



Southern Leyte Coral Reef Conservation Project

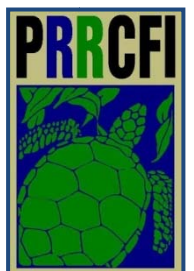
Results of Community and Scientific Work



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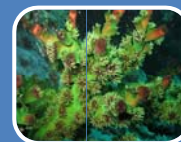


Effective coastal zone management, including conservation of coral reefs, requires a holistic and multi-sectoral approach, which is often a highly technical and costly process and one that many developing countries cannot adequately afford. With appropriate training, non-specialist volunteer divers are able to provide useful data for coastal zone management at little or no cost to the host country (Hunter and Maragos, 1992; Mumby et al., 1995; Wells, 1995; Darwall and Dulvy, 1996; Erdmann et al., 1997). This technique has been pioneered and successfully applied by Coral Cay Conservation (CCC), a British not-for-profit organisation.

Founded in 1986, CCC is dedicated to '*providing resources to protect livelihoods and alleviate poverty through the protection, restoration and sustainable use of coral reefs and tropical forests*'. CCC works in collaboration with government and non-governmental organisations within a host country and does not charge that country for the services provided. CCC is primarily self-financed through a pioneering volunteer participatory scheme whereby international volunteers are given the opportunity to join a phase of each project in return for a financial contribution towards the project costs. Upon arrival at a project site, volunteers undergo a training programme in marine life identification and underwater survey techniques, under the guidance of qualified marine scientists, prior to assisting in the acquisition of data. Finances generated from the volunteer programme allow CCC to provide a range of services, including data acquisition, assimilation and synthesis, conservation education, technical skills training and other capacity building programmes. CCC is associated with the Coral Cay Conservation Trust (the only British-based charity dedicated to protecting coral reefs).

CCC has been successfully running volunteer based conservation programmes in developing countries over the past 20 years with notable conservation successes in Belize (formation of the Belize Reef Marine Park and World Heritage Site) and the Philippines (creation of the Danjungan Island Marine Reserve in Negros Occidental).

EXECUTIVE SUMMARY



The Southern Leyte Coral Reef Conservation Project (SLCRP) was undertaken with the main objective of assisting the Provincial Government of Southern Leyte (PGSL) in the conservation of the coral reefs of Sogod Bay for the long-term benefit and food-security of the residents of the Province. This assistance has been provided under successive Memorandum of Understandings (MoU) between PGSL, CCC and the Philippine Reef & Rainforest Conservation Foundation, Inc. (PRRCFI).

Three strategies have been identified as appropriate for achieving this objective, namely:

- 1 - Conservation education for the fisherfolk, schools, colleges, and Local Government Units (LGUs) of the Province
- 2 - Capacity building of technical skills amongst the employees of the Provincial Government of Southern Leyte
- 3 - Resource appraisal of the current status of the coral reefs of the bay

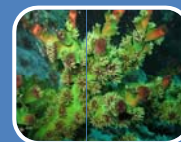
From September 2002 to April 2004, the SLCRCP was based near the town of Malitbog, from where CCC dive teams assessed the north-eastern and north-western reefs. In May 2004, the project moved to the Municipality of Padre Burgos, from where the reefs of the south-west and Limasawa Island could be assessed. This report contains an analysis of all of the data gathered by CCC survey teams from the project's inception in September 2002, until July 2007. It also contains a synopsis of community work and capacity building activities undertaken between January 2006 and July 2007. Community and capacity building work undertaken prior to December 2005 have previously been presented in Taylor et al (2004) and O'Farrell et al (2006).

Since the project's inception in September 2002, CCC has successfully installed

community based Marine Protected Areas (MPAs), trained local government representatives, scholars and suitable community representatives to both dive and conduct scientific surveys whilst also instigating and delivering a wealth of community educational work.

Over the past 36 months, CCC project staff and volunteers undertook an extensive community education programme. In excess of 1250 students from the schools and colleges of Southern Leyte had the opportunity to learn about their reef resources, through a variety of community projects and initiatives, some of which are outlined below.

- Development and provision of school marine educational materials (lesson plans, games, CDs, posters etc.)
- Teacher training workshops in collaboration with the Southern Leyte Department of Education.
- Open days for local schools to teach children about coral reefs, their importance and current threats, all presented in a fun and interactive manner.
- School visits where marine education and awareness lectures are given to students of all ages.
- Creation of information leaflets, signs, posters and murals to inform the community of their marine resources, local MPA rules and regulations, code of conduct.
- Beach and Reef cleanups with partner NGO's (e.g. Dive into Earth Day) and LGU's (e.g. Youth Catholic Movement)
- Training of students in the highly successful 'Reef Ranger' programme in which the students monitor the state of their local reef and present the results to their school. Reef



Rangers are provided with their own snorkel gear and survey equipment by CCC.

- Mangrove replantation schemes as part of coastal resource management initiatives.

CCC survey teams conducted 1088 survey dives, producing a total of 1301 individual survey records for the reefs of Sogod Bay. Because the location of each of these surveys was determined using a Global Positioning System (GPS) receiver, these data can be imported to a Geographic Information System (GIS), to facilitate spatial analysis. These data will be made freely available to the resource managers of Southern Leyte, to allow for target specific querying of the dataset, as well as the selected analysis presented herein.

From these data, a total of 9 benthic habitats were identified within Sogod Bay. Hard coral cover was higher towards the mouth of the bay, which may be linked to higher sediment input into the bay's head in the north. The majority of sediment arrives from the extensive river systems entering at the apex of the bay near Sogod town leading to high levels of sediment deposition smothering corals and lower levels of hard substrate available for coral settlement. Areas of high coral cover were also found outside Sogod Bay in the south-west.

Hard coral species diversity was very high in certain areas of the bay with a number of rare species recorded. A total of 257 species of hard coral have been identified thus far, over 141 of which were recorded on a single dive (Fenner, 2007).

Low abundance of commercially important fish and invertebrate species suggests that there is over-fishing of the reef fish populations within Sogod Bay and follows the trend that fish stocks are considered to be

both biologically and economically overfished in most areas of the Philippines. Setting up networks of properly managed MPAs is suggested as the most effective strategy for securing areas of high coral cover and diversity in addition to allowing fish stocks to recover. Efficient management and implementation of sustainable fishing practices is also essential for the health of Leyte's reefs.

The prevalence of coral disease on Ampo Reef, namely Black Band Disease is concerning and needs to be closely monitored. Coral bleaching within the bay has been limited although localised bleaching has been witnessed during the reporting period.

The high diversity and abundance of reef fish species and high live hard coral cover in existing fish sanctuaries, such as Napantao on the eastern coast of Sogod Bay and the four new fish sanctuaries around Padre Burgos is encouraging and also extremely attractive to divers. The presence of Whale Sharks and other 'megafauna', such as turtles and marine mammals, indicates that there is great potential for coastal or dive related tourism in the area.

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Our Filipino staff, Delia, Tata, Loni, Ariel, Roy and Erlan whose loyalty, trust, and dedication are highly valued

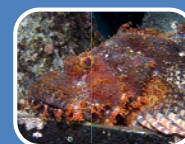
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All the dedicated international volunteers who gathered the data and made this project possible



Photo taken by Hew Dalrymple-Hamilton

Report By: Jan-Willem van Bochove, Dr. Simon Harding, Dr. Matthew Dogget, Claudio de Sassi, Oliver Wood, Karen Holman, Dr. Douglas Fenner, Dr. Greta Smith Aeby and Peter Raines, MBE, August 2007



Coral Cay Conservation

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1. INTRODUCTION



1.1. The Philippines

The Philippine archipelago of approximately 7100 islands forms part of the Wallacea triangle, an area renowned for its high terrestrial and marine biodiversity. Some 499 hard coral species (Chou, 1998) and more than 2500 fish species (Lieske and Myers, 2001), have been identified. This is a higher concentration of fish species per unit area than anywhere else in the world (Carpenter and Springer, 2005). The Philippines has 36,289km of coastline, 25,000km² of which are fringed with coral reefs (Wilkinson, 2004)

Coral reefs provide livelihoods for coastal communities through fishing, aquaculture and tourism. Reef fish are the primary source of protein for most Filipinos, whilst many invertebrates such as giant clams (*Tridacna* spp.) and sea cucumbers (Holothurians) are also commercially harvested, fetching high market prices. Coastal tourism and diving tourism in particular can provide alternative means of income for coastal communities as long as the industry is managed sustainably in terms of the environmental effects of development and the local communities are in favour of it. The majority of the population (approximately 80 million) of the Philippines is concentrated along the coastline putting intense pressure on the marine resources through a range of impacts. The greatest anthropogenic impacts are caused by solid and liquid pollution, overfishing, habitat degradation and elevated sedimentation levels. Coral reefs act as important physical barriers, which, along with mangroves, protect coastal communities from storm damage and coastal erosion. Coastal habitat loss can therefore have a dramatic influence on the success and future livelihoods of coastal populations. Hard corals require

environmental stability in order to thrive and have a narrow band of tolerance for physical parameters such as temperature, salinity and sediment loads. Small changes in these properties can have dramatic impacts on the coral reef ecosystem.

1.2. Southern Leyte

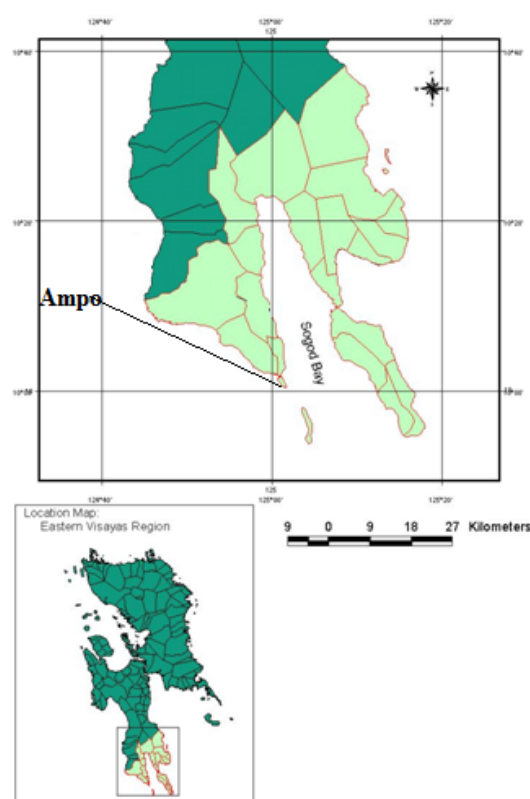


Figure 1 Map of the Eastern Visayas with the province of Southern Leyte in light green. The black lines indicate municipal boundaries. Ampo Maritime College (marked) is where the current CCC base is located. Source: DENR and SLSU, Southern Leyte.

Southern Leyte, one of the six provinces of Eastern Visayas (Figure 1) is bounded in the north by Leyte province, in the south by Mindanao Sea, in the east by the Pacific Ocean and in the west by the Canigao Channel. Sogod Bay (10° 12' N, 125° 12' E) is surrounded by 131.67 km of coastline and is shared by 11 municipalities: Padre Burgos,

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Malitbog, Tomas Oppus, Bontoc, Sogod, Libagon, Liloan, San Francisco, Limasawa, Pintuyan, and San Ricardo. The islands of Panaon and Limasawa also form part of Sogod Bay. Within the bay, Sogod town is the centre for trade, commerce and industry.

The coral reefs of Southern Leyte remain some of the least disturbed and least researched habitats in the Philippines. Sogod Bay is an important fishing ground and the area is rich in tuna, flying fish, herrings, anchovies, shell-fish, lobsters and spanish mackerel. The bay has been targeted by the Fisheries Sector Program of the Department of Agriculture as one of the country's ten largest bays in need of assessment and management (Calumpang *et al.*, 1994). Sogod Bay is also a feeding ground for attractive mega-fauna such as pilot whales, melon-headed whales, dolphins, manta rays and whale sharks.

The bay is characterised by naturally limited mangrove areas, narrow fringing coral reefs, limited seagrass beds and narrow intertidal areas and beaches (Calumpang *et al.*, 1994). Depths in the bay reach a maximum of approximately 800 metres in the central channel. Aquaculture is limited in the province and mainly consists of a clam-culturing programme in Bontoc, mud-crab farming and also fin-fish operations in Liloan, Libagon and Tomas Oppus where groupers (Serranidae) are cultured. However, some of these ventures have been unsuccessful, possibly due to inappropriate placement. The bay is ideal for nearshore fish farms and aquaculture procedures as the seabed is often steeply sloping and current patterns carry water away from the coast to the centre of the bay where they are flushed out during ebb tides.

The topography of the coast surrounding Sogod Bay is characterised by steeply sloping hills. The western side of the bay has a flatter topography than the eastern coast, where steep hills often drop straight into the sea. The seabed is steeply sloping providing the bay with a minimal coastal shelf and a deep, narrow central channel. There are two major rivers entering the north of Sogod Bay: the Divisoria River in Bontoc and the Subang Daku River in Sogod. This area has been subjected to high sediment loadings and subsequent marine life mortality (Calumpang *et al.*, 1994). There are also numerous smaller rivers entering the bay, which do not seem to be transporting excessive amounts of terrigenous sediments into the coastal waters.

The province does not have distinct dry and wet seasons. However, maximum rainfall occurs between October to January during the southwest monsoon and annual rainfall averages 2 metres per year (Calumpang *et al.*, 1994).

Population in the province declined at a rate of 0.84% from 321, 940 in 1990 to 317, 565 in 1995 and resides at a density of 183 people km⁻². Low human population is a factor that has contributed to the protection of coral reefs locally to date. However, a rise in population and subsequent pressure on all marine resources could result in marine habitat degradation and consequently the loss of income or whole livelihoods. The ecosystem diversity in Sogod Bay is limited and the processes of degradation are prevailing (Calumpang *et al.*, 1994).

The first comprehensive survey of marine resources in the area was carried out between 1990 and 1993 (Koch, 1993). The study was aimed at determining the physical and biological condition of the near-shore marine

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environment of the Province of Southern Leyte as well as the state of the fisheries resource. Interviews carried out with local people revealed that the fish catches of coastal areas had decreased. Marine surveys confirmed extensive damage to coral reefs and other critical habitats. The damage can be linked to anthropogenic activities both in the water and on land. Koch recommended the establishment of marine reserves to promote the recovery and protection of the area. The author also identified the need to carry out vigorous education campaigns in order to elucidate the benefits of good marine, land and waste-management practices. From the surveys, it was estimated that 50% of the coral reefs, which were extensive 15 years previously, had been almost totally destroyed. Another 30% had been heavily damaged with less than 25% of the corals remaining.

Silliman University undertook an assessment of the natural resources and coastal ecology in Sogod Bay in 1993/1994 and again in 2001/2002. During the 1993/1994 surveys, water quality and fisheries were assessed and an ecological study of the bay was carried out. The extent and condition of the coral reef resources was assessed using manta tow surveys and quadrat sampling methods. To date, no comprehensive work has been carried out on the deeper parts of the reefs in Sogod Bay.

1.3. Threats to the coral reefs of Sogod Bay

The Philippines is the most highly threatened center of endemism (Roberts et al. 1998). 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 an expanding population, have caused serious

degradation of the coral reefs. The main anthropogenic impacts are described below.

1.3.1. Sedimentation

Over much of South East Asia, extensive deforestation has resulted from the harvesting of tropical hardwoods (Hodgson, 1997) and land clearance for agriculture. Sedimentation is expected to be considerable in Sogod Bay, particularly on reefs in proximity to river mouths. Runoff from the land is substantial due to the elevation of the surrounding land, where mountains are in close proximity to the sea and reach a maximum of 2650m. The extensive mountain range encompassing Sogod Bay is covered with both primary forests dominated by the Philippine mahogany tree as well as planted coconut palms. Logging in the area has been banned but illegal logging does occur, particularly during bad weather. In the wet season (November to February) and during periods of extreme rainfall, increased runoff is expected to have a considerable impact on the narrow band of fringing reefs.

Six main rivers flow into Sogod Bay: the Pandan (with 5 tributaries entering the bay to the east of Sogod town), two rivers enter at Bontoc, two at Libagon and another in the north of the Bay at Concalacion. Anecdotal evidence suggests that the St. Antonio fish sanctuary at Tomas Oppus is prone to high levels of sedimentation (Roy Cahambing, pers. comm.). The area surrounding Sogod town in the apex of the bay is also served by a large river. It has been documented that the coastal resources of this area have already suffered extreme degradation as a result of high sedimentation (Calumpong *et al.*, 1994).

Resuspension of sediments near the coasts is also caused by both wind and wave action.

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The west coast of Sogod Bay may be more affected by wind driven resuspension as the shallow reefs in east of the bay are protected by mountains from the predominantly north-easterly winds. The resuspended sediments may be siliclastic or marine based. That is, the sediments that well up and settle during each tidal cycle, are likely to arise from the movement of natural marine-derived limestone deposits.

Siltation, as a result of natural processes or anthropogenic interference, is thought to be the most important factor influencing the condition of coral reefs (Jacinto *et al.*, 2000). Sedimentation may cause coral mortality and lower recruitment rates leading to decreased rates of accretion of coral reefs and overall habitat degradation. Corals rely on a high level of light irradiance to survive. Increased sediment loading in the water column reduces the light available for photosynthesis by the symbiotic algae (zooxanthellae) living in the coral tissue. Sedimentation also physically smothers coral polyps and removal of sediment requires the production of large amounts of mucous, which is an energetically demanding activity. Excess mucous production over long time periods stresses the coral host, further reducing growth and reproductive capacities. Subsequent coral mortality and decreased coral reef growth rates can have knock-on effects by reducing the diversity of invertebrate and fish life.

1.3.2. Pollution and nutrification

Tropical waters are generally nutrient poor environments (oligotrophic) and anthropogenically-induced nutrient inputs can upset the water chemistry of coral reefs (McCook, 1999). Excess nutrients (nutrification) in the coastal waters can arise

from discharge of untreated effluent and from agricultural run-off containing fertiliser. Pollution may be a particular problem in bay areas where flushing rates are slow and nutrients are not quickly dispersed. Furthermore eddies within coral reef areas can create water circulation patterns, which prevent removal of nutrients to the open ocean and result in localised concentrations.

Nutrification stimulates the growth of marine algae because nutrients such as nitrogen and phosphorous which, under normal conditions limit the growth of marine algae, are in excess. Fast growing algae compete with and can overgrow corals, resulting in a phase shift from a coral-dominated to an algal-dominated community. Certain macroalgae (such as *Lobophora* spp. and *Dictyota* spp.) respond to high levels of nutrients by increasing the growth of their rigid tissue which can contain toxic secondary metabolites. These compounds cannot easily be digested by herbivores, and can therefore result in an almost complete lack of herbivory for these algae on the coral reefs (Hay *et al.*, 1996).

Mangrove removal has exacerbated the problems of sedimentation and pollution. Mangroves are important nursery grounds for juvenile fish and invertebrates and their roots help retain and filter nutrients from sediments. Like coral reefs, they also play an important role in coastal stabilisation. Only 120,000 ha of mangrove forest remains in the Philippines, about 25% of the area present in 1920 (Philippine Coastal Management Guidebook Series, No.1).

The main sources of pollution in Sogod Bay identified by Calumpong *et al.*, (1994) are: domestic garbage, faecal matter and waste water from population centres. In the majority of municipalities in Sogod Bay people

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are responsible for disposing their own domestic waste. This is usually burnt, composted or thrown directly into the sea. Some municipalities have landfill sites and rubbish is collected on a twice-weekly basis. However municipalities such as Padre Burgos have had difficulty locating suitable areas as landfill sites that can also meet the requirements of the Provincial ordinance, although a suitable site has recently been identified within the Padre Burgos Municipality. Some attempts have been made to recycle at least a portion of the waste outputs.

1.3.3. Fishing Pressure

The Philippines is one of the largest island groups in the world with 60% of the population residing in coastal areas (Jacinto *et al.*, 2000). The majority of these people are highly dependent on coastal resources for their livelihood and have sustainably harvested reef resources in the past without causing significant impacts. The current population growth rate will cause the population to double by the year 2035, which will put significant pressure on resources, including fisheries. It has been suggested that the present levels of fishing can no longer be sustained (Courtney *et al.*, 1999).

Increased fishing pressure poses a major threat to the integrity of coral reefs as well as to the future of these coastal communities. In particular the use of destructive fishing techniques (cyanide, blast-fishing, hookah and *muro-ami*), reduce the long-term survival of coral reef communities as they inadvertently cause damage to non-target fish, invertebrate and coral species. The use of explosives and poisonous substances and the exploitation of coral have been banned in the Philippines

according to the New Fisheries Code (Republic Act 8550) and are declining as threats facing the reefs of Sogod Bay, largely through the efforts of the Provincial Government.

In Sogod Bay, a number official Marine Protected Areas (“fish sanctuaries”) have been established. There are also un-official sanctuaries at present that are proposed for incorporation into legislation in the near future. The sanctuaries are managed by Sanctuary Management Council of the Barangay, which in turn is controlled by the Bureau of Fisheries and Aquatic Resources (BFAR). These sanctuaries were established after initial visual assessments were made by government officials using SCUBA diving (Rio Cahambing, Roy Cahambing and Dag Navarette, pers. comm.). The sanctuaries were placed in areas that possessed the most abundant and diverse coral reefs. Following their establishment, visual assessments were carried out by the same group every 1-3 years. The sanctuaries are protected by locally appointed patrol boats but effective surveillance is limited by inadequate funding and a lack of resources. Another problem facing the sanctuaries is that the buoys marking the boundaries tend to disappear during adverse weather and are expensive to replace. Spearfishing within the some of the sanctuaries still occurs, with fishers using the lack of surveillance to fish illegally in the no-take zones. Therefore, many of the sanctuaries have been reduced to ‘paper parks’ and are in need of re-evaluation and effective enforcement.

Coral Cay Conservation assisted in the establishment of four community-based fish sanctuaries within the municipality of Padre Burgos in 2005. Although relatively small (4-8 ha.), the four sanctuaries are located in areas of high coral cover and are in close proximity

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of each other, which is believed to aid in the recovery of commercial fish populations. CCC has been working in close consultation with the fisherfolk conducting socio-economic assessments, community workshops and providing presentations of scientific monitoring results. Through these activities a sense of involvement and ownership has been instilled within the communities. This is believed to have helped in the success of the sanctuaries over the last 2 years.

1.3.4. Coral Disease and Bleaching

Coral reefs are extremely sensitive to climatic influences and especially to temperature changes. Coral bleaching occurs when the colony becomes stressed, which is often caused by changes in water temperature. The term bleaching refers to the expulsion of zooxanthellae from the coral polyps, causing the tissue to become pale or white. Temperature changes of only 1-2°C above the normal maximum or threshold temperature for a few weeks have resulted in the occurrence of mass bleaching events (Spalding *et al.* 2001).

Within Sogod Bay, large scale bleaching has not been observed since 2002, and the region was not significantly affected during the mass bleaching event of 1998 when coral reefs in many parts of the Philippines were severely affected. Taylor *et al.* (2004) suggested that the lack of bleaching was related to the upwelling of cooler water from the deeper parts of the bay to the warmer shallow areas producing a mixed, less stratified water column. A similar effect occurs in the Red Sea where coral bleaching has been minimal.

Coral disease has devastated coral reefs in the Florida Keys and is emerging as a problem in the Indo-Pacific region (Aeby, 2007). For

example, Black Band Disease, previously known only from the Caribbean, has also been recorded in the Indo-Pacific. Black Band Disease was first reported from the Philippines in 1985 and has also been recorded in Australia (Great Barrier Reef), Sulawesi, Indonesia and Fiji (Aeby, 2007). Coral disease has not had a significant impact in Sogod Bay to date but their prevalence over the coming years should be closely monitored.

1.3.5. Crown-of-thorns outbreaks

The Crown-of-thorns sea-star (*Acanthaster planci*) is a corralivore, feeding on the lipid palmatate reserves of hard corals. Under normal conditions, it is thought to be a rare echinoderm inhabiting deeper parts of sheltered reefs throughout the Indo-Pacific region. The most distinguishing feature of the adult starfish is its protective armour of sharp spines up to 50 mm in length, which contain a neurotoxin.

The crown of thorns starfish (COT) was first recognized in an outbreak on the Ryukyu Islands in 1957 and later around Green Island on the Great Barrier Reef in 1962, (Moran, 1986). The number of individuals that constitutes an outbreak varies spatially and temporally but when a population is consuming coral at a rate faster than the rate corals can grow, an outbreak has been established, (Lourey *et al.*, 2000). *A. planci* prefers to feed on commonly occurring and fast-growing corals such as *Acropora* and *Pocillopora* species. However slow-growing (1cm diameter yr⁻¹), massive corals such as *Porites* spp. are also targeted during outbreaks and can suffer significant damage. Local extinction of these long-lived, architectural reef colonies could gradually

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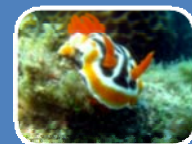


extend the reefs recovery time, (Seymour & Bradbury, 1999). Lourey, (2000), found evidence that up to 25% of the reefs surveyed on the Great Barrier Reef may not recover, as outbreaks over the last thirty years have been occurring more frequently and preventing full regeneration of coral cover.

Whether the outbreaks are a natural phenomenon or are human-induced remains undecided. Given that all major COTs aggregations have occurred near populated areas it seems likely that anthropogenic activities would be linked to the outbreaks (Moran, 1986).

In Sogod Bay COTs are abundant in certain areas, and unusually, often in shallow waters (<12m depth). In particular the reefs on the eastern side of Limasawa Island as well as Malitbog and Tomos Oppus have suffered considerable damage by large numbers of COT's since November 2002. From underwater observations, the reefs around the eastern side of Limasawa now have very low hard coral cover with predominantly soft corals growing on the old dead hard coral skeletons.

2. COMMUNITY WORK



One of the key objectives of the Southern Leyte Coral Reef Conservation Project is to assist the Province in strengthening its human resources. This is achieved by the training of host country counterparts, educators, LGU employees, and students. The nature of the training varies with the needs of the trainees, ranging from simple coral reef appreciation for young children, to technical scientific training for Provincial Government employees and school teachers. This section summarises the extensive community work undertaken by CCC from January 2005 to July 2007.

February 2006

18th and 19th of February

CCC assisted the Provincial Tourism Office at the *Tourism and Trade Fair*, held in Cebu City, in the promotion of Southern Leyte as a coastal tourism destination.

The three members of the Provincial Government staff completed the PADI Rescue Diver course as part of CCC's ongoing local *counterpart training programme*. This course gives training in how to react to incidents both on land and in water while the accompanying Emergency First Response course provides participants with in-depth knowledge of primary and secondary care that may need to be administered during such incidents.

March 2006

Local *counterpart training* continued during March with the successful completion of the first PADI Divemaster course and the full marine science Skills Development Programme (SDP) training by a member of the

MPAs of Padre Burgos

In 2005, 4 community-supported Marine Protected Areas (MPAs) were installed within the municipality of Padre Burgos with the aim to secure some of the diverse coastal resources this municipality harbors and help create a sustainable and productive fish stock for local fishermen to catch through a spillover of fish from inside the MPA to the surrounding reefs. The project is still at its infancy but has significant community support and fisherfolk are already saying they are seeing increases in their fish catch.

Coral Cay will continue to monitor the impact of the MPAs through scientific and social surveying. An assessment report can be found on the website www.coralcay.org



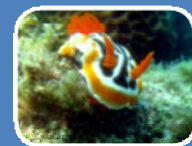
The guard house at Santa Sofia, Padre Burgos, overwatching the MPA

Provincial Government. The PADI Divemaster qualification is a useful skill and essential for most coral reef survey work. The completion of this course by a government employee highlights the PGSL's continued commitment to counterpart training, environmental awareness and local capacity building. The skills acquired can be utilized both within the tourism industry and for local marine environmental assessment but also within other fields including rescue and disaster management.

April 2006

10th of April

2. COMMUNITY WORK



CCC conducted a *teacher training* day with nine science teachers from the College of Maasin. Lectures on reef fish and coral ecology, threats to the marine environment and coastal resource management were followed by a lively debate and a fictitious scenario which highlighted the practical challenges involved in discussing coastal development and the building of a new port scheme. The participants were then given a chance to go snorkelling on the local 'house' reef at Ampo.

19th of April

The CCC science team joined the Barangay Council for a *mangrove cleanup* around the Buenavista MPA. Rubbish was collected both from the shoreline and by a team of snorkellers in the mangroves and the shallow seagrass beds. A quick assessment was also made of the seedlings planted by CCC in 2005. Survival was found to be high; around 60-70%. CCC hopes that the established seedlings will provide increased coastal protection in the future and act as nursery grounds for juvenile fish.

22nd of April

CCC staff, volunteers and local residents took part in a large beach cleanup in the Barangay of Padre Burgos as part of '*Dive into Earth Day 2006*'. This is an international event that encourages the cleaning of both beaches and the adjacent shallow underwater environment. Participants managed to remove large amounts of rubbish from the 500m stretch of beach. Later, dive teams entered the water and collected plastics and other items of trash littering the reef. The day was a great success with the CCC team and the local participants satisfied that a large difference was made, to the aesthetic appearance of the beach and reef and also

Reef Rangers

The 'Reef Ranger' programme allows selected school students to join CCC scientists in helping to monitor coral reefs within and outside the recently established MPAs of Padre Burgos. The programme has been very well received by the students. Monitoring results are written up under CCC guidance and presented to the local schools and at community meetings. This highly successful programme will continue to run and expand in the coming years.



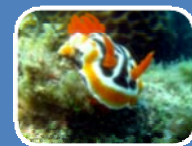
The Reef Ranger logo (above). Recently trained 'Reef Ranger' recruits proudly present their certificates (below)

contributing to the overall health of the reef. Rubbish dropped on the coastline often ends up in the sea. Litter on the reef can damage the ecosystem and organisms within it. Corals are damaged through smothering or physical abrasion while reef fish and marine megafauna such as turtles and mammals are liable to injury through ingestion of plastic bags.

26th of April

CCC staff attended the *7th Annual Environmental Youth Camp* where they gave reef awareness lectures to approximately 40 children from the High Schools of Malitbog.

2. COMMUNITY WORK



Fred the Fish

Fred the Fish has become a bit of a legend around Southern Leyte. The Anemone Fish stars as the main character in a puppet show designed to teach children (and sometimes adults) about marine conservation issues and solutions to them. Fred and his friends face dynamite fishing, falling anchors, trash, mad cyanide fishermen and other dangers before finally finding the safety of a fish sanctuary. The show has been around the province, from Limasawa Island to San Ricardo, entertaining and educating children at the same time.



Students attending an open day at the project site enjoy the adventures of a lost clown fish and his friends as they struggle to find safety inside a fish sanctuary.

This was followed by a role-playing scenario in which the children took part in and were able to use their new found knowledge of coral reef issues.

May 2006

In order to further develop marine awareness and appreciation within local schools, CCC's Educational Co-coordinator developed the '*SEASTARS Award Scheme*'. This is a four level award scheme designed to encourage teachers and schools to include environmental awareness in the curriculum. Schools can progressively attain points or stars by conducting certain reef conservation-based activities including:

- A visit to the CCC base
- Attending CCC marine science lectures

- Organising a beach cleanup
- Developing waste management and recycling schemes for the school.

Another aim of the programme is to make children more familiar with their local marine environment by going out on the local reefs and surveying impacts on the reef in their areas. Each child that participates in the scheme is awarded a '*Reef Ranger*' certificate and given an information pack on corals and reef fishes found in Southern Leyte waters.

June 2006

10th of June

Kinderhilfe, a children's orphanage based in Padre Burgos, visited the CCC base at Ampo College for a *Reef Awareness Day*

July 2006

17th of July

An *Open Day* was held at the CCC project base. Around 30 children attended and took part in a range of awareness raising activities.

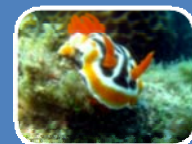
August 2006

19th of August

Newly trained *Reef Rangers* from St James College, Padre Burgos completed their first proper survey inside the Sta. Sofia MPA.

20th of August

2. COMMUNITY WORK



CCC and the Perse School group made a *School Visit* to Maasin College for an afternoon of presentations and lessons with the local school children. Presentations were made to over 150 students about the importance and diversity of the local coral reefs and a demonstration of SCUBA equipment and survey techniques.

27th of August

Forty school children from St. Joseph's College, Maasin visited the CCC base for an educational *Open Day* that included lectures, games and snorkelling on the house reef.

September 2006

16th of September

A large beach cleanup was organised as part of the *International Coast Cleanup 2006 (ICC)* with over 1000 volunteers participating to help clean up Maasin City waters. The aim of the ICC event is to help raise awareness of the need to protect the marine environment, and of course make coasts around the world that bit cleaner. The clean-up was made possible by the collaboration of numerous government and non-government. Over 800 students attended. A CCC team actively took part and CCC also provided SCUBA equipment to local divers for the underwater clean-up.

23rd of September

CCC held an *Open Day* for the Maasin Diocesan Action Group for the Environment. The group, already involved in conservation work allied to forestry and agriculture, has been instrumental in re-planting many mangrove forests. In addition to this they also wish to branch out into marine

Polillo Island Marine Assessment

CCC marine scientists conducted a coral reef assessment of the Polillo island group, to the east of Luzon province. The assessment revealed that the rich and diverse reefs are highly threatened by illegal fishing methods such as blast fishing. Management recommendations were provided for the island group and funding was secured for the purchase of boats for the Bantay Dagat (marine police). The assessment was carried out on invitation of Flora and Fauna Int. A full report can be found on the CCC website

www.coralcay.org



CCC marine scientists and municipal representatives discuss strategies to effectively manage Polillo's coral reef and marine resources.

conservation and educate people within their diocese.

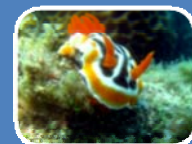
30th of September

Reef Rangers from St James College, Burgos completed working on their data from the survey inside the MPA at Sta. Sofia in August. Two posters of results were produced and subsequently presented to fellow classmates.

14th of September

CCC and members of the Perse School group completed painting a *mural* in the municipal building of Padre Burgos. The mural is in the shape of Burgos and Limasawa and includes some of the most eye-catching species present on local reefs. The words included on the mural, written in both English and Visayan, read: *'The coral reefs around the shores of Padre Burgos, Limasawa and the*

2. COMMUNITY WORK



Philippines are some of the most diverse reefs in the whole world. Coral is an animal. Destruction of corals and over-fishing can kill a coral reef, leaving no fish in the sea. A healthy, protected reef can provide bountiful resources. The Marine Protected Areas around our shores aim to protect reef areas and provide resources now and for future generations.' It is hoped that the mural will remind people of their special but threatened marine environment and that it is worth protecting for future generations.



Science Officer applying the finishing touches to the Padre Burgos Municipal Hall mural

October 2006

6th of October

Reef Rangers from San Roque National High School completed their first proper surveys in order to compare the coral reefs inside and outside of the Sta. Sofia MPA.

28th of October

San Isidro National High School visited CCC for an *Open Day*. A total of 35 staff and students

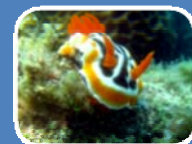
attended. In addition to reef ecology lectures and a snorkelling session, the students prepared poster presentations to take back to their schools for other children to read.



Volunteer Bill shows amazed Tangka'an Elementary School kids exactly what a sea turtle looks like

In October *Southern Leyte schools were recognised as being some of the best in the Philippines*. Reports showed that the top 10 schools in the Philippines could be found within this area and no schools in the province scored below the national average! At the time Superintendent of Schools, Dr. Violeta Merin-Alocilja commented: "Through proper forward planning, a clear vision and the right guidance, we were able to rally the schools and allow them to achieve this success. We have also received a lot of support from NGO's like Coral Cay Conservation that have supported us and really made a difference." It was recognised that CCC has played an important role in elevating the level of science amongst high school, elementary school and college students in the province. Provincial board member Honourable Eva L. Tomol, commented: "Coral Cay Conservation has supported our efforts to improve science education all the way and we are grateful for their presence here in Southern Leyte". CCC recognises that long-term conservation and

2. COMMUNITY WORK



CCC visit to Mactan Shangri-La

In February 2007, CCC representatives visited the Shangri-La Resort on Mactan Island to help develop environmental awareness and educational programmes for hotel guests. Shangri-La is making significant efforts to reduce its waste and CO₂ outputs and to take a lead in developing an eco-friendly resort chain.

livelihood sustainability can only succeed through education and awareness. It was this that led to the appointment by CCC of an Education Co-ordinator in May 2006. CCC is very proud to have played a part in the success of the schools in Southern Leyte and hopes to continue such an involvement for many years to come.

December 2006

4th of December

The *Reef Rangers* of San Roque National High School completed the data analysis of their Sta. Sofia MPA surveys. The posters later went on display in the school and helped to highlight the importance of MPAs to the other pupils.

Presentations were given by CCC to Barangays Tangka'an and Buenavista regarding the findings of the MPA surveys completed earlier in the year. CCC also met with some of the local fishermen and received feedback on their perception of the MPAs, how to improve the management and any concerns they may have. As a result it was found that proper enforcement of the MPAs is needed using patrol boats. Consequently CCC organised an application for funding for the provision of a patrol boat.

17th of December

CCC held a *Christmas party* for some of the local children from Tangka'an and Sta. Sofia.

Traditional 'Tiniklin' dance

After many rehearsals, CCC volunteers successfully performed the Tiniklin traditional dance at the 49th anniversary celebration of Padre Burgos. By being deeply involved with educational and social events such as the town festival, CCC has been able to promote its conservation message to a wider and more attentive audience.



CCC staff and volunteers performing the traditional Tiniklin dance at the anniversary festival.

The afternoon was filled with fun and games and even included a visit from Father Christmas himself. Needless to say, everyone enjoyed themselves immensely and had a great afternoon.

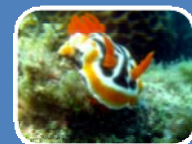
January 2007

28th of January

CCC held an Open Day for pupils from Tangka'an Elementary School. The pupils, aged 7-9 years enjoyed taking part in a range of conservation based educational activities.

CCC produced a set of *marine awareness posters* explaining to SCUBA divers the importance of proper reef etiquette and responsible whale shark viewing. The posters have been given to both local dive centres and those further afield such as Apo Island and centres in Bohol. These posters will help to encourage responsible marine tourism in the region.

2. COMMUNITY WORK



February 2007

9th of February

The CCC science team gave a *MPA assessment presentation* at Macrohon for the MPA surveys conducted in 2006. CCC scientists met with fishermen and Municipal officials to discuss the findings of the surveys along with the management strategies used by the Municipality. The 10 year old MPA which includes a seagrass bed and mangroves was found to be in very good health, to contain a high number of reef fish and to be well managed by the local community who respect its boundaries.

11th of February

CCC undertook a *beach cleanup* at Sta. Sofia. The large amount of litter collected from the shoreline and shallow waters was removed for proper disposal. The cleanup encouraged children and adults from the local community to join in.

16th of February

The four *Dangerous Marine Animals signs* designed for the MPAs in Padre Burgos were delivered to the local Barangay Captains. The signs include information on the dangerous creatures near the shore areas as local children were regularly seen playing with blue-ringed octopus and sea snakes, both of which can kill humans. The signs also detail, in Visayan, the rationale behind MPA establishment.

In addition, several new sets of MPA marker buoys were constructed for the local Barangays with marine sanctuaries. These buoys provide a cheap, effective way of marking the MPAs and reduce the management costs incurred by the Barangays.

18th of February

CCC welcomed 46 children from Tangka'an Elementary School aged between 9 and 12 years for an *Open Day*. The lectures focused on reef awareness and appreciation and gave the children an opportunity to discover the reef's creatures on a snorkel tour.

March 2007

25th of March

Thirty-seven children between, 6 and 11 years old came to the expedition site and participated in the various educational games and activities whilst also having a snorkel tour of the local coral reef.

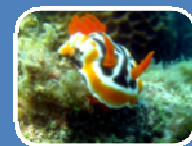
18th of March

CCC resumed the *Reef Rangers* Programme, with ten Rangers of St. Roque took part in a revision session on both theory and practical survey techniques.

20th of March

CCC was invited to give lectures at the Bontoc Campus of the Southern Leyte State University, as part of the *Marine Science Bachelor Programme*. Particular emphasis was given on the threats to coral reefs and management strategies such as the establishment of Marine Protected Areas (MPA). CCC continues to work closely with SLSU in order to help them develop their BSc programme.

2. COMMUNITY WORK



Provincial and municipal representatives visiting Apo Island in 2004 before the MPAs of Padre Burgos were installed (top image). A similar visit was made by the MPA Oversight Committee in 2007 to Mactan Island (bottom image)

22nd of March

The *Padre Burgos MPA Oversight Committee* visited *Mactan Island*, a well known diving destination near Cebu. The combination of attractive coral reefs, easy access for visitors and the close proximity of large cities such as Lapu Lapu and Metro Cebu made the necessity of conservation efforts for Mactan Island through the use of MPA's evident almost 20 years ago. Work by various NGO's and private initiatives, in collaboration with the Government led to the situation today where large coastal areas are protected and capably managed. The protection has created important revenue for the local community both in terms of tourism related activities and local sustainable fisheries. The

MPA Oversight Committee were able to discuss important topics with key people in charge of the management of two very successful MPA's. A debriefing session identified that the team had gained substantial knowledge and insight in

effective MPA management as well as becoming more motivated to make change for the better.

April 2007

11th of April

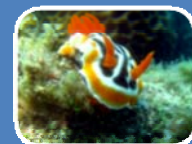
CCC's Project Scientist attended the eighth *Coastal Resources Management Network meeting* in Maasin, organised by PENRMO. This quarterly meeting is an occasion for everyone involved in the management of coastal resources to coordinate and network their activities.

Whale Shark Surveys

In March and April 2007, CCC conducted a photo-ID assessment of whale sharks that frequent the south-eastern part of Sogod Bay. The photos were sent to the Shark Trust (www.sharktrust.org) where they are used to identify individual whale sharks based on the unique pattern of spots below the dorsal fin. 28 individuals were recorded in 68 interactions. Whale Sharks are a common seasonal sighting within the bay. CCC is working closely with the Provincial Government and local Barangay's to help promote sustainable tourism and responsible whale shark watching. For more information and reports, see the CCC website at www.coralcay.org



2. COMMUNITY WORK



Dive into Earth Day: CCC Science Officer explains to local children how separating your waste can create a cleaner community.

CCC's aim for *Dive into Earth Day* in 2007 was to go further than just carrying out a coastal cleanup. CCC took the opportunity to provide local people with information about the importance of coastal resources and their sustainable management, through simple but effective activities and by promoting day-to-day solutions. The main focus was to start an awareness campaign on waste disposal and management. As a first step, CCC provided the Municipality of Padre Burgos with 5 sets of trash bins for organic and non-biodegradable waste. All the bins were brightly painted by the pupils of the Kinderhilfe orphanage.

Another important step made in preparation for the Dive Into Earth Day was the first meeting of women from various Barangay's in Padre Burgos. The main aim was to emphasise the importance of waste management for the sustainability of local coastal resources and also to encourage the women to be more involved in the region. Over 60 women attended a presentation with coral reef facts and waste management tips. The presentation was followed by a healthy and lively discussion, with many participants providing suggestions for action. At the end the presiding board member agreed to

arrange a visit of a sanitary inspector to ensure that households were respecting the laws with regards to waste management.

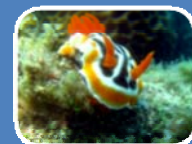
In addition to this CCC contributed to the preparation of educational stalls, with several posters and interactive games set up for the community, targeting all age groups. The actual beach cleanup occurred in five different Barangays; St. Sofia, Poblacion, Cantutang, Lungsodaan and Buenavista. Over 400 people took part, collecting 35 bin bags worth of rubbish.

CCC also took part in painting *a mural* on the beachfront at Maasin, where dozens of Agencies, Schools and NGO's transformed a long concrete wall into a colourful message calling for the respect and protection of the environment.

28th and 29th of April

Twenty-nine elementary school teachers coming from across Southern Leyte attended a *CCC Teacher Training Programme*. The teachers learnt about marine reef ecology, the local MPAs and how to help conserve important marine resources. The training was a combination of lectures, practical sessions and games, many of them intended to be easily replicable with pupils in their respective schools. CCC also provided each represented Municipality with a CD-ROM containing all the teaching resources used in the training programme.

2. COMMUNITY WORK



A woman from Padre Burgos demonstrating how to weave traditional baskets

26th of April

Grace Quiton successfully completed her *Counterpart Training*. Grace was an exemplary scholar gaining great insight into the coral reefs of Southern Leyte and was heavily involved in CCC's community work.

May 2007

9th of May

CCC Science staff *gave lectures to the Catholic Youth Movement* of Mahalo, Anahawan on marine ecology and the threats to the coral reefs.

17th-21st of May

CCC science staff assisted with the *Youth Marine and Wildlife Camp* held on Danjungan Island, Negros Occidental. Forty teenagers aged 13 to 16 from Negros, Cebu and Manila

took part in a range of marine and terrestrial activities and attended lectures on birds and bats as well as marine and mangrove ecosystems.

June 2007

23rd of June

CCC's Project Scientist attended a *CRM planning workshop* in Pintuyan, lead by PLAN International. The workshop, attended by LGUs and various stakeholders, helped all parties to identify the outstanding issues and seek potential counterparts in future projects. CCC's presence was much appreciated, especially regarding MPA assessments and advice about whale shark ecotourism.

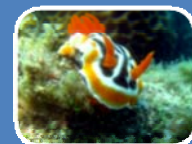
17th of June

CCC re-visited the *Kinderhilfe Orphanage* to provide educational activities about marine ecosystems and how to protect them.

23rd of June

With June being "*World Environment Month*", NGOs in the area collaborated to set up a series of educational activities called "*Beat the Heat*" (a reference to global warming). In conjunction with the "*Adopt a River*" project run by the Maasin Youth Organisation (MMAYO), CCC ran a seminar entitled "Where the River Ends". The subject matter of this seminar included information about coral reefs and how human activities affect them. It was designed to show linkages between the land, river and marine systems and to illustrate that the natural environment is a web of complex and interconnected systems rather than isolated entities.

2. COMMUNITY WORK



24th of June

CCC undertook a *beach clean up* around the estuary of the Canturing River, while MMAYO staff covered the terminal tract of the river. Many local people joined in and the large amount of effort resulted in over 200kg of rubbish being collected.

July 2007

7th of July

CCC invited 25 women from April's 'Dive into Earth Day' to attend another *open day*. The ladies participated in a series of lectures and open discussions about the environment with a focus on waste disposal.

After theory, training was provided in weaving traditional baskets as a potential alternative source of income for local families. The long-term vision is to see a return to traditional baskets being used instead of plastic bags. A small but motivated number of women showed a great deal of interest, and were keen to continue the training for 2 successive Saturdays. They are now able to produce high quality bags and baskets. CCC also agreed to buy any bags and baskets produced in order to reintroduce these in the local markets as ecological, aesthetic and traditional alternatives to plastic bags. In addition to this, children accompanying the women spent their afternoon painting new bins, similar to the ones produced in April, for their own Barangays.

14th and 15th of July

Ten students from St. Roque National High School were trained up as *Reef Rangers*. The training weekend was concluded with a

Governor Rosette Y. Lerias

After many successful years as Governor of Southern Leyte, Rosette Y. Lerias, stepped down from office in September of 2007. CCC is extremely grateful and indebted to 'Rosy' for all the support she has given the project over the past 5 years.



CCC Project Scientist and Governor Rosette Lerias meeting in Maasin

practical survey on the CCC house reef. The survey results were put onto a poster and presented in their school.

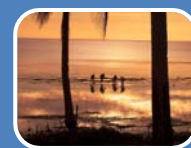
18th of July

CCC attended a *Tree Planting Event* in Malitbog, along with hundreds of students, the LGU and the Philippines National Army. The aim of these events was to raise awareness of conservation issues such as deforestation especially for young students.

30th of July

The Municipality of Padre Burgos, the MPA Oversight Committee, the Federation of Omega Beneficiaries Inc (FOBI) and CCC signed a *Memorandum of Agreement for the purchase of a new patrol boat for the MPA's of Padre Burgos*. Through this MoA, 90'000 pesos have been allocated for the purchase of a patrol boat and accessories. This new patrol boat will help to prevent any illegal fishing in the MPAs, thus increasing their effectiveness.

3. SCIENTIFIC METHODS



3.1. Background

One of the key objectives of the SLCRCP is to survey the coral reefs of Sogod Bay, in order to provide data for the assessment of the nature and status of the reefal resources. As well as providing a 'snapshot' of the reefs at this point in time, these data are used to highlight spatial variation and trends which can be used to make recommendations for management action by the Provincial Coastal Resources Management Office and other LGUs, such as the most appropriate siting of Marine Protected Areas. The analysis presented herein has been undertaken using all of the data gathered from September 2002 (the inception of the SLCRCP) until July 2007. These data and those subsequently gathered by the project will be made freely available to any interested parties who may have use of them.

3.2. Methodology

Developed for the assessment of biological and physical characteristics of reef communities by trained volunteer divers, the CCC Baseline Survey Technique has been continuously refined and improved since 1990. 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). The survey programme is coordinated by the onsite marine science staff to ensure accurate and efficient data collection.

Each survey provides one or more biological record forms which are effectively snapshots of the biological communities (benthic and



Figure 2 Volunteers learning coral reef species identification under guidance of science staff

reef fish) found within any particular reef zone. These data are complimented by basic physical and oceanographic information (see Appendix for examples of the survey forms).

The CCC Baseline Survey Technique utilises a series of plot-less transects, perpendicular to the reef, starting from the 24m contour and terminating at the reef crest or in very shallow water (0.5m). Benthic and reef 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.

During the course of each sub-transect survey, divers may have traversed two or more apparently discrete habitat types, based upon obvious gross geomorphologic (e.g. forereef, escarpment or lagoon) or biological differences. Data gathered from each habitat type are recorded separately for subsequent analysis. Each species, life form or substratum category within each habitat type encountered is assigned an abundance rating from the DAFOR scale, as shown in Table 1.

3. SCIENTIFIC METHODS



Table 1 The ordinal scale assigned to life forms and target species during CCC Reef Survey Technique surveys.

Abundance rating	Corals, other colonial invertebrates and macroalgae	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+

Hard corals are recorded as life forms as described by English et al. (1997) and 36 target corals are identified to genus or species level. Reef fish are generally identified to family level (45 families) but in addition, 104 important target species are identified. Sponges and octocorals are recorded in various life form categories. Macroalgae are classified into three groups (green, red and brown algae) and identified to a range of taxonomic levels such as life form, genus 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 diving in two buddy pairs (A and B). 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 the reef slope on a pre-determined compass bearing until the 10-m line connecting Diver 1 and 3 becomes taut. 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

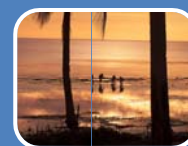
marker buoy (SMB) carried by Diver 2 is deployed to mark the end of that sub-transect. The SMB acts as the start point for the next survey team and this process is repeated until the entire transect is completed. The positions of the SMB at the start and end of each dive are fixed using a Global Positioning 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 impacts such as broken coral or fishing nets. Diver 1 also describes the substratum along the sub-transect by recording the presence of six substratum categories (dead coral, dead coral with algae, bedrock, rubble, sand and mud). Divers 2, 3 and 4 survey reef fish, hard corals, and other invertebrates plus algae 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.

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

During the course of each survey, certain oceanographic data and observations of obvious anthropogenic impacts and activities are recorded at depth by the divers and from the surface support vessel. Sea surface and air temperature ($\pm 0.5^{\circ}\text{C}$) are taken from the survey boat. The survey team also records the temperature at the maximum survey depth (i.e. at the start of the survey).

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Salinity is measured from water samples taken from both the surface and the maximum survey depth using a hydrometer. Water visibility, a surrogate of turbidity (sediment load), is recorded both vertically and horizontally. A Secchi disc is used to measure vertical visibility through the water column (Figure 3). Secchi disc readings are not taken where the water is too shallow to obtain a true reading. Horizontal visibility

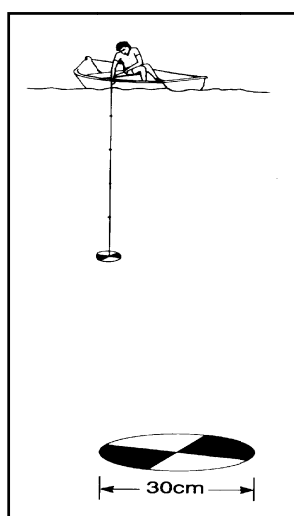


Figure 3 The use of a Secchi disc to assess vertical water clarity. The Secchi disc is lowered into the water until the black and white quarters are no longer distinguishable. The length of rope from the surveyor to the disc is then recorded. Source: English et al

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, the boat marshal on the support vessel qualitatively assesses 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.

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'.

Data collected 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.

3.2.1. Geographic Information System

In a similar way to how extensive geographical data can be 'simplified' to produce a topographical map, the development of GIS software and techniques allows marine ecological data to be manipulated in multi-dimensional space. Once appropriate analysis techniques have been applied, managers and decision makers can use the final product to make informed judgements concerning coastal zone management. The visual nature of GIS outputs facilitates the interpretation of such data by non-technical persons who may nonetheless be key decision makers. Because all CCC teams record the location of each survey on a handheld GPS unit, this allows the



surveys to be 'placed' relative to each other on a map. Relationships between the data from the various survey sites can then be explored to highlight geographical regions of key interest.

Information can be represented in many ways in a GIS, from simple placement techniques ("this was found here") to more intricate mapping techniques such as data contouring ("this area is 'better' than that area"). It is important to bear in mind that the outputs are produced from the data themselves; the maps are not merely 'coloured in' at particular places. This is because the GIS links the map and the database intrinsically, and any data that are required for visual examination can be 'called up' on the screen. GIS is therefore not just a mapmaker; it is a tool that allows ongoing interaction between the decision-maker and the data. When further geographic/ ecological data are gathered in the future, they can be added to the GIS, making a custom-built instrument for visual interpretation of any data that can be represented at any point on Earth, above or below the sea.

The GIS map of Conservation Management Values contained in this report was created using the Inverse Distance Weighted function in the Spatial Analyst of ArcView 8.3 (ESRI software).

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It is not possible (nor necessarily useful) within this report to undertake an exhaustive analysis of all of the data gathered during the reporting period. A more thorough analysis will be made when all the baseline surveys within the bay have been completed and comparison can be made between all sites, producing a clearer picture of the state of Sogod Bay's marine resources. All the data are made freely available in a GIS compatible meta-database, allowing interested parties to undertake further analysis of any particular dataset.

Between September 2002 and July 2007, CCC survey teams produced 1301 individual survey records from 1088 survey dives around Sogod Bay (Figure 4). Although data from 2002 to 2005 have previously been presented (Harding et al, 2003; Taylor et al, 2004), it is considered appropriate to include these data in this analysis, to allow for comparisons to be made throughout the bay region.

Initial rapid assessments of the reefs in the most northerly part of the bay in 2002 indicated that the fringing reefs in this region were very heavily silted, caused by the influx of large quantities of terrigenous sediment via the rivers entering the bay at or near Sogod town. Fringing reefs were either buried under sediment or were very heavily effected and in poor condition. This was known by the Provincial Government, which undertook a

programme of bamboo replanting along the riverbanks in an effort to mitigate this effect. It was therefore considered more appropriate for CCC teams to concentrate the surveying effort on the more southerly reefs of the bay, which were likely to be less affected by sedimentation. Two regions that are located just outside the south-eastern side of the bay were also included as these areas generally had very good coral cover and diversity (Regions 5 and 27, Figure 4).

During the survey programme, the bay was divided into 27 geographically distinct survey sectors (Figure 4). For the purposes of this analysis, the surveys have been recombined into 8 geographical regions (Table 2), the borders of which follow the Municipal boundaries around the bay.

Although data have been gathered from a number of sites adjacent to these regions, analysis of the data for these reefs will not be conducted until a complete dataset has been compiled.

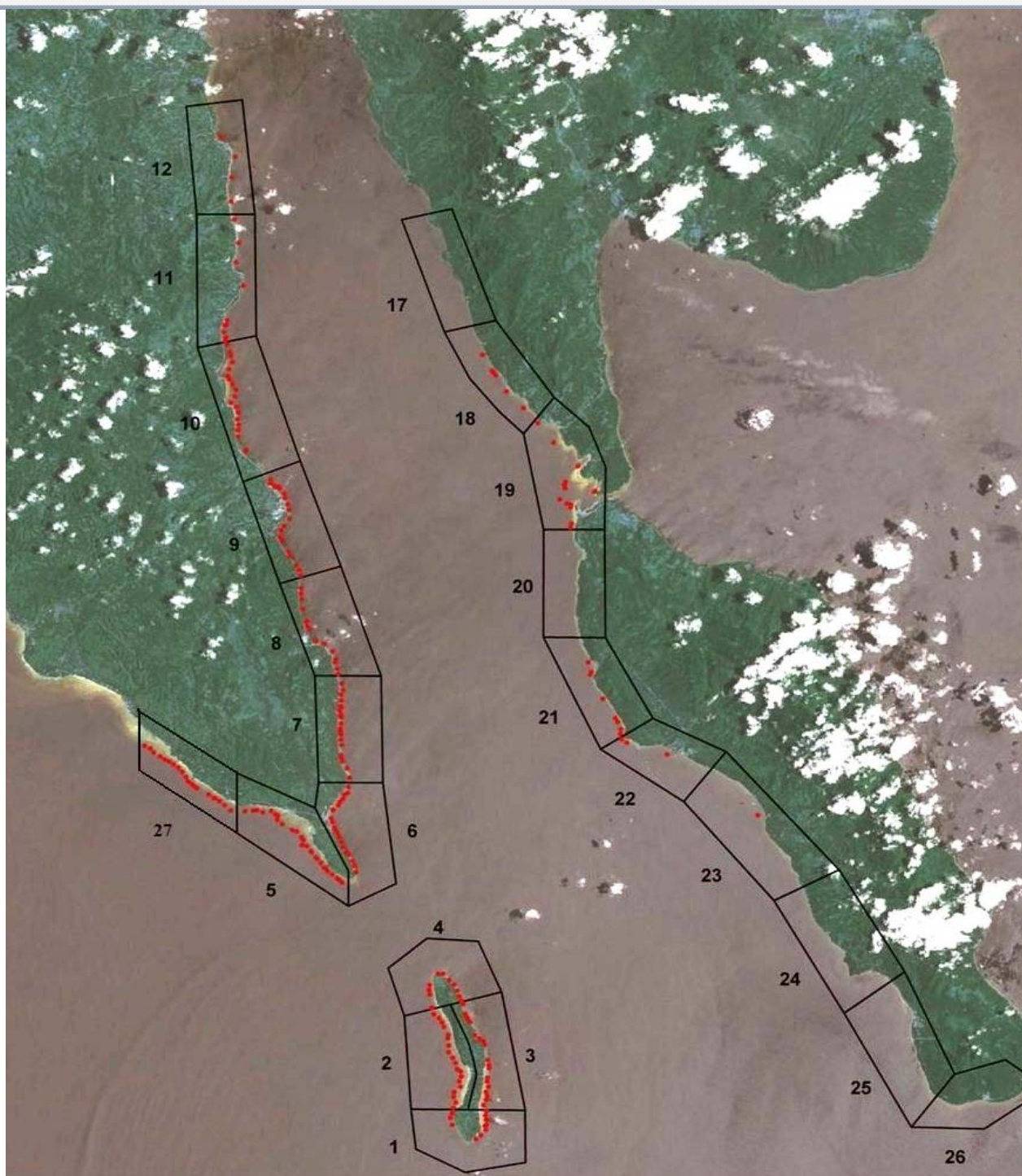


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Table 2 Survey sectors analysed in this report, represented by 8 regions. Survey sectors were grouped to approximate coastal municipalities.

Region	Survey Sectors	Municipality
1	11 and 12	Bontoc
2	10	Tomas Oppus
3	8 and 9	North Padre Burgos and Malitbog
4	6 and 7	East Padre Burgos
5	5 and 27	West Padre Burgos and San Roque
6	19 and 20	Liloan and Libagon
7	21 and 22	San Francisco
8	1,2,3 and 4	Limasawa Island

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Survey Sites

0 2.5 5 10
Kilometers

Figure 4 Locations of survey stations visited in Sogod Bay between January 2006 and July 2007.

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The survey data are presented in a number of ways, namely:

- Results from oceanographic and anthropogenic impact data (4.1)
- Results from biological indicators. Benthic (4.2) and Reef Fish Families (4.3)
- Definition of ecologically distinct marine habitats (4.4)
- Generation of management ratings (Conservation Management Value) for each survey site (4.5)

4.1. Results from Oceanic and Impact Data

4.1.1. Surface Temperature and Salinity

The data for mean sea surface temperatures and salinities are displayed in Figure 5. Data were collected over a 7-year period. Sea surface temperatures reflect seasonal fluctuations in air temperature and solar irradiance, with the highest mean temperatures recorded in June and July. Surface salinity follows the same trend with the highest reading recorded in July.

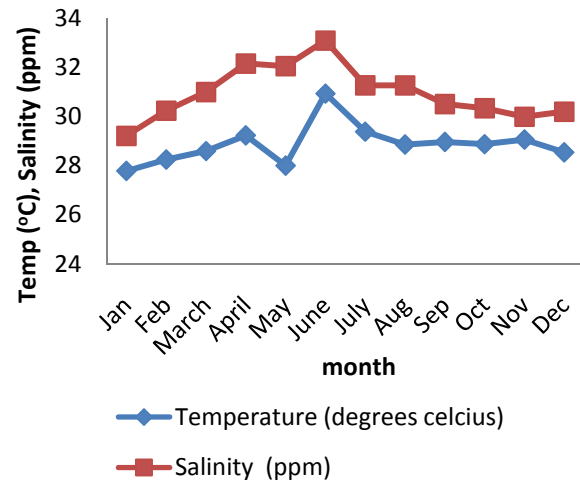


Figure 5 Annual fluctuations in surface salinity and temperature

4.1.2. Boat Frequency and Activity

Boats that were observed during surveys were recorded in 4 activity classes, namely “fishing”, “diving”, “commercial” (such as ferries or cargo vessels) and “other”. The vast majority of boats observed during the survey programme were involved in fishing (82%) – Figure 6. The next single greatest class was “commercial” (10%), then “other” (7%). Two percent of the observations made were of dive boats within the area

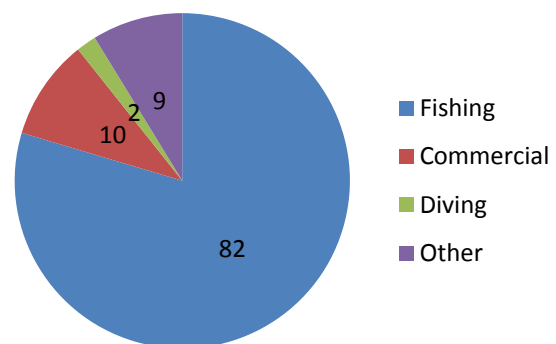


Figure 6 Boat activity by class, as a percentage of total boat observations

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Figure 7 displays boat activity by category in each region. Dive operators were observed in the area of Padre Burgos (regions 4 and 5) on the east side of Sogod Bay as well as the San Francisco and Liloan areas on the west side. These are all popular dive sites, visited by three different dive resorts within Sogod Bay as well as several outside operators, mainly from Cebu and Bohol. The relatively high frequency of commercial boats passing by region 7 is mainly attributed to ferries departing from Liloan and heading south. Bontoc, Malitbog, Liloan and San Francisco (regions 1, 3, 6 and 7 respectively) are all popular fishing grounds for subsistence fishers with fishing boats recorded at least once during most surveys.

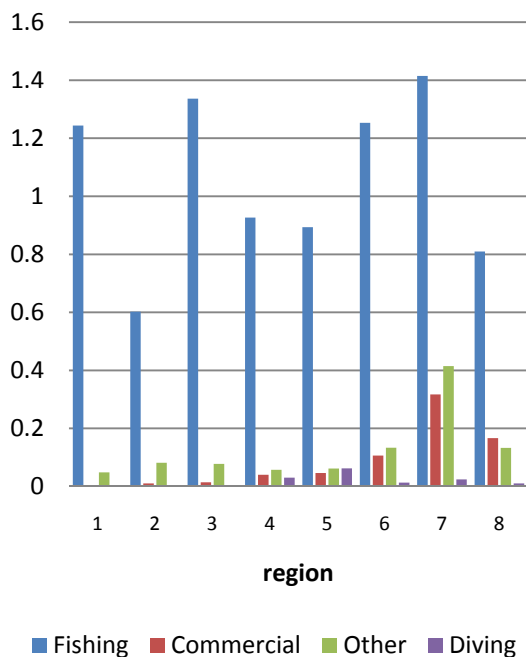


Figure 7 Boat activity by class in each region. The results are given as number of boats of each class seen per survey

4.1.3. Anthropogenic Impacts

Underwater impacts are presented in Figure 8. Litter was dominant in the northern end of

the bay at Bontoc (region 1) and was seen on over a third of the surveys conducted there. Litter from the whole bay tends to collect in the closed end of the bay through the action of tides and currents. Litter is also a serious problem around the village of Padre Burgos (region 4).

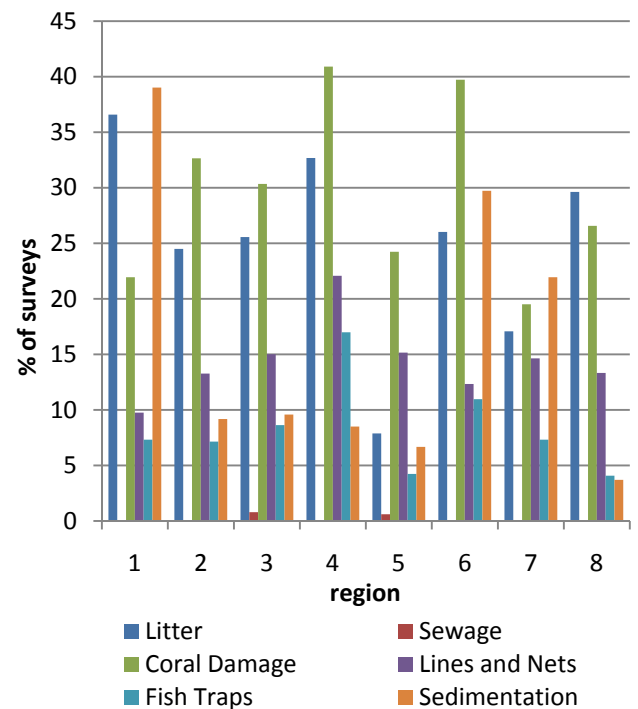


Figure 8 Selected underwater impacts encountered within each region, presented as the percentage of surveys on which they were observed.

Recordings of coral damage were generally highest where high population densities were located nearby areas of extensive reefs (regions 4 and 6). Discarded nets and fish lines were a common sighting around Padre Burgos town (region 4) where shore-based net and hook and line fishing are popular. Fish traps are commonly used as an alternative to hook and line fishing. Socio-economic assessments conducted in region 4 confirm the high reliance on fish trapping in this area.

Heavy sedimentation is one of the factors for responsible for the lack of extensive reefs in

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the north of Sogod Bay. Here, several river systems discharge into the bay, releasing large amounts of sediment transported from upland areas. Sedimentation was also high in the Liloan area where high sediment loads are carried in and out of the bay through the narrow passage between the mainland and Panaon Island. Another contributing factor may be the occurrence of landslides that occurred in this area just prior to the surveys. Very little sedimentation was observed around Limasawa.

4.1.4. Coral Bleaching and Disease

Coral diseases have had a devastating impact on Caribbean reefs (see Introduction). Fortunately, the coral reefs of the Philippines seem to have been largely spared from disease impacts. However, little research has been conducted on the prevalence of coral diseases in the Philippines. Reliable and sufficient data for coral diseases was only available for regions 3, 4, 5 and 8 (Figure 9) in this study. The same holds true for coral bleaching which poses a potentially far greater threat and has previously affected much of the Philippines' coral reefs, namely during the ENSO event of 1998 where coral bleaching was well documented throughout the region. In Sogod Bay coral diseases were generally uncommon, being observed on less than 6% of surveys conducted. This is probably an underestimate of prevalence as coral disease identification was not part of the CCC science training for volunteers for all surveys conducted. Coral bleaching was recorded more often and observed on 15-18% of surveys. No significant variation was found for bleached or diseased corals between regions.

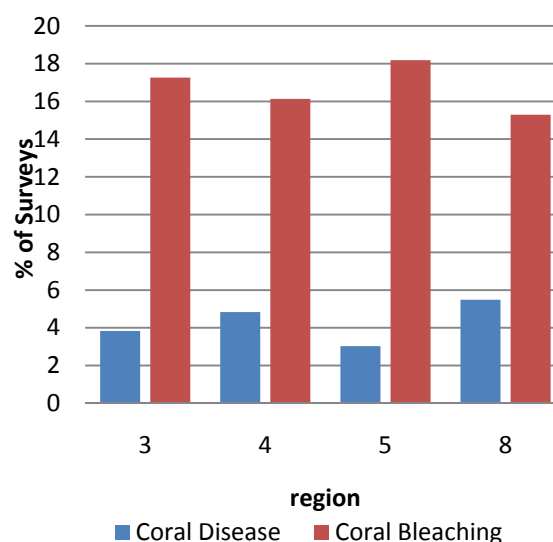


Figure 9 Coral Disease and Coral Bleaching occurrences observed on surveys for 4 selected regions. Results given as a percentage of the surveys on which they were observed.

In July of 2007, Dr. Greta Smith Aeby, a coral disease specialist from the Hawaii Institute of Marine Biology visited the CCC project base at Ampo in order to make an assessment of the prevalence of coral disease in the area. Both quantitative and qualitative observations of coral disease were conducted during 9 dives. Three sites were qualitatively surveyed for coral disease: Ampo reef (Region 5, n= 5 dives), Santa Sophia MPA (Region 4, n=3 dives) and Limasawa Island (Region 8, n=1 dive). A total of 11 different coral diseases were observed, the most common being black band disease (BBD) with 17 documented cases (Figure 10). BBD affected 5 Genera of hard corals. Notably, BBD was only found on Ampo Reef and not at Santa Sofia.



Figure 10 *Pachyseris* sp. infected with black band disease on Ampo Reef (G.A. Smith, 2007)

4.1.5. Site Impression

After each survey, a site impression was given, based on two arbitrary scores that were given to that particular reef. One was given for the aesthetic value of the area and one for the perceived biological value. The scores ranged from 'poor' to 'excellent'.

Two percent of the surveys found 'excellent' biological and aesthetic value on that particular site (Figure 11). Most sites were found to be 'average' (36 and 37% resp.). 29% of sites were found to be of poor aesthetic value. Aesthetic and Biological site impression were found to be closely linked, sites with a high aesthetic appeal were assumed to have a high biological value.

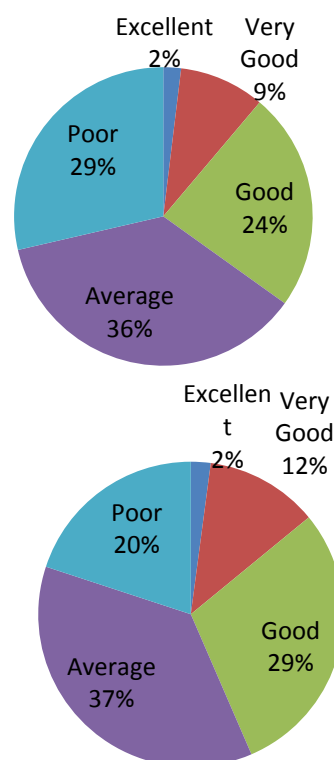


Figure 11 Biological value (above) and aesthetic value (below) for all surveys combined, as a percentage of the total scores given.

4.2. Results from Benthic Indicators

Certain species have been shown to be effective indicators of overall reef health (Hodgson, 1999). Depending on the particular species, they can indicate histories of overfishing, nutrient pollution, destructive fishing practices and the removal of organisms for the curio or aquarium trade. In this analysis, the indicator organisms have been adapted from those defined by the Reef Check Foundation (www.reefcheck.org), which are recognised as robust gauges of general reef health.

4.2.1. Scleractinian corals

Hard coral cover is a useful indicator of general reef health. It is generally accepted

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that reef fish species diversity is directly related to hard coral cover and diversity (Taylor et al., 2004). Figure 12 shows this relationship for all the surveys analysed in this report.

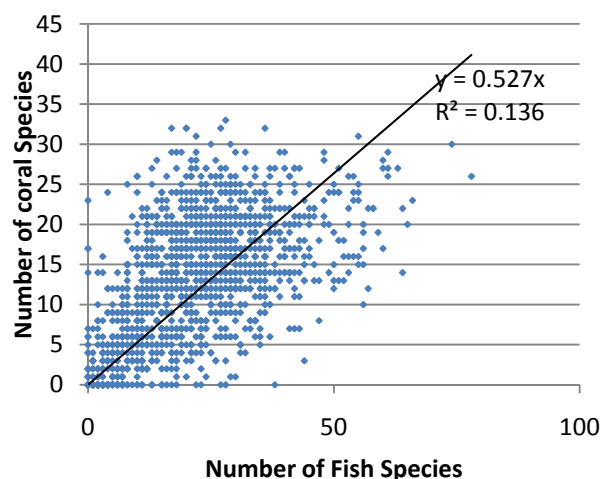


Figure 12 Regression plot for the number of coral species vs. number of fish species for all survey sites. The relationship is significant ($R^2 = 0.136$, $p < 0.01$)

Areas of high hard coral cover were found in all regions. Figure 13 shows that maximum ratings of coral cover (DAFOR 5, >75% cover) were recorded in five of the eight regions visited. The median value indicates the most commonly found level of coral cover. This was between 11-30% (DAFOR 2) within all survey regions except region 8 (Limasawa) where the median coral cover was less than 10% (DAFOR 1).

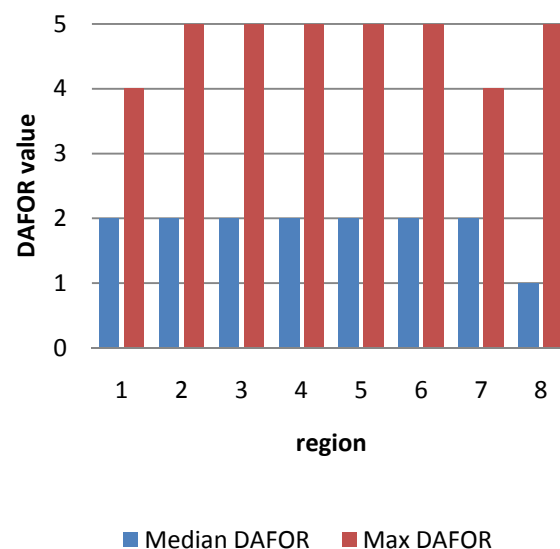
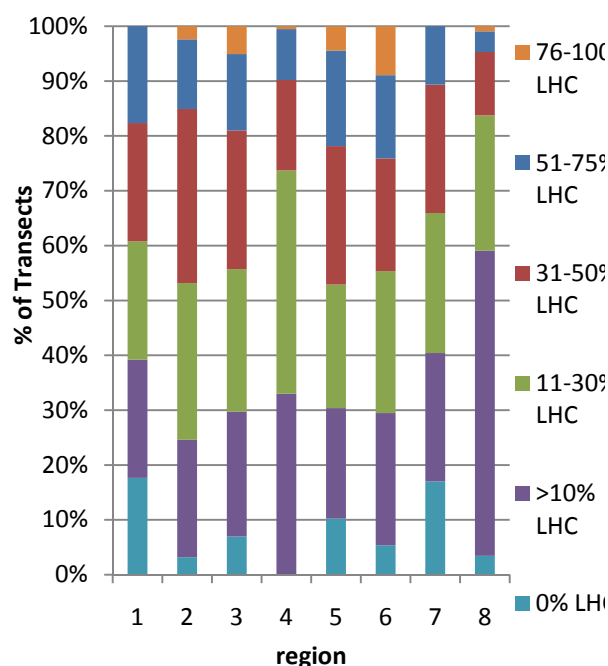


Figure 13 Hard coral cover maximum and median values per region, expressed on a DAFOR scale

Figure 14 shows the composition of Live Hard Coral (LHC) for the eight regions using the DAFOR scale. All five abundance ratings were recorded in each region. Only regions 5 and 6 had LHC over 50% on more than 20% of the transects. Region 6 (Liloan/Libagon) had the greatest amount of high coral cover (>75% LHC) on more than 9% of the transects. Region 7, although having some of the most spectacular diving sites has also been highly affected by sedimentation and recent mud slides. The low coral cover recorded on Limasawa Island's reefs can be partially attributed to severe Crown of Thorns Seastar outbreaks (*Acanthaster planci*).

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Favia, *Favites* and Massive *Porites* were recorded on over 70% of the surveys. *Pavona clavus* was the least abundant target coral species observed within the bay (4%, DAFOR 1).

Figure 14 Composition of hard coral cover for each region using the DAFOR scale. LHC = Live Hard Coral

The most commonly occurring hard coral lifeforms and target species were ranked according to the proportion of transects on which they were recorded (Tables 3 and 4 respectively). This provides a more accurate reflection of coral diversity than using the DAFOR values alone. For example, *Seriatopora hystrix* forms small colonies, and thus would be very far down the table in terms of area cover, yet it was recorded on 48% of all of the surveys (Table 4), and thus is widely distributed on the reefs.

Of the 15 coral lifeforms recorded, non-*Acropora* lifeforms were the most abundant, particularly submassive colonies (78%, DAFOR 5). *Acropora* lifeforms (mainly 'branching' and 'tabulate') can dominate shallow-reef habitats and contribute significantly to overall hard coral cover. Rarer *Acropora* lifeforms (Encrusting and Digitate) were recorded on only 10% of the surveys.

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Table 3 Most commonly recorded hard coral lifeforms in Sogod Bay

Coral Lifeform	Percentage of surveys recorded on (%).	Maximum DAFOR value
Non-Acropora submassive	78	5
Non-acropora encrusting	72	4
Non-acropora branching	71	4
Acropora branching	70	5
Non-acropora mushroom	70	4
Non-acropora massive	67	4
Non-Acropora foliose	56	5
Acropora tabulate	51	4
Acropora bottlebrush	37	5
Acropora submassive	15	4
Acropora encrusting	11	3
Acropora digitate	10	3

Table 4 Most commonly recorded coral targets in Sogod Bay

Coral Species	Proportion of surveys recorded on (%).	Maximum DAFOR value
<i>Favia</i>	74	4
<i>Favites</i>	72	4
<i>Porites</i> spp. (massive)	70	5
<i>Lobophyllia</i>	66	3
<i>Galaxea</i>	64	3
<i>Goniopora</i> / <i>Alveopora</i> spp.	57	5
<i>Seriatopora hystrix</i>	52	3
<i>Pocillopora damicornis</i>	43	3
Brain Coral (Small)	41	3
<i>Euphyllia</i>	36	3
<i>Diploastrea heliopora</i>	35	3
<i>Millepora</i> spp.	35	4
<i>Pocillopora</i> spp. (medium)	34	3
<i>Pectinia lactuca</i>	34	3
<i>Mycedium elephantotus</i>	32	3
<i>Herpolitha limax</i>	31	3
<i>Echinopora</i> spp.	31	4
<i>Plerogyra</i>	30	3
Brain Coral (Medium)	29	3
<i>Porites cylindrica</i>	29	4
<i>Ctenactis echinata</i>	27	3
<i>Montipora</i> spp. (Foliose)	25	3
<i>Pachyseris speciosa</i>	24	3
<i>Pachyseris rugosa</i>	22	2
<i>Porites nigrescens</i>	18	2
<i>Tubastrea micrantha</i>	18	3
Upsidedown bowl	17	3
<i>Turbinaria</i> spp.	16	3
<i>Hydnophora</i> spp.	15	3
<i>Tubipora</i> spp.	13	3
Brain Coral (Large)	15	3
<i>Porites rus</i>	12	2
<i>Polyphyllia talpina</i>	11	2
<i>Heliopora</i> spp.	8	2
<i>Pocillopora</i> (large)	8	2
<i>Pavona clavus</i>	4	1

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Dr. Douglas Fenner, a coral taxonomist has visited Sogod Bay on three occasions (2003, 2005 and 2007). In 2005, Dr. Fenner found that the reefs near Padre Burgos had a highly diverse coral fauna. A total of 251 species of hard corals in 65 genera were identified (see O'Farrell et al., 2005). In July 2007, Dr. Fenner revisited the area and recorded 226 coral species on 11 survey dives of which 6 were previously unrecorded (Table 6), raising the overall total to 257 hard coral species.

1.	<i>Acropora clathrata</i>
2.	<i>Acropora spicifera</i>
3.	<i>Montipora caliculata</i>
4.	<i>Montipora cebuensis</i>
5.	<i>Montipora samarensis</i>
6.	<i>Montipora turgescens</i>

Table 5 New scleractinian corals observed by Dr. Fenner in 2007 in Sogod Bay.

One species that is rarely reported, *Pocillopora danae*, was recognized reliably for the first time in Southern Leyte in 2005. In 2007 it was clear that this is the dominant species of *Pocillopora* on the reef slopes of Tangkaan, Padre Burgos (which is not a common genus on this reef).

It was also noted that there was a thriving community of soft coral species at the Santa Sofia Barangay in Padre Burgos. Some of these coral colonies were between 50 and 100 years old.

4.2.2. Giant Clams (*Tridacna* spp.)

Giant clams (*Tridacna* spp.) are an important local food source and have been traditionally harvested for centuries. Populations of giant clams were highest outside of Sogod Bay in region 5 (Figure 15) where they were recorded on 17% of surveys. Clams were

uncommon in areas of urbanisation, despite high coral cover. This can be attributed to severe overharvesting in these areas (region 3 and 4).

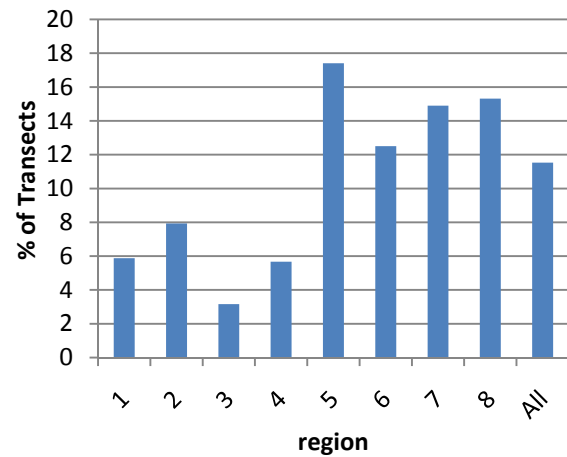


Figure 15 Giant clam (*Tridacna* spp.) prevalence by region, expressed as a percentage of the number of transects in each region on which they were recorded. The last column shows the average for all regions.

4.2.3. Sea Urchins

Sea urchins were recorded in two categories, namely "short spined" and "long-spined" (*Diadema* spp.). The latter is often used as an ecological indicator, with major population changes possibly highlighting shifts in the ecological balance of the ecosystem. Certain reef fish species (e.g. triggerfish) are known to feed on *Diadema* spp., which in turn graze on algae. Reduced populations of triggerfish may result in increased urchin populations and a shift in the ecological balance of the reef as algae becomes increasingly grazed. Likewise, a sudden decrease in *Diadema* populations may result in overgrowth by algae, outcompeting corals for light and space on the reef. *Diadema* urchins have been documented to aggregate in exposed or recently disturbed locations and as such,

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higher abundances of *Diadema* urchins may be indicative of reduced coral cover. Populations of *Diadema* urchins were found to be higher than other urchins in all regions (Figure 16), with the most frequent observations of both categories found in regions 1 (Bontoc) and 6 (Liloan/Libagon).

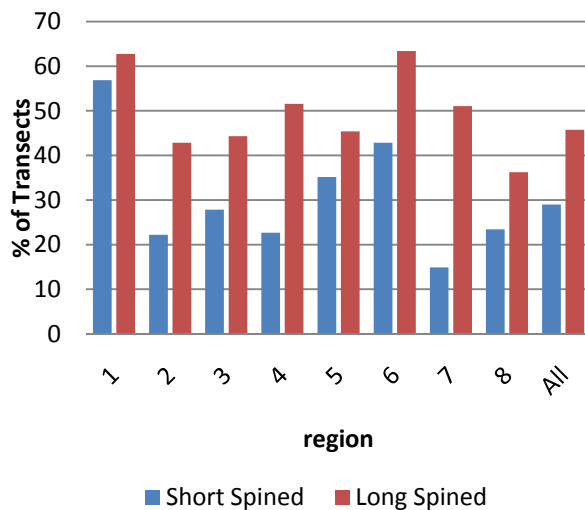


Figure 16 Sea urchin prevalence by region, expressed as a percentage of the number of transects in each region where they were recorded. The last two columns show the average for all regions.

4.2.4. Reef Gastropods

Certain gastropods are good indicators of reef health and are often over-harvested by the curio trade. Conch shells have been severely depleted throughout the world and were rarely encountered on surveys (Figure 17, <5%). *Drupella* spp. feed on live hard coral and may become a threat to coral colonies in high numbers. They were a common sighting throughout region 5, observed on over 50% of surveys. Nudibranchs do not necessarily indicate good reef health, but are a favoured sighting for recreational divers and were included for this reason. The Bontoc area

(Region 1) has a high abundance of Nudibranchs.

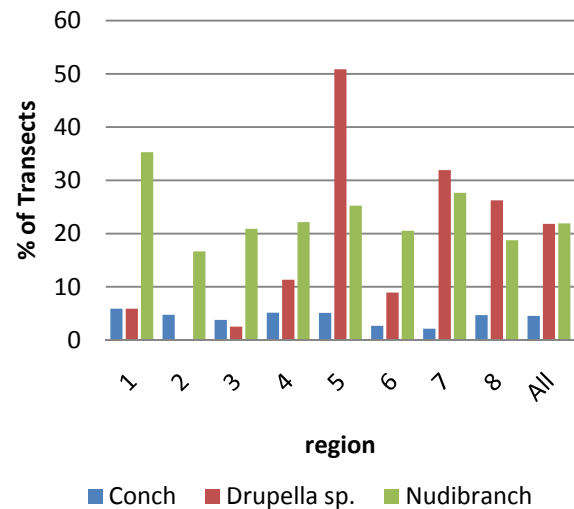


Figure 17 Abundance of selected gastropods by region. The last column shows the average for all regions.

4.2.5. Macro-algae

In this analysis, emphasis has been placed on algae that are thought to be nutrient-indicators, such as brown “fleshy” algae. Although not actually algae, cyanobacteria (a.k.a. blue-green ‘algae’) have been included in this section, as most of them respond in a similar manner to macroalgae in terms of environmental conditions that promote/inhibit their growth. Cyanobacteria were the most commonly encountered taxon in this group, recorded on 63% of all transects (Figure 18). The next most common were *Dictyota* spp. (46%), green filamentous algae (40%), and *Padina* spp. (22%). All survey regions displayed high levels of nutrient indicator algae.

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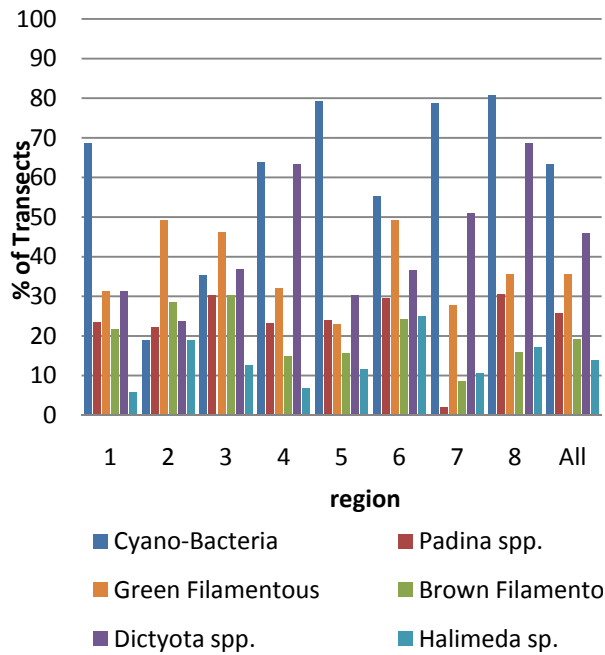


Figure 18 Abundance of selected macro-algae by region. The last column shows the average for all regions.

4.3. Results from Fish Families

The presence or absence of certain reef fish families is an important indicator of overfishing or coral reef health. Commercially targeted families such as Snappers (Lutjanidae), Groupers (Serranidae) and Parrotfish (Scaridae) form an important part of the reef ecosystem and are often the first to suffer severe population declines in overfished areas. These families were generally quite low in abundance and although not expressed here, their sizes were rarely that of a mature individual. If allowed to grow to adult size, many reef fish will produce considerably more offspring. A 12.5kg snapper for example, will produce as many offspring as 212 snappers weighing 1.1kg each (Bohnsack, 1990). Groupers were an uncommon sighting throughout all regions. Limasawa Island (region 8) had the highest maximum abundance of both Groupers and

Snappers (DAFOR 2 and 3 respectively). Butterflyfish had low maximum abundance in most regions with maximum sightings of 20+ (DAFOR 3) individuals recorded only in regions 1, 2 and 7.

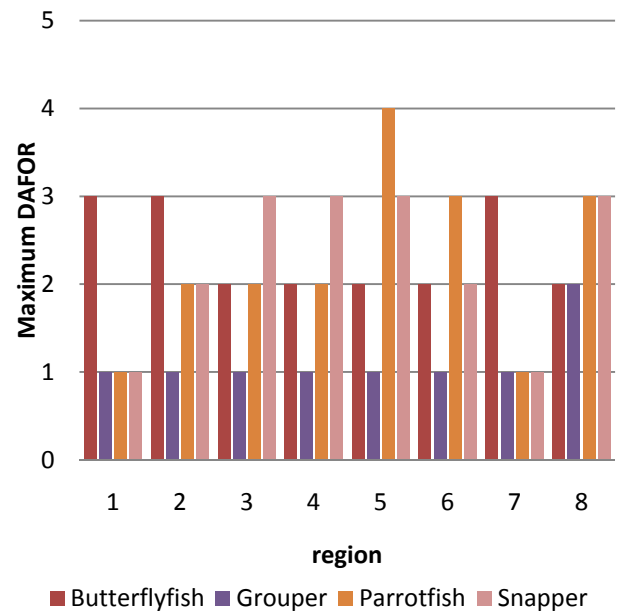


Figure 19 Commercially and ecologically important fish families, expressed as the maximum DAFOR value seen within each Region

4.3.1. Butterflyfish (*Chaetodontidae*)

Butterflyfish are obligate corallivores, making them good indicators of reef health. A high abundance and diversity of Butterflyfish species is usually associated with a diverse reef. The eastern side of Sogod Bay saw a relatively high abundance of Butterflyfish (Figure 20) Over 50% of the surveys conducted around San Francisco (Region 7) and 38% of the surveys in the Liloan/Libagon area (Region 6) found this family present within the survey area.

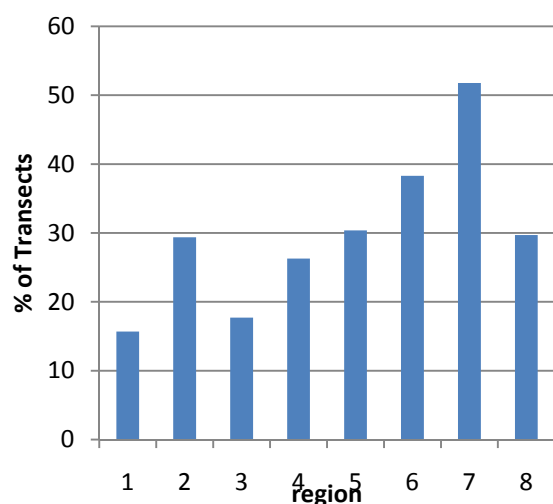


Figure 20 Abundance of Butterflyfish, expressed as a percentage of the number of transects in each region on which they were recorded

4.3.2. Groupers (*Serranidae*)

Groupers are commercially important and very popular food fish all over the world. At a late age (5-7 years), they spawn in aggregations and are extremely vulnerable to over-exploitation. Spawning occurs in large aggregations in order to optimize fertilisation, minimise egg predation, facilitate dispersal and maximise recruitment. The effects of fishing tend to reduce the abundance of the target species, lower their average size and modify their species composition (Van't Hof, 2001) by selectively removing larger individuals due to an ever-increasing requirement for local fish catch. Many researchers believe that it is not possible to fish for Grouper at a rate that is both ecologically sustainable and commercially viable at, although some successes have been achieved in by aquaculture. Grouper sightings were extremely low on reefs throughout Sogod Bay. They were rarely observed on transects area and are known to be wary of divers, hiding in the reef or swimming away. Records of groupers were generally low across

all regions and habitats. Surprisingly, survey regions in the north of Sogod Bay had the highest recorded densities of groupers (Figure 21). This may be partly due to the long-established MPAs in Bontoc and Timba.

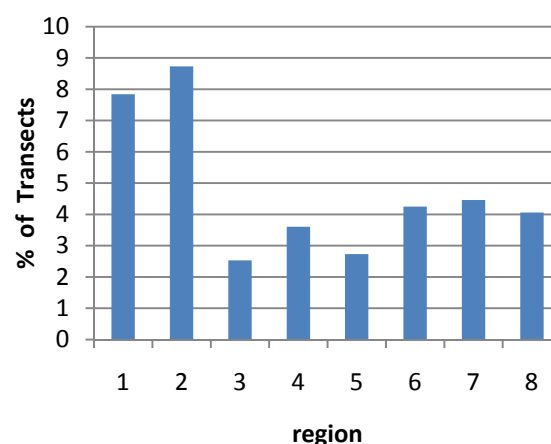


Figure 21 Abundance of Groupers, expressed as a percentage of the number of transects in each region on which they were recorded

4.3.3. Snappers (*Lutjanidae*)

Like Groupers, Snappers are medium to large sized predatory fish and are important targets for artisanal reef-associated fisheries. Depletion in their stocks can indicate overfishing over the whole range of commercially targeted fishes. Snappers were uncommon in all of Sogod Bay (>10%), but sightings were especially low in Bontoc (Region 1, 4%). They were most abundant around Ampo and San Roque (Region 5) where they were sighted on 14% of surveys (Figure 22).

4. SCIENTIFIC RESULTS

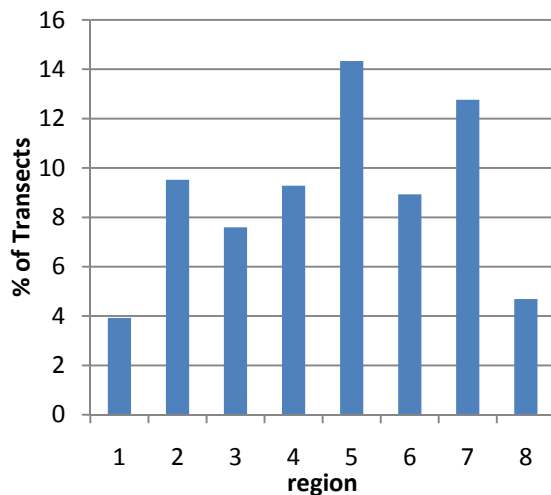


Figure 22 Abundance of Snappers, expressed as a percentage of the number of transects in each region on which they were recorded

4.3.4. Parrotfish (*Scaridae*)

Parrotfish are indicators of reef health as well as being targeted by artisanal fisheries. They are important herbivores, grazing on the reef and help to keep macroalgae in check. Furthermore, some species feed on live hard corals and by doing so, help to maintain coral diversity. Within the classical trophic chain, their herbivorous lifestyle strategy enables greater numbers of individuals within a population, compared to the large carnivores, such as groupers.

Limasawa (region 8) had a relatively high abundance of Parrotfish with individuals recorded on 33% of transects surveyed (Figure 23). Surveys completed around Ampo (regions 5 and 6) where coral cover was generally highest in the bay also revealed a higher abundance of Parrotfish. The regions in the north of the bay had considerably lower abundance with Parrotfish, recorded on less than 10% of the transects.

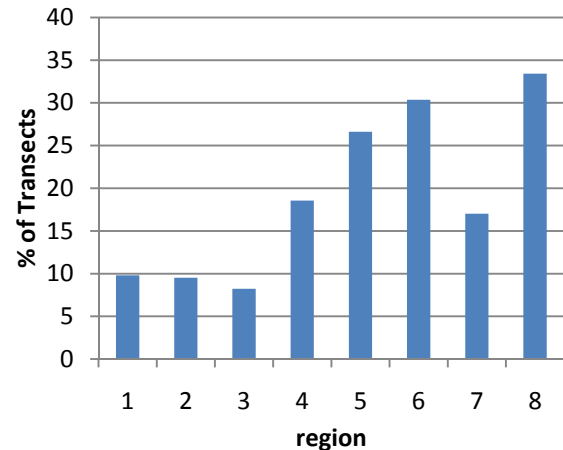


Figure 23 Abundance of Parrotfish, expressed as a percentage of the number of transects in each region on which they were recorded

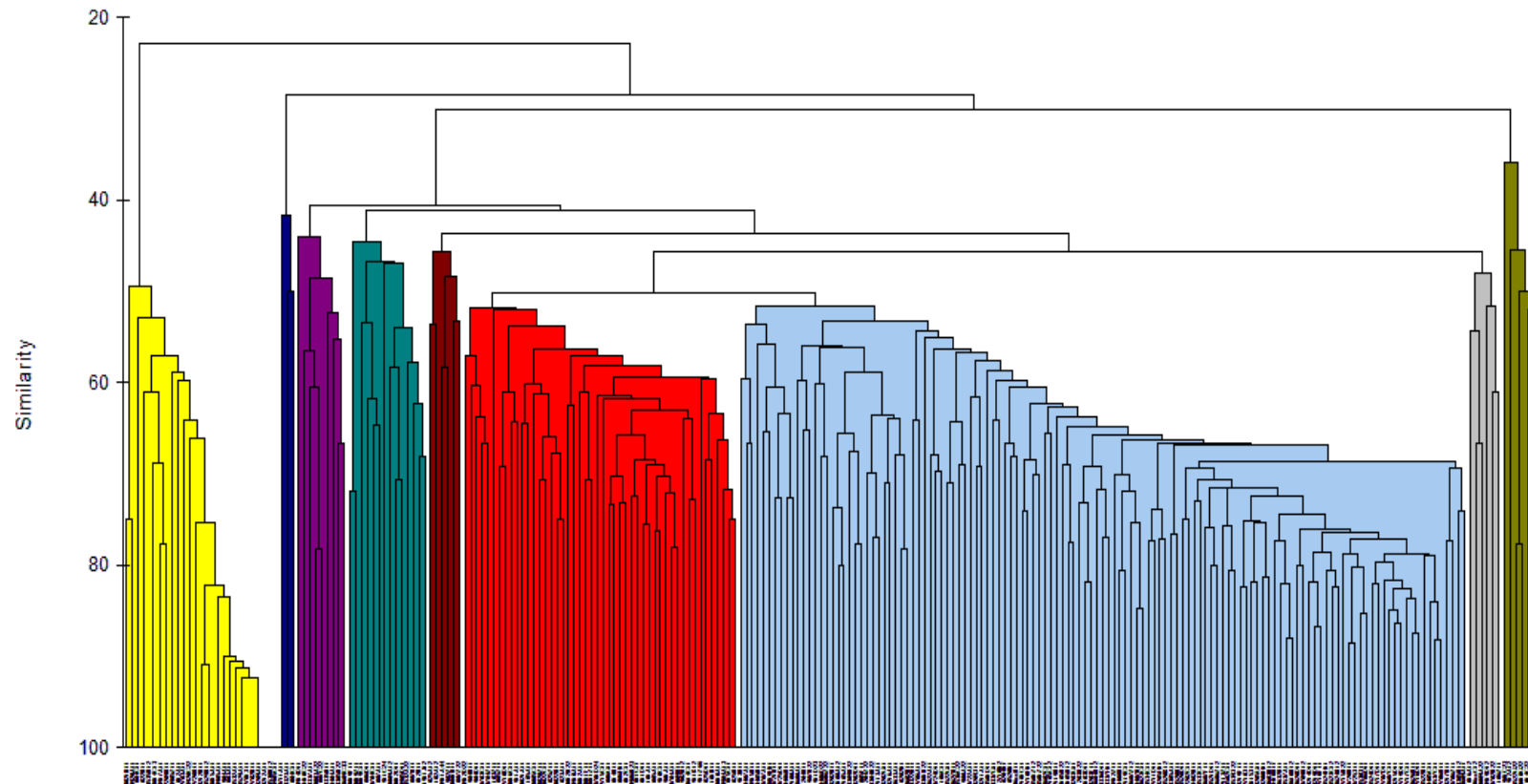
4.4. Habitat Classification

In order to allow for comparison of survey sites, they must first be classified into distinct ecological units, or 'habitats'. Each variable in each survey record (the data from each site) is compared statistically against the same variable in every other survey record and the similarity between any two records is calculated using the Bray-Curtis Similarity Coefficient. This similarity is expressed as a percentage. Using the ecological analysis package, PRIMER (Plymouth Routines in Multivariate Ecological Research), the survey records are then ranked by these similarities to produce natural groupings or 'clusters' from the data (Table 6). SIMPER is then used to define the key characteristics of each cluster. To date, 10 discrete ecological habitats have been defined for the Sogod Bay area. A summary of these is presented in Table 7.

4. SCIENTIFIC RESULTS



Table 6 PRIMER Hierarchical Cluster Analysis output, coloured to show the discreet ecological habitat clusters, as defined from a random sample (n=250) of the survey data. Each vertical line within each cluster represents an individual survey site





4. SCIENTIFIC RESULTS

Table 7 Major characteristics of the benthic classes defined from baseline data collected in shallow coastal waters of Sogod Bay. Figures in parentheses indicate average abundances in accordance with DAFOR ratings assigned during surveys

Habitat	No of Site Records	Average Depth (m)	Dominant Substrata	Hard Corals	Soft Corals	Sponges	Algae/ Seagrass	Avg No of Benthic Spp	Avg No of Fish Spp	Avg Shannon Weiner Diversity Index (Benthic)	Avg Shannon Weiner Diversity Index (Fish)
1 Sand bottom	136	15	Sand (5) Dead Coral with Algae (0.5)	Total (1.0) <i>Acropora</i> branching (0.5)	Total (1.0)	Total (1.0)	<i>Cyanobacteria</i> (1.0)	12	9.9	1.97	1.44
2 Deep mixed abiotic substrata	18	17	Sand (1.0) and Dead Coral (1.5)	Total (2.5) Non- <i>acropora</i> foliose (1.5) Non- <i>acropora</i> sub-massive (1.0)	Total (1.5) Tree (1.0)	Total (1.0)	<i>Cyanobacteria</i> (1.0) Red encrusting (1.0)	19.9	13.4	2.53	1.70
3 Rubble and sand with occasional corals	107	13	Rubble (2.5) Sand (2.0), and Algae (2.0)	Total (1.5) <i>Acropora</i> branching (1.0) Non- <i>acropora</i> sub-massive (1.0)	Total (2.0)	Total (1.0)	<i>Cyanobacteria</i> (1.0) Red encrusting (1.0)	22.9	17.4	2.81	1.97
4 Deep mixed hard coral, soft coral and sand	91	19	Sand (4.0), Hard Coral (2.0) and Soft Coral (2.0)	Total (2.0) <i>Acropora</i> branching (1.0) Non- <i>acropora</i> mushroom (1.0) Non- <i>acropora</i> branching	Total (2.0) mixed lifeforms	Total (1.5)	Green Filamentous (1.0) Red encrusting (1.0)	24.2	14.9	2.77	1.92



4. SCIENTIFIC RESULTS

5	177	12	Hard Coral (4.5) and Sand (3.0)	Total (3.5) <i>Acropora</i> branching, Non- <i>Acropora</i> sub-massive, Non- <i>Acropora</i> encrusting, Non- <i>Acropora</i> massive, Porites, Favia (all 2.0)	Total (2.0)	Total (2.0)	<i>Dictyota</i> spp (1.0) Green Filamentous (1.0)	54.1	27.6	3.42	2.50
6	676	11	Hard Coral (2) Soft Coral (2.0) and Sand (2)	Total (1.5) <i>Acropora</i> tabulate (1.0) <i>Acropora</i> branching (1.0) Non- <i>Acropora</i> encrusting (1.0) Non- <i>Acropora</i> submassive (1.0)	Total (2.0)	Total (1.0)	<i>Cyanobacteria</i> (1.0) Red encrusting (1.0)	38.3	25.9	3.45	2.50
7	32	7	Sand (3.5) Hard Coral (2.5) and soft coral (2.5)	Total (2.5) <i>Acropora</i> branching (1.0) <i>Acropora</i> tabulate (1.0) Non- <i>Acropora</i> sub-massive	Total (2.5) mixed lifeforms	Total (2.0)	Seagrass spp. (1.5) Red filamentous (1.0) <i>Dictyota</i> spp (1.0) <i>Padina</i> spp. (1.0)	43.6	21.6	3.22	2.24
8	45	6	Bedrock (4), Algae (2.5)	Total (1.5) mixed non- <i>Acropora</i>	Total (1.5)	Total (2.0)	<i>Sargassum</i> spp. (1.0) <i>Padina</i> spp. (1.0)	23.2	14.6	2.65	1.85
9	22	11	Silt (3.5)	Total (0.5) No coral targets above 0.5	Total (0.5)	Total (0.5)	Red encrusting (1.0) Red filamentous (1.0) <i>Dictyota</i> spp (1.0) Green Filamentous (1.0)	14.1	7.3	1.95	1.19

4. SCIENTIFIC RESULTS



4.5. Conservation Management Values

Using five ecological indices, comparisons between site records can now be made in order to highlight key areas of ecological importance. The indices used are the site record values for live hard coral cover, the total number of benthic targets (not including algae), total number of reef fish targets, the Shannon-Weiner Biodiversity Indices for both benthic and reef fish targets.

Firstly, an inter-habitat analysis is made to determine the ecological 'value' of each habitat relative to the others. To do this, the average value for each of the 5 indices is calculated for each habitat, and these values are then used to determine the overall averages for each index across all habitats. The habitats are then compared against these overall averages to determine the number of indices in which each habitat is above or below the overall average. If, for example, a habitat is below average in all 5 indices, it would score a value of 0; if it was above average in only 1 index, it would score a value of 1, and so on up to a maximum value of 5 (above average in all 5 indices).

Secondly, an intra-habitat analysis is conducted. Each site record in each habitat is compared against the other site records within that habitat, to determine which sites are the most ecologically 'valuable' examples for their particular habitat. The same system is used to calculate this, with site records scoring values of 0-5. To calculate the Conservation Management Value (CMV) of each site, the inter-habitat value is multiplied by the intra-habitat value, producing scores on a scale of 0 to 25. For example, a poor site record (e.g. one that scored a 2) from a good

habitat type (e.g. one that scored a 5) would score an overall CMV of 10, whereas an excellent site record (e.g. one that scored a 5) from that habitat would score an overall CMV of 25.

Because the location of each survey has been recorded with a GPS unit, the CMVs can be imported into a Geographic Information System (GIS) to enable spatial analysis. The density function in the Spatial Analyst of ArcView (ESRI software) can then be used to highlight areas displaying a particularly high or low density of the various CMVs. These values can be represented on a colour ramp to facilitate visual interpretation. In the GIS output (Figure 24), the colour red represents areas where lower CMVs are dominant; the colours green and yellow represent areas where higher CMVs are dominant. Survey sectors 22 and 23 have relatively low CMV values due to the limited number of surveys conducted there thus far. As more surveys are conducted in these regions, a more accurate picture of the CMV's will develop.

[Note: This technique compares each site against the other sites within a region, and thus it is a *relative value* for that region only. The fact that a site is displayed as a low CMV does not necessarily mean it is biologically 'poor', but simply that there are biologically 'richer' areas in the same region.]

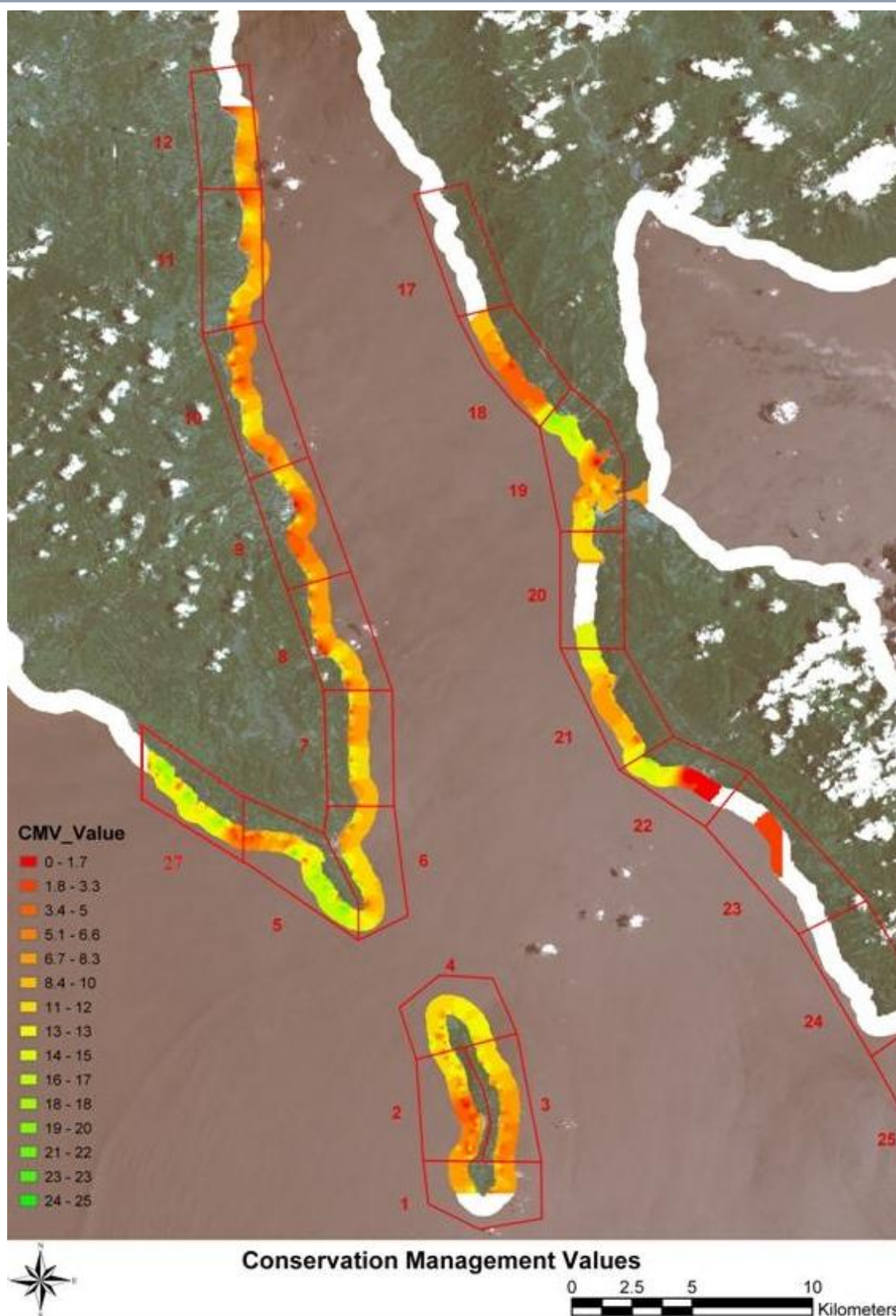


Figure 24 Conservation Management Values (CMVs) displayed as a colour ramp. Areas towards the green end of the spectrum have the highest CMVs.



The general demise of coral reef ecosystems has been well documented with many anthropogenic factors contributing both directly and indirectly to this global phenomenon. The lack of long term data sets and monitoring programmes makes quantification of these processes difficult, but it is likely that no 'pristine' reefs remain anywhere in the world (Wilkinson et al, 2004). Despite this stark appraisal, the reefs of Sogod Bay are, in many places, exceptionally good. This is partly attributable to the efforts of the LGUs and fisherfolk of the Province in enforcing or respecting national legislation governing the use of appropriate fishing gears and methods.

In many countries, Coastal Resources Management strategies have concentrated on the creation of a small number of very large MPAs (>50 hectares). The reefs of the Sogod Bay, however, tend to drop away steeply, with a short backreef area, and thus in most areas, the installation of very large MPAs would likely encompass more deep water than coral reef area. Furthermore, the nature of the Barangay system means large MPAs would almost certainly be trans-boundary, leading to considerable political challenges in the management of such reserves.

The map of CMVs (Figure 24) indicates that areas of moderate to high ecological value (yellows and greens) are dispersed

throughout the coastal zone of the bay. These areas are linked by larval dispersal for coral reef organisms, with water currents within the bay transporting larvae between healthy reef patches.

The creation of a network of smaller MPAs throughout the bay is thus more appropriate ecologically and more achievable politically.

It is encouraging that Barangays are taking the initiative to approach NGOs such as CCC and LGUs such as the PENRMO to ask for their assistance in safeguarding their coastal resources. In this regard the ongoing community education and awareness programmes are crucial and will continue to be a vital tool to help ensure the sustainable management of Sogod Bay's marine resources.

Dive related tourism can be an effective means to create alternative livelihoods and alleviate fishing pressure in coastal waters. Popular and rare mega-fauna such as the Whale Sharks have attracted thousands of tourists to Donsol in Luzon. There is no reason why a similar eco-tourism destination could not be set up in Sogod Bay. In addition, the diverse and often spectacular reefs of Sogod Bay remain one of the most valuable assets in terms of attracting tourists to the province, making a strong case for protecting these sites before they become degraded.

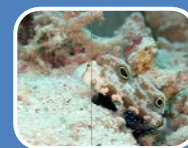


Aesthetic and Biological site impression were found to be closely linked, sites with a high aesthetic appeal were assumed to have a high biological value. This is why dive-related eco-tourism and fisheries management can be mutually beneficial. In overfished areas, MPAs are ideally located in areas that have healthy reefs to maximize fish spawning and recovery. These areas are generally appealing to divers as well, allowing local communities to ask divers to pay a fee in order to dive inside the MPA.

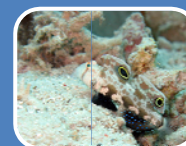
The map of CMVs (Figure 24) indicates that generally the ecological health of the reefs tends to improve with proximity to the mouth of the bay. This may be partly attributable to the influx of clean oceanic water, which is likely to dilute the level of dissolved nutrients and terrigenous sediment entering from the land. In the northern end of the bay there is less mixing resulting in higher levels of both dissolved and particulate matter in the coastal zone.

It was clear from conversations with the fisherfolk during the creation of the MPAs in Padre Burgos that most of the fisherfolk seem to feel that fish catches have dropped as a result of an unsustainable level of historical fishing. Indeed, most fisherfolk are dependent on other sources of income in addition to fishing in order to take care of their families (van Bochove, pers. comm.).

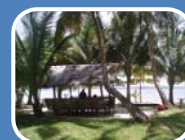
CCC baseline survey data confirms that, in general, target reef fish populations are present at low abundance levels throughout the bay, although a lack of historical data makes it impossible to accurately quantify any long-term temporal changes. However, it is hoped that the major efforts by the various LGUs and NGOs working with the fishing communities of Sogod Bay will help to slow any such decline, and will ultimately contribute to the development of a sustainable artisanal fishery, which will help to safeguard the coral reefs of the Province, and thus the food-security of its people.



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TRANCODE				TRANSECT/PHYSICAL FORM
SURVEY DATE:				
START TIME:		END TIME:		FISH BOUY DEPTH:
END DEPTH:		START DEPTH:		REPEAT VISIT: (Y/N)

Geomorphical Classes Surveyed during entire Dive (ONLY 1 REQD PER SURVEY)

Remember: each new zone is a new habitat, so requires a new biological recording form for each.

	tick	
Lagoon		Shallow zone between backreef and land. Soft substratum
Backreef		Shallow zone between reef crest and lagoon.
Reef Crest		Shallowest (often emergent zone); separates fore from backreef
Forereef		Sloping face of reef unto 45 degrees
* Reef Front		Forereef slope from 3-10m
* Upper Reef Slope		Forereef slope from 10-20m
* Lower Reef Slope		Forereef slope from 20-30m
Escarpment ("wall")		Any area of reef whose slope is greater than 45 degrees
Dense Patch Reef		Area of coral 'bommies' >70% hard coral, often sand between
Diffuse Patch Reef		Area of coral 'bommies' <70% hard coral, often sand between

UNDERWATER IMPACTS

LITTER
SEWAGE
CORAL DAMAGE
LINES/ NETS
FISH TRAPS
SEDIMENTATION
DISEASE
BLEACHING
DYNAMITE
OTHER

IMPRESSION OF THE SITE

AESTHETIC	POOR	AVERAGE	GOOD	V. GOOD	EXCELLENT
BIOLOGICAL	POOR	AVERAGE	GOOD	V. GOOD	EXCELLENT

GENERAL LOCATION

(SHORE REFERENCE)

TOPOGRAPHY

MAIN HABITATS

ORIENTATION

DISTANCE TRAVELLED

APPROX DISTANCE REMAINING

LOW	MEDIUM	HIGH
	m	
	m	

LATITUDE START:	07	LATITUDE END	07
LONGITUDE START:	1	LONGITUDE END	1

CURRENT STRENGTH	NONE	WEAK	MEDIUM	STRONG	WIND STRENGTH (BEAUFORT)	
CURRENT DIR (towards)	(N,NW etc.)				WIND DIR (from)	
TEMPERATURE		AT DEPTH OF		SURFACE TEMPERATURE		
SALINITY		AT DEPTH OF		SURFACE SALINITY		
SECCHI						

SURFACE ACTIVITY

OCCUPANTS	PROXIMITY	ACTIVITY*

*(FISHING
DIVING
PLEASURE
COMMERCIAL)

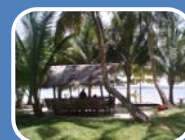
SURFACE IMPACTS

LITTER
ALGAE
SEWAGE
NETS
DRIFTWOOD
OTHER

	FIRST NAME	SURNAME	NO. SURVEYS
PHYSICAL			
FISH			
CORAL			
ALGAE/INVS			

DATABASE INFO

ENTERED BY	
DATE	
LOGGED?	
CHECKED BY	
DATE	

**HABITAT FORM**

HABITATE CODE		TOTAL HABITATS		DIVEDATE	
HABITAT NO		HABITAT COVERAGE (%)		START TIME	
				END TIME	

START DEPTH	
END DEPTH	
HORIZONTAL VISIBILITY	

Geomorphical Classes

Remember: each new zone is a new habitat, so requires a new biological recording form for each.

tick

Lagoon		Shallow zone between backreef and land. Soft substratum
Backreef		Shallow zone between reef crest and lagoon.
Reef Crest		Shallowest (often emergent zone); separates fore from backreef
Forereef		Sloping face of reef unto 45 degrees
* Reef Front		Forereef slope from 3-10m
* Upper Reef Slope		Forereef slope from 10-20m
* Lower Reef Slope		Forereef slope from 20-30m
Escarpment ("wall")		Any area of reef whose slope is greater than 45 degrees
Dense Patch Reef		Area of coral 'bommies' >70% hard coral, often sand between
Diffuse Patch Reef		Area of coral 'bommies' <70% hard coral, often sand between

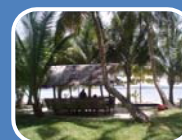
SUBSTRATUM COVER

BEDROCK		Any exposed area of hard, bare substratum without visible corallite structures
DEAD CORAL WITH ALGAE		Dead coral with visible corallite structures and/or lifeform covered in algae
DEAD CORAL		Bare dead coral with visible corallite structures and/or lifeform not covered in algae
RUBBLE		Any area of unconsolidated, loose bedrock or hard substratum (eg. Old coral fragments)
SAND		Coarse sediment (diameter >1mm). "Grainy" when disturbed
MUD		Fine sediment (diameter <1mm). "Milky" when disturbed

BIOLOGICAL COVER

LIVE HARD CORAL		Total hard corals, including both target and non-target lifeforms
SOFT CORAL		
SPONGES		
OTHER INVERTEBRATES		Other Cnidarians, Arthropods, Molluscs, Annelids, Echinoderms
ALGAE		Green, Brown, and Red algae, not including blue/green 'algae'
SEAGRASS		
MANGROVES		

SUBSTRATE TYPES	
COMMENTS (coral,fish,inv,s,algae)	



SPECIES ABUNDANCE		Rating	Abundance Scale (coral, substratum, algae)	Numbers (Fish/ Inverts)
N.B. ALL CORAL AND FISH TARGET SPECIES MUST ALSO BE COUNTED IN THE APPROPRIATE FAMILY OR LIFEFORM		0	None	0
		1	Rare	1-5
		2	Occasional	6-20
		3	Frequent	21-50
		4	Abundant	51-250
5	Dominant	250+		
MICRO-ALGAE Cyano-Bacteria: Blue-Green 1 ☐				
MACRO-ALGAE <u>Chlorophyta : Green</u> Green Filamentous 39 ☐ <i>Chaetomorpha</i> sp. 15 ☐ <i>Marble (Valonia ventricosa)</i> 36 ☐ <i>Bornetella</i> sp. 10 ☐ <i>Neomeris</i> sp. 29 ☐ <i>Codium</i> sp. 18 ☐ <i>Caulerpa</i> sp. 12 ☐ <i>Halimeda</i> sp. 24 ☐ <i>Tydemania</i> sp. 33 ☐ Further Green Algae: ☐ ☐ ☐ TOTAL GREEN ALGAE ☐ <u>Phaeophyta : Brown</u> <i>Dictyota</i> sp. (Flat-Branched) 44 ☐ <i>Padina</i> sp. (Fan Blade) 50 ☐ <i>Lobophora</i> sp. (Blade/Ruffle) 49 ☐ <i>Hydroclathrus</i> sp. 48 ☐ <i>Turbinaria</i> sp. (Pyramid) 55 ☐ Brown Filamentous 42 ☐ <i>Sargassum</i> sp. (Bladder) 53 ☐ Further Brown Algae: ☐ ☐ ☐ TOTAL BROWN ALGAE ☐ <u>Rhodophyta : Red</u> Encrusting coralline algae 70 ☐ <i>Galaxaura</i> sp. 73 ☐ <i>Amphiroa</i> sp. 63 ☐ <i>Jania</i> sp. 83 ☐ Red Filamentous 60 ☐ Sheet 80 ☐ <i>Actinotrichia</i> - spikeweed 61 ☐ Wiry branched (<i>Gelidiella</i> sp.) 74 ☐ Further Red Algae ☐ ☐ ☐ TOTAL RED ALGAE ☐				
MARINE PLANTS <u>(Angiospermophyta)</u> Sea Grass 102 ☐ <i>Thalassia</i> sp. 108 ☐ <i>Halophila</i> sp. 105 ☐ Other: ☐ Mangroves 114 ☐ TOTAL PLANTS ☐ (Not Including Algae)				
TARGET INVERTEBRATES <u>Porifera : Sponges</u> Tube 126 ☐ Barrel 146 ☐ Elephant Ear 128 ☐ Branching 143 ☐ Encrusting 130 ☐ Lumpy 145 ☐ Rope 144 ☐ Vase 125 ☐ <u>Octocorallia: Soft Coral Forms</u> Deadman's Fingers 275 ☐ Leather 277 ☐ Tree 278 ☐ Pulsing 295 ☐ Sea Fan 280 ☐ Sea Whip 281 ☐ Bamboo 283 ☐ Flower 294 ☐ Sea pen 338 ☐ <u>Other Cnidarians</u> Black Coral 303 ☐ Anemone (Sea and tube) 306 ☐ Zoanthid 315 ☐ Jellyfish (Medusa) 327 ☐ Hydroid 333 ☐ Corallimorph 320 ☐ <u>Annelid Worms</u> Segmented Worms 348 ☐ Feather Duster 349 ☐ Christmas Tree 350 ☐ <u>Flatworms</u> 341 ☐ <u>Arthropoda : Crustacea</u> Shrimps 361 ☐ Rock lobster (<i>Panulirus</i> spp.) 366 ☐ Crab 381 ☐				
<u>Mollusca:</u> Gastropods: Abalone 390 ☐ <i>Murex</i> sp. 394 ☐ Conch 398 ☐ Cowrie 402 ☐ Triton 406 ☐ Cone Shell 408 ☐ <i>Drupella</i> sp. 419 ☐ Limpet 445 ☐ Topshell 404 ☐ Nudibranch 448 ☐ Other 389 ☐ Bi-Valves: Oyster 426 ☐ Giant Clam 438 ☐ Other Clam 443 ☐ Other 425 ☐ Chiton 442 ☐ Cephalopods: Cuttlefish 469 ☐ Squid 470 ☐ Octopus 468 ☐ <u>Echinodermata:</u> Sea Stars: <i>Acanthaster planci</i> (COT) 472 ☐ <i>Linkia laevigata</i> (Blue) 478 ☐ <i>Nardoa</i> sp. (Brown) 479 ☐ <i>Culcita novaeguineae</i> 474 ☐ <i>Protoreaster nodosus</i> 482 ☐ <i>Choriaster granulatus</i> 473 ☐ Other 471 ☐ Brittle Star 483 ☐ Feather Star 489 ☐ Basket Star 495 ☐ Sea Urchin: Short Spine 502 ☐ Long Spine 503 ☐ Sea Cucumber: Synaptid 515 ☐ Other 520 ☐ <u>Tunicate (Phylum Chordata)</u> 529 ☐ <u>Bryozoan (Phylum Bryozoa)</u> 526 ☐ FURTHER SPECIES: ☐ ☐ ☐ TOTAL INVERTEBRATES (including tunicates and bryozoans) ☐				

APPENDIX



TARGET FISH

<u>Butterflyfish</u>	540	☐
(Big) Long-Nosed	752	☐
Klein's	651	☐
Vagabond	541	☐
Pyramid	750	☐
Eastern Triangle	783	☐
Latticed	681	☐
Redfin	760	☐
Orange-banded Coral fish	923	☐
Copper-banded	947	☐
Humphead Bannerfish	669	☐
<u>Angelfish</u>	544	☐
Regal	663	☐
Bicolour	673	☐
Pearlscale	545	☐
Emperor	756	☐
Blue-girdled	937	☐
<u>Surgeonfish</u>	546	☐
Convict	547	☐
Ringtail' spp.	548	☐
Brushtail tang	638	☐
Unicorn spp.	550	☐
<u>Tuna/ Mackerel</u>	940	☐
Narrow-banded king mackere	558	☐
<u>Fusilier</u>	571	☐
"Blue and yellow" sp.	929	☐
Bluestreak	930	☐
<u>Damselfish</u>	589	☐
Blue-Green Chromis	596	☐
Black Bar Chromis	646	☐
Other "Chromis" sp.	590	☐
Threespot dascyllus	671	☐
Humbug dascyllus	767	☐
Reticulated dascyllus	771	☐
Whitebelly	654	☐
Staghorn	745	☐
Alexanders	764	☐
"Anemone fish" sp.	591	☐
"Sergeant" sp.	656	☐

<u>Wrasse</u>	598	☐
Diana's hogfish	931	☐
Mesothorax hogfish	611	☐
Humphead	600	☐
Red-banded	932	☐
Checkerboard	725	☐
Twotone	768	☐
Crescent	647	☐
Cigar	685	☐
Bird	610	☐
Cleaner	605	☐
<u>Goatfish</u>	615	☐
Half-and-half	648	☐
Dash-and-dot	781	☐
Blackstriped	616	☐
<u>Triggerfish</u>	624	☐
Orangestriped	625	☐
Clown	626	☐
Blackbelly Picassofish	927	☐
Scythe	692	☐
Picasso	628	☐
Moustache / Titan	623	☐
<u>Groupers</u>	583	☐
Flagtail	682	☐
Peacock	935	☐
Humpback	936	☐
"Honeycomb" sp.	586	☐
Lyretail	946	☐
<u>Parrot Fish</u>	613	☐
Bumphead	933	☐
<u>Spinecheek</u>	581	☐
Twoline	582	☐
Pearly	659	☐
<u>Snapper</u>	565	☐
Two-spot	753	☐
Black-and-white	569	☐
Chequered	665	☐

<u>Rabbitfish</u>	579	☐
Foxface	757	☐
Virgate	630	☐
<u>Dartfish</u>	774	☐
Blackfin	695	☐
<u>Cardinalfish</u>	621	☐
Pajama	917	☐
<u>Puffer</u>	635	☐
Blackspotted	652	☐
<u>Goby</u>	749	☐
Sphynx	954	☐
Brownbarred	955	☐

OTHER MAJOR FAMILIES

Anthias	642	☐
Jack / Trevally	553	☐
Sweetlips	577	☐
Barracuda	560	☐
Moorish Idol	551	☐
Emperor	924	☐
Spadefish / Batfish	595	☐
Porcupine	634	☐
Toby	636	☐
Trunk / Box / Cowfish	640	☐
Blenny	926	☐
Sweeper	689	☐
Squirrelfish / Soldierfish	619	☐
Filefish	629	☐
Lionfish	631	☐
Scorpionfish / Stonefish	632	☐
Lizardfish	643	☐
Hawkfish	902	☐
Sandperch	675	☐
Sharksucker	787	☐
Needlefish	562	☐
Pipefish	911	☐
Shrimp fish	790	☐
Trumpetfish	664	☐
Moray Eel	637	☐

FURTHER SPECIES

	☐
	☐
	☐
	☐
	☐
	☐
	☐

TOTAL FISH

