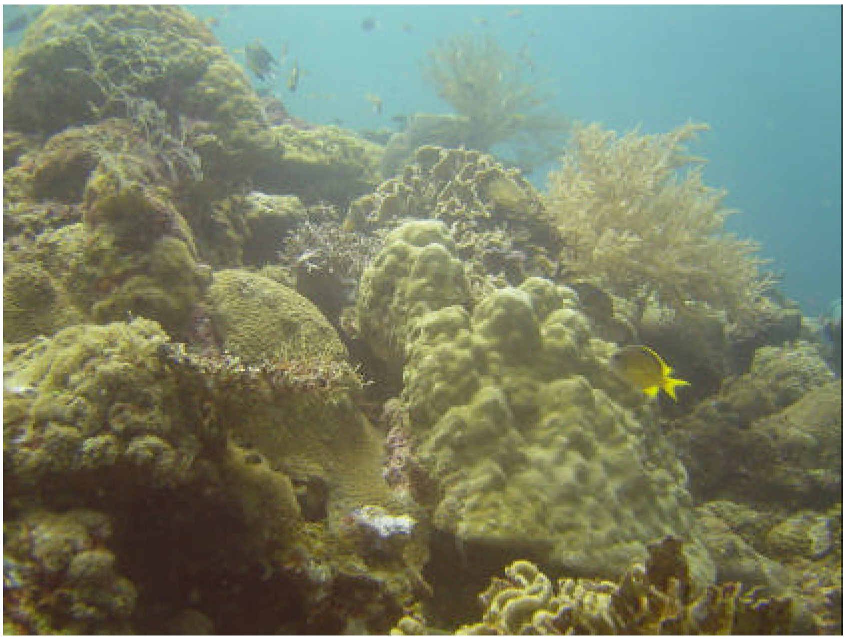
SOUTHERN LEYTE CORAL REEF CONSERVATION PROJECT – SECOND YEAR REPORT AND CORAL SPECIES LIST FOR SOGOD BAY.



Napantau Coral Reef, Panaon, Southern Leyte.
Photo Taken by Mike Wallace

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EXECUTIVE SUMMARY

- The Southern Leyte Coral Reef Conservation Project (SLCRCP) was initiated in September 2002 after an agreement was signed between Coral Cay Conservation (CCC), a UK-based not-for-profit organisation, the Philippines Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and the Provincial Government of Southern Leyte.

- The primary aims of the SLCRCP are to survey the coral reefs of the Sogod Bay region and provid both training and conservation education for project counterparts and local communities.

- Since September 2002, teams of international CCC volunteers have carried out survey dives including rapid reef assessments, CCC baseline reef surveys, Reef Check surveys, crown of thorns monitoring and the initialising of a sedimentation monitoring programme. Results of reef check surveys and sedimentation studies were presented in the 1st Bi-annual report

- Anthropogenic impacts such as over-fishing and the use of destructive techniques, nutrient enrichment of coastal areas and sedimentation, threaten the health and diversity of the coral reef ecosystem around Sogod Bay. Litter was frequently observed both on the surface and sub-surface and although not considered an actual threat to the reef ecosystem, abandoned rubbish is aesthetically unpleasant and can give a negative impression to tourists who visit the area.

- Sector 18 was found to be particularly threatened by high levels of sedimentation and large amounts of broken and dead coral. It is likely that these observations are directly linked with the recent landslides that have been reported in this area.

- A total of 9 benthic habitats were identified within Sogod Bay and sand was identified as the major benthic substrate. Hard coral cover was found to be relatively low throughout the bay, but areas with higher abundances of hard bedrock substrates showed higher levels of hard coral cover, highlighting the importance of hard substrates upon which coral larvae can settle.

- 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 head 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.

- Despite relatively low levels of hard coral cover, species diversity was found to be exceptional in certain areas of the bay with a number of rare species being identified. Efficient management and implementation of sustainable fishing practices is therefore essential if the health of these reefs is to be conserved.

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

- Significant correlation between habitat diversity and fish species richness, demonstrates the intricate balance of the coral reef ecosystem and the importance of coral cover in maintaining high fish populations. Monitoring of fish stocks in relation to benthic cover is essential if management plans are to be effective.

- Further surveys are necessary to identify trends in fish populations throughout Sogod Bay, and results of these surveys will be presented in future reports.

- 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.

- Crown-of-thorns sea stars, which feed on live coral have been observed in several areas within the bay and although not at outbreak levels, widespread damage is evident. Monitoring of these echinoderms is continuing and control measures may have to be implemented in the future if the integrity of economically important reef areas is threatened.

- Two hundred and seventy six species of coral were positively identified by a coral taxonomist. Four species were considered very rare, and 5 species were not previously recorded as occurring by any other published literature of the Philippines.

- The importance of community education in maintaining the effectiveness of marine protected areas is well recognised and a positive attitude towards marine resource management at the level of the Provincial government, municipality and local barangay already exists within Southern Leyte.

- Community education has been a major focus throughout the *Southern Leyte Coral Reef Conservation Project* and a number of successful open days and workshops have been held both at the CCC project base and in local schools and colleges.

- Community education and local counter-part training will continue for the remainder of the *Southern Leyte Coral Reef Conservation Project* and a number of new training initiatives and ideas are currently being developed.

1. INTRODUCTION

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 km^2 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 70 million) of the Philippines is concentrated along the coastline putting intense pressure on the marine resources through a range of impacts. Solid and liquid pollution, overfishing, habitat degradation and increased sedimentation cause the greatest anthropogenic impacts throughout the Philippines. Coral reefs act as important physical barriers, which, along with mangroves, protect coastal communities from storm damage and coastal erosion. Coastal habitat loss can therefore have a dramatic influence on the success and future livelihoods of coastal populations. Hard corals require environmental stability in order to thrive and have a narrow band of tolerance for physical parameters such as temperature, salinity and sediment loads. Small changes in these properties can have dramatic impacts on the reef ecosystem.

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-scientifically trained, self-financing 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 (Mumby *et al*., 1995; Harding *et al.*, 2000; Harborne *et al*., In press). 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.

1.1 PROJECT BACKGROUND

The Southern Leyte Coral Reef Conservation Project (SLCRCP) was initiated in September 2002 after an agreement was signed between Coral Cay Conservation (CCC), the Philippines Reef and Rainforest Conservation Foundation Inc. (PRRCFI) and the Provincial Government of Southern Leyte (PGSL). The project is initially planned to run for three years, completing surveys within Sogod Bay in the province of Southern Leyte, Eastern Visaya. Following the completion of accessible surveys from the previous site near Malitbog, the project is now based in the municipality of Padre Burgos on the southern most tip of the western coast of Sogod Bay.

The objectives of the project are to:

- Undertake a comprehensive assessment of coastal marine resources in Sogod Bay.
- Collect quantitative information on ecologically and commercially important marine species.
- Produce detailed coastal habitat maps for use as an educational and planning tool for Marine Protected Area (MPA) designation.
- Undertake community education and capacity building programmes in order to:
    - Increase local awareness of marine environmental issues.
    - Highlight the importance and economic benefits of MPAs.
    - Train PGSL employees in SCUBA and marine surveying techniques.
    - Initiate the planning of an ICZM scheme for Southern Leyte with full stakeholder involvement.

Southern Leyte, one of the six provinces of Eastern Visayas (Figure 1.a,b) 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, Bontoc, Sogod, Libagon, Liloan, San Francisco, Limasawa, Pintuyan, San Ricardo and Tomas Oppus (Calumpong *et al*. 1994). 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.

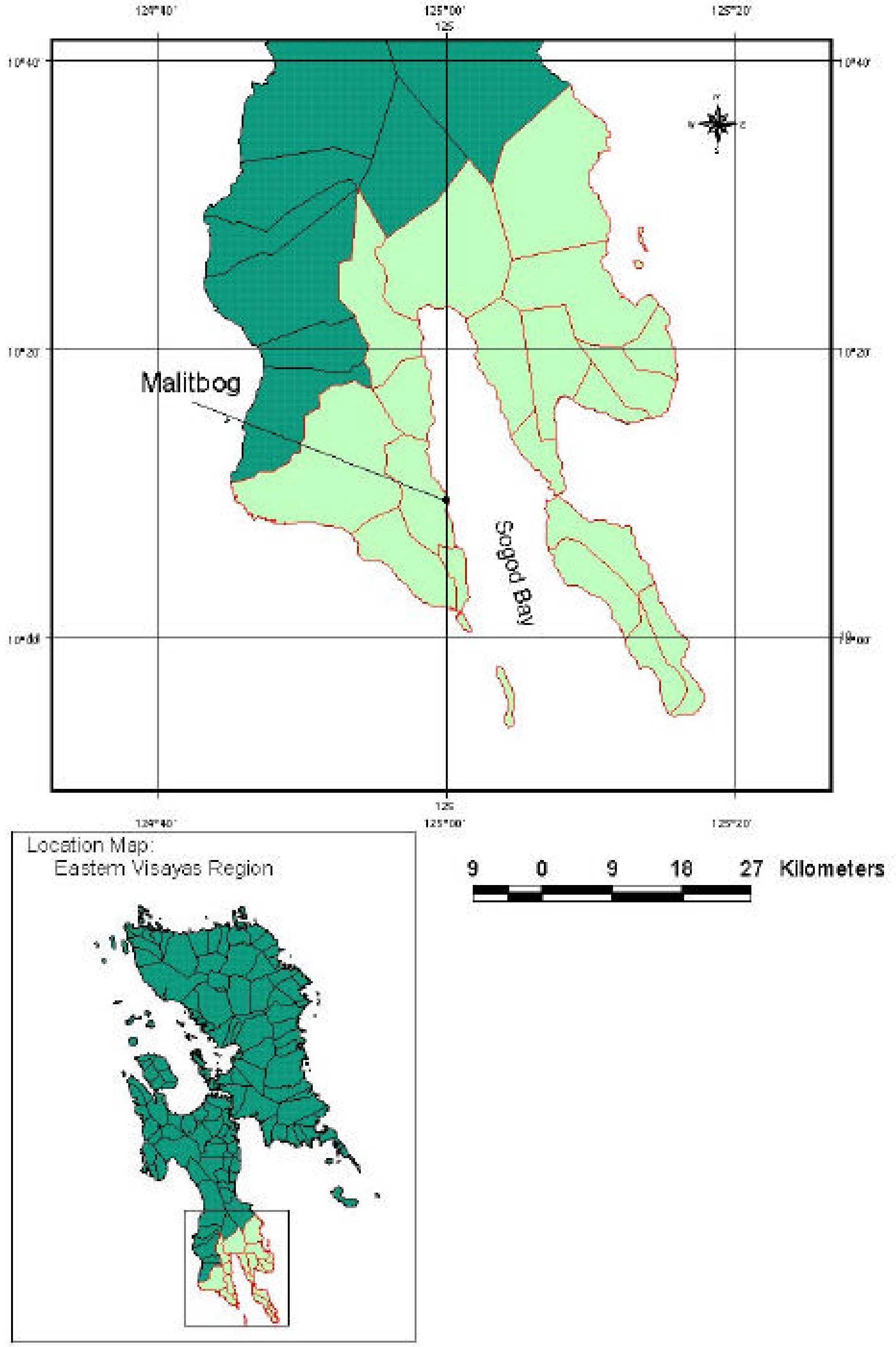


Figure 1: **1a.** Map of Eastern Visayas Region showing the location of Southern Leyte Province in light green. Sogod Bay and the location of Malitbog where CCC is based are also marked (**1b.**). Source: DENR, Leyte and SLSCST, Southern Leyte.

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 (Calumpong *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 (Calumpong *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 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 poor placement and management. 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 slope directly 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 (Calumpong *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 and January during the southwest monsoon and annual rainfall averages two metres per year (Calumpong *et al*., 1994).

Population in the province has 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}, 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).

1.2 Previous Studies in the area

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 (1993) 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 a thorough assessment of the natural resources and coastal ecology in Sogod Bay in 1993/1994 and again in December 2002. During the 2002 surveys fisheries, habitats and water quality were assessed as well as a brief municipal, policy and institutional profile. A summary of the main findings is presented below. 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.

Fisheries

- A profile of fisheries, their standing stock and activities was undertaken.
- The species composition was 90 species including 81 fish species (7 unidentified, 74 identified and 9 mollusc species in 4 families: 5 squids, 2 cuttlefishes, 1 octopus and 1 gastropod.
- Reef species (42%) dominated the catch. Pelagic species compose only 37%.
- The highest frequency of respondents had fished for between 17 and 22 years. The average number of years respondents have been fishing is 18.5 years.
- Almost half of the respondents go fishing the whole year round. The average number is 9.3 months.

Water Quality

- Water chemistry was tested at Ploblacio, in front of the pier. Water samples were collected at 0 and 10 metres deep for pH, salinity, dissolved oxygen, nitrate and phosphate

Habitats

Coral Reefs.

- Juangon (Maujo) Sanctuary, Timba reef and an artificial reef, Abgao, Malitbog were surveyed.
- Substrate predominantly sand, little reef development except around Sanctuary of Juangon (Maujo) and Timba reef to Malibog town.
- Coast south of Malitbog toward Padre Burgos dominated by sand flats to deeper water, with nearshore strip of small rocks.
- Live coral cover of 10-15% along this strip.
- Highly disturbed reef, dominated by dead coral and rubble south of Malitbog.
- 17 coral species, across 5 families, found in Timba, Malitbog.

Seagrass and algal beds.

- A total of 40 species found in the three sites, consisting of 1 blue, 15 red, 10 brown and 13 green.
- Only about half the species present in 1993-94.

Mangroves.

- Eba, Sta., Cruz (Jagna) and Juangon sampled.
- 12 mangrove species found through 6 families.

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 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 (Pretentio, pers. comm.). 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 project base in Malitbog (Doyle, pers. obs.). The seabed was coated in a thick layer of brown, terrigenous sediment.

Five 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 resupension as the shallow reefs located east of the bay are protected by mountains from the predominant north-easterly winds. The resuspended sediments may be eather silliclastic 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 to the symbiotic algae (zooxanthellae) living in the corals tissues for photosynthesis. 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 increase of sediments and nutrients to the adjacent coral reefs.

The main sources of pollution in Sogod Bay identified by Calumpong *et al.*, (1994) are: domestic garbage, faecal matter and waste water from population centres. One particular mangrove area in Liloan was being used as a dump for garbage. 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 are having difficulties locating suitable areas as landfill sites that can also meet the requirements of the Provincial ordinance.

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 in accordance with the New Fisheries Code (Republic Act 8550) and are declining threats facing the reefs of Sogod Bay.

In Sogod Bay 16 official fish sanctuaries have been established (Table 1.1). There are also eight un-official sanctuaries 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 but have not been recently assessed. 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 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 and are apparently replaced by the BFAR only every 6 months. Although fishing does not often occur within the sanctuary, boats do pass through the sanctuaries using them as shortcuts. Spearfishing within the sanctuary boundaries at Liloan has occasionally been observed (Doyle, pers. obs.).

Table 1.1 Established fish sanctuaries in Sogod Bay.

Sanctuary name	Approx. area (ha)	Municipality
Son-ok	10	Pintuyan
Napantau	5	San Francisco
Tabugon	20	Liloan
Biasong	Not known	Libagon
Otikon	5	Libagon
San Jose	Not known	Sogod
Tampoong	Not known	Sogod
San Antonio	Not known	Sogod
San Augustin	6	Tomas Oppus
Juangon	2	Malitbog
Timba	2	Malitbog
Lugsongan	Not known	Limasawa
Benit	5	Sn. Ricardo

Residents of the local municipalities predominantly carry out fishing in Sogod Bay. Of the approximately 3000 fishing boats in use 99% are less than 3 tons in weight (Calumpong *et al*., 1994). The majority of the boats are non-motorized but bangkas with inboard engines are becoming more frequent. Approximately 2000 fishers depend on the bay's marine resources and the majority of these are part time fishers (Calumpong *et al*., 1994).

The fishery in the bay is multispecific and multigear. Total catch composition is diverse consisting of a total of 347 finfish, 26 molluscan, 8 crustacean, 4 echinoderm and 3 marine mammal species (Calumpong *et al*., 1994). Multiple hook and line is the most common type of fishing gear used, followed by jigger, trolline, single hook and drift gill net (Calumpong *et al*., 1994). Studies carried out by Silliman University indicated that the total recorded catch for Sogod Bay was 400.5 metric tonnes. Thirty percent was contributed by drift gill netting. Finfishes comprised 88% of the catch and molluscs 11.5% (Calumpong *et al*., 1994). Most fishermen still use traditional fishing methods and commercial gears have been banned within the bay. There was evidence of high fishing pressure however it was concluded that no growth overfishing was occurring (Calumpong *et al*., 1994).

Although the use of destructive fishing methods is illegal, there have been unconfirmed reports of the use of cyanide in both Limasawa and Padre Burgos. Furthermore hookah diving, a dangerous means to an end is still being carried out in both aforementioned municipalities.

1.3.4 Crown-of-thorns outbreaks

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

The crown of thorns starfish (COT) was first recognized in an outbreak on the Ryukyu Islands in the 1957 and then around Green Island on the Great Barrier Reef in 1962, (Moran, 1986). The actual numbers of individuals that constitute an outbreak varies spatially and temporally but when a population is consuming coral at a rate faster than the rate corals can grow, an outbreak has been established, (Lourey *et al*., 2000). *A. planci* prefers to feed on commonly occurring and fast-growing corals such as *Acropora* and *Pocillopora* species. However slow-growing (1cm diameter yr^{-1}), massive corals such as *Porites* spp. are also targeted during outbreaks and can suffer significant damage. Local extinction of these long-lived, architectural reef colonies could gradually extend the reefs recovery time, (Seymour & Bradbury, 1999). Lourey, (2000), found evidence that up to 25% of the reefs surveyed on the Great Barrier Reef may not recover, as outbreaks over the last thirty years have been occurring more frequently and preventing full regeneration of coral cover.

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

In Sogod Bay crown-of-thorns are abundant in certain areas, and unusually, often in shallow waters (<12m depth). In particular the reefs outside the CCC base at ‘Loggers Eden’ and ‘Secret Garden’ have suffered considerable damage by large numbers of COT’s since November 2002. From underwater observation the numbers have increased considerably since January 2003 and large areas of dead branching *Acropora* are visible.

1.3.5 Coral Bleaching

A further impact affecting coral reefs globally is coral bleaching, which occurs across all tropical seas as a result of increases in surface water temperature (Hoegh-Guldberg, 1999). Corals either temporarily or permanently disassociate from the symbiotic algae (zooxanthellae) on which they depend, leaving only the white coral skeletons remaining. It is believed that bleaching could become more frequent and more severe as sea surface temperatures rise in response to global warming.

Large-scale bleaching has not been observed within Sogod Bay, which may be a consequence of the movement of cooler water from the deep parts of the bay to the shallow areas as a result of upwelling currents. The sea surface temperature has been recorded to be less than 28°C to date.

1.4 MARINE PROTECTED AREAS

The establishment of Marine Protected Areas (MPAs) has proved to be an effective method for preserving reefs which have suffered reduction in both coral cover and fish catch. Excellent case studies are Apo Island off the coast of Negros Oriental (Russ and Alcala, 1996) and Danjugan Island in Negros Occidental (Harborne *et al.*, 1996).

Apo Island in Negros Oriental was initially set up as a marine reserve with the full commitment and backing of the local community. It was planned that a small section of the reef (<250 x 50m) would be used as a fish sanctuary (no-take zone). Monitoring surveys showed that large reef associated predator fish such as Jacks (Carangidae) and Grouper (Serranidae) populations increased in biomass and number within 5 years of establishment, both within, and outside the fish sanctuary (Russ and Alcala, 1996). A local education programme was combined with the surveys to promote understanding of the value of reserves and resulted in the reserve regulations being respected by the fishing community of the island. The reserve continues to provide considerable spill-over of fish to areas surrounding the no-take zone whilst maintaining fish populations within the sanctuary (see Roberts 2000 and Roberts and Hawkins, 2000).

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

The Danjugan Island Marine Reserve and Wildlife Sanctuaries (DIMRS) in Negros Occidental is another good example of effective marine reserve management. The Philippine Reef and Rainforest Conservation Foundation Inc. (PRRCFI) has been managing Danjugan Island since 1994, with assistance from the UK-based Non Governmental Organisation (NGO), Coral Cay Conservation (CCC) (Solandt *et al.*, 2000; Harborne *et al.*, 1996). CCC recruited volunteer divers in order to carry out biological surveys of both the marine and terrestrial resources of the island between 1996 and 2001. PRRCFI and CCC also provided training for local fishermen and other community members in marine identification and survey skills, such that the local community is now successfully monitoring the reefs themselves. Alternative livelihoods have also been initiated in the area of Bulata (the coastal village adjacent to the island) in order to take the pressure off the natural resources of the area. These include the development of a mud-crab fishery and mangrove replanting scheme; basket weaving and employment as terrestrial guides, dive guides and reef surveyors.

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

These projects are beacons that stand out as the success stories of Marine Protected Areas in the Philippines. It has to be the aim of a sustainable development initiative within the Philippines that more success stories such as those from Apo Island, Danjugan Island and Tubbataha are born from other areas of the Philippines. This will help alleviate the poverty resulting from destruction of natural marine resources and help to accommodate large coastal populations and their dependence on the marine environment.

2. METHODS

2.1 SURVEY STRATEGY OVERVIEW

The area of Sogod Bay is extensive, with approximately 131 km of coastline and a maximum distance of 15 km between the eastern and western landmasses. The coastline of the bay has been divided into 26 survey sectors each approximately 5 km in length (Figure 2.1) to enable the establishment of a methodical surveying programme.

Initially Rapid Reef Assessments (RRA) were carried out in order to gain an immediate snapshot of the status of the coral reef environment within Sogod Bay and adaptations of the global *Reef Check* methodology were performed at selected sites. The results of Rapid Reef Assessments and Reef Check studies have been previously reported in the 1st Biannual Report for this projects (Doyle *et al.*, 2003).

The purpose of this report is to focus on the results of the data gathered in 8 of the proposed 26 survey sectors within Sogod Bay, using *CCC Reef Survey Technique*. Originally, survey transects were sited at 1 km intervals along the coastline to determine the extent and condition of the coral reef environment present in each sector. Depending upon the results of the initial assessment, further transects have been completed at intervals of either 500 or 250 metre. Areas with extensive reefs in good condition will be surveyed in more detail than those with degraded reefs.

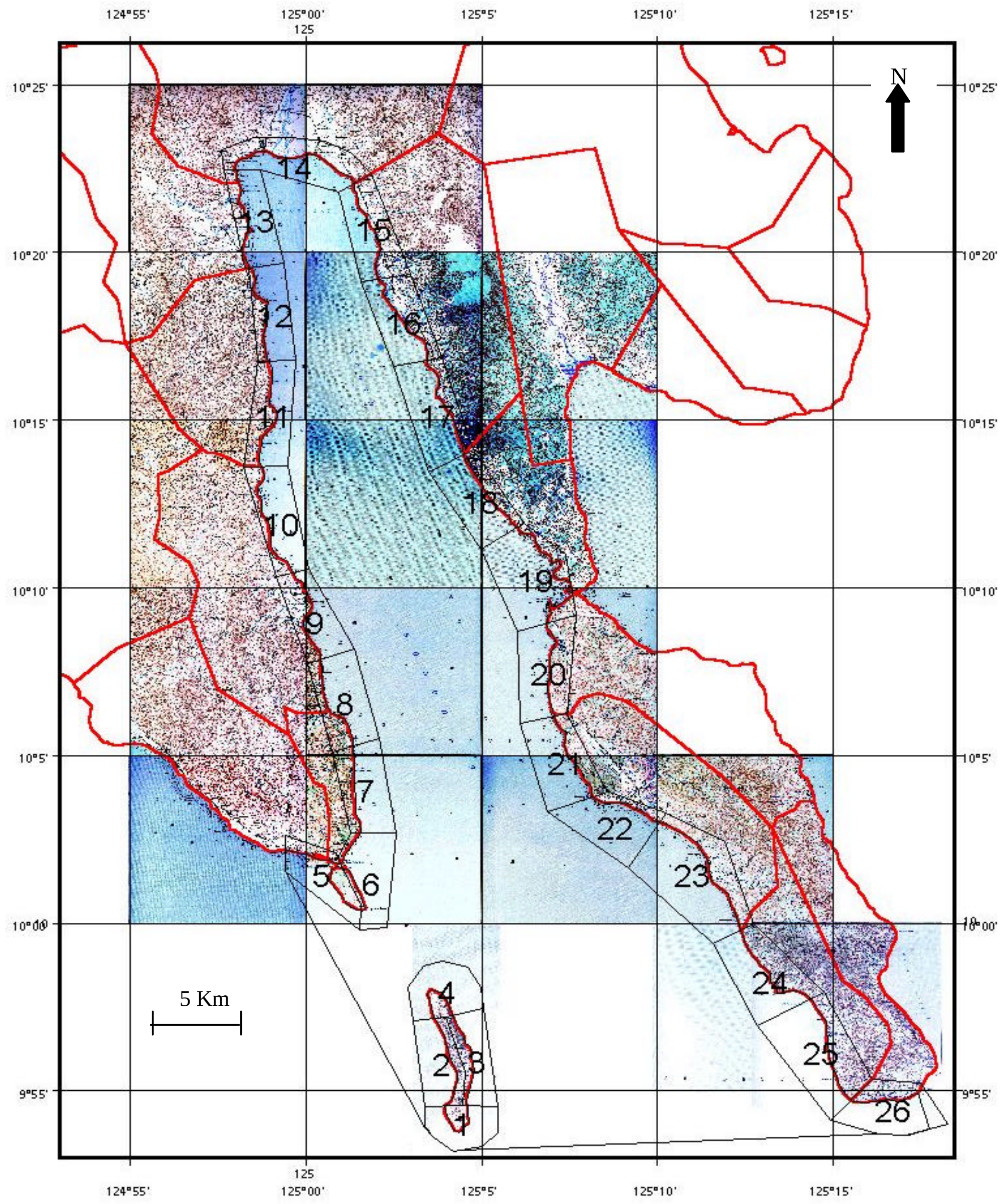


Figure 2.1 Topographic map of Sogod Bay showing the 26 survey sectors. Source: DENR, Leyte and SLSCST, Southern Leyte.

2.2 VOLUNTEER TRAINING

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

An important component of the training schedule is a series of testing procedures to ensure that each volunteer has reached a minimum acceptable standard. Hence the training programme concludes with a series of tests, which ensures that the volunteers reach an acceptable standard of knowledge. These tests use both slides, 'flash-cards' and in-water identification exercises for corals, fish and invertebrates. Furthermore, to assess the quality of data collected by CCC volunteers during actual survey work, two validation exercises are undertaken. The coral validation exercise uses a 30m test transect survey set up and thoroughly surveyed by the PS and SO to collate a reference data set. Test transects are conducted in buddy pairs with both people recording hard coral species and abundances (as performed by Diver 3 during surveys; Section 2.3). Data are then transferred to recording forms and entered into a spreadsheet where the results from each pair are compared to the reference using the Bray-Curtis similarity coefficient (Equation 1; Bray and Curtis, 1957). Validations for soft corals, sponges and other benthic colonial invertebrates are also conducted along a 30m transect. Data collected by one of the science staff is used as the reference data-set against which all volunteer data is compared. Results are compared using the Bray-Curtis similarity coefficient.

Equation 1:

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

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

Since it is impossible to compare volunteer fish data to a reference, validation of fish surveys are conducted by measuring the consistency between pairs of surveyors. It is then assumed that if surveyors are consistent they are also accurate.

2.3 BASELINE SURVEY TECHNIQUE

The CCC Reef Survey Technique was developed by CCC for the rapid assessment of biological and physical characteristics of reef communities by trained volunteer divers. Following an intensive training programme, CCC's techniques have been shown to generate precise and consistent data appropriate for baseline mapping (Mumby *et al*., 1995). All surveys were co-ordinated by the PS and SO to ensure accurate and efficient data collection.

CCC's baseline survey technique has been continuously refined and improved since 1990. The technique is designed to be appropriate for non-professional surveyors and to provide appropriate data for classifying remotely sensed imagery and hence producing marine habitat maps. The basic rationale is to use teams of divers to undertake a transect from 18m (or 28m where the reef extends below 18m) to the reef crest. Each survey provides one or more biological record forms which are effectively snapshots of the biological community (benthic and fish) found within any particular reef zone. These data are complimented by basic physical and oceanographic information. The technique has been favourably reviewed by Dr Andrew Price (University of Warwick – 1991) and Dr John Turner (University of Wales – 1996).

The major changes, which have occurred since 1990 are:

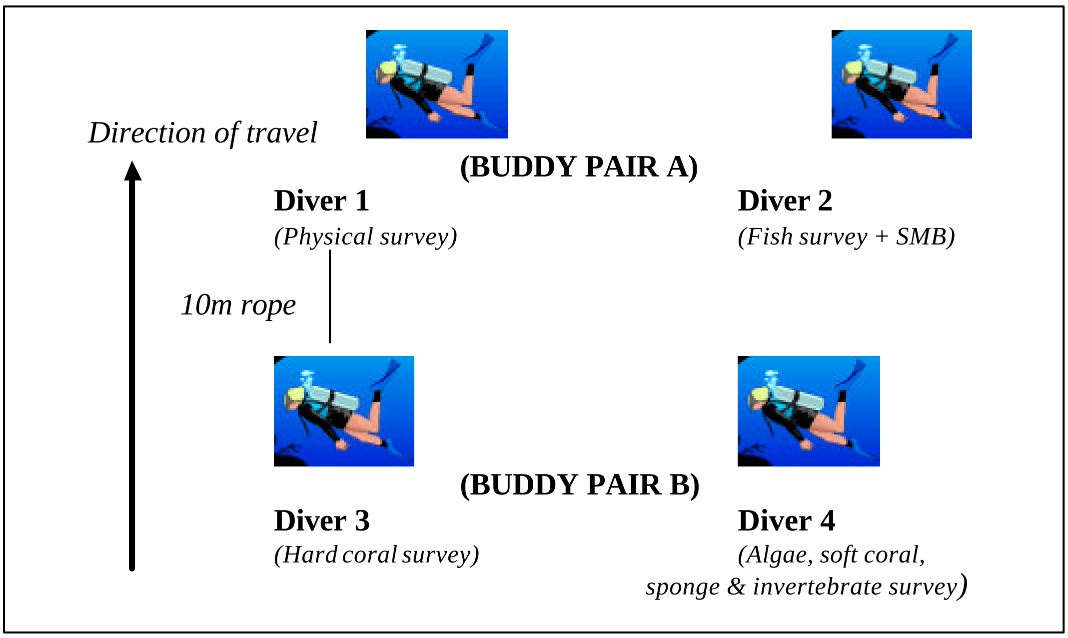
- 1991: Surveying fish at species level.
- 1991: Using Global Positioning Systems (GPS) for locating the start and end of each transect (GPS became commercially available in the early 1990's).
- 1994: The use of a 10m line to improve assessment of the distance travelled by survey teams.
- 1996: Use of quantitative limits within the 0-5 scale for fish and invertebrates.
- 1997: Change of maximum depth from 30 m to 28 m in accordance with new diving protocols.

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. 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, genera or species.

Since most transects require two or more dives to complete, transect surveys are divided up into sections (or 'sub-transects') with surveys of each sub-transect carried out by a team of four trained divers diving into two buddy pairs (A and B) as shown in Figure 2.2. At the start point of each sub-transect, Buddy Pair B remains stationary with Diver 3 holding one end of a 10 m length of rope, whilst Buddy Pair A swims away from them, navigating up or along the reef slope on a pre-determined bearing until the 10 m line connecting Diver 1 and 3 becomes taught. Buddy Pair A then remains stationary whilst Buddy Pair B swims towards them. This process is repeated until the end of the planned dive profile, when a surface marker buoy (SMB) carried by Diver 2 is deployed to mark the end of that sub-transect. The SMB acts as the start point for the next survey team and this process is repeated until the entire transect is completed. The positions of the SMB at the start and end of each dive are fixed using a Global Positioning System (GPS).

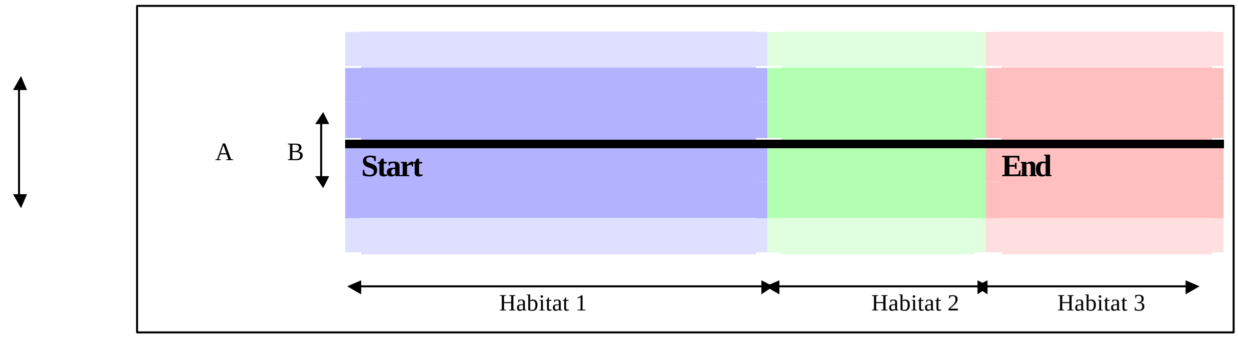
Diver 1 is responsible for leading the dive, taking a depth reading at the end of each 10m interval and documenting signs of anthropogenic impact such as broken coral or fishing nets. Diver 1 also describes the substratum along the sub-transect by recording the presence of six substrate categories (dead coral, dead coral with algae, bedrock, rubble, sand and mud). Divers 2, 3 and 4 survey fish, hard corals and invertebrates (soft corals, sponges) and algae respectively. Diver 3 surveys an area of approximately 1 metre to each side of the transect line whilst Divers 1, 2 and 4 survey an area of approximately 2.5 metres to either side of the line.

Figure 2.2 Schematic diagram of a CCC Reef Survey Technique dive team showing the positions and data gathering responsibilities of all four divers. Details of the role of each diver are given in the text.



During the course of each sub-transect survey, divers may traverse two or more apparently discrete habitat types, based upon obvious geo-morphological (e.g. fore reef, escarpment or lagoon) or biological differences (e.g. dense coral reef, sand or rubble; Figure 2.3). Data gathered from each habitat type are recorded separately for subsequent analysis.

Figure 2.3 Schematic diagram (aerial aspect) of an example of a reef area mapped by divers during a sub-transect survey. Solid line represents imaginary sub-transect line. Dashed lines and shaded areas represent areas surveyed (A=5m wide band surveyed by Divers 1, 2 and 4; B=2m wide band surveyed by Diver 3). Benthic data from habitats 1, 2 and 3 (e.g. reef, sand and rubble) are recorded separately



Each species, life form or substratum category within each habitat type encountered is assigned an abundance rating from the ordinal scale shown in Table 2.1.

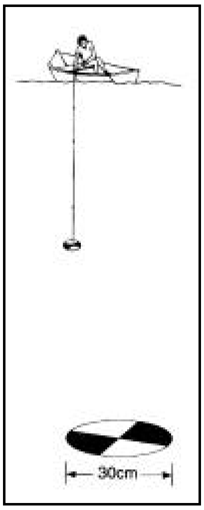
Table 2.1 The ordinal scale assigned to life forms and target species during CCC Reef Survey Technique surveys.

Abundance rating	Corals, other colonial invertebrates and macroalgae	Fish and invertebrates (number of individuals)
0	None	0
1	Rare	1-5
2	Occasional	6-20
3	Frequent	21-50
4	Abundant	51-250
5	Dominant	250+

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 (±0.5°C) are taken from the survey boat using a bulb thermometer at the sea surface. The survey team also takes the temperature at the maximum survey depth (i.e. at the start of the survey) and the air temperature.

Similarly, the salinity is recorded using a hydrometer and a water sample taken from both the surface and the maximum survey depth. Water visibility, a surrogate of turbidity (sediment load), is measured both vertically and horizontally. A secchi disc is used on the survey boat to measure vertical visibility through the water column (Figure 2.4). Secchi disc readings are not taken where the water is too shallow to obtain a true reading. Horizontal visibility through the water column is measured by divers' estimates while underwater. Survey divers qualitatively assess the strength and direction of the current at each survey site. Direction is recorded as one of eight compass points (direction current was flowing towards) and strength is assessed as being 'None', 'Weak', 'Medium' or 'Strong'. Similarly, volunteers on the survey boat qualitatively assess the strength and direction of the wind at each survey site. Direction is recorded as one of eight compass points (direction wind was blowing from) and strength is assessed using the Beaufort scale.

Figure 2.4 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 (m). Source: English et al. (1997).



Natural and anthropogenic impacts are assessed both at the surface from the survey boat and by divers during each survey. Surface impacts are classified as 'litter', 'sewage', 'driftwood', 'algae', 'fish nets' and 'other'. Sub-surface impacts are categorised as 'litter', 'sewage', 'coral damage', 'lines and nets', 'sedimentation', 'coral disease', 'coral bleaching', 'fish traps', 'dynamite fishing', 'cyanide fishing' and 'other'. All information is assessed as presence/ absence and then converted to binary data for analysis. Any boats seen during a survey are recorded, along with information on the number of occupants and its activity. The activity of each boat is categorised as 'diving', 'fishing', 'pleasure' or 'commercial'. Finally the divers record a general impression of the site during each survey.

These ratings are completed for biological (e.g. benthic and fish community diversity and abundance) and aesthetic (e.g. topography) parameters. Both parameters are ranked on a scale from 5 (excellent), 4 (very good), 3 (good), 2 (average) to 1 (poor).

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. The recording forms consist of a 'Boat Form', 'Physical Form' and 'Biological Form'. Each form is completed for each individual dive, although there may be more than one biological form depending on the number of habitats observed. The Boat Form holds data on the GPS co-ordinates of the dive along with oceanographic and climate data such as winds, currents, temperatures and salinities. The Physical Form contains data on the maximum and minimum depths of the dive, the aesthetic and biological quality and also a reef profile drawn from the depths collected every 10m. Finally the Biological Form(s) contain data on the reef zone, the major biotic and substratum features of the habitat and the ordinal ratings of each life form and target species. Survey forms are presented in Appendix A.

2.3.1 Generation of habitat information

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

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

To identify characteristic features, SIMPER calculates the average Bray-Curtis similarity between all pairs of intra-group samples (e.g. between all Site Records of the first cluster). Since the Bray-Curtis similarity is the algebraic sum of contributions from each species, the average similarity between Site Records of the first cluster can be expressed in terms of the average contribution from each species. The benthic class of each Site Record is combined with the geo-morphological class assigned during the survey to complete the habitat label. The combination of a geo-morphological class and benthic class to produce a habitat label follows the format described by Mumby and Harborne (1999).

3. RESULTS

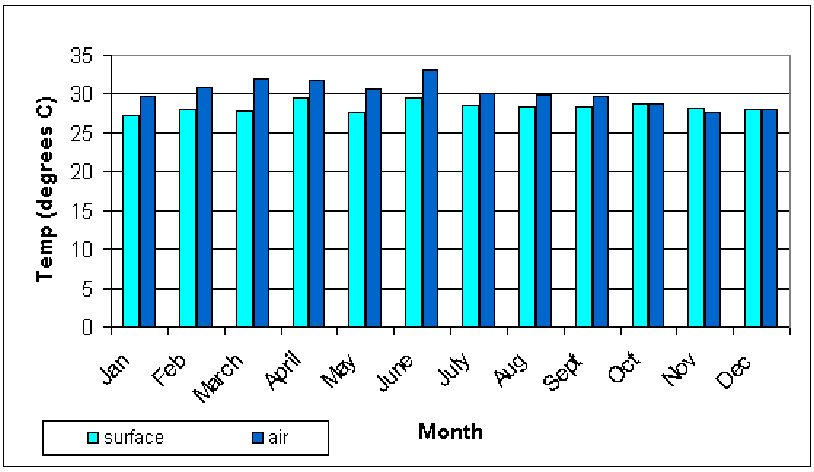
Data presented in this report includes habitat classification for 8 of the 26 proposed survey sectors within Sogod Bay. This habitat classification will be repeated at the end of the project, when data from all sectors is available, and will be incorporated into a habitat map of the benthic resources of Sogod Bay.

3.1: OCEANOGRAPHIC, CLIMATE AND ANTHROPOGENIC DATA

3.1.1: Temperature

A total of 216 recordings of air temperature were made throughout the course of this study, with extremes ranging from 25°C to 38°C. Monthly average air temperatures were found to be at their highest from March through to June, whilst the lowest values were recorded around November (figure 3.1). Surface temperatures were found to range from 25°C to 36°C, with an average annual surface temperature of 28°C. Whilst monthly average air temperatures were found to fluctuate by over 5°C, mean surface temperature was shown to fluctuate by only 2°C throughout the course of the year, ranging from 27.3°C to 29.5°C.

Figure 3.1: Annual fluctuation in mean average air and surface temperatures recorded on surveys within Sogod bay. Air temperature: n = 216 Surface temperature: n = 368.



Sub-surface temperatures were recorded on 358 surveys, with values ranging from lows of 24°C to highs of 33°C. Temperature recordings were split into depth categories. Table 3.1 details the average temperature of each depth class. Analysis of variation indicates significant temperature variation with depth ($F = 2.57$, $p<0.05$) and a general trend of decreasing water temperature with depth is observed.

Table 3.1: Mean temperatures recorded in different depth classes. Total n = 358

Depth category	Number of samples	Mean Temp (°C)	Standard Deviation
0 – 5m	27	27.63	1.21
6 – 10m	43	27.86	1.39
11 – 15m	36	27.44	1.28
16 – 20m	97	27.27	1.62
21 – 25m	86	27.63	1.53
26 – 30m	69	27.00	1.38

3.1.2: Salinity

Salinity samples were taken on 323 surveys within Sogod Bay and values were found to range from 20‰ to 37‰. These extremes are likely to represent sampling errors and only account for a few samples. The average surface salinity recorded from all samples within the bay was 30.45‰ ±1.94‰. Salinity samples were also taken at various depths within the water column and mean salinity's of different depth categories are given in table 3.2.

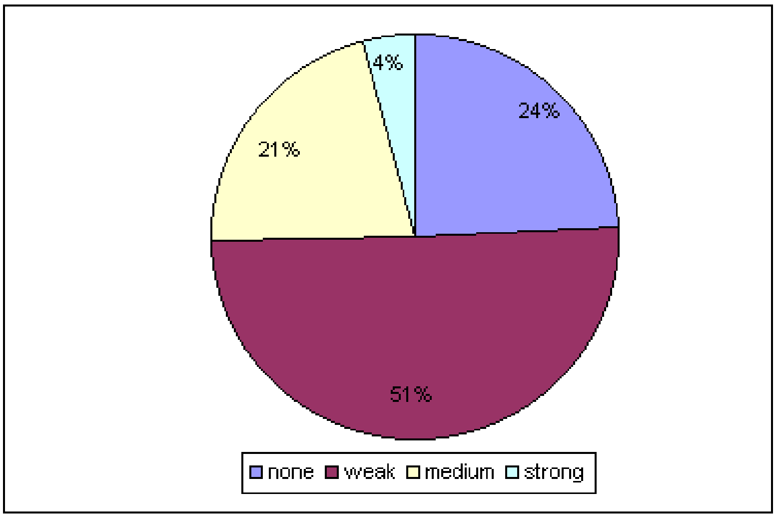
Table 3.2: Mean sub-surface salinity recordings throughout the water column in Sogod Bay.

Depth category	Number of samples	Mean Salinity (‰)	Standard Deviation
0 – 5m	25	30.14	1.68
6 – 10m	38	30.56	1.45
11 – 15m	35	30.45	1.98
16 – 20m	83	30.53	2.05
21 – 25m	81	30.95	1.47
26 – 30m	66	30.19	2.35

3.1.3: Current strength and direction

A total of 387 recordings of current strength were made throughout the course of this study (figure 3.2). 75% of all estimates claimed either 'no current' or 'weak current' and only 4% of all estimates indicate a 'strong current', which were recorded largely in sectors 7, 8 and 19.

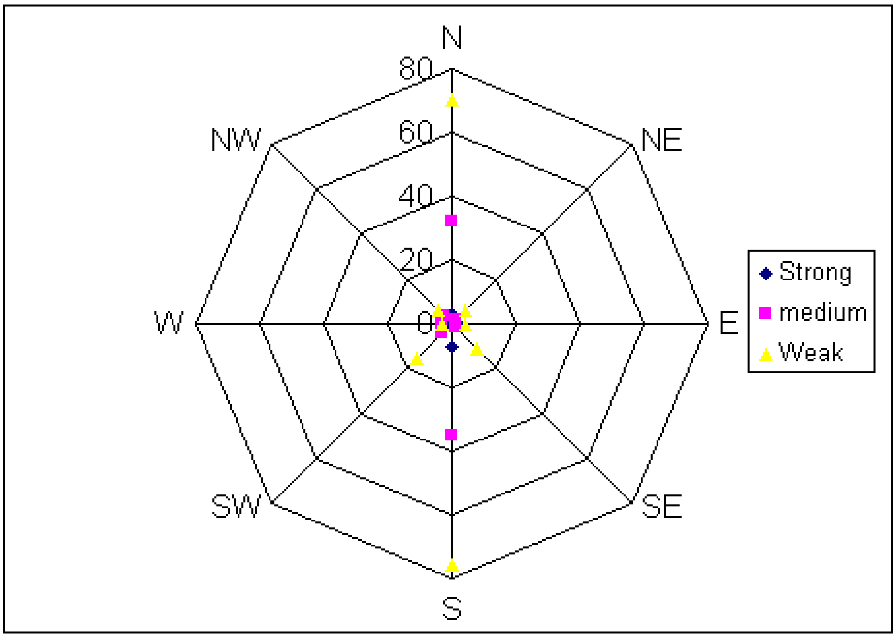
Figure 3.2: Current strength as a percentage of all observations made.



Estimates of current direction were also made, and northwards and southwards flowing currents account for the greatest proportion of recordings in all sectors. In sector 7, only north and south flowing currents were recorded and these account for 35% and 65% of all observations made in that sector. The data set for sector 7 is however, relatively small and as such, surveys may not have been completed when currents were flowing in other directions. The largest data set was available for sector 10, with 86 recordings of current direction. In sector 10, currents were observed to flow in all directions. North and south flowing currents still accounted for the largest proportion of the results, together making up 63% of all observations in this sector. Towards the northern end of the east coast of Sogod Bay (sectors 11 and 12), south flowing currents were more frequently observed than north-flowing currents.

Analysis of current direction and strength together suggest that the majority of currents flowing within the bay at the time of these surveys are weak northwards or southwards currents (figure 3.3) with roughly even distribution between the two. Strong currents were more frequently observed flowing in a southwards direction, but this may be linked with a relatively small sample size of 'strong currents' as opposed to any possible current gyres within the bay.

Figure 3.3: Number of observations of current strength and direction from observations made within Sogod Bay. N = 290.



e.g. ~ 70 observations of weak northwards flowing currents were made.

3.1.4: Wind strength and direction

Wind strength is recorded using the Beaufort scale with values observed within Sogod Bay ranged from 0 – 4, with wind strength 4 only accounting for 4% of all 291 recordings made (table 3.3). Almost 60% of all recordings estimated wind strength within the bay to be none or strength 1. It should however be noted that it is considered unsafe for small boats to venture out in wind strength conditions greater than 6 on the Beaufort scale. Due to safety considerations, surveys were not completed in stormy conditions and may explain the low number of recordings of high wind strengths.

From a total of 306 recordings of wind direction throughout the course of the year, the pattern of wind direction was not as clear as that for currents. The highest proportions of wind direction recordings were from the north (23% of al recordings); with northeasterly and southerly winds each accounting for 18% of all recordings. Winds from a southerly, south-westerly or north-westerly direction together accounted for 16% of all observations.

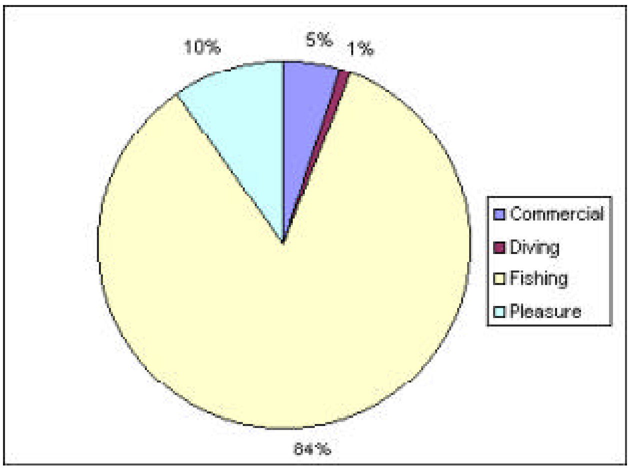
Table 3.3: Wind strength recordings and observations within Sogod Bay.

Wind strength	Description	N^{o} Recordings	% Of recordings	Observations
0	Calm <1 knot	47	12	Recorded in all sectors all year round
1	Light air 1 –3 knots	184	47	
2	Light breeze 4 – 6 knots	91	23	
3	Gentle breeze 7 – 10 knots	55	14	
4	Moderate breeze 11 – 16 knots	14	4	Mainly recorded in February to April

3.1.5: Surface Activity

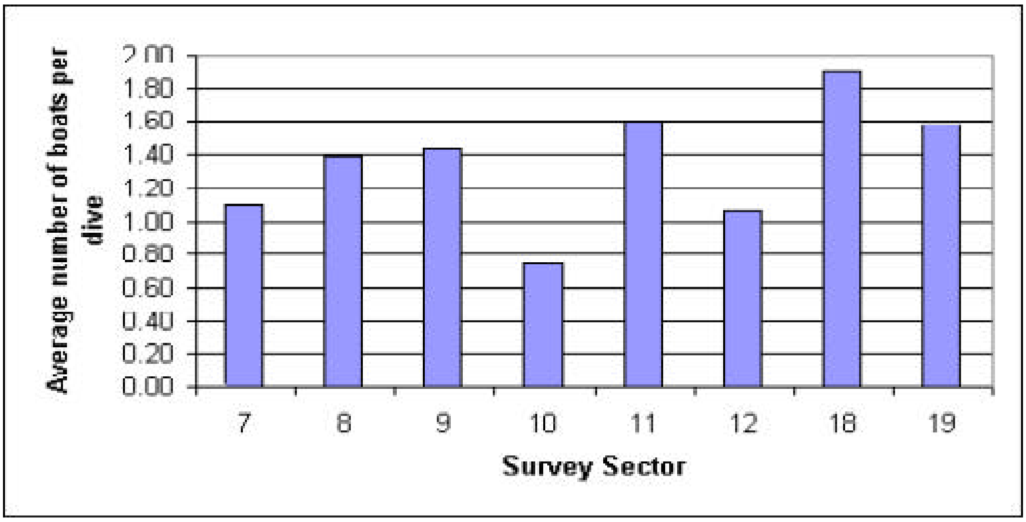
A total of 489 boats were observed during surveys within Sogod Bay and, as expected, over 80% of these were fishing vessels. 10% of the boats were identified as 'pleasure' crafts, but it is likely that thee refer to personal boats used by local people for transportation. Commercial vessels account for 5% of all boats observed and these were observed more frequently in sector 19 than any other area within the bay. Diving boats were rarely observed, accounting for only 1% of all of the boats observed during surveys. The diving industry is not as developed in Southern Leyte as other area of the Philippines and there are only a limited number of well-established dive sites and diving schools in the area.

Figure 3.4: Activities of boats observed within Sogod Bay. Total number of boats recorded = 489.



In relation to the number of surveys carried out in each of the 8 survey sectors, higher surface activity was recorded in sector 18 with an average of 1.9 boats per survey, in comparison with 0.7 boats per dive in sector 10.

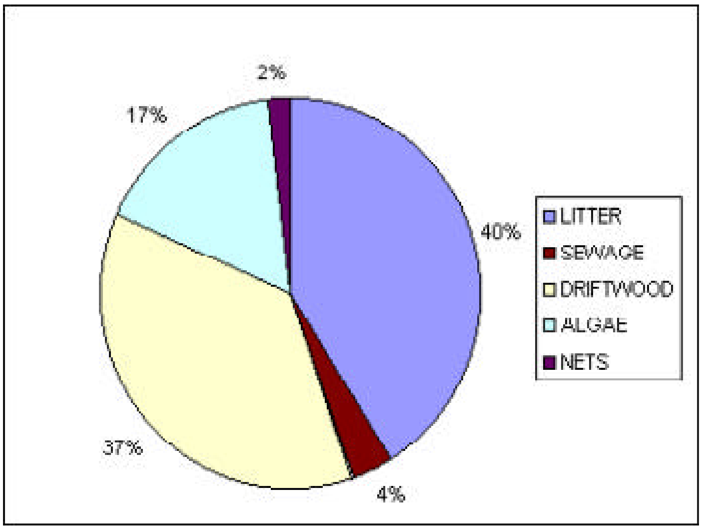
Figure 3.5: Mean number of boats per survey in 8 different survey sectors within Sogod Bay.



3.1.6: Surface Impacts

The most abundant impacts recorded on the surface from surveys within Sogod Bay were litter and driftwood, together accounting for around 80% of all total impacts recorded (figure 3.6). Algae was found to be present on the surface on 17% of all surveys, being present on approximately a quarter of all surveys completed in sectors 7, 11 and 19. Sewage and fishing nets were recorded, but only accounted for minimal observations of surface impacts, accounting for only 4% and 2% of all surface impact observations.

Figure 3.6: Surface impacts recoded within Sogod Bay.

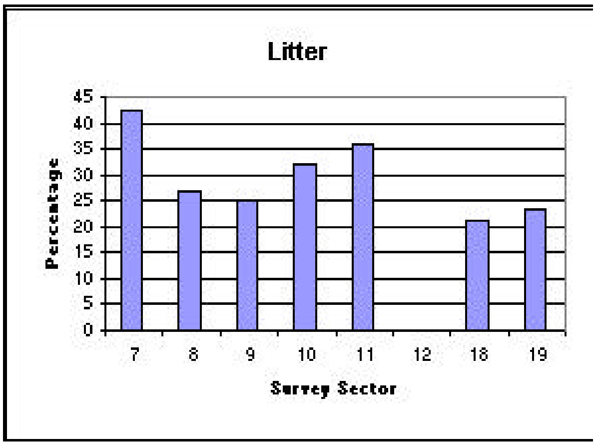


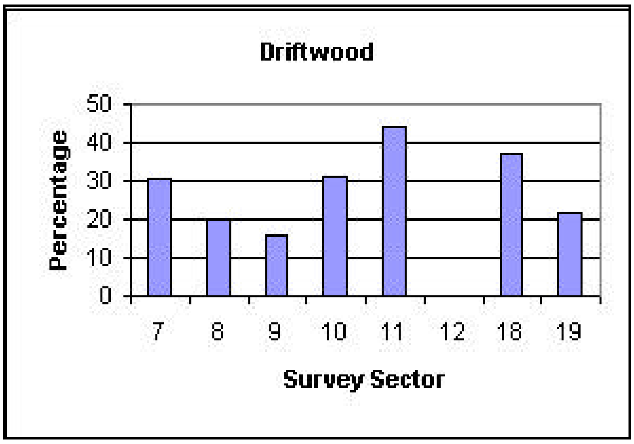
No surface impacts were recorded within sector 12 throughout the course of this study. In relation to the number of surveys completed in each sector, litter was observed more frequently in sector 7, being recorded on 42% of all surveys done in this sector. The lowest frequency of litter observation were found in sectors 18 and 19, but even in these two sectors, litter was still observed on just under a quarter of all surveys completed in the area representing a relatively high frequency of litter within Sogod Bay.

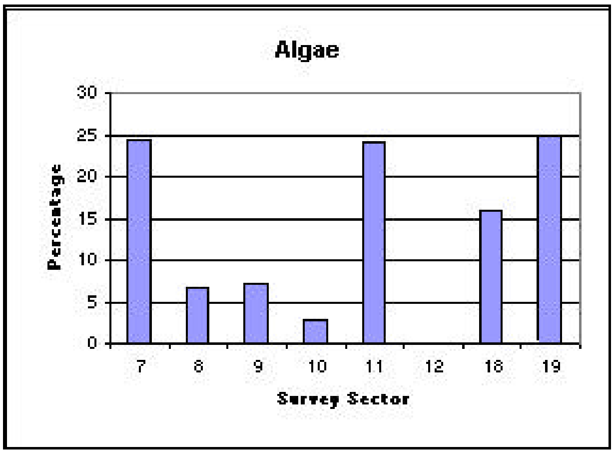
Mats of surface algae were more frequently observed in sectors 7, 11 and 19, whilst observations in sectors 8 – 10 accounted for fewer than 10% of the total surveys completed in each of these sectors. Sewage was only recorded on a total of 4% of all surveys, but the spatial distribution of these observations suggest higher frequencies of sewage in sectors 7 and 18 than other areas within Sogod Bay. Fishing nets were observed on the surface in 4 of the 8 sectors, namely sectors 8, 9, 10 and 11. These observations accounted for a very low percentage of impacts recorded in these sectors, but do indicate a low level of 'ghost fishing' within Sogod Bay.

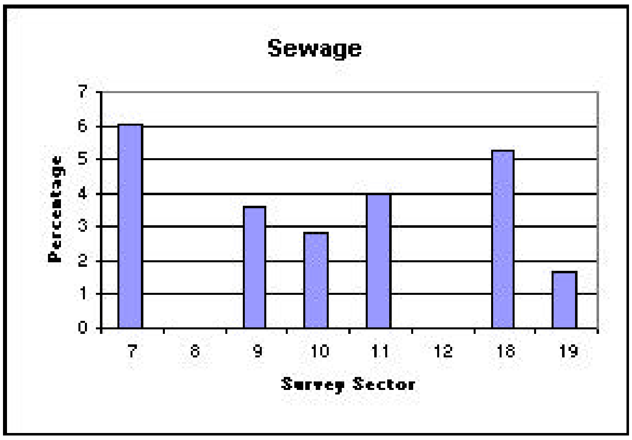
Other impacts recorded included the presence of oil and fuel on the surface of the water, and organic debris including dead animals that had been discarded in the sea. These observations were, however, isolated incidents and not generally found throughout the Bay.

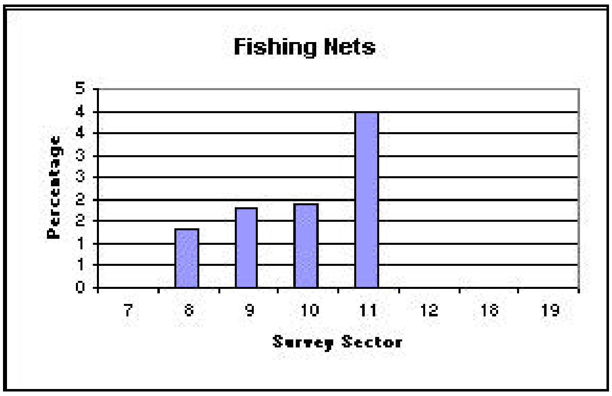
Figure 3.7: Surface impacts as a percentage of the number of surveys completed in each sector.







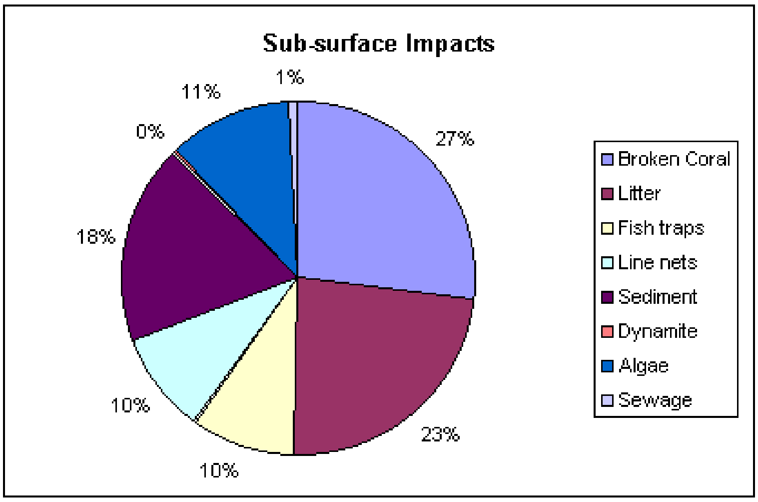




3.1.7: Sub-Surface Impacts

Broken coral and litter were found to account for the largest proportion of all sub-surface impacts recorded during surveys, accounting for 27% and 23% of all recordings respectively. Evidence of dynamite fishing and sewage were both extremely low, representing <1% of all observations made.

Figure 3.8: Sub-surface impacts recorded within Sogod Bay.

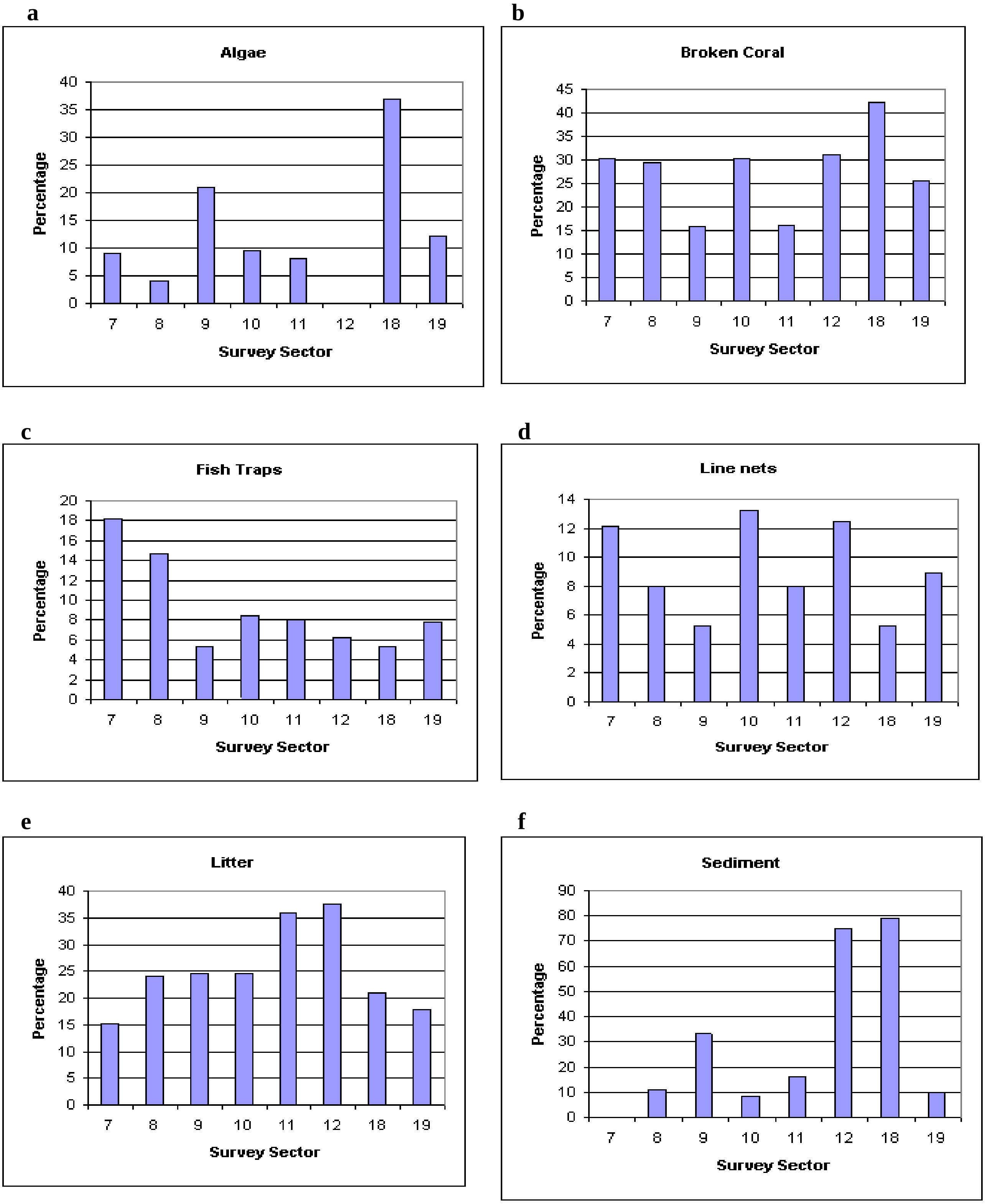


Observations of algae were more frequent in sector 18, being recorded on over 35% of all surveys completed in this sector. Algal observations were made on around 20% of all surveys in sector 9, but accounted for less than 10% of surveys in the remaining sectors. Broken coral observations were relatively high throughout all sectors in comparison with other impacts recorded, ranging from around 15% of all surveys in sectors 9 and 11, to over 40% of all surveys in sector 18. Fish trap were more frequently observed in sectors 7 and 8, being found on 18% and 15% of all surveys completed in these sectors respectively. Fish traps were recorded in all remaining sectors, but in lower frequencies (figure 3.9c).

Evidence of line fishing was found throughout all survey sectors, ranging from 5% to 13% of surveys in various sectors. Frequencies were higher in sectors 7, 10 and 12. Sub surface litter was one of the most frequently observed sub-surface impacts, being identified on 23% of all surveys. The distribution of litter on the reef was fairly even throughout Sogod Bay, with the highest frequencies in sectors 11 and 12, where litter was found on around a third of all surveys.

Sedimentation, although observed to some extent in all sectors, was more frequent in sectors 12 and 18, where it was observed on around 80% of all surveys in both of these sectors. Sector 9 also showed relatively high levels of sedimentation, with smothering of the reef being found on around 30% of all surveys in this sector.

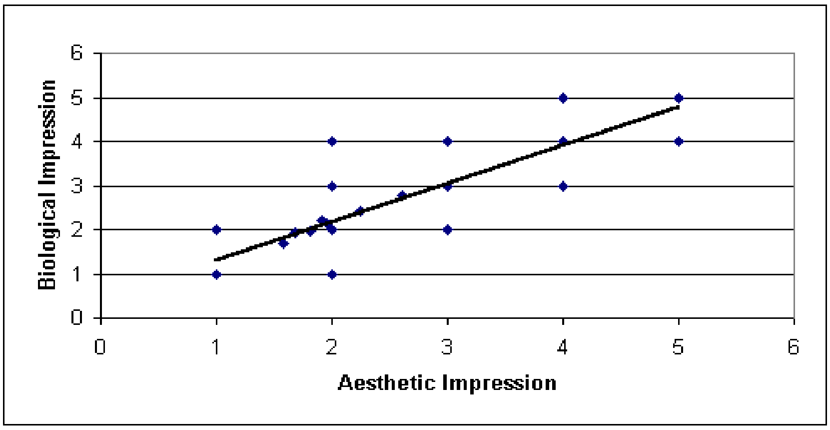
Figure 3.9: Sub surface impacts as a percentage of total number of surveys in each sector



3.1.8: Aesthetic and Biological impression

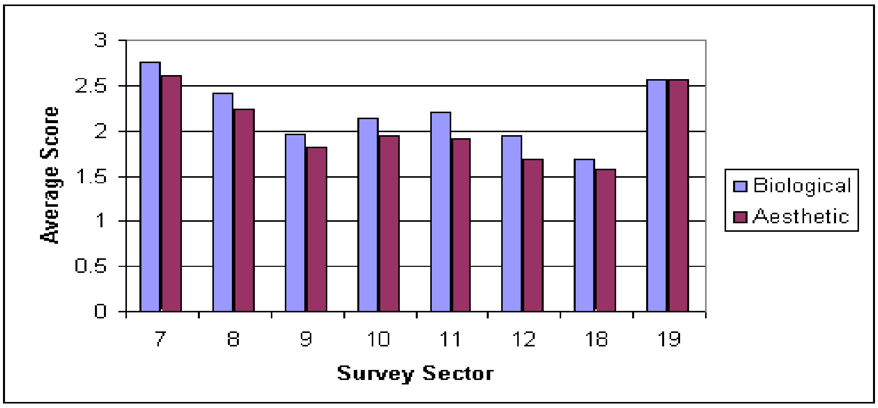
A total of 390 recordings of site impression were made during the course of this survey period, where CCC volunteers assessed both the biological and aesthetic value of the survey site. Linear regression demonstrates a strong positive correlation between these two variables (figure 3.10), where sites with high biological potential are often considered to be aesthetically appealing.

Figure 3.10: Correlation between aesthetic and biological impression of survey sites. 1 = Poor, 2 = Average, 3 = Good, 4 = Very Good, 5 = Excellent. $R^2 = 76.9\%$, $p<0.01$.



Based on ratings of 1 – 5, where 1 = Poor and 5 = Excellent, average scores were calculated for all survey sectors (figure 3.11). Biological scores were greater than aesthetic scores for all survey sectors, and only sectors 7, 8 and 19 showed both biological and aesthetic average values greater than 2 (average). Surveys in sector 18 showed the lowest average scores for both aesthetic and biological value.

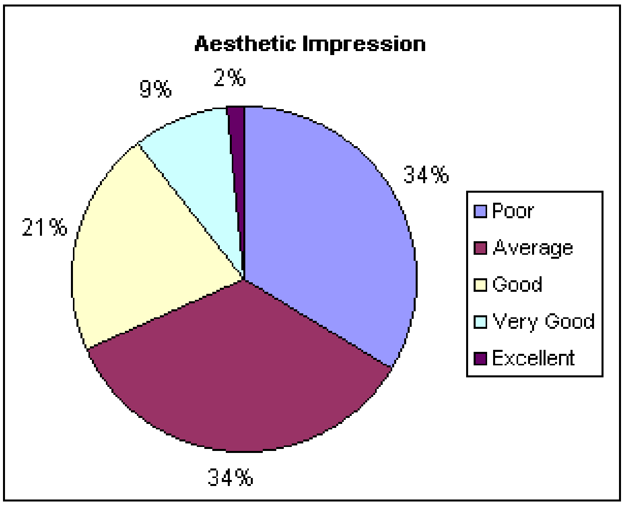
Figure 3.11: Average biological and aesthetic impressions in all sectors.



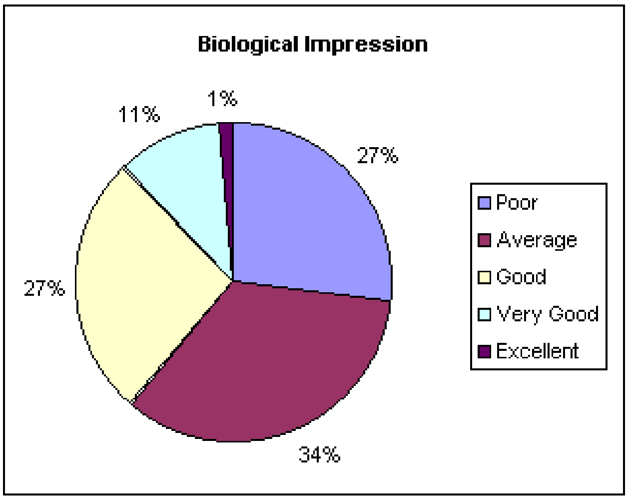
Few sites throughout Sogod Bay were considered to be biologically or aesthetically very good or excellent and the majority of surveys ranged between poor – good (figures 3.12a and 3.12b).

Figure 3.12: Aesthetic and Biological impression of all survey sites throughout Sogod Bay

a



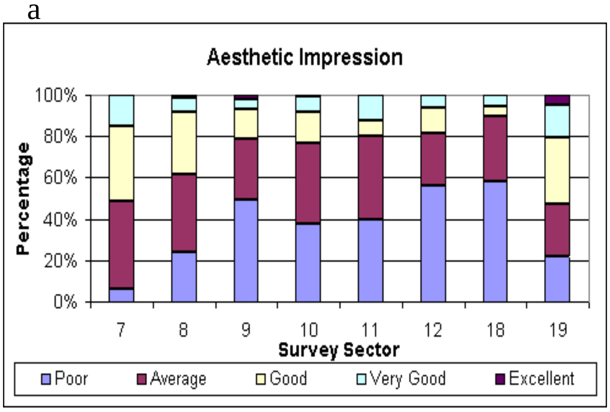
b



A greater proportion of surveys (>40%) in sectors 9, 12 and 18 were considered to be both aesthetically and biologically poor in comparison with other sectors. This pattern can be linked back to sub surface impacts where these sectors showed relatively high levels of detrimental impacts and in particular, high levels of sedimentation. Sectors 7 and 19 showed the lowest proportion of sites considered to be 'poor' and the highest proportion of sites that were considered to be either 'very good' or 'excellent', both biologically and aesthetically. In relation to sub-surface impacts recorded around these two sectors, the relative abundance of litter and sediment were the lowest levels recorded.

Figure 3.13: Aesthetic and Biological impression as a proportion of the number of surveys completed within different survey sectors in Sogod Bay.

a



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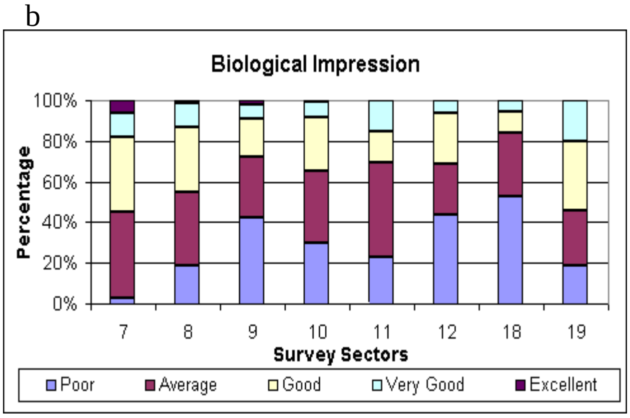


3.2: BENTHIC HABITAT CLASSIFICATION AND MULTIVARIATE ANALYSIS

From analysis of the data presented in this report, a total of 9 distinctive habitat types were identified using agglomerative hierarchal cluster analysis. These data sets do however, only represent half of the intended survey area for the course of this project, and include information gathered in 8 of the proposed survey sectors within the Sogod Bay area. The habitat descriptions suggested below are intended only as guides to aid in the analysis of this data set and can also be used to support future habitat classification of the area. Over the next three years, CCC aims to survey the remaining sectors within Sogod Bay and a full habitat map will be produced at the end of the project to aid in coastal zone management of the area.

Data from a total of 512 surveys over 8 sectors was available for habitat classification, but due to this relatively large sample size, cluster analysis was performed on a random subset of the data and then discriminant analysis was applied to the remainder of the data set to classify the outstanding sites. Out of a random set of 250 samples, 12 were discarded because they represented either erroneous data or extremely rare habitats and as such, did not cluster with other sites. These samples have been labelled as 'unknown' but future classification of a larger data set when all sectors within the bay are complete, may identify these 'unknown' samples as a distinct habitat. Labels for the 9 benthic classes as discriminated by cluster analysis are listed in table 3.4. SIMPER and univariate analysis techniques were used to define the major characteristics of each of the 9 benthic classes and table 3.5 highlights in more detail, the biological composition of each habitat type.

Table 3.4: Habitat descriptions for the 9 benthic classes identified within 8 survey sites presented in this report.

Habitat #	# Site Records	Habitat Description
1	18	Shallow sand and mud with algae and seagrass
2	6	Shallow sand and bedrock with abundant mixed algae and *non-Acropora* submassive and encrusting hard corals
3	173	Lower reef slope with sand and occasional mixed hard and soft corals
4	105	Mid-reef slope with frequent mixed *Acropora* and *non-Acropora* lifeforms
5	70	Upper-reef slope with dense mixed *Acropora* and *non-Acropora* hard coral lifeforms and abundant mixed soft corals and algae
6	47	Shallow reef with diffuse mixed *Acropora* and *non-Acropora* hard coral lifeforms and soft corals
7	43	Shallow sand habitat dominated by seagrass and algae, with sparse hard and soft corals
8	19	Bedrock with *non-Acropora* branching and sub-massive hard coral lifeforms
9	20	Shallow rubble with dead coral and algae
10	12	Unknown

Table 3.5: Major characteristics of the 9-benthic classes discriminated from baseline data collected from 8 survey sectors within Sogod Bay. Figures in parentheses indicate mean abundances in accordance with DAFOR ratings assigned during surveys. Full list of all averages is given in appendix B. The most characteristic species, lifeforms or substratum categories (greater the 5% contribution to cluster similarity as highlighted by SIMPER analysis) are highlighted in bold.

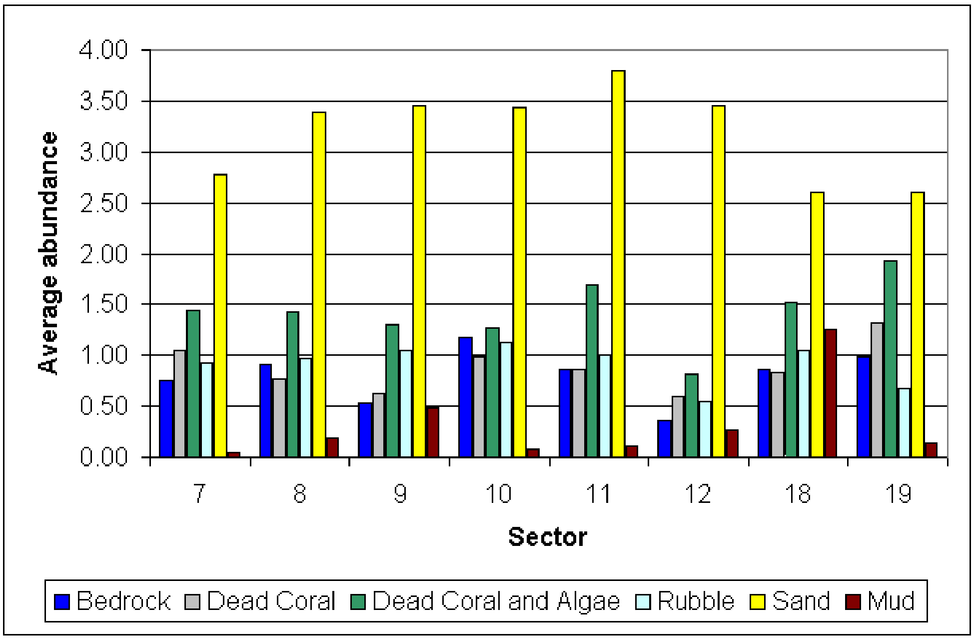
Habitat number	Average Depth (m)	Substrate	Hard Corals	Soft Corals	Algae & Seagrass
1	3.3	Sand (3.75) **Mud (2.25)**	-	-	**Algae (0.75)** **Seagrass (1.00)** ***Thalassia spp. (1.00)***
2	1.8	Bedrock (2.50) Sand (2.25) Rubble (1.50)	Total Hard Coral (2.75) ***NA-submassive (2.00)*** *NA-encrusting (1.75)* *Favia (1.25)*	Total Soft Coral (1.25) *Pulsing (1.50)* *Leather (0.75)*	Algae (3.25) ***Green Filamentous algae (2.50)*** ***Padina (2.25)*** ***Corallina (2.00)*** *Brown Filamentous algae (1.75)* *Red Filamentous algae (1.50)*
3	22.6	**Sand (3.59)** Dead coral & algae (1.06) Rubble (0.66)	**Total Hard Coral (1.62)** *NA-mushroom (0.84)* *NA-submassive (0.74)* *Acropora-branching (0.60)*	**Total Soft Coral (1.47)** *Tree (0.94)* *Leather (0.71)* *Pulsing (0.54)*	**Algae (1.59)**
4	15.8	**Sand (3.06)** Dead coral & algae (2.00) Bedrock (1.04)	**Total Hard Coral (2.80)** *Acropora-branching (1.92)* *NA-submassive (1.67)* *NA-mushroom (1.63)* *NA-encrusting (1.67)*	Total Soft Coral (1.76) *Leather (1.08)* *Pulsing (1.12)* *Tree (1.02)*	Algae (1.63)

Habitat number	Average Depth (m)	Substrate	Hard Corals	Soft Corals	Algae & Seagrass
5	6.4	**Sand (3.25)** Dead coral & algae (1.90) Bedrock (1.08)	Total Hard Coral (2.88) *NA-branching (2.00)* *NA-submassive (2.00)* *NA-massive (1.80)* *Acropora branching (1.75)*	Total Soft Coral (2.63) *Tree (1.95)* *Leather (1.88)* *Pulsing (1.83)*	Algae (2.43) *Green Filamentous algae (1.23)* *Dictyota (1.25)*
6	6.6	**Sand (3.90)** Dead coral & algae (1.45)	Total Hard Coral (1.85) *Acropora-branching (1.15)* *NA-submassive (1.30)* *Favites (1.30)* *NA-branching (1.05)*	Total Soft Coral (1.15) *Tree (1.00)*	Algae (1.00)
7	6.1	**Sand (3.71)** Dead coral & algae (1.38) Rubble (1.29)	Total Hard Coral (1.48) *Acropora-branching (0.90)* *Favites (0.76)* *Favia (0.71)*	Total Soft Coral (1.43)	**Algae (2.71)** *Padina (1.52)* **Seagrass (2.43)** *Halophila spp. (1.76)* *Thalassia spp. (1.62)*
8	1.1	Bedrock (3.80) Sand (2.00) Dead coral & algae (1.00)	**Total Hard Coral (1.20)** ***NA-branching (1.00)*** ***NA-Submassive (0.80)*** ***Favites (0.80)*** *Favia (0.60)* *Acropora tabulate (0.80)*		Algae (1.80) *Padina (0.60)* Seagrass (0.60)
9	1.7	**Rubble (4.00)** Dead coral & algae (0.75) Sand (0.63)	Total Hard Coral (0.63)	**Total soft coral (0.88)** *Tree (0.88)* *Pulsing (0.50)*	**Algae (1.88)** *Padina (1.13)* *Green Filamentous algae (0.75)*

3.3: BENTHIC HABITATS IN SURVEY SECTORS

Analysis of the substrate data from baseline surveys within sectors 7 – 12 and 18 – 19, clearly demonstrate the high abundances of sand throughout the bay (figure 3.14). The relative abundance of sand was generally higher in survey sectors towards the north of the bay (sectors 11 and 12), whilst fine mud sediments were more abundant in sector 18. Both rubble and bedrock are present in roughly equal abundances in each of the sectors, suggesting that the substrate throughout Sogod Bay is largely sandy with mixtures of bedrock and broken up dead coral and bedrock producing rubble.

Figure 3.14: Average substrate cover based of DAFOR scale abundances in each of the 8 survey sectors.



1 = Rare, 2 = Occasional, 3 = Frequent, 4 = Abundant, 5 = Dominant

The reef profile is generally found to be gentle in its slope, with only a few isolated areas showing steep wall profiles with abundant hard coral cover. Instead, areas of hard coral are distributed in patches throughout the bay, with large expanses of sandy substrate. The average abundance of total hard coral cover shows slight variation throughout the 8 survey sectors analysed within this report. The biological composition of each of the sectors will be discussed in detail in later sections of this report.

Habitat classification based on the benthic data collected across the eight survey sectors indicated greater coverage of mixed hard corals at different depths on the reef (habitats 3, 4 and 5). The lower reef slope with sand and occasional mixed hard and soft corals (habitat 3) accounted for approximately 30% of all surveys completed in each sector and indicates a relatively even distribution of this benthic class throughout the bay (table 3.6). The abundances of the mixed hard coral class on the mid and upper reef slope (habitats 4 and 5) were more variable in their distribution across the bay. The mid-reef slope with frequent mixed *Acropora* and *non-Acropora* lifeforms (habitat 4) was more prominent in survey sectors 7 and 19, and showed decreasing coverage in relation to the number of surveys completed in each sector as you move northwards into the bay. The upper-reef slope with dense mixed *Acropora* and *non-Acropora* hard coral lifeforms and abundant mixed soft corals and algae (habitat 5) showed a similar pattern of distribution, accounting for 27% of all surveys completed in sector 7 in comparison with only 5% of all surveys completed in sector 12.

Shallow rubble with dead coral and algae (habitat 9) accounted for around 13% of all surveys completed in sector 18, whilst the upper reef slope with dense mixed hard coral and algae (habitat 5) was not recorded in this sector. Shallow rubble habitat with dead coral and algae was not identified on any of the surveys in sector 19, suggesting that the isolated presence of rubble and dead coral in sector 18 is associated with localized processes such as landslides which have been recorded in this area.

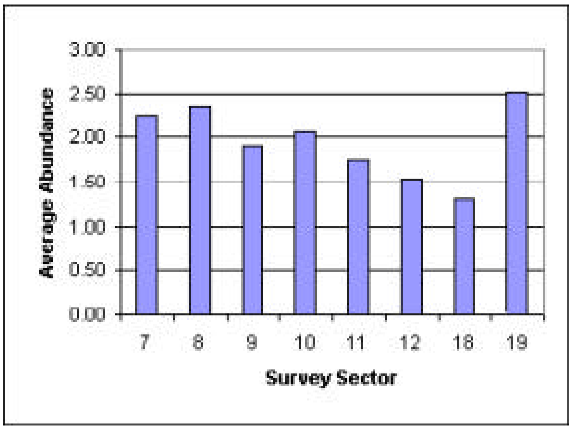
Table 3.6: Number of surveys classified into each habitat in all survey sectors across Sogod Bay.

Habitat	7	8	9	10	11	12	18	19
1. Shallow sand and mud with algae and seagrass	0	4	4	5	0	2	3	0
2. Shallow sand and bedrock with abundant mixed algae and *non-Acropora* submassive and encrusting hard corals	0	2	0	0	1	0	1	2
3. Lower reef slope with sand and occasional mixed hard and soft corals	11	34	27	48	11	7	5	30
4. Mid-reef slope with frequent mixed *Acropora* and *non-Acropora* lifeforms	12	13	9	26	6	4	6	29
5. Upper-reef slope with dense mixed *Acropora* and *non-Acropora* hard coral lifeforms and abundant mixed soft corals and algae	12	11	9	21	5	1	0	11
6. Shallow reef with diffuse mixed *Acropora* and *non-Acropora* hard coral lifeforms and soft corals	3	4	12	10	2	5	2	9
7. Shallow sand habitat dominated by seagrass and algae, with sparse hard and soft corals	5	14	7	12	2	0	0	3
8. Bedrock with *non-Acropora* branching and sub-massive hard coral lifeforms	1	6	1	2	0	2	2	5
9. Shallow rubble with dead coral and algae	1	3	4	6	2	1	3	0
10. Unknown	0	1	2	5	0	0	1	3
Total Number of Surveys	**45**	**92**	**75**	**135**	**29**	**22**	**23**	**92**

3.4: HARD CORAL COVER IN SOGOD BAY

Average abundance of total hard coral cover ranged between 1.5 and 2.5 over all of the survey sectors, roughly equating from occasional to frequent hard coral cover as defined by the DAFOR scale.

Figure 3.15: Average abundances of total hard coral cover in different survey sectors within Sogod Bay. Number of samples refers to total number of surveys completed in each sector. Average abundances relate to the DAFOR scale



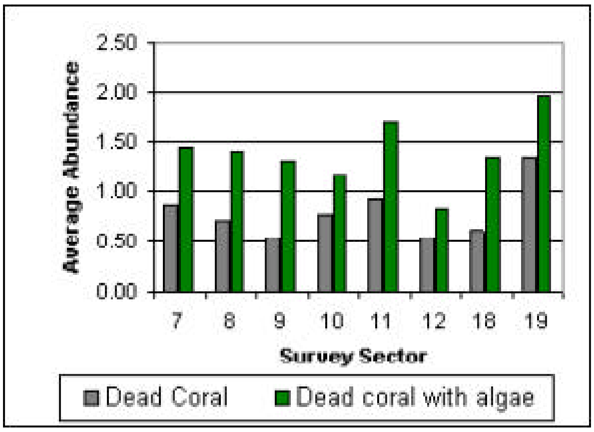
Sector	Average Abundance	Number Samples
7	2.27	45
8	2.35	92
9	1.91	75
10	2.07	135
11	1.76	29
12	1.55	22
18	1.30	23
19	2.51	92

As indicated by Kruskal-Wallis statistical tests, there is a significant difference in the average total hard coral cover between the 8 survey sectors ($H = 32.85$, $p<0.05$). The highest average total hard coral cover was observed in sector 19, whilst its neighbouring sector, sector 18, showed the lowest average abundance of hard coral cover. Sectors 11 and 12, towards the northern end of Sogod Bay have lower total hard coral cover than were observed in sectors towards the southern end of the bay.

Significant variation in the distribution of dead coral and dead coral covered with algae was also observed throughout the 8 survey sectors within the bay. Average values for dead coral were lower than those for dead coral covered with algae, suggesting that a high proportion of the dead coral within Sogod Bay is not recently killed coral. The pattern of dead coral throughout the bay tends to follow the same pattern as is observed for total hard coral cover, with the highest average value of 1.34 being observed in sector 19 (figure 3.16).

The highest average values for dead coral that has been overgrown with algae were observed in sectors 11, 18 and 19, with mean averages of 1.69, 1.35 and 1.96 respectively.

Figure 3.16: Average abundances of dead coral and dead coral with algae cover in different survey sectors within Sogod Bay. Average abundances relate to the DAFOR scale.



Sector	Dead Coral	Dead Coral with Algae
7	0.87	1.44
8	0.71	1.41
9	0.55	1.31
10	0.78	1.18
11	0.93	1.69
12	0.55	0.82
18	0.61	1.35
19	1.34	1.96

Of the 13 lifeforms categorised by CCC volunteers, *Acropora* branching and *Non-Acropora* sub-massive were the two most abundant lifeforms, with mean abundances over all survey sectors of 1.26 and 1.24 respectively (table 3.6). *Acropora* sub-massive, encrusting and digitate coral were less common, with average values of around 0.2. These lifeforms are typically less common and account for a lower proportion of the substrate cover than *Acropora* branching corals, which can be observed to cover virtually all of the benthos in some areas. Other lifeforms, such as *Non-Acropora* mushroom corals do not cover high proportions of the substrate as such, but are observed relatively frequently and as such, can have higher average abundances than other *Non-Acropora* lifeforms.

Table 3.7: Average abundance of hard coral lifeforms recorded during CCC surveys within Sogod Bay.

Lifeform	Average Abundance
Acropora branching	1.26
Non-Acropora sub-massive	1.24
Non-Acropora encrusting	1.12
Non-Acropora branching	1.11
Non-Acropora mushroom	1.03
Non-Acropora massive	0.91
Acropora tabulate	0.67
Non-Acropora foliose	0.66
Non-Acropora fire	0.39
Acropora sub-massive	0.22
Acropora encrusting	0.21
Acropora digitate	0.14
Non-Acropora blue	0.02

3.4.1: Target Species

CCC surveys target on 37 species of hard coral, focusing primarily on those that are most easily distinguished by visual characteristics to aid in identification. Overall abundances, as defined by the DAFOR scale, were relatively low with average values of <1 for all species. Sectors surveyed within Sogod Bay all show relatively high abundances of sand, with hard corals settled with a patchy distribution. Average abundances of hard coral targets in each survey sector are listed in appendix C.

Table 3.8: Average abundance of top ten most frequently recorded target coral species throughout all survey sectors within Sogod Bay.

Target Species	Average Abundance
Favia	0.95
Massive *Porites*	0.94
Favites	0.88
Lobopyllia	0.85
Galaxea	0.78
Goniopora / Alveopora	0.76
Bottlebrush *Acropora*	0.65
Seriatopora hystrix	0.53
Pocillopora small	0.45
Mycedium elephantosus	0.42

3.4.2 Coral Species Diversity

Recent studies by Douglas Fenner (2003) identified a total of 276 species and 72 genera of stony corals (263 species and 66 genera of zooxanthellate Scleractinia) within Sogod Bay (appendix D). Slopes in the Sogod area are generally gentle and sandy, with gravel in shallow water. In sandy areas, staghorn thickets and branching *Goniopora* often predominate. There are also communities of small unattached branching corals such as *Anacropora* and Fungiids which are interspersed with soft coral communities on soft substrates. In the few areas where solid substrate is exposed, a much higher diversity community of attached corals can be found.

Many sandy sites are dominated by staghorn *Acropora*, usually including but not restricted to *Acropora formosa*. Other smaller areas are dominated by branching *Goniopora* (likely *G. palmensis* or *G. pandoraensis*), or branching *Alveopora* (*Alveopora catalai*). Small patches are dominated by *Anacropora matthai.*

Four species were found that are uncommon to rare, which are listed in Table 3.19. A total of 5 species were found which have not previously been reported from the Philippines in the published literature. These species are listed in Table 3.20

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Table 3.9: Rare species of coral discovered in Sogod Bay.

Species	Status
Nemenzophyllia turbida	Known from only about 17 sites in the world
Halomitra clavator	Rarely reported
Catalaphyllia jardenei	Rare or uncommon most places
Micromussa amakusensis	Rarely reported

Table 3.10: Coral species not previously reported from the Philippines in published literature.

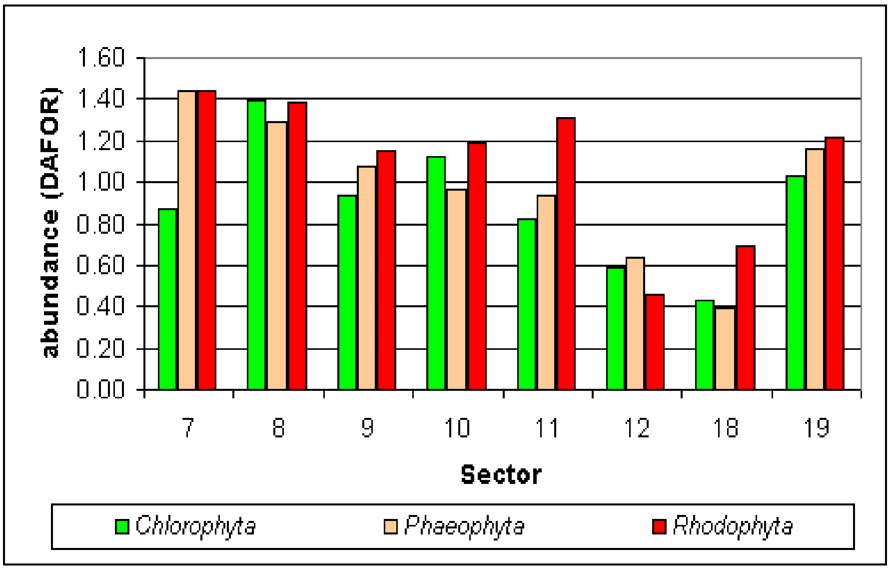
Rare species
*Acropora plumosa**#
*Favia truncatus**
Goniopora albiconus+
*Lobophyllia flabelliformis**#
*Montipora vietnamensis**

*Also found by DF in Tubbataha and Cagancillio.
+Also found by DF in Sierra Madre
#Also found by DF at Mabini

3.5: Abundance of Macro Algae in Sogod Bay

Total macroalgal abundance was shown to vary significantly across Sogod Bay, with the highest average abundance in sector 11 (2.28) and sectors 8 and 10 also displaying mean abundances greater than 2 for total macroalgae cover (figure 3.17). Sectors 12 and 18 both show considerably lower average abundance of all three algal classes, which is consistent with the lower amounts of total dead coral and algae recorded in these two sectors as previously discussed (figure3.16).

Figure 3.17: Average abundance of total green, brown and red algae cover in different survey sectors within Sogod Bay.



Sector	Abundance
7	1.87
8	2.10
9	1.68
10	2.04
11	2.28
12	0.86
18	1.43
19	1.83

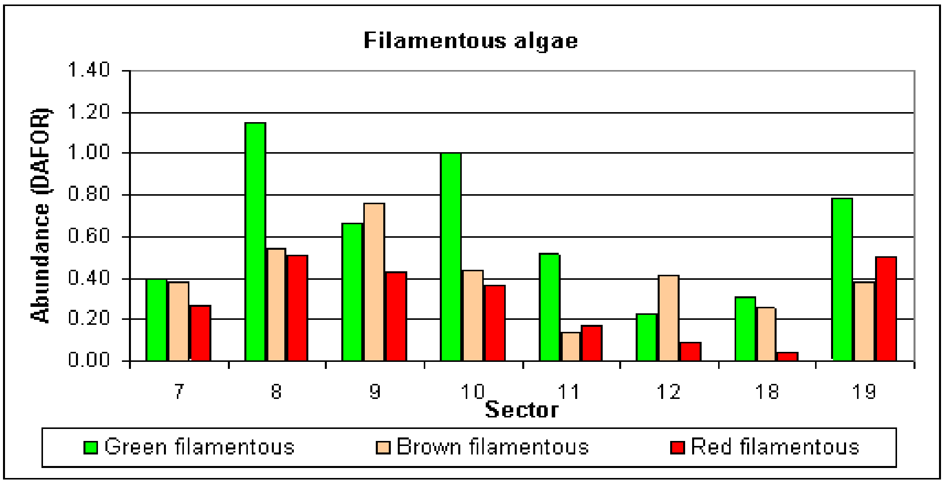
Total Macroalgae abundance

3.5.1: Chlorophyta

Overall abundance of green algae ranges from a low of 0.43 in sector 18, to a high of 1.39 in sector 8. Average abundances of green algae were generally lower than those for red or brown algae. Calcified *Halimeda* spp. were the most commonly recorded of the *Chlorophyta* target species and distribution was shown to be highly variable across the survey sectors with average abundances ranging from absent in sector 12, to 0.46 in sector 19.

Filamentous green algae represent the most abundant green algae (figure 3.18). Green filamentous algae were particularly abundant in sectors 8, 10 and 19 and the relative abundances of both red and brown filamentous algae were also higher in these sectors. Sectors 7, 12 and 18 show lower mean abundances of filamentous algae.

Figure 3.18: Average abundance (DAFOR scale) of green, brown and red filamentous algae across 8 survey sectors within Sogod Bay.

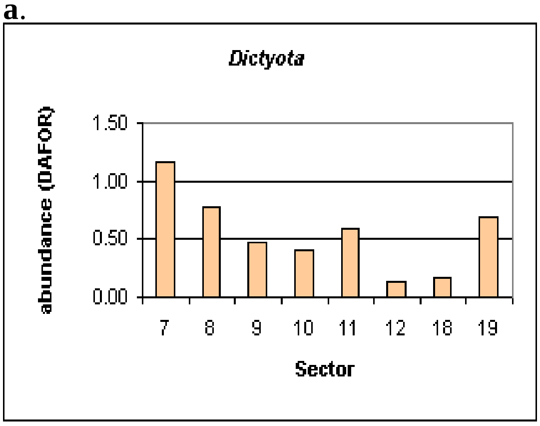


3.5.2: Phaeophyta

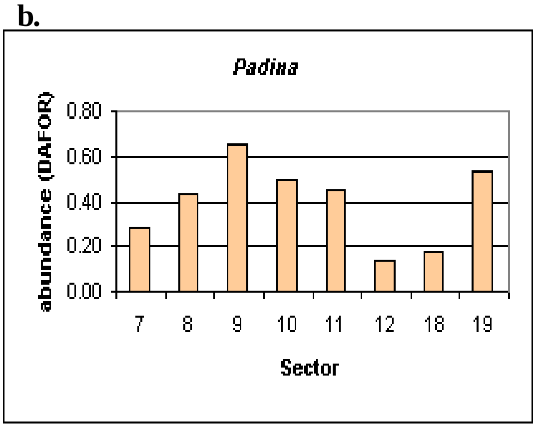
The abundance of brown algae tends to show a general decrease in abundance in sectors towards the northern end of Sogod Bay, with mean abundance ranging from 1.44 in sector 7 to just over 0.6 in sector 12 and the lowest value of 0.39 in sector 18. The most commonly recorded species were *Dictyota*, and *Padina* (figures 3.19 a and b), whilst species such as *Lobophora* and *sargassum* were present in very low abundances and not even recorded in some sectors. The distribution of mean abundances of *Dictyota* and *Padina* appear to be inverse of one another, whereby sectors with higher average abundance of *Dictyota* (mean = 1.16 in sector 7), have a low relative abundance of *Padina* (mean = 0.24 in sector 7)

Figure 3.19: Mean abundance (DAFOR) scale of two relatively abundant brown algae target species across different survey sectors.

a.



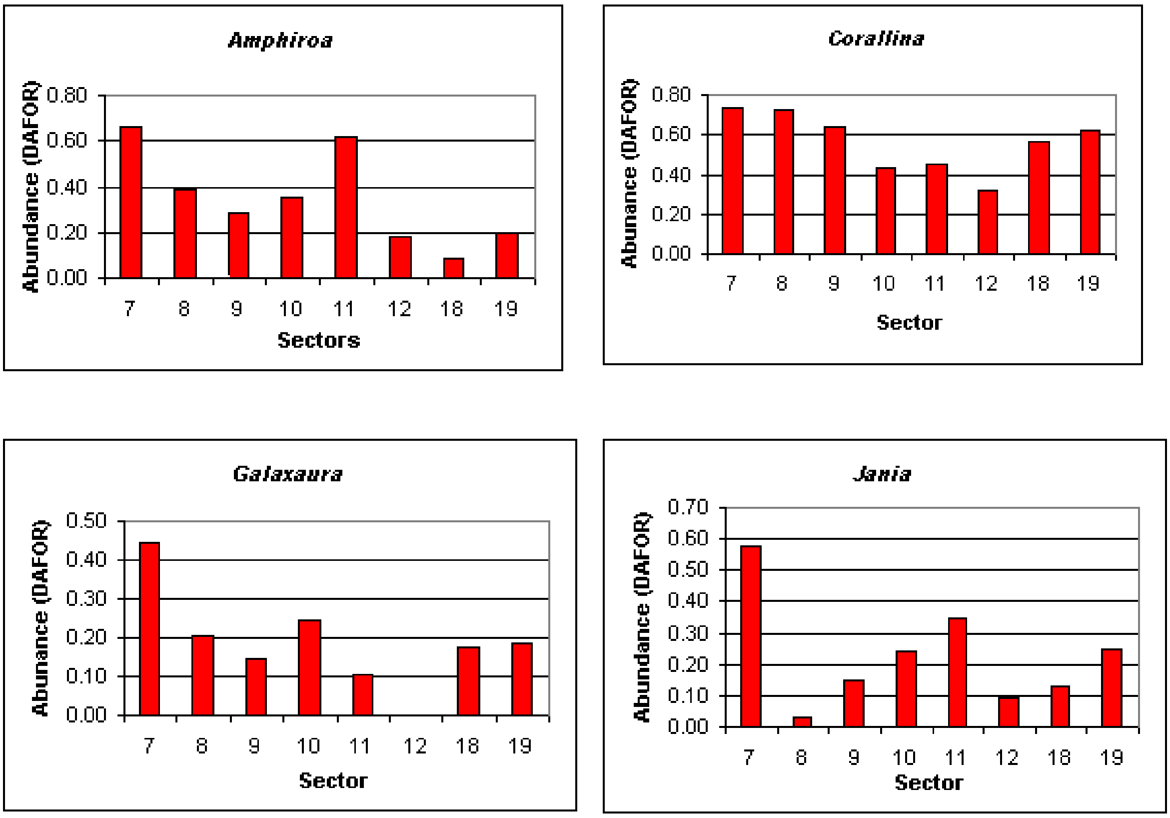
b.



3.5.3: Rhodophyta

Total abundance of red algae was greater than 1 for all sectors with the exception of sectors 12 and 18, where the average abundances were 0.45 and 0.7 respectively. Sector 17 showed the highest average abundance of red algae (mean = 1.44). Calcified red algae were the most prominent of the target species and their distributions across the 8 survey sectors within Sogod Bay are given in figures 3.20 a – d. Of these four targets, *Jania* showed the highest variation in distribution across the different sectors, with an abundance of 0.58 in sector 7 in comparison with 0.03 in sector 8. *Amphiroa* and *Galaxaura* also showed considerably higher average abundances in sector 7 suggesting that the algal composition is more varied than in other areas throughout the bay. As highlighted in other algal classes, the abundance of red algae targets was lowest in sectors 12 and 18.

Figure 3.20: Average abundance (DAFOR scale) of four target species of calcified red algae across survey sectors within Sogod Bay.



3.6: FISH ABUNDANCES IN SOGOD BAY

CCC baseline surveys focus on a number of commercially or ecologically important fish species, genera or families. These targets are relatively simple to distinguish from other species, and as such, can afford a high level of confidence in the data gathered. Abundance data of these target fish was available from 513 survey sites over the 8 survey sectors presented in this report and the data has been analysed in a number of different ways:

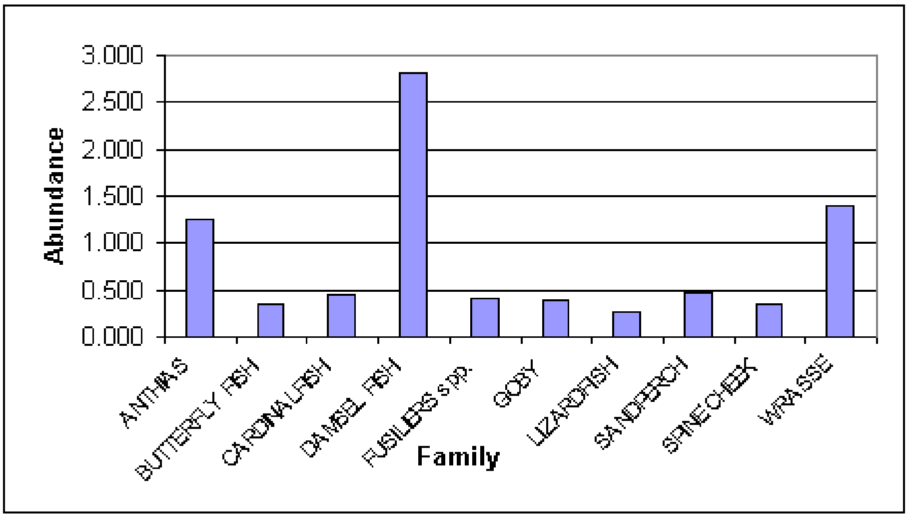
- Analysis of fish families and selected species within the whole project area
- Analysis of fish abundances within different benthic habitat types as previously defined
- Analysis of variation in fish abundance throughout the survey sectors

As described in the methods, abundance ratings of 1 – 5 were assigned using the DAFOR scale where; 1: Rare, 2: Occasional, 3: Frequent, 4: Abundant, 5: Dominant.

3.6.1: Fish communities within Sogod Bay

A total of 129 target fish species, genera or families were identified within the Sogod Bay area. General abundances of reef fish were found to be relatively low within Sogod Bay. Damselfish (*Pomacentridae)* were the most abundant family with a mean abundance of 2.8 (figure 3.21), and Anthias and wrasse were also frequently observed with abundances of 1.3 and 1.4 respectively. Pelagic fish such as tuna and mackerel that often come onto the reef to feed were rarely observed during surveys. Commercially important families such as Parrotfish, Snappers, Groupers and Rabbitfish were also relatively rare, with averages abundances of <0.2.

Figure 3.21: Mean abundance (DAFOR scale) of the ten most common fish families recorded during baseline surveys within Sogod Bay.



The most commonly observed fish species was the Humbug dascyllus (*Dascyllus aruanus)*. Due to the relatively higher abundance of damselfish and wrasse families as a whole, it is not surprising that species from these families were identified within the top ten species within Sogod Bay (table 3.9).

Table 3.11: Mean abundance (DAFOR scale) of ten most frequently observed fish species within Sogod Bay.

Species		Abundance
Humbug dascyllus	*Dascyllus aruanus*	1.28
Chromis spp.	*Chromis spp.*	0.80
Crescent wrasse	*Thalassoma lunare*	0.79
Reticulated dascyllus	*Dascyllus carneus*	0.74
Blackbar chromis	*Chromis retrofasciata*	0.73
Three-spot damselfish	*Pomacentrus tripunctatus*	0.65
Anemone spp.	*Amphiprion spp.*	0.64
Blue devil damselfish	*Pomacentrus spp.*	0.45
Cleaner wrasse	-	0.40
Black damselfish	*Neoglyphidodon melas*	0.40

3.6.2: Fish populations within different habitat types

The relationship between benthic habitat and associated fish populations is of high importance for management strategies since diverse habitats with rich coral reef fish assemblages may be of higher conservation value than sites with seemingly excellent benthic cover and yet low reef fish association.

As detailed in previous sections, cluster analysis identified 9 habitats, distinguished by their benthic class. The 12 site records that were classified as 'unknown' habitat were removed from this analysis to avoid confusion. Analysis of similarity (ANOSIM) identified significant differences between fish communities in each of the 9-benthic habitats ($R = 0.033$, $p<0.05$). Detailed ANOSIM showed that the most significant differences were between the coral rich habitats (3, 4, 5 and 6) and those where hard coral cover was relatively sparse with higher abundances of sand and rubble.

Biodiversity indices, based on the average abundance of target fish in each of the 9-benthic habitats identify habitats 3 (Lower reef slope, mixed hard and soft corals), 4 (Mid-reef slope with mixed *Acropora* and *non-Acropora* lifeforms) and 5 (Upper reef slope, dense mixed hard corals and abundant soft coral and algae) as hosting the highest species diversity (table 3.10). Margalef's species richness index (d) is a measure of the number of species present in a sample, clearly highlighting habitats 3, 4 and 5 as having the highest species richness. Habitat 2 (sand and bedrock, *non-Acropora* submassive and encrusting corals) showed the lowest species richness, and only 32 different target fish were observed in this habitat.

Pielous evenness rating (J') assesses the distribution of individuals within the population and in this data set, habitats with lower species richness showed higher evenness ratings. A more even distribution of species is characteristic of sites where certain targets might be observed regularly and in approximately the same abundances within a particular habitat. Habitats 3, 4 and 5 however show a lower evenness rating, suggesting that despite far higher species richness, certain species dominate these habitats. The Shannon-Weiner diversity index (H' log^e) serves as a combination of both species richness and evenness and distinguishes the coral rich habitats 3, 4 and 5 from areas with more sparse coral cover such as benthic habitats 2 and 9.

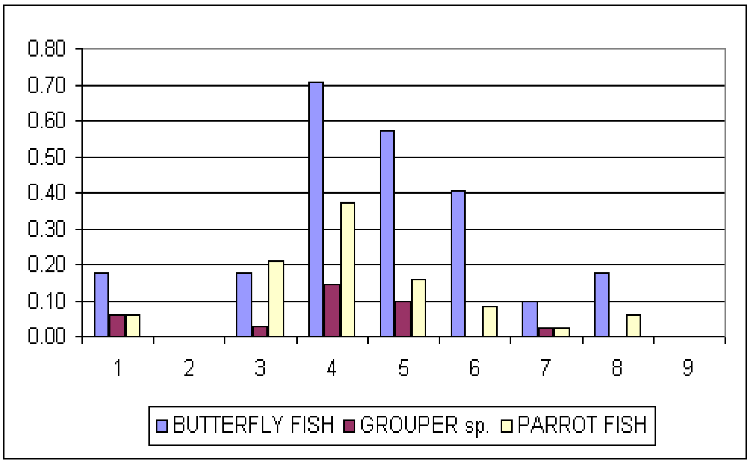
Table 3.12: Univariate biodiversity indices calculated for fish assemblages associated with each of the 9 benthic habitats defined from data collected within Sogod Bay. Shaded habitats indicate highest species diversity.

Benthic Class	Number of Species	Marglef Richness (d)	Pielous Evenness (J')	Shannon-Weiner (H' Log^e)
1	53	19.21	0.826	3.279
2	32	10.05	0.894	3.097
3	106	41.53	0.786	3.664
4	118	35.08	0.786	3.748
5	101	28.49	0.790	3.642
6	75	23.42	0.793	3.425
7	66	22.33	0.772	3.234
8	49	19.38	0.817	3.180
9	34	17.08	0.859	3.029

Damselfish were found to be the most frequently observed fish in each of the benthic habitats, with mean averages ranging from 1.35 in habitat 9, to 3.94 in habitat 5. Wrasse were also relatively common in all of the benthic habitats, with mean abundance over 2 on the upper reef slope with mixed hard corals and algae (habitat 5). Certain families, such as Anthias and Spine cheeks were more abundant in coral rich habitats than those with sparse or diffuse hard coral cover. Due to their cryptic nature and difficulties in identification, Gobies are often overlooked on surveys, but analysis of the data by different habitats indicates a mean average abundance of 0.83 for gobies in habitat 1 (shallow sand and mud with mixed algae and seagrass). Abundances of gobies in other benthic classes range between 0.25 and 0.57. Fusiliers were relatively abundant in habitat 2 (mean abundance = 1.00) but displayed average abundances of less than 0.5 in the remaining habitats and were completely absent from habitat 9, suggesting possible habitat preferences for this family.

Kruskal-Wallis analysis was used to test for differences in 6 commercially and ecologically important target families. Significant differences between the abundance of Groupers ($H = 21.77$, $p<0.01$), Parrotfish ($H = 23.6$, $p<0.05$) and Butterflyfish ($H = 72.11$, $p<0.01$) across the 9-benthic habitat types were identified. Snappers, Surgeonfish and Rabbitfish showed no significant variation in abundance between the 9 habitat types. Further analysis showed that Butterflyfish were absent from sectors 2 and 9 (figure 3.22), both of which contain relatively sparse hard coral cover.

Figure 3.22: Mean abundance (DAFOR scale) of three commercially and ecologically important target families across different benthic habitat types.



1 Sand & mud with mixed algae and seagrass
2 Shallow sand & bedrock with *non-Acropora* submassive and encrusting hard corals
3 Lower reef slope with sand and occasional mixed hard and soft corals
4 Mid-reef slope with frequent mixed *Acropora* and *non-Acropora* lifeforms
5 Upper-reef slope with dense mixed hard coral lifeforms and abundant mixed soft corals and algae
6 Shallow reef with diffuse mixed *Acropora* and *non-Acropora* hard coral lifeforms and soft corals
7 Shallow sand, seagrass and algae, with sparse hard and soft corals
8 Bedrock with *non-Acropora* branching and sub-massive hard coral lifeforms
9 Shallow rubble with dead coral and algae

As identified by the diversity indices, many species were only observed in the relatively coral rich benthic classes (i.e. habitats 3, 4, 5 and 6). Relatively common species such as the Crescent wrasse, Humbug dascyllus and the three-spot damselfish were observed throughout all habitats, but tend to show higher mean abundances in habitats 4 and 5.

3.6.3: Fish population variation between survey sectors

Analysis of the variation in fish assemblages between different survey sectors is essential if factors such as differential fishing pressures are to be highlighted. As previously identified, fish populations vary significantly with habitat type. Comparisons for species variation between sectors were therefore made only between data collected from one particular habitat, so as to remove any possible variation due to benthic class.

From of the data available, habitat 3 (lower reef slope with sand and occasional mixed hard and soft corals) was the most abundant, with 168 site records available for analysis. ANOSIM of all of the families, genera and species targeted during baseline surveys showed a significant variation in fish populations between survey sectors ($R = 0.051$, $p<0.01$). Further analysis, suggested that the variation between survey sectors was more pronounced in certain species, such as the parrotfish and rabbitfish. Due to the high level of variation in sample size between the 8 survey sectors however, it is difficult to identify with any confidence how significant these differences are and where the variation is greatest. Further surveys in sectors 7, 11, 12 and 18 would need to be carried out in order for statistical differences to be ascertained.

Figures 3.23 (a-f) show the mean abundance of 6 different commercially or ecologically important target families across the 8 different survey sectors. Although no statistical difference is certain, there appears to be some level of variation in abundances amongst these six families between different sectors within Sogod Bay.

Although the average abundances of Butterfly fish were low throughout all sectors, they were more frequently observed in sectors 10, 18 and 19 and were found to be absent in surveys completed on this habitat in sector 11. Parrotfish and Rabbitfish also show low overall abundances but there does appear to be a distinct difference in abundance across the 8 survey sectors, with Rabbitfish only being observed in sectors 7, 10 and 19. For all six of the species detailed below, sector 19 appears to host relatively higher abundances of those species than the other sectors within Sogod Bay.

Snappers were not recorded in sectors 7, 12 and 18, and abundances in the remaining sectors were extremely low, with the highest average abundance in sector 8 and this was still less than 0.3 suggesting snappers are rarely observed within the survey area. Average abundances of both Wrasse and Damselfish were higher than other species but the results still indicate a certain amount of spatial variation in the data. The average abundance of wrasse in sector 12 (0.14) is considerably lower than that which was observed in sectors 7 (1.55) and 19 (1.41).

Figure 3.23: Mean average abundance (DAFOR) of ecologically and commercially important fish families across survey sectors within Sogod Bay.

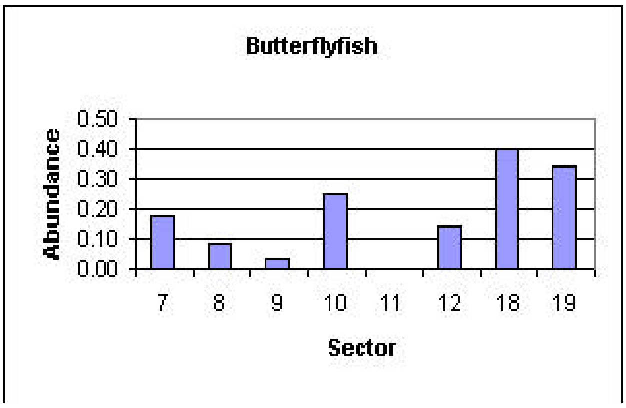


Fig: 3.23: a

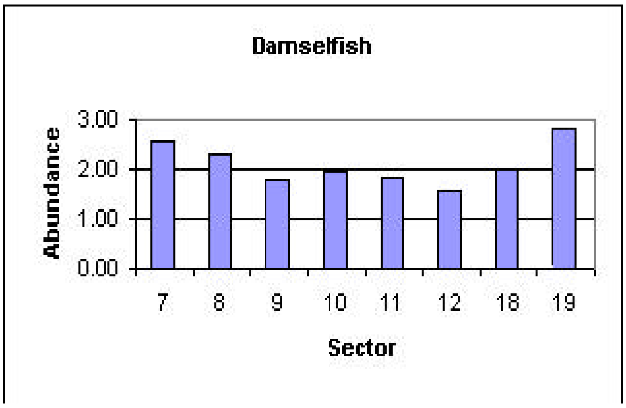


Fig:3.23: b

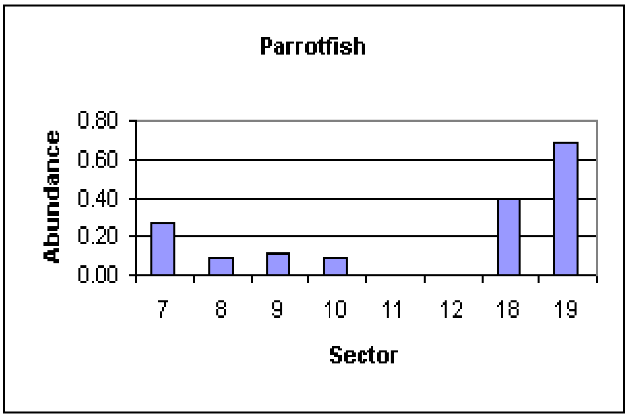


Fig: 3.23: c

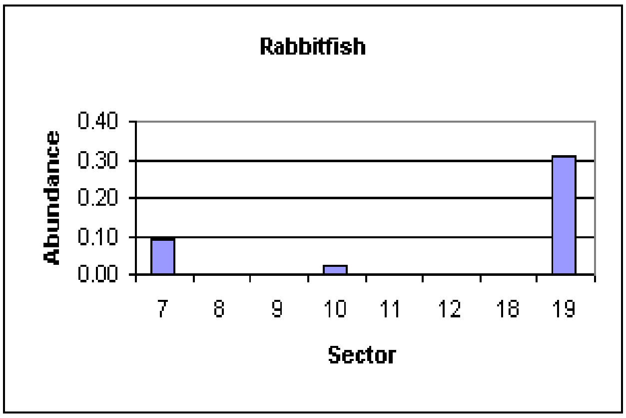


Fig: 3.23: d

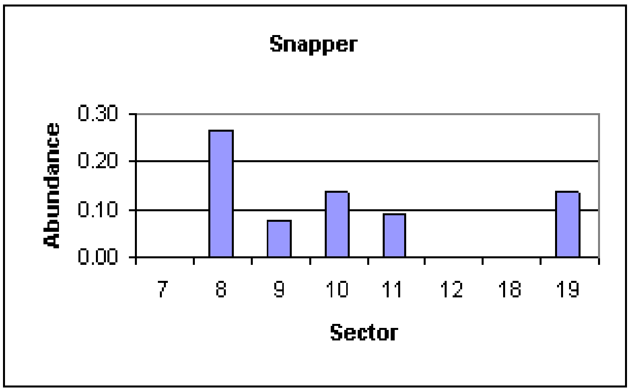


Fig: 3.23: e

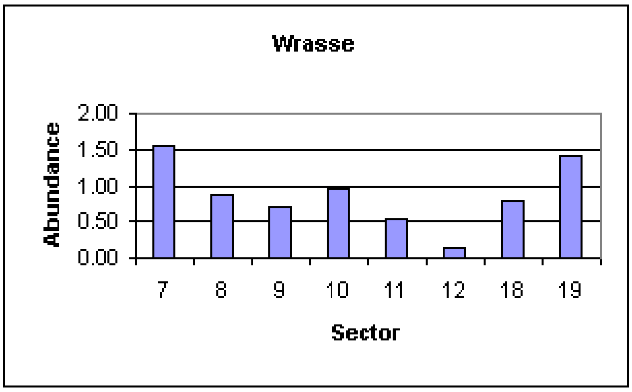
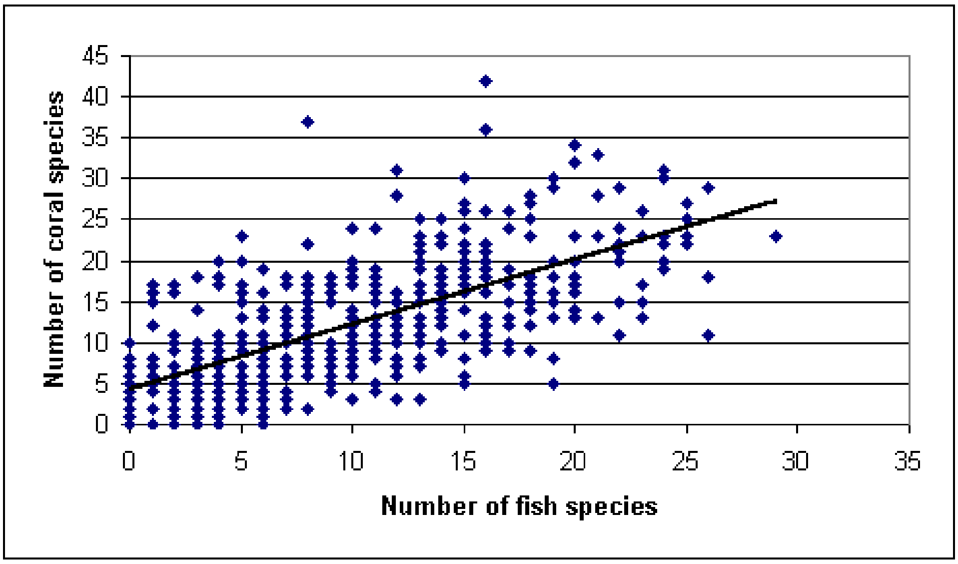


Fig: 3.23: f

3.6.4: Correlation between fish and coral species richness

To highlight the relationship between coral species richness and high fish diversity on the reef, regression analysis between the number of coral species and the number of target fish species recorded at each survey site was performed. The results indicate a significant correlation between the two variables (R^2 = 47.2, p<0.01) as shown in figure 3.24. The correlation co-efficient R^2 varies from –1 (strong negative correlation) to +1 (strong positive correlation). The results of this regression analysis indicate that greater fish species richness is significantly correlated with high coral species richness.

Figure 3.24: Relationship between number of target fish and coral species recorded during baseline transect surveys. Trendline shows linear relationship via regression analysis.

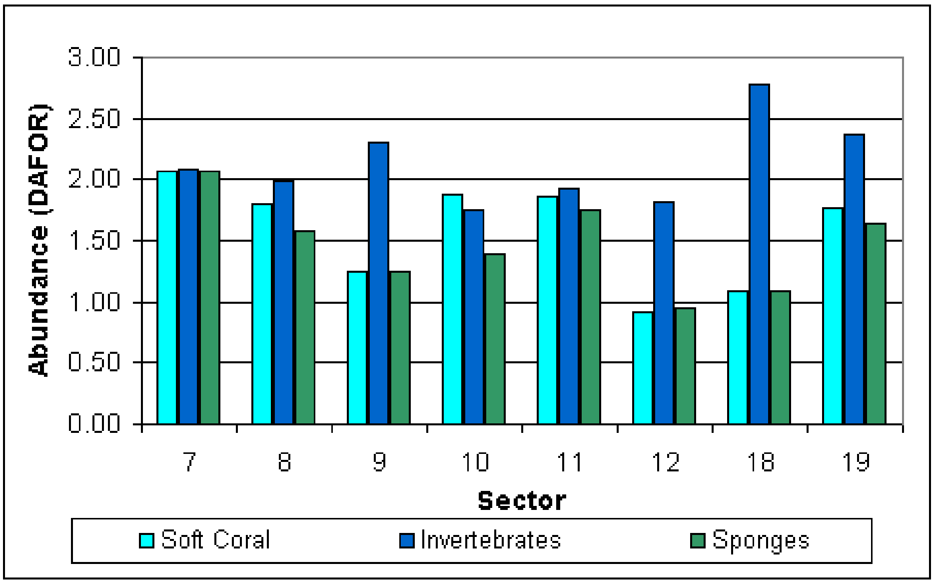


3.7: INVERTEBRATES ABUNDANCES WITHIN SOGOD BAY

Total invertebrate abundance recorded on each survey was shown to vary significantly between different survey sectors (Kruskal-Wallis, H = 30.16, p<0.01), with invertebrates being more frequently recorded in sectors 9 and 18 (figure 3.25). Significant variation in total abundance of soft corals and sponges were also identified across each of the eight survey sectors (Soft Coral: H = 42.67, p<0.01, Sponge's H = 38.01, p<0.01) and both show relatively similar abundances across Sogod Bay.

The total abundance of soft corals and sponges was relatively low in sector 18 with average abundances around 1.00, whilst average abundances of total invertebrates were at their highest (mean abundance: 2.78). Sectors 9 and 12 also show a similar pattern with higher abundances of invertebrates than soft corals and sponges, but not to the same extent as that which is seen in sector 18.

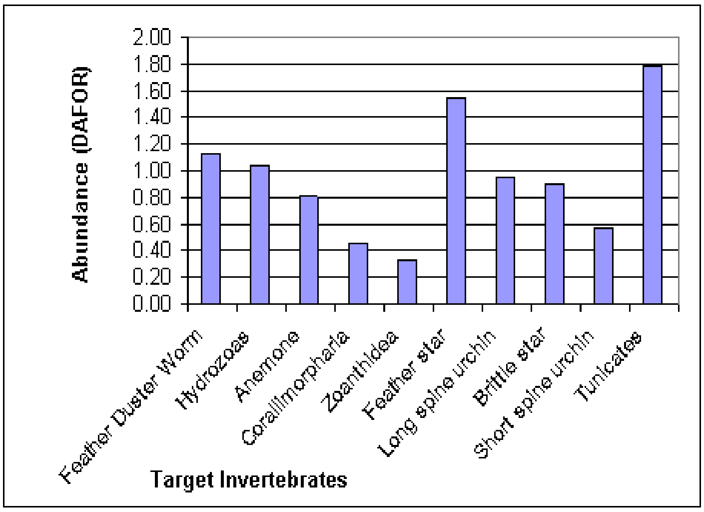
Figure 3.25: Average abundance (DAFOR scale) of total soft coral, invertebrates and sponges in different survey sectors.



3.7.1: Target Invertebrates

A total of 44 invertebrate families, genus or species are targeted during baseline surveys, with representatives from 6 major phyla. Tunicates were the most commonly observed target, with an overall average abundance of 1.79. Members of the phylum *Cnidaria* and *Mollusca* were also relatively well represented (figure 3.26). Less frequently observed were invertebrates such as the Lobster, Cuttlefish, Octopus, Squid and Abalone with mean abundances of <0.1 across all sectors.

Figure 3.26: Average abundance of the top ten most commonly recorded invertebrate targets within Sogod Bay.



Phylum	Target	Rank
Annelida	Feather Duster worm	3
Cnidaria	Hydrozoans	4
Cnidaria	Anemone	7
Cnidaria	Corallimorph	9
Cnidaria	Zoanthid	10
Echinoderm	Feather Star	2
Echinoderm	Long Spine Urchin	5
Echinoderm	Brittle Star	6
Echinoderm	Short Spine urchin	8
Uro - Chordata	Tunicates	1

Certain invertebrates are often targeted as food sources and may be subject to high levels of fishing pressure, whilst other species or families may be useful as ecological indicators of other processes that are occurring within the reef ecosystem. Lobsters are often considered to be high priced food items and are subject to over-fishing in many areas of the world. Lobsters were found to be extremely rare on surveys completed within the 8 sectors during the course of this study (mean total abundance <0.1). Giant clams were also found to be relatively low, again with an average abundance of <0.1. Local fishermen commonly target invertebrates such as sea cucumbers (*Holothuroidea)*, abalones and conch (*Strombus spp.)*. Average abundances of these targets were found to be relatively low throughout the bay, but no significant difference between abundances in different sectors was identified. Significant differences in the abundance of oysters, short-spine urchins, long-spine urchins and crown of thorns starfish were however detected (figures 3.27 a – d).

Oysters were found to be present in relatively low abundances throughout all sectors, but the lowest mean abundances were observed in sector 11 (0.1). Sector 19 showed the highest average abundance of oysters, with mean abundance of 0.4. Short-spine urchins are commonly collected for food sources throughout the area. Average abundances were shown to be extremely low in sectors 7, 8 and 10 with mean abundances of around 0.2, compared with higher abundances of around 0.9 in sector 12. Long-spine urchins (*Diadema spp.)* and Crown of Thorns Starfish (*Acanthaster planci)* are useful targets to monitor as ecological indicators and Kruskal-Wallis statistical analysis suggest that both of these targets display significant variation in their distribution across survey sectors. Crown of Thorns Starfish, although only present in relatively low abundances, were more frequently recorded in sector 19 (mean abundance = 0.5). Average abundances of *Diadema* urchins were found to be significantly higher in sectors 11 and 18 than in other areas throughout the bay.

Figure 3.27: Average abundance (DAFOR Scale) of commercially and ecologically important target invertebrates throughout survey sectors within Sogod Bay.

Commercially Important Targets

Fig: 3.27: a.

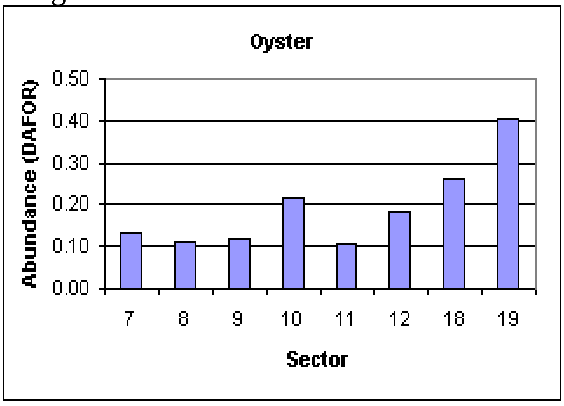
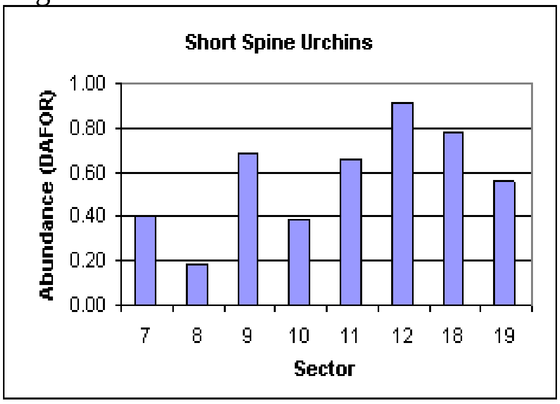


Fig: 3.27: b.



H = 18.96; p<0.01

H = 49.23; p<0.01

Ecologically Important Targets

Fig: 3.27: c.

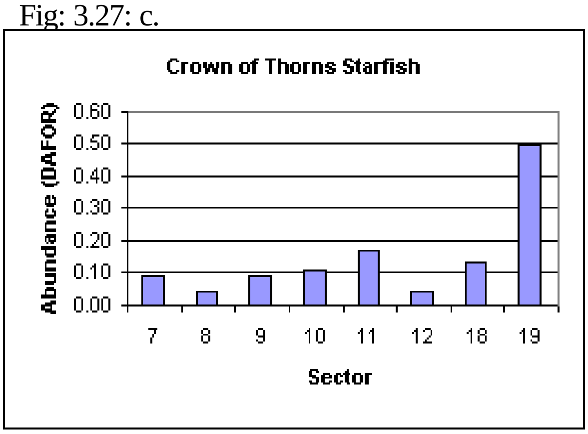
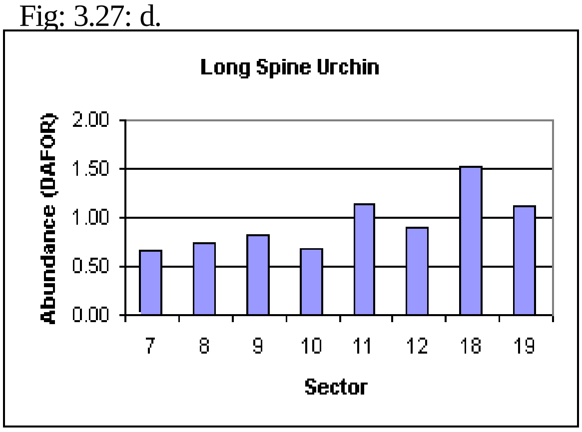


Fig: 3.27: d.



H = 63.16; p<0.01

H = 20.70, p<0.01

H-statistic and associated probability refer to Kruskal-Wallis statistical analysis.

4. COMMUNITY EDUCATION

Community education is an integral part of the Southern Leyte Coral Reef Conservation Projects (SLCRCP) and a number of initiatives have been developed to encourage local participation and aid environmental awareness:

- Schools open days
- Participation in community events
- Teacher training workshops
- Counter-part training

4.1: SCHOOLS OPEN DAYS

Open days are focused on increasing young peoples understanding and awareness of issues surrounding the marine environment. School groups are invited to the project base for the open days to participate in a series of lectures and activities including:

- Learning how to snorkel and to identify marine organisms underwater.
- Beach walk whilst identifying coral skeletons, macroalgae and other animal remains washed onto the shore.
- Touring the interactive displays with a guide.
- SCUBA kit demonstrations
- Watching a video documentary on "Reefs at Risk" which is based in the Philippines.
- Drawing favourite marine organism and creating a collage of an underwater seascape.
- Marine life puppet show entitled "The Adventures of Fred the Fish" which reiterates the messages introduced during the day of environmental respect and awareness.

4.2: PARTICIPATION IN COMMUNITY EVENTS

Table 4.1: Synopsis of Community Events undertaken since May 2003.

Organisation and/ or Event	*Month*	*Nature of Participation*
Kampo Kalikasan, (Limasawa)	May 2003	CCC staff and volunteers attended the camp and made presentations on marine conservation management.
Open day Bontoc Central School (CCC Project Base, Malitbog)	July 2003	60 students of the age between 11 and 13 attended an open day at the CCC base to learn about the conservation of their vital natural resources. The day started with lectures on marine ecology, with emphasis on the importance of their coral reefs as the foundation of their livelihood, both in terms of food and as a form of coastal protection. Snorkelling sessions provided an opportunity for many of them to see their marine environment for the first time.
Attendance at Coastal Resources Management Workshop (Sogod)	July 2003	3-day workshop organised by the PGSL and GTZ aimed at generating information from coastal Municipal mayors and officers from agricultural and fisheries departments, resulting in the eventual formation of a CRM plan for Southern Leyte.
Open Day Sogod Central School (CCC Project Base, Malitbog)	August 2003	58 students were involved in the open day, which involved a variety of activities with the purpose of teaching the elementary students about their marine environment and how to protect it.
Attendance at Marine Conservation Awareness Presentation (Padre Burgos)	August 2003	CCC were invited to give a presentation on reef ecology and marine resources management for the Municipal Agricultural Officers and members of the Fish Sanctuary Council at Padre Burgos.
Community Presentation on the viability of creating a Marine Protected Area at 'Jon's Wreck' (Malitbog Municipality)	September 2003	In coordination with the Provincial Coastal Resources Management Office of Southern Leyte and the GTZ-Leyte Island Project, the data collected by CCC volunteers was presented to the local communities, providing information about the valuable resource they possess and the action required in order to protect it.
Participation in the International Coastal Clean-up Day (Malitbog Municipality)	September 2003	CCC conducted an in-water cleanup of the coastal waters outside the town of Malitbog. Representatives from each barangay were involved in cleanups along the shoreline, resulting in the removal of 1037kg of rubbish.

PLAN International Children & Youth 'Sea Camp' (San Ricardo)	September 2003	Sea Camp is an annual event aimed at inspiring young people to be more aware of the current state of the marine and coastal resources and also to celebrate the International Coastal Cleanup month. Attended by over 400 young people from 5 municipalities from the east coast of Sogod Bay, activities were designed to increase environmental awareness and encourage teamwork amongst young people.
Information Drive on Coastal Resources Management, (Hinungan)	October 2003	CCC and Provincial Coastal Resource Management Office attended an information education campaign in Hinungan on the Pacific side of Southern Leyte. The targeted audiences were 500 high school and elementary school students, with the main aim of improving environmental awareness and understanding. The Mayor of Hinungan and members from the fish sanctuary council also attended the event.
Open Day Buenavista Elementary School (CCC Project Base, Malitbog)	October 2003	30 elementary students age 11 and 12 spent a day at the CCC project base learning about their marine environment and how to conserve it. The highlight of the day was the educational puppet show "Fred the Fish", the journey of a clownfish after it's home had been destroyed and eventually finding a new home inside a fish sanctuary.
Panaon Institute (San Francisco)	October 2003	A seminar on reef ecology and conservation in fish sanctuaries was given to 200 high school students at the Panaon Institute in the Municipality of San Francisco. A video on successful fish sanctuaries in the Philippines was shown to the students.
St. Joseph's College, Maasin: Seminar on Coral Reef Ecology and Conservation	November 2003	300 elementary students of St. Joseph College attended a seminar held at their school. This was a great opportunity for CCC to reach a wide audience of younger students.
Open Day St. Joseph's College, Maasin Grade School Department (CCC Project Base, Malitbog)	November 2003	Following on from the success of the seminar, 30 elementary students age 11 and 12 spent a day at the CCC project base learning about their marine environment and how to conserve it.
Mahayahay Marine Reserve Mangrove Replanting Project	November 2003	In coordination with the College of Maasin, CCC volunteers and staff helped to plant mangrove tree seedlings.

Open Day St. Joseph's College, Maasin Engineering Dept (CCC Project Base, Malitbog)	January 2004	Another very successful and enjoyable Open Day was held at the CCC project base, with the programme being altered to make it more relevant to the older age group of the students attending.
Thomas Oppus Normal College 'Mini' Open Day (CCC Project Base, Malitbog)	February 2004	15 students from the Environmental Science Class attended a mini-Open Day (to fit with their schedule) at the CCC project base, involving demonstrations, lectures and a resource video.
Symposium on Coral Reef Conservation, (Thomas Oppus Normal College, San Isidro)	March 2004	Project Scientist and two volunteers presented two lectures on reef biology and conservation, and fielded a Q&A session for around 150 assembled students.
Celebration of First Mass in the Philippines, (Limasawa)	March 2004	Presentation given to 600 assembled youth leaders from all across Southern Leyte.
Dive-In to Earth Day Beach Cleanup, (Malitbog Pier)	April 2004	CCC staff and volunteers took part in the community clean-up by scouring the seabed of rubbish. Educational posters and materials were used at the site, serving as an opportunity to increase awareness of marine conservation issues amongst the children.
Foundation Conservation Biology Workshop, (CCC Project Base, Tangkaan)	Group 1 – 19th-21st May Group 2 – 26th-28th May	Two 3- day intensive marine science workshops aimed at the educators of Southern Leyte were helad at the CCC project base.
Youth Environmental Camp (Juangon)	21st May 2004	At the invitation of the Peace Corps, CCC attended their Youth Camp, hosting in-water species ID events and discussion/lecture groups on the marine resources of Southern Leyte.
Official launch of Fish Aggregation Device *('Gakit')*, (Barangay Dinahugan)	3rd June 2004	Our Project Scientist and our visiting Senior Field Scientist were invited by the MAO for Padre Burgos to give a presentation on the importance of sustainable marine resource use to the fisherfolk of Dinahugan. At the request of the MAO, CCC returned to dive under the 'shelter' to document it photographically for the fisherfolk.

Forthcoming Events		
Tangkaan Primary School Grades 1 & 2	July 4th 2004	Open Day (45 students, teachers and parents)
St. James College, Padre Burgos	July 18th 2004	Open Day (35 students and teachers)
Foundation Conservation Biology Workshop, (CCC Project Base, Tangkaan)	July 31st & August 1st 2004	Proposed Workshop for a small number of Provincial Government employees who are interested in the counterpart training along with Municipal Officers from Padre Burgos.
Tangkaan Primary School Grades 3 & 4	August 15th 2004	Open Day (47 students, teachers and parents)

4.3: TEACHER TRAINING WORKSHOPS

The *Foundation Conservation Biology Workshop* was developed to provide increased environmental awareness and understanding of marine resources amongst the educators of the Province of Southern Leyte. Following a series of lectures and practical demonstrations, the teachers learned about diverse topics such as shark biology, fisheries management, coral reef ecology, threats to coral reef ecosystems and the socio-economic impacts of coral reef degradation.

4.4: COUNTER-PART TRAINING

Management of marine resources is often overlooked until such time as they have become a significant problem or have suffered from detrimental impacts. A common phenomenon with reef fisheries for example, is the gradual and subtle deterioration in fish stocks leading to an abrupt and unanticipated collapse. This may happen without the fisherfolk being aware of the worsening stock depletion until it is too late. To effectively manage any form of resource requires up-to-date, specific and accurate information regarding its status and trends and as such, monitoring of the status of the heavily fished reefs of Southern Leyte is essential.

CCC's counter-part training programme aims to provide guidance and instruction in underwater survey techniques for local people to carry out efficient monitoring of their natural resources.

5: DISCUSSION

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 within the tropics. The data presented in this report was collected over an 18-month survey period from September 2002, forming the initial part of the Southern Leyte Coral Reef Conservation Project (SLCRCP). The project is planned to continue for another three years, the end result of which will be the production of a detailed habitat map of the coastal resources within Sogod Bay for use as an educational and planning tool for marine protected area (MPA) designation.

5.1: OCEANOGRAPHIC, CLIMATE AND ANTHROPOGENIC DATA

Due to the nature of the baseline transect technique, oceanographic and climate data collected by CCC volunteers is generally qualitative and it is therefore not possible to detail spatiotemporal trends and patterns. From the variables that were monitored however, it is possible to present patterns and general trends, thus providing a baseline from which a more detailed study can be completed.

Surface temperatures showed relatively little variation throughout the year, with average temperatures below the critical threshold for the onset of bleaching. Significant variation in temperature with water depth was identified and may suggest that mixing of the water column in Sogod Bay is not as thorough as is usually observed in shallow coastal waters (<30m). Due to the well-established link between coral bleaching and temperature, it is important to monitor temperature variation throughout the year, as even slight increases can lead to the onset of coral bleaching. Salinity variations have also been shown to have an adverse effect on the growth and development of coral reefs and should also be monitored. Average surface salinities within Sogod bay were found to be around 31‰ which is lower than those reported by Caliente *et al.,* (2002) who recorded surface salinities of around 35‰ during surveys around San Roque and Tangkaan. These surveys were, however, completed outside of Sogod Bay and it is possible that the greater freshwater influence within the bay from large rivers towards the northern end have lead to decreased salinities in this area.

Accurate modelling of water movement patterns is essential for conservation since fish and coral larvae become entrained within the currents and rely upon this as their mechanism of dispersal (e.g. Caley *et al.,* 1996). Ideally, marine reserves should therefore be placed in areas which act as sources of marine larvae, thus protecting the larval stock which can then be transferred via current flow to adjacent reef areas and replenish fish stocks and regenerate benthic communities (Robert & Hawkins, 2000). Current systems within Sogod Bay are poorly documented, and the results of this study are difficult to interpret due to the dynamic nature of the currents with the state of the tides. The majority of current recordings were in northerly or southerly directions; as would be expected within a bay that is strongly influenced by tidal flows. A greater proportion of southerly flowing currents around sectors 11 and 12 towards the northern end of Sogod Bay may possibly be indicative of an anti-clockwise gyre within the bay with predominant southwards flowing currents along the east coast of the bay. Completion of further surveys and the generation of a larger data are necessary for more conclusive results.

Like many coastal areas throughout the world, people around Sogod Bay, and indeed the rest of the Philippines, rely heavily upon fishing to generate local income, thus explaining the high abundance of fishing boats recorded within the bay. The highest levels of surface activity were recorded in sectors 8, 9, 11, 18 and 19, with commercial vessels being more frequently recorded in sector 19 than elsewhere throughout the bay. This latter factor is presumed to be due to the presence of the port of Liloan, which receives large boat traffic, such as passenger ferries and commercial fishing bangkas (boats). The majority of fishing is small scale and as noted by Spalding *et al.*, (2001), coastal waters (up to 15km from the shore) fall under local municipality control within which the operation of commercial fishing is prohibited under the New Fisheries Code of the Republic Act 8550, although commercial vessels may enter these waters during transit.

Data collected by CCC survey teams concerning anthropogenic impacts is highly qualitative (e.g. presence or absence) but due to the high levels of data generated, this can identify useful trends for further studies. Overall, the results of this study so far suggest that the reefs of Sogod Bay are subject to a number of anthropogenic stressors, the most notable of which is litter. The presence of litter was identified as the most frequently recorded surface impact, with the highest frequencies being in sectors 7. Further studies on current patterns within the bay may highlight current gyres that are responsible for moving rubbish that is dumped in the sea and depositing it elsewhere along the coast. The presence of an anti-clockwise gyre within the bay would provide some explanation for the low levels of rubbish recorded in sectors 18 and 19 as it may be transferred throughout the bay in the current system.

Although not considered as an actual threat to the reef ecosystem, abandoned rubbish is aesthetically unpleasant and can give a negative impression to tourists who visit the area. Large pieces of plastic rubbish have also been shown to pose a mechanical threat to larger creatures such as turtles, dolphins and sea birds, which may become entangled and possibly drowned (Pruter, 1987). Leaching of toxic chemicals from litter is also a potential threat and efficient waste disposal facilities are essential if the problems associated with litter are to be reduced.

No surface impacts were recorded in sector 12 at the northern end of Sogod Bay. The presence of abandoned line nets along the east coast of the bay highlights the potential for 'ghost-fishing' (fish becoming trapped in abandoned nets) within this area. Abandoned nets also pose a threat to air breathing animals such as dolphins, turtles and sea birds, which can become trapped and eventually drowned.

The two main sub-surface impacts identified by CCC survey teams were 'litter' and 'broken coral'. Despite lack of any surface impacts recorded in sector 12, this area was found to have the highest levels of sub-surface impacts, with litter being recorded on over a third of all surveys in sectors 11 and 12. The term 'broken coral' is not specific and may be as a result of storms or landslide damage or anthropogenic impacts such as divers or anchors. Localised coral damage can also be caused by destructive fishing practices such as dynamite fishing or abalone gathering for example. Although dynamite fishing is illegal throughout the Philippines, it is still know to occur and can reduce large coral colonies into fragments of rubble. Although no evidence of blast fishing was identified during these surveys, studies by Caliente *et al.*, (2002) have identified areas of reef on the tip of Sogod Bay, around Tangkaan and San Roque, that have been subject to blast fishing in previous years leaving crater-like formations surrounded by rubble on the reef. Fishing for the highly commercially priced gastropod Abalone, although not actually illegal, can lead to high levels of destruction due to the nature of the practices involved (uprooting and overturning coral heads to search the undersides) (Caliente *et al.*, 2002).

Broken coral was found to be the highest in sector 18, where it was recorded on over 40% of all surveys. This may be associated with landslides, which have been recorded in this area. Evidence of sedimentation on over 80% of all surveys in sector 18 also indicates significant damage to the reefs in this area as a result of landslides. Evidence of line netting was present throughout the bay and discarded fish traps were found on surveys in sectors 7 and 8. Nylon markers, possibly used by Hookah divers, were also observed around the base of coral colonies.

The opinions of CCC survey teams on the aesthetic and biological value of an area provides an excellent objective data set from the viewpoint of non-scientific divers. The clear correlation between aesthetic and biological impression of a site is based on the observations that areas with higher levels of biological diversity are aesthetically more appealing to divers and as such would be valuable as commercial dive sites. Sites within sectors 7, 8 and 19 were found to be the most aesthetically appealing and it is worth noting that the lowest levels of anthropogenic impacts were recorded in these areas. Such sites would appear to be ideal locations for the increased monitoring and protection of fish stocks so as to enhance fish populations and make the area attractive to divers. The baseline survey series has revealed a significant reefal area within the vicinity of Barangay Santo Rosario (sector 7) and further surveys have been planned within the area to objectively assess its suitability for formal protection. Areas that were considered to be aesthetically poor were also found to have relatively high levels of sedimentation, broken coral and sub surface litter, for example sectors 9, 12 and 18.

5.2: BENTHIC HABITAT CLASSIFICATION AND SUBSTRATE COVER

The results of the baseline data collected so far during the course of this study highlights 9 distinct benthic classes with Sogod Bay. There are however, lkely to be additional classes following the completion of surveys within the bay by the end of this project. The main characteristic of all areas of reef within the Sogod bay area is the high abundance of sand as the dominant substrate type. Sand and seagrass areas were identified as a distinctive habitat type, but even in reef areas with mixed hard and soft corals, sand was still shown to account for a large proportion of the substrate. The higher abundance of hard bedrock substrates in areas with higher coral cover highlights the need for solid substrate upon which coral larvae can settle and grow. Around the area of Malitbog, a dive site that has been referred to as 'Jons Wreck' is clear evidence of the potential for coral larvae settlement on any appropriate hard substratum. This sunken vessel has provided an ideal substrate for many hard and soft corals to settle upon and abundances of both fish and invertebrate species in this area are extremely encouraging.

The reef profile is generally gently sloping with more evidence of a mid to upper reef slope dominated by mixed hard corals and algae in survey sectors towards the mouth of the bay. Total hard coral cover was also shown to increase towards the mouth of the bay, with the highest total hard coral cover being recorded around sector 19.

The presence of shallow rubble habitat with high levels of dead coral and algae, and the absence of dense mixed coral communities on the upper forereef around sector 18 demonstrates the high levels of damage that have occurred in this area, possibly as a result of landslides. Observations of dead coral in comparison with dead coral covered with algae, suggest that the majority of dead coral within Sogod Bay is a result of previous detrimental impacts as opposed to present activities.

The presence of moderately extensive coral rubble beaches around the bay is made notable by the lack of significant existing coral cover within the bay. Furthermore, the large size of the rubble and the fact that much of the rubble retains its species-distinctive corallite structure may imply the relatively recent aggregation of these rubble particles.

Although overall coral cover is generally quite low throughout the survey area, high diversity indices on reef areas, and the results of studies by D. Fenner (2003), highlight the high species richness that exists on the reefs in and around Sogod Bay, with 59% of all known species for the Philippines recorded on the reefs of Sogod Bay. Efficient management and implementation of sustainable fishing practices is therefore essential if the health of these reefs is to be conserved. Previous studies of the marine resources within Sogod Bay (Calumpong *et al.,* 1994) identified low levels of coral cover with 78% of the 123 manta tows undertaken showing 1 –10% live hard coral cover. These studies were however completed in only shallow reef environments and cannot be considered representative of the lower reef slope.

Low levels of coral cover in Sogod Bay may be linked with high turbidity and sedimentation, including significant damage from regular typhoons in this area. It is possible that activities such as land clearance in watersheds adjacent to the bay have resulted in the transportation of high sediment loads by the many large rivers, such as the *Fiong, Cansolacion* and the *Salog* rivers, that flow into the bay. Sediment and turbidity have both been shown to increase stress levels imposed upon coral reefs and can ultimately reduce their ability to recover from further detrimental impacts. Increased turbidity, leading to reduced irradiance levels within the water column ultimately affects the corals ability to metabolise and therefore to grow. Previous studies by Calumpong *et al.,* (1994) identified rivers at the northern end of Sogod bay as the main source of sediment entering the bay and Jacinto *et al.,* (2000) cite sedimentation as the single most important impact influencing coral reef health in the Philippines

Decreased light penetration has been shown to increase corals susceptibility to the onset of disease and shifts in coral communities in favour of those more suitably adapted to growth in lower light conditions can lead to significant alterations to the coral reef ecosystem of an area. As noted by Doyle *et al.,*(2003) in previous reports for this project, coral susceptibility to sedimentation is species specific and also varies as a function of coral morphology, whereby massive lifeforms, for example, are better adapted to high sediment loading than flat, plate-like corals. Monitoring of species and lifeform abundance is therefore important for highlighting the effects of processes such as sedimentation in certain areas.

5.3: FISH POPULATIONS WITHIN SOGOD BAY

The high abundance of small, reef dwelling fish families such as the Damselfish, Wrasse and Anthias, is not surprising and this pattern is often observed on most reefs throughout the world. Larger pelagic, and commercially more important species such as the groupers and snappers were rarely observed during surveys and it is noticeable that none of the ten most abundant fish families presented here in this report are major targets of local fisherfolk. Commercially important fish are naturally large and are more likely to swim away if disturbed by divers than small reef dwelling species. The relative abundances of whole families of groupers, parrotfish, snappers and rabbitfish were however extremely low and despite the nature of these species; abundances would normally be expected to be higher in an un-fished system. Demersal fish stocks, including reef fish and small pelagics are now considered to be both biologically and economically overfished in most areas of the Philippines and in some areas, it has been suggested that there are now insufficient adult fish stocks to allow for local recruitment (Spalding *et al.,* 2001).

The significant correlation between habitat diversity and fish species richness is a pattern that is becoming more and more recognised as studies on coral reef ecosystems are becoming more frequent. Increased spatial complexity of coral reef habitats provides a larger variety of niches to support greater diversities of fish at both species and family levels (Luckhurst and Luckhurst, 1978). Areas with mixed hard coral species and algae provide greater sources of food and shelter than sandy substrate with rubble and seagrass, for example.

Fish populations were also found to vary in relation to the benthic class, whereby certain species were more frequently observed around particular habitats. Many studies have shown that fish communities are not randomly distributed over coral reef habitats and that there is clear habitat segregation between different species (Sale and Douglas. 1984). This is likely to be related to feeding preferences of certain species, for example parrotfish feed on algae growing largely on hard substrate in coral rich areas or in areas of shallow bedrock that support significant algal biomass (Harborne *et al., 2001).* Other species of fish that are know to be obligate corallivores, such as certain species of

Butterflyfish, are used as indicators of reef health. The results of this study show higher abundances of Butterflyfish around coral rich habitats on the mid to upper reef slope.

Due to the inconsistent sample size in different survey sectors or habitat types, it is difficult to identify with a high level of confidence exactly what populations are associated with different habitats. Further surveys in sectors 7, 11, 12 and 18 will provide a more rounded data set from which trends in fish populations within Sogod Bay can be more accurately predicted.

Sightings of Megafauna during surveys were extremely low, due largely to the pelagic lifestyle of large marine mammals and fish. Whale sharks (*Rhincodon typus)* are often spotted within the Bay, and more frequently on the eastern coast of the bay around the straits of Liloan, which opens up the east coast of Southern Leyte to the Philippine Sea. Whale sharks are associated with the pelagic environment and often observed in close association with a number of other species forming an intricate food chain, often allowing whale sharks to be easily located. Planktivorous fish species often school with the patches of plankton close to the surface and are followed by schools of larger fish, which often leap from the water in pursuit of the smaller planktivorous fish. The whale sharks feed on the plankton and also on these schools of fish. Other large species, such as manta rays and many different shark species are also commonly observed following this interesting food chain. Whale sharks and their associated fauna represent a major attraction for divers, since many divers want to see big fish! Relatively lower abundances of large fish species are therefore not only detrimental to the fishing industries, but also poses a potential threat to the possibilities of dive related tourism in the area.

5.4: INVERTEBRATE POPULATIONS WITHIN SOGOD BAY

Commercially important species such as lobster, abalone, squid, octopus and urchins were all rarely observed during surveys. Due to their cryptic nature, and often-nocturnal lifestyle, such invertebrates are often found in low abundances on baseline surveys and the relatively higher abundance of tunicates and echinoderms is not surprising. Abundance ratings for such commercially important species were however extremely low, with lobsters being rarely recorded in all sectors throughout the bay. Further studies are required to identify any major patterns or possible trends in over harvesting of marine invertebrates throughout Sogod bay.

The long spine sea urchin, *Diadema spp*. is often used as an ecological indicator, with major population changes possibly highlighting shifts in the ecological balance of the ecosystem. Certain fish species, such as triggerfish for example, are known to feed on *Diadema* spp., which in turn graze on algae. Reduced populations of triggerfish may result in increased *Diadema* populations and a shift in the ecological balance of the reef as algae becomes increasingly grazed. Likewise, a sudden decrease in *Diadema* populations may result in overgrowth of algae, competing with corals for light and space on the reef. *Diadema* urchins have been documented to aggregate in exposed or recently disturbed locations and as such, higher abundances of *Diadema* urchins may be indicative of reduced coral cover. The highest populations of *Diadema* urchins were found to be around sectors 11 and 18 which also displayed the lowest levels of total hard coral cover throughout Sogod Bay, and comparatively high levels of dead coral covered with algae.

The damage caused by crown of thorns sea stars has been well documented and although evidence of crown of thorns was relatively low throughout the majority of the bay, sector 19 did show a significantly higher abundance of these echinoderms. As noted by Fenner (2003) Crown of thorns outbreaks can destroy significant areas of coral reefs that will not regenerate within a human lifetime and even small outbreaks have the potential to produce large numbers of larvae which will pose a much larger threat in coming years. Links between overfishing of certain species, such as large Napoleon wrasse, and crown of thorns sea stars have been suggested and research has suggested possible correlations between fishing pressure and crown of thorns outbreaks (Fenner, 2003).

As noted by Doyle *et al.,* (2003), it has not yet been established whether aggregations of these sea stars are a natural phenomenon or human-induced in some way and the use of control methods is controversial. Populations should however be monitored and if numbers are found to increase, control methods should be considered – especially if aggregations are found to appear in areas which are commercially important for diving, such as the fish sanctuary at Napantau where divers pay an admission fee to the fish warden for access to the dive site.

Giant Clams (*Tridacna spp.)* were found to be present in extremely low abundances throughout the bay, and were often observed only in isolated sections of the bay. Collected for their shells and also as a food source, this highly prized bivalve mollusc is under huge threat from illegal poaching and the true giant clam (*Tridacna gigas)* is listed on the CITES threatened species list (Colin & Arneson, 1995).

5.5: COMMUNITY WORK

If any form of coastal zone management is to be effective, local communities must first be educated in the importance of protecting the marine environment and given the opportunities to understand the precious resource that lies just beyond their coastline. Designation of areas as marine reserves or protected areas is, theoretically, relatively straight forward. Enforcement of such legislation however, is much more difficult to maintain and is often overlooked – especially if local communities are not aware of the need for such regulations (e.g. Kanton *et al.,* 2000).

Many areas are now recognising the importance of community education in maintaining effective marine protected areas, and the need for local enforcement of the regulations associated with them. The provision of community based education is one of the primary focuses of the Southern Leyte Coral Reef Conservation Project and CCC is dedicated to building local capacity and providing training in SCUBA diving and scientific surveying to local counterparts for the continued monitoring of the coral reefs within Sogod Bay.

6: RECOMMENDATIONS

The data collected for this report represents only around half of that which will be collected for the Southern Leyte Coral Reef Conservation Project over the next three years but already it is clear that there are a number of steps which can be taken to facilitate reef regeneration within Sogod Bay. There is already a positive attitude towards marine resource management both within the Provincial government and at local Municipality and Barangay levels. A number of 'fish sanctuaries' exist within the bay but unfortunately, monitoring and control of these miniature reserves has been difficult to maintain in certain areas.

RECOMMENDATION 1:
Re-establish existing 'fish sanctuaries' as marine protected areas and employ local people as 'wardens to monitor and enforce the regulations of these sanctuaries. Encourage local communities to become stakeholders in the marine reserves within their barangays, thus affording a local level of ownership over fishing activities.

Preliminary observations made around Tangka'an and Eastern Limasawa indicate that the reefs of these areas display the high levels of hard coral cover and biodiversity that was once associated with all pristine reefs. Further CCC surveys will identify the extent of this cover, but it is likely that these areas play an important role in production of coral larvae for the rest of Sogod Bay and as such, should be protected with a matter of priority.

RECOMMENDATION 2:
Prioritise areas which display high coral cover and biodiversity for marine protection to provide a source of coral larvae for future regeneration of coral cover within Sogod Bay

RECOMMENDATION 3:
Increase levels of education offered to local people on the importance of marine sanctuaries and the need to conserve precious marine resources.

In order to effectively manage marine protected areas within Sogod Bay, it is important that designated sites are monitored by survey teams to identify changes in fish stocks and general reef health.

RECOMMENDATION 4:
Establish survey programmes to monitor the status of existing marine protected areas and co-ordinate all research through a central organising body.

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APPENDIX A:

CCC Baseline Survey forms

1. Boat form recording surface anthropogenic, oceanographic and climate data
2. Physical form recording sub-surface anthropogenic and oceanographic data
3. Biological form recording species abundances of selected target species

BOAT FORM

DATE: ____________________
STUDY: ____________________
TRANSECT: ____________________
SUBZONE: ____________________

COX: ____________________
BM: ____________________
BUOY: ____________________

COORDINATES

START:

GPS Unit: ____________________
Datum: ____________________

	Latitude (UTM)	Longitude (UTM)	Time	Est. error	Waypoint
1.					
2.					
3.					

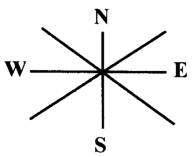
END:

	Latitude (UTM)	Longitude (UTM)	Time	Est. error	Waypoint
1.					
2.					
3.					

CURRENT STRENGTH

none
weak
medium
strong

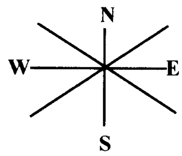
CURRENT DIRECTION (towards)



WIND STRENGTH (1-12)

1 5
2 6
3 7
4 8

WIND DIRECTION (from)



Temperature: **°C at depth of:** **m** **Surface temperature:** **°C** **Secchi disc:** **m**

Salinity: **at depth of:** **m** **Surface salinity:**

SURFACE ACTIVITY

BOAT	No. OCCUPANTS	PROXIMITY (m)	ACTIVITY eg. diving/fishing/pleasure/commercial
1.	________	________	________
2.	________	________	________
3.	________	________	________
4.	________	________	________

SURFACE IMPACTS

	LITTER	SEWAGE	DRIFTWOOD	ALGAE	NETS / POTS
(please tick)	☐	☐	☐	☐	☐

Other Impacts/Details..

OTHER COMMENTS:...

PHYSICAL RECORDING FORM

Study.	Transect No.	Zone Code.

Date: ____/____/____

Start Time: __________ End Time: __________

Recorder's Name: __________ Phys.

__________ Fish

__________ Corals

__________ Algae/Inverts.

Depth Limits - Min: __________ m

- Max: __________ m

Underwater visibility __________ m

Repeat visit? Y/N

TYPE OF SURVEY

- Spot dive ☐
- Transect ☐
- General ☐
- Mapping ☐
- Photography ☐
- Sounding ☐
- Other ☐

ZONE (Tick all that apply)

- Backreef ☐
- Reef crest ☐
- Spur & groove ☐
- *Low spur & groove* ☐
- *High spur & groove* ☐
- Forereef ☐
- Escarpment ☐
- Patch reef ☐
- *Dense patch reef* ☐
- *Diffuse patch reef* ☐
- Lagoon floor ☐
- *Shallow lagoon* ☐
- *Deep lagoon* ☐

Italics indicate a sub-class of a main class

IMPACTS

- Litter ☐
- Sewage ☐
- Coral damage ☐
- Lines / nets ☐
- Fish traps ☐
- Sedimentation ☐
- Coral disease ☐
- Bleaching ☐
- Dynamite ☐
- Other: __________

YOUR IMPRESSION OF THE SITE

	AESTHETIC	BIOLOGICAL
Excellent		
Very good		
Good		
Average		
Poor		

Other comments:

Navigation bearing: ______ °

Depth buoy tied: ______ m

Buoy colour/I.D.: ______

SITE DESCRIPTION (Describe general location of the site, topography and main habitats - coral, sand, etc.)

General Location ______________________________

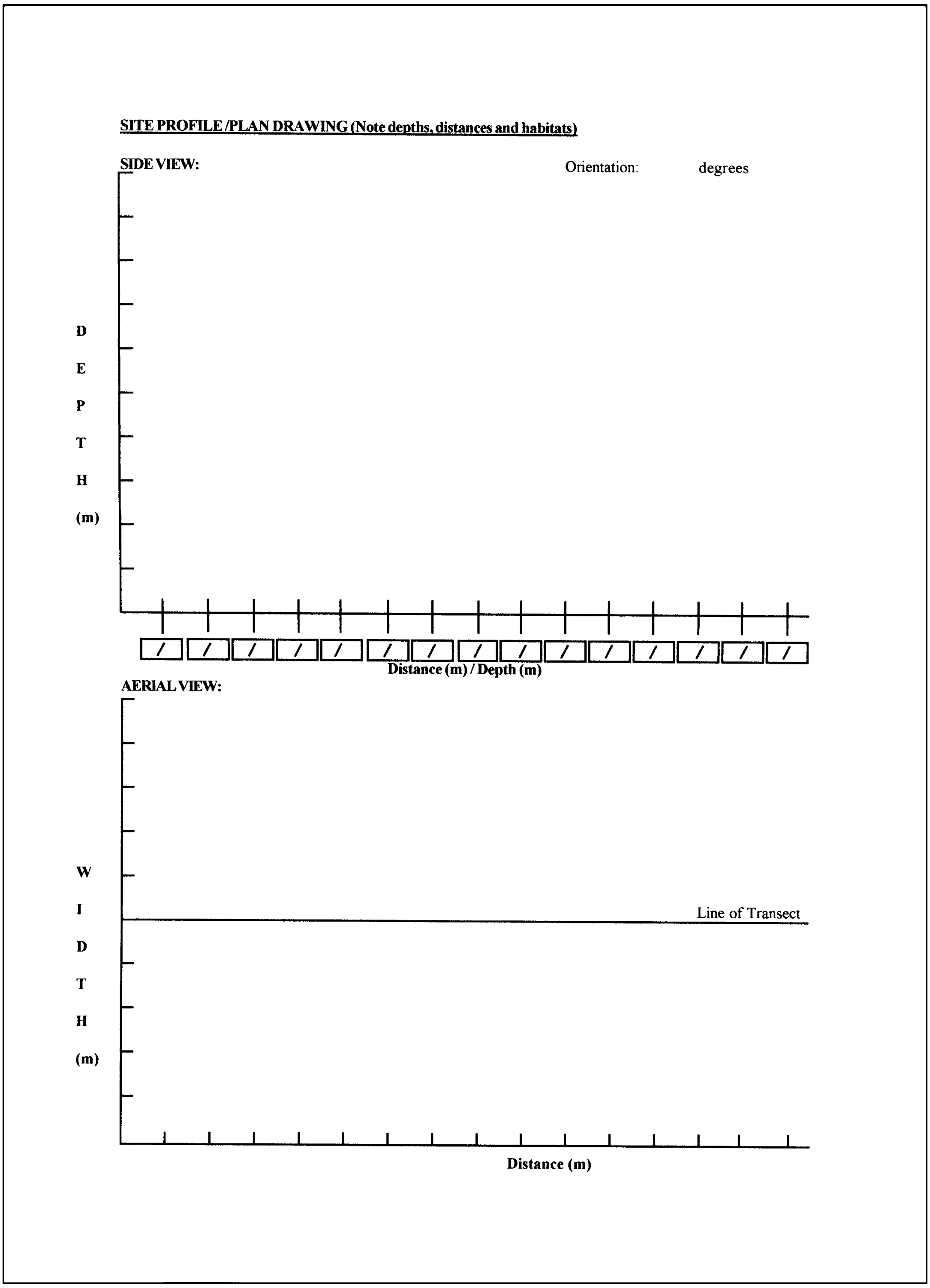
____

Topography ______________________________

____

Main Habitats ______________________________

____



SITE PROFILE /PLAN DRAWING (Note depths, distances and habitats)

SIDE VIEW: Orientation: degrees

DEPTH (m)

Distance (m) / Depth (m)

AERIAL VIEW:

WIDTH (m)

Line of Transect

Distance (m)

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 Fji		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 grooes.
Low spur and groove	☐	Spurs less than 5m high
High spur and groove	☐	Spurs greater than 5m high
Forereef	☐	Any area of reef with an incline of between 0 and 45º
Escarpment	☐	Any area of benthos whose angle of slope exceeds 45º
Patch reef	☐	Coral formations in the lagoon which are surrounded by either seagrass, sand or algae
Dense patch reef	☐	Areas of aggregated coral colonies (living or dead) which cover > 70% of the benthos
Diffuse patch reef	☐	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 45º
Shallow lagoon floor	☐	Lagoon with a depth of > 12m
Deep lagoon floor	☐	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 coraline structures
Dead Coral with Algae	☐	Any area of hard bare substratum with visible coralite structure covered in algae
Dead Corals	☐	Any area of hard bare substratum with visible coralite 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-calcerous 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 : ______________________________

HARD CORAL

Life Forms

DEAD CORAL	148	
DEAD CORAL WITH ALGAE	149	
ACROPORA:		
BRANCHING	150	
ENCRUSTING	151	
SUBMASSIVE	152	
DIGITATE	153	
TABULATE	154	
NON-ACROPORA:		
BRANCHING	155	
ENCRUSTING	156	
FOLIOSE	157	
MASSIVE	158	
SUB-MASSIVE	159	
MUSHROOM	160	
OTHER:		
FIRE (*Millepora*)	161	
BLUE (*Heliopora*)	162	
ORGAN PIPE (*Tubipora*)	293	
TOTAL CORAL LIFE FORMS		

Target Life forms, genera and species

Pocilloporidae			
Pocillopora:	Small	164	
	Medium	165	
	Large	166	
Seriatopora hystrix		834	
Stylophora pistillata		833	
Acroporidae			
Bottlebrush *Acropora*		163	
"Foliose" *Montipora* spp.		167	
Montipora digitata		808	
Poritidae			
Massive *Porites*		844	
Porites cylindrica		845	
Porites nigrescens		846	
Porites rus		848	
Goniopora / Alveopora		893	
Agariciidae			
Pavona clavus		855	
Pachyseris speciosa		859	
Pachyseris rugosa		858	
Fungiidae			
Ctenactis echinata		208	
Herpolitha limax		248	
Polyphyllia talpina		861	
Upsidedown bowl		167	
Oculinidae			
Galaxea		236	
Pectiniidae			
Pectinia lactuca		865	
Mycedium elephantotus		815	
Mussidae			
Lobophyllia		269	
Faviidae			
Favia		222	
Favites		227	
Diploastrea heliopora		215	
Echinopora spp.		886	
Caryophylliidae			
Euphyllia		895	
Plerogyra		874	
Milleporidae			
Millepora platyphylla		827	
Millepora intricata		826	
Dendrophylliidae			
Tubastrea micrantha		877	
Turbinaria spp.		888	

Merulinidae			
Hydnophora spp.		247	
Miscellaneous			
Brain:	Small	202	
	Medium	273	
	Large	253	

Further Species

TOTAL TARGET CORALS

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

TARGET FISH

Butterflyfish	540
(Big) Long-Nosed	752
Klein's	651
Vagabond	541
Pyramid	750
Eastern Triangle	783
Latticed	681
Redfin	760
Chevroned	677
Orange-banded Coral fish	923
Copper-banded	947
Eight-banded	948
Humphead Bannerfish	669
Pennant Bannerfish	939
Angelfish	544
Regal	663
Bicolour	673
Pearlscale	545
Emperor	756
Blue-girdled	937
Vermiculated	938
Surgeonfish	546
Convict	547
Ringtail' spp.	548
Brushtail tang	638
Thompson's	747
Mimic	700
Eyestripe	549
Unicorn spp.	550
Tuna/ Mackerel	940
Narrow-banded king mackerel	558
Fusilier	571
"Blue and yellow" sp.	929
Bluestreak	930
Damselfish	589
Blue-Green Chromis	596
Black Bar Chromis	646
Other "Chromis" sp.	590
Blue devil	657
Threespot dascyllus	671
Humbug dascyllus	767
Reticulated dascyllus	771
Whitebelly	654
Staghorn	745
Black	759
Behn's	593
Honeyhead	594
Alexanders	764
Blackspot	758
"Anemone fish" sp.	871
"Sergeant" sp.	656

Wrasse	598
Diana's hogfish	931
Mesothorax hogfish	611
Humphead	600
Red-banded	932
Checkerboard	725
Twotone	768
Crescent	647
Sixbar	744
Jansen's	678
Cigar	685
Bird	610
Cleaner	605
Goatfish	615
Half-and-half	648
Two-barred	666
Dash-and-dot	781
Multibarred	934
Blackstriped	616
Triggerfish	624
Redtooth	786
Orangestriped	625
Clown	626
Blackbelly Picassofish	927
Pinktail	782
Scythe	692
Halfmoon	796
Bluethroat	660
Picasso	628
Moustache / Titan	623
Groupers	583
Flagtail	682
Peacock	935
Humpback	936
"Honeycomb" sp.	586
Lyretail	946
Parrot Fish	613
Bumphead	933
Spinecheek	581
Twoline	582
Pearly	659
Snapper	565
Two-spot	753
Black-and-white	569
Bluelined	925
Spanish Flag	679
Chequered	665
'Blackspot'	564

Rabbitfish	579
Foxface	757
Virgate	630
Dartfish	774
Blackfin	695
Cardinalfish	621
Pajama	917
Blackstriped	717
Puffer	635
Blackspotted	652
Goby	749
Sphynx	954
Brownbarred	955
Dottyback	900
Darkstriped	686
OTHER MAJOR FAMILIES	
Anthias	642
Soapfish	928
Jack / Trevally	553
Sweetlips	577
Barracuda	560
Moorish Idol	551
Emperor	924
Spadefish / Batfish	595
Porcupine	634
Toby	636
Trunk / Box / Cowfish	640
Blenny	926
Sweeper	689
Squirrelfish / Soldierfish	619
Filefish	629
Lionfish	631
Scorpionfish / Stonefish	632
Lizardfish	643
Hawkfish	902
Sandperch	675
Sharksucker	787
Needlefish	562
Pipefish	911
Shrimp fish	790
Trumpetfish	664
Moray Eel	637

FURTHER SPECIES

____

____

____

____

____

____

TOTAL FISH

SPECIES ABUNDANCE

N.B. ALL CORAL AND FISH TARGET SPECIES MUST ALSO BE COUNTED IN THE APPRORIATE FAMILY OR LIFEFORM

Rating	Abundance Scale (coral, substratum, algae)	Numbers (Fish/Inverts)
0	None	0
1	Rare	1-5
2	Occasional	6-20
3	Frequent	21-50
4	Abundant	51-250
5	Dominant	250+

MICRO-ALGAE

Cyano-Bacteria: Blue-Green	1

MACRO-ALGAE

Chlorophyta: Green

Green Filamentous	39
Chaetomorpha sp.	15
Marble (*Valonia ventricosa*)	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

Phaeophyta: Brown

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

Rhodophyta: Red

Encrusting coralline algae	70
Galaxaura sp.	73
Amphiroa sp.	63
Jania sp.	83
Red Filamentous	60
Sheet	80
Actinotrichia - spikeweed	61
Wiry branched (*Gelidiella* 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

Porifera: Sponges

Tube	126
Barrel	146
Elephant Ear	128
Branching	143
Encrusting	130
Lumpy	145
Rope	144
Vase	125

Octocorallia: Soft Coral Forms

Deadman's Fingers	275
Leather	277
Tree	278
Pulsing	295
Sea Fan	280
Sea Whip	281
Bamboo	283
Flower	294
Sea pen	338

Other Cnidarians

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

Arthropoda: *Crustacea*

Shrimps	361
Rock lobster (*Panulirus* 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

Echinodermata:

Sea Stars:		
	Acanthaster planci (COT)	472
	Linkia laevigata (Blue)	478
	Nardoa sp. (Brown)	479
	Culcita novaequineae	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)

APPENDIX B:

Mean averages of benthic cover from habitat classification

Habitat #	Habitat Description
1	Shallow sand and mud with algae and seagrass
2	Shallow sand and bedrock with abundant mixed algae and *non-Acropora* submassive and encrusting hard corals
3	Lower reef slope with sand and occasional mixed hard and soft corals
4	Mid-reef slope with frequent mixed *Acropora* and *non-Acropora* lifeforms
5	Upper-reef slope with dense mixed *Acropora* and *non-Acropora* hard coral lifeforms and abundant mixed soft corals and algae
6	Shallow reef with diffuse mixed *Acropora* and *non-Acropora* hard coral lifeforms and soft corals
7	Shallow sand habitat dominated by seagrass and algae, with sparse hard and soft corals
8	Bedrock with *non-Acropora* branching and sub-massive hard coral lifeforms
9	Shallow rubble with dead coral and algae
10	Unknown

HABITAT NUMBER	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Average Depth	3.3	1.8	22.6	15.8	6.4	6.6	6.1	1.1	1.7
SUBSTRATE COVER									
Bedrock	0.0	2.5	0.5	1.0	1.1	0.7	0.3	3.8	0.6
Dead Coral	0.3	0.3	0.7	1.3	1.4	0.8	0.9	0.4	0.4
Dead Coral and Algae	0.5	0.3	1.1	2.0	1.9	1.5	1.4	1.0	0.8
Rubble	0.0	1.5	0.7	1.2	0.8	0.5	1.3	0.0	4.0
Sand	3.8	2.3	3.6	3.1	3.3	3.9	3.7	2.0	0.6
Mud	2.3	0.0	0.2	0.0	0.1	0.2	0.5	0.0	0.1
BIOLOGICAL COVER									
Green Algae	0.8	3.3	1.6	1.6	2.4	1.0	2.7	1.8	1.9
Seagrass	0.5	0.0	0.0	0.2	1.2	0.4	2.4	0.6	0.4
Hard Coral	0.3	2.8	1.6	2.8	2.9	1.9	1.5	1.2	0.6
Soft Coral	0.0	1.3	1.5	1.8	2.7	1.2	1.4	0.4	0.9
Inverts	0.8	2.8	1.5	2.4	2.7	2.0	2.3	0.6	1.5
Sponges	0.3	1.3	1.3	2.0	2.3	0.9	1.3	0.0	0.3
HARD CORAL LIFEFORMS									
Acropora branching	0.0	0.5	0.6	1.9	1.8	1.2	0.9	0.2	0.5
Acropora encrusting	0.0	0.3	0.2	0.4	0.4	0.1	0.0	0.0	0.0
Acropora submassive	0.0	0.0	0.1	0.4	0.7	0.3	0.1	0.0	0.0
Acropora digitate	0.0	0.0	0.0	0.2	0.4	0.3	0.2	0.4	0.0
Acropora tabulate	0.0	0.0	0.5	1.1	1.0	0.3	0.1	0.8	0.0
Non-Acopora branching	0.0	1.3	0.6	1.4	2.0	1.1	1.0	1.0	0.3
Non-Acopora encrusting	0.0	1.8	0.6	1.7	1.7	1.1	0.6	0.6	0.4
Non-Acopora foliose	0.0	0.3	0.5	1.2	0.9	0.5	0.1	0.0	0.0
Non-Acopora massive	0.3	1.0	0.5	1.2	1.8	0.9	0.7	0.4	0.0
Non-Acopora submassive	0.0	2.0	0.7	1.7	2.0	1.3	0.7	0.8	0.5
Non-Acopora mushroom	0.0	0.0	0.8	1.6	1.3	0.8	0.8	0.0	0.0
Non-Acopora fire	0.0	0.0	0.1	0.5	1.1	0.6	0.3	0.0	0.0
Non-Acopora blue	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TARGET HARD CORAL SPECIES									
Pocillopora small	0.0	0.3	0.2	0.5	0.8	0.8	0.5	0.2	0.0
Pocillopora meduium	0.0	0.5	0.0	0.4	1.0	0.7	0.3	0.2	0.0
Pocillopora large	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.4	0.0
Seriatopora hystrix	0.0	0.5	0.2	0.8	1.3	0.5	0.4	0.2	0.1
Stylophora pistillata	0.3	0.3	0.1	0.3	0.5	0.4	0.4	0.0	0.0
Bottlebrush Acropora	0.0	0.0	0.2	1.3	0.8	0.5	0.3	0.2	0.1
Montipora foliose	0.0	0.0	0.2	0.4	0.3	0.1	0.0	0.0	0.0
Montipora digitata	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0
Massive *Porites*	0.0	1.5	0.3	1.5	1.6	1.0	0.7	0.6	0.3

Porites cylindrica	0.0	0.8	0.0	0.3	0.5	0.2	0.0	0.0	0.0
Porites nigrescens	0.0	0.0	0.0	0.3	0.7	0.2	0.0	0.2	0.0
Goniopora/Alveopora	0.0	0.3	0.6	1.0	1.2	0.4	0.3	0.2	0.3
Pavona clavus	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Pacyseris speciosa	0.0	0.0	0.2	0.4	0.3	0.1	0.0	0.0	0.0
Pachyseris rugosa	0.0	0.0	0.1	0.2	0.5	0.1	0.1	0.0	0.0
Ctenactis echinata	0.0	0.0	0.2	0.6	0.5	0.3	0.2	0.0	0.0
Herpolitha limax	0.0	0.0	0.2	0.9	0.6	0.2	0.1	0.0	0.0
Polyphyllia talpina	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0
Upsidedown bowl	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0
Galaxea	0.0	0.3	0.3	1.3	1.6	0.7	0.2	0.4	0.0
Pectinia lactuca	0.0	0.0	0.1	0.5	0.4	0.3	0.1	0.0	0.0
Mycedium elephantotus	0.0	0.0	0.4	0.9	0.6	0.2	0.0	0.0	0.0
Lobophyllia	0.3	0.0	0.3	1.0	1.6	0.7	0.3	0.2	0.1
Favia	0.3	1.3	0.5	1.4	1.8	1.1	0.7	0.6	0.5
Favites	0.3	0.8	0.4	1.2	1.8	1.3	0.8	0.8	0.1
Diploastrea heliopora	0.0	0.5	0.2	0.6	0.5	0.3	0.0	0.2	0.0
Euphyllia	0.0	0.0	0.2	0.5	0.7	0.1	0.1	0.2	0.0
Plerogyra	0.0	0.3	0.2	0.8	0.3	0.0	0.0	0.0	0.0
Millepora platyphyllia	0.0	0.0	0.0	0.1	0.4	0.1	0.0	0.0	0.0
Millepora intricata	0.0	0.0	0.0	0.4	0.9	0.5	0.2	0.0	0.0
Brain small	0.0	0.0	0.1	0.4	1.0	0.2	0.3	0.2	0.0
Brain medium	0.0	0.3	0.0	0.5	0.6	0.3	0.1	0.0	0.0
Brain large	0.0	0.0	0.0	0.2	0.4	0.1	0.0	0.0	0.0
TARGET ALGAE SPECIES									
Green filamentous	0.3	2.5	0.6	0.5	1.2	0.5	1.6	0.2	0.8
Chaetomorpha	0.0	0.3	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Valonia	0.0	0.3	0.0	0.0	0.2	0.0	0.1	0.0	0.0
Bornetella	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Neomeris	0.0	0.5	0.1	0.1	0.2	0.3	0.2	0.0	0.1
Codium	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.0	0.1
Caulerpa	0.0	0.5	0.0	0.1	0.2	0.1	0.3	0.0	0.0
Halimeda	0.0	0.8	0.2	0.1	0.1	0.2	0.6	0.2	0.0
Tydemania	0.0	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Dictyota	0.0	1.5	0.3	0.6	1.3	0.3	1.1	0.0	0.4
Padina	0.0	2.3	0.1	0.2	0.4	0.6	1.5	0.6	1.1
Lobophora	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydroclathrus	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
Turbinaria	0.0	1.5	0.0	0.0	0.5	0.1	0.3	0.4	0.3
Brown filamentous	0.3	1.8	0.3	0.4	0.6	0.2	0.7	0.0	0.0
Sargassum	0.0	1.5	0.0	0.0	0.1	0.0	0.2	1.0	0.0
Corallina	0.3	2.0	0.5	0.7	0.6	0.3	0.6	0.0	0.5
Galaxaura	0.0	1.5	0.0	0.2	0.5	0.2	0.4	0.0	0.0
Amphiroa	0.0	1.0	0.1	0.3	1.1	0.4	0.5	0.0	0.3

Jania	0.0	1.0	0.1	0.0	0.7	0.2	0.5	0.0	0.0
Red filamentous	0.0	1.5	0.4	0.4	0.4	0.1	0.4	0.0	0.1
Halymenia	0.0	0.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Actinotrichia	0.0	0.0	0.1	0.1	0.7	0.2	0.3	0.0	0.4
Gelidiella	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0
SEA GRASSES									
Seagrass sp	1.0	0.0	0.1	0.2	1.0	0.3	2.1	0.4	0.5
Thalassia	1.0	0.0	0.0	0.1	0.4	0.1	1.6	0.0	0.4
Halophila	0.0	0.0	0.1	0.2	1.3	0.4	1.8	0.2	0.3
SPONGE LIFEFORMS									
Tube sponge	0.3	0.5	0.5	1.2	1.3	0.5	0.4	0.0	0.0
Barrel sponge	0.0	0.0	0.2	0.3	0.2	0.0	0.0	0.0	0.0
Elephant Ear sponge	0.0	0.5	0.5	0.8	0.9	0.4	0.0	0.0	0.0
Branching sponge	0.0	0.0	0.2	0.3	0.5	0.2	0.4	0.0	0.1
Encrusting sponge	0.0	0.5	0.8	1.4	1.4	0.5	0.7	0.0	0.3
Lumpy sponge	0.0	1.0	0.6	0.9	1.5	0.4	0.9	0.2	0.1
Rope sponge	0.0	0.3	0.2	0.3	0.3	0.1	0.1	0.0	0.0
Vase sponge	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0
SOFT CORAL TARGETS AND LIFEFORMS									
Deadman's fingers	0.0	0.5	0.2	0.4	1.2	0.4	0.4	0.2	0.0
Leather	0.0	0.8	0.7	1.1	1.9	0.4	0.6	0.4	0.3
Tree	0.0	0.8	0.9	1.0	2.0	1.0	0.9	0.4	0.9
Pulsing	0.0	1.5	0.5	1.1	1.8	0.4	0.7	0.4	0.5
Sea Fan	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.1
Sea whip	0.0	0.3	0.2	0.1	0.2	0.1	0.0	0.0	0.0
Bamboo	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Flower	0.0	0.3	0.5	1.1	1.2	0.2	0.4	0.2	0.1
Sea Pen	0.0	0.0	0.1	0.1	0.2	0.2	0.4	0.0	0.1
Black Coral	0.0	0.0	0.5	0.6	0.2	0.1	0.0	0.0	0.0

APPENDIX C:

Mean averages abundances of target species in 8 different survey sectors within Sogod Bay

Abundances based on DAFOR scale

Abundance rating	Corals, other colonial invertebrates and macroalgae	Fish and invertebrates (number of individuals)
1	Rare	1- 5
2	Occasional	6 – 20
3	Frequent	21 – 50
4	Abundant	51 – 250
5	Dominant	250+

HARD CORAL TARGET SPECIES	**SURVEY SECTORS**							
	7	**8**	**9**	**10**	**11**	**12**	**18**	**19**
Bottlebrush *Acropora*	0.44	0.74	0.59	0.70	0.55	0.55	0.22	0.82
Brain large	0.22	0.18	0.13	0.13	0.24	0.09	0.04	0.10
Brain medium	0.49	0.36	0.29	0.18	0.17	0.09	0.17	0.20
Brain small	0.49	0.30	0.27	0.41	0.45	0.23	0.26	0.34
Ctenactis echinata	0.36	0.40	0.44	0.16	0.24	0.32	0.17	0.43
Diploastrea heliopora	0.36	0.10	0.29	0.24	0.41	0.18	0.57	0.53
Echinopora spp.	0.25	0.16	0.12	NR	0.10	0.23	0.09	0.34
Euphyllia	0.58	0.43	0.27	0.33	0.48	0.32	0.30	0.25
Favia	1.29	0.92	0.83	0.88	1.17	0.68	0.78	1.05
Favites	1.36	0.70	0.84	0.94	1.03	0.73	0.52	0.83
Galaxea	0.84	0.74	0.63	0.90	0.76	0.50	0.70	0.85
Goniopora/Alveopora	0.80	0.85	0.57	0.75	0.86	0.64	0.74	0.82
Herpolitha limax	0.49	0.33	0.51	0.28	0.34	0.36	0.39	0.51
Hydnophora spp.	0.11	0.02	0.03	NR	0.17	0.09	0.13	0.23
Lobophyllia	0.84	0.98	0.72	0.72	1.03	0.55	0.65	1.07
Massive Porites	1.13	0.88	0.97	0.84	0.86	0.82	0.87	1.08
Millepora intricata	0.27	0.25	0.24	0.20	0.31	0.41	0.39	0.49
Millepora platyphyllia	0.18	0.15	0.24	0.09	0.03	0.23	0.09	0.09
Montipora digitata	0.00	0.09	0.03	0.11	0.00	0.00	0.00	0.09
Montipora foliose	0.42	0.21	0.23	0.21	0.10	0.18	0.13	0.34
Mycedium elephantotus	0.36	0.52	0.32	0.45	0.62	0.18	0.26	0.45
Pachyseris rugosa	0.29	0.12	0.12	0.15	0.14	0.18	0.39	0.33
Pacyseris speciosa	0.18	0.10	0.17	0.31	0.10	0.09	0.04	0.50
Pavona clavus	0.02	0.03	0.07	0.01	0.03	0.05	0.00	0.03
Pectinia lactuca	0.36	0.12	0.23	0.16	0.17	0.14	0.09	0.34
Plerogyra	0.36	0.27	0.16	0.33	0.34	0.32	0.30	0.28
Pocillopora large	0.02	0.01	0.12	0.08	0.03	0.27	0.00	0.14
Pocillopora meduium	0.31	0.41	0.40	0.39	0.62	0.05	0.17	0.34
Pocillopora small	0.51	0.45	0.67	0.38	0.29	0.55	0.09	0.46
Polyphyllia talpina	0.07	0.21	0.09	0.04	0.03	0.00	0.00	0.13
Porites cylindrica	0.11	0.04	0.08	0.18	0.14	0.09	0.26	0.39
Porites nigrescens	0.22	0.13	0.15	0.34	0.28	0.00	0.04	0.42
Seriatopora hystrix	1.07	0.46	0.35	0.56	0.62	0.36	0.39	0.50
Stylophora pistillata	0.22	0.34	0.28	0.21	0.17	0.05	0.09	0.16
Tubastrea micrantha	0.31	0.25	0.19	NR	0.07	0.14	0.61	0.23
Turbinaria spp.	0.38	0.27	0.07	NR	0.28	0.18	0.35	0.25
Upsidedown bowl	0.13	0.10	0.08	0.10	0.10	0.05	0.04	0.17

TARGET SPECIES AND FAMILIES	**SURVEY SECTORS**							
	7	**8**	**9**	**10**	**11**	**12**	**18**	**19**
BUTTERFLY FISH	0.20	0.17	0.27	0.33	0.21	0.27	0.30	0.79
Long-nosed butterflyfish	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Klein's Butterflyfish	0.00	0.00	0.00	0.02	0.00	0.05	0.00	0.09
Vagabond Butterflyfish	0.02	0.00	0.07	0.01	0.00	0.00	0.04	0.07
Pyramid butterflyfish	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
Eastern triangle butterflyfish	0.18	0.13	0.17	0.14	0.21	0.14	0.17	0.40
Latticed Butterflyfish	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.07
Redfin butterflyfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
Chevroned Butterflyfish	0.00	0.01	0.04	0.04	0.00	0.05	0.04	0.16
Orange-banded coralfish	0.00	0.01	0.00	0.04	0.00	0.09	0.00	0.02
Copper banded butterflyfish	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.05
Eight banded butterfyfish	0.00	0.00	0.00	0.00	0.03	0.05	0.00	0.01
Humphead Bannerfish	0.00	0.00	0.03	0.06	0.00	0.00	0.09	0.14
Pennant bannerfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
ANGEL FISH	0.11	0.09	0.13	0.07	0.03	0.05	0.04	0.38
Regal Angelfish	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.01
Bicolour Angelfish	0.00	0.02	0.01	0.00	0.03	0.00	0.00	0.00
Pearlscale Angelfish	0.00	0.00	0.07	0.00	0.03	0.00	0.00	0.05
Emperor angelfish	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00
Blue- girdled angelfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Vermiculated angelfish	0.04	0.00	0.00	0.01	0.00	0.05	0.00	0.07
SURGEON FISH	0.00	0.08	0.11	0.11	0.00	0.00	0.00	0.07
Convict	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
Ringtail	0.00	0.05	0.04	0.02	0.00	0.00	0.00	0.02
Brushtail Tang	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01
Thompson's surgeonfish	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Mimic Surgeonfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eyestripe	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Unicorn sp.	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
TUNA/ MACKEREL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
FUSILIERS sp.	0.24	0.28	0.23	0.57	0.66	0.00	0.04	0.60
"Blue and yellow" fusilier	0.11	0.07	0.00	0.13	0.17	0.00	0.00	0.21
Bluestreak fusilier	0.02	0.00	0.04	0.04	0.17	0.00	0.00	0.11
DAMSEL FISH	3.20	2.87	2.79	2.53	2.55	2.59	2.39	3.28
Blackbar Chromis	0.80	0.87	0.47	0.67	0.45	0.27	0.35	1.16
Chromis sp.	0.89	0.80	0.69	0.83	0.28	0.50	0.39	1.12
Blue Devil Damselfish	0.42	0.87	0.65	0.38	0.59	0.00	0.00	0.18
Three spot Damselfish	0.82	0.98	0.53	0.51	0.76	0.14	0.57	0.65
Humbug dascyllus	1.38	1.23	1.33	1.17	1.38	1.09	0.61	1.57
Reticulated dascyllus	1.04	1.12	0.92	0.49	0.76	0.41	0.13	0.65

White Belly Damselfish	0.24	0.33	0.24	0.42	0.31	0.05	0.04	0.60
Staghorn damselfish	0.16	0.10	0.04	0.16	0.07	0.18	0.13	0.28
Black damselfish	0.89	0.41	0.31	0.28	0.97	0.27	0.17	0.27
Behn's damsel	0.02	0.00	0.00	0.06	0.00	0.05	0.00	0.33
Honeyhead damsel	0.04	0.07	0.03	0.03	0.00	0.00	0.00	0.03
Alexander's damselfish	0.42	0.20	0.20	0.27	0.17	0.32	0.43	0.64
Blackspot damselfish	0.07	0.10	0.07	0.09	0.03	0.23	0.00	0.18
Anemone fish sp.	0.84	0.72	0.57	0.51	0.45	0.50	0.78	0.75
Sergeant Majors	0.33	0.25	0.12	0.06	0.10	0.00	0.13	0.16
WRASSE	1.73	1.55	1.27	1.21	1.38	1.14	1.04	1.58
Dianas hogfish	0.04	0.04	0.08	0.10	0.00	0.00	0.00	0.10
Mesothorax Hogfish	0.02	0.01	0.00	0.04	0.00	0.00	0.09	0.07
Humphead Wrasse	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Redbanded wrasse	0.04	0.01	0.00	0.01	0.00	0.05	0.09	0.21
Checkerboard Wrasse	0.04	0.03	0.01	0.06	0.07	0.00	0.04	0.02
Two tone wrasse	0.22	0.23	0.13	0.18	0.17	0.18	0.22	0.18
Crescent Wrasse	1.22	0.90	0.71	0.51	0.76	0.95	0.70	0.89
Six bar wrasse	0.11	0.02	0.07	0.06	0.03	0.09	0.13	0.13
Jansen's Wrasse	0.02	0.00	0.01	0.00	0.00	0.05	0.00	0.12
Cigar Wrasse	0.00	0.08	0.20	0.01	0.00	0.00	0.00	0.04
Bird Wrasse	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.02
Cleaner	0.42	0.65	0.44	0.27	0.31	0.05	0.09	0.47
GOAT FISH	0.22	0.05	0.08	0.10	0.03	0.00	0.00	0.14
Half & Half Goatfish	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.07
Two-Barred Goatfish	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
Dash and dot goatfish	0.13	0.00	0.03	0.07	0.03	0.00	0.00	0.07
Multibarred goatfish	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
Blackstriped goatfish	0.09	0.05	0.04	0.01	0.00	0.00	0.00	0.01
TRIGGER FISH	0.02	0.04	0.03	0.02	0.00	0.00	0.04	0.01
Redtooth triggerfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orangestriped Triggerfish	0.00	0.01	0.01	0.01	0.00	0.00	0.04	0.00
Clown triggerfish	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black bellied picassofish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Pinktail triggerfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scythe Triggerfish	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.03
Halfmoon triggerfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bluethroat Triggerfish	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
GROUPER sp.	0.07	0.03	0.01	0.10	0.07	0.09	0.00	0.05
Flagtail Grouper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Peacock grouper	0.00	0.02	0.00	0.00	0.00	0.05	0.00	0.01
Humpback grouper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
"Honeycomb" sp.	0.00	0.01	0.00	0.02	0.03	0.00	0.00	0.00
Lyretail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PARROT FISH	0.18	0.09	0.11	0.10	0.03	0.18	0.17	0.52
Bumphead parrotfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SPINE CHEEK	0.44	0.13	0.33	0.24	0.24	0.18	0.48	0.73
Twoline Spinecheek	0.29	0.08	0.21	0.20	0.17	0.18	0.43	0.66
Pearly spinecheek	0.02	0.04	0.04	0.02	0.03	0.00	0.04	0.05
SNAPPER	0.02	0.14	0.08	0.14	0.03	0.05	0.09	0.11
Two-spot snapper	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02
Black & White Snapper	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Bluelined snapper	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01
Spanish Flag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Checkered Snapper	0.02	0.05	0.07	0.06	0.00	0.05	0.09	0.05
Blackspot'	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
RABBIT FISH	0.04	0.01	0.01	0.01	0.00	0.00	0.00	0.24
Foxface rabbitfish	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.17
Virgate rabbitfish	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.04
DART FISH	0.02	0.03	0.00	0.03	0.03	0.05	0.04	0.01
Blackfin Dartfish	0.02	0.02	0.00	0.01	0.00	0.00	0.04	0.00
CARDINALFISH	0.29	0.42	0.51	0.48	0.45	0.27	0.70	0.45
Pajama	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.11
Blackstriped	0.20	0.17	0.29	0.01	0.31	0.18	0.17	0.28
PUFFER	0.04	0.00	0.03	0.04	0.10	0.18	0.04	0.05
Blackspotted	0.04	0.00	0.00	0.00	0.00	0.09	0.00	0.02
GOBY	0.18	0.36	0.43	0.41	0.10	0.77	0.83	0.37
Sphynx	0.07	0.11	0.08	0.00	0.03	0.05	0.00	0.04
Brownbarred	0.07	0.10	0.05	0.00	0.00	0.00	0.04	0.02
DOTTYBACK	0.00	0.02	0.08	0.04	0.00	0.00	0.17	0.02
Lined dottyback	0.00	0.01	0.03	0.01	0.00	0.00	0.00	0.00
OTHER TARGET FAMILIES								
ANTHIAS	1.98	1.49	1.16	0.85	0.90	0.95	1.13	1.52
SOAPFISH	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.00
JACK/ TREVALLY	0.04	0.01	0.00	0.01	0.00	0.00	0.00	0.02
SWEETLIPS	0.07	0.03	0.08	0.05	0.03	0.00	0.13	0.08
BARRACUDA	0.04	0.00	0.04	0.01	0.00	0.00	0.00	0.00
MOORISH IDOL	0.20	0.09	0.09	0.10	0.07	0.00	0.00	0.12
EMPEROR	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.05
SPADEFISH/ BATFISH	0.04	0.04	0.00	0.04	0.00	0.00	0.00	0.01
PORCUPINE	0.04	0.07	0.01	0.01	0.00	0.05	0.04	0.03
TOBY	0.16	0.02	0.00	0.04	0.00	0.14	0.04	0.12
TRUNKFISH/ BOXFISH/ COWFISH	0.09	0.01	0.00	0.01	0.00	0.05	0.09	0.01

BLENNY	0.20	0.11	0.17	0.11	0.14	0.18	0.39	0.20
SWEEPERS	0.04	0.00	0.04	0.01	0.00	0.00	0.04	0.00
SOLDIERFISH/ SQUIRRELFISH	0.07	0.01	0.01	0.08	0.00	0.09	0.00	0.10
FILEFISH	0.07	0.03	0.04	0.02	0.00	0.09	0.09	0.05
LIONFISH	0.11	0.12	0.09	0.19	0.17	0.09	0.26	0.11
SCORPIONFISH	0.04	0.02	0.03	0.01	0.00	0.00	0.13	0.02
LIZARDFISH	0.22	0.22	0.28	0.36	0.14	0.32	0.39	0.24
HAWKFISH	0.13	0.26	0.29	0.14	0.14	0.05	0.17	0.14
SANDPERCH	0.58	0.36	0.76	0.32	0.55	0.41	0.61	0.43
SHARKSUCKER/ REMORA	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00
NEEDLEFISH	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01
PIPEFISH	0.04	0.03	0.04	0.05	0.00	0.05	0.13	0.05
SHRIMPFISH	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.03
TRUMPETFISH	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01
MORAL EEL	0.07	0.01	0.01	0.03	0.07	0.00	0.09	0.02

PHYLUM	TARGET SPECIES OR FAMILY	SURVEY SECTORS							
		7	8	9	10	11	12	18	19
annelida	Feather Duster Worm	1.40	1.04	1.09	0.97	1.34	0.86	1.39	0.89
annelida	Christmas Tree	0.42	0.17	0.12	0.16	0.17	0.09	0.09	0.13
annelida	Segmented Worm	0.07	0.12	0.13	0.05	0.10	0.00	0.00	0.05
bryozoans	BRYOZOAN	0.11	0.00	0.08	0.02	0.07	0.00	0.04	0.20
cnidaria	Hydrozoas	1.27	1.12	0.99	0.51	1.55	1.36	1.00	0.50
cnidaria	Anemone	1.13	0.82	0.71	0.72	0.76	0.50	1.09	0.77
cnidaria	Corallimorpharia	0.62	0.27	0.44	0.41	0.45	0.59	0.74	0.10
cnidaria	Zoanthidea	0.64	0.28	0.21	0.28	0.38	0.32	0.30	0.23
cnidaria	Jelly Fish	0.02	0.09	0.04	0.15	0.07	0.05	0.09	0.04
crustacea	Shrimp	0.16	0.16	0.33	0.21	0.38	0.18	0.78	0.17
crustacea	Crab	0.18	0.08	0.21	0.15	0.24	0.05	0.26	0.08
crustacea	Spiny/ Rock Lobster	0.00	0.01	0.00	0.02	0.00	0.05	0.00	0.00
echinoderm	Feather star	1.56	1.82	1.97	1.21	1.83	1.59	1.39	1.00
echinoderm	Long spine urchin	0.67	0.75	0.83	0.69	1.14	0.91	1.52	1.12
echinoderm	Brittle star	0.98	0.85	0.75	0.81	1.14	0.77	0.96	0.89
echinoderm	Short spine urchin	0.40	0.18	0.68	0.39	0.66	0.91	0.78	0.57
echinoderm	Linckia laevigata sea star	0.33	0.20	0.04	0.32	0.21	0.00	0.43	0.48
echinoderm	sea cucumber	0.07	0.15	0.17	0.10	0.24	0.18	0.09	0.22
echinoderm	Crown-of -thorns	0.09	0.04	0.09	0.11	0.17	0.05	0.13	0.50
echinoderm	Basket star	0.31	0.16	0.12	0.13	0.17	0.09	0.13	0.05
echinoderm	other sea stars	0.24	0.09	0.08	0.07	0.07	0.18	0.18	0.17
echinoderm	Culcita novoguinea sea star	0.07	0.07	0.01	0.04	0.21	0.09	0.22	0.16
echinoderm	Nardoa sea star	0.11	0.05	0.04	0.09	0.14	0.09	0.17	0.07
echinoderm	Choriaster granularis sea star	0.16	0.05	0.00	0.02	0.07	0.09	0.05	0.09
echinoderm	Protoaster nodosus sea star	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.26
mollusc	nudibranch	0.20	0.22	0.21	0.18	0.31	0.41	0.39	0.18
mollusc	Oyster	0.13	0.11	0.12	0.21	0.10	0.18	0.26	0.40
mollusc	Cowrie	0.11	0.08	0.16	0.07	0.10	0.18	0.17	0.11
mollusc	Cone Shell	0.07	0.12	0.05	0.08	0.07	0.05	0.09	0.11
mollusc	other gastropod	0.07	0.03	0.07	0.05	0.14	0.14	0.00	0.13
mollusc	Drupella sp.	0.07	0.01	0.04	0.00	0.07	0.05	0.22	0.07
mollusc	GiantClam	0.02	0.04	0.01	0.08	0.07	0.05	0.00	0.15
mollusc	Conch	0.09	0.03	0.04	0.04	0.03	0.09	0.00	0.03
mollusc	Topshell	0.04	0.05	0.00	0.01	0.07	0.05	0.09	0.02
mollusc	Other bivalve	0.02	0.03	0.03	0.11	0.00	0.00	0.04	0.04
mollusc	Limpet	0.00	0.05	0.01	0.01	0.00	0.00	0.00	0.09
mollusc	Cuttlefish	0.00	0.00	0.03	0.00	0.03	0.00	0.00	0.00
mollusc	Squid	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00
mollusc	Abalone	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.01
mollusc	Octopus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
mollusc	Chitonida	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
mollusc	Triton Trumpet	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
tunicates	Tunicates	2.29	1.82	1.75	1.21	2.00	1.45	2.35	1.43

APPENDIX D:

Coral Species list for Sogod Bay

	Species
	Family Astrocoeniidae
1.	Palauastrea ramosa (Yabe & Sugiyama, 1941)
2.	Stylocoeniella armata (Ehrenberg, 1834)
3.	Stylocoeniella guentheri (Bassett-Smith, 1890)
	Family Pocilloporidae
4.	Pocillopora damicornis (Linnaeus, 1758)
5.	Pocillopora verrucosa (Ellis & Solander, 1786)
6.	Seriatopora caliendrum (Ehrenberg, 1834)
7.	Seriatopora hystrix (Dana, 1846)
8.	Stylophora subseriata (Ehrenberg, 1834)
	Family Acroporidae
9.	Acropora abrolhosensis (Veron, 1985)
10.	Acropora aculeus (Dana, 1846)
11.	Acropora aspera (Dana, 1846)
12.	Acropora brueggemanni (Brook, 1893)
13.	Acropora carolineana Nemenzo, 1976
14.	Acropora cerealis (Dana, 1846)
15.	Acropora cytherea (Dana, 1846)
16	Acropora digitifera (Dana, 1846)
17.	Acropora divaricata (Dana, 1846)
18.	Acropora echinata (Dana, 1846)
19.	Acropora elegans (Milne Edwards and Haime, 1860)
20.	Acropora exquisita (Nemenzo, 1971)
21.	Acropora fenneri (Veron, 2000)
22.	Acropora florida (Dana, 1846)
23.	*Acropora sp. 1
24.	Acropora formosa (Dana, 1846)
25.	Acropora grandis (Brook, 1892)
26.	*Acropora sp. 2
27.	Acropora granulosa (Milne Edwards & Haime, 1860)
28.	Acropora hoeksemai (Wallace, 1997)
29.	Acropora horrida (Dana, 1846)
30	Acropora humilis (Dana, 1846)
31.	Acropora hyacinthus (Dana, 1846)
32.	Acropora insignis (Nemenzo, 1967)
33.	Acropora latistella (Brook, 1891)
34.	Acropora longicyathus (Milne Edwards & Haime, 1860)
35.	Acropora loripes (Brook, 1892)
36.	Acropora millepora (Ehrenberg, 1834)
37.	Acropora nasuta (Dana, 1846)
38.	Acropora palifera (Lamarck, 1816)

39. Acropora parilis (Quelch, 1886)
40. Acropora plumosa (Wallace & Wolstenholme, 1998)
41. Acropora samoensis (Brook, 1891)
42. Acropora selago (Studer, 1878)
43. Acropora simplex (Wallace and Wolstenholme, 1998)
44. Acropora solitaryensis (Veron & Wallace, 1984)
45. Acropora speciosa (Quelch, 1886) as in Veron, 2000
46. Acropora speciosa as in Wallace 1999
47. Acropora subglabra (Brook, 1891)
48. Acropora subulata (Dana, 1846)
49. Acropora tenuis (Dana, 1846)
50. Acropora valenciennesi (Milne Edwards & Haime, 1860)
51. Acropora vaughani (Wells, 1954)
52. Anacropora forebesi (Ridley, 1884)
53. Anacropora matthai (Pillai, 1973)
54. Anacropora puertogalerae (Nemenzo, 1964)
55. Anacropora reticulata (Veron and Wallace, 1984)
56. Anacropora spinosa (Rehberg, 1892)
57. Astreopora gracilis (Bernard, 1896)
58. Astreopora myriophthalma (Lamarck, 1816)
59. Astreopora ocellata (Bernard, 1896)
60. Astreopora randalli (Lamberts, 1980)
61. Astreopora suggesta (Wells, 1954)
62. Montipora aequituberculata (Bernard, 1897)
63. Montipora altasepta (Nemenzo, 1967)
64. Montipora cactus (Bernard, 1897)
65. Montipora capitata (Dana, 1846)
66. Montipora confusa (Nemenzo, 1967)
67. Montipora corbettensis (Veron & Wallace, 1984)
68. Montipora digitata (Dana, 1846)
69. Montipora florida (Nemenzo, 1967)
70. Montipora gaimardi (Bernard, 1897)
71. Montipora hispida (Dana, 1846)
72. Montipora incrassata (Dana, 1846)
73. Montipora informis (Bernard, 1897)
74. Montipora mactanensis (Nemenzo, 1979)
75. Montipora malampaya (Nemenzo, 1967)
76. Montipora mollis (Bernard, 1897)
77. Montipora palawanensis (Veron, 2000)
78. Montipora spongodes (Bernard, 1897)
79. Montipora stellata (Bernard, 1897)
80. Montipora tuberculosa Lamarck, 1816)
81. Montipora undata (Bernard, 1897)
82. Montipora venosa (Ehrenberg, 1834)
83. Montipora vietnamensis (Veron, 2000)

Family Poritidae

84. Alveopora catalai (Wells, 1968)
85. Alveopora gigas (Veron, 1985)
86. Alveopora spongiosa (Dana, 1846)
87. Goniopora columna (Dana, 1846)
88. Goniopora lobata (Milne Edwards and Haime, 1860)
89. Goniopora panadorensis (Veron and Pichon, 1982)
90. Goniopora stutchburyi (Wells, 1955)
91. Porites annae (Crossland, 1952)
92. Porites attenuata (Nemenzo, 1955)
93. **Porites cf Bernardi (Vaughan 1907)
94. Porites cylindrica (Dana, 1846)
95. Porites evermanni (Vaughan, 1907)
96. Porites horizontalata (Hoffmeister, 1925)
97. Porites lobata (Dana, 1846)
98. Porites lutea (Milne Edwards and Haime, 1851)
99. Porites monticulosa (Dana, 1846)
100. Porites rus (Forskål, 1775)
101. Porites solida (Forskål, 1775)
102. Porites vaughani (Crossland, 1952)
103. Coscinaraea columna (Dana, 1846)
104. Psammocora contigua (Esper, 1797)
105. Psammocora digitata (Milne Edwards & Haime, 1851)
106. Psammocora explanulata (van der Horst, 1922)
107. Psammocora nierstraszi (van der Horst, 1921)
108. Psammocora profundacella (Gardiner, 1898)
109. Psammocora superficialis (Gardiner, 1898)

Family Agariciidae

110. Coeloseris mayeri (Vaughan, 1918)
111. Gardineroseris planulata (Dana, 1846)
112. Leptoseris explanata (Yabe & Sugiyama, 1941)
113. Leptoseris mycetoseroides (Wells, 1954)
114. Leptoseris papyracea (Dana, 1846)
115. Leptoseris scabra (Vaughan, 1907)
116. Leptoseris striata (Fenner & Veron, 2000)
117. Pachyseris foliosa (Veron, 1990)
118. Pachyseris gemmae (Nemenzo, 1955)
119. Pachyseris rugosa (Lamarck, 1801)
120. Pachyseris speciosa (Dana, 1846)
121. Pavona bipartita (Nemenzo, 1980)
122. Pavona cactus (Forskål, 1775)
123. Pavona clavus (Dana, 1846)
124. Pavona decussata (Dana, 1846)
125. Pavona explanulata (Lamarck, 1816)
126. Pavona frondifera (Lamarck, 1816)
127. Pavona varians (Verrill, 1864)
128. Pavona venosa (Ehrenberg, 1834)

Family Fungiidae

129. Ctenactis crassa (Dana, 1846)
130. Ctenactis echinata (Pallas, 1766)
131. Cycloseris colini (Veron, 2000)
132. Cycloseris costulata (Ortmann, 1889)
133. Cycloseris cyclolites (Lamarck, 1801)
134. Cycloseris erosa (Döderlein, 1901)
135. Cycloseris sinensis (Milne Edwards and Haime, 1851)
136. Cycloseris tenuis (Dana, 1846)
137. Cycloseris vaughani (Boschma, 1923)
138. Diaseris distorta (Michelin, 1843)
139. Diaseris fragilis (Alcock, 1893)
140. Fungia concinna (Verrill, 1864)
141. Fungia fungites (Linneaus, 1758)
142. Fungia granulosa (Klunzinger, 1879)
143. Fungia horrida (Dana, 1846)
144. Fungia moluccensis (Horst, 1919)
145. Fungia paumotensis (Stutchbury, 1833)
146. Fungia scruposa (Klunzinger, 1816)
147. Fungia spinifer (Claereboudt & Hoeksema 1987)
148. Halomitra clavator (Hoeksema, 1989)
149. Halomitra pileus (Linnaeus, 1758)
150. Heliofungia actiniformis (Quoy & Gaimard, 1837)
151. Herpolitha limax (Houttuyn, 1772)
152. Herpolitha weberi (Horst, 1921)
153. Lithophyllon mokai (Hoeksema, 1989)
154. Lithophyllon undulatum (Rehberg, 1892)
155. Podabacia crustacea (Pallas, 1766)
156. Podabacia motuporensis (Veron, 1990)
157. Polyphyllia talpina (Lamarck, 1801)
158. Sandalolitha dentata (Quelch, 1884)
159. Sandalolitha robusta (Quelch, 1886)

Family Oculinidae

160. Galaxea astreata (Lamarck,. 1816)
161. Galaxea fascicularis (Linnaeus, 1767)
162. Galaxea horrescens (Dana, 1846)

Family Pectinidae

163. Echinophyllia aspera (Ellis & Solander, 1788)
164. Echinophyllia echinoporoides (Veron & Pichon, 1979)
165. Echinophyllia orpheensis (Veron & Pichon, 1980)
166. Echinophyllia patula (Hodgson & Ross, 1982)
167. Mycedium elephantotus (Pallas, 1766)
168. Mycedium robokaki (Moll & Borel-Best, 1984)
169. Oxypora crassispinosa (Nemenzo, 1979)
170. Oxypora lacera (Verrill, 1864)
171. Oxypora sp. 1

172. Pectinia alcicornis (Saville-Kent, 1871)
173. Pectinia lactuca (Pallas, 1766)
174. Pectinia paeonia (Dana, 1846)
175. Pectinia teres (Nemenzo & Montecillo, 1981)

Family Mussidae

176. Acanthastrea echinata (Dana, 1846)
177. Acanthastrea faviaformis (Veron, 2000)
178. Acanthastrea hemprichii (Ehrenberg, 1834)
179. Acanthastrea lordhowensis (Veron & Pichon, 1982)
180. Acanthastrea rotundoflora (Chevalier, 1975)
181. Australomussa rowleyensis (Veron, 1985)
182. Cynarina lacrimalis (Milne Edwards & Haime, 1848)
183. Micromussa amakusensis (Veron, 2000)
184. Lobophyllia corymbosa (Forskål, 1775)
185. Lobophyllia flabelliformis (Veron, 2000)
186. Lobophyllia hataii (Yabe & Sugiyama, 1936)
187. Lobophyllia hemprichii (Ehrenberg, 1834)
188. Lobophyllia robusta (Yabe & Sugiyama, 1936)
189. Lobophyllia cf. serratus (Veron, 2000)
190. Scolymia vitiensis (Brüggemann, 1877)
191. Symphyllia agaricia (Milne Edwards & Haime, 1849)
192. Symphyllia hassi (Pillai & Scheer, 1976)
193. Symphyllia radians (Milne Edwards & Haime, 1849)
194. Symphyllia recta (Dana, 1846)
195. Symphyllia valenciennesii (Milne Edwards & Haime, 1849)

Family Merulinidae

196. Hydnophora exesa (Pallas, 1766)
197. Hydnophora grandis (Gardiner, 1904)
198. Hydnophora microconos (Lamarck, 1816)
199. Hydnophora pilosa (Veron, 1985)
200. Hydnophora rigida (Dana, 1846)
201. Merulina ampliata (Ellis & Solander, 1786)
202. Merulina scabricula (Dana, 1846)
203. Scapophyllia cylindrica (Milne Edwards & Haime, 1848)

Family Faviidae

204. Barabattoia amicorum (Milne Edwards & Haime, 1850)
205. Caulastrea curvata (Wijsman-Best, 1972)
206. Caulastrea echinulata (Milne Edwards & Haime, 1849)
207. Cyphastrea decadia (Moll and Borel-Best, 1984)
208. Diploastrea heliopora (Lamarck, 1816)
209. Echinopora gemmacea (Lamarck, 1816)
210. Echinopora hirsuitissima (Milne Edwards & Haime, 1849)

211 Echinopora horrida (Dana, 1846)

212. Echinopora lamellosa (Esper, 1795)
213. Echinopora mammiformis (Nemenzo, 1959)
214. Echinopora pacificus (Veron, 1990)

215. Favia matthai (Vaughan, 1918)
216. Favia pallida (Dana, 1846)
217. Favia rotundata (Veron & Pichon, 1977)
218. Favia stelligera (Dana, 1846)
219. Favia truncatus (Veron, 2000)
220. Favia vietnamensis (Veron 2000)
221. Favites abdita (Ellis & Solander, 1786)
222. Favites acuticollis (Ortmann, 1889)
223. Favites halicora (Ehrenberg, 1834)
224. Favites paraflexuosa (Veron, 2000)
225. Favites pentagona (Esper, 1794)
226. Goniastrea aspera (Verrill, 1905)
227. Goniastrea edwardsi (Chevalier, 1971)
228. Goniastrea favulus (Dana, 1846)
229. Goniastrea minuta (Veron, 2000)
230. Goniastrea pectinata (Ehrenberg, 1834)
231. Goniastrea retiformis (Lamarck, 1816)
232. Leptastrea pruinosa Crossland, 1952
233. Leptastrea purpurea (Dana, 1846)
234. Leptastrea transversa Klunzinger, 1879
235. Leptoria phrygia (Ellis & Solander)
236. Montastrea colemani Veron, 2000
237. Montastrea curta (Dana, 1846)
238. Montastrea magnistellata Chevalier, 1971
239 Montastrea salebrosa (Nemenzo, 1959)
240. Oulastrea crispata (Lamarck, 1816)
241. Oulophyllia bennettae (Veron, Pichon, & Wijsman-Best, 1977)
242. Oulophyllia crispa (Lamarck, 1816)
243. Platygyra daedalea (Ellis & Solander, 1786)
244. Platygyra lamellina (Ehrenberg, 1834)
245. Platygyra pini (Chevalier, 1975)
246. Platygyra sinensis (Milne Edwards & Haime, 1849)
247. Platygyra verweyi (Wijsman-Best, 1976)
248. Plesiastrea versipora (Lamarck, 1816)

Family Trachyphyllidae

249. Trachyphyllia geoffroyi (Audouin, 1826)

Family Euphilliidae

250. Catalaphyllia jardenei (Saville-Kent, 1893)
251. Euphyllia ancora (Veron & Pichon, 1979)
252. Euphyllia cristata (Chevalier, 1971)
253. Euphyllia divisa (Veron & Pichon, 1979)
254. Euphyllia glabrescens (Chamisso & Eysenhardt, 1821)
255. Nemenzophyllia turbida (Hodgson & Ross, 1981)
256. Plerogyra sinuosa (Dana, 1846)

Family Dendrophylliidae

257. *Balanophyllia sp. 1

258. Dendrophyllia cf gracilis (Milne Edwards & Haime, 1848)
259. *Dendrophyllia sp. 1
260. Rhizopsammia verrilli (van der Horst, 1922)
261. Tubastraea coccinea (Lesson, 1829)
262 Tubastraea diaphana (Dana, 1846)
263. Tubastraea micranthus (Ehrenberg, 1834)
264. Turbinaria frondens (Dana, 1846)
265. Turbinaria heronensis (Wells, 1958)
266. Turbinaria irregularis (Bernard, 1896)
267. Turbinaria mesenterina (Lamarck, 1816)
268. Turbinaria peltata (Esper, 1794)
269. Turbinaria reniformis Bernard, 1896
270. Turbinaria stellulata (Lamarck, 1816)

Family Heliporidae

271. Heliopora coerulea (Pallas, 1776)

<u>Family Clavulariidae</u>

272. Tubipora musica (Linnaeus, 1758)

<u>Family Milleporidae</u>

273. Millepora dichotoma (Forskål, 1775)
274. Millepora exaesa (Forskål, 1775)
275. Millepora intricata (Milne-Edwards & Haime, 1857)
276. Millepora platyphylla (Hemprich and Ehrenberg, 1834)

* Unidentified *Acropora* sp or *Dendrophyllia* sp