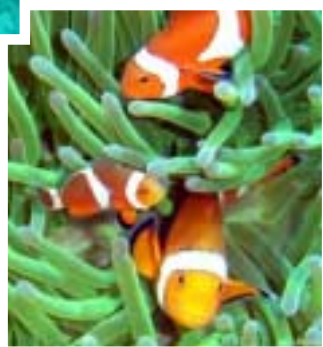
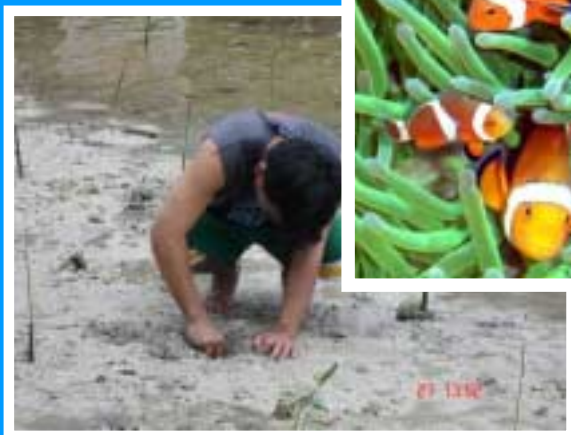


Southern Leyte Coral Reef Conservation Project

Results of Community
and Scientific Work

May 2004 to
December 2005





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 have been shown to be 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'* in collaboration with government and non-governmental organisations within a host country. CCC does not charge the host country for the services it provides and 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 project 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).



His Royal Highness, the Prince of Wales, visits the CCC Fiji project site in March 2005

Acknowledgements



Coral Cay Conservation would like to extend its heartfelt thanks to the following people, without whom this project would not have been possible:

Hon. Rosette Y. Lerias, Provincial Governor for Southern Leyte, for her vision and constant encouragement

Gerry L. Ledesma, and all the staff from the Philippine Reef & Rainforest Conservation Foundation Inc (PRRCFI)

His Excellency, Peter Beckingham, British Ambassador to the Philippines, and the staff of the British Embassy, Manila, in particular Sherah Chua and Nicole Cadwallader

Hon. Eva L. Tomol, Board Member for Southern Leyte

Hon. Genis S. Murallos, Provincial Administrator

Hon. Rimmon Borces, Municipal Mayor of Padre Burgos

The barangay captains of Santa Sofia, Lungsodaan, Tangkaan and Buenavista

Nedgar Garves and all the staff at the Provincial Tourism Office

Mam Eva Abad and all the staff at the Provincial Coastal Resources Management Office

Tim Packeiser of GTZ

The staff of the Municipal Agricultural Office of Padre Burgos

The Philippine National Police of Padre Burgos

Professor Senona A. Cesar and the other staff of Leyte State University

The staff of Southern Leyte State University

The members of the Coastal Resources Management Network of Southern Leyte

In alphabetical order, Günter (Southern Leyte Divers), Pete (Peter's Dive Resort) and Ron (Sogod Bay Divers), for their support and for sharing their knowledge of Sogod Bay

Our Filipino staff, Delia, Tata, Loni and Ariel, whose loyalty, trust, and dedication are valued more than we could ever say

A very special thanks goes out to Dag Navarette, Neil Pretencio, Lloyd "Wang Yu" Abiera, Andy Arnaiz, Emmanuel Gulay, SB Boniel, and Mam Beverly Navarette, for their support, their advice and, most of all, for their friendship.

All the international volunteers who gathered the data and made this possible
Report By:

Shay O'Farrell, Jan Willem Van Bochove, Hannah Bodley, Douglas Fenner, PhD, and Peter Raines, MBE, July 2006



The Southern Leyte Coral Reef Conservation Project (SLCRCP) is a tri-partite initiative, convened jointly by Coral Cay Conservation (CCC), the Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and the Provincial Government of Southern Leyte.

The project has been undertaken with the objective of assisting in the conservation of the coral reefs of Sogod Bay for the long-term benefit and food-security of the residents of the Province. 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 December 2005. It also contains a synopsis of community work and capacity building activities undertaken at the new project base, between May 2004 and December 2005. Community and capacity building work undertaken prior to May 2004 have previously been presented in Taylor et al (2004).

Over the 19 month period covered by this report, CCC project staff undertook an extensive community education programme. In excess of 500 students from the schools and colleges of Southern Leyte had the opportunity to learn about their reef resources, through a series of Open Days held at the CCC project base, plus various workshops and seminars organised, or attended, by the CCC Project Scientist. As a result of an innovative study visit to the famous Apo Island marine reserve in Negros Oriental, 4 new community-based Marine Protected Areas (MPAs) were created in the Municipality of Padre Burgos by the fisherfolk and LGUs. Furthermore, a series of successful teacher training workshops was held, 14 MPA wardens were tutored, extensive mangrove planting projects were undertaken, and Provincial Government Employees were qualified in SCUBA diving, plus marine science and surveying.

CCC survey teams conducted a total of 531 survey dives, producing a total of 671 individual survey records for the reefs of



the 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 10 benthic habitats were identified within Sogod Bay. Hard coral cover was found to increase towards the mouth of the bay, which may be linked to sediment input into the north of the bay. The majority of sediment appears to stem from the extensive river systems entering at the apex of the bay near Sogod town and this may result in high levels of sediment deposition and therefore relatively low hard substrate upon which corals will settle.

Coral species diversity was found to be exceptional in certain areas of the bay with a number of rare species being identified. For example, 141 different species of corals were recorded on a single dive by the coral taxonomist, Dr. Douglas Fenner in December 2005. Efficient management and implementation of sustainable fishing practices is essential if the health of these reefs is to be conserved.

Low abundances of commercially important fish and invertebrate species provides an indication of over-fishing of the reefs within the Bay and highlights the concern that fish stocks are considered to be both biologically and economically overfished in most areas of the Philippines.

The high diversity and abundances of fish species and live hard coral cover in existing fish sanctuaries, such as Napantau on the eastern coast of Sogod Bay, are extremely attractive to divers. The presence of Whale sharks and various other 'megafauna', such as turtles and different shark species, represent great potential for dive related tourism in this area.

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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 recorded to date. The coastline is fringed with approximately 25,000 km² of coral reefs, about 10% of the land area of the whole archipelago (Spalding *et al.*, 2001).

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 and fetch high prices on the market. 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. 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 and salinity and sediment loads. Small changes in these properties can have dramatic impacts on the reef ecosystem.

1.2 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 bordered by 11 municipalities: Padre Burgos, 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.

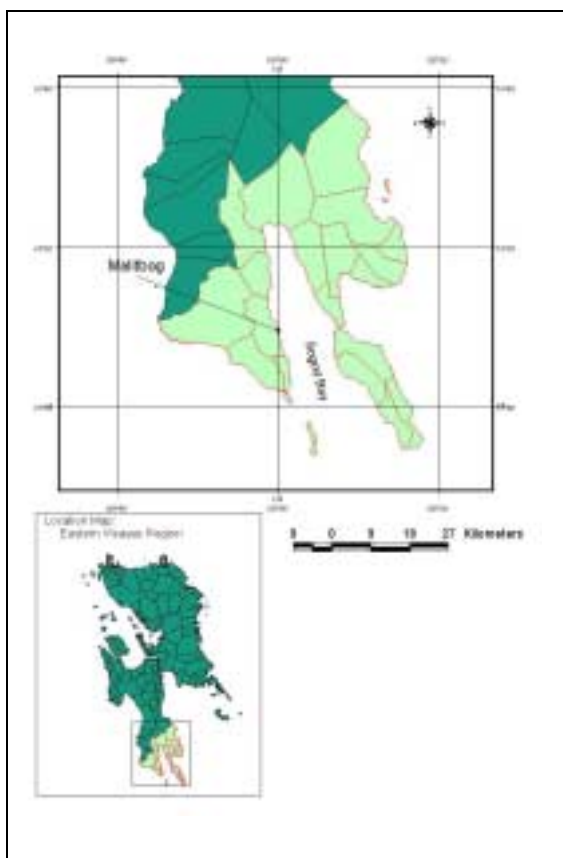


Figure 1 Map of the Eastern Visayas Region showing the location of Southern Leyte Province in light green.

Source: DENR and SLSU, Southern Leyte.

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 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 (Calumpong *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 (Calumpong *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 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

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, harvested every three months. Logging in the area has been banned but illegal logging does occur, particularly in times of bad weather. During the wet season (between November and February) and during periods of extreme rainfall, runoff is expected to be greater and hence have a considerable impact on the narrow band of fringing reefs.

Following particularly heavy rainfall during December 2002 sedimentation from runoff was evident around the reef in front of the CCC base in Malitbog (Joanna Doyle, pers. obs.). The seabed was coated in a thick layer of brown, terrigenous sediment.

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. 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 predominant 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 amount 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. Faster-growing algae begin to compete with and 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 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. The loss of considerable areas of these coastal forests has resulted in the removal of sediments and nutrients to the adjacent coral reefs.

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

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 without causing significant impacts. The current population growth rate will cause the population to double by the year 2035 and this 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 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 unofficial sanctuaries at present which 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 by initial visual assessments made by government officials who have been SCUBA diving in the bay for many years (Rio Cahambing, Roy Cahambing and Dag Navarette). The sanctuaries were placed in areas which possessed the most abundant and diverse coral reefs. Following their development visual assessments were carried out by the same group every 1-3 years. Initially the sanctuaries were actively guarded by the local Bantay-dagat which each had their own boat for patrol purposes. However in the last four years the Bantay-dagat have not been needed to patrol the areas as vigorously and no longer have local boats to do so. A problem facing the sanctuaries is that the white buoys marking the boundaries tend to disappear during stormy weather. Although fishing does not often occur within the sanctuary, boats do pass through the

1 Introduction



sanctuaries using them as shortcuts. Spearfishing within the sanctuary boundaries at Liloan has occasionally been observed (Joanna Doyle, pers. obs.).

2 Capacity Building



One of the key objectives of the Southern Leyte Coral Reef Conservation Project is to assist the Province in strengthening its human resources. It was for this purpose that CCC created the position of Project Scientist, whose responsibilities include 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 project personnel from May 2004 to December 2005.

MAY 2004

Having completed its work within the Malitbog region, CCC moved expedition base south to Barangay Tangkaan, in the Municipality of Padre Burgos, and began to work with the local community in the new area.

During the periods of the 19th-21st May and the 26th-28th May, 35 teachers from all around Southern Leyte attended the tailor-made Foundation Conservation Biology Workshop at the new project site. The 3 day workshops were designed to increase awareness and knowledge of marine resource issues amongst the educators of the Province. Using lectures and practical demonstrations, the teachers learned about such diverse topics as shark biology, fisheries

management, coral reef ecology, threats to reefs and the socio-economic impacts of coral reef degradation. On the final day, the teachers were presented with a role-playing exercise that was designed to test all of their new-found knowledge.



Members of the Barangay Council of Tangkaan welcome CCC staff upon arrival at the new project base

The 'scenario' involved a fictional Visayan island whose fishing community has been presented with a proposal from a group of international developers, who wish to build a deep-water port on the island. This will have a profound effect on the island's ecosystem, but will also bring an influx of much needed income to the community. The teachers were split into three groups: the developers, the environmental lobby, and the fisherfolk. The three groups were then given the opportunity to make plans and consider all of the issues involved, before holding a 'Barangay meeting' to attempt to reach a resolution. It was a very productive exercise, forcing the participants to consider the many development issues from many sides, and ultimately to work together to find solutions.

2 Capacity Building



JUNE 2004

At the invitation of the Municipal Agricultural Officer, the Project Scientist visited Barangay Lungsuda-an to give a presentation to the fisherfolk on the occasion of the official launch of their new *payout*, which is an anchored fish aggregation device (FAD), consisting of 4 large coconut palms tethered to a vertical line. These devices are effective in the aggregation of pelagic fishes, such as jacks and barracuda.

Although they don't actually increase fish stocks, FADs such as this *payout* have distinct conservation benefits. Firstly, they take fishing pressure off the reef, where demersal stocks are often lower than the pelagic stocks of the surrounding waters. Secondly, because the fish can be landed with a hook-and-line, they remove nets from the waters, which have been an ongoing source of reef litter and of secondary mortality of reef fishes and megafauna, such as turtles and reef sharks. Thirdly, in areas with depleted fish stocks such as Sogod Bay, they allow Barangay fisherfolk to make a living without having to resort to destructive and/or unsustainable fishing practices on the reefs.

JULY 2004

On 4th of the month, we held our inaugural Open Day at the new project site. Two teachers and 25 parents accompanied 60 pupils from Tangkaan

Primary School for an afternoon of marine environmental appreciation and awareness. The children had the opportunity to snorkel with our project team and observe the marine life firsthand. They also saw a slideshow of the fishes, corals and invertebrates of Sogod Bay, created an undersea collage, and enjoyed CCC's famous *Fred the Fish* educational puppet show. The show was created in 2002 by a CCC Project Scientist as a way of getting the conservation message across to younger audiences, and *Fred* has since become a bit of a local legend!



Children from Tangkaan Primary School get the chance to look beneath the waves with their CCC reef guides

On Thursday 29th July, CCC attended a forum hosted by the Provincial Coastal Resources Management Office (PCRMO) to discuss ways of improving communication and co-operation between the various agencies working in Coastal Resources Management in Southern Leyte. All parties were in agreement that enhanced communication would be beneficial to all involved in CRM in the Province. Quarterly meetings of this 'CRM Network'

2 Capacity Building



will help to streamline the CRM effort and to enhance the sharing of expertise and information.

AUGUST 2004

On Sunday the 8th of August, CCC smashed its Southern Leyte attendance record for a Marine Educational Open Day, when over 150 students from the College of Maasin came to our project base. The students took part in a series of lectures, videos and practical demonstrations. The slightly 'older' age group of the students allowed us to delve a little deeper into the ecology of coral reefs and the impacts, both positive and negative, that we have on their 'health'.



Students and teachers from the College of Maasin at the project base during the record-breaking open day

Every week, CCC volunteers and staff do a 'clean-up' of our beach front at Tangkaan, removing the plastic debris that wash ashore. During the Open Day, the beach received the best cleaning ever, when all of the students helped us to remove the plastic bags, sandals, bottles, packaging etc, that would

otherwise be washed back into the sea and clog the reefs. All in all, the "Clean-Up Crew" collected around 300 litres' volume of harmful garbage.



College of Maasin students cleaning litter from the beachfront at Tangkaan

SEPTEMBER 2004

The CCC Trust sponsored six representatives from Southern Leyte to accompany our Project Scientists on an official inter-Barangay study visit to the Apo Island in Negros Oriental. This programme was intended to create an invaluable opportunity for Filipino people to learn from each other how sustainable marine resource management can be of long-term benefit to coastal communities.

Apo Island is renowned for its long established and highly successful Marine Protected Area (or 'Fish Sanctuary'), which was created by the local community, in association with Silliman University of Dumaguete City. Many consider it to be a model of how an MPA should be managed.

2 Capacity Building



The Barangay Captain and fisherfolk of Apo spent a day discussing the history, hurdles and triumphs they have experienced over the years. Their passion and commitment were carried back to Southern Leyte by the delegates, and shared with the fisherfolk of the Barangays. Despite having been made aware of effort, sacrifices and uncertainties involved, the fisherfolk voted overwhelmingly to emulate the endeavour of their compatriots, and thus began the first tentative steps on the long road towards the creation of the 4 Community Based MPAs that now exist in Padre Burgos.



Representatives of the Provincial, Municipal and Barangay Local Government Units on the way to Apo Island

Back at base, two Open Days were held in September for the children of Kinderhilfe Children's Village. A variety of activities took place aimed at the different age groups from 4 to 18 years old. The children watched a slide show and were amazed to hear about the many different types of fish and coral in Sogod bay. Many of the children were keen to

experience the way that SCUBA divers breathe under water, so a 'dunk tank' was built for them to put their heads into and find out!

A symposium was held by St. James College, Padre Burgos, on the importance of Coral Reefs ecosystems. CCC gave lectures on coral reef ecology and structure, fish identification and behaviour. The Project Scientist then showed a video that explored the pressure on the Philippines reefs from destructive fishing practices, and highlighted possible solutions. The students subsequently engaged in a discussion on the past, present and future of Philippine marine resources. As these high school students will be amongst the key decision-makers of the future, this kind of debate is invaluable in opening young peoples' eyes and minds to the natural world around them, on which so many of their neighbours directly depend.



One of the Kinderhilfe children gets the chance to try breathing from a SCUBA regulator

2 Capacity Building



OCTOBER 2004

At the start of the month, over three thousand mangrove seedlings (or “propagules”) were planted as part of the *Alay Lakid* in Barangay Buenavista. The area concerned had previously been settled by two different species of mangrove, but most of the vegetation was destroyed by a typhoon several years ago. Over 500 people showed up on the day, and helped to plant the seedlings of the same two species of mangroves that had once dominated the foreshore area. Care was taken to ensure seeds were planted using the correct spacing and depth to help increase the chances of germination and survival. As mangroves provide important nursery areas for fish, if established properly they can contribute to increasing the juvenile fish biomass of the area.



Mangrove propagules being planted in Barangay Buenavista during the annual Alay Lakid

Later in the month, CCC was honoured to act as a facilitator at the 2nd Marine Protected Area Stakeholder Congress in

Hinundayan. This two day event, run by the PCRMO, brought together representatives from all 37 fish sanctuaries in Southern Leyte, providing an ideal opportunity to exchange information and discuss management options for successful fish sanctuaries.

NOVEMBER 2004

Following the success of the mangrove planting event in October, CCC was invited to take part in further mangrove replanting in Maasin as part of scout week. 20 scouts were selected to take part in a series of lectures on the importance of marine conservation and mangroves, followed by the planting of over 100 seedlings. The scouts learned how each leaf on a mangrove can support a single juvenile fish, and thus by “giving nature a hand”, they were contributing to the effort to safeguard food security for generations to come.

DECEMBER 2004

The heavy rainfall of December necessitated the postponing of a number of planned events for the month. These events took place early in 2005. The month was spent making repairs to the project base and getting ready for the new diving year.

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JANUARY 2005

Our Project Scientist accompanied Provincial Government employees in assessing the status of two established MPAs in the Municipality of Libagon, as well as exploring the potential of a further site that has been proposed. Both of the established sanctuaries showed signs of increasing fish numbers, as well as recovery of corals which had been damaged by historical fishing activities.

CCC continued to assist the Local Government Units (LGUs) of Padre Burgos in the establishment of four new MPAs within the Municipal waters. A number of graduates from CCC's counterpart training programme joined our project science staff as they conducted several dives to measure the depths of the corners of the proposed sanctuaries in Tangkaan, Buenavista and Santa Sofia. This information was used in the completion of the proposal for establishing permanent buoys to mark the sanctuaries and in the sourcing of funding for the purchasing of the appropriate quantities of mooring lines for the buoys.

FEBRUARY 2005

Although an Open Day had been arranged for school children from Libagon during the month of February, our Project Scientist was called away this month in order to assist in the assessment of the damage caused by the December 2004

Indian Ocean tsunami. At the invitation of a sub-committee of the Royal Thai Government, a team of scientists from CCC conducted an intensive two-week survey of the reefs of Mu Ko Surin Marine National Park in Thailand. Despite the heavy coral damage that had been sustained in other areas of the country, these islands were relatively unscathed, with only 18% of the coral being damaged by the tsunami event. As these coral reefs of these islands had been declared the "Best in Thailand", this was a small piece of good news in a country so badly affected overall. It is hoped that ocean currents from this island group may transport coral larvae to repopulate may of the badly damaged reefs, thus rehabilitating some of the fishing grounds on which many of the local communities depend for their livelihoods.

MARCH 2005

One of the inherent drawbacks in scientific data gathering is that differing methods are used by various individuals and organisations to achieve specific aims. This means that the results are often not comparable. To get around this problem, a common method for the gathering of data about the Marine Protected Areas of the Philippines has been proposed under the auspices of the Marine Protected Areas Project (www.coast.ph). A database has been created to collect all of this information to allow the various sites to be evaluated

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relative to each other and to provide a 'yardstick' for the monitoring of progress. The database is managed by the Coastal Conservation and Education Foundation (formerly known as the *Sulu Fund*), and currently has over 90 participating MPAs from around the country. Coral Cay is keen to encourage this monitoring program in the nascent MPAs of Padre Burgos Municipality, as there are currently no MPAs from Southern Leyte involved in the project. The first biological surveys were conducted this month in 3 of the MPAs, with the fourth timetabled for April.

A new series of Reef Checks was also started, and with the increasing number of volunteers due to arrive over the next few months, a comprehensive surveying programme was scheduled around our local reefs. It is apparent that the coral cover in the waters of Southern Leyte is, in places, exceptional but to this point in time there has been no way of accurately quantifying this. The Reef Check method will allow this to be done. Early results were encouraging, with 75% hard coral cover being recorded at the very first survey site.

The Crown-of-Thorns Seastar (COTS) outbreak that befell Limasawa Island was quite a shock to all involved. Despite the large amount of international effort and funding invested in the study of these organisms, their peculiar habits make them extremely difficult to conduct research on and thus little is known about

them. According to the Australian Institute of Marine Science (www.aims.gov.au), physical removal of the COTS from the immediate reef area is one of the few strategies to have any impact on an outbreak, and even this can only have a localised effect. Although the immediate future looked bleak for much of the corals of eastern Limasawa, the healthy coral cover remaining around Sogod Bay will hopefully provide enough coral larvae to facilitate recolonisation of the reefs over time.

APRIL 2005

With 21 volunteers on site, it was a busy month. CCC survey teams made a concerted effort to complete the first set of surveys from the Reef Check program, and thus were not undertaking any CCC Baseline surveys. The latter recommenced in May, when the Baseline program ran side-by-side with the Reef Checks.

Eighteen full 100m Reef Check surveys were completed on the west coast of Tangkaan in order to produce quantitative data on the reefs of the area. A further 2 surveys were completed on the east coast, bringing the surveyed area up to a total of 2 kilometres. Together, these data will be used to quantitatively map the reefs, which are considered to have outstanding live hard coral (LHC) cover. On various transects, LHC has been repeatedly

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quantified at greater than 70%, with a number of surveys returning values of over 80%. In a country where over 95% of reefs are classified as being 'at risk', with a massive number in a state of severe degradation, the results are very encouraging and are testament to the efforts of the fisherfolk and the LGUs to limit the destruction that has happened all too frequently elsewhere in the Philippines.

On April 22nd, CCC was pleased to part of the International Dive-In-To-Earth Day.



This is an annual event around the globe, whereby individuals and organisations can pitch in and make a difference to the marine environment on which so many of the world's people directly depend

(and on which we all depend on a wider scale). With the impending opening of the new Marine Protected Areas in Padre Burgos Municipality, seven teams of divers 'spring-cleaned' the reefs at the proposed site of the Santa Sofia MPA, removing garbage, old fishing gear, car tyres and a multitude of other alien objects. Simultaneously, a dozen of the local children helped to tidy up the shoreline, and collected an enormous amount of plastics and other debris. The day was a great success, and CCC would like to extend its thanks to all involved.



Local children from Barangay Santa Sofia help with cleaning the shoreline, while CCC dive teams collect rubbish from the reefs

MAY 2005

After a long but rewarding process, the four carefully planned Marine Protected Areas were launched simultaneously in Tangkaan, Santa Sofia, Buenavista and Lungsoda-an Barangays of the Padre Burgos Municipality. Attended by the Provincial Governor of Southern Leyte, Hon. Rosette Y. Lerias, the opening was an outstanding success. Encouraging speeches were made by the Mayor of Padre Burgos, as well as by representatives of the fisherfolk, the Local Government Units and by the CCC Project Scientist. Everyone got a chance to visit the MPAs and see firsthand how the effort put in by the community has paid off. In the coming years, the MPAs are hoped to encourage the conservation of the reefs, and potentially even to augment the regeneration of local fish stocks, giving the fisherfolk the chance to continue their livelihoods in a sustainable fashion.

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Jan Van Bochove (CCC Project Scientist) addresses the assembly during the opening ceremony for the new MPAs

It must be borne in mind that the installation of the marker buoys is not the end of the MPA process, but is really just the beginning; ongoing effort and vigilance will be required if the MPAs are to have the best chance of succeeding. CCC would like to take this opportunity to extend its sincerest gratitude to Dr. Alan T. White (Tetra Tech EM Inc., Cebu) and Mike Ross (Coastal Dynamics Foundation, Cebu) for their giving their invaluable advice and experience to the project.

At the start of the month, CCC representatives were pleased to be invited to assist in the monthly beach cleanup organised by the Catholic Youth Movement of Sogod Municipality. After the event, the CCC Project Scientist gave a talk on the marine environment of Sogod Bay, pointing out the opportunities and the threats that face the coastal communities. Community initiatives such as this are a keystone in enhancing local understanding of the processes and behaviours that can impact both

positively and negatively on the ecology of the coastal zone.

An underwater reef cleanup was held in the Buenavista Fish Sanctuary on the 21st of May, a week before the official opening ceremony. Six teams of divers cleaned the reefs at the newly installed MPA, from a depth of 25m to the shallow backreef areas.



The CCC dive boat, "Sanga", stands off during the underwater cleanup of the new MPA in Barangay Buenavista.

JUNE 2005

A workshop was held in Padre Burgos municipality for the local fisherman so that they could share ideas and opinions with representatives of Coral Cay, the Provincial Coastal Resource Management Office and representatives from the Municipality on the recently installed marine protected areas (MPAs). The project scientist gave a lecture on the importance of protecting coral reefs and the sustainable management of fish stocks through the use of fish sanctuaries. The fishermen were asked to fill in a

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survey at the end of the session, in which they could express their expectations and thoughts about the sanctuaries. There was full support and enthusiasm for the sanctuaries. This is a good basis for successful management and is a bold step towards achieving sustainable livelihoods for the community.

Coral Cay volunteers again helped out with the Youth Catholic Movement this month with their beach cleanup in Sogod. CCC would like to congratulate YOCAM on their being placed in the top 20 youth organisations in the Philippines this year. Coral Cay representatives also helped the United States Peace Corps in conducting an Open Day for several classes of school children in the Municipality of Malitbog.



CCC Volunteers pitching in with members of YOCAM during the beach cleanup

After years of service, the 'Fred the Fish Show' puppet show props were starting to show their age, so the whole show was completely rebuilt from scratch, and it made a big comeback this month with shows given to the children of Padre Burgos at the town centre and the

chapel. A show was also given at the Miss Southern Leyte beauty pageant; a rather more mature audience, although no less enthusiastic!



The new set and props for "Fred the Fish", CCC's educational puppet show, on its maiden outing

Apart from collecting data and increasing community awareness about the importance of protecting the marine environment, another aim of the Southern Leyte Coral Reef Conservation Project is to give SCUBA diving and marine survey training to local counterparts. The counterpart training involves three days of dive training that will bring the participants up to the PADI Open Water SCUBA diving level. The trainees subsequently undergo a three day 'science development program' during which they receive lectures in tropical marine biology, and learn how to conduct underwater surveys. Future monitoring of fish sanctuaries can then be carried out without the presence of Coral Cay representatives. Close monitoring of the sanctuaries ensures that changes in fish numbers and sizes are detected and

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this will help keep the community enthusiastic and involved in the project. This programme was relaunched in June, with three candidates being accepted for training.

JULY 2005

On the 17th of July, an Open Day was held at the SLCRCP base, when CCC welcomed back some of the children from Kinderhilfe. Around 30 children got the opportunity to try out some diving equipment, watch a movie about the coral reefs, get a tour of our facilities and take part in a game called the 'Coral Race for Survival'. Afterwards there was a slide show by the science staff. As a grand finale, the famous 'Adventures of Fred the Fish Show' was put on by some of the volunteers.



"Team Anemone" try on their headgear during the Kinderhilfe Open Day at the CCC project base

AUGUST 2005

The *Habagat* monsoon that affects the Visayas at this time washed up a lot of rubbish on the beaches. To increase community awareness about the effects of using the ocean as a waste disposal site, CCC regularly organises beach cleanups.



Representatives from Barangay Tangkaan with the dump truck full of rubbish collected from the beaches of the Barangay

Representatives from the Tangkaan Barangay helped CCC to do a thorough cleanup at the project site beach. The teams managed to collect almost a truck full of plastic, Styrofoam and other non-biodegradable items. Mistaking them for food, turtles often die after eating plastic bags. They also smother the corals, preventing them from receiving the light needed for the primary production of sugars.

The 'Adventures of *Fred the Fish*' show took a trip to Limasawa Island this month. The Project Scientist gave a lecture on the beauty and importance of the reefs

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around the island. Coral Cay volunteers showed the elementary school children how to use SCUBA equipment in one of the dunk tanks, and the afternoon was finished off with the already quite famous puppet show. Fred and his friends will continue to play a starring role in this environmental awareness campaign.



Schoolchildren from Limasawa Island join CCC Volunteers for an Open Day in the town of Triana

CCC would like to take this opportunity to thank the British Ambassador to the Philippines, His Excellency Peter Beckingham, and his wife Jill, for spending some time at the project site this month. The interest they showed in CCC's work was a great inspiration to everyone to continue the work that has been done so far. Gerry L. Ledesma, from the Philippine Reef & Rainforest Conservation Foundation Inc (PRRCFI), also honoured the project with a visit at this time. Gerry is a cornerstone of the Southern Leyte Coral Reef Conservation Project, and without his vision and enthusiasm, the SLCRCP would never have come into being.



The British Ambassador to the Philippines, Peter Beckingham, joins CCC and PRRCFI personnel aboard the CCC dive boat

The Provincial Government did a fantastic job in organising a banquet and entertaining the assembly, with a display of traditional dancing, and singing from the Provincial choir. CCC hopes the British Embassy in Manila will continue to support its efforts to help sustain livelihoods and alleviate poverty through the protection, restoration and management of coral reefs here in Southern Leyte.

SEPTEMBER 2005

Together with the Provincial Coastal Resource Management Office, CCC has been actively involved in helping the community of Molopolo (on the Pacific side of Southern Leyte) to develop a management plan for their fisheries. This has led to the creation of a proposal for the installation of a 12 hectare fish sanctuary in an area that has been previously surveyed by CCC dive teams. The results of these surveys were used to

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determine suitable locations for potential MPAs, giving the greatest chance of recovery without interfering with current fishing grounds. In a seminar held in the community chapel, the proposals were put to the fishermen and were received enthusiastically. The initial proposal had involved installing one smaller sanctuary in one of two locations, but the fisherfolk voted in favour of creating a larger sanctuary, encompassing both of the proposed sites. CCC will continue to provide assistance to the people of Molopolo, by teaching practical conservation science and marine survey methodology to local counterparts from the area.



CCC's Project Scientist giving a marine awareness talk to elementary school children in Molopolo

OCTOBER 2005

High School students at the College of Maasin enjoyed watching a DVD of the 'Blue Planet' television series that highlights the amazing diversity and beauty of coral reefs. These videos were kindly donated to the project by the BBC and have been put to great use. The enthusiastic crowd was taught what they

could do to stop the destruction of the reefs. Simple measures such as throwing garbage in proper disposal bins instead of into the ocean, and taking care to avoid stepping on corals whilst reef-gleaning for edible invertebrates, can have a profound effect on the general health of the reef in populated areas. With a better understanding and appreciation of the reefs (as well as of their future potential as a source of income from both fishing and tourism), comes an increased willingness to protect this vital resource.

Also this month, the quarterly meeting of the Coastal Resources Management Network was held at the CCC project base on the 12th of October, and a high attendance led to an interesting and productive meeting.

NOVEMBER 2005

On the 27th of November, an Open Day was organised for the Youth Catholic Movement (YOCAM). About 35 children got to try on some SCUBA equipment, go for a snorkel with our volunteers and watch a video that underlines the problems facing the Philippine reefs. The highlight of the day was a mangrove replant in Buenavista. Around 1000 6-month old seedlings were planted in order to promote mangrove regrowth in the area. At one time, over 75% of the Philippine coasts were covered with mangrove forest. Unfortunately, much of this has been cleared for land reclamation, deforestation and for use as

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fishponds for aquaculture. It is now understood that healthy mangrove forest can provide more protein per unit area than fish ponds, and in addition to this have an important ecological function as a nursery ground for juvenile fish before they migrate to the reefs as they mature.



YOCAM and CCC hard at work planting 1000 mangrove seedlings in Barangay Buenavista

Also this month, 14 local counterparts successfully completed a 5-day 'Marine Awareness Scholarship Programme for Sanctuary Wardens'. During the week, the participants were taught to recognise and identify benthic life forms and fish families. After the classroom training, a simple but robust snorkelling survey methodology was practiced in the water. This method, developed within the MPA Project (www.coast.ph) will be used by the wardens to assess the success of marine protected areas. Most of the participants will be 'sanctuary wardens' in their respective Barangays, monitoring and guarding the marine protected areas and making sure the restrictions that apply to the area are upheld. CCC wishes them all the best of luck in their future

roles, and would like to extend a very special thanks to the British Embassy in Manila for providing funding in support of this initiative.

DECEMBER 2005

To celebrate the end of a very productive year for the SLCRCP, Santa Claus made a surprise appearance at a special Christmas Open Day, held for the local children of Tangkaan. In addition to the usual Open Day activities, Santa's grotto was open to visitors. When the Christmas season is over, Santa Claus spends the rest of the year masquerading as Dr. Doug Fenner, the world renowned coral taxonomist. Doug kindly made room in his busy schedule to visit the SLCRCP for the second time, on this occasion cataloguing the species of hard corals found on the reefs of Tangkaan. The results were startling: Doug identified 141 species of coral on a single dive, his 4th highest species tally on a single dive anywhere in the world. Details of Doug's findings are presented in section 4.



Santa Claus (a.k.a. Dr. Doug Fenner) in his grotto during the Christmas Open Day at the project base

3 Scientific - Background & 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 December 2005. 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.



Volunteers learning coral reef species identification under the guidance of project science staff

Each survey provides one or more biological record forms which are effectively snapshots of the biological communities (benthic and fish) found within any particular reef zone. These data are complimented by basic physical and oceanographic information (see the Appendix for reproductions of the survey forms).

The CCC Reef Survey Technique utilises a series of plot-less transects, perpendicular to the reef, starting from the 18m contour (28m if the reef extends beyond 18m) and terminating at the reef crest or in very shallow water (0.5m). Benthic and fish surveys are focused on life forms or families along with a pre-selected number of target species that are abundant, easily identifiable or ecologically or commercially important.

During the course of each sub-transect survey, divers may have traversed two or more apparently discrete habitat types,

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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.

Abundance rating	Sessile species (approximate percentage cover)	Fish and motile invertebrates (no. of individuals)
0	0	0
1	1-10%	1-5
2	11-30%	6-20
3	31-50%	21-50
4	51-75%	51-250
5	76-100%	250+

Table 1 Ordinal scale (DAFOR) assigned to life forms and target species during baseline surveys.

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. 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 into 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 impact such as broken coral or fishing nets. Diver 1 also describes the substratum along the sub-transect by recording the presence of six substrate categories (dead coral, dead coral with algae, bedrock, rubble, sand and mud). Divers 2, 3 and 4 survey 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

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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 geomorphological (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 on obvious anthropogenic impacts and activities are recorded at depth by the divers and from the surface support vessel. Water temperature readings ($\pm 0.5^{\circ}\text{C}$) are taken from the survey boat at the sea surface. The survey team also records the temperature at the maximum survey depth (i.e. at the start of the survey) and the air temperature.

Similarly, salinity is recorded using a hydrometer and water samples taken from both the surface and the maximum survey depth. Water visibility, a surrogate of turbidity (sediment load), is measured both vertically and horizontally. A Secchi disc is used on the survey boat to measure vertical visibility through the water column (Figure 2). Secchi disc readings are not taken where the water is too shallow to obtain a true reading. Horizontal visibility through the water column is measured by divers' estimates while underwater.

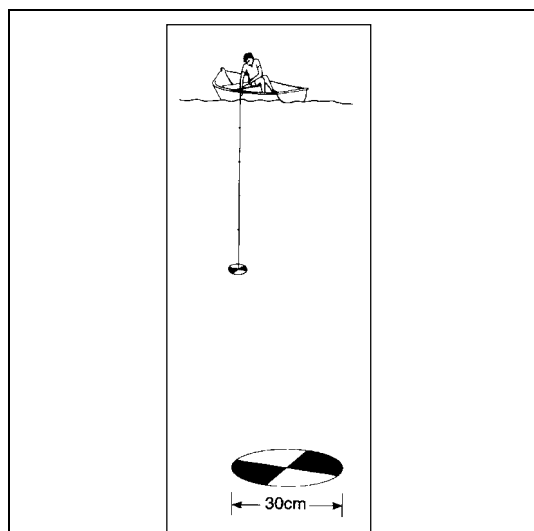


Figure 2 *The use of a Secchi disc to assess vertical water clarity. The Secchi disc is lowered into the water until the black and white quarters are no longer distinguishable. The length of rope from the surveyor to the disc is then recorded. Source: English et al. (1997).*

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',

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‘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 that in which extensive geographical data can be ‘simplified’ in the form of 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, land-based managers and decision makers can ‘look below the surface’ without getting wet. 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 therefore 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, building a customisable 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 with the Inverse Distance Weighted function in the Spatial Analyst of ArcView 8.3 (ESRI software).

4 Scientific – Results & Discussion



It would not be possible (nor necessarily useful) within this report to undertake an exhaustive analysis of all of the data gathered during the reporting period. However, all of the data are made freely available in a GIS compatible database, allowing interested parties to undertake further analysis of any particular data.

Between September 2002 and December 2005, CCC survey teams produced 671 individual survey records from 531 survey dives around Sogod Bay (Figure 3). Although data from 2002 and 2003 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 reefs in this region were very heavily sedimented, likely as a result of the influx of large quantities of terrigenous sediment via the river tributaries entering the bay at or near Sogod town. Reefs that had not been buried under sediment were found to be very heavily impacted, a fact known to the Provincial Government, which has been undertaking a programme of bamboo replanting along the riverbanks in an effort to mitigate this effect. For this reason, it was considered appropriate for CCC teams to concentrate the surveying effort on the more southerly reefs of the bay, which were likely to be less impacted.

During the survey programme, the bay was divided into 26 geographically distinct survey sectors (see Figure 18). For the purposes of this analysis, the surveys have been recombined into 6 geographical Regions, the boundaries of which approximate the Municipal boundaries around the bay. These are Region A (Padre Burgos: Sectors 5,6 & 7), Region B (Malitbog: Sectors 8 & 9), Region C (Tomas Oppus/Bontoc: Sectors 10, 11 & 12), Region D (Libagon: Sector 18), Region E (Liloan: Sectors 19 & 20) and Region F (San Francisco: Sectors 21 & 22).

Although data have been gathered from a number of sites around Limasawa Island, analysis of the reefs here will not be conducted until a larger dataset has been compiled from survey work that has been conducted in 2006.

The data have been analysed in a number of ways, namely:

Results from oceanographic and impact data [Section 4.1]

Results from biological indicators [Section 4.2]

Definition of ecologically distinct marine habitats [Section 4.3]

Generation of management ratings (Conservation Management Value) for each survey site [Section 4.4]

4 Scientific – Results & Discussion

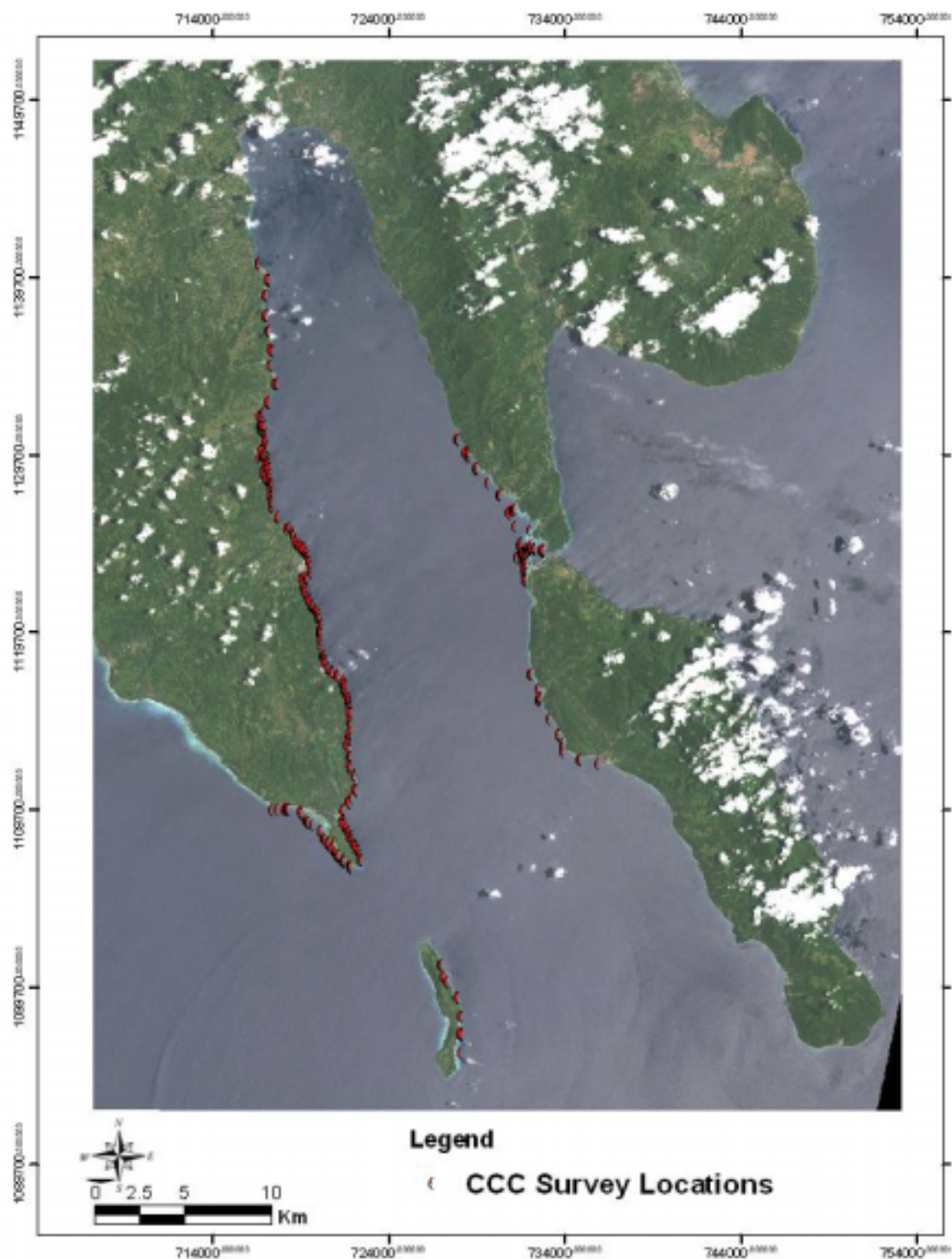


Figure 3 Locations of the 531 survey dives conducted around Sogod Bay by CCC teams between September 2002 and December 2005

4 Scientific – Results & Discussion



4.1 RESULTS FROM OCEANOGRAPHIC AND IMPACT DATA

4.1.1 Water temperature

The data for mean recorded sea surface temperatures are displayed in Figure 4. Predictably, sea surface temperatures can be seen to reflect seasonal fluctuations in air temperature and solar irradiance, with the highest mean temperatures being recorded in the months of May to July. The highest single value (33°C) was recorded in July 2004.

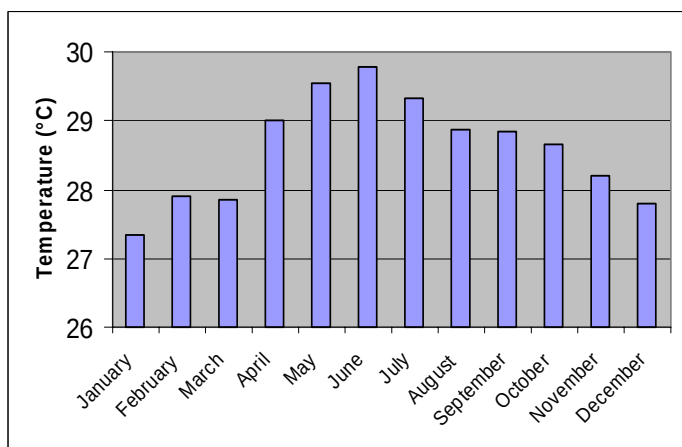


Figure 4 Annual fluctuation in mean surface water temperature

4.1.2 Salinity

Sea water salinity measurements were taken from samples obtained at the surface and at the lowest depth of each survey dive. These data are presented in Figure 5, with mean values calculated in 5m depth classes. Error bars in the graph represent the standard deviation of samples within each class. The overall mean was found to be 30.4‰.

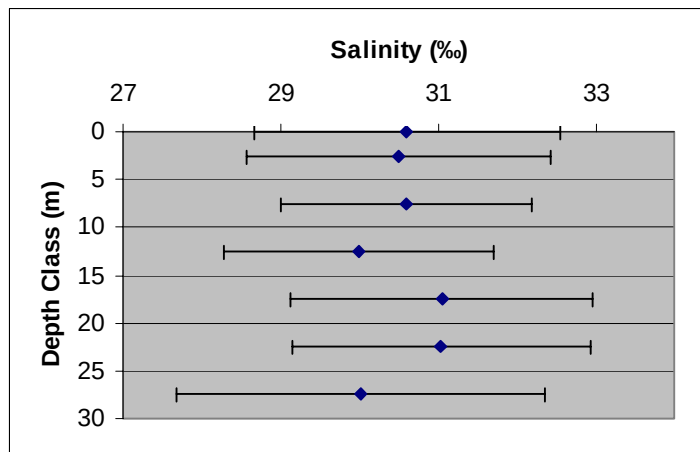


Figure 5 Mean seawater salinity in 5m depth classes

4.1.3 Current

Survey teams collected data on water current direction and strength. Current direction was found to be either north or south (i.e. following the shoreline of the bay, as the tide ebbed or flowed), with no statically significant variation. Current strength was recorded qualitatively in the classes “none”, “weak”, “medium”, and “strong”. The majority of currents were either weak or medium (49% and 33% respectively). Strong currents were only recorded on 4% of surveys, particularly around headlands. These areas were also found to have the highest populations of pelagic fishes, such as jacks/trevallies.



4.1.4 Boat frequency and activity

Boats that were observed during surveys were recorded in 4 activity classes, namely “fishing”, “diving”, “commercial” and “other”. The vast majority of boats observed during the survey programme were involved in fishing (81%) - Figure 6. The next single greatest class was “diving” (10%), then “commercial” (7%).

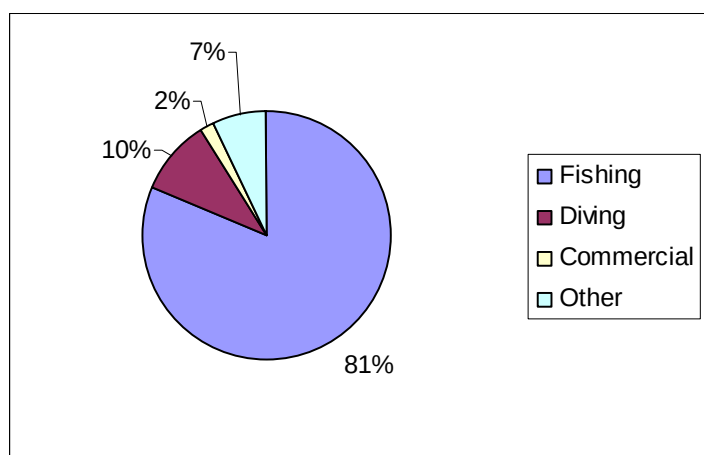


Figure 6 Boat activity by class, as a percentage of total boat observations

Figure 7 displays boat activity by class in each region. It can be seen that boat traffic tends to be higher on the eastern side of the bay. The relatively large number of commercial boats observed in Region E is likely accounted for by ferry traffic at the port of Liloan, and the relatively large number of dive boats observed in Region F is likely accounted for by traffic at Napantao Fish Sanctuary in the Municipality of San Francisco.

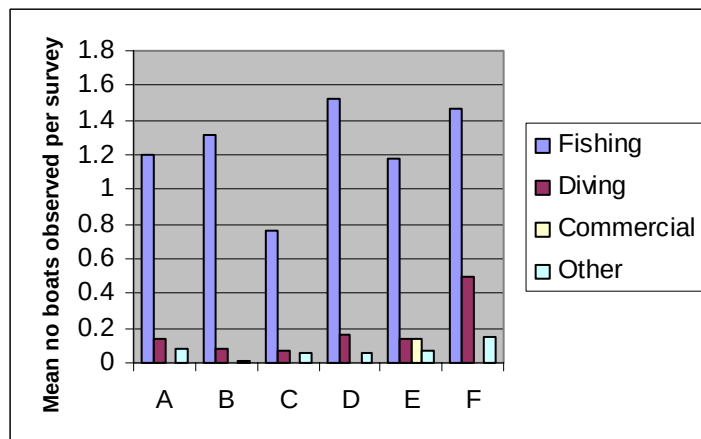


Figure 7 Boat activity by class in each region

4.1.5 Subsurface Impacts

Data were gathered on the presence of subsurface impacts, divided into a number of classes (Figure 8). Regions A and E had the highest recorded incidence of fish traps (13% and 12% of transects respectively; the overall mean was 9%). They also had the highest recorded incidence of discarded fishing gear (16% of transects for both; overall mean 11%). Overall, Region D was the most heavily impacted, with evidence of such being recorded on 95% of transects. However, evidence of fishing was particularly low, with fish traps or discarded fishing gear only being recorded on 5% of transects. The particularly high incidence of sediment in this Region is probably as a result of a series of landslides which had occurred just prior to the surveying of the area.

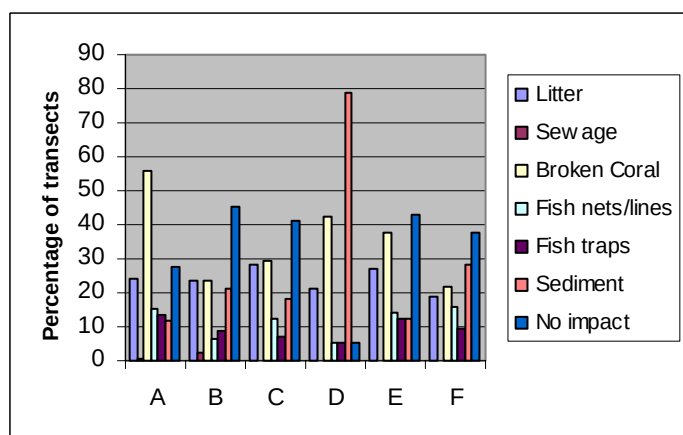


Figure 8 Percentage of surveys within each sector on which each sub-surface impact class was observed

4.2 RESULTS FROM BIOLOGICAL INDICATORS

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

4.2.1 Scleractinian Corals

Areas with high live hard coral cover were discovered in all survey Regions, with exceptionally high cover found in Regions

A, E and F (Figure 9). Region A was found to have the highest overall coral cover, with a median value of DAFOR 3 ($\approx$ 31%-50% of surveyed benthos). Although sites with coral cover values of DAFOR 5 (>75% of surveyed benthos) were recorded in Regions A and F, these were far more prevalent in Region A, accounting for 26% of all surveys, compared to only 5% of surveys in Region F.

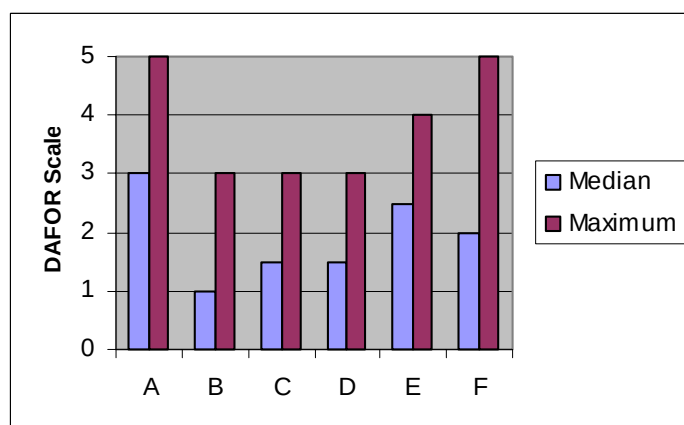


Figure 9 Hard coral cover median and maximum values by Region

The most commonly occurring hard corals have been ranked according the percentage of the total number of transects on which they were recorded (Table 2). The most commonly occurring coral lifeforms have also been ranked in Table 3. The justification for this approach is that it is 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 2), and thus is widely distributed on the reefs.

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Taxonomic name	% of transects on which each coral was recorded	Maximum recorded DAFOR value
<i>Favia</i> spp.	70	3
<i>Favites</i> spp.	67	3
<i>Porites</i> spp. (massive)	65	4
<i>Lobophyllia</i> spp.	62	3
<i>Galaxea</i> spp.	60	3
<i>Goniopora</i> / <i>Alveopora</i> spp.	58	4
<i>Seriatopora hystrix</i>	48	1
<i>Pocillopora damicornis</i>	40	2
<i>Millepora</i> spp.	36	4
<i>Herpolitha limax</i>	34	1
<i>Mycedium elephantotus</i>	31	2
<i>Euphyllia</i> spp.	31	3
<i>Pocillopora</i> spp. (medium)	31	3
<i>Diploastrea heliopora</i>	30	3
<i>Plerogyra</i> spp.	30	2
<i>Ctenactis echinata</i>	29	1
<i>Pectinia lactuca</i>	27	3
<i>Pachyseris speciosa</i>	23	3
<i>Echinopora</i> spp.	22	4
<i>Montipora</i> spp. (foliose)	21	3
<i>Pachyseris rugosa</i>	20	2
<i>Porites cylindrica</i>	19	4
<i>Tubastrea micrantha</i>	18	3
<i>Turbinaria</i> spp.	17	3
Upsidedown bowl	13	2
<i>Polyphyllia talpina</i>	10	1
<i>Hydnophora</i> spp.	10	3
<i>Pocillopora</i> spp. (large)	8	2
<i>Tubipora</i> spp.	6	1
<i>Heliopora</i> spp.	5	2
<i>Pavona clavus</i>	4	1
<i>Porites rus</i>	3	1
<i>Porites nigrescens</i>	2	1

Table 2 Most commonly recorded hard coral genera and /or species

Coral Lifeform	% of transects on which each lifeform was recorded	Maximum recorded DAFOR value
Non- <i>Acropora</i> Submassive	80	4
Non- <i>Acropora</i> Branching	72	4
Non- <i>Acropora</i> Mushroom	71	4
<i>Acropora</i> Branching	71	5
Non- <i>Acropora</i> Encrusting	67	4
Non- <i>Acropora</i> Massive	64	4
Non- <i>Acropora</i> Foliose	53	5
<i>Acropora</i> Tabulate	49	4
<i>Acropora</i> Bottlebrush	39	5
Brain: Small	36	3
Brain: Medium	27	3
<i>Acropora</i> Submassive	18	4
Brain: Large	15	3
<i>Acropora</i> Encrusting	14	3
<i>Acropora</i> Digitate	11	3

Table 3 Most commonly recorded hard coral lifeforms

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In December 2005, Dr. Douglas Fenner conducted a series of survey dives on the reefs of Region A (Padre Burgos Municipality), compiling a list of corals for 4 sites. The survey involved about 9 hours of scuba diving (plus additional snorkelling) by D. Fenner to a maximum depth of 17.6 meters.

The results of this survey campaign showed the reefs near Padre Burgos to have a highly diverse coral fauna. A total of 251 species in 65 genera of hard corals (239 species and 59 genera of zooxanthellate Scleractinia) were observed during the survey, which is more than the number found after the same number of hours of diving in Tubbataha (205), Sierra Madre (108), Cagiangcillio (220), Calamianes (202), Malitbog (227), Cagdanao (245), and Apo Island (229).

Species numbers at visually sampled sites ranged from 83 to 141, with an average of 108.8 per site. This latter site (141 species) was, in terms of coral diversity, the fourth highest ranking site that Dr. Fenner has surveyed anywhere in the world. Previous surveys with the same method and author have produced an average of 93.6 species per site in extensive diving in 12 locations within the “Coral Triangle” area of highest diversity. Thus, the reefs of Padre Burgos have been found to accommodate more coral species than most Philippine reefs.

This discreet study found 54% of the (461) species of zooxanthellate Scleractinia reported so far from all of the Philippines, and it is felt that additional study would find many more. This high diversity supports the value of efforts to use these reefs sustainably.

4.2.2 Lobsters

Lobsters populations were found to be very low, with individuals being recorded on only 0.6% of all transects in the bay. Zero lobsters were recorded in Regions E and F. Region C had the highest incidence of lobsters (2% of transects), which may be at least partially attributable to this Region having some of the longest established Marine Protected Areas in Sogod Bay, including those at Tomas Oppus and Timba.

4.2.3 Giant Clams (*Tridacna* spp.)

Giant clams have probably been harvested for food and ornamentation for longer than recorded history. Although they can grow very quickly, adverse environmental conditions can have retarding effect. Populations of giant clams were found to be higher on the eastern side of the bay, with individuals being recorded on 16% and 19% of surveys in Regions E and F respectively (Figure 10).



The paucity of giant clams in Region D may be attributable to the landslides which had occurred just prior to the Region being surveyed in 2004. The magnitude of the volume of terrigenous sediment that settled on the reefs (see Figure 8 - sediment) is likely to have had a severely adverse effect on this, and other, benthic filter feeders.

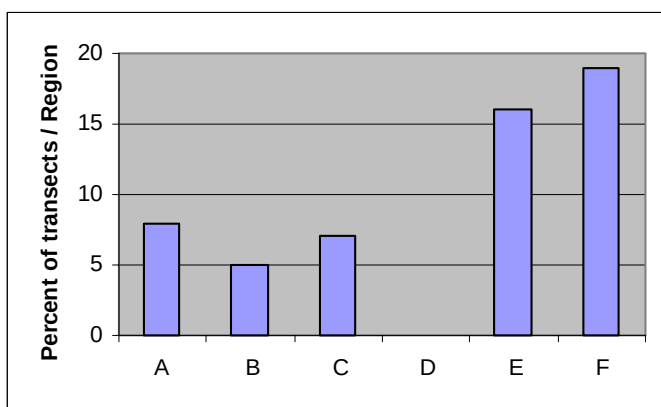


Figure 10 Giant clams (*Tridacna* spp.) by Region, expressed as a percentage of the number of transects in each Region on which they were recorded

4.2.4 Sea-Urchins

Sea urchins were recorded in two classes, namely “short spined” and “long-spined” (*Diadema* spp.). Populations of *Diadema* urchins were found to be higher than other urchins in all Regions (Figure 11), with the most frequent observations of both classes found in Regions D and E. Most urchins are macroalgal grazers, and thus the relatively high abundance of urchins in Region D is of particular interest, as macroalgal populations in the Region are relatively low (Figure 12). It is worth noting that the frequency of observations of urchins shown in Figure 11 closely mirrors the frequency of

observations for cyano-bacteria in all Regions.

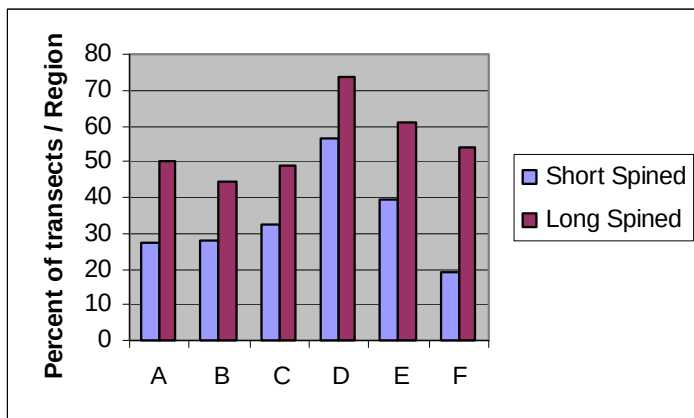


Figure 11 Sea urchins by Region, expressed as a percentage of the number of transects in each Region on which they were recorded

4.2.5 Macroalgae

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 of the analysis, as most cyanobacteria 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, being recorded on 55% of all transects in the bay (Figure 12). The next most common were green filamentous algae (40%), *Dictyota* spp. (38%), and *Padina* spp. (22%).

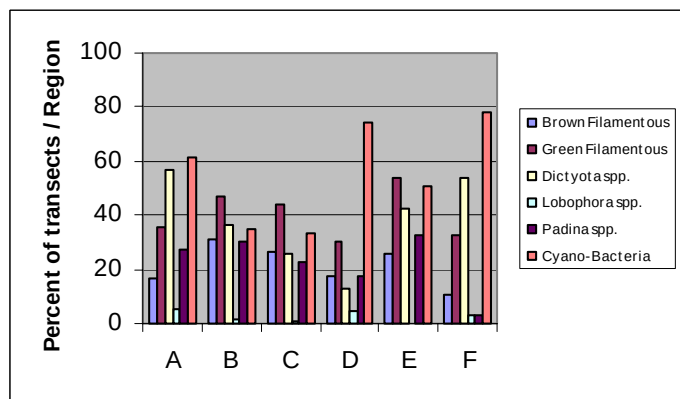


Figure 12 *Macroalgae by Region, displayed as a percentage of the number of transects on which they were recorded*

The maximum DAFOR values for each of these taxa in each Region are displayed in Figure 13. It can be seen that the abundance of algae tends to higher on the west side of the bay than on the east (even discounting Region D because of the effects of recent landslide detritus on the reef).

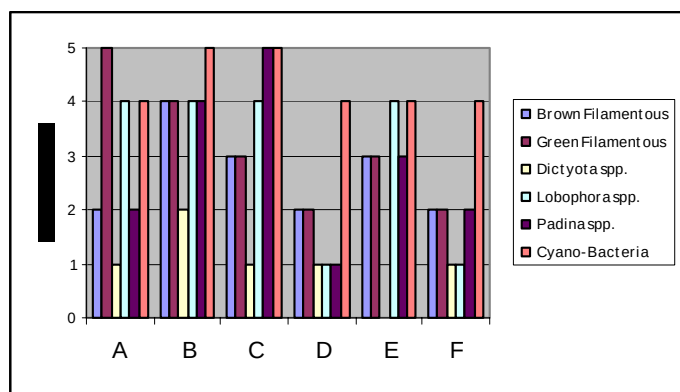


Figure 13 *Maximum recorded DAFOR values for each algal taxon by Region*

4.2.6 Groupers (Serranidae)

Groupers are recognized to be one of the most valuable fisheries targets, and tend to be consumed as a ‘fish of choice’ because they are easy to eat with comparatively few bones. Most, if not all,

grouper species are particularly vulnerable to exploitation, as they tend not to begin spawning until the age of 5-7 years. 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 Grouper are not possible to fish in a many that is ecologically sustainably at a rate that is commercially viable, although some successes have been achieved in Grouper aquaculture. Grouper populations were found to be extremely low throughout the bay, where the median DAFOR value recorded across all Regions was zero (Figure 14). Furthermore, zero grouper of any species were recorded in Regions D and F, and the graphed maximum DAFOR 2 (6-20 individuals) was only recorded at one site in Region C. As with lobsters, this may be at least partially accounted for by the long-established MPAs in Tomas Oppus and Timba.

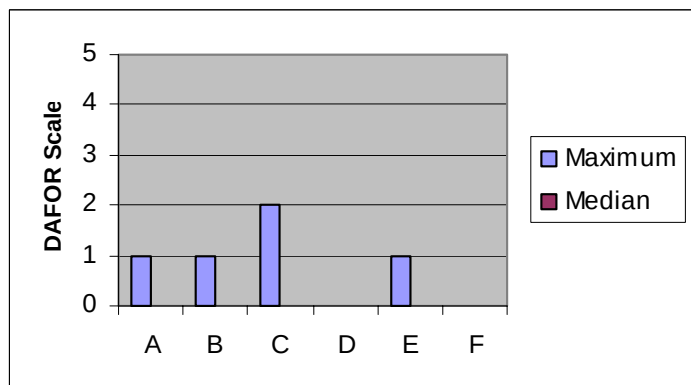


Figure 14 *Grouper maximum and median values by Region*

4.2.7 Snappers

Like groupers, most snappers are medium to large carnivores, and are important targets for artisanal reef-associated fisheries. Although the median value for snappers was zero across all Regions (Figure 15), the highest abundances were found on the west side of the bay (Regions A, B and C). However, they were recorded on an average of 10% of all transects throughout the bay, and this distribution was of low variability by Region ($\delta = \pm 1.3\%$).

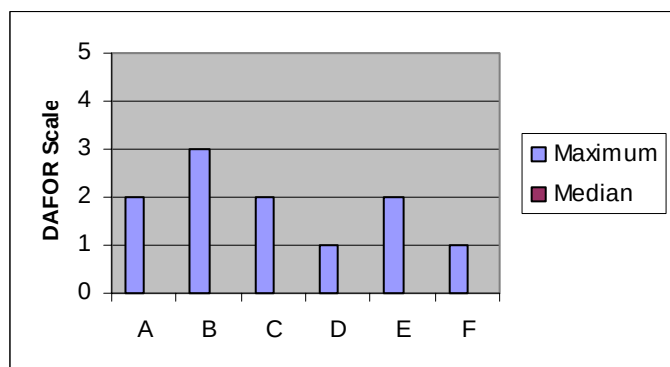


Figure 15 *Snapper maximum and median values by Region*

4.2.8 Parrotfish

Parrotfish are important grazers on the reef, helping to keep macroalgal abundance in check. Within the classical trophic chain, their herbivorous lifestyle strategy tends to provide for greater numbers of individuals within a population, compared with the large carnivores, such as groupers. Only in Region E was the average value for parrotfishes found to be >0 (Figure 16). This region also had the highest recorded maximum (DAFOR 3 = 21 to 50 individuals).

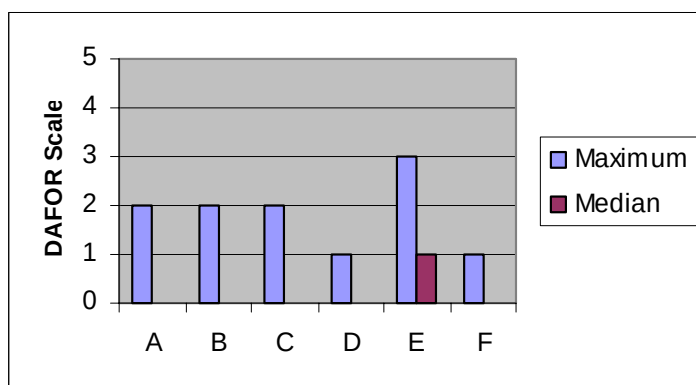


Figure 16 *Parrotfish maximum and median values by Region*

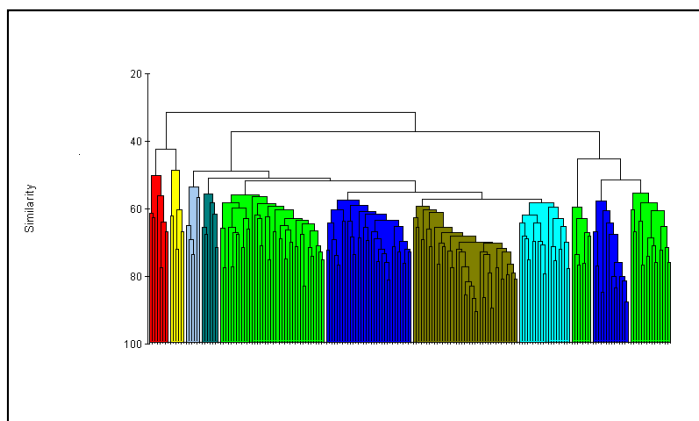


4.2.9 Rare and Endangered Species

Southern Leyte is fortunate enough to play host to a number of key endangered species, such as humphead wrasse (*Cheilinus undulatus*), bumphead parrotfish (*Bolbometopon muricatum*), and tritons trumpet (*Charonia tritonis*), many of which are protected under Philippine and international law. As these species are particularly vulnerable to human exploitation, it is not considered appropriate to highlight their locations in a freely available report. The location and abundances of these organisms are contained in the GIS compatible database which will be made available to governmental and academic institutions, and will be discussed in person with the Provincial Coastal Resources Management Office of Southern Leyte.

4.3 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 percent. 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 (Figure 17). SIMPER is then used to define the key characteristics of each cluster. Ultimately, 10 discreet ecological habitats have been defined for the area. A summary of these is



presented in Table 4.

Figure 17 PRIMER Hierarchical Cluster Analysis output, coloured to show the discreet ecological habitat clusters, as defined from a random sample ($n=300$) of the survey data. Each vertical line within each cluster represents an individual site record

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Habitat	No of Site Records	Avg Depth (m)	Dominant Substrata	Hard Corals	Soft Corals	Sponges	Algae / Seagrass	Avg # Benthic Spp	Avg # Fish Spp	Avg Shannon Weiner Diversity Index (Benthic)	Avg Shannon Weiner Diversity Index (Fish)
1 Coralline rubble	31	10	Rubble (4.0) Sand (1.5) Hard Coral (1.5)	Total (1.5) <i>Acropora</i> branching (0.5) Non- <i>Acropora</i> Sub Massive (0.5) Massive <i>Porites</i> (0.5)	Total (1.0) Tree (0.5) Pulsing (0.5)	Total (1.0)	<i>Padina</i> spp (1.0) Encrusting Red (1.0) <i>Dictyota</i> spp (0.5)	16	13	2.30	1.60
2 Shallow bedrock; low biotic cover but complex algal assemblages	31	6	Bedrock (3.5) Hard Coral (1.5)	Total (1.5) Non- <i>Acropora</i> Sub Massive (1.0) Non- <i>Acropora</i> branching (0.5) <i>Acropora</i> branching (0.5)	Total (1.0) Leather (0.5) Tree (0.5)	Total (1.0)	<i>Padina</i> Spp (1.0) <i>Sargassum</i> spp. (1.0) Green filamentous (1.0)	16	11	2.24	1.45
3 Deep bedrock; high hard coral and sponge cover, and sparse algae	13	24	Bedrock (3.0) Hard Coral (3.0)	Total (3.0) Non- <i>Acropora</i> encrusting (2.0) <i>Pachyseris speciosa</i> (2.0) <i>Acropora</i> tabulate (1.0) <i>Acropora</i> branching (1.0)	Total (2.0) Diverse lifeforms	Total (2.0)	Green filamentous (1.0)	30	16	2.83	2.17
4 Mixed hard coral and sand	24	15	Sand (3.0) and Hard Coral (3.0)	Total (3.0) <i>Acropora</i> branching (2.0) Non- <i>Acropora</i> encrusting (1.5) <i>Acropora</i> tabulate (1.0)	Total (1.5) Encrusting (1.5)	Total (2.0)	<i>Dictyota</i> spp (1.0) Green Filamentous (1.0) Red encrusting (1.0)	36	22	3.11	2.30

Table 4 Major characteristics of the benthic classes defined from baseline data collected from the reefs of Sogod Bay. Figures in parentheses indicate average abundances in accordance with DAFOR ratings assigned during surveys (continued next page).

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5 Very high hard coral cover	92	15	Hard Coral (4.0) and Sand (3.0)	Total (4.0) <i>Acropora</i> branching (2.5) Non- <i>Acropora</i> sub-massive (2.0) Non- <i>Acropora</i> encrusting (2.0) <i>Acropora</i> bottlebrush (1.5)	Total (2.0)	Total (2.0)	<i>Dictyota</i> spp (1.0) Green Filamentous (1.0)	53	31	3.33	2.64
6 Shallow sand and seagrass	80	7	Sand (3.5)	Total (1.5) Non- <i>Acropora</i> branching (1.5) <i>Acropora</i> branching (1.0)	Total (1.0) Tree (1.0) Leather (1.0) Pulsing (1.0)	Total (1.0)	<i>Halophila</i> spp (2.0) <i>Padina</i> spp (1.0) <i>Dictyota</i> spp (1.0) Green Filamentous (1.0)	43	26	3.24	2.45
7 Mixed abiotic substrate	151	10	Sand (1.5) Dead Coral (1.5) and Bedrock (1.0)	Total (1.0) <i>Acropora</i> branching (1.0) <i>Acropora</i> tabulate (1.0)	Total (1.0)	Total (1.0)	No species greater than 0.5	39	25	3.43	2.49
8 Mid-depth sand with low biotic cover	192	17	Sand (3.5)	Total (1.0) <i>Acropora</i> branching (1.0) Non- <i>Acropora</i> branching (1.0)	Total (1.5)	Total (2.0)	No species greater than 0.5	23	14	2.60	1.86
9 Deep soft coral, sand and rubble	27	20	Sand (3.0) and rubble (2.0)	Total (2.0) Non- <i>Acropora</i> mushroom (2.0)	Total (3.0)	Total (2.0)	Red encrusting (1.0) Red filamentous (1.0) <i>Dictyota</i> spp (1.0) Green Filamentous (1.0)	25	15	2.67	1.87
10 Deep sand with low biotic cover	53	23	Sand (5.0)	Total (1.0) <i>Acropora</i> branching (1.0)	Total (1.5)	Total (1.0)	No species greater than 0.5	20	13	2.56	1.79

Table 4 (Continued) Major characteristics of the benthic classes defined from baseline data collected from the reefs of Sogod Bay. Figures in parentheses indicate average abundances in accordance with DAFOR ratings assigned during surveys.



4.4 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, number of benthic species recorded (not including algae), number of fish species recorded, the Shannon-Weiner Biodiversity Index for benthic species (not including algae) and the Shannon-Weiner Biodiversity Index for fish species.

First, 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).

Second, an intra-habitat analysis is conducted, with each site record in each habitat being compared against the other site records within that habitat, to

determine which sites are the most ecologically ‘valuable’ examples of their particular habitat. The same system is used to do this, with site records scoring values of 0-5. To calculate the Conservation Management Value 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 to a Geographic Information System (GIS) to allow for 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 on the next page (Figure 18), the colour red represents areas where lower CMVs are dominant; the colours green and yellow represent areas where higher CMVs are dominant.

[Note: It should be borne in mind that this technique compares each site against the other sites within the region, and thus it is a *relative value*. 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 bay.]

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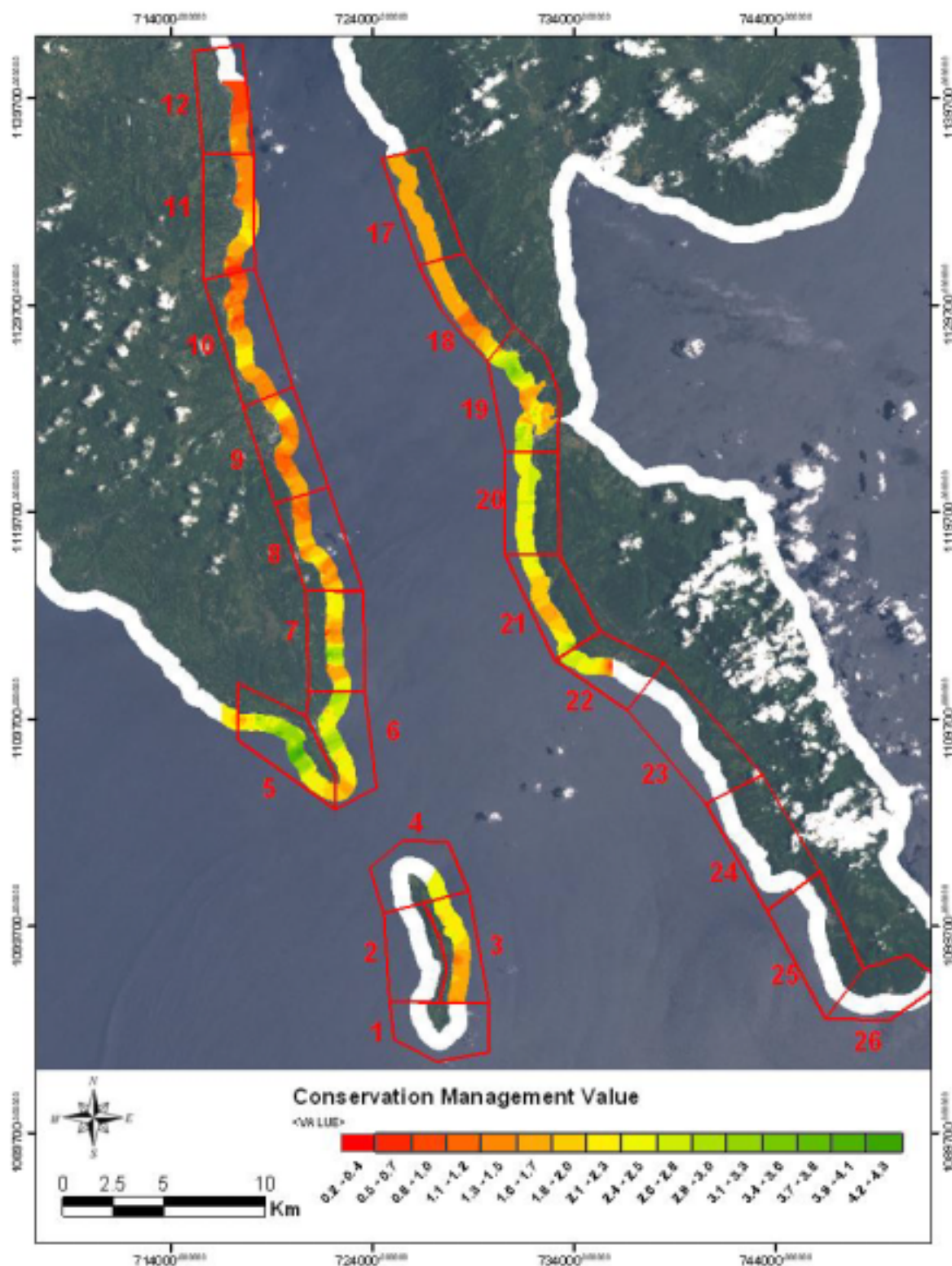


Figure 18 Conservation Management Values (CMVs) displayed as a colour ramp. Areas towards the green end of the spectrum have the highest CMVs.

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The general demise in coral reef ecosystems has been well documented and many factors such as pollution, over-fishing, tropical storms and bleaching events have been reported to contribute to this global phenomenon. The lack of availability 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 likely to be largely attributable to the efforts of the LGUs and fisherfolk of the Province in enforcing 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 reefal 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 installations.

It can be seen from the map of CMVs shown in Figure 18 that areas of moderate to high ecological value (yellows and greens) are dispersed throughout the Sogod Bay area. These areas are necessarily linked by larval dispersal corridors, with water currents within the bay transporting larvae between patch reefs areas.

The creation of a network of smaller MPAs throughout the bay is thus more appropriate for both the ecological and political status of the bay, and the Provincial Coastal Resources Management Office should be congratulated and encouraged in the continuing pursuit of such a strategy.

The reader will be able to observe from the map of CMVs shown in Figure 18 that the ecological health of the reefs tends to improve with proximity to the mouth of the bay. This may be at least partially attributable to the influx of clean oceanic water, which is likely to be lower both in dissolved nutrients and terrigenous sediment than the water in the northern end of the bay into which the rivers and terrestrial runoff flow unchecked, with such dissolved and/or particulate matter being trapped by lower flushing rates than those that would be expected near the mouth of the bay.

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

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have dropped as a result of an unsustainable level of historical fishing (O'Farrell, pers. comm.). The data gathered during the surveying component of the Southern Leyte Coral Reef Conservation Project confirm that, in general, target fish populations are indeed low throughout the bay, although a paucity of historical data makes it impossible to quantify any change at this time. 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 artisinal fishing industry, safeguarding the reefs of the Province., and thus the food-security of its people.



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BIOLOGICAL RECORDING FORM

Study: _____ Transect No: _____ Zone Code: _____

Habitat No: _____ of _____ Date: _____

Database Code: _____

Percentage of Dive: _____ % Start time: _____ End time: _____

First:	Last:	No. dives/snorkels in Fiji	Depth Limits:
Recorder's Name _____	Phys _____	_____	Min: _____ m
_____	Fish _____	_____	Max: _____ m
_____	Coral _____	_____	Underwater Visibility: _____ m
_____	Algae _____	_____	Cox: _____

GEOMORPHOLOGICAL CLASS - TICK ONE ONLY.

Remember that if the geomorphology changes you must start another habitat

Backreef	☐	Shallow zone between the reef crest and lagoon or land. Usually hard substratum pavement
Reef crest	☐	Shallowest and often emergent part of the reef, separating forereef from backreef / lagoon
Spur and groove	☐	Spurs of hard corals / calcified green algae with sand / bedrock grooves.
<i>Low spur and groove</i>	☐	Spurs less than 5m high
<i>High spur and groove</i>	☐	Spurs greater than 5m high
Forereef	☐	Any area of reef with an incline of between 0 and 45°
Escarpment	☐	Any area of benthos whose angle of slope exceeds 45°
Patch reef	☐	Coral formations in the lagoon which are surrounded by either seagrass, sand or algae
<i>Dense patch reef</i>	☐	Areas of aggregated coral colonies (living or dead) which cover > 70% of the benthos
<i>Diffuse patch reef</i>	☐	Areas of dispersed coral colonies where < 30% of the benthos is covered by coral colonies
Lagoon floor	☐	The lagoon floor where the angle of the slope does not exceed 45°
<i>Shallow lagoon floor</i>	☐	Lagoon with a depth of > 12m
<i>Deep lagoon floor</i>	☐	Lagoon with a depth of < 12m

Italics indicate a sub-class of a main class and if there is any uncertainty, the main class should be used.

SUBSTRATUM AND BIOLOGICAL COVER

Rating from 0-5 (figures need not add up to 5 total)

Bedrock	☐	Any exposed area of hard, bare substratum without visible coralline structures
Dead Coral with Algae	☐	Any area of hard bare substratum with visible corallite structure covered in algae
Dead Corals	☐	Any area of hard bare substratum with visible corallite structure
Rubble	☐	Any area of oose bedrock or hard substratum
Sand	☐	Coarse sediment (diameter > 1mm). "Grainy" when disturbed
Mud	☐	Fine sediment (diameter < 1mm). "Milky" when disturbed
Hard corals	☐	
Soft corals	☐	
Sponges	☐	
Green algae	☐	Non-calcareous algae forming mats or turfs
Brown fleshy algae	☐	e.g. Lobophora, Padina, Sargassum, Turbinaria
Red/brown branching algae	☐	e.g. Dictyota, Galaxaura, Amphiroa, Jania
Green calcified algae	☐	e.g. Halimeda, Tydemania
Red coralline algae	☐	e.g. Cement, crustose coralline
Seagrass	☐	

Substratum types within the habitat: (e.g. sand / bedrock) _____

Other comments : _____



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 <u>Cyano-Bacteria: Blue-Green</u> 1 ☐ MACRO-ALGAE <u>Chlorophyta : Green</u> Green Filamentous 39 ☐ Chaetomorpha sp. 15 ☐ Marble (<i>Valonia ventricosa</i>) 36 ☐ Bornetella sp. 10 ☐ Neomeris sp. 29 ☐ Codium sp. 18 ☐ Caulerpa sp. 12 ☐ Halimeda sp. 24 ☐ Tydemania sp. 33 ☐ Further Green Algae: ☐ ☐ ☐ TOTAL GREEN ALGAE ☐ <u>Phaeophyta : Brown</u> Dictyota sp. (Flat-Branched) 44 ☐ Padina sp. (Fan Blade) 50 ☐ Lobophora sp. (Blade/Ruffle) 49 ☐ Hydroclathrus sp. 48 ☐ Turbinaria sp. (Pyramid) 55 ☐ Brown Filamentous 42 ☐ Sargassum sp. (Bladder) 53 ☐ Further Brown Algae: ☐ ☐ ☐ TOTAL BROWN ALGAE ☐ <u>Rhodophyta : Red</u> Encrusting coralline algae 70 ☐ Galaxaura sp. 73 ☐ Amphiroa sp. 63 ☐ Jania sp. 83 ☐ Red Filamentous 60 ☐ Sheet 80 ☐ Actinotrichia - spikeweed 61 ☐ Wiry branched (<i>Gelidiella</i> sp.) 74 ☐ Further Red Algae ☐ ☐ ☐ TOTAL RED ALGAE ☐ MARINE PLANTS (Angiospermophyta) Sea Grass 102 ☐ Thalassia sp. 108 ☐ Halophila 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 ☐ Annelid Worms Segmented Worms 348 ☐ Feather Duster 349 ☐ Christmas Tree 350 ☐ Flatworms 341 ☐ <u>Arthropoda : Crustacea</u> Shrimps 361 ☐ Rock lobster (<i>Panulirus</i> spp.) 366 ☐ Crab 381 ☐ Mollusca: Gastropods: Abalone 390 ☐ Murex sp. 394 ☐ Conch 398 ☐ Cowrie 402 ☐ Triton 406 ☐ Cone Shell 408 ☐ Drupella 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: Acanthaster planci (COT) 472 ☐ Linkia laevigata (Blue) 478 ☐ Nardoa sp. (Brown) 479 ☐ Culcita novaeguineae 474 ☐ Protoreaster nodosus 482 ☐ Choriaster granulatus 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 ☐ Tunicate (Phylum Chordata) 529 ☐ Bryozoan (Phylum Bryozoa) 526 ☐ FURTHER SPECIES: ☐ ☐ ☐ TOTAL INVERTEBRATES (including tunicates and bryozoans) ☐				

**N.B. ALL CORAL TARGET SPECIES
MUST ALSO BE COUNTED IN THE
APPROPRIATE LIFEFORM.**



TARGET FISH								
<u>Butterflyfish</u>	540	☐	<u>Wrasse</u>	598	☐	<u>Rabbitfish</u>	579	☐
(Big) Long-Nosed	752	☐	Diana's hogfish	931	☐	Foxface	757	☐
Klein's	651	☐	Mesothorax hogfish	611	☐	Virgate	630	☐
Vagabond	541	☐	Humphead	600	☐			
Pyramid	750	☐	Red-banded	932	☐	<u>Dartfish</u>	774	☐
Eastern Triangle	783	☐	Checkerboard	725	☐	Blackfin	695	☐
Latticed	681	☐	Twotone	768	☐			
Redfin	760	☐	Crescent	647	☐	<u>Cardinalfish</u>	621	☐
Chevroned	677	☐	Sixbar	744	☐	Pajama	917	☐
Orange-banded Coral fish	923	☐	Jansen's	678	☐	Blackstriped	717	☐
Copper-banded	947	☐	Cigar	685	☐			
Eight-banded	948	☐	Bird	610	☐	<u>Puffer</u>	635	☐
Humphead Bannerfish	669	☐	Cleaner	605	☐	Blackspotted	652	☐
Pennant Bannerfish	939	☐						
			<u>Goatfish</u>	615	☐	<u>Goby</u>	749	☐
<u>Angelfish</u>	544	☐	Half-and-half	648	☐	Sphynx	954	☐
Regal	663	☐	Two-barred	666	☐	Brownbarred	955	☐
Bicolour	673	☐	Dash-and-dot	781	☐			
Pearlscale	545	☐	Multibarred	934	☐	<u>Dottyback</u>	900	☐
Emperor	756	☐	Blackstriped	616	☐	Darkstriped	686	☐
Blue-girdled	937	☐						
Vermiculated	938	☐	<u>Triggerfish</u>	624	☐	OTHER MAJOR FAMILIES		
			Redtooth	786	☐	Anthias	642	☐
<u>Surgeonfish</u>	546	☐	Orangestriped	625	☐	Soapfish	928	☐
Convict	547	☐	Clown	626	☐	Jack / Trevally	553	☐
Ringtail' spp.	548	☐	Blackbelly Picassofish	927	☐	Sweetlips	577	☐
Brushtail tang	638	☐	Pinktail	782	☐	Barracuda	560	☐
Thompson's	747	☐	Scythe	692	☐	Moorish Idol	551	☐
Mimic	700	☐	Halfmoon	796	☐	Emperor	924	☐
Eyestripe	549	☐	Bluethroat	660	☐	Spadefish / Batfish	595	☐
Unicorn spp.	550	☐	Picasso	628	☐	Porcupine	634	☐
			Moustache / Titan	623	☐	Toby	636	☐
<u>Tuna/ Mackerel</u>	940	☐	<u>Groupers</u>	583	☐	Trunk / Box / Cowfish	640	☐
Narrow-banded king mackerel	558	☐	Flagtail	682	☐	Blenny	926	☐
			Peacock	935	☐	Sweeper	689	☐
<u>Fusilier</u>	571	☐	Humpback	936	☐	Squirrelfish / Soldierfish	619	☐
"Blue and yellow" sp.	929	☐	"Honeycomb" sp.	586	☐	Filefish	629	☐
Bluestreak	930	☐	Lyretail	946	☐	Lionfish	631	☐
						Scorpionfish / Stonefish	632	☐
<u>Damselfish</u>	589	☐	<u>Parrot Fish</u>	613	☐	Lizardfish	643	☐
Blue-Green Chromis	596	☐	Bumphead	933	☐	Hawkfish	902	☐
Black Bar Chromis	646	☐				Sandperch	675	☐
Other "Chromis" sp.	590	☐	<u>Spinecheek</u>	581	☐	Sharksucker	787	☐
Blue devil	657	☐	Twoline	582	☐	Needlefish	562	☐
Threespot dascyllus	671	☐	Pearly	659	☐	Pipefish	911	☐
Humbug dascyllus	767	☐				Shrimp fish	790	☐
Reticulated dascyllus	771	☐	<u>Snapper</u>	565	☐	Trumpetfish	664	☐
Whitebelly	654	☐	Two-spot	753	☐	Moray Eel	637	☐
Staghorn	745	☐	Black-and-white	569	☐			
Black	759	☐	Bluelined	925	☐	FURTHER SPECIES		
Behn's	593	☐	Spanish Flag	679	☐	_____		☐
Honeyhead	594	☐	Chequered	665	☐	_____		☐
Alexanders	764	☐	'Blackspot'	564	☐	_____		☐
Blackspot	758	☐				_____		☐
"Anemone fish" sp.	871	☐				_____		☐
"Sergeant" sp.	656	☐				_____		☐
						TOTAL FISH		☐