SAVING PHILIPPINE REEFS

Coral Reef Monitoring Expedition
to Southeastern Cebu, Philippines
March 22 – 30, 2010

A project of:

The Coastal Conservation and Education Foundation, Inc.

With the participation and support of the

Expedition Research Volunteers

Summary Field Report:
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Produced by the Coastal Conservation and Education Foundation, Inc.

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ABSTRACT

The Saving Philippine Reefs Expedition assessed the biophysical conditions of the marine sanctuaries (MPAs) in Southeast Cebu in March 2010. Surveys were conducted in seven out of the twenty one MPAs that are located in the Southeast Cebu cluster and updated the data from previous surveys. Living hard coral (LHC) cover ranged from fair to good (29.4±10.9% to 55.0±5.1%). Six of the seven MPAs surveyed are in fair condition (25-50% LHC) (Daanlungsod-Guiwang, Granada, Gawi, Sumilon Is., Pasil and Colase). Four sanctuaries (Arbor, Gawi, Colase and Pasil) showed no significant change overtime. LHC in Daanlungsod-Guiwang decreased significantly from 2005 to 2010 while in Granada and Sumilon Is., LHC increased significantly from 2002 to 2010 and 1992-2010 respectively. Arbor MPA had the highest LHC (55.0±5.1%) followed by Gawi (48.8±8.7%) and Sumilon sanctuary (47.8%±3.7%). Among all sites surveyed, LHC is stable and increasing on average. No signs of coral bleaching were seen.

Target fish densities ranged from very poor to poor both inside and outside of MPAs while densities inside sanctuaries were generally higher than outside. Four sites had very low fish densities (Arbor, Granada, Gawi and Colase) and three sites were low (Daanlungsod-Guiwang, Sumilon and Pasil). Target fish density in Arbor, Granada and Pasil increased significantly overtime while Sumilon and Colase decreased marginally. Furthermore, Daanlungsod-Guiwang and Gawi showed no significant changes after 8 years of monitoring. Daanlungsod-Guiwang had the highest target density (144.2±82.4 fish/500m^2) followed by Pasil (143.6± fish/500m^2) and Sumilon (135.0±?fish/500m^2). Despite relatively low fish density in all areas, the marked differences between inside and outside shows the benefits of protection and the potential to improve.

Target fish diversity was very low in four of the seven sites. The remaining three are slighty more diverse. Pasil recorded the highest mean target species at 18.3±2.9 spp/500m^2 followed by Sumilon Is. (16.0±2.6 spp/500m^2) and Daanlungsod-Guiwang (13.5±0.8spp/500m^2). Target species richness in Sumilon showed a significant increase from 1999 to 2010 and correlates with improved management.

All seven sites have a very low biomass of target fish. Pasil recorded the highest (57.4±13.8 kg/500m^2) followed by Sumilon (35.8±18.1 kg/500m^2) and Gawi (22.4±18.1 kg/500m^2). Fish biomass inside all the MPAs was higher than outside.

In 2010, MPAs in Southeast Cebu generally showed improvement since the beginning of their establishment (around year 2002, Sumilon in 1974). Such results correlate with the efforts of the local municipal governments and their communities to establish and protect small MPAs to improve fish catch and to attract scuba diving tourists to the area. Presently the Southeast Cebu Coastal Resource Management Council supports the development of a MPA network which is encouraging the use of improved management techniques and the evaluation of MPA sizes, representation of habitats and activities allowed in the vicinity of the no-take sanctuaries in an effort to improve overall effectiveness. Specific recommendations are included herein.

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ACKNOWLEDGEMENTS

This coral reef monitoring expedition and its outcome are credited to the 14 international volunteers (see Appendix 2) from the United States, Australia and the Philippines who dedicated their time and funding to the research work. Equally important are the Coastal Conservation and Education Foundation staff, partners and volunteers (see Appendix 2) that prepared for the trip, worked long hours and have all done their part in the overall successful completion of the Expedition. They include: Agnes Sabonsolin, Data and Logistics Assistant; Sheryll Tesch, Logistics and Research Coordinator; Dean Apistar, Researcher and Divemaster; Rafael Martinez, GIS Specialist; Ethan Lucas, Divemaster; Wenifel Porpetcho, Research Assistant; Jane Trangia, CCEF Chief Accountant; Pablita Toyong-Huerbana, CCEF Administrative Assistant; and Vangie White, overall Project Manager and support coordinator for the trip.

The Sumilon Bluewater Island Resort staff and management hosted our group with traditional Filipino hospitality and provided excellent service, accommodations, and food. We would like to thank the staff of the Maribago Dive Shop for providing excellent diving and boat services and assistance and for making the expedition a safe and smooth trip.

Special thanks to Dr. Eugene Matildo, the Municipal Agricultural Officer of the Municipality of Boljoon whose brief visit and presentation inspired volunteers in their mission to monitor reefs for the good of the local communities and MPA managers. The Municipalities of Alcoy, Boljoon, Oslob, Santander, and Samboan are thanked for their graciousness is accommodating our dive expedition teams to their MPAs.

The final production of this report has been efficiently accomplished by Sheryll Tesch and Dean Apistar of the CCE Foundation. Finally, any unpopular opinions or remaining errors are assumed by the authors.

Alan T. White
Principal Investigator

LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
BFAR	Bureau of Fisheries and Aquatic Resources
CB	branching coral
CFD	flat/encrusting coral
CFO	foliose/cup coral
CM	massive coral
DC	white dead standing coral
DCA	dead coral with algae
DENR	Department of Environment and Natural Resources
DepEd	Department of Education
EcoGov	EcoGovernance Project
ENSO	El Niño Southern Oscillation
FVC	fish visual census
LC	live coral
LHC	live hard coral
M/V	marine vessel
MPA	marine protected area
MS	marine sanctuary
NL	non living
NS	not significant
PAMB	Protected Area Management Board
PO	peoples organization
R	coral rubble
RCK	rock and block
SC	soft coral
SD	standard deviation
SE	standard error
SI	sand and silt
spp.	species
SPR	Saving Philippine Reefs
UVC	underwater visual census

SAVING PHILIPPINE REEFS
A coral reef monitoring expedition to
Southeastern Cebu, Philippines
March 22 – March 29, 2010

INTRODUCTION

The Saving Philippine Reefs (SPR) Project is a reef monitoring expedition that was initiated in the early 1980s. The primary goal of this project is to improve the quality and quantity of information available on coral reefs for use in improving management and creation of appropriate policies for protection and sustainable use of coastal resources. The SPR Project has been doing regular coral reef monitoring assessments mostly within the vicinity of marine protected areas (MPAs) located in selected sites in the provinces of Cebu, Negros Oriental, Siquijor, Bohol, Batangas and Palawan.

In March of 2010, the expedition was conducted in the Southern area of Cebu Province where the Coastal Conservation and Education Foundation (CCEF) implements the Local Governance for Coastal Management Project (LGCMP). The southeastern part of Cebu province consists of five municipalities, namely: Alcoy, Boljoon, Oslob, Santander, and Samboan. Since as early as 2000, Southeastern Cebu has demonstrated an interest and initiative in protecting its coral reef and mangrove habitats through municipal and province-wide efforts in coastal resource management.

The SPR Project first surveyed Cebu and Negros Oriental in 2002 and only covered Sumilon Island Fish Sanctuary in the Municipality of Oslob. However, reef assessments have been done annually since 2002 and onward by the research monitoring team (REMOTE) of CCE Foundation. In this report, findings strongly recommend a more active effort for conservation, coastal law enforcement and management of the area. The MPAs in Cebu have varying duration in management and protection which makes comparison between sites and inside and outside of MPAs interesting.

Management of Marine Protected Areas in Southeastern Cebu Province

Management of Southeastern Cebu MPAs reflects strong support from both the local and provincial governments. Nevertheless, with large outside threats like commercial fishing, coastal law enforcement and overall MPA management remain a challenge. Many of Southeastern Cebu MPAs were established after the year 2000, except for the oldest municipal MPA in the Philippines, Sumilon Island Fish Sanctuary of Oslob Municipality that was established in 1974.

Southeast Cebu is a unique area because of the inter-municipal partnership that exists among eight of the municipalities (Sibonga, Argao, Dalaguete, Alcoy, Boljoon, Oslob, Santander and Samboan). The municipalities have evolved from the simple establishment and management of individual MPAs in their waters to viewing their marine resources as part of a network of MPAs within a common fisheries ecosystem. It is with this inter-municipal partnership that they are able to address multiple issues– environmental, cultural, socioeconomic, institutional, and even political – for effective management. The council that runs the management of the inter-municipal partnership is called the Southeast Cebu Coastal Resource Management Council (SCCRMC) which was established in 2005 through the execution of a Memorandum of Agreement between the eight municipalities represented by their local chief executives and the Province of Cebu by its governor.

The whole area of coast being protected in Southeast Cebu is roughly 188 kilometers in length and covers about 1,250 square kilometers of municipal waters. Each town, by the mandate of the 1991 Local Government Code of the Philippines, has individual jurisdiction over its municipal natural resources, which includes 15 km of municipal waters from the coastline. This also means that each town governs the planning, law enforcement, policy-making, management and the restriction of fishing activities within their municipal waters and among their constituents.

After the establishment of Sumilon Island Fish Sanctuary in 1974, Southeast Cebu has had assistance in coastal resource management, through the Coastal Resource Management Project of USAID/DENR from 1999 to 2002, and then through the CCEF from 2002 to the present. To date, there are about two MPAs per municipality with the exception of Sibonga, Samboan, and Santander that have one each and Argao with ten MPAs. These municipalities have benefited from eight years of research and monitoring that has helped promote management efforts in the towns and encouraged them to upgrade their management as part of their CRM initiatives.

This EXPEDITION—2010

This 8-day expedition to Southeastern Cebu (Figure 1) was participated in by a team of 14 research volunteers and 8 staff members (Appendix 2). The volunteers hailed from the USA, UK, Australia and the Philippines. Most of them are seasoned SPR Expedition volunteers who have joined in one or more of the previous expeditions.

The expedition team's home for nine days was Sumilon Bluewater Island Resort on the small island of Sumilon off the Municipality of Oslob. The expedition team's boats were provided by Maribago Dive Shop that assisted the expedition research diving to run smoothly. The trip itinerary is shown in Appendix 1. The expedition team also benefited from a visit by a local marine conservation champion, Dr. Eugene Matildo, the Municipal Agriculture Officer of Boljoon Municipality**.**

The survey team monitored the condition of the coral reef substratum, fish diversity, abundance, indicator species and human activities affecting the MPAs. This report documents the recorded changes in reef conditions in the sites over time. It also aims to report possible factors contributing to such changes and provides recommendations for improvement in MPA management.

Data Collected and Methods

Study site

Cebu is a province in Region 7 (Central Visayas) (Figure 1). It is bounded on the east by Leyte, southeast by Bohol Island and the west by Negros Island. Cebu is flanked on either side by Tanon Strait and Cebu Strait. Each marine sanctuary is managed by a local people's organization and its corresponding municipal government. All vary in age and management. The reefs around the island are wide and shallow and are usually characterized by a gentle slope of corals, some reef walls, and large diversity of marine life. The area has historically been affected by heavy fishing pressure often using destructive methods such as explosives, poison, fine mesh net, spearing using compressed air among others. In recent years most destructive fishing has stopped but fishing pressure using legal methods remains.

Data collection

Substrate cover. Systematic snorkeling surveys were carried out in the shallow reef flat at 2-3 m depth covering a distance of 0.5 – 1 km parallel to the reef crest. The distance covered for sampling is limited by the reef extent and may be less than 0.5 km in some sites. The substrate was evaluated within an estimated area of 1 m^2 quadrant at every 50-meter stop (or station). The following data was recorded:

1. Percent cover of living coral (hard and soft)
2. Percent cover of non-living substrate (e.g., rock, rubble, sand, dead coral)
3. Percent cover of living substrate (e.g., seagrass, algae, sponges)
4. Numbers of indicator species (e.g., butterflyfish, giant clams, lobsters, Triton shells, Crown of thorns starfish and other invertebrates)
5. Presence of large marine life (e.g., sharks, manta rays, Humphead wrasses, sea turtles, whales, dolphins and others)
6. Causes of reef damage

Distances between stations were estimated through kick cycles, wherein volunteers calibrated their kicks along a transect tape prior to surveys. Each volunteer attempted to make at least ten or more stations on one snorkel survey, limited by the extent of the reef.

Scuba surveys were carried out in the deep area (7-9 m) parallel to the reef crest using a systematic point-intercept method. Transects were laid on sections of a reef flat, reef crest or slope. Substrate was evaluated at 25 cm intervals along a 50 m transect. Data gathered during scuba surveys were the same type as those collected during snorkel surveys. The distance between transects was approximately 5 m.

Fish estimates. Fish abundance and diversity were estimated using a 50 x 10 m visual census (UVC; n = 4 - 8) technique done by four specialists (AT White, W Porpetcho, A. Candido, and TJ Mueller). Specified substrate transects were utilized for UVC. The abundance of target species, indicator species and numerically dominant and visually obvious were all counted. Lengths of fish counted were also estimated (Uychiaoco et al. 2001; English et al. 1997). Biomass of target species was computed using length-weight constants (www.fishbase.org).

Data Analyses

Coral and fish abundance. Substrate was categorized into total live hard coral (branching, massive, encrusting and foliose), soft coral, rubble, non-living substrate (white dead standing coral, dead coral, rock and block, sand and silt) and others (sponges, algae, and seagrass) for comparison and presented graphically. Each category was compared within site between years using a one factor analysis of variance (1-ANOVA) or Kruskal-Wallis whichever is appropriate. Similarly, each category was also compared between sites per year using 1-ANOVA. Surveys in the previous years with low replication ($n<3$) were excluded from statistical analyses. Thus, T-test was used in sites with only two survey points available. Data included in the statistical analyses were tested for normality (when necessary) using probability plots, log or square root transformation was made whenever appropriate; and Tukey's Test was used as post hoc. All statistical analyses used the software Minitab 14® . Regression lines are also shown for long-term trends. In describing coral condition, the following terms may have the corresponding values:

Gomez et al (1994) categories:

Live Coral Cover (%mean ±SE)			
Poor	Fair	Good	Excellent
0% – 25%	25% – 50%	50% - 75%	75 – 100

Density of fish was presented and classified according to the 19 coral reef fish families/subfamily which include target fish families (Serranidae: Epinephelinae and Anthiinae, Lutjanidae Haemulidae, Lethrinidae, Carangidae, Caesionidae, Nemipteridae, Mullidae, Balistidae, Chaetodontidae, Pomacanthidae, Labridae, Scaridae, Acanthuridae, Siganidae, Kyphosidae, Pomacentridae and Zanclidae), used as indicators in Coral Reef Monitoring for Management (Uychiaoco *et al*. 2001). Target fish families were also classified according to trophic groups: Piscivores, Planktivores, Invertebrate Feeders, Herbivores, Omnivores; and Coral Indicators for comparison and presented graphically. When applicable, species richness was expressed as mean number of species per 500m². Target fish densities were compared between years where raw data is available, using 1-ANOVA and Tukey's Test was used for post hoc. T-Test was used for sites having only 2 years of data. All data were tested for variance equality and normality using Minitab 14®. A log or square root transformation was made whenever appropriate. Classification of target fish densities followed that of Hilomen et al. (2000), where values were computed from a $1000m^2$ area. Thus, our values were extrapolated from the $500m^2$ sampling area to $1000m^2$ to be able to use the aforementioned fish density categories.

Hilomen et al. (2000) categories:

Fish Species Diversity (no. of species/1000m^2):				
Very Poor	Poor	Moderate	High	Very High
0 – 26	27 – 47	48 - 74	76 – 100	>100
Fish Density (no. of fish/1000m^2):				
Very Poor	Poor	Moderate	High	Very High
0 – 201	202 – 676	677 – 2,267	2,268 – 7,592	>7,592
Biomass (metric tons/km^2)				
Very Poor	Poor	Moderate	High	Very High
<5.0	5.1 – 20.0	20.1 – 35.0	35.1 – 75.0	>75

Fish biomass. Fish biomass was computed using the formula: $\mathbf{a} \cdot \mathbf{L}^{\mathbf{b}}$ (Fishbase 2004), using standardized length-weight constants (www.fishbase.org). Biomass of target fish species were computed on the species level and summed up per family, based on selected target fish/commercially important food fish: Epinephilinae (Serranidae), Lethrinidae, Lutjanudae, Acanthuridae, Caesionidae, Carangidae, Haemulidae, Nemipteridae, Mullidae, Scaridae, Siganidae, Labridae (larger species, i.e., *Cheorodon* spp., *Cheilinus* spp.), including a non-reef family, Scombridae. Fish biomass data did not meet the assumptions of variance equality, thus, comparisons between families within sites used the Kruskal-Wallis. For this report, biomass computations were based on species-specific lengths (n=3-5).

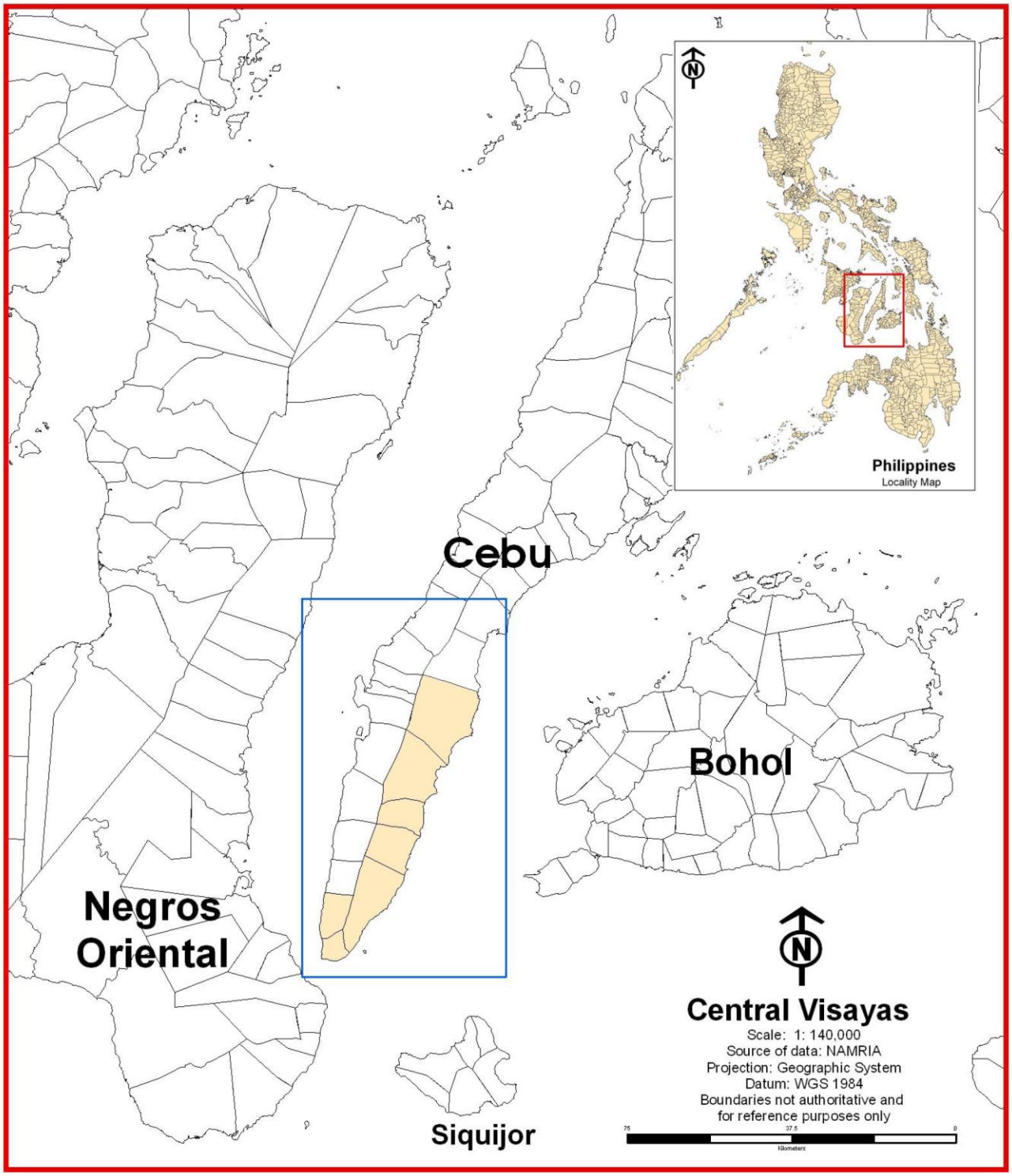


Figure 1.Southern Cebu Province (*Source:* NAMRIA and CCE Foundation, Inc.).

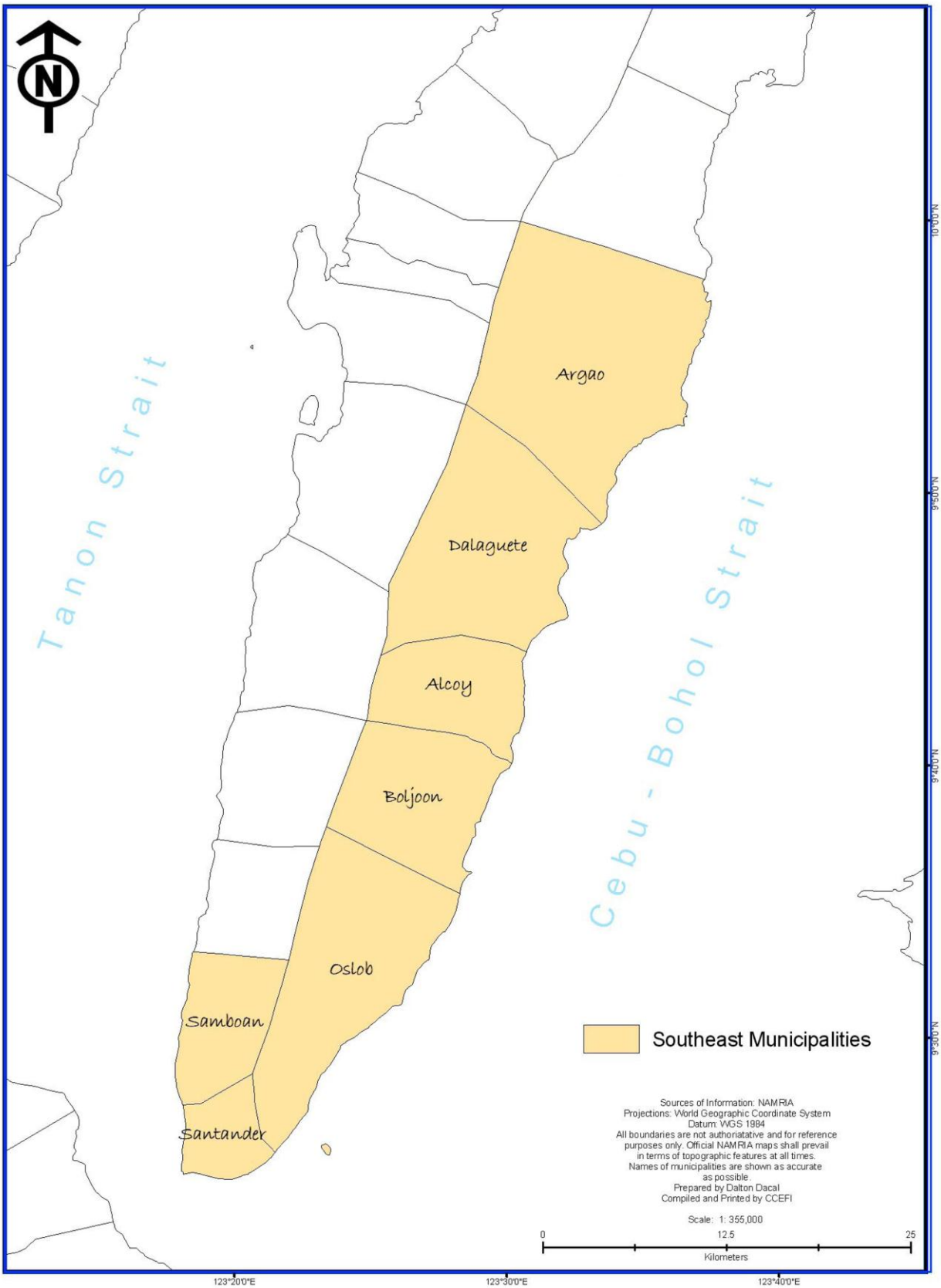


Figure 2. Southeastern Cebu Province Study Sites (*Source*: NAMRIA and CCE Foundation, Inc.).

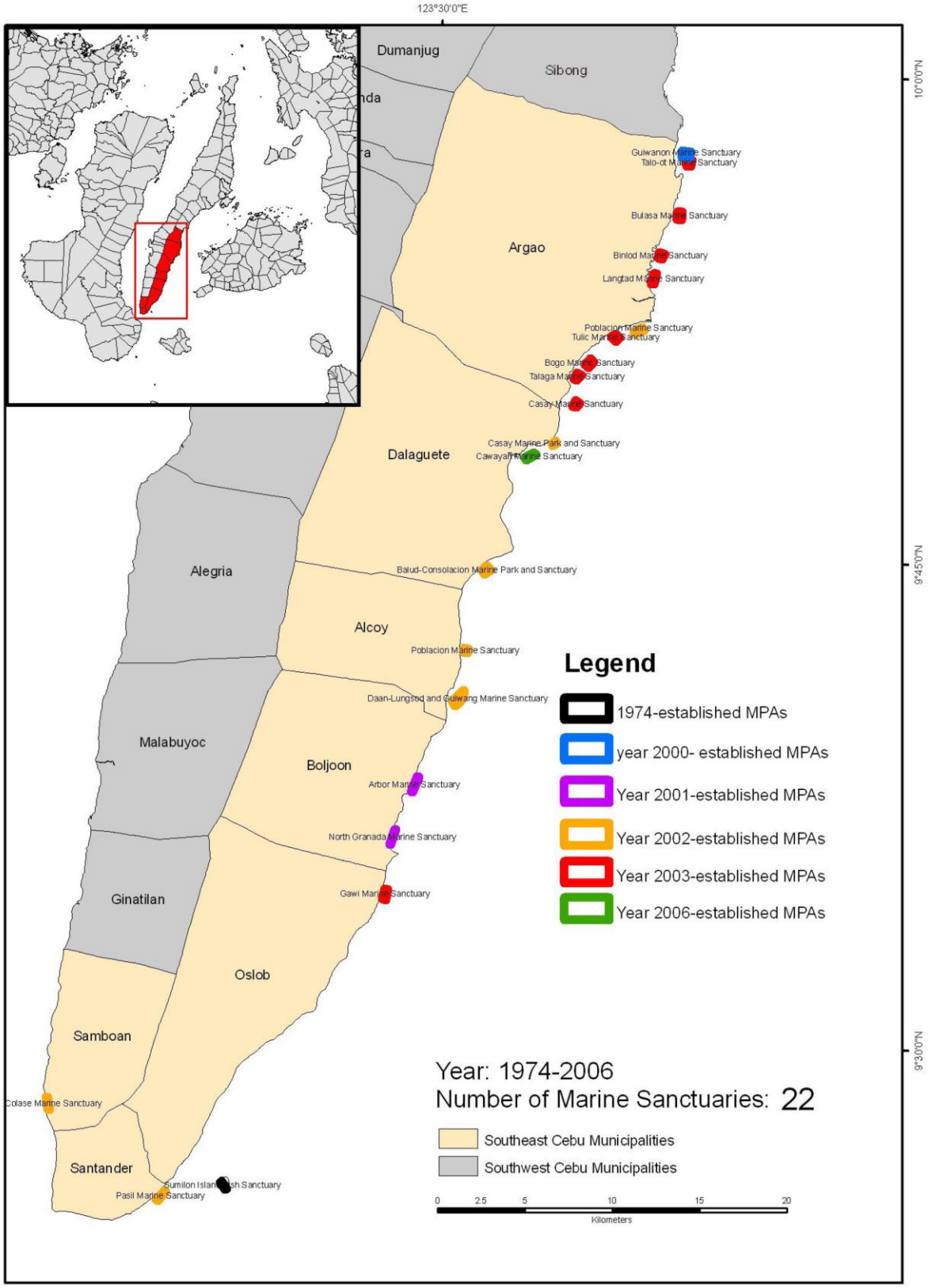


Figure 3. MPAs in Southeastern Cebu

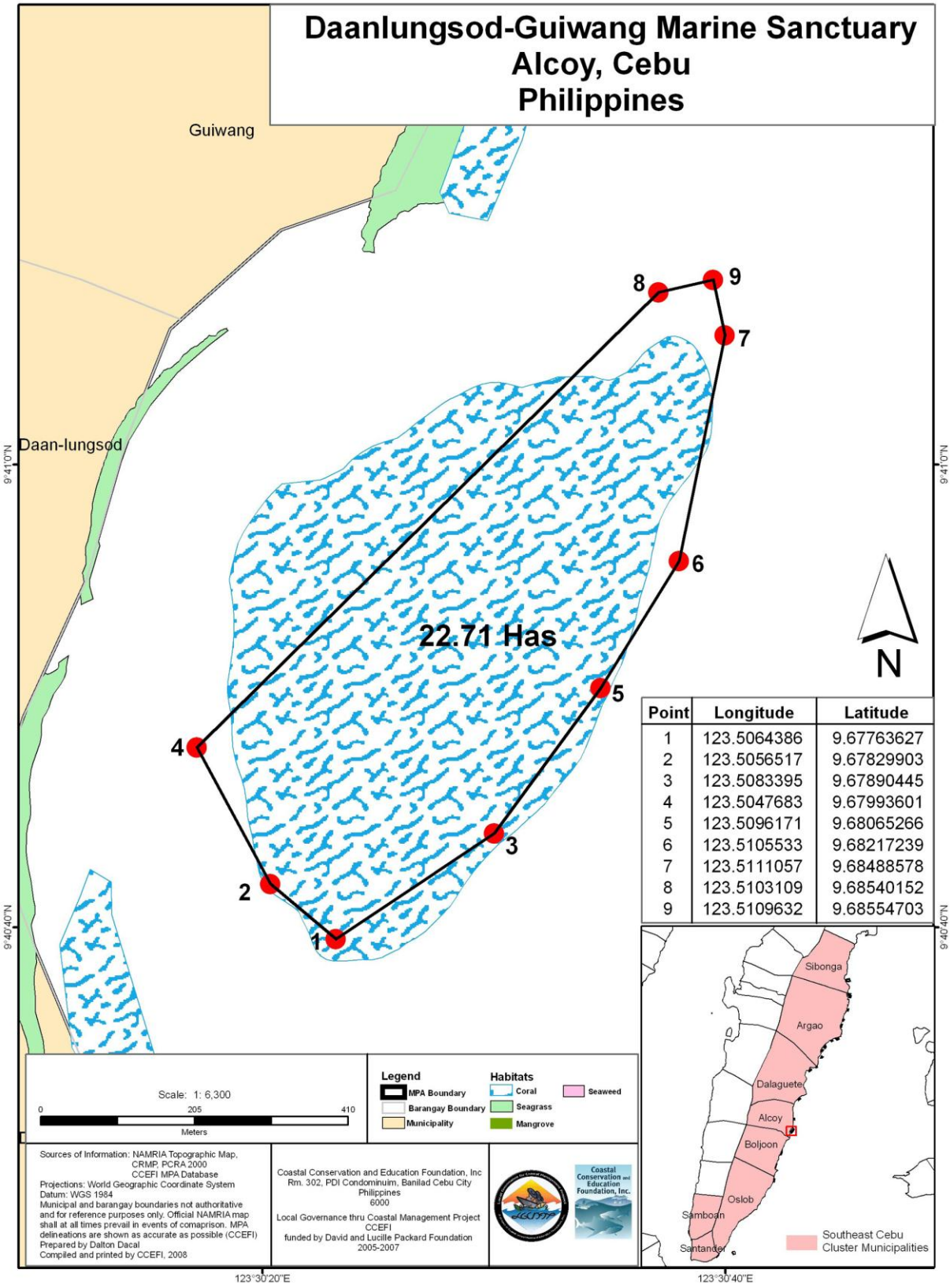


Figure 4. Daanlungsod-Guiwang Marine Sanctuary, Municipality of Alcoy, Cebu.

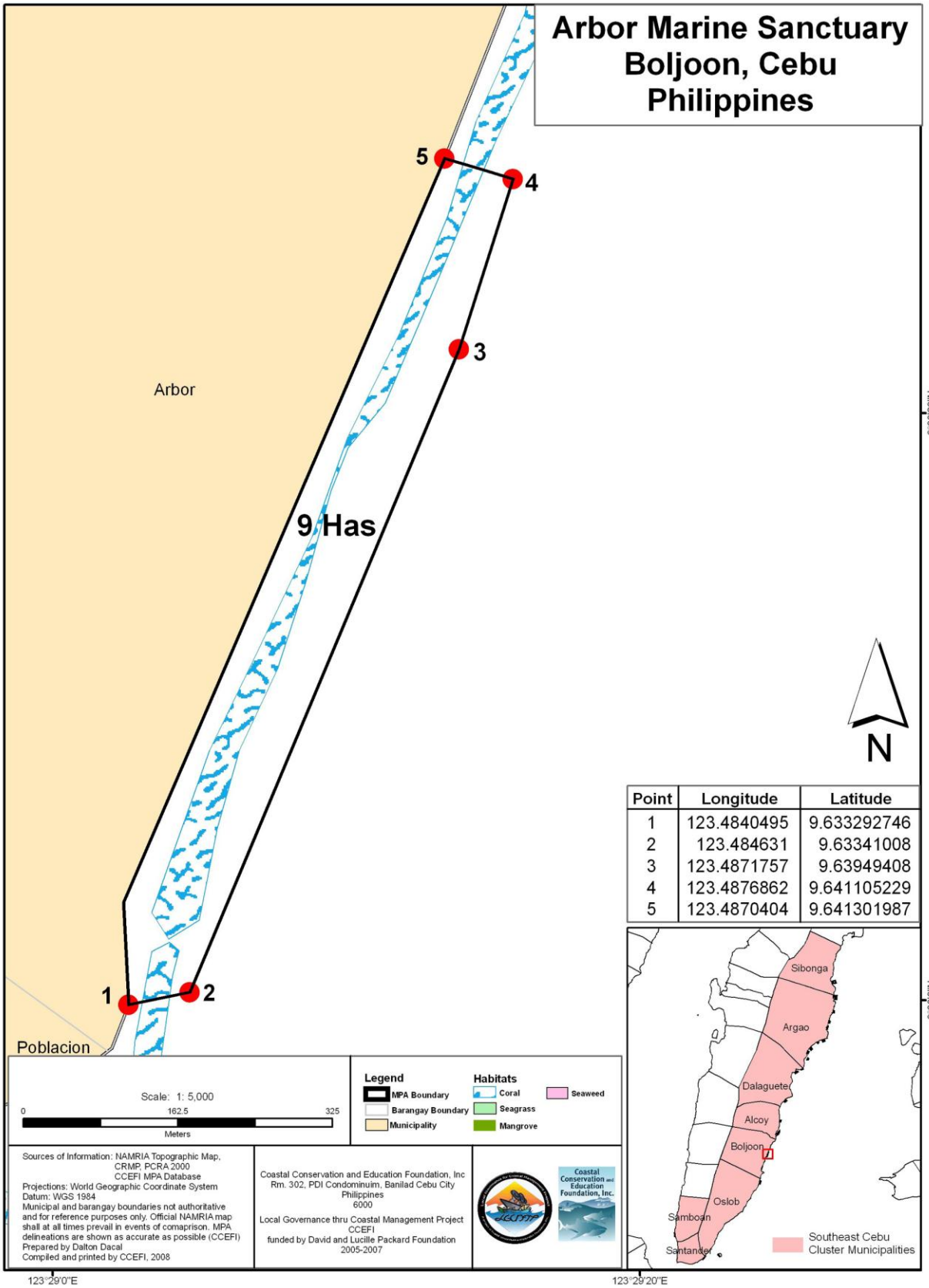


Figure 5. Arbor Marine Sanctuary, Municipality of Boljoon, Cebu.

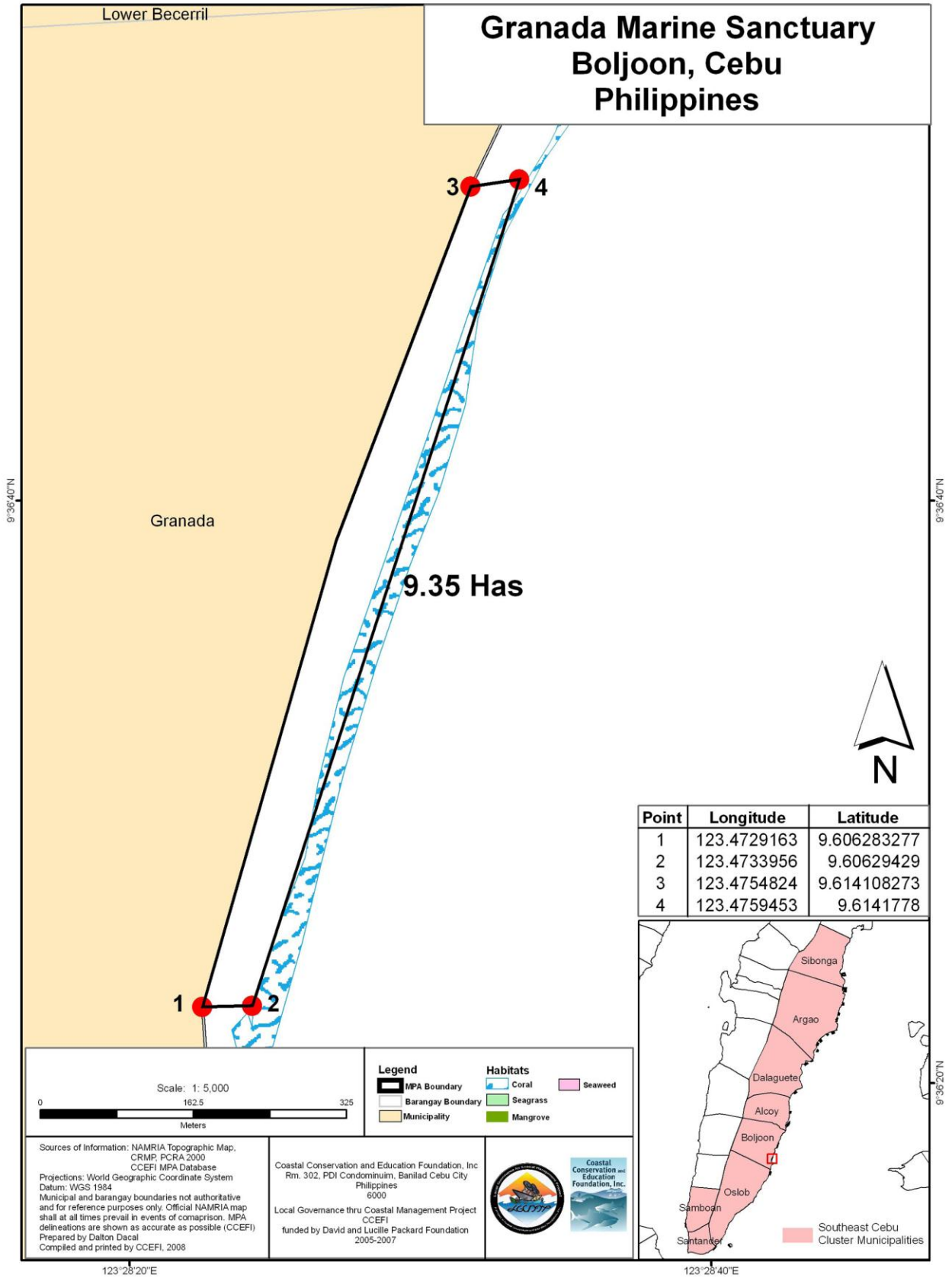


Figure 6. Granada Marine Sanctuary, Municipality of Boljoon, Cebu.

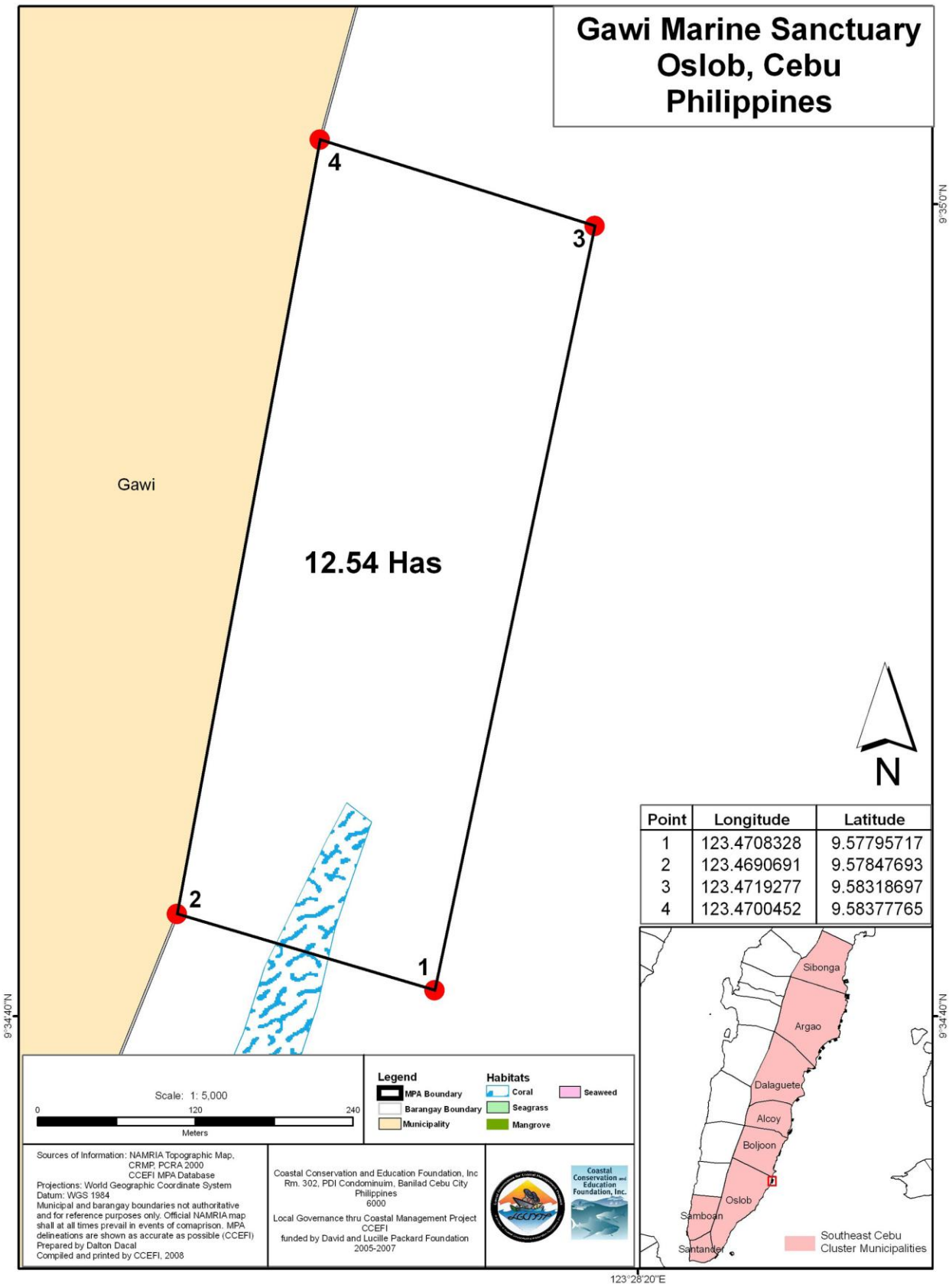


Figure 7. Gawi Marine Sanctuary, Municipality of Oslob, Cebu.

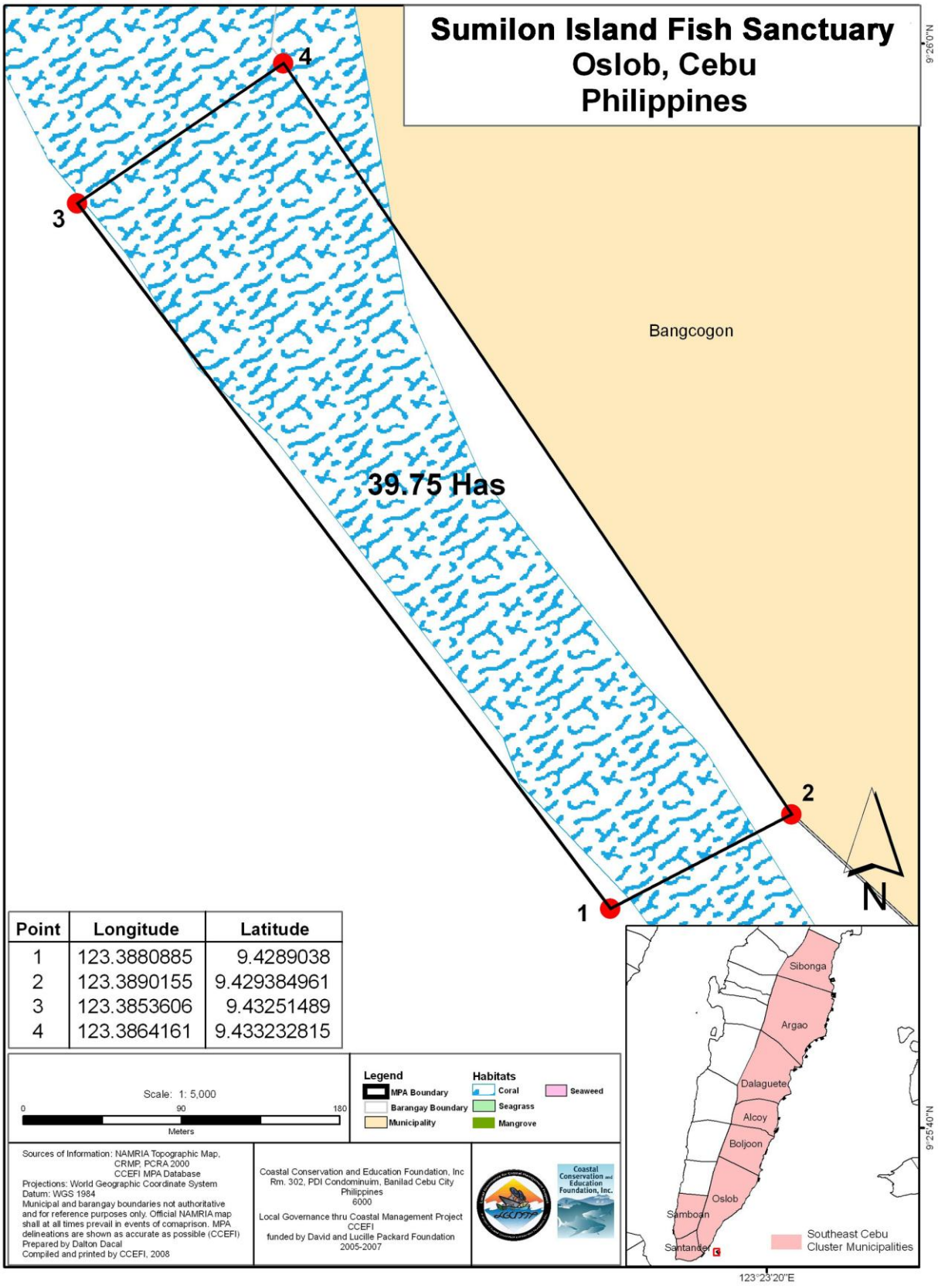


Figure 8. Sumilon Island Fish Sanctuary, Municipality of Oslob, Cebu.

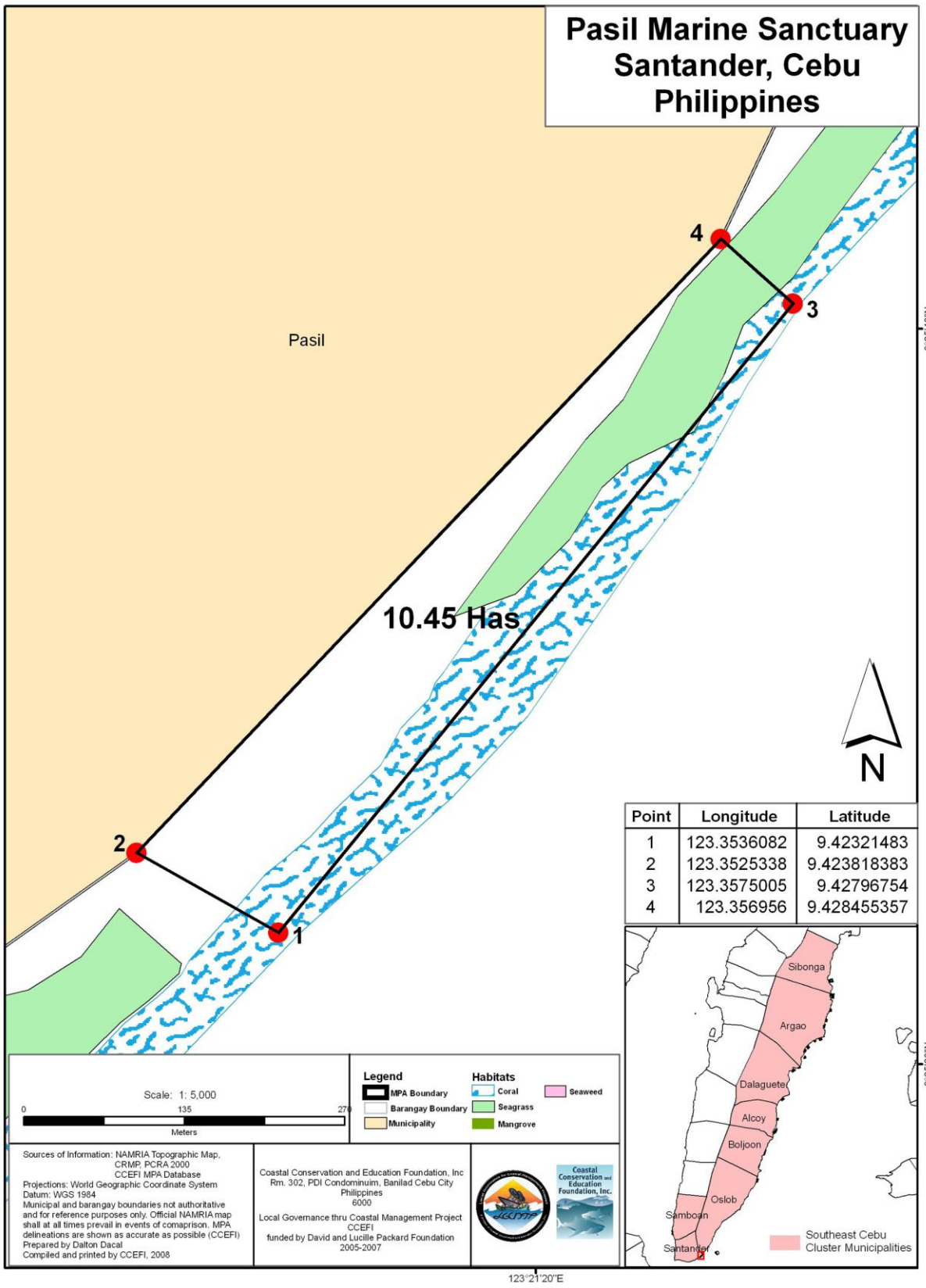


Figure 9. Pasil Marine Sanctuary, Municipality of Santander, Cebu.

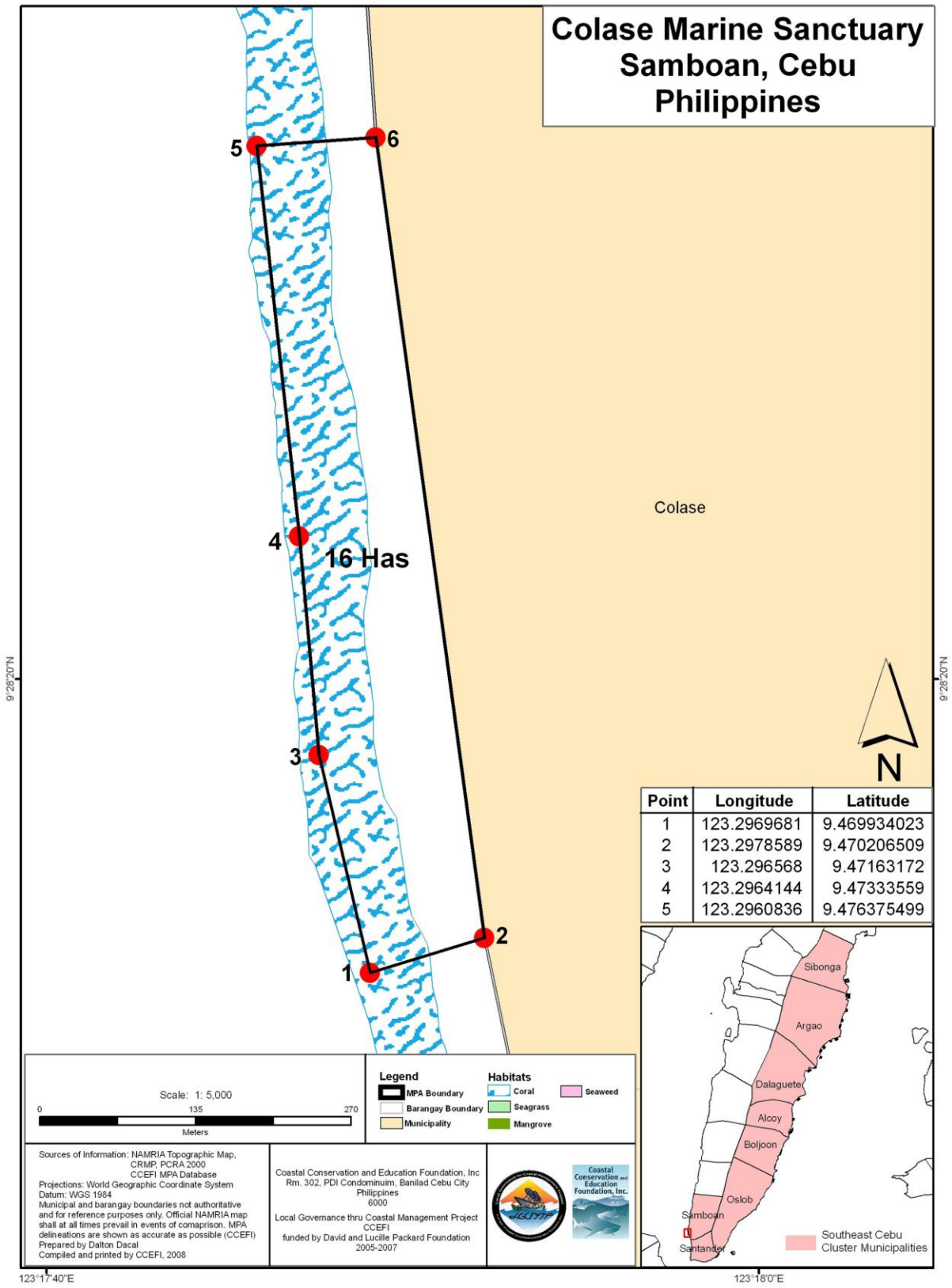


Figure 10. Colase Marine Sanctuary, Municipality of Samboan, Cebu.

RESULTS

Daanlungsod-Guiwang Marine Sanctuary, Alcoy, Cebu

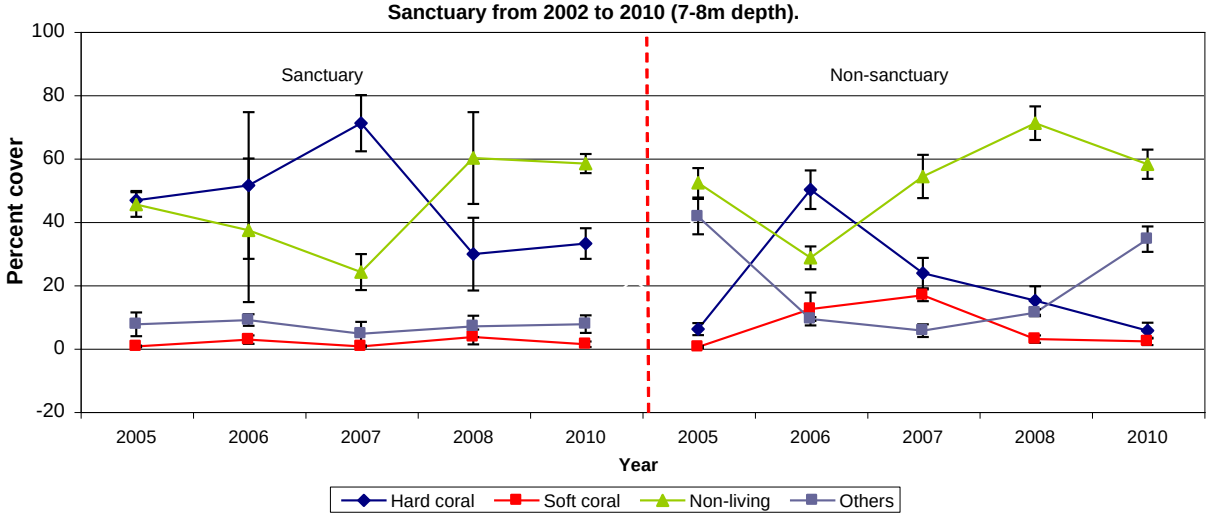
Site overview. The Daanlungsod-Guiwang Marine Sanctuary was established in 2002 and is one of the few small barrier reefs in the Philippines (Figure 3, 4). This 22.71 hectare MPA was legally established in 2002. The ordinances state the illegality to fish or gather all marine products within the perimeter of the fish sanctuary for the purposes of conserving and rehabilitating the marine habitat and to improve it as an income source for the fishing community.

This barrier coral reef includes several habitats like sandy and soft bottom, a seagrass bed and a reef wall in different locations of the sanctuary area. This MPA is managed by the Daanglungsod and Alcoy Fishermen's Association (DAFA), GUFOG, and the Alcoy Kingfishers Organization (AKO). The assisting groups in managing and monitoring the sanctuary are the Municipality of Alcoy, Cebu Province and CCE Foundation. This sanctuary was ranked as one of the top five best managed MPAs in the Philippines in the 2009 MPA Support Network and EcoGovernance Project of the DENR search for the best managed MPAs nationwide.

The site has large marker buoys, to mark the corners of the boundaries. To date the issues that have been observed concerning this sanctuary are illegal fishing, encroachment, sand extraction, construction of structures within the foreshore areas, and pollution due to upland run-off and dolomite mining. The MPA Management Rating that Daanlungsod-Guiwang Marine Sanctuary achieved is Level 4: MPA is sustained with 32 points. The priorities for improved management are: (1) the development of a sustainable financing mechanism; (2) need for more government support; and (3) strengthening law enforcement.

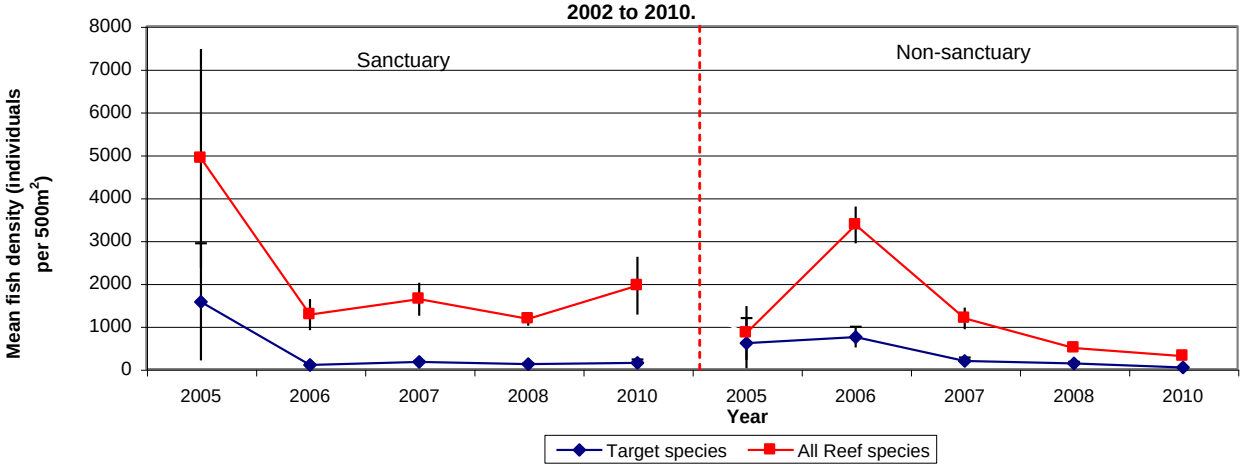
Substrate. Live hard coral (LHC) cover in the shallow (2-3m depth) and deep (6-8m depth) areas of Daanlungsod-Guiwang Marine Sanctuary are both in fair condition (Figure 11; Table 1). LHC cover was 27.5±4.5% in the shallow and 33.0±4.8% in the deeper area. The LHC in the deeper zone is higher compared to the previous survey wherein LHC in 2008 was at 29.7±23.0%. However, compared to data in 2005 (46.7±5.8%), LHC has decreased significantly. Outside the sanctuary, LHC was recorded at 5.52±2.5% in 2010 lower compared to LHC of 6.0±3.8% in 2005 and 15.0±9.0% in 2009. Analysis indicates a significant decrease (1-ANOVA: p=0.004, F=5.78, DF=4) in LHC from 2005 to 2010.

Figure 11. Changes in substrate composition (% mean ±SE) in Daanlungsod-Guiwang Marine Sanctuary from 2002 to 2010 (7-8m depth).



Fish density, species richness and biomass. Total reef fish density inside and outside the core zone appeared to decrease from 2005 (4920.3±2547.5 fish/500m^2 and 562.0±458.2 fish/500m^2 respectively) to 2010 (1947.3±674.40 fish/500m^2 and 303.7±674.40 fish/500m^2 respectively, Figure 12, Table 3). Similarly, target reef fish density on both areas also decreased from 2005 (inside:1569.3±1365.9 fish/500m^2**;** outside**:** 404.3±393.8 fish/500m^2) to 2010 (inside:144.2±82.36 fish/500m^2; outside:39.8±7.69 fish/500m^2) placing the areas in poor condition. However, the observed decrease in the core zone was not significant. On the other hand, target density outside decreased significantly (1-ANOVA: p=0.000,F=16.73, DF=3) after five years of survey.

Figure 12. Mean (±SE) fish density (density/500m^2) in Daanlungsod-Guiwang Marine Sanctuary from 2002 to 2010.



Mean target species richness inside Daanlungsod-Guiwang is low. All reef fish species was recorded at 45.3±2.33 spp/500m^2 wherein only 13.5±0.81 spp/500m^2 of these are considered target species. Outside, only 4.37 spp/500m^2 of the total 30.2±6.2 spp/500m^2 are recorded as target fish species. T-test analysis revealed no significant difference in species richness in both areas surveyed in 2010.

Target fish biomass inside was recorded at 9.5±3.8 kg/500m^2 which is very low. No significant difference in target biomass where observed between the core zone and the adjacent area (5.5±1.6 kg/500m^2) and reflect either the core zone being too small to be effective or fishing occurring almost equally inside and outside of the sanctuary area.

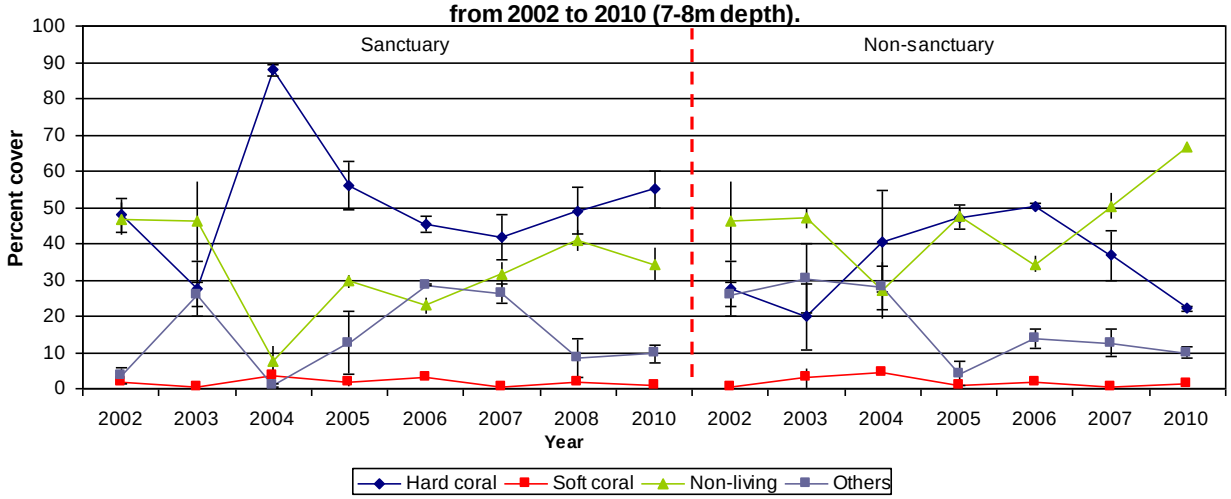
Arbor Marine Sanctuary, Boljoon, Cebu

Site overview. The Arbor Marine Sanctuary (Figure 3, 5) is 8.99 hectares and was established in 2001 through Municipal Ordinance 2001-04. It has marker buoys and is complete with a signboard and a guardhouse for patrolling. The site is a fringing coral reef characterized by rock and block and hard live coral. This MPA is managed by the MAMSA (Mga Kaugalingon na Mangiisda sa Arbor) and is assisted by the Municipality of Boljoon's Municipal Fisheries and Aquatic Resource Management Council (MFARMC); the barangay fish wardens, the municipality of Boljoon; the Bureau of Fisheries and Aquatic Resources (BFAR); Department of Education of the Philippines (DepEd) and the DENR. CCE Foundation also provides technical assistance in MPA management activities.

The MPA Management Rating for Arbor Marine Sanctuary is Level 3: MPA is enforced with 27 points. The priority concerns for improved management are: (1) increasing education and information campaigns to raise community awareness and support; and (2) need for management capacity and development; and (3) the need to overcome politically-motivated decision-making.

Substrate. LHC in Arbor Fish Sanctuary is in fair to good condition with 34.8±2.4% (shallow) and 55.0%±5.1% (deep, Figure 13, Table 4). LHC appeared to decrease from 2004 to 2008 wherein it was found to be significant (p=0.009,F=5.8,DF=4, Apistar et al, 2009). However, if we were to include the previous data from 2002 and 2003, LHC showed maintenance wherein no significant change were seen by 2010. Outside, LHC was 22.0±0.7% in 2010, a decrease from 2005.

Figure 13. Changes in substrate composition (% mean ±SE) in Arbor Marine Sanctuary from 2002 to 2010 (7-8m depth).

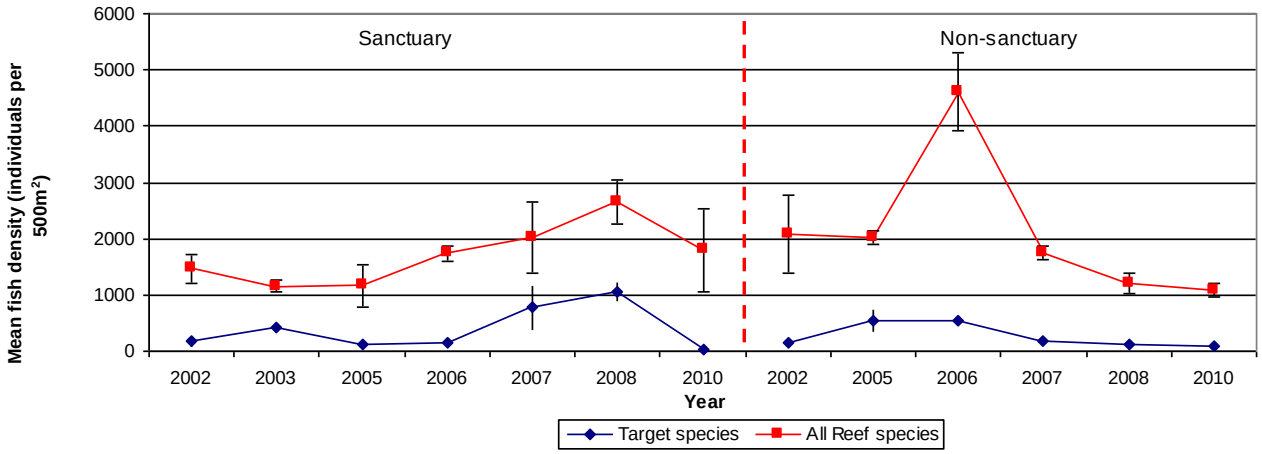


Fish density, species richness and biomass. Target fish density was very low in 2010 based on the index category of Hilomen et al (2000). Target fish density was 36.0±8.72 fish/500m^2 (Figure 14, Table 7, 8). Target fish density increased from 2002 (166.3±45.5 fish/500m^2) to 1061.2±179.6 fish/500m^2) in 2008. However, by 2010, it then decreased to 36.0±8.72 fish/500m^2. Nevertheless, going back to baseline data, target density increased significantly (p=0.004, F=5.82, DF=5) after 7 years. Outside the sanctuary target fish density decreased (p=0.007, F=6.02, DF=4) from 155.5±45.5 fish/500m^2 in 2002 to 99.5±42.7 fish/500m^2 in 2010.

Total species richness inside was 34.0±2.08 spp/500m^2 in 2010 (Table 8). Of the total fish species recorded, only 11.7±1.2 spp/500m^2 were target species. Outside, only 10.3±6.2 spp/500m^2 of the total reef species (27.3±8.9 spp/500m^2) were target species. No significant differences were seen between the target species richness inside and outside the sanctuary.

Target fish biomass in the core zone was very low at 13.4±6.6 kg/500m^2 (Figure 33). Outside, target biomass was at 17.2±11.8 kg/500m^2. No statistical comparison was made due to low replication of data outside the core zone (n<2). The low quantities of fish seen reflect the relatively small size of the sanctuary and that fishing pressure outside (and possibly inside) is high.

Figure 14. Mean (±SE) fish density (density/500m^2) in Arbor Marine Sanctuary from 2002 to 2010.



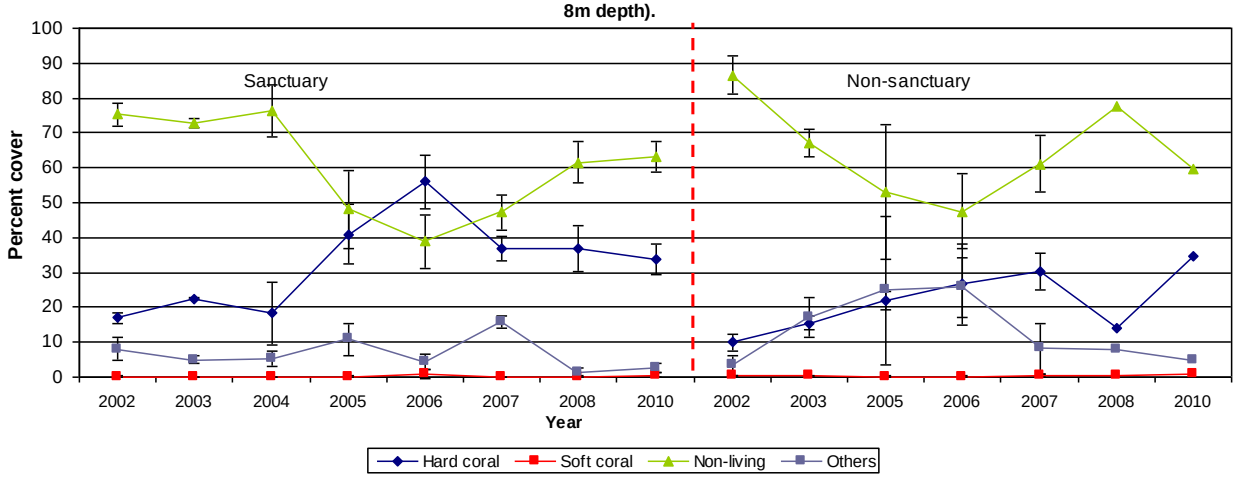
Granada Marine Sanctuary, Boljoon, Cebu

Site overview. The Granada Marine Sanctuary (Figure 3, 6) is 9.35 ha established in 2001 through Municipal Ordinance 2001-04. It has fringing coral reefs and seagrass beds and the boundaries are demarcated by marker buoys. This MPA is managed by the FARMING (Fisheries Aquatic Resource Management in North Granada) and the Municipality of Lazi. Assisting groups include barangay fish wardens, the municipality of Boljoon, BFAR, DA, DepEd and the DENR. The CCE Foundation provides technical assistance in MPA management activities.

The Granada Marine Sanctuary has 31 points in the Rating system (Level 3: MPA is enforced). Priorities for improved management include: (1) strengthening management capacity and development; (2) increasing community awareness and support through information and education campaigns; and (3) overcoming politically motivated decision-making and individuals.

Substrate. Granada marine sanctuary was in fair condition in 2010. LHC increased from 17.0±1.5% in 2002 to 33.75±4.2% in 2010 (Figure 15, Table 7). Similarly, 1-ANOVA analysis showed a significant increase (p=0.004, F=4.69, DF=6) in LHC after 6 years of protection. As for the adjacent area, a similar trend was also observed. LHC increased significantly (1-ANOVA: p=0.034, F=4.24, DF=4) from 21.8±2.6% in 2005 to 34.5±4.5% in 2010. LHC was highest in 2010 and may indicate that effective management is also being reflected both inside and outside the MPA area.

Figure 15. Changes in substrate composition (% mean ±SE) in North Granada Marine Sanctuary from 2002 to 2010 (7-8m depth).

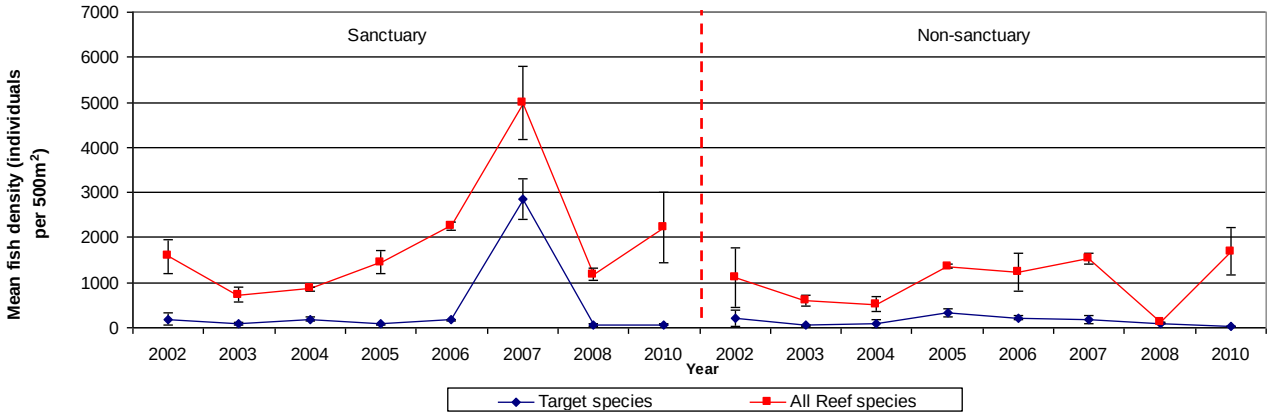


Fish density, species richness and biomass. Target fish density in Granada is very low. Target fish density is slightly lower in 2010 (36.0±42.7 fish/500m^2) compared to 2008 (38.7±19.2 fish/500m^2) and its baseline data in 2002 (190.3±137.4 fish/500m^2, Fig. 16, Table 9). A similar trend was seen outside where target fish density decreased from 215.0±186 fish/500m^2 in 2002 to 99.3±42.6 fish/500m^2 in 2010 although the observed decline was insignificant.

Mean target species richness was very low in 2010. Of the total species seen (31.6±5.75 spp/500m^2), only 10.4±1.60 were target species (Table 8). Moreover, all reef and target species outside was recorded at 43.5±2.50 spp/500m^2 and 2.12±1.50 spp/500m^2 respectively.

Mean target biomass was 19.3± kg/500m^2 in 2010 while outside; it was 3.3± kg/500m^2 (Fig. 33) While the biomass is very low in both areas, it is noteworthy that the biomass inside is significantly more.

Figure 16. Mean (±SE) fish density (density/500m^2) in North Granada Marine Sanctuary from 2002 to 2010.



Gawi Marine Sanctuary, Oslob, Cebu

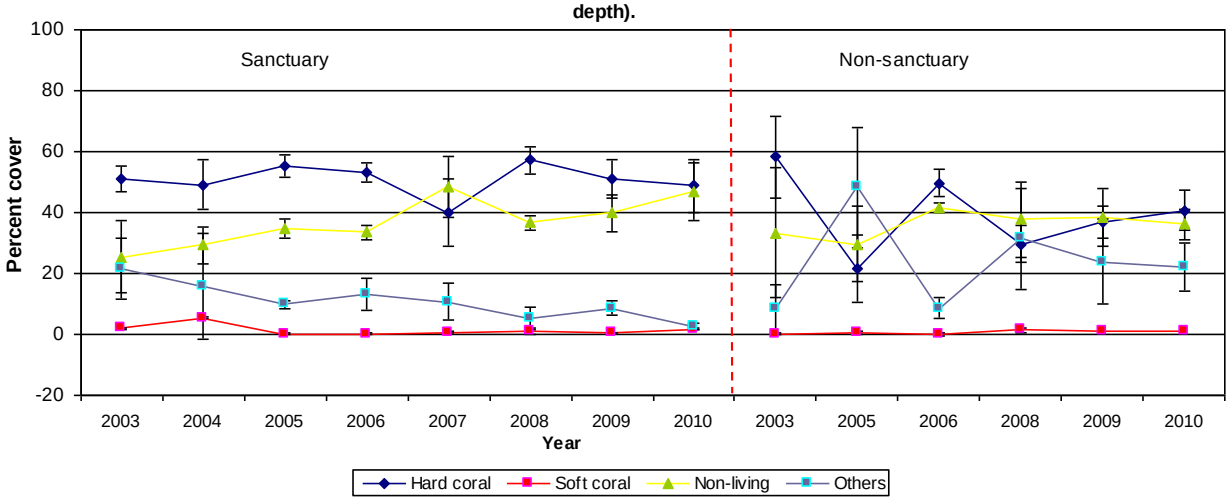
Site overview. The Gawi Marine Sanctuary (Fig 3, 7) is 13 ha and was established in 2003 through Municipal Ordinance 2003-19. This MPA has a fringing reef and a large algal and seagrass bed in a rocky intertidal reef flat that is followed by a crest dominated by growth forms of live hard corals. All

forms of fishing are not allowed at the core zone. In the buffer zone, however, hook and line fishing is allowed.

The MPA is managed by the Gawi barangay council and is assisted by the Municipality of Oslob and CCE Foundation in terms of reef monitoring and assessments. Based on the Management Rating, Gawi Marine Sanctuary is Level 4: MPA is sustained with 31 points. According to community surveys, priorities for improved management include: (1) developing a sustainable financing mechanism for MPA management; (2) developing community awareness and support; and (3) improving coastal law enforcement.

Substrate. LHC in the shallow and deep areas of Gawi marine sanctuary was fair in 2010 (32.1±3.4% and 48.8±8.6% respectively, Fig. 17, Table 10). LHC was slightly lower in 2010 compared to previous years (2009:50.9±12.8% and 2003:51.0±4.4%) but appear stable since there is no significant increase or decrease between years of LHC from 2005 to 2010. Furthermore, over all trends including years 2003 and 2004 (where no raw data is available) suggest a maintained trend in a span of six years. Outside, LHC decreased from 58.3±13.3% in 2002 to 40.6±6.5% in 2010 but is not a significant change.

Figure 17. Changes in substrate composition (% mean ±SE) in Gawi Marine Sanctuary from 2002 to 2010 (7-8m depth).

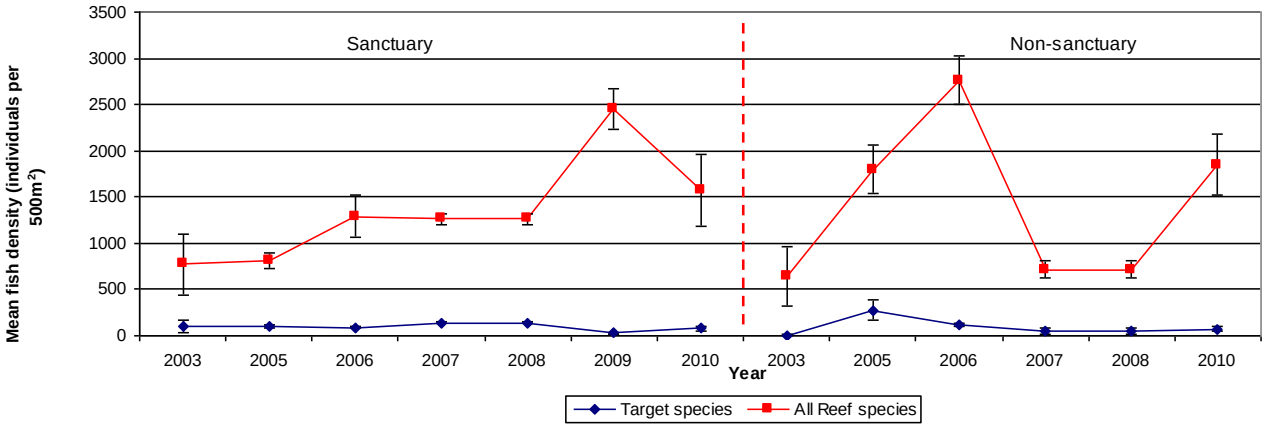


Fish density, species richness and biomass. Target fish density inside was found to be very low. Target density decreased from 796.8±337.2 fish/500m^2 in 2003 to 76.7±24.8 fish/500m^2 in 2010 (Fig. 18, Table 12). The same pattern was observed outside where target density went from 645.5±318.5 fish/500m^2 in 2003 and to 71.4±26.6 fish/500m^2 in 2010. Analysis however showed no significant change in target fish density from 2003 to 2010 due to few replicates. Outside target density decreased significantly (1-ANOVA: p=0.071, F=0.071, DF=3) from 2005 to 2010.

All reef species was recorded at 32.8±6.7 spp/500m^2 in 2010 with 10.8±2.18 spp/500m^2 being target fish species (Table 11) which based on Hilomen et al. (2000) is very low. As for the adjacent area, only 9.5±2.01 spp/500m^2 of the total reef fish species (31.8±4.9 spp/500m^2) were target fish species. No significant differences were seen on both areas surveyed in terms of target fish species.

Target fish biomass was 22.4±5.6 kg/500m^2 in 2010, significantly higher (T-test: p=0.017) than the adjacent area where it was only at 2.5± kg/500m^2 (Fig. 33) However, target fish biomass was considered very low based from the relative scale of Hilomen et al (2000) for the Philippines.

Figure 18. Mean (±SE) fish density (density/500m^2) in Gawi Marine Sanctuary from 2002 to 2010.



Sumilon Island Fish Sanctuary, Oslob, Cebu

Site overview. Sumilon Island (Fig. 3, 8) lies about 2 kilometers off the coast of Barangay Bangcogon, under the jurisdiction of Oslob Municipality. Sumilon Island Fish Sanctuary establishment was initiated by Silliman University Marine Laboratory in 1973 (Russ and Alcala 1999) and was the first municipal marine reserve in the Philippines. The Bureau of Fisheries and Aquatic Resources (BFAR) Fisheries Administrative Order (1980) declared Sumilon Reserve as a nationally protected fish sanctuary, covering an area of 39.75 ha.

Sumilon Island Fish Sanctuary generated 36 points (Level 4: MPA is sustained) on the MPA rating system. The priorities identified by the community for marine sanctuary management are: (1) developing a sustainable financing mechanism to cover sanctuary management costs; (2) training for supplemental and alternative livelihood; (3) improving management capacity of the managing group; and (4) Working effectively with the resort on the island to help enforce the MPA rules.

Substrate.
LHC in the shallow (40.2±2.42%, Fig. 20) and deep areas (44.6±3.7%) of Sumilon sanctuary is fair in 2010. LHC in the deep zone appeared to increase from 25.8±4.7% in 1981 to 2010 (Fig. 19, Table 16a). Statistical analysis were only possible from 1992, 1999 and 2002-2010 due to no raw or low replication of data (n<2) in other years. Results revealed a highly significant increase (p=0.000, F=5.93, DF=7) from 1992 to 2010. The increase in LHC cover may be partially attributed to the continued protection of the sanctuary in spite of various lapses in management during previous years. LHC outside the sanctuary was also fair (31.35±5.8%) in 2010. LHC cover appeared to fluctuate from 15.8±7.5% in 1981 to 53.2±11.1% and 31.4±5.8% in 2002 (Table 16b). Nevertheless, the observed changes in LHC cover remained insignificant.

Figure 19. Changes in substrate composition (% mean ±SE) in Sumilon Island Fish Sanctuary from 1981 to 2010 (7-8m depth).

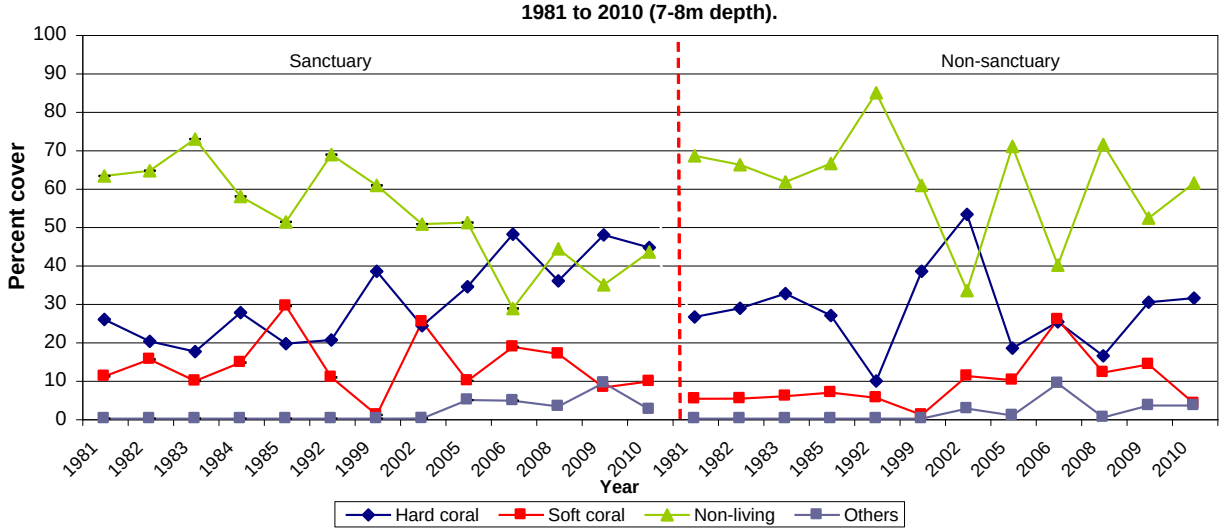
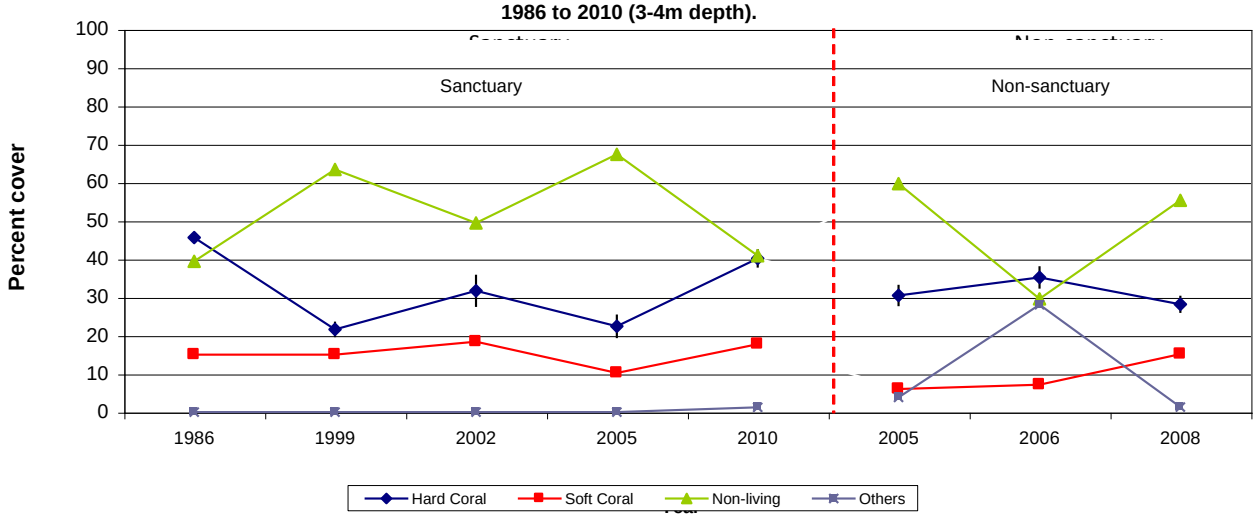


Figure 20. Changes in substrate composition (% mean ±SE) in Sumilon Island Fish Sanctuary from 1986 to 2010 (3-4m depth).



Fish density, species richness and biomass. Target fish density in Sumilon was low in 2010. Total target fish density was recorded at 135.0±37.3 fish/500m^2 somewhat higher compared to the 2009 survey (97.8±41.7 fish/500m^2, Fig. 22, Table 19). Statistical analysis was only possible from 1999 and 2002-2010 due to no raw or low replications of data in other years. Results revealed a significant decrease (p=0.007, F=4.01, DF=6) in target fish density from 1999 (515.5±268.7 fish/500m^2) to 2010. Target density was highest in 2005 (1623.0±540.43 fish/500m^2) and lowest in 2009. Conversely, target fish density outside also appeared to decrease from 153.3±35.6 fish/500m^2 in 2002 to 120.4±43.6 fish/500m^2 in 2010. A significant increase (p=0.000, F=9.0, DF=5) was seen from 2004 (49.3±27.0 fish/500m^2) to 2010 (were raw data were available).

Figure 21. Changes in mean (±SE) fish species richness (species/500m^2) in Sumilon Island Fish Sanctuary from 1992 to 2010.

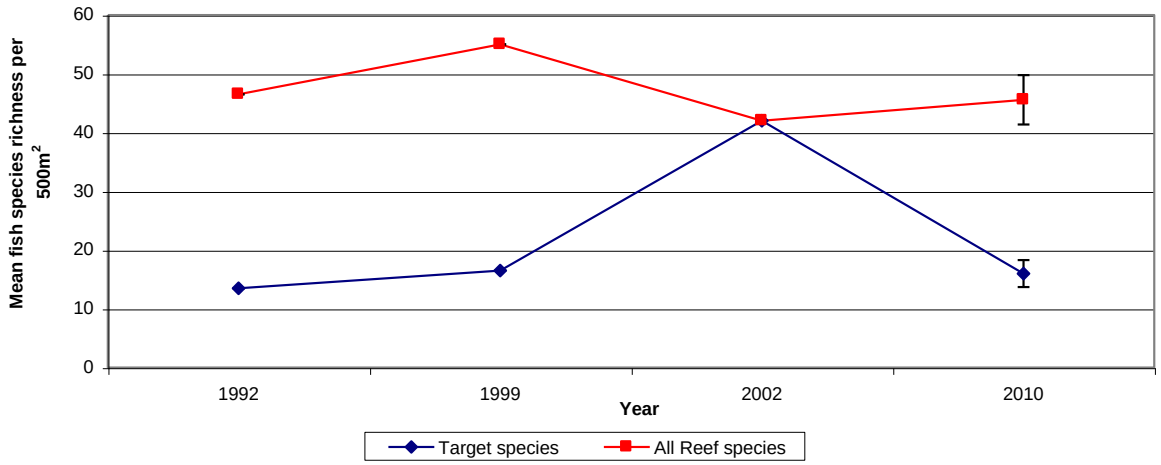
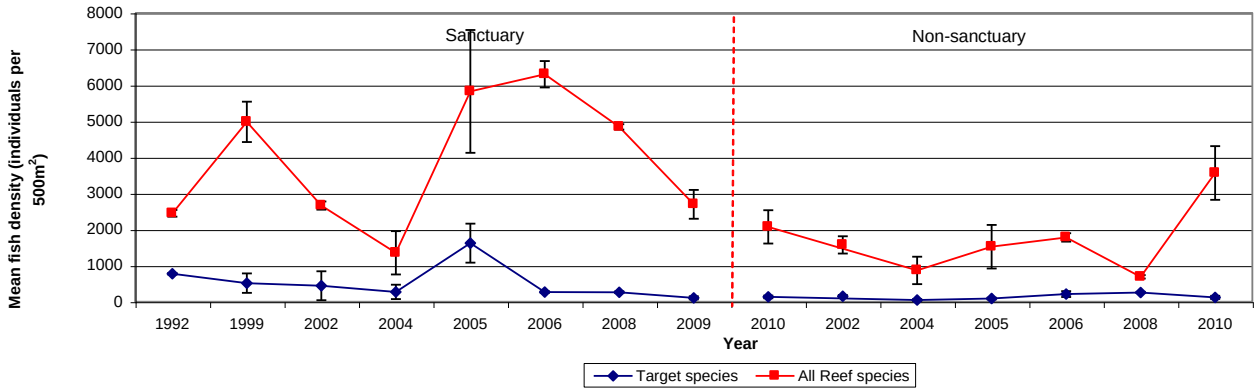


Figure 22. Mean (±SE) fish density (density/500m^2) in Sumilon Island Fish Sanctuary from 2002 to 2010.



Target fish species richness was recorded at 16.0±2.9 species/500m^2 in 2010, lower than 1999 (42.6±5.3 species/500m^2, Fig.21). T-tests revealed a significant decrease (p=0.000, T=7.98, DF=10) in target species richness from 1999 to 2010. Outside, target fish species was 9.9±5.6 species/500m^2 in 2010. Butterflyfish species observed was 18 compared to 22 in 1992 (Table 23).

Target biomass inside was 35.8±18.1 kg/500m^2 in 2010 which is low. Outside, mean target fish biomass was in 30.9±20.4 kg/500m^2 (Fig. 33). No significant differences were observed between sites. Sumilon Island reef has the capacity to maintain a high level of fish productivity while the low target fish biomass indicates that fishing pressure is high and possibly increasing in recent years.

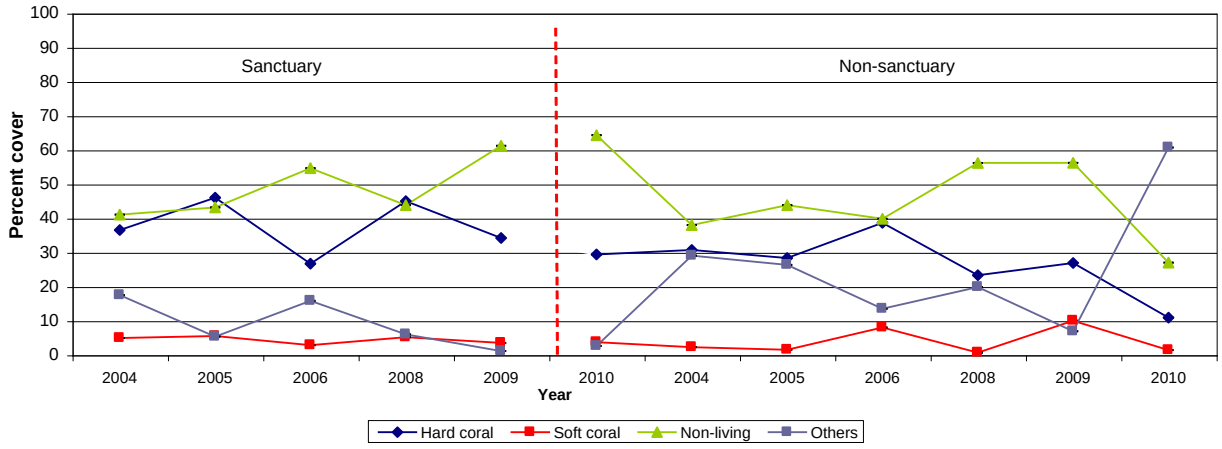
Pasil Marine Sanctuary, Santander, Cebu

Site overview. Pasil Marine Sanctuary (Figure 3, 9) contains a narrow fringing reef characterized by a shallow reef flat that gradually slopes down to the reef crest. The reef flat is largely comprised of sand flats, algae and seagrass beds. The reef slope is dominated by massive coral colonies and in the deeper part, branching and foliose forms of hard corals dominate. The reef fish community is dominated numerically by damselfishes, fusiliers, and surgeonfish species. Invertebrates such sea urchins (e.g. *Diadema* spp.), sea stars, sea cucumbers, and giant clams are present.

The Pasil Marine Sanctuary, established in 2002, is rated level 4 (sustained) with 36 points using the MPA rating system. This means the CRM activities have been retained, CRM plans implemented and budget increased, continued enforcement of regulations, active participation of the management body, marker and mooring buoys maintained and sustainable financial mechanism for CRM initiatives operating..

Substrate. Pasil sanctuary has good LHC in the shallow area (50.0±4.5%) and fair LHC in the deep areas (Fig. 23, Table 13). LHC in the deep zone decreased slightly from 35.6±6.5% in 2004 to 29.4±7.2% in 2010 which is not significant. LHC was highest in 2005 (46.0±16.2%) and lowest in 2006 (26.7±27.9%). Outside, the same decreasing trend was also seen going from 30.7±9.5% in 2004 to 10.9±5.1% in 2010. Statistical test from 2005-2010 only due to low replication of raw data in 2004 (n>2) revealed a significant decrease (1-ANOVA p=0.005, F=6.39, DF=4) in LHC after five years of survey. The decrease in LHC cover outside the sanctuary may have been due to the disturbance in the area wherein a docking port for cargo vessels from Negros is situated near the boundary of the sanctuary.

Figure 23. Changes in substrate composition (% mean ±SE) in Pasil Marine Sanctuary from 2002 to 2010 (7-8m depth).

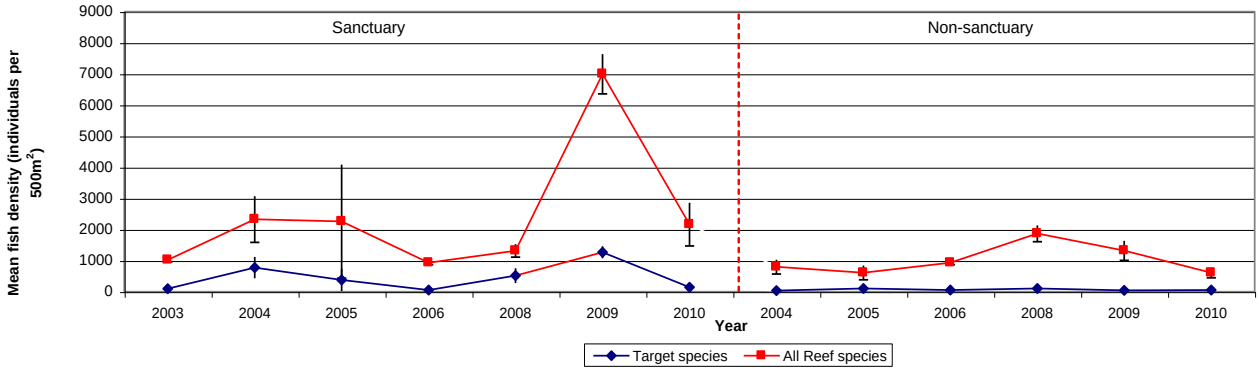


Fish density, species richness and biomass. Similar with other sites, target fish density in Pasil was also low (Hilomen et al. 2000). Target fish density recorded at 143.6±28.8 fish/500m^2 in 2010, lower compared to the previous year (2009:1006.0±129.8 fish/500m^2, Fig. 24, Table 15). 1-ANOVA analysis however revealed a significant increase (p=0.004, F=4.75, DF=6) in target fish density from 2003 to 2010. Outside, target fish density appeared to increase from 35.7±3.7 fish/500m^2 in 2004 to 52.2±19.4 fish/500m^2 in 2010.

Target fish species richness in Pasil is low. Of the total species recorded (46.2±7.2 spp/500m^2), only 18.2±2.9 spp/500m^2 are target fish species (Table 15). Outside, only 6.7±3.4 spp/500m^2 of the total reef fish species (21.7±7.4 spp/500m^2) are target fish species. Analysis indicates that the number of target species inside is significantly higher (T-test: p=0.51) compared to the adjacent area.

Target biomass inside (178.2±62.9 kg/500m^2) was found to be significantly higher (T-test: p=0.66) than the adjacent area with target biomass of only 5.4±2.0 kg/500m^2 (Fig. 33). Pasil is a good example of excellent sanctuary protection in relation to adjacent fished areas. The biomass inside the sanctuary is higher than other sites surveyed in 2010.

Figure 24. Mean (±SE) fish density (density/500m^2) in Pasil Marine Sanctuary from 2002 to 2010.



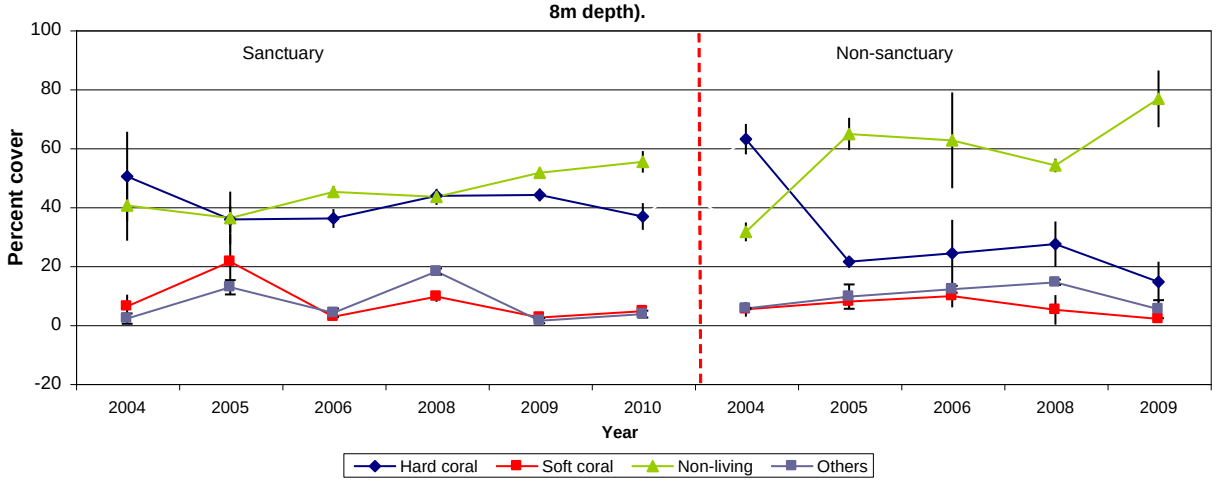
Colase Marine Sanctuary, Samboan, Cebu

Site overview. Colase Marine Sanctuary (Fig. 3, 10) is characterized by a shallow reef flat that gradually slopes down to the reef crest. The reef flat is largely comprised of sandy areas, algae and seagrass beds, and a well developed narrow coral reef crest. The reef slope, situated in the western part of the sanctuary is dominated by branching forms of hard corals along with massive and foliose life forms. The reef fish community is mainly composed of damselfishes, fusiliers, and surgeonfish. Invertebrates include sea urchins, sea stars, sea cucumbers, and giant clams.

The 15.88 ha MPA was established in 2002 through Municipal Ordinance 2001-03 and is now jointly managed by the Baryohanong Nagpakbana sa Colase (BANAC), the LGU, MFARMC, PNP and barangay council of Colase. It is also a component in the Tanon Strait Protected Seascape which is founded on Municipal ordinance 2002-119. The Colase Marine Sanctuary is rated level 3 (enforced) with 29 points using the MPA rating system. Priority areas for improvement in management include: (1) training for supplemental and alternative livelihood; (2) training for management capacity development; and (3) and overcoming politically-motivated decision-making.

Substrate. Similar to other sites, LHC in the shallow and deep zones of Colase marine sanctuary were fair (45.7±4.9% and 36.7±4.5% shallow) in 2010 (Fig. 25, Table 20). LHC in the deep zone is slightly lower than the baseline year of 2004 with 51.14±32.2 LHC. However, the observed decrease is insignificant. Outside, the same trend was also observed. LHC decreased dramatically from 63.9±18.8% in 2004 to 14.4±13.7% in 2009. 1-ANOVA revealed a significant decrease (p=0.003, F=5.81, DF=5) in LHC. The observed decrease in LHC cover outside may have been due to the expansion of the sanctuary to its southern boundary. The sampling area for the outside in the previous years is now a part of the core zone of the sanctuary and that the sampling area in 2010 is now moved further south.

Figure 25. Changes in substrate composition (% mean ±SE) in Colase Marine Sanctuary from 2002 to 2010 (7-8m depth).



Fish density, species richness and biomass. Target fish density in Colase in 2010 was also low by broader standards. Target density decreased from 66.3±21.1 fish/500m^2 in 2004 to 44.4±15.3 fish/500m^2 in 2010 (Fig. 26, Table 22) which is a marginally significant decrease (p=0.061, F=3.21, DF=4) in target density. Outside, target density decreased dramatically from 234.7±21.1 fish/500m^2 in 2004 to 44.4±8.7 fish/500m^2 in 2010, a significant decrease (p=0.035, F=3.18, DF=5).

Target species richness in Colase was very low in 2010. All fish species were 28.8±8.1 spp/500m^2 wherein only 9.0±2.4 spp/500m^2 were target fish species (Table 21). The family Pomacentrids (damselfishes) is the most dominant species (8.6±3.1 spp/500m^2) followed by Chaetodontids (3.8±1.1 spp/500m^2).

Target fish biomass in Colase was recorded at 17.2±6.8 kg/500m^2 in 2010 (Fig. 33).

Figure 26. Mean (±SE) fish density (density/500m^2) in Colase Marine Sanctuary from 2002 to 2010.

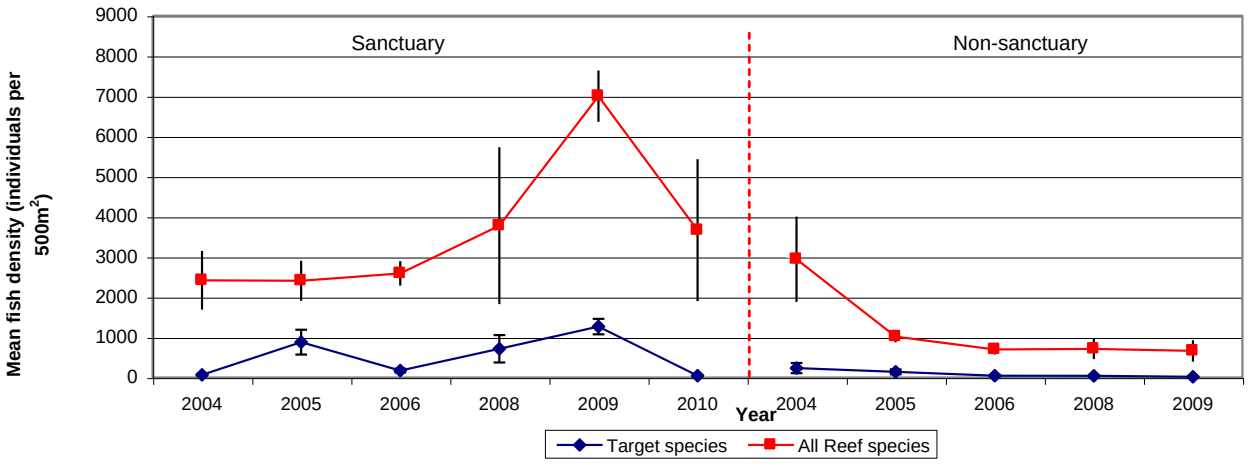


Table 1. Changes in substrate composition (% mean) in Daanlungsod-Guiwang Marine Sanctuary from 2005 to 2010.

	SANCTUARY							NON-SANCTUARY					
	SCUBA SURVEYS						SNORKEL SURVEY	SCUBA SURVEYS					
	2005	2006	2007	2008	2010	% Change 2002-2009	2010	2005	2006	2007	2008	2010	% Change 2002-2009
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	11.7	19.7	2.3	5.0	3.4	-32.0	35.5	28.5	3.2	20.7	33.3	39.4	18.2
Coral Rubble (R)	14.2	3.8	9.2	26.3	25.9	-1.8	4.0	12.2	15.8	16.3	11.8	7.1	-40.1
Rock and Block (RK)	5.0	5.3	2.0	2.0	6.7	232.5	23.0	2.5	1.5	14.7	12.0	6.2	-48.2
White Dead Standing Coral (DC)	6.2	8.3	1.2	1.7	1.5	-13.0	1.8	0.2	0.0	0.2	0.3	0.0	-100.0
Dead Coral with Algae (DCA)	8.3	0.0	9.3	25.0	20.9	-16.4	2.9	8.8	8.0	2.3	13.5	5.3	-60.7
Subtotal Non-living Substrate	***45.3***	***37.2***	***24.0***	***60.0***	***58.3***	-2.9	***67.3***	***52.2***	***28.5***	***54.2***	***71.0***	***58.0***	-18.3
Branching (CB)	38.7	43.3	57.0	15.7	25.6	63.4	15.2	2.3	13.0	17.0	8.3	2.1	-74.8
Massive (CM)	5.0	0.3	4.2	7.7	3.0	-60.9	9.3	3.2	10.0	1.2	3.2	1.7	-46.0
Flat/Encrusting (CFD)	1.8	3.8	0.8	4.0	2.3	-42.5	1.1	0.2	22.3	4.3	2.5	1.6	-37.6
Foliose Cup (CFO)	1.2	3.8	9.0	2.3	2.1	-10.0	1.8	0.3	4.7	1.2	1.0	0.2	-85.0
Total Hard Coral	**46.7**	**51.3**	**71.0**	**29.7**	**33.0**	11.2	**27.5**	**6.0**	**50.0**	**23.7**	**15.0**	**5.5**	-63.2
Total Soft Coral	0.5	2.7	0.5	3.5	1.2	-65.7	1.0	0.3	12.3	16.7	2.8	2.1	-25.9
Subtotal Coral	***47.2***	***54.0***	***71.5***	***33.2***	***34.2***	3.1	***28.5***	***6.3***	***62.3***	***40.3***	***17.8***	***7.6***	-57.3
Sponges	0.2	0.8	0.8	0.8	0.9	8.0	0.4	5.3	3.3	1.8	2.7	2.6	-1.0
Other animals	1.8	0	0.5	0.2	0.1	-70.0	0.0	1	1.7	1.5	0.5	0.1	-80.0
Algae	5.5	4.0	3.2	5.5	4.0	-27.3	2.6	21.5	4.2	1.8	4.2	10.7	
Turf algae	~	~	~	~	2.4	N/A	0.8	~	~	~	~	3.4	N/A
Fleshy algae	~	~	~	~	0.4	N/A	1.6	~	~	~	~	6.8	N/A
Coralline algae	~	~	~	~	1.3	N/A	0.1	~	~	~	~	0.5	N/A
Seagrass	0.0	4.0	0.0	0.3	2.6	680.0	1.3	13.7	0.0	0.3	3.8	21.0	446.8
Subtotal Others	***7.5***	***8.8***	***4.5***	***6.8***	***7.6***	10.5	**4.3**	***41.5***	***9.2***	***5.5***	***11.2***	***34.4***	207.7
TOTAL	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters													
Mean Slope (degrees)	~	~	~	~	26.7		4.1	~	~	~	~	22.0	
Mean Topography (m) *	~	~	~	~	1.6		0.7	~	~	~	~	11.8	
Mean Depth/Range (m)	7-10	7-10	7-10	7-10	7.0		3.5	7-10	7-10	7-10	7-10	8.4	
Horizontal Visibility (m)	~	~	~	~	18.3		14.4	~	~	~	~	12.9	
No. of 50 m Transects	3	3	3	3	10		14	3	3	3	3	10	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 2. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Daanlungsod-Guiwang Marine Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	4.3	4.7	7.3	0.3	0.0	12.3
Rabbitfish (Siganids)*	1.3	0.0	3.8	0.8	0.0	4.7
Groupers (Serranids)*	0.7	0.3	0.3	0.0	0.0	0.7
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.2	0.2	0.2	0.2	0.0	0.5
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	1.0	0.0	102.3	8.5	0.0	110.8
Spinecheeks (Nemipterids)*	0.8	0.3	1.0	0.0	0.0	1.3
Goatfish (Mullids)*	0.8	0.0	3.0	0.3	0.0	3.3
Parrotfish (Scarids)*	4.3	1.2	6.3	7.5	0.2	15.2
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.8	0.0	2.5	0.2	0.0	2.7
Butterflyfish (Chaetodonids)	3.2	3.2	3.0	0.0	0.0	6.2
Angelfish (Pomacanthids)	2.0	0.0	3.8	0.0	0.0	3.8
Wrasses (Labrids)	9.2	16.8	12.0	4.3	0.0	33.2
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	15.0	1577.7	86.2	0.0	0.0	1663.8
Fairy Basslets (Anthids)	0.8	86.8	0.0	0.0	0.0	86.8
Moorish Idols (*Zanclus cornutus*)	0.8	0.0	2.0	0.0	0.0	2.0
Total (target reef spp.):	**11.8**	**2.0**	**124.3**	**17.7**	**0.2**	**144.2**
Total (all reef spp.):	**39.2**	**1691.2**	**233.8**	**22.2**	**0.2**	**1947.3**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 3. Mean (±SE) fish density (density/500m^2) in Daanlungsod-Guiwang Marine Sanctuary from 2005 to 2010.

Family	SANCTUARY					% Change 2008-2010	NON-SANCTUARY					% Change 2008-2010
	2005	2006	2007	2008	2010		2005	2006	2007	2008	2010	
	Mean	Mean	Mean	Mean	Mean		Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	23.3	3.0	4.7	24.7	12.3	-50.0	0.0	54.3	12.3	1.3	2.2	62.5
Rabbitfish (Siganids)*	7.7	0.3	1.0	12.0	4.7	-61.1	0.0	1.3	0.7	0.0	3.3	+
Groupers (Serranids)*	4.0	1.3	1.3	3.0	0.7	-77.8	1.0	16.7	2.0	0.0	0.7	+
Barramundi cod	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	16.3	0.0	1.3	0.0	0.5	+	0.0	2.7	1.3	5.0	0.3	-93.3
Sweetlips (Haemulids)*	0.0	0.0	0.0	1.3	0.0	-100.0	0.0	0.0	0.0	0.7	0.0	-100.0
Emperors (Lethrinids)*	6.7	0.0	0.0	2.7	0.0	-100.0	2.5	6.7	0.0	0.3	0.3	0.0
Jacks (Carangids)*	0.7	0.3	1.3	0.0	0.0	N/A	1.0	16.7	13.7	0.0	0.0	N/A
Fusiliers (Caesionids)*	1473.3	36.7	65.0	0.0	110.8	+	575.0	623.3	135.3	100.0	18.0	-82.0
Spinecheeks (Nemipterids)*	0.0	2.0	5.3	5.0	1.3	-73.3	0.0	11.0	3.3	5.0	4.5	-10.0
Goatfish (Mullids)*	6.3	5.0	3.3	6.7	3.3	-50.0	1.5	12.7	3.3	4.7	6.2	32.1
Parrotfish (Scarids)*	32.0	48.3	85.0	85.0	15.2	-82.2	25.5	36.3	20.7	15.7	5.3	-66.0
Bumphead parrotfish	3.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	2.0	0.7	1.0	9.7	2.7	-72.4	0.0	10.7	1.3	0.0	0.2	+
Butterflyfish (Chaetodonids)	13.3	1.7	6.0	14.7	6.2	-58.0	1.5	30.7	7.0	8.0	1.7	-79.2
Angelfish (Pomacanthids)	6.0	1.3	2.3	13.3	3.8	-71.3	0.0	12.3	4.3	7.7	0.8	-89.1
Wrasses (Labrids)	25.3	86.0	103.3	44.3	33.2	-25.2	57.5	182.7	63.7	110.0	22.0	-80.0
Humphead wrasse	2.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	3283.3	1033.0	1200.0	950.0	1663.8	75.1	177.5	1171.3	583.3	150.0	229.5	53.0
Fairy Basslets (Anthids)	15.0	52.3	150.0	0.0	86.8	+	0.0	1173.3	330.0	83.3	8.0	-90.4
Moorish Idols (*Zanclus cornutus*)	0.0	0.3	0.0	0.0	2.0	+	0.0	0.0	1.0	1.0	0.7	-33.3
Total (target reef spp.):	**1569.3**	**97.0**	**168.3**	**115.7**	**144.2**	24.6	**606.5**	**747.3**	**191.3**	**132.7**	**39.8**	-70.0
Total (all reef spp.):	**4920.3**	**1272.3**	**1631.0**	**1172.3**	**1947.3**	66.1	**843.0**	**3362.7**	**1183.3**	**492.7**	**303.7**	-38.4

* Target species/families

Table 4. Changes in substrate composition (% mean) in Arbor Marine Sanctuary from 2005 to 2010.

	SANCTUARY							NON-SANCTUARY				
	SCUBA SURVEYS						SNORKEL SURVEY	SCUBA SURVEYS				
	2005	2006	2007	2008	2010	% Change 2008-2010	2010	2005	2006	2007	2010	% Change 2007-2010
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	9.2	10.5	15.8	9.9	12.1	22.1	20.8	20.8	7.3	16.7	24.0	44.0
Coral Rubble (R)	7.8	9.7	7.5	16.4	6.8	-58.3	1.9	4.7	5.2	11.3	14.0	23.5
Rock and Block (RK)	3.3	0.0	0.0	4.7	5.8	22.3	25.1	0.0	0.0	6.5	7.3	11.5
White Dead Standing Coral (DC)	0.2	0.5	0.0	0.1	0.1	-16.7	2.4	1.2	5.3	3.0	0.6	-79.2
Dead Coral with Algae (DCA)	9.2	2.3	8.2	9.6	9.7	0.7	3.7	21.0	16.5	12.8	20.8	61.7
Subtotal Non-living Substrate	***29.7***	***23.0***	***31.5***	***40.7***	***34.4***	-15.4	***54.0***	***47.7***	***34.3***	***50.3***	***66.6***	32.4
Branching (CB)	35.8	28.0	26.8	28.2	32.3	14.4	18.6	22.5	22.8	24.7	12.6	-48.8
Massive (CM)	12.7	8.7	9.7	9.7	11.4	17.7	9.0	16.3	18.3	8.0	4.0	-50.0
Flat/Encrusting (CFD)	2.8	1.5	2.2	5.1	7.2	40.5	4.4	2.5	1.8	0.7	4.3	537.5
Foliose Cup (CFO)	4.7	7.2	3.2	6.1	4.2	-31.7	2.8	6.0	7.3	3.3	1.3	-62.5
Total Hard Coral	**56.0**	**45.3**	**41.8**	**49.1**	**55.0**	12.0	**34.8**	**47.3**	**50.3**	**36.7**	**22.1**	-39.7
Total Soft Coral	1.7	3.0	0.5	1.9	0.9	-51.8	1.0	0.8	1.7	0.5	1.3	150.0
Subtotal Coral	***57.7***	***48.3***	***42.3***	***51.0***	***55.9***	9.6	***35.9***	***48.2***	***52.0***	***37.2***	***23.4***	-37.1
Sponges	1.3	1.3	1.7	0.7	0.5	-28.6	0.4	1.2	2.5	2.5	0.1	-95.0
Other animals	0.3	0	0.7	0.0	0.3	+	0.3	0.0	1	0.3	0.1	-62.5
Algae	2.3	27.3	21.5	7.5	8.7	15.6	2.7	1.2	10.2	6.2	6.3	1.4
Turf algae	~	~	~	~	3.6	N/A	0.4	~	~	~	2.9	N/A
Fleshy algae	~	~	~	~	4.3	N/A	2.0	~	~	~	2.9	N/A
Coralline algae	~	~	~	~	0.8	N/A	0.4	~	~	~	0.5	N/A
Seagrass	8.7	0.0	2.3	0.1	0.2	66.7	6.7	1.8	0.0	3.5	3.5	0.0
Subtotal Others	***12.7***	***28.7***	***26.2***	***8.3***	***9.7***	16.5	**10.1**	***4.2***	***13.7***	***12.5***	***10.0***	-20.0
TOTAL	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters												
Mean Slope (degrees)	~	~	~	~	36.7		4.1	~	~	~	48.3	
Mean Topography (m) *	~	~	~	~	2.2		0.7	~	~	~	1.0	
Mean Depth/Range (m)	7-10	7-10	7-10	7-10	7.375		3.5	7-10	7-10	7-10	7.75	
Horizontal Visibility (m)	~	~	~	~	19.8		14.4	~	~	~	16.5	
No. of 50 m Transects	3	3	3	5	6		14	3	3	3	4	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 5. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Arbor Marine Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	2.3	1.0	5.3	0.0	0.0	14.3
Rabbitfish (Siganids)*	0.7	0.0	3.7	0.0	0.0	0.5
Groupers (Serranids)*	0.3	0.0	0.3	0.0	0.0	2.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.0	0.0	0.0	0.0	0.0	0.8
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.3	0.0	2.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.7	1.7	0.0	0.0	0.0	62.5
Spinecheeks (Nemipterids)*	1.0	0.0	1.0	3.0	0.0	2.0
Goatfish (Mullids)*	2.0	0.0	2.3	3.0	0.0	5.8
Parrotfish (Scarids)*	4.3	0.0	11.3	2.3	0.0	16.5
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.7	0.0	1.7	0.3	0.0	0.3
Butterflyfish (Chaetodonids)	2.7	0.7	5.7	0.0	0.0	4.3
Angelfish (Pomacanthids)	1.0	0.7	1.3	0.0	0.0	2.8
Wrasses (Labrids)	4.0	14.7	74.3	0.0	0.0	44.3
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	11.7	1239.0	82.0	0.0	0.0	738.5
Fairy Basslets (Anthids)	1.7	346.0	0.0	0.0	0.0	191.5
Moorish Idols (*Zanclus cornutus*)	0.7	0.0	1.3	0.0	0.0	0.8
Total (target reef spp.):	**11.7**	**1.7**	**26.0**	**8.3**	**0.0**	**99.3**
Total (all reef spp.):	**34.0**	**1603.7**	**192.3**	**8.7**	**0.0**	**1086.5**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 6. Mean (±SE) fish density (density/500m^2) in Arbor Marine Sanctuary from 2005 to 2010.

Family	SANCTUARY					% Change 2008-2010	NON-SANCTUARY					% Change 2008-2010
	2005	2006	2007	2008	2010		2005	2006	2007	2008	2010	
	Mean	Mean	Mean	Mean	Mean		Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	18.0	16.3	21.3	26.2	6.3	-75.8	39.0	36.0	2.0	10.6	14.3	34.4
Rabbitfish (Siganids)*	11.7	6.7	13.0	12.2	3.7	-69.9	4.3	8.0	0.3	0.8	0.5	-37.5
Groupers (Serranids)*	1.7	5.7	5.7	6.0	0.3	-94.4	6.0	16.7	3.0	1.6	2.0	25.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	8.0	2.7	0.0	1.2	0.0	-100.0	1.0	7.0	0.0	1.4	0.8	-46.4
Sweetlips (Haemulids)*	0.0	0.3	3.7	0.0	0.0	N/A	4.7	0.0	0.0	0.2	0.0	-100.0
Emperors (Lethrinids)*	1.3	0.0	5.3	0.0	0.0	N/A	10.3	4.0	0.0	0.0	0.0	N/A
Jacks (Carangids)*	0.0	3.3	0.7	0.0	2.0	+	0.3	2.0	0.0	0.0	0.0	N/A
Fusiliers (Caesionids)*	2.3	69.7	624.0	960.0	1.7	-99.8	429.0	375.0	155.7	89.2	62.5	-29.9
Spinecheeks (Nemipterids)*	1.3	7.7	4.7	3.0	4.0	33.3	9.3	15.0	2.3	1.4	2.0	42.9
Goatfish (Mullids)*	9.3	4.7	24.7	0.4	5.3	1233.3	12.7	26.3	5.3	2.8	5.8	105.4
Parrotfish (Scarids)*	66.3	27.7	85.0	62.2	13.7	-78.0	63.3	57.7	11.0	10.4	16.5	58.7
Bumphead parrotfish	0.0	0.0	0.7	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A	2.7	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	23.0	11.7	2.7	3.2	2.0	-37.5	8.3	9.0	0.3	0.2	0.3	25.0
Butterflyfish (Chaetodonids)	4.7	16.7	12.3	15.2	6.3	-58.3	20.7	28.0	5.0	6.0	4.3	-29.2
Angelfish (Pomacanthids)	3.3	10.0	11.3	7.6	2.0	-73.7	5.3	18.3	3.0	4.2	2.8	-34.5
Wrasses (Labrids)	30.3	81.3	32.7	100.6	89.0	-11.5	38.7	445.7	83.7	41.8	44.3	5.9
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	918.7	850.0	1172.3	841.6	1321.0	57.0	1350.0	1856.7	950.0	748.2	738.5	-1.3
Fairy Basslets (Anthids)	66.7	620.0	0.0	602.2	346.0	-42.5	4.3	1716.7	516.7	289.2	191.5	-33.8
Moorish Idols (*Zanclus cornutus*)	0.3	2.0	9.3	5.4	1.3	-75.3	3.3	1.3	4.0	2.0	0.8	-62.5
Total (target reef spp.):	**113.0**	**144.7**	**769.0**	**1061.2**	**36.0**	-96.6	**543.7**	**547.7**	**179.7**	**115.2**	**99.3**	-13.8
Total (all reef spp.):	**1167.0**	**1736.3**	**2029.3**	**2647.0**	**1804.7**	-31.8	**2013.3**	**4623.3**	**1742.3**	**1210.0**	**1086.5**	-10.2

* Target species/families

Table 7. Changes in substrate composition (% mean) in Granada Marine Sanctuary from 2004 to 2010.

	SANCTUARY							NON-SANCTUARY					
	SCUBA SURVEYS												
	2004	2005	2006	2007	2008	2010	% Change 2004-2010	2005	2006	2007	2008	2010	% Change 2005-2010
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	68.3	19.0	19.5	23.2	32.7	40.7	24.6	33.7	26.2	25.2	50.2	39.8	-20.8
Coral Rubble (R)	5.0	15.0	12.7	17.0	17.2	8.6	-49.8	4.5	10.7	18.5	17.7	15.8	-10.8
Rock and Block (RK)	1.3	2.5	1.2	0.0	2.3	5.4	133.0	0.0	6.7	3.3	0.0	1.8	+
White Dead Standing Coral (DC)	2.0	0.0	1.8	0.0	0.0	0.6	+	0.0	1.5	0.3	0.0	0.0	N/A
Dead Coral with Algae (DCA)	0.0	11.7	3.7	7.2	9.3	7.8	-16.3	15.0	2.5	13.8	9.8	2.3	-77.1
Subtotal Non-living Substrate	***76.5***	***48.2***	***38.8***	***47.3***	***61.5***	***63.1***	2.6	***53.2***	***47.5***	***61.2***	***77.7***	***59.5***	-23.4
Branching (CB)	12.3	19.0	29.5	20.8	22.0	21.1	-4.0	7.8	9.0	14.5	7.5	18.3	143.3
Massive (CM)	1.5	18.7	22.5	11.3	12.0	8.0	-33.3	11.2	12.0	13.7	5.5	7.3	31.8
Flat/Encrusting (CFD)	3.3	0.7	1.2	2.8	2.3	3.2	36.6	0.8	4.7	0.8	0.0	8.0	+
Foliose Cup (CFO)	1.3	2.5	2.8	1.8	0.7	1.4	115.6	2.0	1.0	1.2	0.8	1.0	20.0
Total Hard Coral	**18.3**	**40.8**	**56.0**	**36.8**	**37.0**	**33.8**	-8.8	**21.8**	**26.7**	**30.2**	**13.8**	**34.5**	149.4
Total Soft Coral	0.0	0.2	0.8	0.0	0.2	0.6	237.5	0.2	0.2	0.5	0.5	1.0	100.0
Subtotal Coral	***18.3***	***41.0***	***56.8***	***36.8***	***37.2***	***34.3***	-7.7	***22.0***	***26.8***	***30.7***	***14.3***	***35.5***	147.7
Sponges	0.5	1.5	0.7	0.8	0.5	0.8	62.5	1.8	1.5	1.2	2.0	1.5	-25.0
Other animals	0.0	0.3	0.0	0.2	0.0	0.1	+	0.0	0.8	0.0	0.0	0.0	N/A
Algae	1.5	8.2	0.5	14.8	0.8	1.4	65.0	6.0	9.8	6.8	4.8	3.5	
Turf algae	~	~	~	~	~	0.7	N/A	~	~	~	~	0.0	N/A
Fleshy algae	~	~	~	~	~	0.6	N/A	~	~	~	~	3.5	N/A
Coralline algae	~	~	~	~	~	0.1	N/A	~	~	~	~	0.0	N/A
Seagrass	3.3	0.8	3.2	0.0	0.0	0.3	+	17.0	13.5	0.2	1.2	0.0	-100.0
Subtotal Others	***5.3***	***10.8***	***4.3***	***15.8***	***1.3***	***2.6***	92.2	***24.8***	***25.7***	***8.2***	***8.0***	***5.0***	-37.5
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters													
Mean Slope (degrees)	~	~	~	~	~	41.3		~	~	~	~	40.0	
Mean Topography (m) *	~	~	~	~	~	1.5		~	~	~	~	2.3	
Mean Depth/Range (m)	7-10	7-10	7-10	7-10	7-10	7.3		7-10	7-10	7-10	7-10	8.5	
Horizontal Visibility (m)	~	~	~	~	~	16.8		~	~	~	~	11.5	
No. of 50 m Transects	2	3	3	3	3	8		3	3	3	3	2	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 8. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Granada Marine Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	2.0	0.0	7.2	5.4	0.0	12.6
Rabbitfish (Siganids)*	1.2	0.0	3.0	1.6	0.0	4.6
Groupers (Serranids)*	0.8	0.0	0.6	0.4	0.2	1.2
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.4	0.0	0.2	0.4	0.0	0.6
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.6	0.0	26.6	1.0	0.0	27.6
Spinecheeks (Nemipterids)*	0.6	0.0	1.2	1.8	0.0	3.0
Goatfish (Mullids)*	2.0	0.0	2.4	4.4	0.0	6.8
Parrotfish (Scarids)*	2.8	0.0	14.2	3.4	0.8	18.4
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.2	0.0	0.4	0.0	0.0	0.4
Butterflyfish (Chaetodonids)	3.8	4.4	7.0	0.2	0.0	11.6
Angelfish (Pomacanthids)	1.8	1.4	2.4	1.0	0.0	4.8
Wrasses (Labrids)	5.0	42.2	15.0	7.0	0.0	64.2
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	8.2	1452.0	128.2	0.0	0.0	1580.2
Fairy Basslets (Anthids)	1.6	478.4	0.0	0.0	0.0	478.4
Moorish Idols (*Zanclus cornutus*)	0.6	0.0	1.0	0.6	0.0	1.6
Total (target reef spp.):	**10.4**	**0.0**	**55.4**	**18.4**	**1.0**	**74.8**
Total (all reef spp.):	**31.6**	**1978.4**	**209.4**	**27.2**	**1.0**	**2216.0**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 9. Mean (±SE) fish density (density/500m^2) in North Granada Marine Sanctuary from 2004 to 2010.

Family	SANCTUARY						% Change 2008-2010	NON-SANCTUARY						% Change 2008-2010
	2004	2005	2006	2007	2008	2010		2004	2005	2006	2007	2008	2010	
	Mean	Mean	Mean	Mean	Mean	Mean		Mean	Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	8.0	3.0	29.0	106.0	3.0	12.6	320.0	0.0	7.0	2.0	0.5	1.5	4.0	166.7
Rabbitfish (Siganids)*	9.0	2.0	0.0	76.5	3.0	4.6	53.3	0.0	5.0	2.0	0.0	4.0	13.0	225.0
Groupers (Serranids)*	7.0	7.5	11.0	13.5	1.0	1.2	20.0	1.5	3.5	1.5	2.0	1.5	1.5	0.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	3.0	4.0	6.0	11.0	1.0	0.6	-40.0	0.0	0.0	0.5	1.5	0.0	0.5	+
Sweetlips (Haemulids)*	1.5	0.0	3.0	6.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	1.5	0.0	-100.0
Emperors (Lethrinids)*	0.0	1.0	6.5	23.5	0.0	0.0	N/A	0.0	3.5	6.5	0.0	3.0	0.0	-100.0
Jacks (Carangids)*	2.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.5	0.0	0.0	2.0	0.0	-100.0
Fusiliers (Caesionids)*	99.0	0.0	27.5	1984.0	35.0	27.6	-21.1	75.0	202.5	108.5	126.5	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	1.0	7.0	30.5	6.0	2.5	3.0	20.0	0.0	3.5	9.0	3.0	10.0	1.0	-90.0
Goatfish (Mullids)*	2.0	7.0	22.5	16.0	4.5	6.8	51.1	25.5	12.0	38.0	15.0	38.0	13.0	-65.8
Parrotfish (Scarids)*	56.5	51.5	47.5	655.5	8.0	18.4	130.0	0.0	92.0	54.5	24.5	31.0	7.0	-77.4
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	7.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	4.0	2.0	5.0	8.0	1.0	0.4	-60.0	0.0	10.5	3.0	1.0	0.5	1.0	100.0
Butterflyfish (Chaetodonids)	10.0	13.0	22.0	16.5	8.5	11.6	36.5	10.0	9.5	10.0	5.0	2.0	31.0	1450.0
Angelfish (Pomacanthids)	1.0	5.5	22.0	20.5	3.0	4.8	60.0	0.0	4.5	3.5	3.0	5.5	3.0	-45.5
Wrasses (Labrids)	32.5	51.0	198.5	39.5	43.5	64.2	47.6	95.5	54.0	134.0	112.5	15.0	28.0	86.7
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	595.5	1068.0	1037.5	2001.0	900.0	1580.2	75.6	202.0	950.0	697.5	850.0	0.0	1483.5	+
Fairy Basslets (Anthids)	28.0	227.5	777.5	0.0	165.0	478.4	189.9	112.5	0.0	147.5	375.0	0.0	109.5	+
Moorish Idols (*Zanclus cornutus*)	0.0	3.0	6.0	3.5	1.5	1.6	6.7	0.0	0.0	1.0	1.0	1.5	1.0	-33.3
Total (target reef spp.):	**189.0**	**83.0**	**167.0**	**2850.0**	**58.0**	**74.8**	29.0	**102.0**	**322.5**	**221.5**	**173.0**	**91.0**	**38.0**	-58.2
Total (all reef spp.):	**860.0**	**1453.0**	**2252.0**	**4994.0**	**1180.5**	**2216.0**	87.7	**522.0**	**1358.0**	**1219.0**	**1520.5**	**117.0**	**1697.0**	1350.4

* Target species/families

Table 10. Changes in substrate composition (% mean) in Gawi Marine Sanctuary from 2005 to 2010.

	SANCTUARY								NON-SANCTUARY					
	SCUBA SURVEYS							SNORKEL SURVEY	SCUBA SURVEYS					
	2005	2006	2007	2008	2009	2010	% Change 2005-2010	2010	2005	2006	2008	2009	2010	% Change 2005-2010
SUBSTRATE COVER	% cover	% cover	% cover	% cover		% cover		% cover	% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	8.7	2.0	11.5	4.3	10.0	17.0	292.3	20.1	18.3	2.8	25.7	18.9	7.1	-62.3
Coral Rubble (R)	1.7	10.0	6.1	10.2	11.0	11.0	8.2	2.6	3.8	17.8	5.3	8.9	12.9	44.7
Rock and Block (RK)	0.0	0.0	18.2	0.8	2.9	5.1	510.0	23.2	2.7	1.2	0.0	0.0	4.5	+
White Dead Standing Coral (DC)	0.2	0.0	0.0	0.0	0.0	1.7	+	2.0	0.0	4.3	0.7	5.7	0.1	-97.8
Dead Coral with Algae (DCA)	24.3	21.7	12.8	21.3	16.0	12.1	-43.4	4.7	4.8	15.5	6.0	4.8	11.5	139.6
Subtotal Non-living Substrate	***34.8***	***33.7***	***48.6***	***36.7***	***39.9***	***46.8***	27.7	***52.5***	***29.7***	***41.7***	***37.7***	***38.3***	***36.1***	-5.7
Branching (CB)	27.7	43.2	35.5	49.5	44.4	38.9	-21.4	14.9	14.2	37.2	19.5	26.2	28.8	9.7
Massive (CM)	7.5	4.2	2.6	4.3	4.3	4.4	1.9	12.7	5.3	6.7	8.8	7.8	2.8	-64.7
Flat/Encrusting (CFD)	9.5	2.3	0.6	1.0	1.5	2.6	158.3	2.5	2.0	3.7	1.0	0.9	5.3	483.3
Foliose Cup (CFO)	10.5	3.3	1.4	2.3	0.7	2.8	21.4	2.0	0.2	2.2	0.3	1.7	3.9	127.9
Total Hard Coral	**55.2**	**53.0**	**40.1**	**57.2**	**50.9**	**48.8**	-14.7	**32.1**	**21.7**	**49.7**	**29.7**	**36.6**	**40.6**	11.0
Total Soft Coral	0.2	0.2	0.7	1.0	0.6	1.8	83.3	2.9	0.5	0.0	1.3	1.3	1.3	-3.8
Subtotal Coral	***55.3***	***53.2***	***40.8***	***58.2***	***51.5***	***50.6***	-13.0	***35.0***	***22.2***	***49.7***	***31.0***	***37.9***	***41.9***	10.5
Sponges	0.0	0.8	0.2	0.3	0.3	0.4	25.0	0.1	0.7	1.7	0.5	0.6	1.4	129.2
Other animals	1.7	1	0.2	0.3	0.6	0.2	-50.0	0.3	0.2	0.3	0.2	0.0	0.5	+
Algae	7.8	7.7	0.3	0.5	3.6	0.8	66.7	3.4	0.3	2.5	0.0	0.2	7.0	
Turf algae	~	~	~	~	~	0.0	N/A	2.5	~	~	~	~	1.4	N/A
Fleshy algae	~	~	~	~	~	0.2	N/A	0.6	~	~	~	~	1.3	N/A
Coralline algae	~	~	~	~	~	0.7	N/A	0.3	~	~	~	~	4.4	N/A
Seagrass	0.3	3.7	9.9	4.0	4.1	1.2	-70.8	8.7	47.0	4.2	30.7	23.0	13.1	-42.9
Subtotal Others	***9.8***	***13.2***	***10.6***	***5.2***	***8.6***	***2.6***	-50.0	**12.5**	***48.2***	***8.7***	***31.3***	***23.8***	***22.0***	-7.6
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters														
Mean Slope (degrees)	~	~	~	~	~	32.5		11.7	~	~	~	~	26.7	
Mean Topography (m) *	~	~	~	~	~	1.2		1.2	~	~	~	~	1.0	
Mean Depth/Range (m)						5		3.5					7.5	
Horizontal Visibility (m)	~	~	~	~	~	7.5		17.2	~	~	~	~	18.0	
No. of 50 m Transects	3	3	5	3	5	6		18	3	3	3	5	4	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 11. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Gawi Marine Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	3.0	0.0	8.7	1.0	0.0	9.7
Rabbitfish (Siganids)*	0.5	0.0	1.3	0.0	0.0	1.3
Groupers (Serranids)*	1.0	0.0	0.7	0.7	1.0	2.3
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.3	0.0	0.2	0.2	0.0	0.3
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.2	0.0	0.0	0.2	0.0	0.2
Fusiliers (Caesionids)*	0.3	0.0	16.7	5.5	0.0	22.2
Spinecheeks (Nemipterids)*	0.7	0.0	0.8	1.2	0.0	2.0
Goatfish (Mullids)*	1.8	0.0	4.0	1.3	0.0	5.3
Parrotfish (Scarids)*	2.8	0.0	22.7	8.2	1.5	32.3
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.2	0.0	0.0	1.0	0.0	1.0
Triggerfish (Balistids)	0.8	0.0	2.0	0.5	0.0	2.5
Butterflyfish (Chaetodonids)	2.2	3.0	3.2	0.0	0.0	6.2
Angelfish (Pomacanthids)	1.7	0.7	2.0	0.0	0.0	2.7
Wrasses (Labrids)	5.0	27.3	84.8	1.2	0.0	113.3
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	10.3	1090.2	208.5	0.8	0.0	1299.5
Fairy Basslets (Anthids)	1.2	64.7	0.0	0.0	0.0	64.7
Moorish Idols (*Zanclus cornutus*)	0.8	0.0	2.8	0.2	0.0	3.0
Total (target reef spp.):	**10.8**	**0.0**	**55.0**	**19.2**	**2.5**	**76.7**
Total (all reef spp.):	**32.8**	**1185.8**	**358.3**	**21.8**	**2.5**	**1568.5**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 12. Mean (±SE) fish density (density/500m^2) in Gawi Marine Sanctuary from 2005 to 2010.

Family	SANCTUARY						% Change 2009-2010	NON-SANCTUARY					% Change 2008-2010
	2005	2006	2007	2008	2009	2010		2005	2006	2007	2008	2010	
	Mean	Mean	Mean		Mean	Mean		Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	8.7	5.3	32.3	32.3	2.8	9.7	245.2	5.7	14.7	3.7	3.7	4.4	20.0
Rabbitfish (Siganids)*	3.7	4.0	20.3	20.3	2.4	1.3	-44.4	0.0	4.0	0.3	0.3	0.4	20.0
Groupers (Serranids)*	9.0	0.7	1.3	1.3	0.8	2.3	191.7	0.0	1.3	0.3	0.3	0.4	20.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.7	0.7	0.7	0.2	0.3	66.7	0.0	1.3	0.3	0.3	0.6	80.0
Sweetlips (Haemulids)*	0.0	0.0	0.7	0.7	0.0	0.0	N/A	9.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.0	0.0	3.0	3.0	0.4	0.0	-100.0	7.7	2.0	0.0	0.0	0.2	+
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.2	+	0.0	0.0	0.0	0.0	0.8	+
Fusiliers (Caesionids)*	15.3	59.7	33.3	33.3	1.0	22.2	2116.7	219.3	65.0	30.0	30.0	8.6	-71.3
Spinecheeks (Nemipterids)*	1.0	0.0	5.3	5.3	0.2	2.0	900.0	0.0	10.0	1.7	1.7	1.4	-16.0
Goatfish (Mullids)*	1.7	0.7	9.7	9.7	0.2	5.3	2566.7	18.7	15.3	5.3	5.3	12.8	140.0
Parrotfish (Scarids)*	63.3	23.3	44.0	44.0	18.2	32.3	77.7	17.7	19.7	4.7	4.7	43.4	830.0
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	2.7	0.0	0.0	0.0	0.0	1.0	+	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	6.3	2.7	2.0	2.0	3.8	2.5	-34.2	1.7	3.3	0.7	0.7	1.0	50.0
Butterflyfish (Chaetodonids)	12.0	6.7	20.7	20.7	2.4	6.2	156.9	6.3	14.0	4.7	4.7	6.2	32.9
Angelfish (Pomacanthids)	3.7	4.3	0.7	0.7	0.6	2.7	344.4	11.3	10.3	1.0	1.0	5.2	420.0
Wrasses (Labrids)	65.7	71.7	56.0	56.0	99.4	113.3	14.0	35.7	36.3	65.7	65.7	83.4	27.0
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	546.7	1000.0	800.0	800.0	2279.4	1299.5	-43.0	1466.7	1390.0	541.0	541.0	1304.0	141.0
Fairy Basslets (Anthids)	70.0	111.7	230.0	230.0	34.0	64.7	90.2	0.0	1166.7	56.7	56.7	371.0	554.7
Moorish Idols (*Zanclus cornutus*)	1.0	1.3	1.3	1.3	0.0	3.0	+	0.0	5.3	0.0	0.0	0.8	+
Total (target reef spp.):	**104.0**	**92.7**	**141.3**	**141.3**	**26.2**	**76.7**	192.6	**273.3**	**120.0**	**46.3**	**46.3**	**71.4**	54.1
Total (all reef spp.):	**811.7**	**1292.7**	**1261.3**	**1261.3**	**2445.8**	**1568.5**	-35.9	**1799.7**	**2759.3**	**716.0**	**716.0**	**1844.6**	157.6

* Target species/families

Table 13. Changes in substrate composition (% mean) in Pasil Marine Sanctuary from 2004 to 2010.

	SANCTUARY								NON SANCTUARY						
	SCUBA SURVEYS							SNORKEL SURVEY	SCUBA SURVEYS						
	2004	2005	2006	2008	2009	2010	% Change 2004-2010	2010	2004	2005	2006	2008	2009	2010	% Change 2004-2010
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	13.9	28.8	36.5	22.5	50.1	49.6	-1.0	19.7	9.8	17.8	16.5	32.3	43.2	17.6	-59.3
Coral Rubble (R)	11.6	3.0	9.0	8.0	5.3	6.0	13.2	5.4	8.8	4.7	8.5	9.8	5.9	2.2	-62.7
Rock and Block (RK)	3.6	1.0	0.0	1.3	3.8	4.5	17.1	15.1	7.0	3.3	5.7	0.0	0.0	4.2	+
White Dead Standing Coral (DC)	0.0	0.8	0.0	0.0	0.0	0.3	+	0.5	3.3	1.8	1.8	0.0	1.7	0.0	-100.0
Dead Coral with Algae (DCA)	11.9	9.5	9.2	12.0	2.0	4.0	97.5	3.2	9.1	16.2	7.3	14.0	5.4	3.0	-44.4
Subtotal Non-living Substrate	***41.0***	***43.2***	***54.7***	***43.8***	***61.2***	***64.3***	5.1	***44.0***	***38.0***	***43.8***	***39.8***	***56.2***	***56.2***	***27.0***	-52.0
Branching (CB)	28.0	36.7	7.8	13.3	28.4	15.8	-44.4	41.2	17.6	14.2	13.7	15.3	11.3	4.8	-57.5
Massive (CM)	8.2	5.5	8.2	6.8	5.0	5.1	2.0	5.4	8.3	7.2	15.7	3.0	6.1	2.9	-52.5
Flat/Encrusting (CFD)	0.0	0.5	2.0	6.7	0.3	2.2	633.3	2.2	2.8	1.7	1.7	2.3	7.4	2.1	-71.6
Foliose Cup (CFO)	0.3	3.3	8.7	18.2	0.5	6.3	1160.0	1.2	2.0	5.3	7.7	2.7	2.1	1.1	-47.6
Total Hard Coral	**36.5**	**46.0**	**26.7**	**45.0**	**34.2**	**29.4**	-14.0	**50.0**	**30.7**	**28.3**	**38.7**	**23.3**	**26.9**	**10.9**	-59.5
Total Soft Coral	4.9	5.5	2.8	5.2	3.5	3.7	5.7	5.3	2.3	1.5	8.0	0.7	10.0	1.4	-86.0
Subtotal Coral	***41.5***	***51.5***	***29.5***	***50.2***	***37.7***	***33.1***	-12.2	***55.3***	***33.0***	***29.8***	***46.7***	***24.0***	***36.9***	***12.3***	-66.7
Sponges	4.0	0.0	1.2	0.3	0.6	0.8	25.0	0.2	1.3	0.0	0.5	0.5	0.6	1.0	66.7
Other animals	0.3	0	0.2	0.0	0.1	0.1	-50.0	0.0	0.25253	0	2.3	11.0	3.1	0.3	-90.3
Algae	4.0	0.3	14.5	0.8	0.4	0.5	12.5	0.3	3.5	0.0	6.8	3.3	0.6	1.6	
Turf algae	~	~	~	~	~	0.1	N/A	0.0	~	~	~	~	~	0.9	N/A
Fleshy algae	~	~	~	~	~	0.3	N/A	0.3	~	~	~	~	~	0.3	N/A
Coralline algae	~	~	~	~	~	0.1	N/A	0.0	~	~	~	~	~	0.4	N/A
Seagrass	9.1	5.0	0.0	4.8	0.0	1.4	+	0.2	24.0	26.3	3.8	5.0	2.6	57.8	2123.1
Subtotal Others	***17.5***	***5.3***	***15.8***	***6.0***	***1.1***	***2.6***	136.4	**0.6**	***29.0***	***26.3***	***13.5***	***19.8***	***6.9***	***60.7***	779.7
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters															
Mean Slope (degrees)	~	~	~	~	~	21.5		13.3	~	~	~	~	~	8.6	
Mean Topography (m) *	~	~	~	~	~	1.5		1.2	~	~	~	~	~	0.5	
Mean Depth/Range (m)	7-10	7-10	7-10	7-10	7-10	9.4		3.5	7-10	7-10	7-10	7-10	7-10	7.0	
Horizontal Visibility (m)	~	~	~	~	~	19.0		16.4	~	~	~	~	~	12.0	
No. of 50 m Transects	2	3	3	3	5	10		14	3	3	3	3	5	5	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 14. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Pasil Marine Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	4.6	1.3	17.9	22.4	13.3	54.9
Rabbitfish (Siganids)*	1.0	0.0	2.0	0.6	0.0	2.6
Groupers (Serranids)*	1.4	0.0	1.3	2.0	0.4	3.7
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.0	0.0	3.3	1.0	0.3	4.6
Sweetlips (Haemulids)*	0.3	0.0	0.0	0.0	0.3	0.3
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.6	0.0	0.4	0.1	0.3	0.9
Fusiliers (Caesionids)*	0.7	0.0	11.1	14.3	0.0	25.4
Spinecheeks (Nemipterids)*	1.1	0.1	4.7	1.9	0.0	6.7
Goatfish (Mullids)*	3.0	0.3	10.0	7.7	0.1	18.1
Parrotfish (Scarids)*	4.6	0.3	14.7	11.7	1.0	27.7
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.9	0.7	2.6	0.9	0.0	4.1
Butterflyfish (Chaetodonids)	4.4	5.4	11.3	0.1	0.0	16.9
Angelfish (Pomacanthids)	2.7	4.4	5.3	1.0	0.0	10.7
Wrasses (Labrids)	7.4	24.3	54.6	2.7	0.0	81.6
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	10.9	1243.1	449.9	0.3	0.0	1693.3
Fairy Basslets (Anthids)	1.0	154.4	57.1	0.0	0.0	211.6
Moorish Idols (*Zanclus cornutus*)	0.9	0.6	1.3	0.1	0.0	2.0
Total (target reef spp.):	**14.7**	**0.7**	**65.4**	**61.7**	**15.7**	**143.6**
Total (all reef spp.):	**46.4**	**1435.0**	**647.4**	**66.9**	**15.7**	**2165.0**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 15. Mean (±SE) fish density (density/500m^2) in Pasil Marine Sanctuary from 2003 to 2010.

Family	SANCTUARY							% Change 2009-2010	NON-SANCTUARY						% Change 2009-2010
	2003	2004	2005	2006	2008	2009	2010		2004	2005	2006	2008	2009	2010	
	Mean	Mean	Mean	Mean	Mean	Mean	Mean		Mean	Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	52.0	6.3	100.3	20.0	77.0	260.0	54.9	-78.9	4.7	30.7	20.0	2.3	7.2	5.6	-22.2
Rabbitfish (Siganids)*	5.7	13.3	20.0	0.3	6.0	13.0	2.6	-80.2	3.0	16.3	0.3	15.0	0.0	0.4	+
Groupers (Serranids)*	0.7	2.0	5.3	0.3	9.7	34.6	3.7	-89.3	0.0	2.7	0.3	2.0	0.0	0.4	+
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.4	0.0	-100.0
Snapper (Lutjanids)*	0.0	18.3	18.7	0.0	8.7	56.0	4.6	-91.8	1.7	0.7	0.0	0.0	1.4	0.0	-100.0
Sweetlips (Haemulids)*	0.7	4.0	18.3	0.0	12.7	6.0	0.3	-95.2	0.0	1.3	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	0.0	5.7	0.0	4.7	9.2	0.0	-100.0	0.0	1.7	0.0	0.0	0.0	0.2	+
Jacks (Carangids)*	0.0	0.3	16.7	0.3	0.0	104.6	0.9	-99.2	0.0	0.0	0.3	0.0	0.0	0.2	+
Fusiliers (Caesionids)*	0.0	657.3	116.7	2.7	309.3	700.0	25.4	-96.4	0.0	37.0	2.7	60.0	22.0	0.0	-100.0
Spinecheeks (Nemipterids)*	4.7	1.7	16.0	4.7	2.7	8.0	6.7	-16.1	2.7	5.0	4.7	4.3	0.8	1.6	100.0
Goatfish (Mullids)*	11.7	15.7	17.3	6.7	10.0	14.6	18.1	24.3	5.7	6.7	6.7	6.3	3.4	6.8	100.0
Parrotfish (Scarids)*	47.0	62.3	39.7	27.0	97.7	78.0	27.7	-64.5	20.7	23.3	27.0	12.7	7.2	38.4	433.3
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	10.0	0.0	0.0	11.0	0.0	-100.0	2.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.3	2.7	9.3	1.3	10.0	2.8	4.1	48.0	0.0	2.0	1.3	4.0	1.2	0.0	-100.0
Butterflyfish (Chaetodonids)	13.0	39.3	19.7	5.3	26.0	85.0	16.9	-80.2	15.7	8.7	5.3	3.0	2.4	5.6	133.3
Angelfish (Pomacanthids)	14.0	1.0	15.3	5.0	20.0	9.8	10.7	9.3	1.3	6.7	5.0	4.0	3.0	5.0	66.7
Wrasses (Labrids)	32.7	190.3	55.7	100.3	36.3	159.4	81.6	-48.8	46.3	60.0	100.3	547.7	235.0	43.4	-81.5
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	1.7	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	777.3	1196.3	700.3	536.7	666.7	3440.0	1693.3	-50.8	694.3	321.7	536.7	595.0	1034.8	386.0	-62.7
Fairy Basslets (Anthids)	60.7	116.7	1065.7	222.0	16.7	2000.0	211.6	-89.4	0.0	83.3	222.0	451.7	0.0	117.2	+
Moorish Idols (*Zanclus cornutus*)	0.0	0.0	9.0	0.7	4.7	5.8	2.0	-65.5	0.0	2.3	0.7	161.3	2.0	0.0	-100.0
Total (target reef spp.):	**94.7**	**775.0**	**378.0**	**53.0**	**516.0**	**1267.0**	**143.6**	-88.7	**35.7**	**103.7**	**53.0**	**102.7**	**41.6**	**52.2**	25.5
Total (all reef spp.):	**1021.3**	**2327.7**	**2259.7**	**933.3**	**1318.7**	**6997.8**	**2165.0**	-69.1	**798.0**	**611.7**	**933.3**	**1869.3**	**1320.8**	**610.8**	-53.8

* Target species/families

Table 16b. Changes in substrate composition (% mean) in Sumilon Island Fish Sanctuary from 1981 to 2010.

	NON-SANCTUARY																
	SCUBA SURVEYS													SNORKEL SURVEYS			
	1981	1982	1983	1985	1992	1999	2002	2005	2006	2008	2009	2010	% Change 2009-2010	2005	2006	2008	% Change 2006-2008
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	
Sand (s) and Silt (SI)	21.8	21.0	20.3	38.6	83.0	24.4	18.2	8.8	9.2	28.0	43.1	31.2	-27.6	23.1	2.3	38.2	1560.1
Coral Rubble (R)	22.6	22.6	24.0	14.7	0.1	17.0	7.7	29.3	16.9	26.7	6.7	20.7	209.0	6.4	5.1	9.3	81.3
Rock and Block (RK)	6.9	8.0	7.6	8.2	0.3	4.3	2.9	6.0	3.3	12.7	0.0	4.1	+	2.7	5.2	3.2	-39.6
White Dead Standing Coral (DC)	17.1	14.5	9.8	5.1	1.4	1.8	0.3	7.2	6.6	1.2	2.1	0.2	-90.5	3.7	13.3	3.8	-71.1
Dead Coral with Algae (DCA)	0.0	0.0	0.0	0.0	0.0	13.3	4.3	19.5	4.0	2.8	0.3	5.1	1600.0	23.8	3.6	0.8	-77.1
Subtotal Non-living Substrate	***68.4***	***66.1***	***61.6***	***66.4***	***84.8***	***60.7***	***33.3***	***70.8***	***39.9***	***71.3***	***52.2***	***61.3***	17.4	***59.7***	***29.6***	***55.3***	86.9
Branching (CB)	23.8	25.8	29.8	19.1	9.0	31.5	47.5	16.0	24.3	14.7	29.6	26.9	-9.3	9.6	9.6	28.2	192.1
Massive (CM)	1.3	1.5	1.1	3.5	0.8	2.7	3.2	2.3	0.3	1.7	0.5	1.7	240.0	12.9	11.7	0.0	-100.0
Flat/Encrusting (CFD)	0.0	0.6	1.2	1.6	0.0	1.6	0.9	0.0	0.2	0.0	0.2	1.0	400.0	2.5	8.5	0.0	-100.0
Foliose Cup (CFO)	1.4	0.9	0.5	2.7	0.0	2.5	1.6	0.0	0.3	0.0	0.0	1.8	+	5.5	5.4	0.0	-100.0
Total Hard Coral	**26.5**	**28.7**	**32.6**	**26.9**	**9.8**	**38.3**	**53.2**	**18.3**	**25.2**	**16.3**	**30.3**	**31.4**	3.5	**30.5**	**35.2**	**28.2**	-20.0
Total Soft Coral	18.4	5.2	5.9	6.8	5.4	1.0	11.1	10.0	25.8	12.0	14.1	4.0	-72.0	6.0	7.2	15.2	112.0
Subtotal Coral	***44.8***	***33.9***	***38.4***	***33.6***	***15.2***	***39.3***	***64.3***	***28.3***	***50.9***	***28.3***	***44.4***	***35.3***	-20.5	***36.5***	***42.4***	***43.3***	2.3
Sponges	~	~	~	~	~	~	2.2	0.0	7.3	0.3	3.0	2.1	-30.0	3.8	8.2	0.2	-98.0
Other animals	~	~	~	~	~	~	0.1	0.8	1.7	0.0	0.4	0.7	75.0	0.0	0.0	0.0	N/A
Algae	~	~	~	~	~	~	0.1	0.0	0.2	0.0	0.0	0.6		0.0	0.0	1.2	+
Turf algae	~	~	~	~	~	~	0.2	~	~	~	~	0.3	N/A	~	~	~	N/A
Fleshy algae	~	~	~	~	~	~	0.1	~	~	~	~	0.2	N/A	~	~	~	N/A
Coralline algae	~	~	~	~	~	~	0.0	~	~	~	~	0.1	N/A	~	~	~	N/A
Seagrass	~	~	~	~	~	~	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	19.9	0.0	-100.0
Subtotal Others	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***0.0***	***2.6***	***0.8***	***9.1***	***0.3***	***3.4***	***3.4***	0.0	***3.8***	***28.0***	***1.3***	-95.2
TOTAL	**113**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	
Environmental Paramenters														**~**	**~**	**~**	
Mean Slope (degrees)	~	~	~	~	~	~	~	~	~	~	~	22.0		~	~	~	
Mean Topography (m) *	~	~	~	~	~	~	~	~	~	~	~	1.1		~	~	~	
Mean Depth/Range (m)	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7.8		3-4 m	3-4 m	3-4 m	
Horizontal Visibility (m)	~	~	~	~	~	~	~	~	~	~	~	18.5		~	~	~	
No. of 50 m Transects	2	3	2	2	1	~	~	~	~	~	~	10		~	~	~	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 16a. Changes in substrate composition (% mean) in Sumilon Island Fish Sanctuary from 1981 to 2010.

	SANCTUARY																			
	SCUBA SURVEYS														SNORKEL SURVEYS					
	1981	1982	1983	1984	1985	1992	1999	2002	2005	2006	2008	2009	2010	% Change 2009-2010	1986	1999	2002	2005	2010	% Change 2005-2010
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	16.9	17.1	16.8	21.7	7.5	17.5	24.4	16.5	6.0	4.5	0.3	9.2	7.1	-22.8	0.0	13.8	10.7	16.8	11.0	-34.5
Coral Rubble (R)	22.7	26.4	23.5	11.1	22.0	20.9	17.0	17.8	14.2	20.3	29.3	17.1	21.9	28.1	3.1	23.4	12.0	10.7	12.3	15.1
Rock and Block (RK)	15.7	11.9	24.6	19.1	7.9	25.4	4.3	7.1	8.0	0.5	5.3	5.7	7.7	35.1	27.5	12.1	14.8	14.4	12.2	-15.2
White Dead Standing Coral (DC)	7.9	9.2	7.9	5.9	13.8	5.0	1.8	3.5	16.2	2.3	4.8	0.0	2.3	+	8.8	5.7	0.3	11.3	1.7	-84.7
Dead Coral with Algae (DCA)	0.0	0.0	0.0	0.0	0.0	0.0	13.3	5.8	6.7	1.0	4.3	2.8	4.4	57.1	~	8.4	11.6	14.1	3.6	-74.7
Subtotal Non-living Substrate	***63.2***	***64.5***	***72.8***	***57.8***	***51.2***	***68.7***	***60.7***	***50.6***	***51.0***	***28.7***	***44.2***	***34.8***	***43.4***	24.6	***39.4***	***63.4***	***49.4***	***67.3***	***40.8***	-39.3
Branching (CB)	16.3	14.4	15.0	18.9	8.8	14.5	31.5	16.0	16.7	39.0	21.0	40.4	32.0	-20.8	~	~	21.1	3.9	32.1	721.9
Massive (CM)	2.5	1.7	1.0	1.0	3.2	1.4	2.7	2.5	10.8	5.0	6.8	3.4	2.0	-42.6	~	~	7.0	12.5	2.1	-83.5
Flat/Encrusting (CFD)	0.9	0.7	0.4	5.5	3.0	1.5	1.6	2.1	2.2	1.8	4.8	0.6	6.7	1008.3	~	~	1.9	3.2	3.0	-6.3
Foliose Cup (CFO)	6.1	3.4	1.2	2.2	4.5	3.1	2.5	3.6	4.7	2.2	3.2	3.4	4.0	16.2	~	~	1.7	2.8	3.0	7.8
Total Hard Coral	**25.8**	**20.1**	**17.5**	**27.6**	**19.5**	**20.5**	**38.3**	**24.2**	**34.3**	**48.0**	**35.8**	**47.8**	**44.6**	-6.8	**45.6**	**21.6**	**31.7**	**22.4**	**40.2**	79.2
Total Soft Coral	**11.0**	**15.4**	**9.8**	**14.6**	**29.3**	**10.7**	**1.0**	**25.2**	9.8	18.7	16.8	8.1	9.7	19.8	15.0	15.0	18.4	10.2	17.8	73.2
Subtotal Coral	***36.8***	***35.5***	***27.3***	***42.2***	***48.8***	***31.2***	***39.3***	***49.4***	***44.2***	***66.7***	***52.7***	***55.9***	***54.3***	-3.0	***60.6***	***36.6***	***50.1***	***32.7***	***57.9***	77.3
Sponges	~	~	~	~	~	~	~	0.0	2.8	2.7	2.3	2.5	1.0	-62.0	~	~	~	0.0	0.3	+
Other animals	~	~	~	~	~	~	~	0.0	0.3	0.8	0.2	0.4	0.3	-25.0	~	~	~	0.0	0.2	+
Algae	~	~	~	~	~	~	~	0.0	1.7	1.2	0.7	6.4	1.1	-83.6	~	~	~	0.0	0.7	+
Turf algae	~	~	~	~	~	~	~	0.0	~	~	~	~	0.2	N/A	~	~	~	~	0.1	N/A
Fleshy algae	~	~	~	~	~	~	~	0.0	~	~	~	~	0.5	N/A	~	~	~	~	0.2	N/A
Coralline algae	~	~	~	~	~	~	~	0.0	~	~	~	~	0.4	N/A	~	~	~	~	0.4	N/A
Seagrass	~	~	~	~	~	~	~	0.0	0.0	0.0	0.0	0.0	0.1	+	~	~	~	0.0	0.0	+
Subtotal Others	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0.0***	***4.8***	***4.7***	***3.2***	***9.3***	***2.4***	-74.2	**0.0**	**0.0**	**0.0**	**0.0**	**1.2**	+
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters																				
Mean Slope (degrees)	~	~	~	~	~	~	~	~	~	~	~	~	65.0		~	2.2	1.7	~	22.5	
Mean Topography (m) *	~	~	~	~	~	~	~	~	~	~	~	~	31.3		2.3	1.3	1	~	1.5	
Mean Depth/Range (m)	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	6.3		~	2.7	3.1	3-4 m	3.4	
Horizontal Visibility (m)	~	~	~	~	~	~	~	~	~	~	~	~	12.5		~	25.4	17.7	~	17.5	
No. of 50 m Transects	2	2	2	1	1	5	12	2	~	~	~	~	10		~	244	225	~	15	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 17. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Sumilon Island Fish Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	5.3	5.3	18.0	2.3	0.6	26.1
Rabbitfish (Siganids)*	0.7	0.0	1.3	0.4	0.0	1.7
Groupers (Serranids)*	0.6	0.0	0.3	0.3	0.0	0.6
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.0	0.0	0.3	5.3	2.1	7.7
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.7	0.0	0.0	0.7	0.0	0.7
Jacks (Carangids)*	0.3	0.0	8.6	2.6	0.0	11.1
Fusiliers (Caesionids)*	1.6	14.3	40.0	6.0	0.0	60.3
Spinecheeks (Nemipterids)*	0.1	0.0	0.1	0.0	0.0	0.1
Goatfish (Mullids)*	1.4	0.0	2.0	0.6	0.0	2.6
Parrotfish (Scarids)*	4.0	0.0	9.0	3.0	1.0	13.0
Bumphead parrotfish	0.1	0.0	0.0	0.0	0.1	0.1
Rudderfish (Kyphosids)*	0.3	0.0	0.0	2.6	13.6	16.1
Triggerfish (Balistids)	0.9	0.3	0.1	0.7	0.3	1.4
Butterflyfish (Chaetodonids)	6.3	5.6	8.0	0.9	0.0	14.4
Angelfish (Pomacanthids)	2.0	5.6	3.7	0.4	0.0	9.7
Wrasses (Labrids)	6.9	3.1	15.3	1.9	0.9	21.1
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	10.9	1248.7	149.4	0.4	0.0	1398.6
Fairy Basslets (Anthids)	1.6	463.9	21.7	0.0	0.0	485.6
Moorish Idols (*Zanclus cornutus*)	1.0	0.6	1.7	0.6	0.1	3.0
Total (target reef spp.):	**16.0**	**14.3**	**79.6**	**23.7**	**17.4**	**135.0**
Total (all reef spp.):	**45.6**	**1747.3**	**279.6**	**28.6**	**18.7**	**2074.1**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 18. Mean (±SE) fish density (density/500m^2) in Sumilon Island Fish Sanctuary from 1992 to 2010.

Family	SANCTUARY									% Change 2009-2010	NON-SANCTUARY						% Change 2008-2010
	1992	1999	2002	2004	2005	2006	2008	2009	2010		2002	2004	2005	2006	2008	2010	
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean		Mean	Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	103.5	42.8	35.7	3.0	51.0	56.3	68.3	10.6	26.1	146.6	25.3	0.7	24.7	41.3	20.7	24.4	18.2
Rabbitfish (Siganids)*	2.5	3.3	2.7	1.0	7.3	7.0	8.0	3.0	1.7	-42.9	0.0	2.7	1.3	0.0	0.7	0.3	-57.1
Groupers (Serranids)*	0.0	1.3	0.8	0.3	5.0	18.3	18.3	0.2	0.6	185.7	0.5	0.0	8.7	1.0	0.0	0.9	+
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	3.0	2.8	1.7	0.3	2.0	10.3	12.3	3.4	7.7	126.9	2.3	1.0	0.0	0.3	0.0	0.7	+
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	1.3	3.3	6.3	0.0	0.0	N/A	0.0	0.0	2.7	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	0.0	0.2	0.0	10.0	7.0	1.0	10.2	0.7	-93.0	1.8	0.0	12.0	0.0	0.0	0.3	+
Jacks (Carangids)*	0.0	37.8	0.5	2.7	5.3	1.7	2.0	0.6	11.1	1757.1	3.3	1.3	17.3	2.0	17.0	0.4	-97.5
Fusiliers (Caesionids)*	577.5	375.5	372.5	261.7	1500.0	80.0	75.0	73.4	60.3	-17.9	105.5	41.7	0.0	196.7	209.0	80.4	-61.5
Spinecheeks (Nemipterids)*	0.0	2.2	2.2	0.0	4.0	14.3	8.3	0.0	0.1	+	2.3	0.0	0.0	0.7	0.3	0.6	71.4
Goatfish (Mullids)*	6.0	11.2	3.3	0.0	0.0	22.0	11.7	0.4	2.6	542.9	2.0	1.0	6.0	2.0	1.0	9.9	885.7
Parrotfish (Scarids)*	81.0	37.7	11.7	5.3	65.7	60.7	60.0	5.8	13.0	124.1	10.5	1.0	31.3	7.3	8.3	6.0	-28.0
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	+	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.8	11.5	0.0	3.3	5.0	0.0	0.2	16.1	7971.4	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	0.5	3.8	2.2	0.7	3.7	8.3	2.0	0.6	1.4	138.1	0.8	0.7	3.3	3.7	1.0	1.3	28.6
Butterflyfish (Chaetodonids)	35.5	24.8	15.3	13.7	15.3	31.7	32.7	9.4	14.4	53.5	21.3	14.3	6.7	5.3	13.7	16.9	23.3
Angelfish (Pomacanthids)	11.0	12.0	8.5	5.7	12.7	11.3	2.7	2.4	9.7	304.8	8.3	3.7	102.0	21.3	1.3	11.4	757.1
Wrasses (Labrids)	64.0	71.5	19.0	92.0	63.7	328.7	330.3	62.6	21.1	-66.2	55.8	128.0	95.3	86.7	27.0	583.1	2059.8
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	910.5	3709.5	1406.5	584.7	2703.3	2933.3	2266.7	1443.2	1398.6	-3.1	1251.3	656.0	1213.3	1333.3	214.0	1856.0	767.3
Fairy Basslets (Anthids)	642.0	641.8	766.3	383.3	1366.7	2700.0	1933.3	1072.0	485.6	-54.7	79.5	16.7	0.0	79.7	173.3	971.7	460.6
Moorish Idols (*Zanclus cornutus*)	9.0	4.3	4.3	1.3	6.0	2.7	5.0	1.0	3.0	200.0	4.3	0.3	0.0	0.0	3.0	1.9	-38.1
Total (target reef spp.):	**776.5**	**515.5**	**442.7**	**272.7**	**1623.0**	**268.0**	**263.0**	**107.8**	**135.0**	25.2	**153.3**	**49.0**	**89.3**	**213.0**	**257.0**	**120.4**	-53.1
Total (all reef spp.):	**2449.0**	**4983.3**	**2664.8**	**1355.7**	**5826.3**	**6302.0**	**4844.0**	**2699.0**	**2074.1**	-23.2	**1574.3**	**869.0**	**1524.7**	**1781.3**	**690.3**	**3566.1**	416.6

* Target species/families

Table 19. Mean (±SE) fish species richness (species/500m^2) in Sumilon Island Fish Sanctuary from 1992 to 2010.

Family	SANCTUARY				% Change 2002-2010	NON-SANCTUARY
	1992	1999	2002	2010		2010
	Mean	Mean	Mean	Mean		Mean
Surgeonfish (Acanthurids)*	7.5	5.0	4.5	5.3	17.5	3.0
Rabbitfish (Siganids)*	0.5	2.0	1.3	0.7	-45.1	0.1
Groupers (Serranids)*	0.0	0.5	0.5	0.6	14.3	0.6
Barramundi cod	0.0	0.0	0.0	0.0	N/A	0.0
Snapper (Lutjanids)*	1.0	2.5	0.3	1.0	233.3	0.6
Sweetlips (Haemulids)*	1.0	0.0	0.0	0.0	N/A	0.0
Emperors (Lethrinids)*	0.0	0.0	0.2	0.7	257.1	0.1
Jacks (Carangids)*	0.0	1.0	0.3	0.3	-4.8	0.4
Fusiliers (Caesionids)*	1.5	3.0	2.2	1.6	-28.6	1.0
Spinecheeks (Nemipterids)*	0.0	0.0	0.5	0.1	-71.4	0.4
Goatfish (Mullids)*	1.0	1.0	0.7	1.4	104.1	1.4
Parrotfish (Scarids)*	1.0	1.0	1.5	4.0	166.7	2.1
Bumphead parrotfish	0.0	0.0	0.0	0.1	+	0.0
Rudderfish (Kyphosids)*	0.0	0.5	0.5	0.3	-42.9	0.0
Triggerfish (Balistids)	0.5	2.0	1.0	0.9	-14.3	0.7
Butterflyfish (Chaetodonids)	9.0	10.0	6.8	6.3	-7.6	3.4
Angelfish (Pomacanthids)	2.5	2.5	2.3	2.0	-13.0	2.7
Wrasses (Labrids)	6.0	7.0	4.5	6.9	52.4	9.1
Humphead wrasse	0.0	0.0	0.0	0.0	N/A	0.0
Damselfish (Pomacentrids)	12.0	14.5	12.2	10.9	-11.0	10.3
Fairy Basslets (Anthids)	2.0	1.5	2.0	1.6	-21.4	1.3
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.7	1.0	42.9	0.9
Total (target reef spp.):	**13.5**	**16.5**	**42.0**	**16.0**	-61.9	**9.9**
Total (all reef spp.):	**46.5**	**55.0**	**42.0**	**45.6**	8.5	**38.3**

* Target species/families

Table 20. Changes in substrate composition (% mean) in Colase Marine Sanctuary from 2004 to 2010.

	SANCTUARY								NON-SANCTUARY					
	SCUBA SURVEYS							SNORKEL SURVEY	SCUBA SURVEYS					
	2004	2005	2006	2008	2009	2010	% Change 2009-2010	2010	2004	2005	2006	2008	2009	% Change 2008-2009
SUBSTRATE COVER	% cover	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	% cover	
Sand (s) and Silt (SI)	5.6	12.0	16.8	16.3	9.6	18.6	93.4	11.8	12.6	22.8	9.2	25.7	18.6	-27.5
Coral Rubble (R)	12.8	13.2	20.8	14.0	19.3	18.4	-4.5	9.8	8.3	23.7	45.3	17.7	50.7	187.0
Rock and Block (RK)	4.8	1.8	0.0	0.8	5.3	6.2	17.5	8.6	2.4	9.0	3.2	0.0	0.0	N/A
White Dead Standing Coral (DC)	0.7	1.8	0.0	0.0	0.0	0.4	+	0.9	4.3	1.0	0.8	0.0	0.0	N/A
Dead Coral with Algae (DCA)	16.5	7.3	7.3	12.2	17.4	11.7	-32.9	8.1	3.8	8.2	4.0	10.7	7.3	-31.6
Subtotal Non-living Substrate	***40.4***	***36.2***	***45.0***	***43.3***	***51.5***	***55.2***	7.2	***39.2***	***31.5***	***64.7***	***62.5***	***54.0***	***76.6***	41.9
Branching (CB)	30.2	9.2	15.7	19.8	30.4	18.9	-37.6	33.7	45.7	3.3	7.0	16.7	7.9	-52.6
Massive (CM)	11.5	10.5	13.0	13.2	7.8	9.8	26.2	5.2	9.2	8.8	10.2	7.3	3.3	-55.0
Flat/Encrusting (CFD)	3.0	10.5	2.0	6.8	4.6	5.8	24.9	0.0	4.1	6.0	2.3	0.5	1.6	220.0
Foliose Cup (CFO)	5.5	5.5	5.3	3.8	1.3	2.2	73.3	6.7	3.9	3.2	4.7	2.8	1.7	-40.0
Total Hard Coral	**50.3**	**35.7**	**36.0**	**43.7**	**44.0**	**36.7**	-16.7	**45.7**	**62.9**	**21.3**	**24.2**	**27.3**	**14.5**	-47.0
Total Soft Coral	6.2	21.3	2.7	9.5	2.4	4.6	91.8	15.2	5.2	7.8	9.7	5.0	1.9	-62.0
Subtotal Coral	***56.5***	***57.0***	***38.7***	***53.2***	***46.4***	***41.2***	-11.1	***60.8***	***68.1***	***29.2***	***33.8***	***32.3***	***16.4***	-49.3
Sponges	0.2	1.5	2.0	3.2	0.5	1.2	144.4	0.0	0.0	2.7	0.8	0.5	0.2	-60.0
Other animals	0.3	2.8	1.5	0.0	0.0	0.4	+	0.0	0.4	0.8	0.8	2.3	0.2	-91.4
Algae	2.6	2.3	12.8	0.3	1.6	1.9	16.2	0.0	0.0	2.7	1.5	6.2	6.6	7.0
Turf algae	~	~	~	~	~	0.4	N/A	0.0	~	~	~	~	~	N/A
Fleshy algae	~	~	~	~	~	0.9	N/A	0.0	~	~	~	~	~	N/A
Coralline algae	~	~	~	~	~	0.5	N/A	0.0	~	~	~	~	~	N/A
Seagrass	0.0	0.2	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.5	4.7	0.0	-100.0
Subtotal Others	***3.1***	***6.8***	***16.3***	***3.5***	***2.1***	***3.6***	67.3	***0.0***	***0.4***	***6.2***	***3.7***	***13.7***	***7.0***	-48.8
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**		**100**	**100**	**100**	**100**	**100**	**100**	
Environmental Paramenters														
Mean Slope (degrees)	~	~	~	~	~	60.0		4.1	~	~	~	~	~	
Mean Topography (m) *	~	~	~	~	~	32.1		0.7	~	~	~	~	~	
Mean Depth/Range (m)	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	6.9		3.5	7-10 m	7-10 m	7-10 m	7-10 m	7-10 m	
Horizontal Visibility (m)	~	~	~	~	~	10.4		14.4	~	~	~	~	~	
No. of 50 m Transects	3	3	3	3	4	9		14	3	3	3	3	5	

~ no data available

* mean distance between lowest and highest point on the horizontal transect line

% change = $[(Yr_2/Yr_1)-1] \times 100$

(-) = decrease

(+) = increase

Table 21. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Colase Marine Sanctuary in 2010.

Family	Species	Size Class				Density
	Mean	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean
Surgeonfish (Acanthurids)*	3.0	0.0	11.6	5.4	0.0	17.0
Rabbitfish (Siganids)*	0.6	0.0	0.2	2.0	0.0	2.2
Groupers (Serranids)*	1.0	0.0	0.0	1.2	0.8	2.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.6	0.0	0.0	0.2	1.2	1.4
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.2	0.0	3.0	0.0	0.0	3.0
Spinecheeks (Nemipterids)*	0.8	0.0	1.0	0.4	0.0	1.4
Goatfish (Mullids)*	0.2	0.0	0.0	1.0	0.0	1.0
Parrotfish (Scarids)*	2.6	0.0	9.2	6.8	0.4	16.4
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	1.0	0.0	1.2	1.4	0.0	2.6
Butterflyfish (Chaetodonids)	3.8	2.4	11.2	0.8	0.0	14.4
Angelfish (Pomacanthids)	1.8	1.0	3.0	3.2	0.0	7.2
Wrasses (Labrids)	3.4	6.6	10.2	1.0	0.6	18.4
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	8.6	1885.6	389.2	0.0	0.0	2274.8
Fairy Basslets (Anthids)	1.2	1300.0	2.0	0.0	0.0	1302.0
Moorish Idols (*Zanclus cornutus*)	0.0	0.0	0.0	0.0	0.0	0.0
Total (target reef spp.):	**9.0**	**0.0**	**25.0**	**17.0**	**2.4**	**44.4**
Total (all reef spp.):	**28.8**	**3195.6**	**441.8**	**23.4**	**3.0**	**3663.8**

* Target species/families

** Surgeonfish in this size class are not counted as targets

Table 22. Mean (±SE) fish density (density/500m^2) in Colase Marine Sanctuary from 2004 to 2010.

Family	SANCTUARY						% Change 2009-2010	NON-SANCTUARY					% Change 2008-2009
	2004	2005	2006	2008	2009	2010		2004	2005	2006	2008	2009	
	Mean	Mean	Mean	Mean	Mean	Mean		Mean	Mean	Mean	Mean	Mean	
Surgeonfish (Acanthurids)*	38.0	67.7	50.3	310.3	260.0	17.0	-93.5	36.3	21.0	17.0	23.7	5.6	-76.3
Rabbitfish (Siganids)*	0.7	25.0	4.3	0.0	13.0	2.2	-83.1	0.0	2.3	0.0	1.0	0.6	-40.0
Groupers (Serranids)*	4.7	17.7	4.0	10.0	34.6	2.0	-94.2	2.7	2.7	1.0	0.0	0.0	N/A
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	2.0	4.7	6.7	0.0	56.0	1.4	-97.5	2.0	2.7	1.3	0.0	0.0	N/A
Sweetlips (Haemulids)*	0.0	10.7	0.0	10.0	6.0	0.0	-100.0	1.7	2.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	23.0	0.0	4.7	9.2	0.0	-100.0	7.7	1.3	0.0	0.3	0.0	-100.0
Jacks (Carangids)*	0.0	11.7	0.0	168.0	104.6	0.0	-100.0	0.0	2.3	0.3	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	610.0	55.0	139.3	700.0	3.0	-99.6	133.3	73.0	16.7	3.3	0.0	-100.0
Spinecheeks (Nemipterids)*	9.7	18.0	8.0	4.3	8.0	1.4	-82.5	0.0	6.0	0.7	1.3	0.4	-70.0
Goatfish (Mullids)*	8.0	23.0	25.7	8.7	14.6	1.0	-93.2	5.3	12.7	4.7	3.3	3.6	8.0
Parrotfish (Scarids)*	31.7	115.0	25.3	119.0	78.0	16.4	-79.0	63.7	31.3	16.7	9.0	6.6	-26.7
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	7.0	0.0	0.0	11.0	0.0	-100.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.3	8.3	9.3	10.7	2.8	2.6	-7.1	2.3	10.7	1.0	2.0	0.6	-70.0
Butterflyfish (Chaetodonids)	19.3	36.3	17.3	29.7	85.0	14.4	-83.1	20.0	13.7	9.3	8.0	3.8	-52.5
Angelfish (Pomacanthids)	15.7	15.7	8.7	24.0	9.8	7.2	-26.5	4.3	10.3	5.0	1.3	0.6	-55.0
Wrasses (Labrids)	65.3	66.0	138.3	37.0	159.4	18.4	-88.5	413.0	90.0	75.3	41.0	4.0	-90.2
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.0	0.0	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	1409.0	1333.3	1200.0	2900.0	3440.0	2274.8	-33.9	1649.7	733.3	431.7	433.3	634.6	46.4
Fairy Basslets (Anthids)	812.0	12.7	1036.7	0.0	2000.0	1302.0	-34.9	600.0	0.0	116.7	183.3	0.0	-100.0
Moorish Idols (*Zanclus cornutus*)	0.0	1.7	0.0	1.0	5.8	0.0	-100.0	0.3	2.3	0.0	0.0	0.4	+
Total (target reef spp.):	**66.3**	**877.3**	**171.0**	**714.7**	**1267.0**	**44.4**	-96.5	**234.7**	**140.7**	**45.3**	**39.7**	**16.2**	-59.2
Total (all reef spp.):	**2417.3**	**2407.3**	**2589.7**	**3776.7**	**6997.8**	**3663.8**	-47.6	**2942.3**	**1017.7**	**697.3**	**711.0**	**660.8**	-7.1

* Target species/families

Table 23. Species list of butterflyfish in Southeast Cebu Province, 2010.

Butterfly species	Common name	Daanlungsod-Guiwang	Arbor	Granada	Gawi	Pasil	Sumilon Is.				Colase
		2010	2010	2010	2010	2010	1992	1999	2002	2010	2010
Chaetodon adiergastos	Philippine butterflyfish	1			1	1	1	1	1		1
Chaetodon auriga	Threadfin butterflyfish						1			1	
Chaetodon baronessa	Eastern triangular butterflyfish	1	1	1	1	1	1	1	1	1	1
Chaetodon bennetti	Bluelashed butterflyfish						1		1		
Chaetodon ephippium	Saddle butterflyfish							1			
Chaetodon kleinii	Klein's butterflyfish		1	1		1	1	1	1	1	1
Chaetodon lineolatus	Lined butterflyfish		1				1		1		
Chaetodon lunula	Raccoon butterflyfish	1				1	1	1	1	1	1
Chaetodon lunulatus	Pacific redfin butterflyfish	1		1	1		1	1	1	1	
Chaetodon melannotus	Blackback butterflyfish	1					1			1	
Chaetodon meyeri	Meyer's butterflyfish								1		
Chaetodon ocellicaudus	Spottail butterflyfish					1		1	1	1	
Chaetodon octofasciatus	Eightband butterflyfish	1	1	1	1	1			1		
Chaetodon ornatissimus	Ornate butterflyfish					1	1	1	1	1	
Chaetodon oxycephalus	Spot-nape butterflyfish	1								1	
Chaetodon plebeius	Blueblotch butterflyfish						1				
Chaetodon punctatofasciatus	Spotband butterflyfish						1	1	1	1	
Chaetodon rafflesi	Latticed butterflyfish				1		1	1			
Chaetodon selene	Yellowdotted butterflyfish				1						
Chaetodon speculum	Mirror butterflyfish					1	1	1	1		1
Chaetodon trifascialis	Chevron butterflyfish					1	1	1	1	1	
Chaetodon ulietensis	Pacific doublesaddle butterflyfish						1			1	
Chaetodon unimaculatus	Teardrop butterflyfish	1									
Chaetodon vagabundus	Vagabond butterflyfish	1	1			1	1	1			
Forcipiger flavissimmus	Forcepsfish			1		1	1	1	1	1	1
Forcipiger longirostris	Longnose butterflyfish			1						1	
Hemitaurichthys polylepis	Pyramid butterflyfish						1	1	1	1	
Heniochus acuminatus	Pennant coralfish						1	1	1		
Heniochus chrysostomus	Threeband pennantfish						1	1	1		
Heniochus monoceros	Masked bannerfish									1	
Heniochus singularius	Singular bannerfish									1	
Heniochus varius	Horned bannerfish	1	1	1	1	1	1	1	1	1	1
Coradion melanopus	Two-eyed coralfish										1
Total number of species/site		10	6	7	7	12	22	18	19	18	8

Total number of species observed in all sites surveyed in 2010: 28

SUMMARY OF RESULTS AND TRENDS

Coral reef and other substrate. LHC cover in six of the seven MPAs surveyed are in fair condition (Daanlungsod-Guiwang, Granada, Gawi, Sumilon Island, Pasil and Colase). Only Arbor Fish Sanctuary had good cover (55±5.1%) in 2010. Further, four sanctuaries (57.1%, Arbor, Gawi, Colase and Pasil) showed no significant changes overtime. Daanlungsod-Guiwang, Sumilon Island and Granada, however, showed significant changes in 2010. LHC cover in Daanlungsod-Guiwang decreased from 2005 to 2010 while in Granada and Sumilon Island, LHC increased from 2002-2010 and 1992-2010 respectively. Studies (Eisma-Osorio et. al, 2009) show that it usually takes approximately 3-5 years to see significant improvement in LHC cover assuming this is coupled with positive management. In southeast Cebu case, 4 of the 7 sites surveyed are in status quo for 2010. Only Sumilon Island Sanctuary showed an increase after more than 10 years of survey. The maintenance in LHC cover in almost all sites may reflect the benefits of a collaborative approach in protecting the MPAs and addressing the threats and issues of the area. It is a credit to each municipality working together with the Southern Cebu CRM Council that the protected coral reefs are in stable condition (Figs 27 and 28).

Figure 27. Changes in live coral cover (%mean ±SE) at all sites in Southeastern Cebu from 1981 to 2010.

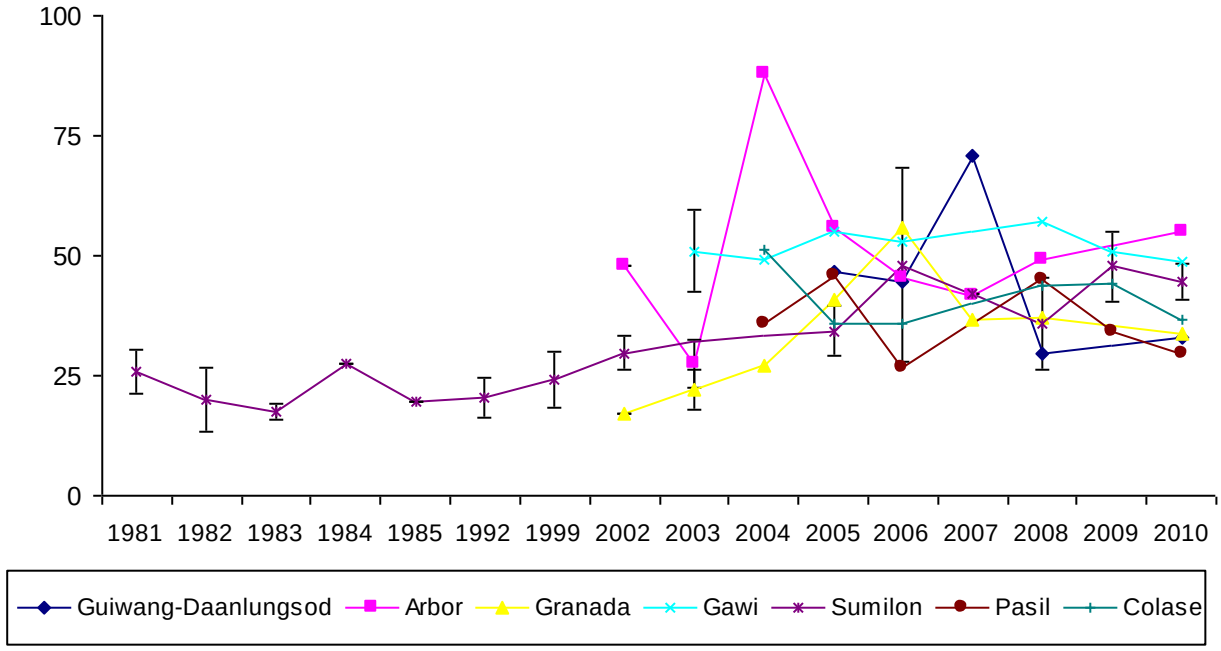
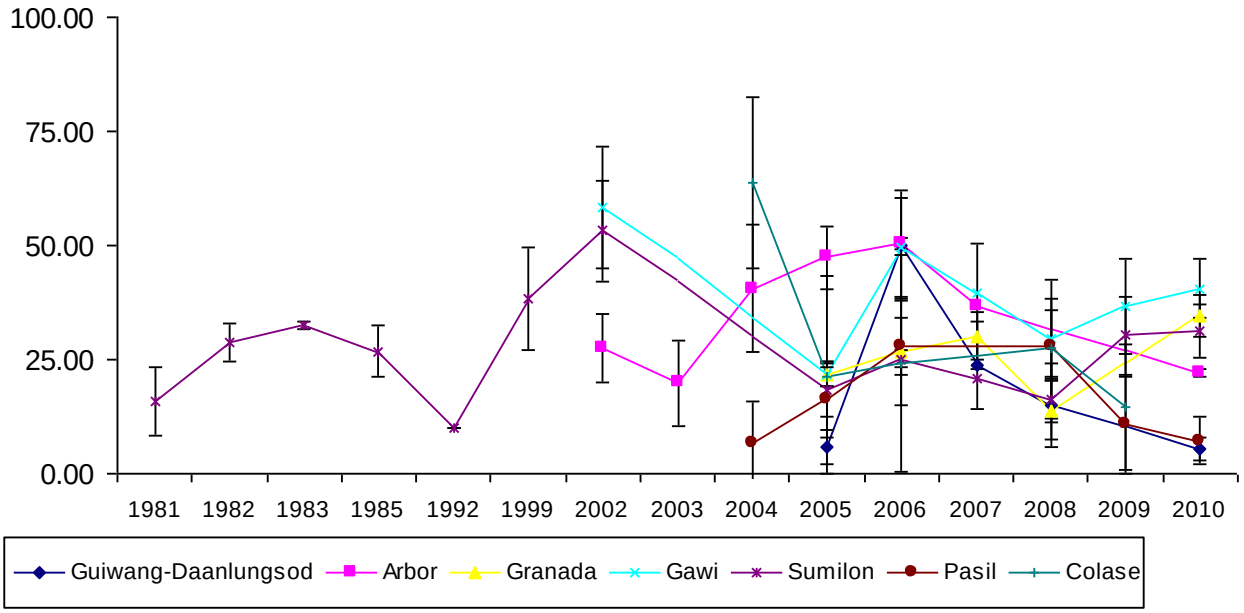


Figure 28. Changes in live coral cover (%mean ±SE) at all sites (non-sanctuary) in Southeastern Cebu from 1981 to 2010.



Fish diversity and abundance. Target fish densities ranged from very poor to poor. In seven sites surveyed, four are in very poor condition (Arbor, Granada, Gawi and Colase). The remaining three were poor (Daanlungsod-Guiwang, Sumilon Island and Pasil). Conversely, statistical tests revealed significant changes in five sites in 2010. Target fish density in Arbor, Granada and Pasil increased significantly while Sumilon Island and Colase on the other hand, decreased. Furthermore, Daanlungsod-Guiwang and Gawi showed no significant changes after 8 years of survey and thus are in status quo for 2010. Daanlungsod-Guiwang recorded the highest target density (144.2±82.4 fish/500m^2) followed by Pasil (143.6± fish/500m^2) and Sumilon Island 135.0± fish/500m^2) in 2010. As for target fish species diversity, four of seven sites are very low. The remaining three are low while Pasil recorded the highest species number mean at 18.3±2.9 spp/500m^2 followed by Sumilon Island (16.0±2.6 spp/500m^2) and Daanlungsod-Guiwang (13.5±0.8spp/500m^2). All seven sites have very low target fish biomass wherein Pasil has the highest (57.4±13.8 kg/500m^2) followed by Sumilon Island (35.8±18.1 kg/500m^2) and Gawi MS (22.4±18.1 kg/500m^2).

The majority of the fishes recorded in all sites surveyed are less than 10cm in length. Colase recorded the highest density of fishes that belong to 1-10cm size class with an average of 3195.6 fish/500m^2 followed by Granada (1978.4 fish/500m^2) and Sumilon Island with 1747.3 fish/500m^2. Pasil had the highest recorded fishes in the 11-20cm size class with an average of 647.4 fish/500m^2 followed by Colase and Sumilon with 441.8 and 279.6 fish/500m^2. These 3 sanctuaries also had the most number of fish in the 21-30cm size class which indicates effective protection.

The relatively low fish densities, species richness and biomass in all sites reflects the generally high fishing pressure in the southern Cebu region and that fishermen tend to fish near (or sometimes inside) the boundaries of the fish sanctuaries. This scenario makes it difficult for fish biomass to return to more normal historical levels. Even on Sumilon Island reef that has the potential to hold a much higher biomass of fish, given its island nature and exposure to currents and larval recruitment, has a relatively low biomass. This evidence suggests that no-take fishing areas must be strictly enforced and also that larger areas are better. Very small marine

sanctuaries are not as effective as larger ones. A minimum size should be 15 to 20 hectares with a sufficient buffer so that the protected core areas can truly serve as a reservoir for fish to recruit, propagate and spill over biomass and disburse their larvae outside of the area. This also implies that if fishers will provide this space, they will be rewarded with a larger and more stable fish catch.

Figure 29. Mean (±SE) density (fish/500m^2) of all reef species at all surveyed sites in the Southeastern Cebu.

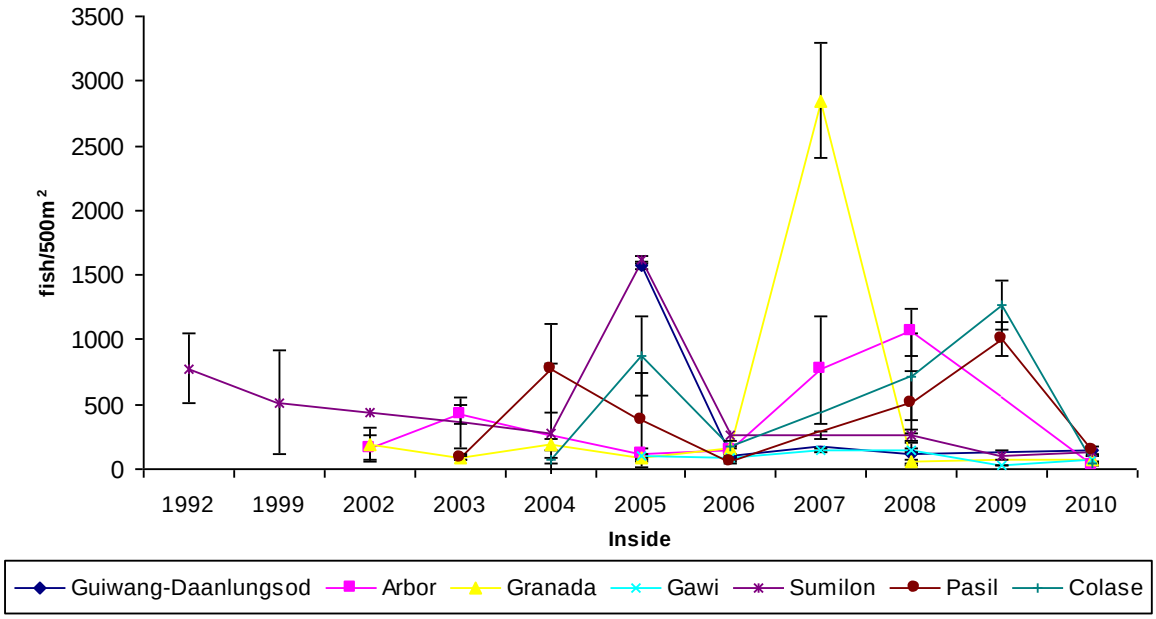
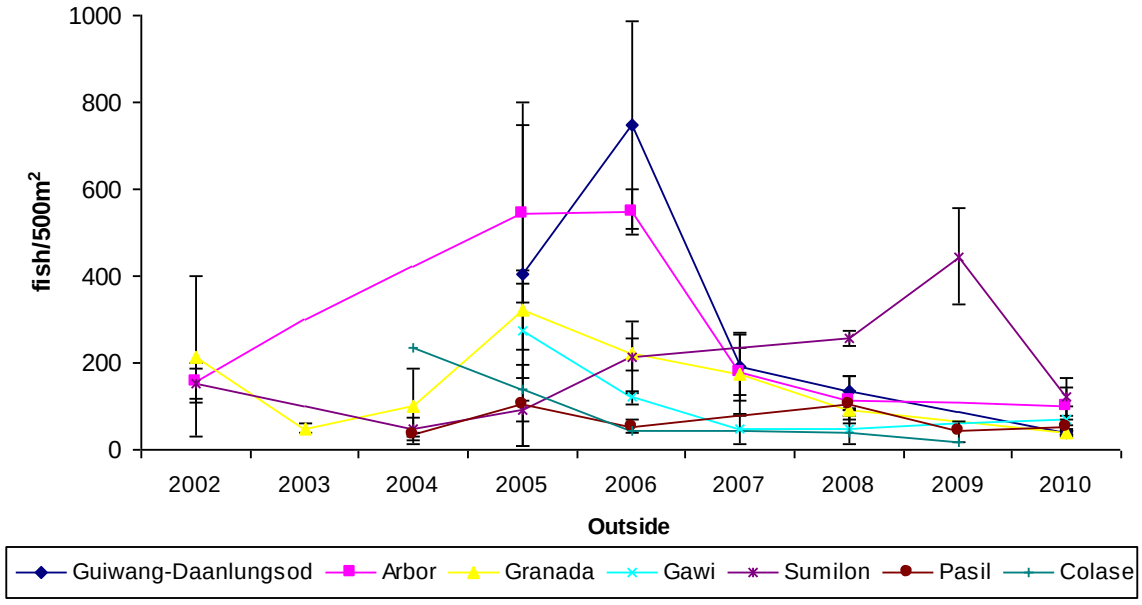


Figure 30. Mean (±SE) density (fish/500m^2) of target species at five sites in Southeastern Cebu.



Using data on LHC cover and target fish densities and when long term data is available, it is suggested that positive management can play an important role in the enhancement of coastal resources, especially the condition of coral reef substrate and its associated fish population. Previous studies in the Southeast Cebu cluster have shown that LHC and target fish densities have been maintained on most sites and with some showing positive changes after several years of protection (Diaz et al, 2009). Equally, results of this study show that the majority of the sites

surveyed revealed improvements in biophysical conditions. However, these results must be interpreted with caution if only the fish density factor is used. A better picture in showing the effects of positive management is if fish diversity and biomass is included as in this current survey (e.g., Russ and Alcala 1998, Raymundo et al. 2007).

Figure 31. Mean (±SE) species richness (species/500m^2) of all reef species at survey sites in Southeastern Cebu.

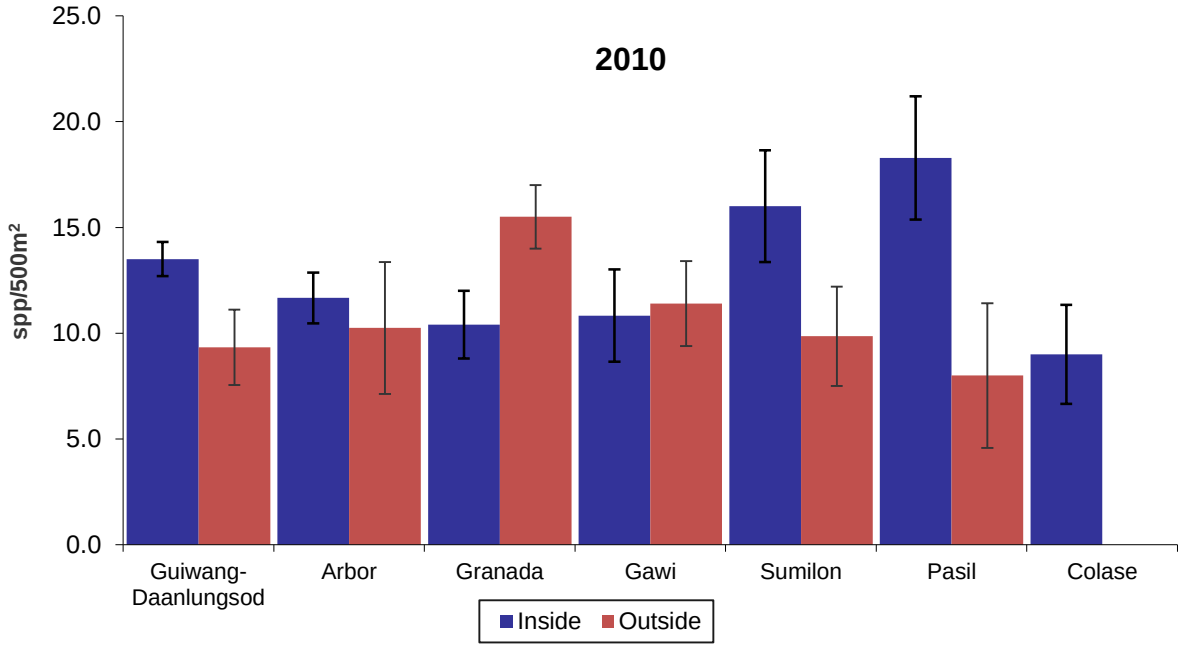
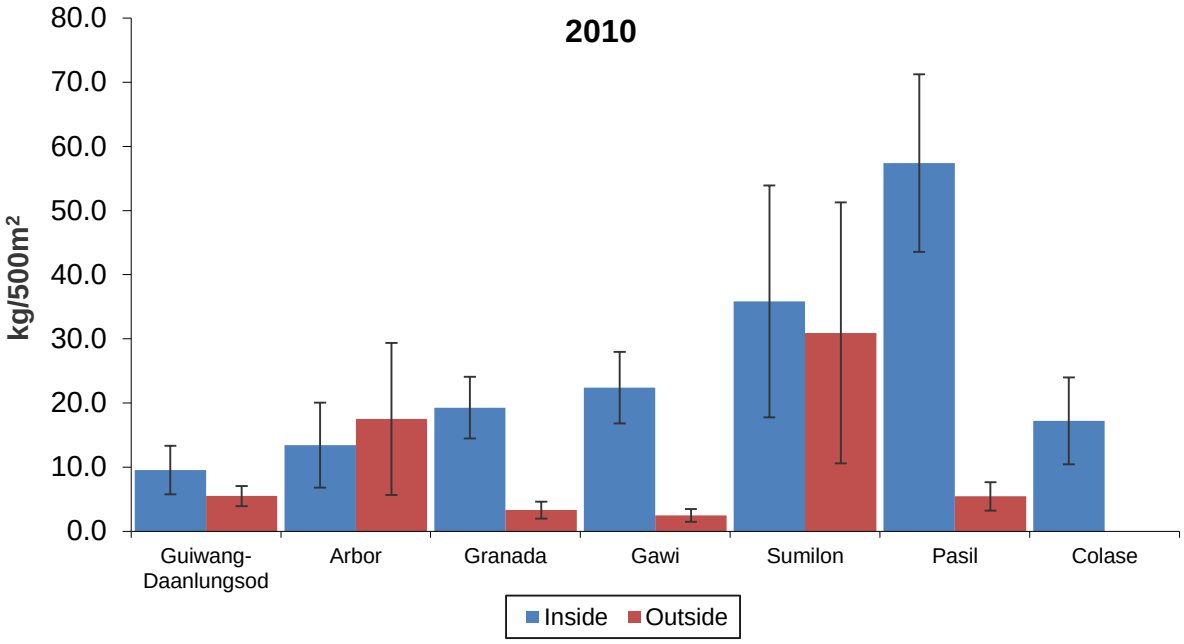


Figure 32. Biomass inside and outside the Southeastern Cebu MPA study areas.



RECOMMENDATIONS FOR IMPROVED MANAGEMENT

Southeast Cebu Province has been very active in coastal resource management since the entry of CCE Foundation into the area in 2002. However, there is still the challenge that lies in sustaining efforts to enforce the law against illegal and commercial fishing, strengthen MPA management bodies, and manage the growing volume of tourism. Southeastern Cebu, however, looks forward to a bright future in protected area management with the strong support that it is receiving from the provincial government and the SCCRMC cluster. Recommendations to further enhance conservation of Southeastern Cebu MPAs are:

1. **Continue monitoring for sustained management.** Since Southeast Cebu already has long term data, it is important to continue reef monitoring activities because this data is very useful in understanding current environmental issues such as overfishing, shoreline development, impacts of illegal fishing as well as long term impacts of sea level rise and ocean warming. With continuous monitoring, stakeholders and managers can be kept informed of the most critical issues that they need to address so that they can prioritize them in planning for and protection of the reef and its environs.

2. **Build capacity for improved coral reef and MPA monitoring.** Utilizing standard and complete coral reef monitoring methods is important to detect changes within relatively short times thus contributing to more effective management. Equally important is the participation of local stakeholders in the process to build sustainable management regimes. Local monitoring groups need to be trained in monitoring methods and they need to learn how to manage data so that long term changes can be understood and used to improve the management process.

3. **Need for more and larger MPAs**. Southeast Cebu has improved its marine conservation and marine resource management regimes markedly in the 10 years since its initial efforts began. Now, in light of the establishment of the southeast Cebu MPA network as well as continued fishing pressure in the near-shore waters surrounding Cebu, more and larger no-fishing reserves are needed to ensure that fish catches are sustainable, representation of ecosystems are achieved, and connectivity between reefs can return the local ecosystems to a balanced ecological condition. This will increase the fish biomass on the reefs.

4. **Need to improve coastal fisheries law enforcement.** A main finding in the study is that there are very low fish densities inside and adjacent to most of the MPAs surveyed. This indicates that high fishing pressure exists and that it is necessary to control fishing activities inside and adjacent to MPAs. Such fishing pressure negates the contribution of the marine sanctuaries. Law enforcement of the no-take zones should be a primary concern of managing bodies. This also includes the prevention of commercial fishing vessels from fishing within municipal waters.

5. **Increase diver, boat operator, and visitor education.** With the increasing popularity of tourism in Southeast Cebu, each dive and tourist operation needs to allocate time for diver and tourist education. This can highlight Cebu MPAs and their rules and regulations. Useful materials include: flip-charts, videos, handouts that explain MPA regulations and the do's and don'ts of the core sanctuary areas. Dive operations should have trained dive-masters and guides on dive trips who can brief visitors. Information on the natural and human history and on the uniqueness of Cebuano culture should be available for all.

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Appendix 1. Expedition Itinerary

Saving Philippine Reefs Expedition
Southern Cebu, Philippines
March 22-29, 2010

DAY	DATE & SITE	TIME	ACTIVITIES
1	Monday, March 22 Cebu Travel from Montebello Hotel, Cebu City to Sumilon Island, Oslob Sumilon House Reef, Oslob	7:00 AM 8:00 11:30 12:00 PM 1:00 2:00 7:00	Rendezvous Montebello Garden Hotel, Cebu City Proceed to Oslob via Sunrays bus (pickup at hotel) Welcome and Short briefing - Alan White; - Resort Manager; - Vangie White; and - Ethan Lucas, SPR Divemaster Lunch at resort Briefing on SPR project by Alan, Agnes and Dean/Review Method Practice snorkel and scuba dive at Sumilon Resort house reef Dinner Slides show on Butterflyfish/ discussion (Dean and Agnes)
2	Tuesday, March 23 Daanlungsod-Guiwang Marine Sanctuary, Alcoy	7:00 AM 8:00 9:00 12:00 PM 2:00 5:00 7:00	Breakfast Briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile data and submit data electronically or by forms Dinner Presentation - Siquijor results (Alan White)
3	Wednesday, March 24 Arbor Marine Sanctuary and North Granada Sanctuary, Boljoon	7:00 AM 8:00 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (snorkel and scuba) Compile and submit completed data forms Dinner Presentation – Coral Triangle Initiative (Alan)
4	Thursday, March 25 Pasil Marine Sanctuary, Santander	7:00 AM 8:00 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Dinner Night dive (can be done dusk time/before dinner in Sumilon Island Reef)

DAY	DATE & SITE	TIME	ACTIVITIES
5	Friday, March 26 Gawi Marine Sanctuary, Oslob	7:00 AM 8:00 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Dinner Presentation – MPA database/National Geographic Survey project (Elline)
6	Saturday, March 27 Colase Marine Sanctuary, Samboan	6:00 AM 7:00 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Dinner Presentation – Cebu Situationer (Romel Kirit) Presentation – Southeast Cebu Coastal Resource Management Council (Dr. Eugene Matildo) Presentation - CCE Foundation and future directions (Liza) Barrio Fiesta presentation and dinner
7	Sunday, March 28 Sumilon Marine Sanctuary, Oslob	7:00 AM 8:00 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Dinner Presentation – SPR volunteer trends (Vangie) Summary of Impressions and Debriefing (Alan)
8	Monday, March 29 Travel back to Cebu City	6:00 AM 9:00 AM	Breakfast Closing Summary Depart for Cebu City

Appendix 2. Expedition Staff and Volunteers

Volunteers:

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
1	**Denise Illing** 34 Oakland Drive Warrandyte 3113 Australia	Home: +613 9844 1583 Mobile: +61 429 146 147 denise@illing.com.au	Financial Department, UNICO Computer Systems. BA in Geography and Sociology. Interested in marine life, reefs, and diving. Wildlife artist. Watercolourist. 8th Saving Philippine Reefs Expedition.
2	**Geoff Illing** 34 Oakland Drive Warrandyte, VIC 3113 Australia	Phone: 03 9865 9140 Office Phone: +613 9865 9118 Home Phone: +613 9844 1583 Mobile: +61 419307047 geoff@illing.com.au or geoff@unico.com.au	Originally a mathematician, but now director/owner of software development company. Amateur musician, playing clarinet, bass clarinet, sax and bassoon in concert bands, orchestra and small ensembles. 8th Saving Philippine Reefs Expedition.
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APPENDIX 3. FISH SPECIES LIST

Southeastern Cebu Province Fish Species List as of March, 2010		Daanlungsod-Guiwang Marine Sanctuary	Arbor Marine Sanctuary	Granada Marine Sanctuary	Gawi Marine Sanctuary	Sumilon Marine Sanctuary		Pasil Marine Sanctuary	Colase Marine Sanctuary
		2010	2010	2010	2010	2002	2010	2010	2010
I	**Acanthuridae - surgeonfishes**								
	Acanthurus auranticavus						1	1	
	Acanthurus blochii							1	
	Acanthurus grammoptilus							1	
	Acanthurus japonicus				1		1	1	
	Acanthurus lineatus							1	
	Acanthurus nigricans	1			1		1	1	
	Acanthurus nubilus							1	
	Acanthurus mata						1	1	1
	Acanthurus pyroferus	1	1	1	1		1	1	1
	Acanthurus thompsoni					1			
	Ctenochaetus binotatus			1	1		1	1	1
	Ctenochaetus striatus	1	1	1	1	1	1	1	1
	Ctenochaetus tomimiensis	1	1		1	1	1		1
	Naso annulatus				1			1	
	Naso caeruleacauda	1							
	Naso hexacanthus			1			1	1	
	Naso lituratus	1	1	1	1		1	1	1
	Naso minor	1		1	1	1	1		
	Naso unicornis	1			1				
	Naso vlamingii	1				1	1	1	1
	Zebrasoma scopas	1	1	1	1	1	1	1	1
II	**Apogonidae - cardinalfishes**								
	Apogon agustatus							1	
	Apogon aureus					1			
	Apogon compressa						1		
	Apogon sp. 1				1		1	1	
	Apogon sp. 2				1		1	1	
	Apogon sp. 3						1		
	Apogon sp. 4						1		
	Apogon sp. 5						1		
	Cheilodipterus quinquilineatus		1	1		1			
	Sphaeramia nematoptera		1	1					
III	**Aulostomidae - trumpetfishes**								
	Aulostomus chinensis		1			1			
IV	**Balistidae - triggerfishes**								
	Balistapus undulatus	1	1	1	1	1	1	1	1
	Balistoides viridicens					1			
	Melichthys niger					1			
	Melichthys vidua				1			1	
	Odonus niger								1
V	**Belonidae - needlefishes**								
	Tylosorus crocodilus					1		1	
VI	**Blennidae**								
	Meiacanthus grammistes					1			
VII	**Caesionidae - fusiliers**								
	Caesio caerulaurea	1	1			1	1	1	
	Caesio cuning				1				
	Caesio lunaris					1			
	Caesio teres	1	1					1	1
	Caesio tessellata						1		
	Pterocaesio diagramma				1				
	Pterocaesio pisang	1	1	1	1	1	1		
VIII	**Carangidae - jacks**								
	Carangoides ferdau		1		1			1	
	Caranx bajad					1			
	Caranx melampygus					1			
	Caranx orthogrammus					1			
	Caranx sp.1						1		
	Elagatis bipinnulatus				1			1	
IX	**Centriscidae - shrimpfishes**								
	Aeoliscus strigatus			1		1			

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		2010	2010	2010	2010	2002	2010	2010	2010
X	**Chaetodontidae - butterflyfishes**								
	Chaetodon adiergastos	1			1	1		1	1
	Chaetodon auriga						1		
	Chaetodon baronessa	1	1	1	1	1	1	1	1
	Chaetodon kleinii	1	1	1		1	1	1	1
	Chaetodon lineolatus		1						
	Chaetodon lunula	1					1	1	1
	Chaetodon lunulatus	1		1	1	1	1		1
	Chaetodon melannotus	1					1		
	Chaetodon menalopus	1							
	Chaetodon ocellicaudus					1	1	1	
	Chaetodon octofasciatus	1	1	1	1	1		1	
	Chaetodon ornatissimus						1	1	
	Chaetodon oxycephalus	1					1		
	Chaetodon plebeius								
	Chaetodon punctatofasciatus					1	1		
	Chaetodon rafflesi				1	1			
	Chaetodon selene				1				
	Chaetodon speculum					1		1	1
	Chaetodon trifascialis						1	1	
	Chaetodon ulietensis						1		
	Chaetodon unimaculatus	1							
	Chaetodon vagabundus	1	1					1	
	Coradion melanopus								1
	Forcipiger flavissimus			1			1	1	1
	Forcipiger longirostris						1		
	Hemitaurichthys polylepis					1	1		
	Heniochus acuminatus					1			
	Heniochus monoceros						1		
	Heniochus singularis						1		
	Heniochus varius	1	1	1	1	1	1	1	1
XI	**Congridae**								
	Gorgasia sp.							1	
XII	**Fistulariidae - cornetfishes**								
	Fistularia commersoni	1				1			
XIII	**Holocentridae**								
	Myripristis sp. 1				1		1	1	
	Myripristis sp. 2						1		
XIV	**Kyphosidae - drummers**								
	Kyphosus biggibus				1				
	Kyphosus cinerascens						1		
	Kyphosus vaigiensis						1		
XV	**Labridae - wrasses**								
	Anampses caeruleopunctatus			1			1		
	Anampses meleagrides	1							
	Anampses melanurus		1						
	Anampses sp.						1		
	Bodianus axillaris				1	1		1	
	Bodianus mesothorax	1	1	1	1		1	1	1
	Cheilinus chlorourus	1	1		1		1	1	
	Cheilinus fasciatus	1	1	1	1	1	1	1	1
	Cheilinus trilobatus	1			1		1	1	
	Cheilinus undulatus	1							
	Cheilio inermis	1	1		1		1	1	
	Choerodon fasciatus				1		1	1	
	Choerodon sp.						1		
	Cirrhilabrus cyanopleura	1	1	1	1	1	1	1	1
	Cirrhilabrus sp. 1	1		1	1		1		
	Cirrhilabrus sp. 2				1				
	Cirrhilabrus sp. 3				1				
	Coris batuensis	1	1	1	1	1		1	
	Coris gaimard	1					1	1	
	Epibulus insidiator	1		1	1	1	1	1	1
	Gomphosus varius	1	1	1	1	1	1	1	

Southeastern Cebu Province Fish Species List as of March, 2010		Daanlungsod-Guiwang Marine Sanctuary	Arbor Marine Sanctuary	Granada Marine Sanctuary	Gawi Marine Sanctuary	Sumilon Marine Sanctuary		Pasil Marine Sanctuary	Colase Marine Sanctuary
		2010	2010	2010	2010	2002	2010	2010	2010
	Halichoeres hortulanus	1		1	1	1	1	1	1
	Halichoeres melanurus	1	1	1	1			1	1
	Halichoeres podostigma						1		
	Halichoeres richmondi	1		1	1				
	Halichoeres scapularis	1	1	1	1		1	1	1
	Halichoeres solorensis				1				
	Halichoeres sp				1				
	Halichoeres trimaculatus							1	
	Hemigymnus fasciatus	1			1	1	1	1	1
	Hemigymnus melapterus		1	1	1	1	1	1	1
	Hologymnosus doliatus	1							
	Labrichthys unilineatus	1		1	1	1	1	1	1
	Labroides dimidiatus	1	1	1	1	1	1	1	
	Labroides sp.						1		
	Labropsis sp.						1		
	Labropsis xanthonata					1			
	Macolor macularis	1		1					
	Macropharyngodon meleagris							1	
	Macropharyngodon negrosensis	1							
	Novaculichthys taeniorus	1					1	1	
	Oxycheilinus celebicus	1	1		1	1			
	Oxycheilinus diagrammus	1		1	1		1		
	Oxycheilinus unifasciatus				1			1	
	Pseudocheilinus octotaenia	1							
	Pteragogus cryptus					1			
	Stetojulis bandanensis	1					1		
	Stetojulis trilineata	1					1	1	
	Thalassoma hardwicke	1		1	1	1	1	1	1
	Thalassoma lunare	1	1	1	1	1	1	1	1
	Thalassoma lutescens		1		1		1	1	1
	Thalassoma purpureum	1	1		1		1	1	
XVI	**Lethrinidae - emperors**								
	Lethrinus harak	1			1	1	1	1	
	Lethrinus ornatus					1			
	Monotaxis grandoculis					1			
XVII	**Lutjanidae - snappers**								
	Aphareus furca						1		
	Aphareus sp.						1		
	Lutjanus bigibbus						1		
	Lutjanus bohar						1		
	Lutjanus decussatus	1		1	1	1	1	1	1
	Lutjanus ehrenbergi		1		1		1	1	
	Lutjanus fulviflamma				1				
	Lutjanus fulvus					1			
	Macolor macularis	1				1	1	1	
XVIII	**Monacanthidae - leatherjackets**								
	Aluterus scriptus						1		
	Amanses scopas					1			
	Arothron meleagris						1		
	Arothron nigropunctatus				1		1	1	
	Cantherhines dumerilii	1							
	Paramonacanthus sp.							1	
	Pervagor melanocephalus					1	1		
XIX	**Mullidae - goatfishes**								
	Mulloidichthys flavolineatus						1		
	Mulloidichthys vanicolensis			1					
	Parupeneus barbarinoides			1	1			1	
	Parupeneus barberinus	1	1	1	1	1	1	1	1
	Parupeneus bifasciatus		1	1	1		1	1	
	Parupeneus cyclostomus							1	
	Parupeneus indicus						1	1	
	Parupeneus multifasciatus	1	1	1	1	1	1	1	
	Parupeneus trifaciatus							1	
	Upeneus tragula	1	1	1					

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		2010	2010	2010	2010	2002	2010	2010	2010
XX	**Nemipteridae - breams**								
	Pentapodus emeryii	1							
	Scolopsis bilineatus	1	1	1	1	1	1	1	1
	Scolopsis ciliata	1							1
	Scolopsis margaritifer							1	
	Scolopsis sp.	1							
XXI	**Pinguipedidae - sandperches**								
	Parapercis hexopthalma	1							
	Parapercis maculatus	1							
	Parapercis millapunctata					1			
XXII	**Plotosidae - catfishes**								
	Plotosus lineatus	1			1	1			
XXIII	**Pomacanthidae - angelfishes**								
	Centropyge bicolor		1						
	Centropyge flavissima	1					1		
	Centropyge nox					1			
	Centropyge tibicen						1	1	
	Centropyge vroliki	1	1	1	1	1	1	1	1
	Chaetodontoplus mesoleucus	1	1		1		1		1
	Chaetodontoplus sp.				1				1
	Pomacanthus navarchus				1	1		1	1
	Pygoplites diacanthus	1	1	1	1	1	1	1	1
XXIV	**Pomacentridae - damselfishes**								
	Abudefduf sexfasciatus	1		1			1	1	1
	Abudefduf vaigiensis	1			1	1	1	1	
	Amblyglyphidodon aureus	1	1			1	1		1
	Amblyglyphidodon curacao	1		1	1	1	1	1	1
	Amblyglyphidodon leucogaster	1	1	1	1	1	1	1	1
	Amblyglyphidodon ternatensis						1		
	Amphiprion clarkii	1	1	1	1	1	1	1	1
	Amphiprion frenatus	1	1		1	1	1	1	
	Amphiprion melanopus	1						1	
	Amphiprion ocellaris	1	1		1		1	1	
	Amphiprion percula						1		
	Amphiprion perideraion	1		1	1	1	1	1	1
	Amphiprion sandaricinos							1	
	Amphiprion sp.		1	1	1		1	1	1
	Chromis agilis	1							
	Chromis amboinensis	1	1	1	1		1	1	1
	Chromis analis	1	1			1	1		1
	Chromis atripectoralis						1		
	Chromis atripes					1			
	Chromis caudalis							1	
	Chromis cyanea		1	1				1	
	Chromis margaritifer		1				1	1	
	Chromis parasema							1	
	Chromis retrofasciata	1	1	1	1	1	1	1	1
	Chromis scotochiloptera		1	1	1		1	1	
	Chromis ternatensis	1	1	1	1	1	1	1	1
	Chromis viridis	1	1	1	1	1	1	1	
	Chromis weberi	1			1			1	1
	Chromis xanthura							1	1
	Chrysiptera cyanea	1					1	1	
	Chrysiptera rex							1	
	Chrysiptera springeri	1	1	1	1				
	Dascyllus aruanus	1	1	1	1	1	1	1	
	Dascyllus reticulatus	1	1	1	1	1	1	1	1
	Dascyllus trimaculatus	1	1	1	1	1	1	1	1
	Dischitodus perspicillatus	1		1	1			1	
	Dischistodus sp.	1							
	Neoglyphidodon melas	1	1	1	1		1	1	1
	Neoglyphidodon nigroris	1	1	1	1		1	1	1
	Neoglyphidodon thoracotaeniatus	1			1		1		1
	Neopomacentrus taeniurus						1		

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		2010	2010	2010	2010	2002	2010	2010	2010
	Plectroglyphidodon dickii	1			1				
	Plectroglyphidondon lacrymatus			1	1	1	1	1	
	Pomacentrus alexanderae	1	1	1	1	1	1	1	1
	Pomacentrus amboinensis	1	1	1		1	1	1	
	Pomacentrus auriventris						1	1	
	Pomacentrus bankanensis	1	1		1		1		
	Pomacentrus brachialis	1	1	1	1	1	1	1	1
	Pomacentrus burroughi	1	1	1	1		1	1	1
	Pomacentrus chrysurus	1							
	Pomacentrus chrysurus	1							
	Pomacentrus lepidogenys	1			1				
	Pomacentrus moluccensis	1	1	1	1	1	1	1	1
	Pomacentrus nigrominus				1				
	Pomacentrus opisthostigma	1			1		1		
	Pomacentrus philippinus	1					1		
	Pomacentrus retrofasciata							1	
	Pomacentrus simsiang			1					
	Pomacentrus stigma					1	1	1	1
	Pomacentrus taeniometopon	1							
	Pomacentrus vaiuli	1					1		
	Pomacentrus sp.							1	
	Premnas biaculeatus			1					
XXV	**Pseudochromidae**								
	Labracinus cyclopthalmus							1	
XXVI	**Ptereleotridae**								
	Ptereleotis evides	1	1						
XXVII	**Scaridae - parrotfishes**								
	Acanthurus binotalus		1						
	Bulbometopon muricatum						1		
	Cetoscarus bicolor				1	1	1	1	1
	Chlorurus bleekeri	1	1	1	1		1	1	1
	Chlorurus bowersi				1		1	1	
	Chorurus sordidus	1	1				1	1	1
	Hipposcarus longiceps								
	Leptoscarus vaigiensis							1	
	Ptescarus vaigiensis				1				
	Scarus argenteus		1						
	Scarus bleekeri	1	1			1			
	Scarus chameleon	1	1				1	1	
	Scarus dimidiatus	1	1	1	1		1	1	1
	Scarus flavipectoralis	1	1	1	1		1	1	
	Scarus frenatus		1	1	1				
	Scarus ghobban	1							
	Scarus hypselopterus						1		
	Scarus niger	1	1	1	1	1	1	1	1
	Scarus oviceps	1	1	1	1			1	
	Scarus prasiognathos	1			1			1	
	Scarus quoyi						1		
	Scarus rivulatus	1	1	1			1	1	
	Scarus rubroviolaceus						1		
	Scarus russelli	1						1	
	Scarus spinus							1	
	Scarus sp. 1	1	1	1				1	
	Scarus sp. 2	1		1					
	Scarus spinus							1	
	Scarus tricolor	1	1	1	1		1	1	
	Siganus virgattus	1							
XXVIII	**Scorpaenidae - scorpionfishes**								
	Pterois antennata	1				1			
	Pterois volitans	1			1	1	1	1	
XXIX	**Serranidae - groupers/ basslets**								
	Aethaloperca rogaa				1		1		
	Anyperodon leucogrammicus								1
	Cephalopolis argus	1	1	1	1	1	1	1	1

Southeastern Cebu Province Fish Species List as of March, 2010		Daanlungsod-Guiwang Marine Sanctuary	Arbor Marine Sanctuary	Granada Marine Sanctuary	Gawi Marine Sanctuary	Sumilon Marine Sanctuary		Pasil Marine Sanctuary	Colase Marine Sanctuary
		2010	2010	2010	2010	2002	2010	2010	2010
	Cephalopolis boenak	1					1		
	Cephalopolis cyanostigma					1	1	1	
	Cephalopolis microprion	1	1	1	1			1	
	Cephalopolis miniata							1	
	Cephalopolis sexmaculata							1	
	Cephalopolis urodeta					1			
	Diploprion bifasciatum	1							
	Epinephelus cyanostigma							1	
	Epinephelus maculatus					1			
	Pseudoanthias huchtii	1	1	1	1		1	1	1
	Pseudoanthias pascalus		1						
	Pseudoanthias tuka	1	1	1	1		1	1	1
	Variola albimarginata							1	
XXX	**Siganidae - rabbitfishes**								
	Siganus argenteus			1	1				
	Siganus canaliculatus	1		1					
	Siganus corallinus							1	1
	Siganus doliatus					1			
	Siganus guttatus						1		
	Siganus punctatissimus					1			
	Siganus unimaculatus	1		1	1		1	1	1
	Siganus virgatus	1	1	1	1			1	
	Siganus vulpinus	1				1		1	
XXXI	**Sphyraenidae - barracudas**								
	Sphyraena flavicauda	1	1		1			1	
XXXII	**Syngnathidae - pipefishes**								
	Corythoichthys intestinalis					1			
XXXIII	**Synotodontidae - lizardfishes**								
	Saurido gracilis								
	Synodus dermatogenys	1		1			1	1	
XXXIV	**Tetraodontidae - puffers**								
	Arothron hispidus					1			
	Arothron meleagris					1			
	Arothron nigropunctatus	1				1	1		
	Canthigaster compressa	1							
	Canthigaster papua	1	1				1		
	Canthigaster valentini		1		1	1	1		
XXXV	**Zanclidae - moorish idol**								
	Zanclus cornutus	1	1	1	1	1	1	1	1
TOTAL		153	96	94	131	106	168	162	77

295 species and 35 families overall for 2010

Appendix 4. Saving Philippine Reefs 2010 Expedition Photos

A mantis shrimp (*Odontodacyllus scyllarus)* up close and personal. (*E. Lucas*)

A fisherman with the mountains of Boljoon in the background. (*E. Lucas*)

Alan and Vangie sharing yet another sweet anniversary together. (*J. Johnson*)


A school of surgeonfishes (*Acanthurus hexacanthus)* inside the Pasil Marine Sanctuary. (*J. Johnson*)

An anemone crab (*Neopetrolisthes sp.)* hiding in North Granada Marine Sanctuary. (*J. Johnson*)

A pair of cuttlefishes (Sepia sp.) hanging out at Gawi Marine Sanctuary. (J. Cichowski)

The breathtaking view everyone wakes up to in the morning at Sumilon Island. (*J. Cichowski*)

A seasnake (*Laticauda colubrina)* about to take some fresh air at the surface. (*J. Cichowski*)

Lively and colorful sealife inside the Sumilon Island Marine Sanctuary. (*A. Sabonsolin*)

A school of batfishes (*Platax tiera)*. (*TJ Mueller*)

A view above from deep down inside the Sumilon Island Marine Sanctuary. (*L. Boillon*)

Sumilon Island, Oslob, Cebu. (*L. Boillon*)

Saving Philippine Reefs Team 2010 (L-R standing: Chance Usrey, Raffy Martinez, Analie Candido, TJ Mueller, Alan White, John Rowland, Heather D'Agnes, Peter Haasz, Steve Ludemann, Jimmy Paguio, Ian White, Alastair Pennycook, Geoff Illing, Ethan Lucas, Dean Apistar, Agnes Sabonsolin, Wenifel Porpetcho. L-R sitting: Sandy Robb, Jill Johnson, Vangie White, Sheryll Tesch, Liza Osorio, Jong Rojas, Heather Ludemann, Julia Cichowski, Laurent Boillon, Vittoria Thornley, Denise Illing, Eugene Matildo, Romel Kirit)