-known dive site is Sombrero Island, possibly the most heavily visited dive and recreational location in the survey area (Fig. 25). Sombrero has suffered considerable damage from shallow water blast fishing, which has only recently ceased. This may be a result of the island having no indigenous population, making it more susceptible to visits from illegal fishers as their activities are likely to be undetected by people once the visitors to the island leave. Much of the east and west side of the island is dominated by rubble and sand, with the best coral areas occurring in shallow waters in the south west side of the island. The island lies in the middle of the channel between Sepoc Point (Tingloy) and Mabini in the north. As a result, there are considerable currents that rush around this island, making it a potentially important source/sink for both coral and fish larvae. Therefore, it is important to preserve this area for potential future generations of coral reef organisms.

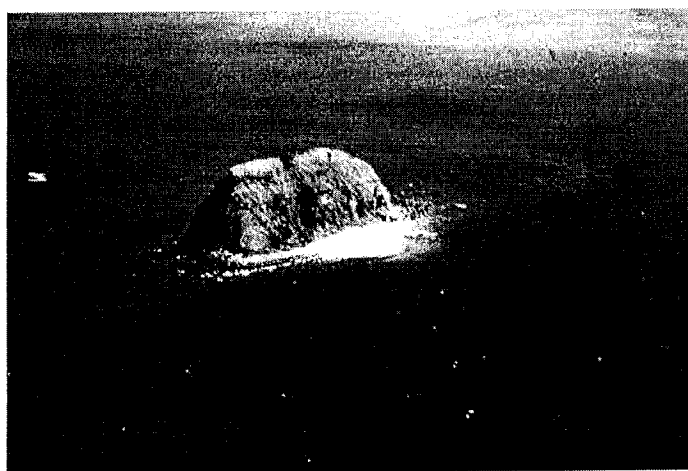


Figure 27. Sombrero Island.

The extensive *Acropora* beds, surveyed on the south west side of Sombrero Island make the location an important resource and source of *Acropora* coral larvae, and show the resilience of this island to recover from catastrophic coral damage. The relatively high percent cover of *Acropora* in this area (as well as Sepoc and Mabini) suggests that the Mabini-Tingloy area is fairly resistant to bleaching. *Acropora* is one of the most susceptible families to bleaching stress (Marshall and Baird, 2000), and many other areas of the Philippines have seriously reduced *Acropora* cover as a result of destructive fishing practices, sedimentation, and bleaching (especially the event in 1998). Therefore, signs are encouraging for the whole of the Mabini-Tingloy area, with the presence of relatively high *Acropora* cover. Total coral cover in the Mabini-Tingloy area as a result of reef check dives is $27.6\% \pm 12.3(\text{SD})$. Coral cover is often used as a gross surrogate of reef health and the ASEAN-Australia Living Coastal Resources project has proposed the criteria that: $>75\%$ = excellent; $75\text{-}50\%$ = good; $50\text{-}25\%$ = fair and $<25\%$ = poor (Chou *et al.*, 1994). Therefore, the reefs of the Mabini-Tingloy area are at least fair in quality overall.

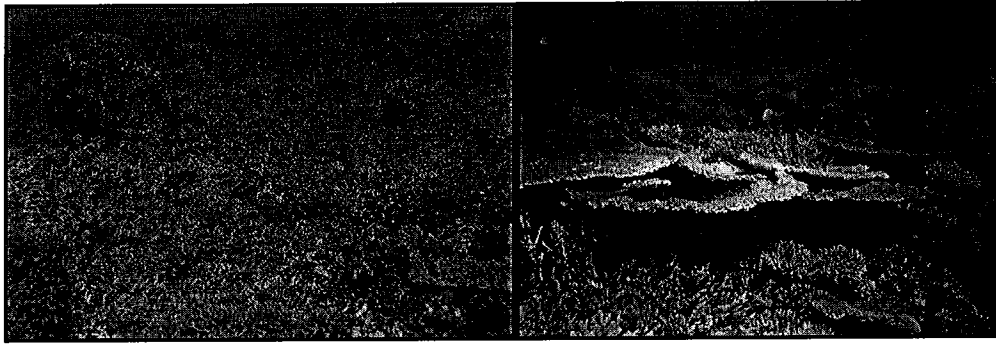


Figure 28. A blasted reef (left) – many shallow water areas of the Philippines have been subjected to considerable blast fishing. Delicate branching and table *Acropora* corals (right) are severely affected by these practices, and populations of these lifeforms have declined in the nation. However, in many areas of the Mabini-Tingloy waters, hard coral populations and benthic cover are considerable.

High coral cover combined with even diversity of habitats and hard coral lifeforms, indicates that the coastline from Sepoc Point south through Buriyar (BA sector) has considerable coral diversity and healthy coral cover. Intermediate depth reefs at Sepoc are particularly rich and abundant in reef fish. The area of Sepoc, from the southern border, to the northern section of coastline, appears to be highly diverse both in the number of different habitats, and the number of juvenile fish. It is also an area that has a coastline perpendicular to most points of the compass from west-south- north. This has the effect of creating a number of very different geomorphologic zones in a small area, which in turn has provided the historical oceanographic diversity in conditions to create a multitude of different reef habitats (as can be seen from the mapping side of the survey data).

5. CONCLUSION

It appears that the general condition of the coral reefs of Mabini, and especially western Tingloy are in a relatively healthy state compared to that of many other Philippine reefs. Previous Coral Cay projects indicate that considerable blast fishing accompanied by chronic sedimentation, periodic bleaching and typhoon damage has caused long-term coral cover loss to the reefs of Palawan (some) and Negros (the majority). Similarly, Philippines reefs have an average number of excellent coral reefs (coral cover >75%) but this was around only 5.5% of the South East Asian regions coral reefs in 1985 (Yap and Gomez, 1985). This therefore makes many of the reefs areas of the Mabini-Tingloy area extremely worthy for conservation and protected status, as they are in the fair category (ASEAN coral reef health guide – Chou *et al.*, 1984).

The coral cover and diversity of the reefs around and south of Sepoc Point would suggest that this marine area is unique for the Mabini-Tingloy region (number of habitats and species recorded per unit space). Serious consideration and effort needs to be made to allow the reefs in this area to reach their full potential. There is also the argument, that in the high current regime, the Sepoc Point region could be an important source of larvae for adjacent reefs in Mindoro, and further east and west of the Cape Verde passage. Therefore, CCC suggest that Sepoc is an ecologically viable site for marine protected area status. The recommendation that there be designation of a fish sanctuary around the headland island itself (north-western tip), with no extractive (fishing/gleaning) or coastal development in this area is proposed. There is the need to start a considerable round of discussions with all local stakeholders in order to present findings, facilitate management discussions, and to provide recommendations for potential marine reserves, which will then be mediated by KKP (WWF-Philippines).

An effective use of the CCC data would be for the baseline habitat data presented here to be extrapolated to other parts of the Mabini-Tingloy area (via remotely sensed habitat mapping) in order to provide the full picture of the status of the marine resources of the bay.

Following, this, it is recommended that the activities of the Mabini-Tingloy Marine Biodiversity Conservation Project are continued in some form in the absence of CCC, as there is a considerable quantity of reef area that has not been surveyed within the project. The work carried out here provides a comprehensive survey report from north-west Maricaban and south-west Calumpán, but there are areas of Tingloy in particular that need to be visited and rigorously surveyed. CCC therefore recommends that surveys are continued in the area in order to facilitate better understanding of areas of exceptional coral cover, and fish populations from sites further afield. Secondly, the importance and development of community outreach and survey training for the local communities cannot be stressed enough. The application of strong scientific evidence combined with an empowered and environmentally aware stakeholder population, can push through effective MPA site recommendations for the Mabini-Tingloy region.

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7. APPENDICES

Substrate categories

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Dead substrate	0.0	0.0	0.3	0.0	0.6	0.8	0.8	1.3	0.5	1.0	0.9	0.5	0.3
Mud	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0
Rubble	0.0	0.0	0.3	4.0	1.6	2.3	1.1	1.4	1.7	3.7	2.6	0.7	0.0
Sand	5.0	5.0	5.0	2.5	3.5	2.3	2.4	2.0	2.4	0.7	3.9	4.6	1.5
Bedrock	0.4	0.0	0.0	0.3	1.0	1.5	2.9	3.8	3.4	2.7	2.0	1.3	5.0
Newly dead coral	0.0	0.0	0.0	0.3	0.2	0.8	0.3	0.4	0.4	1.0	0.5	0.1	0.0
Dead coral with algae	0.0	0.1	0.0	0.0	0.9	1.3	1.4	2.4	1.8	0.7	2.3	1.3	1.5

Cover of benthic organisms

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Algae	5.0	1.8	2.1	1.5	1.8	1.5	1.9	2.7	1.5	3.0	3.4	2.4	1.3
Hard corals	0.2	0.1	0.0	1.8	1.3	1.5	3.2	4.3	3.1	2.3	2.5	1.7	1.5
Seagrass	0.0	2.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Soft coral	0.0	0.1	0.4	1.0	0.9	0.5	1.3	1.7	2.5	1.3	2.2	1.8	3.8
Sponge	0.2	0.1	0.0	0.5	1.0	0.8	1.3	2.0	2.7	2.0	2.6	1.5	0.5

Hard Coral life-forms

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Growth form													
<i>Acropora</i> branching	0.0	0.0	0.0	0.0	1.0	1.0	1.5	2.5	1.3	1.0	1.5	0.8	0.8
<i>Acropora</i> encrusting	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.6	0.7	0.2	0.1	0.0
<i>Acropora</i> submassive	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1	0.3	1.0	0.2	0.3	0.0
<i>Acropora</i> digitate	0.0	0.0	0.0	0.0	0.1	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.0
<i>Acropora</i> abulate	0.0	0.0	0.0	0.0	0.2	0.0	0.7	1.4	0.7	0.7	0.7	0.6	0.0
Non- <i>Acropora</i> branching	0.0	0.0	0.0	0.0	0.4	0.8	1.4	2.4	1.3	1.0	1.5	0.7	0.8
Non- <i>Acropora</i> encrusting	0.0	0.0	0.0	0.0	0.9	0.8	1.2	2.7	2.4	1.7	1.5	0.9	0.0
Non- <i>Acropora</i> foliose	0.0	0.0	0.0	1.0	0.9	1.0	0.9	1.4	1.7	0.0	0.7	0.3	0.3
Non- <i>Acropora</i> massive	0.0	0.0	0.0	0.0	0.5	0.3	1.1	3.0	2.1	1.7	1.6	1.2	1.0
Non- <i>Acropora</i> submassive	0.2	0.1	0.0	0.5	0.6	1.0	1.1	2.0	1.1	0.7	0.8	0.9	0.5
Non- <i>Acropora</i> mushroom	0.0	0.0	0.0	1.3	1.0	2.0	1.2	2.5	2.6	2.3	1.3	0.4	0.3
Non- <i>Acropora</i> fire coral	0.0	0.0	0.0	0.0	0.1	1.3	0.4	1.1	0.2	0.0	0.4	0.3	0.0
Non- <i>Acropora</i> blue coral	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0

Hard coral species and groups

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Pocillopora small	0.0	0.0	0.0	0.0	0.3	0.5	0.7	0.5	0.5	0.7	0.3	0.5	0.3
Pocillopora medium	0.0	0.0	0.0	0.0	0.2	0.3	0.6	1.2	0.5	0.3	0.6	0.3	0.3
Pocillopora large	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.1	0.1	0.0
Seriatopora hystrix	0.0	0.0	0.0	0.0	0.3	0.8	0.8	1.6	0.5	1.0	0.8	0.2	0.5
Stylophora pistillata	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.9	0.1	0.3	0.3	0.3	0.0
Stylophora mordax	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.1	0.3	0.1	0.1	0.0
Montipora foliose	0.0	0.0	0.0	0.0	0.4	0.3	0.5	0.2	0.1	0.3	0.1	0.0	0.0
Montipora digitata	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0
Bottlebrush <i>Acropora</i>	0.0	0.0	0.0	0.0	0.3	0.5	0.4	0.1	0.4	0.0	0.4	0.0	0.0
Massive <i>Porites</i>	0.0	0.0	0.0	0.0	0.8	0.3	1.0	2.7	1.5	2.0	1.6	1.1	1.3
<i>Porites cylindrica</i>	0.0	0.0	0.0	0.0	0.1	0.8	1.0	1.1	0.1	0.0	0.1	0.1	0.0
<i>Porites nigrescens</i>	0.0	0.1	0.0	0.0	0.1	0.8	0.6	1.1	0.2	0.0	0.2	0.1	0.3
<i>Goniopora/Alveopora</i>	0.0	0.0	0.0	0.5	0.4	0.0	0.7	1.1	0.3	0.7	0.4	0.1	0.3
<i>Pavona clavus</i>	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0
<i>Pacyseris speciosa</i>	0.0	0.0	0.0	0.0	0.7	0.3	0.5	0.7	0.8	0.0	0.3	0.0	0.0
<i>Pachyseris rugosa</i>	0.0	0.0	0.0	0.0	0.2	0.3	0.6	0.7	0.6	0.0	0.2	0.1	0.0
<i>Ctenactis echinata</i>	0.0	0.0	0.0	0.8	0.6	0.3	0.5	0.6	0.6	0.0	0.3	0.1	0.3
<i>Herpolitha limax</i>	0.0	0.0	0.0	1.0	0.6	0.8	0.8	1.0	1.0	0.7	0.4	0.1	0.3
<i>Polyphyllia talpina</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0
Upsidedown bowl	0.0	0.0	0.0	0.3	0.1	0.8	0.4	0.3	0.7	0.7	0.1	0.1	0.0
<i>Galaxea</i>	0.0	0.0	0.0	0.0	0.5	0.5	0.8	1.7	1.1	0.3	0.6	0.2	0.0
<i>Pectinia lactuca</i>	0.0	0.0	0.0	0.0	0.4	0.5	0.8	1.2	0.8	0.0	0.4	0.1	0.0
<i>Mycodium elephantotus</i>	0.0	0.0	0.0	0.0	0.9	0.8	0.7	0.8	1.6	0.7	0.2	0.0	0.0
<i>Lobophyllia</i>	0.0	0.0	0.0	0.0	0.5	1.0	1.0	1.7	1.6	0.3	0.7	0.6	0.3
<i>Favia</i>	0.0	0.0	0.0	0.0	0.6	0.3	1.0	1.8	2.1	1.7	1.2	0.6	0.0
<i>Favites</i>	0.2	0.0	0.0	0.0	0.6	0.0	1.1	2.3	1.7	1.0	0.9	0.7	0.8
<i>Diploastrea heliopora</i>	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.6	0.4	0.7	0.3	0.3	0.0
<i>Euphyllia</i>	0.0	0.0	0.0	0.0	0.2	0.5	0.5	0.5	0.6	0.3	0.3	0.2	0.3
<i>Plerogyra</i>	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.1	0.1	0.3	0.1	0.1	0.0
<i>Millepora platyphyllia</i>	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.5	0.1	0.0	0.1	0.2	0.0
<i>Millepora intricata</i>	0.0	0.0	0.0	0.0	0.1	1.0	0.3	0.9	0.1	0.0	0.4	0.1	0.0
Brain small	0.0	0.0	0.0	0.0	0.3	0.0	0.7	1.4	0.8	0.3	0.4	0.4	0.3
Brain medium	0.0	0.0	0.0	0.0	0.2	0.0	0.6	0.6	0.4	0.0	0.2	0.2	0.0
Brain large	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.5	0.9	0.0	0.6	0.1	0.0

Algae

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
CYANOBACTERIA													
Schizothrix sp.	0.0	0.0	0.0	0.3	0.4	0.0	0.5	0.4	0.1	0.0	0.6	0.6	0.5
CHLOROPHYTA													
Filamentous	5.0	1.8	1.8	1.0	1.1	0.5	1.2	1.6	1.1	2.3	1.8	1.9	1.0
Chaetomorpha	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.0
Valonia	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.3	0.0	0.0
Bornetella	0.0	0.0	0.4	0.3	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0
Neomeris	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.6	0.0	0.0
Codium	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.3	0.1	0.0	0.0
Caulerpa	0.4	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.9	1.7	0.7	0.1	0.0
Halimeda	0.0	0.0	0.0	0.3	0.0	0.3	0.5	0.4	0.0	0.3	0.4	0.0	0.0
Tydemania	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.0
PHAEOPHYTA													
Ralfsia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Sphacelaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rosenvingea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Dictyota	1.8	0.2	0.1	0.0	0.4	0.0	0.6	1.5	0.8	1.0	2.0	1.4	1.0
Padina	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.2	0.2	0.3	0.4	0.1	0.0
Lobophora	0.4	0.0	0.0	0.0	0.2	0.0	0.1	0.2	0.1	0.0	0.1	0.0	0.3
Hydroclathrus	0.0	0.0	0.4	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0
Turbinaria	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.3
Brown filamentous	0.2	0.0	0.0	0.3	0.5	0.5	0.5	0.8	0.1	0.0	0.6	0.6	0.8
Sargassum	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.3
RHODOPHYTA													
Eucheuma	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.3	0.0	0.0
Gelidium	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	0.0	0.0	0.3	0.1	0.0
Gelidiella	0.0	0.1	0.0	0.0	0.2	0.0	0.2	0.2	0.1	0.0	0.4	0.2	0.3
Laurencia	0.0	0.0	0.1	0.3	0.4	0.0	0.1	0.2	0.1	0.0	0.4	0.2	0.5
Corallina	0.0	0.0	0.0	0.0	0.9	0.3	0.7	1.0	0.2	0.0	2.2	0.6	0.0
Galaxaura	0.0	0.0	0.0	0.0	0.1	0.0	0.7	0.7	0.6	0.0	1.2	0.8	0.5
Amphiroa	0.0	0.0	0.0	0.3	0.2	0.0	0.6	0.6	0.1	0.0	0.5	0.4	0.3
Jania	0.0	0.1	0.0	0.3	0.5	0.0	0.7	0.6	0.3	0.7	0.8	0.1	0.5
Mastophora	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Red filamentous	0.0	0.1	0.0	0.3	0.3	0.5	0.4	0.4	0.3	0.7	0.7	0.2	0.8
Halymenia	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.0
Amansia	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0
Actinotrichia	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.7	1.0	0.4	0.2	0.8
ANGIOSPERMATA													
Seagrass sp	0.0	2.4	0.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Thalassia	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Halophila	0.0	2.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Mangroves	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0

6. Sponges (Porifera)

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Growth form													
Tube	0.0	0.0	0.0	0.5	0.3	0.3	0.3	0.3	0.9	0.7	1.0	0.4	0.5
Plate	0.0	0.0	0.0	0.0	0.5	0.0	0.2	0.2	0.6	1.0	1.2	0.3	0.3
Elephant Ear	0.0	0.0	0.0	0.3	0.7	0.5	0.5	1.0	1.4	1.0	0.4	0.2	0.0
Branching	0.2	0.1	0.0	0.0	0.3	0.0	0.2	0.5	0.8	0.0	0.9	0.2	0.0
Encrusting	0.0	0.0	0.0	0.3	0.6	0.8	1.1	1.2	2.3	1.0	2.1	0.9	0.0
Lumpy	0.0	0.0	0.0	0.5	0.6	0.3	0.9	1.2	1.8	0.7	1.5	0.8	0.0
Rope	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.6	0.2	0.0	0.2	0.2	0.0
Vase	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Octocorals

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Growth form													
Dead mans fingers	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.5	0.2	0.0	0.3	0.0	0.8
Leather	0.0	0.0	0.0	0.3	0.2	0.0	0.4	0.4	0.8	0.0	0.5	0.3	0.0
Tree	0.0	0.0	0.4	0.8	0.4	0.0	0.6	0.7	2.1	1.0	1.3	0.6	2.0
Pulsing	0.0	0.1	0.0	0.0	0.1	0.0	0.5	0.5	1.5	0.7	0.8	0.9	3.3
Sea fan	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.0	0.4	0.7	0.1	0.1	0.0
Sea whip	0.0	0.0	0.0	0.3	0.5	0.5	0.2	0.4	0.7	2.0	0.6	0.0	0.0
Bamboo	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tubipora musica	0.0	0.0	0.0	0.3	0.1	0.0	0.3	0.2	0.4	1.0	0.1	0.0	0.0
Xenid	0.0	0.0	0.0	0.3	0.7	0.3	0.8	1.0	2.3	1.3	1.6	1.1	2.8

Others

Benthic class	1	2	3	4	5	6	7	8	9	10	11	12	13
Black coral	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.1	0.4	1.0	0.3	0.1	0.0
Anemone	0.2	0.1	0.0	0.5	0.7	0.5	0.7	0.6	0.8	1.3	0.8	0.4	0.3
Zoanthid	0.0	0.0	0.0	0.3	0.1	0.0	0.4	0.5	0.3	0.7	1.4	0.4	0.0
Hydrozoa	0.0	0.0	0.0	0.0	0.2	0.3	0.7	0.8	0.7	0.0	0.9	0.8	0.0
Corallimorph	0.0	0.0	0.0	0.3	0.5	0.3	0.6	0.5	0.6	0.7	0.7	0.0	0.3

Survey records encountered in each benthic class

BENTHIC CLASS															
1	2	3	4	5	6	7	8		9	10	11	12	13		
BA05A1/5	BA05B1/6	BA05B2/6	CI02A1/1	CI01A1/1	CI07B1/1	BA04A2/3	CI09C3/3	BA03A1/2	NA08C1/1	CI01A1/1	NA12B1/2	BA06A1/2	NA11B2/2	BA02A1/2	NA04B2/2
BA05A2/5	BA05B3/6	BA08A1/5	CI03A1/1	CI01A1/1	CI07C1/1	BA04A3/3	NA01B1/1	BA03A2/2	NA10B1/3	NA02F1/1	SE03B1/2	BA06A2/2	SI01B1/1	BA04A1/3	NA07C1/4
BA05A3/5	BA05C1/8	BA08A2/5	CI04A1/1	CI01B1/3	CI07D1/2	CI02C1/2	NA01C1/1	BA04B1/3	NA10B2/3	NA02H1/1	SE03B2/2	BA06B1/3	SO02A1/1	BA05B4/6	NA07C2/4
BA05A4/5	BA05C2/8	BA08A3/5	CI07A1/1	CI01B2/3	CI07D2/2	CI02C2/2	NA01E1/1	BA04B2/3	NA10B3/3	SE01A1/3		BA06B2/3		BA05B5/6	NA07C3/4
BA05A5/5	BA05C3/8	BA08A4/5		CI01B3/3		CI02D1/2	NA01F1/1	BA04B3/3	SE02A1/2	SE01A2/3		BA06B3/3		BA05B6/6	
	BA05C4/8	BA08B1/5		CI02B1/1		CI02D2/2	NA01G1/1	BA04C1/2	SE02A2/2	SE01A3/3		BA06C1/3		BA05C7/8	
	BA05C5/8	SO01A1/4		CI03B1/1		CI03D1/2	NA01H1/2	BA04C2/2	SE02B1/3	SE03A1/1		BA06C2/3		BA05C8/8	
	BA05C6/8	SO01A2/4		CI03C1/1		CI03D2/2	NA01H2/2	BA04D1/1	SE02B2/3	SE04A1/1		BA06C3/3		BA07E1/4	
	BA07F3/4			CI04B1/1		CI04C1/2	NA03A1/1	BA06D2/2	SE02B3/3	SI01A1/1		BA06D1/2		BA07E2/4	
	BA07F4/4			CI05B1/1		CI04C2/2	NA03B1/2	BA06E1/3	SE02C1/2	SI01C1/1		BA07B1/2		BA07E3/4	
	BA07G1/2			CI06B1/1		CI04D1/2	NA03B2/2	BA06E2/3	SE02C2/2	SI01D1/2		BA07B2/2		BA07E4/4	
	BA08A5/5			CI08A1/1		CI04D2/2	NA03C1/1	BA06E3/3	SE02D1/2	SI01D2/2		BA07C1/1		BA07F1/4	
	BA08B2/5			CI08B1/1		CI04E1/1	NA04A1/2	BA06F1/4	SE02D2/2	SI02A1/1		NA02E1/1		SO03A1/3	
	BA08B3/5			CI09A1/1		CI05C1/1	NA04A2/2	BA06F2/4	SO01D1/3	SI03B1/1		NA02G1/1		SO03A2/3	
	BA08B4/5			NA01D1/1		CI05D1/2	NA04B1/2	BA06F3/4	SO01D2/3	SO02B1/1		NA06B1/3		SO03A3/3	
	BA08B5/5			NA02A1/1		CI05D2/2	NA05B1/1	BA09B2/2	SO01D3/3	SO10A1/1		NA06B2/3		NA01A1/1	
				NA02B1/1		CI05E1/1	NA07A1/2	BA09C1/2				NA06B3/3		NA05A1/3	
				NA02C1/1		CI06D1/3	NA07A2/2	BA09C2/2				NA06D1/2		NA05A2/3	
				NA06A1/2		CI06D2/3	SE01B1/4	BA09D1/1				NA06D2/2		NA05A3/3	
				NA06A2/2		CI06D3/3	SE01B3/4	BA09E1/3				NA06E1/2		NA07B1/2	
						CI07E1/2	SE01B4/4	BA09E2/3				NA06E2/2		NA07B2/2	
						CI07E2/2		BA09E3/3				NA08B1/2		NA09A1/3	
						CI08C1/1		BA09F1/2				NA08B2/2		NA09A2/3	
						CI08D1/2		SO04A1/2				NA10A1/2		NA09A3/3	
						CI08D2/2		SO04A2/2				NA10A2/2		NA09B1/3	
						CI08E1/1		SO04B1/1				NA11A1/3		NA09B2/3	
						CI09B1/1		SO04C1/1				NA11A2/3		NA09B3/3	
						CI09C1/3		NA02D1/2				NA11A3/3			
						CI09C2/3		NA02D2/2				NA11B1/2			

EXIT REPORT ON CCC EXPEDITION IN DAIKEDA BAY RESORT, MABINI

Steve Box, Expedition Leader
James Comley, Project Scientist

INTRODUCTION

A previous report (dated 24th April 2002) outlined why relocation of the Coral Cay expedition base to Maricaban was imperative for the successful continuation of CCC/PRRCFI's ability to perform essential reef surveys. That report proposed that if a move did not occur then CCC/PRRCFI could not ensure that they would meet realistic targets in respect to data assimilation, due to a number of factors including the location of the remaining survey sites, the S.W. Monsoon and the financial drain of remaining at the present project site. In addition other factors such as the distribution of socio-economic benefits to the local community, and the effective targeting of educational and training activities were also discussed.

The reversal of WWF in their verbal agreement with CCC/PRRCFI in which WWF would finance and build a suitable expedition base on Maricaban by August 31st 2002 has resulted in no relocation occurring for the Coral Cay Expedition. Therefore, as predicted CCC/PRRCFI's involvement in the Mabini-Tingloy Marine Biodiversity Conservation Project has had to be suspended and a withdrawal from the project initiated.

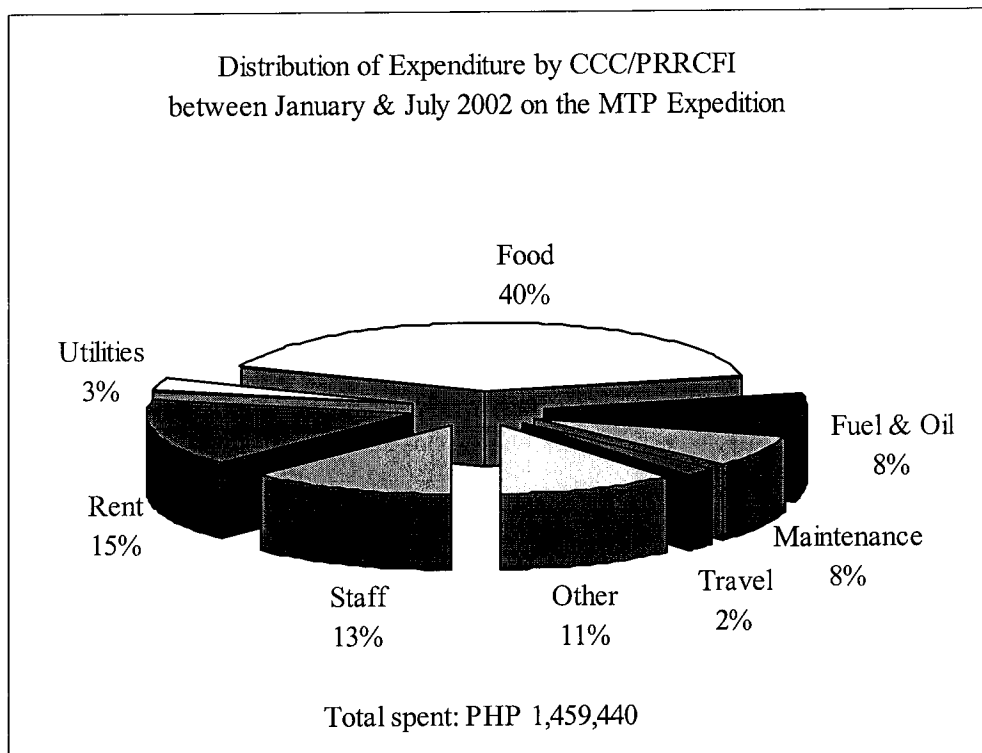
Although this withdrawal is extremely regrettable CCC/PRRCFI's involvement in the MTBCP over the past seven months has been very successful in terms of the quality and quantity of the scientific data collected, the exceptionally good relationships forged with both governmental and non-governmental stakeholders of Balayan Bay and the direct economic benefit that the CCC expedition has provided to the local area.

This exit report outlines the accomplishments and direct benefits that CCC/PRRCFI's participation in the Mabini-Tingloy Marine Biodiversity Conservation Project has made to date. In addition this report may also demonstrate the potential effect that a prolonged withdrawal by CCC/PRRCFI would have on the achievability of the long-term Integrated Coastal Zone Management Plan for Balayan Bay in general and Mabini-Tingloy in particular.

FINANCIAL EXPENDITURE

Between January and July 2002 inclusive CCC/PRRCFI have spent nearly US\$30,000 on the operational costs of the project. This total excludes all expenses incurred in originally locating the project field base and the purchase of essential equipment such as boats and diving equipment. The total is purely the cost of collecting the data and includes the running costs of the boats, staff costs, the rental and utilities for the project site, in addition to staffing and running the field station and equipment maintenance. All of which are fundamental for the archival of project targets.

As a result of the expenditure on staff, food, fuel, rent, utilities and some maintenance, over 70% of the money that CCC/PRRCFI spent was a direct input into the local municipality of Mabini. Of the remainder nearly all would have been spent in the principality of Batangas in local businesses.



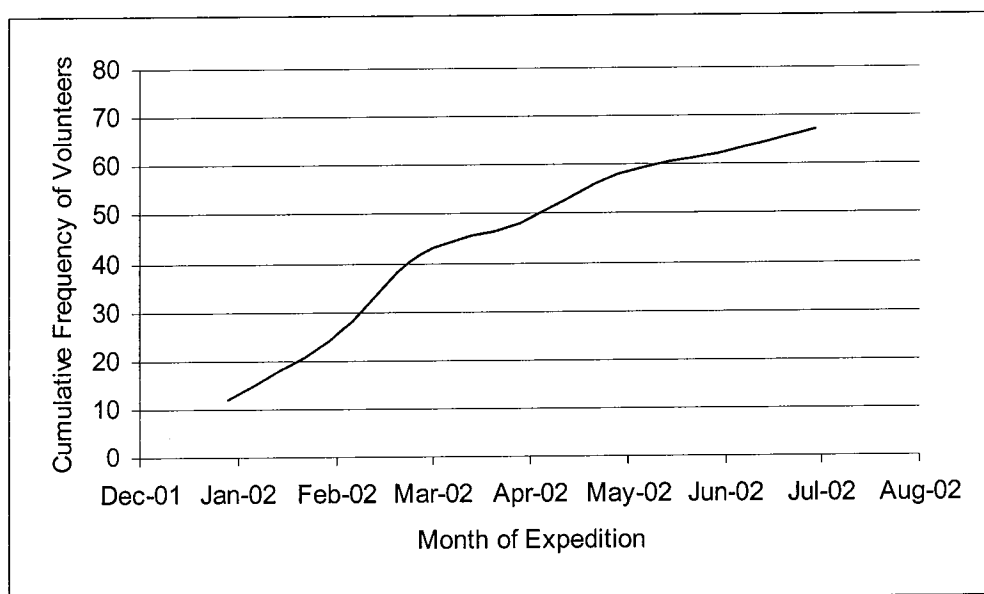
N.B. The "Other" category includes expenditure on staff subsistence when off site, medical expenses, staff visas etc.

TRAINING & DATA COLLECTION

Coral Cay Conservation Volunteers

This Coral Cay expedition base has trained 48 volunteers to at least PADI Advanced Open Water certification and has had 67 volunteers successfully complete the scientific skills development programme. These CCC volunteers as a whole have conducted in excess of 900 survey team dives (consisting of 4 divers per team) in the Mabini Tingloy area. This equates to approximately 2,200 diver hours. This estimate is based solely on the time spent underwater collecting data and excludes all travel times to or from survey sites, data entry or analysis. In addition this figure does not include any dives conducted during SCUBA training or science skills development.

Cumulative Number of Volunteers trained at Dakieda Bay



Project Counterparts Trained

As part of the initial agreement between CCC/PRRCFI and WWF, CCC agreed to train two counterparts from WWF during each and every SCUBA and Science training session. This has resulted in 2 WWF personnel trained to PADI Advanced Openwater certification and 4 successfully passing the science skills development programme. This training will be invaluable to these individuals in the future. However more project counterparts could have benefited from this agreement, as there has been a total of 14 places available on both the SCUBA and SDP training programmes. Unfortunately only 14% and 28% respectively of the places allocated to WWF were utilised.

In addition CCC staff conducted a two-day training seminar for WWF staff based in Manila. This was attended by 5 members of WWF and provided information on the methodology involved in collecting data for habitat mapping, detailed explanations of statistical analysis and the resolution of products from this data, the possible limitations including the accuracy of habitat mapping, the potential benefits that habitat maps can provide and the range of possible financial expenditure involved.

STAKEHOLDER RELATIONSHIPS FORMED

The presence of a CCC expedition ultimately provides a valuable and undeniably economical source of data to our project partners. The work of CCC however is by no means restricted to this role alone. Instead CCC staff through community liaison activities provides a wealth of opportunities and information to local stakeholders. Opportunities have ranged from simply the dissemination of initial findings, as has been carried out to the local government units (LGU) of Mabini and Tingloy to the other extreme, where during the course of the MTBCP, CCC technical expertise has been of invaluable assistance in the monitoring of environmental conditions and initiating and establishing WWF's coral bleaching studies; to name but a few examples.

In return for the community liaison work conducted throughout the expedition, strong links have been forged with stakeholder groups. The relationships formed have proved indispensable for the success of the expedition, the assimilation of the data and ultimately the achievement of the overall goals of the project.

Working with and within the local community groups on a daily basis has led to the development of innumerable links. Key links that have been established during the course of CCC's involvement in MTBCP are outlined below (in alphabetical order):

Bureau of Fisheries and The University of The Philippines

Although outside the remit of CCC's community interaction commitment, CCC were instrumental in the response to a red tide event and fish kill observed in Balayan Bay from 7th – 11th June 2002. The event was first noted around Barangay Locloc, in the municipality of Bauan, on the morning of the 7th June. WWF were notified initially and CCC's assistance immediately requested by Romy Trono (Sulu-Sulawesi Marine Eco-region Project Manager for WWF-Philippines).

CCC scientists were the first to suggest that the cause of the water discolouration and associated fish kill was an algal bloom. In the following days CCC remained instrumental in the monitoring of the geographic extent and intensity of the bloom. Water samples were taken to the University of the Philippines, Manila for toxicology testing, with confirmation that an algal bloom had indeed occurred provided by the Bureau of Fisheries. In the follow up to the bloom CCC's close involvement in the monitoring and management of the event meant that we provided scientific information and advice to many stakeholders, including but not limited to, the provincial government (PGENRO) and the press division of WWF-Philippines for the subsequent use in their press releases.

Eagle Point Resort

Ton Francisco manages Eagle Point resort, Mabini. Interaction with Eagle Point has therefore centred on Ton. Throughout the project CCC have enjoyed superb relations with Ton who has been invaluable. His logistical help has ranged from providing us with the use of his vehicles in the case of an emergency, to giving us free access to both his pool for dive training and his beach resort at Sepoc for relaxation. In return from the outset CCC have provided technical knowledge on environmental issues to Ton, on a personal scale, as well as conducting lectures to his guests on general reef ecology and function.

Friends of Balayan Bay (FOBB)

FOBB are a local NGO comprised of dive resort owners and dive professionals within the MTBCP area. Initial contact was aimed at introducing CCC, the role of the project in the area and to facilitate the ultimate assimilation of the data we gather. After these initial meetings it became clear that FOBB are a major stakeholder group in the area, one that could not only help with logistical support for our expedition but also be an important aspect in raising local community awareness to the resource conflicts occurring within the study area.

The potential for this latter role was discussed with Boy Venus (FOBB chairman), Jun Sarmento (Owner of Aquaventure resort) and all members of the FOBB committee. In response to this, the initiation of a series of reef surveys following the reef check methodology was discussed. Whilst the data from these surveys would be of great value, the main intended purpose of the proposed

programme is to raise environmental awareness amongst FOBB members and in due course create a self perpetuating sense of stewardship amongst this group of key stakeholders.

At the time of writing FOBB were still discussing the potential dates during which training and subsequent surveys could occur. With CCC/PRRCFI's withdrawal, this programme will unfortunately be stalled.

Municipal Government of Mabini-Tingloy

The municipal governments of both Mabini and Tingloy have been liased with on numerous occasions. The full support of both local government units (LGU's) has been essential to the smooth running of the MTBCP. Liaison has included courtesy calls to ensure continued support, progress reports on work completed and target fulfillment as well as the provision of technical advice on the certification and suitability of potential locations to site fish cage developments. In this way CCC has provided technical experience and advice to the LGU's of Mabini and Tingloy in return for the positive working environment we have enjoyed with both municipalities.

Philippine Government Environment & Natural Resource Office (PGENRO)

The natural resources office of the Batangas provincial government (PGENRO) partner WWF in the integrated coastal management planning procedure for Balayan Bay and the subsequent implementation of this plan. The construction phase of this project is due for completion by Summer 2003, with a four year implementation phase due to start in Autumn 2003. The Mabini-Tingloy management plan of WWF falls under the wider jurisdiction of the Balayan Bay project but is working to a different timeframe, with the implementation phase of the Mabini-Tingloy management plan set to start at the time of this report (August 2002).

CCC staff have attended all of the consultation workshops for the various stakeholder partners in the management area. In addition CCC have had input into the bi-monthly technical working group meetings of the management team comprised primarily of PGENRO staff. These inputs have ranged from simple observations to the detailed planning of sampling strategies associated with the quantification of seawater quality parameters.

CONCLUSION

The breadth and depth of CCC's involvement in the MTBCP over the past seven months speaks for itself. The commitment and dedication shown by the CCC field staff and international volunteers to this project has enabled CCC/PRRCFI to achieve an incredible amount in a remarkably short space of time. This achievement would not have been possible if not for the logistical support of CCC Expedition management and PRRCFI's unwavering assistance.

The strong working relationship formed between Coral Cay field staff and local WWF counterparts has also been an enormous asset to the project and this relationship has gratifyingly expanded into the formation of many personal friendships.

In our opinion, the eventual success of a project that is community based is inherently reliant on the ability of an organisation to work within that community and in turn for that community to accept, understand and assist the project. It is a great pleasure to be able to say that that has truly happened beyond all expectations. The acceptance of CCC/PRRCFI's work in Mabini-Tingloy, it's backing by local WWF staff and the involvement, through an incredible range of interactions, by the community has been truly incredible and that is unquestionably the biggest success of all.

This exit report has only outlined the major inputs and outputs that CCC/PRRCFI's involvement in the MTBCP has had. Unfortunately it cannot include all the day-to-day successes that occur or impart even a fraction of the commitment and dedication shown by all involved. Needless to say that it is a travesty that CCC/PRRCFI is being forced to withdraw and we can only wish that circumstances will change in the near future that will enable our return, to complete what is of fundamental importance not only to the long-term project outcomes but, far more importantly, for the local people and the natural environment that a completed Integrated Coastal Zone Management Plan is surely meant to be helping.

Breakdown of Expenditure in Philippine Pesos

Exp code	Total spent(PhP)	Staff	Rent	Utilities	Food	Fuel & Oil	Maintenance	Travel	Other
02.01wk1	52,453		25,000		18,453	875	3,058	990	4,077
02.01wk2	88,391	15,750	18,750	7,405	30,247	4,661	2,874	1,339	7,365
02.01wk3	47,519			1,200	23,544	5,890	8,226	1,116	7,543
02.01wk4	95,595	16,460	35,000		28,803	5,560	2,830	1,295	5,647
02.02wk1&2	102,506	16,350			57,640	9,050	4,479	973	14,014
02.02wk3	43,968				32,454	3,715	4,448	1,025	2,326
02.02wk4	83,309	15,900	5,000	7,256	25,832	8,361	4,277	1,756	14,927
02.03wk1	48,820	300	1,000	7,076	18,554	4,110	3,254	372	14,154
02.03wk2	104,603	15,000	20,000	250	27,931	4,870	26,708	2,320	7,524
02.03wk3	67,363				52,017	6,704	1,187	545	6,910
02.03wk4	76,949	15,210		7,419	37,808	7,450	3,152	1,048	4,862
02.04wk1	40,294			1,200	22,500	3,500	2,833	912	9,349
02.04wk2	61,585	15,000			28,424	5,775	7,510	1,092	3,784
02.04wk3	32,925				22,912	2,780	3,623	1,134	2,476
02.04wk4	48,679	15,000		1,200	21,345	4,830	1,475	863	3,966
02.05wk1	39,528				21,765	6,214	5,680	1,032	4,837
02.05wk2	38,537			11,721	19,769	3,230		313	3,504
02.05wk3	46,799	15,000			18,079	4,830	5,185	754	2,951
02.05wk4	60,351	15,000			21,148	5,340	7,468	1,065	10,330
02.06wk1	50,087		15,000		21,756	5,370	1,218	853	5,890
02.06wk2	131,457		108,000		4,096	1,615	459	2,685	14,602
02.06wk3	54,124	17,000		250	23,340	3,870		1,966	7,698
02.06wk4	43,598	13,000		1,250	12,805	3,020	11,736	402	1,385
Total	1,459,440	184,970	227,750	46,227	591,222	111,620	111,680	25,850	160,121
Percentage	100	12.7	15.6	3.2	40.5	7.6	7.7	1.8	11.0

Volunteer Numbers

Month	New Volunteers	Cumulative Frequency
Jan-02	12	12
Feb-02	12	24
Mar-02	18	42
Apr-02	6	48
May-02	10	58
Jun-02	4	62
Jul-02	5	67

Total Site Numbers at Dakieda Bay

