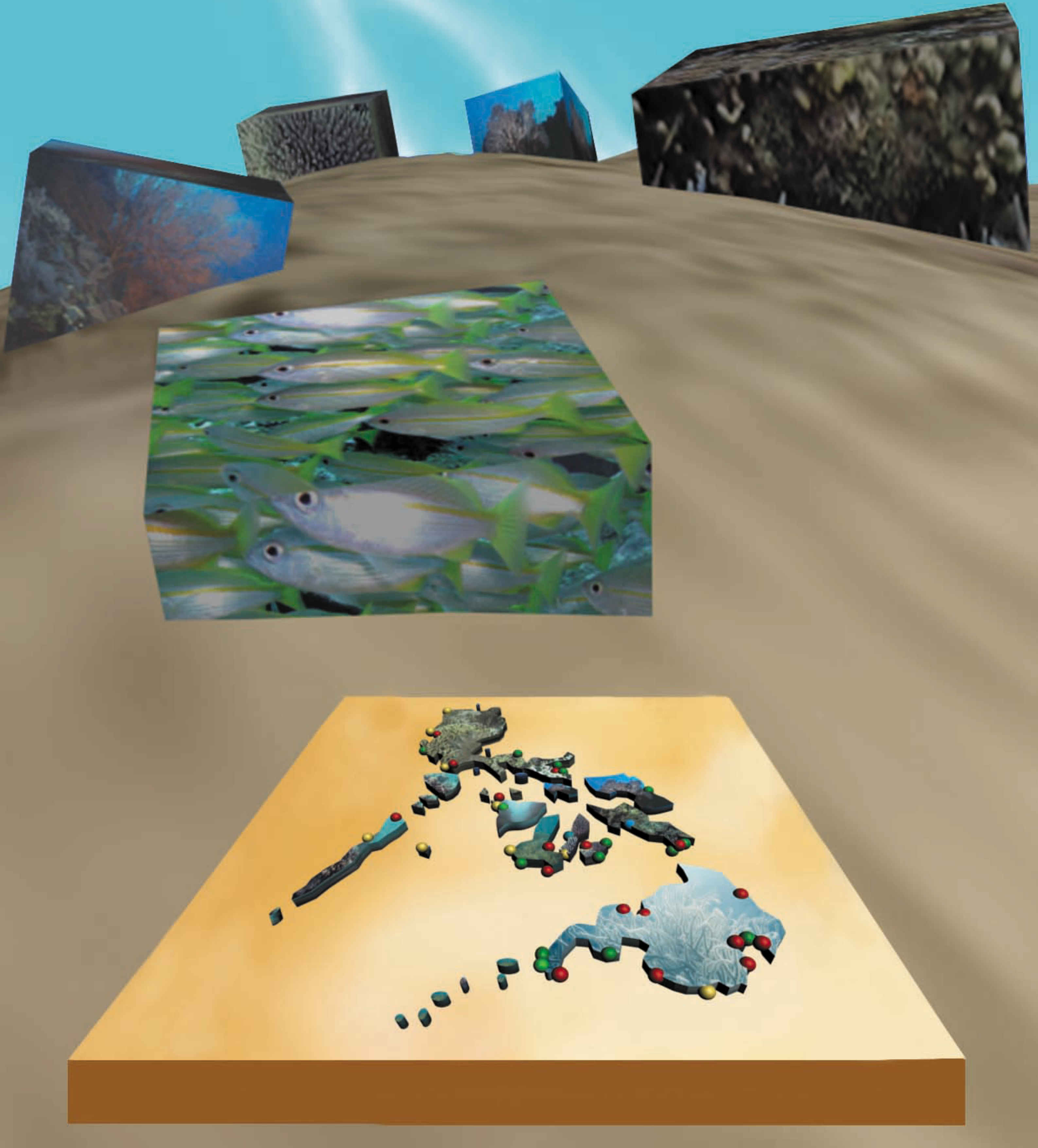
PHILREEFS

SECOND OF A SERIES

# PHILIPPINE CORAL REEFS THROUGH TIME



**P H I L R E E F S**
**SECOND OF A SERIES**

# philippine coral reefs through time

## workshop proceedings
## second of the atlas of philippine coral reefs series

**by**
**Coral Reef Information Network of the Philippines (PhilReefs)**
**and the University of the Philippines Marine Science Institute**
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# FOREWORD

Studies on Philippine coral reefs date back to the 1930s with the pioneering taxonomic works of Francisco Nemenzo, then based at the University of the Philippines. However, it was not until the mid-1970s when intensive studies on coral reefs as ecosystems were started, this time also by a scientist, Dr. Edgardo D. Gomez, at the University of the Philippines. Gomez founded the newly established Marine Science Institute (then known as the Marine Science Center) at the University of the Philippines, Diliman in 1974. Unlike Nemenzo, who worked alone, Gomez involved other academic institutions in the central Philippines and a couple of national government agencies (Bureau of Fisheries and National Mapping & Resource Information Authority) in a comprehensive survey of Philippine coral reefs beginning in 1976. The academic institutions are Silliman University and University of San Carlos. The choice of these institutions was of strategic importance as these institutions are situated near the southern and southwestern parts of the country where many of the coral reefs of the country exist. The initial effort blossomed into a major scientific development that five years later in 1981, when the Fourth International Coral Reef Symposium was held in Manila, Filipino scientists were able to present a number of coral reef and reef-related papers.

We must recognize the pioneering effort and vision of Dr. Edgardo D. Gomez of the University of the Philippines that led to the present compilation of the results of the research effort of scientific workers on the various aspects of coral reef studies in the Philippines. It is notable that the scientists behind the publication of this volume are colleagues of Dr. Gomez at the UP Marine Science Institute.

This collection of coral reef papers further illustrates how much coral research has accomplished and the progress of conservation effort thus far. One thing seems clear and that is, much remains to be done by scientists and conservationists alike to assure the survival of these important marine ecosystems. The contributions in this collection also show the variety of interests of present-day coral reef biologists in the country. One clear direction is the conservation, management and protection of reef resources. Another one is the drive toward sustainable coral reef fisheries.

This report should be considered an initial attempt to mark the progress of coral reef research and conservation through time that may be updated from time to time. It is hoped the present volume will serve to sustain the interest of Filipino scientists on coral reef research and to provide current information on the status of Philippine coral reefs.

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# PREFACE

Recent pioneering coral reef studies have been undertaken in the Philippines by the dynamic duo of Gomez and Alcala which provided the first nationwide surveys. In the mid-seventies Alcala and co-workers paved the way for the establishment of no-take areas in small islands which are managed by local communities. These two complementary themes in understanding and proactively responding to coral reef issues and concerns at different scales, show the importance of integrating reef science and the management of human society's activities. Beyond the serendipitous initiatives of individual studies and institutional mandates, a convergence of connected efforts in linking science and management has been emphasized in the 1981 4$^{th}$ International Coral Reef Symposium hosted in Manila. Highlighting the emphasis of global action and the responsibilities of governments and civil society to coral reefs and its related ecosystems, the International Coral Reef Initiative (ICRI) was hosted in 1995 at Dumaguete City. As part of the Philippine contribution to this initiative, the Philippine Coral Reef Information Network was born in 1997 (through funds from the Department of Science and Technology [DOST] – Philippine Council of Aquatic and Marine Research and Development [PCAMRD]) which helped to facilitate coral reef information and management action. Many noteworthy national efforts in coastal management have been undertaken such as: the establishment of the Coastal Environment Program (CEP) of the Department of Environment and Natural Resources (DENR) and the DENR-Coastal Resources Management Project (CRMP) funded by the United States Agency for International Development (USAID); the Department of Agriculture - Bureau of Fisheries and Aquatic Resources (DA-BFAR) Fisheries Sector Program (FSP) and the Fisheries Resources Management Project (FRMP) through the Asian Development Bank - Overseas Economic Cooperation Fund (OECF). The blossoming of good practices from a multitude of non-governmental organizations (NGOs) is seen through the ever increasing contributions of community based coastal management efforts and marine conservation apparent in the pages of the "Atlas of the Philippine Coral Reef (PhilReefs 2002)". Regional efforts have also enhanced our understanding of threats and risks on reefs as seen through the Reefs at Risk of Southeast Asia (Burke et al. 2002). This update "Philippine Coral Reefs through Time" is part of the contribution of the Philippines to the bi-annual status reports by the Global Coral Reef Monitoring Network (GCRMN) funded by the Marine Parks Center of Japan, Ministry of Environment, Japan.

A general framework which summarizes the status of reefs (including trends), the pressures and the management efforts being undertaken in the area is reported. "Philippine Coral Reefs through Time" is the second of a series produced by PhilReefs and can be viewed through its homepage (www.msi.upd.edu.ph/midas). It seeks to: share information on the assessment and evaluation of reefs in the Philippines, identify gaps in their monitoring and evaluation, synthesize some emergent trends and suggest some future areas of concern and action.

There has been a range of monitoring methodologies on reefs employed in the Philippines (see Uychiaoco et al. 2001 for a brief overview). Methods such as those employed by the GCRMN (with modifications using blocks as markers as reported by Quibilan et al. in this volume) and community based participatory methods with fishers such as that used by UNDP-GEF-SGP/CRMP (Uychiaoco et al. 2001) are easily compatible with Reef Check and Earthwatch used mainly by White and co-workers [this volume]. This attempt to derive some general trends from a highly variable multidimensional space-time continuum is laudable. The results through various years from over three dozen sites (with reports of at least two time periods) have been compiled. In each section, the pressures (e.g., threats and their impacts), conditions (e.g., gross trends through time) and management regimes in the area are reported. In general, despite the prevalent indications of decline in reef conditions, the Visayas region showed more sites having indications of increased coral cover. Despite the limitations of the various methods employed here, there seems to be promising signs to propose that perhaps the exemplary efforts in establishing no-take areas in the Visayas biogeographic region have shown some positive effects (as seen in the Philippine overview section). Also, noteworthy in this report is the importance of the interaction of naturally-induced impacts (e.g., coral bleaching from El Niño and storms) with that of human-induced impacts (e.g., overfishing and siltation from deforestation). The Philippines despite being considered as one of the hottest of the hotspot in the world, offers hope amidst the seeming decline against all odds of runaway population growth, poverty and deprivation. Environmental governance mechanisms are emerging to deal with lack of political will in many areas and a growing constituency is seen from all the community-based initiatives in coastal management.

Aside from lessons gained, there are great needs for improved spatially and temporally explicit design for better explanatory and predictive power in tandem with proactive action through an adaptive management approach. Capacity building efforts have seen the linking of monitoring and evaluation initiatives to timely responses and enhancing the feedback cycle. More nationwide efforts are seen in formulating a national marine sanctuary strategy and also a network of marine sanctuary managers (e.g., through PAMANA) and through ecoregion approaches and marine corridors which all lead to a functional network of MPAs. Coordinating mechanisms for more integrated efforts towards a more equitable and synergistically beneficial outcome to the greater majority of the populace remains to be addressed. The increasing threats and complexity of coral reef ecosystems seen in the Philippines at different scales, emphasizes the urgent need for more enhancement and remediation initiatives of the degraded and overexploited areas. Despite the presumed connectivity of reefs, understanding the implications of recruitment processes will still be a challenging arena in the science and management of reefs.

## Acknowledgements

Clearly this work has been the result of painstaking efforts in time by many people and institutions. Not only are their efforts emblazoned in these pages but many more needs to be recognized for making this document possible. The Marine Parks Center of Japan and the Ministry of Environment provided the financial assistance for the holding of the workshop. Many thanks are greatly deserved by the secretariat of the Marine Science Institute and the partners of the Philippine Coral Reef Information Network.

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# GCRMN-PHILIPPINES WORKSHOP: PHILIPPINE CORAL REEFS THROUGH TIME

February 27-28, 2002
A Synthesis of the Discussions

Prepared by Andre J. Uychiaoco, Melchor R Deocadez and Hiyasmin G. Alano

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The workshop, sponsored by the Marine Parks Center of Japan, aimed to mobilize a network in the Philippines through which information on the trends in Philippine coral reefs may be shared (with researchers properly acknowledged) and jointly (in a participatory fashion) synthesized. This information will be the Philippines' input to the Global Coral Reef Monitoring Network (GCRMN) specifically to the GCRMN Southeast Asia report. Even though the synthesis is being organized as an input to the Southeast Asian region, the synthesis should also be made useful for management at various (including local) scales. There were 35 participants representing at the very least that many coral reef sites that were observed at least on two separate years.

The participants were interested in: (1) Definition of Monitoring, (2) What to monitor (including threats and their effects) and how (standard methods, including with the community), (3) Status and trends (of fish and benthos), (4) Interpretation of status and trends (including indigenous knowledge), (5) Solutions the trends and interpretations may point to (i.e., application), and (6) How do we collaborate further and sustain collaboration (including technical assistance with analyses, regional meetings, etc.). The first 3 were addressed more directly while the last 3 are to be addressed through future communications among the participants.

Three presentations revealed different aspects of coral reef monitoring and interpretation of information. Hazel Arceo presented on the monitoring of adult and juvenile fishes in and around some marine protected areas. However, it was still too early to tell whether biomass increase in and around the MPAs were due to decreased mortality of fish recruits or due to adult spillover. Miledel Christine Quibilan presented the difficulties involved in inferring changes through time of El Nido coral reefs from various uncoordinated studies. She also presented on the impact of bleaching on coral reefs and coral recruits in the South China Sea and Sulu Sea. Cleto Nañola, Jr. presented on the change in the reef fish community and the macrobenthic reef community and their subsequent (partial) shift back due to the 1998 mass bleaching event.

## Definition of Monitoring

Monitoring is not simply repeated surveys, rather monitoring is specifically designed to detect changes over time and as such would generally repeat measurement of the same variables using consistent methods in the same area. Moreover, research complements monitoring specifically by using the scientific method to answer research questions. Ideally, monitoring should lead to actions (e.g., management response). It should not matter as much who monitors as long as standardized methods are used; this will require standardized trainings as well.

## What and How to Monitor

Coral reef monitoring methods being used in the Philippines include those in English et al. 1997, ReefCheck, Uychiaoco et al. 2001 and ReefBase's Aquanaut. Fisheries species of importance to the local community (including sea urchins and sea cucumbers), water quality and management interventions are also being monitored by some. Transects are sometimes marked/fixed. The AFMA-MFR team has put together a comparison matrix of the various monitoring methods being used in the Philippines. Monitoring is/must be done at various scales. Standard and comparable techniques and analyses were recognized to be important even though there would inevitably be observer differences. Those who monitor Philippine coral reefs range from scientists to local community groups. Monitoring must be of sufficient precision to be able to detect the changes of interest.

Summarization and visualization methods include using ReefSum, Lifeform, CANOCO, TWINSPAN, Statistica, and PC-ORD. Interpretation is derived mainly through discussions. Comparing monitoring results to set/acceptable levels of change was also suggested.

## Uses of Monitoring

Monitoring may be used to: (1) evaluate the extent of management effectiveness, (2) to ascertain level of management benefits, (3) to identity problems and gaps, (4) to determine trends through time, to help determine cause and effect of people and of natural disturbances and reefs, (5) to predict changes, (6) to help direct management efforts, (7) to set research priorities, (8) to aid legislation, (9) to improve understanding, and (10) to lend a better appreciation, and (11) to aid lobbying.

Monitoring data can be made more useful and accessible by setting up a regional information-sharing system (e.g., database) that generates data summaries (e.g., on the internet) and is easily accessible. The different sectors must be involved (academe, grassroots organizations, local government, national government agencies, NGOs, etc.). Regular feedback of the results on-site is very important. On the other hand, regional and national information must also be synthesized accurately. We should also be contributing to existing information networks (e.g., PhilReefs, PAMANA, ICLARM's ReefBase); we will need a directory of such networks. It should not be necessary to contribute raw data but only to inform others that such data exists and who has it. The information should be published both for a popular audience as well as for a scientific audience. Small bits of information (not necessarily scientific) would also be useful to have available. These would allow for information on things that we commonly ignore, provides leads/opportunities for further studies and may give an indication on the scale of problems (e.g., local or regional).

## Problems in Monitoring

Some of the problems in monitoring include (1) the project-specific nature of data collection (e.g., when project ends, data collection stops and nobody gets to use it), (2) the lack of long-term commitment to following up the monitoring of specific sites, (3) unclear roles and expectations between various agencies, (4) lack of data validation procedures (suggestions: have more people involved, publish results, agree on principles for reporting, process and mutual respect), (5) lack of a facility to consolidate data, (6) lack of sustainability in monitoring.

## Sustainability of Monitoring

Sustainability may be approached by: training local communities, institutional/personal commitment, greater understanding of the importance of monitoring, greater support from research groups, improved access to equipment, more technical/financial support, empowering local government, encouraging people to monitor, greater education and guidance in monitoring. Another way is make sure local institutions are involved, more regional or national institutions should play a more facilitative rather than a more direct role.

## Regional Summaries

The participants were divided into 6 groups corresponding to each of the Philippines' 6 marine biogeographic regions to synthesize trends in coral reefs (i.e., benthos, fish assemblage, fisheries, management and threats) (Appendix 1). The groupings were as follows (point persons selected within each group are underlined):

1. Visayan Seas – <u>Angel Alcala</u>, <u>Wilfredo Uy</u>, Catalina Rañola, Jade Fraser, Annabel Barillo, Joselito Alcaria and Senona Cesar
2. Sulu Sea – Anna Meneses, Micaela Ledesma, Pacifico Beldia, Terence Dacles, Joel Palma
3. South China Sea – <u>Miledel Christine Quibilan</u>, Hazel Arceo, Rene Dumlao, Edmundo Enderez
4. North Philippine Sea – <u>Vic Soliman</u>, <u>Vincent Hilomen</u>, Michael Atrigenio, Ephraim Batungbacal, Kristine Santos
5. South Philippine Sea – <u>Rowan Byrne</u>, <u>Danilo Alura</u>, Wilfredo Licuanan, Bernadette Nanual
6. Celebes Sea – <u>Ninette Lasola</u>, <u>Julie Otadoy</u>, Cleto Nañola Jr.

Each group was to synthesize the trends of the following in their region: (1) Change in condition indicators (benthos change, fish assemblages, fishing effect or like changes). (2) Threat indications (destructive fishing, habitat modification (including sedimentation), pollution, natural threats, coral disease). (3) Management response indicators (MPA, other type of interventions, or no management intervention). Each of the 6 groups presented a summary of their region.

## Suggestions and Standardization

Suggestions that came from the regional summarization exercise include: (1) standardization of the units used to measure fishing effort, (2) use of the mean/median as a standard/basis for designating high or low, (3) for this year, monitoring transects that were not fixed will still be used for time series information. (4) Trends of fisheries CPUE may be erratic but composition shifts might be more revealing.

Factors to consider in standardization include: seasonal variability, within and among site variability, threats and management being done in the area. It was suggested that we look further into standardizing: (1) the criteria to be used to judge trends (as increasing, stable or decreasing), management and issues (to be led by Julie Otadoy and Wilfredo Uy), (2) how to report results (to be led by Terence Dacles but see next paragraph), and (3) data collection methods (e.g., replication, transect lengths; to be led by Rowan Byrne).

To help standardize reporting of results, it was agreed that benthos data be reported as % cover of the following: hard coral, soft coral, dead coral, dead coral with algae, algae, and other biota and abiotic. Fish data should be reported as $mt/km^2$ (in the case of yield), kg/1000 $m^2$ (in the case of biomass) and/or individuals/1000 $m^2$ (in the case of density). The abundance of the following fish families would be reported where possible: Scaridae, Acanthuridae, Labridae, Pomacentridae, Serranidae, Chaetodontidae. Fisheries data would be reported as kg/man-hr. Other suggestions include monitoring the presence of coral diseases (and the required training for this) and management issues.

A system and guiding principles must be drafted for the proper acknowledgement of information contributed. A suggested option was that one would be considered an author if he/she substantially contributed to 2 out of the following 3 (a. Conceptualization, b. Data collection, and c. Analyses/Report Writing). For this volume, it was suggested that monitoring team members involved in collecting data on at least 2 of the years might be included as an author if the information had not been previously published and it is not merely being cited.

Further discussions will be facilitated through e-mail and other telecommunication.

## Acknowledgements

We would like to acknowledge Rain Mendoza for encoding some of the workshop documentation.

# PHILIPPINE CORAL REEFS THROUGH TIME

Summarized by Andre J. Uychiaoco and Melchor R. Deocadez
from all the contributed chapters
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c/o Marine Science Institute, University of the Philippines, Diliman, Quezon City 1101, Philippines

## Reef Status

Coral reefs are widespread throughout the Philippines with an estimated area of 26,000 km$^2$ (Burke et al. 2002). Much of the reefs are in and around Palawan (western Philippines). Slightly less than 70% of sampled reef sites exhibit less than 50% coral cover (Licuanan et al. 2000). Reef fish biomass is generally very low compared to other places (Hilomen et al. 2000). However the Philippines is within the global center of coral diversity (Veron & Stafford-Smith 2000) and reef fish diversity (Allen 2000, Hilomen et al. 2000).

This update focuses on time-series data of Philippine coral reefs in 63 municipalities/cities from 32 provinces. From all the contributed information, trends were determined for each site by computing the slopes (annual rates of change) of (1) hard coral cover and (2) total fish biomass, target fish density or total fish density (in order of decreasing preference). Individual slope estimates were averaged for sites which were closer than 0.1 degree (combined longitude and latitude) apart and within the same municipality. Sites were combined to help make them distinct when plotted on a map. Hard coral slopes whose absolute values were less than an arbitrarily-chosen 1.0% per year were considered "stable/variable/unknown". Slopes of fish abundance were divided by the average fish abundance estimates to yield a percentage rate of change. Percentage rates of change of fish whose absolute values were less than the arbitrarily-chosen 2.0% per year were considered stable. Hard coral and fish rates that were higher than the 1% and 2% cut-offs respectively were considered increasing while rates that were less than the cut-offs were considered decreasing.

These time series were mostly began in the 1990s. Unfortunately, this is a biased data set since an overwhelming majority of these time series were collected on managed (e.g., protected) reef sites. The data exhibits an overall increasing trend for coral and an approximately half-increasing, half-decreasing trend for reef fish abundance (Table 1, Figures 1 & 2). It must be stressed that these trends were not statistically tested. Sampling that is not explicitly designed for monitoring would tend to have somewhat random trends and exhibit equally increasing and decreasing trends as was observed for reef fish abundances.

Table 1. Trends in hard coral and fish abundance by biogeographic region

| | Hard Coral | | | Fish Abundance | | |
|---|---|---|---|---|---|---|
| | Increasing | Stable/Variable/Unknown | Decreasing | Increasing | Stable/Variable/Unknown | Decreasing |
| South China Sea | 3 (Alaminos, Masinloc, Mabini-Tingloy) | 4 (Luna, San Fernando, Anda, Pasuquin) | 6 (Bolinao, Sual, San Vicente, El Nido, Kalayaan, Sablayan) | 2 (Luna, Pasuquin) | 1 (Sual) | 6 (Anda, Bolinao, Mabini-Tingloy, Masinloc, Puerto Galera, San Vicente) |
| Philippine Sea | 3 (Tabaco, San Andres, Borongan) | 1 (Hinatuan) | 2 (Mercedes, Sagnay) | 2 (Borongan, Mercedes) | 0 | 0 |

Table 1. Trends in hard coral and fish abundance by biogeographic region (continued)

| | Hard Coral | | | Fish Abundance | | |
|---|---|---|---|---|---|---|
| | Increasing | Stable/Variable/Unknown | Decreasing | Increasing | Stable/Variable/Unknown | Decreasing |
| Visayan Seas* | 12 | 5 | 7 | 9 | 1 | 9 |
| Sulu Sea | 3 (Sebaste, Culasi, Nueva Valencia) | 3 (Cauayan, Turtle Islands, Tubbataha) | 2 (Libertad, Pandan) | 1 (Tubbataha) | 3 (Cauayan, Culasi, Pandan) | 3 (Libertad, Nueva Valencia, Sebaste) |
| Celebes Sea | 3 (Kiamba, Vicenzo Sagun, Babak) | 4 (Kalamansig-Lebak, Digos, Zamboanga City, Mabini) | 3 (Malita, Kaputian, Gov. Generoso) | 3 (Kiamba, Vicenzo Sagun, Zamboanga) | 0 | 0 |
| TOTAL | 24 | 17 | 20 | 17 | 5 | 18 |

* Please see individual chapters for specific municipalities/cities

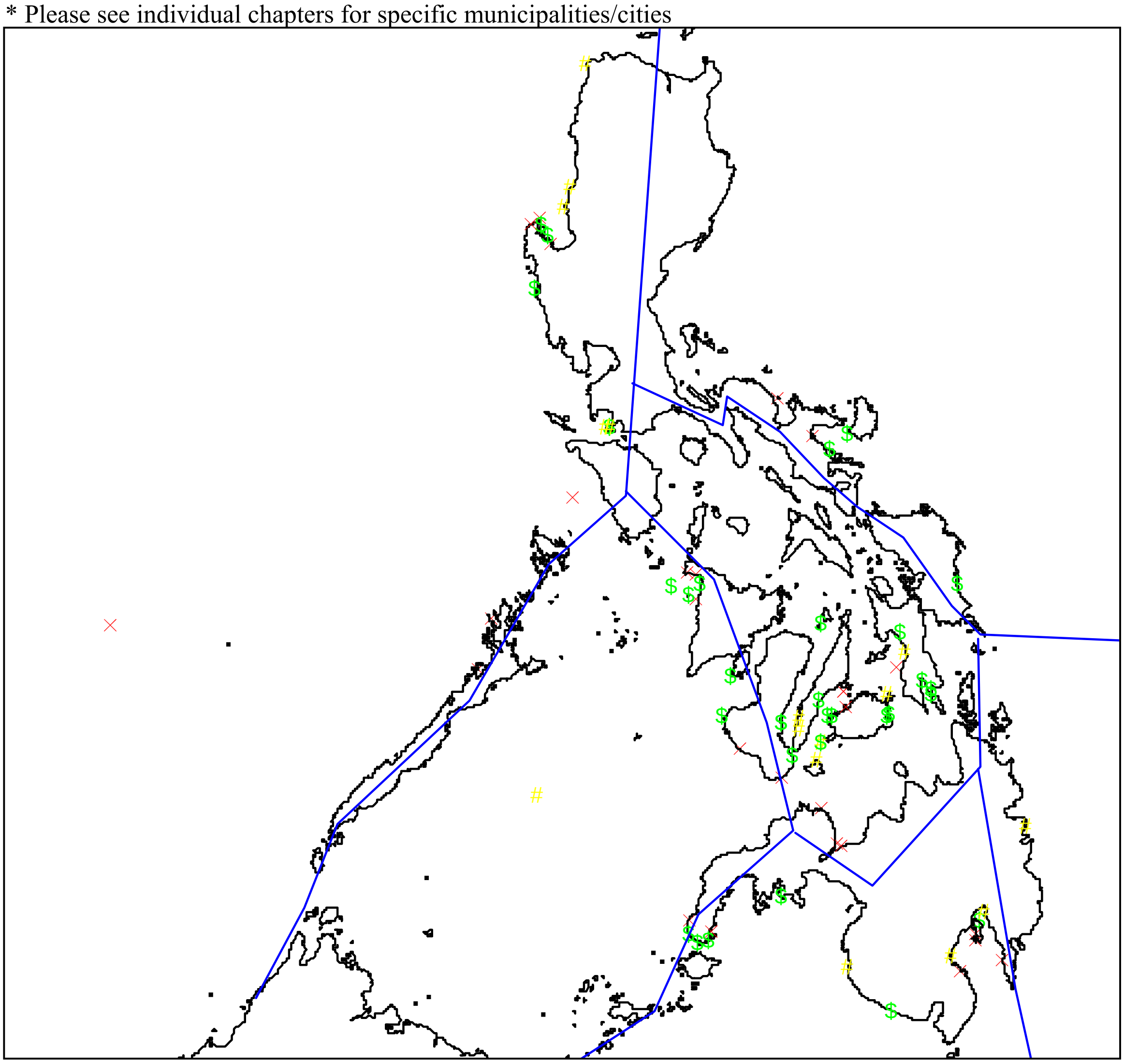

Figure 1. Hard coral trends observed in the Philippines (red X refer to decreasing, yellow circles refer to stable/variable/unknown, green triangles refer to increasing)

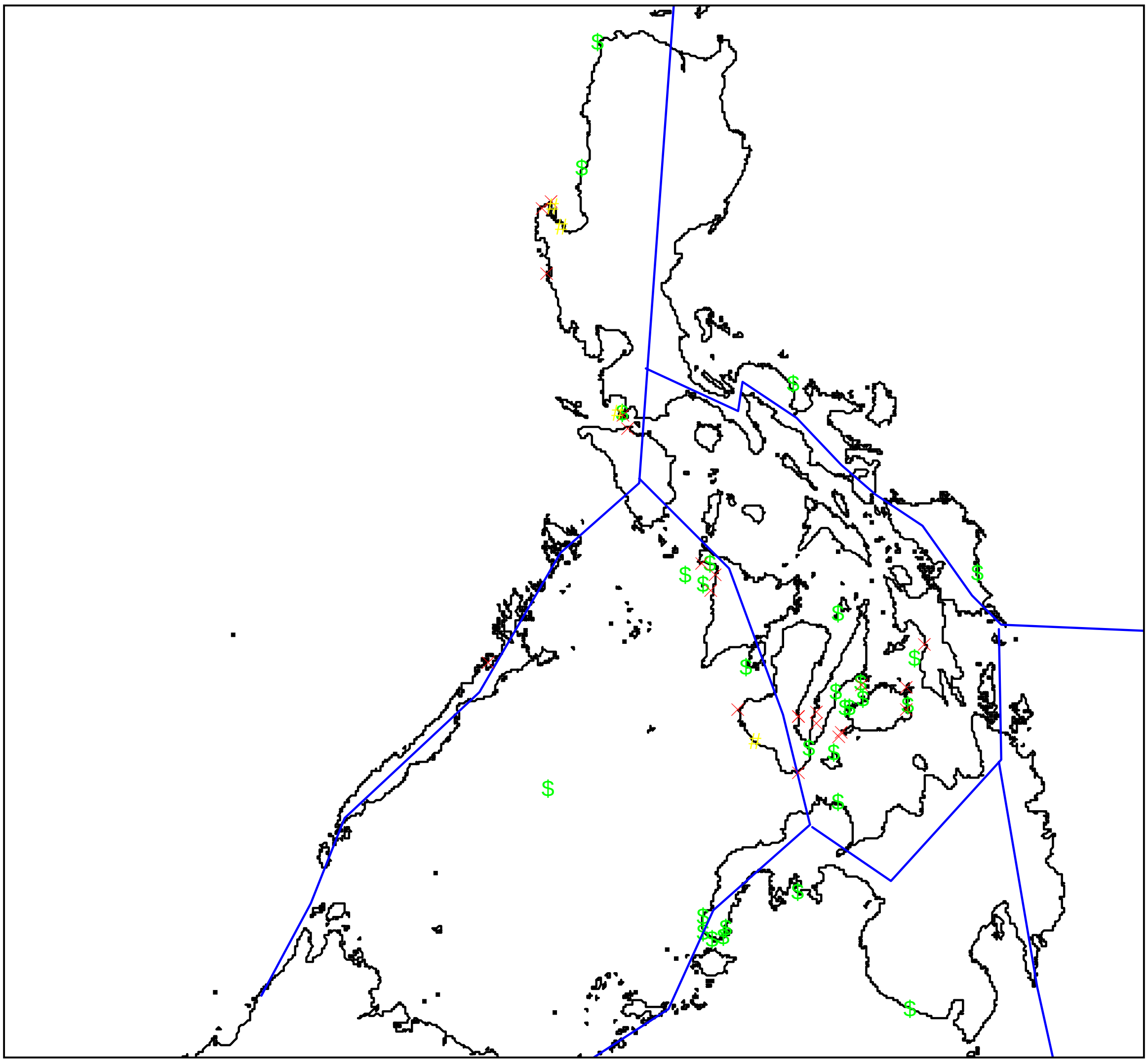

Figure 2. Reef fish abundance trends observed in the Philippines (red X refer to decreasing, yellow circles refer to stable/variable/unknown, green triangles refer to increasing)

## Impacts

The estimated threats mapped in Reefs at Risk in Southeast Asia are probably the most up-to-date national picture of overfishing, destructive fishing, coastal development, marine-based pollution, and climate change impacts (Burke et al. 2002). A large proportion of the impacts on Philippine reefs stem from the very high population density of the nation (and associated food and income requirements). Destructive fishing (blasting and poisons) and overfishing continue to top the list of anthropogenic impacts on Philippine coral reefs. Poaching in protected areas and/or by large commercial fishing boats nearshore (including the weakness of local communities and poor governance). The Reefs at Risk overfishing indicator, which is based on population, is high throughout most of the country except the far west (Palawan). On the other hand, destructive fishing is most intense in Palawan and the Visayas (central Philippines). The most significant threats to Philippine coral reefs are those associated with fishing. Coastal development threats to coral reefs are high to medium in the Visayas. Sedimentation is a threat mainly to western Luzon (northern Philippines) and to Mindanao (southern Philippines); however, the sedimentation map reflects a modeled risk, impact of which may either have already occurred in the past, is happening now or is yet to occur. There were many reports of bleaching in 1998 mostly coinciding with sea-surface temperature anomalies (Arceo et al. 2000, Burke et al. 2002). Many storms come through the country generally from the east.

## Management

Generally, only a tiny fraction of the nation's coral reefs are being managed adequately, the rest are under heavy stress. Community-based management, while sometimes very effective, continues to be successfully implemented only in very small areas. Management in conjunction with local government (including coastal law enforcement) continues to rapidly gain ground but its conservation effectiveness is not yet evident in the reef data.

Conservation International and the Worldwide Fund for Nature have both conducted geographic priority-setting exercises for management/protection of Philippine marine biodiversity (Ong et al. 2002, WWF in press). Management is still clearly inadequate for the Spratly Islands, the Babuyan Channel, the Sulu Archipelago and the San Bernardino Strait.

The Philippines has approximately 400-500 marine protected areas (Aliño et al. 2000). The ones focused on biodiversity conservation are mainly guided by the National Integrated Protected Areas System Act of 1992 or for mangroves it is Presidential Proclamations 2151 and 2152 and managed by the Department of Environment and Natural Resources (DENR). The Department of Environment and Natural Resources' (DENR) Coastal Environment Program has just been institutionalized (in 2002) as the DENR's Coastal and Marine Management Office. The ones managed by the Department of Tourism are focused on tourism and guided by Presidential Proclamation 1801. The most numerous type of MPAs are those established by municipal governments mostly for the purpose of sustainable fisheries. These latter MPAs are also guided by the Fisheries Code of 1998. The Wildlife Resources Conservation and Protection Act of 2001 (Republic Act 9147) is a new law that aims (a) to conserve and protect wildlife species and their habitats to promote ecological balance and enhance biological diversity; (b) to regulate the collection and trade of wildlife; (c) to pursue, with due regard to the national interest, the Philippine commitment to international conventions, protection of wildlife and their habitats; and (d) to initiate or support scientific studies on the conservation of biological diversity. The implementing Rules and Regulations of a new Wildlife Act by which wildlife sanctuaries may also be established are currently being discussed.

The Philippines' needs to contextualize individual protected areas and form alliances within larger national and international frameworks to address large-scale economic and political forces beyond the protected area. The need for widespread replication must be addressed alongside the need for sustainability of human and financial resources (Uychiaoco et al. 2002). The Philippines does not yet have a nationally-recognized national coral reef action plan.

The lack of sustainable financing is one of the most often cited problems in Philippine coastal management. Tourism is not applicable as a source of revenue in many far-flung areas and so other sources of financing must be sought. More attention must be leveled at resource rents, user fees and co-financing/counterpart arrangements that would be adequate for the coral reef management costs. To this end, monitoring data should also be collected on the various resource fees, coastal management revenues and expenditures (e.g. the costs of managing 1 hectare of no-take zone) and their various sources.

## Monitoring

Monitoring methods being used for coral reef biota include (in decreasing order of estimated prevalence of use): GCRMN (English et al. 1994), simplified GCRMN, simplified hybrid (GCRMN, ReefCheck & Aquanaut) plus enhancements developed by UPMSI/GDFI/VSO/GEF-SGP/UPCIDS/CRMP/FRMP for local communities (Uychiaoco et al. 2001), ReefCheck, ReefBase's Aquanaut, and Coral Cay Conservation protocol. Systematic monitoring of stresses and threats have only been begun in the last 5 or so years. Systematic monitoring of local government management of coastal resources has only been begun by the USAID/DENR-Coastal Resource Management Project in the last 3 years.

Reef monitoring still needs to be better coordinated: uneven sampling distribution and unnecessary re-establishment of new transects (as opposed to re-sampling old transect sites). Some capacity for socio-economic assessments is available but has not yet been much used specifically for monitoring. During the 2002 AFMA-MFR national meeting, government, NGOs, community organizations and academic organizations identified priority indicators for MPA monitoring as: (1) fish abundance and fish catch, (2) habitat quality, (3) quality of human life, (4) participation in management, and (5) enforcement and compliance (Campos in prep.). The Philippine experience in participatory monitoring of coral reefs together with local communities shows that participatory monitoring yields more information (especially of times between formal monitoring activities), takes less resources and is more closely related with and actually helps management (Uychiaoco et al. 1998).

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# CHAPTER 1 SOUTH CHINA SEA REGION

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## 1.1 Introduction

The South China Sea (SCS) basin is strategically located between the Pacific and the Indian Oceans and covers a total area of approximately 3.4 million km$^2$ (Chou and Aliño 1992). It is bordered by the People's Republic of China to the north; Republic of the Philippines to the east; Malaysia, Singapore, Indonesia, Sultanate of Brunei to the south; and to the west are the Kingdoms of Thailand and Cambodia and the Socialist Republic of Vietnam. The SCS marine bio-geographic region is one of the most biologically diverse in the world. Forty-five species of mangrove from the global total of 57, 50 of 70 coral genera, 20 of 50 species of seagrass, and 7 of 9 giant clam species are found in the nearshore areas of the South China Sea (Talaue-McManus 2000). A recent checklist of marine fishes in the area reveals a total of 3365 species belonging to 263 families (Randall and Lim 2000). The estimated value of the products and ecological services provided by the coral reef systems of the SCS is estimated at US$ 13,792 million per year (UNEP SCS/SAP Ver. 3 1999).

## 1.2 Biophysical Setting

The coral reefs west of the Philippines, based on geographic location, can be categorized into two types namely: nearshore fringing reefs lining the coastlines of islands and the more developed and extensive offshore reef areas like those in the Kalayaan Island Group. The distribution of reef areas in this area is far ranging. With Manila as the reference point, reefs can be found far north such as the Batanes group of islands and along the coastlines of Luzon Island (including the Scarborough shoal). Towards the south, reef areas fringe the bays of Batangas and Mindoro provinces. Apo reef the second largest marine park in the country is situated along the Mindoro strait. Moving southwest from Manila, reef areas can also be found in the Calamianes group of Islands, along the main island of Palawan and all the way to the Balabac islands. However, the most extensive and least explored reef areas can be found west of Palawan – the Kalayaan Island Group.

On a broad-scale, western Philippine reefs are greatly influenced by the pre-dominant current patterns and hydrodynamic regimes of the South China Sea. However, there are areas where reefs are constantly exposed to the exchange of water masses via the straits. For example, the Luzon strait links the South China Sea and the Pacific Ocean while the Mindoro, Linapacan and Balabac straits are major corridors for the exchange of water masses between the South China Sea and the Sulu Sea as well as to other adjacent seas (e.g., Sibuyan Sea).

## 1.3 Socio-economic Setting

A total of 270 million people live in the coastal sub-regions of seven countries namely: China, Philippines, Indonesia, Malaysia, Thailand, Vietnam and Cambodia. The population is expected to double in 32 years. The major economic driving forces behind this dramatic increase in coastal populations are tourism, increasing fisheries development as well as oil exploration and exploitation. Capture fisheries from the SCS contribute 10% of the world's landed catch (i.e., 5 million tons per year) and 5 of 8 top shrimp producers in the world are border states of the SCS. Moreover, the countries of the region produce 23% of the world tuna catch and almost three-quarters of the world's canned tuna. The share of world production of aquaculture products including shrimp rose from 46% in 1984 to 66% in 1994 (Talaue-McManus 2000).

## 1.4 Management

Within the SCS bio-geographic region only one MPA is declared a national marine park (i.e., Apo Reef Marine Reserve) while some are relatively small marine protected areas or fish sanctuaries (Table 1.1). Establishment of fish sanctuaries such as those in Bolinao and Anda, Pangasinan; Masinloc, Zambales and Mabini-Tingloy, Batangas were made possible by passing municipal ordinances. However, the greatest challenge is how to manage reefs located in relatively larger areas such as Bacuit Bay, Lingayen Gulf and the Kalayaan Island Group. Managing reef areas covered by more than one province and/or municipality or a number of barangays may be more difficult as it will need a more comprehensive management plan formulated and regulations enforced by the various stakeholders in the area. How to manage offshore reefs in the Kalayaan Island Group is a totally different story as it is claimed in part or whole by six states. Based on ecological considerations, it is proposed that it be declared as the "Spratly Island Marine Park" to benefit the whole region (McManus and Meñez 1997).

## 1.5 Issues and Threats

Issues associated with coral reef degradation in the SCS are loss of biodiversity, reduction in fisheries, coastal tourism, threatened or endangered species, and trade of corals, shells and associated biota (UNEP SCS/SAP Ver. 3 1999). Eighty two percent of the coral reefs surveyed under collaborative ASEAN projects in the SCS display evidence of degradation (Chou et al. 1994). Recent estimates reveal that 70% and 48% of Philippine and Indonesian reefs respectively, are considered at high risk (Burke et al. 2002).

According to Talaue-McManus (2000), shrimp aquaculture contributes significantly to the loss of mangroves and other coastal habitats bordering the SCS. It is estimated that the rates of loss for mangrove forests in each country range from 0.5 to 3.5% of total per annum. It is foreseen that a continuation of these present trends could result in total loss of mangrove habitats in the region by 2030. In addition, demersal fisheries within the region are fully exploited, with evidence showing that the landings of many species are currently declining (Abesamis et al. in press). The decline in fish availability in the subsistence fisheries sector has led to the adoption of destructive fishing practices such as blast fishing. Based on present consumption patterns and population growth rates, Cambodia, the Philippines and Vietnam will have to produce significantly more fish by 2005 just to meet domestic demand (Talaue-McManus 2000).

## 1.6 Monitoring, Evaluation and Feedback

Reefs through time data (i.e., coral and reef fish information) of the South China Sea bio-geographic region was summarized and integrated from the individual site reports included in this volume as well as secondary data from unpublished technical reports. It is apparent that for such a large area, coral reef sites, that would have at least two periods of monitoring, are few and far in between (Fig.1.1). Hard data from seven provinces is provided in Table 1.2. Taking the data at face value, the data presented in this report represents only 8% of the total number of coastal municipalities (i.e., 134) in this area.

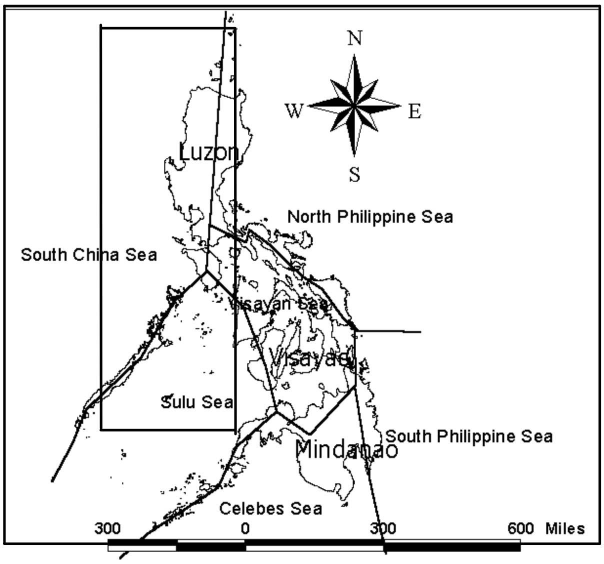
Provided in Table 1.2 is a summary of the trends for the hard coral cover as well as for reef fish abundance and biomass from 11 municipalities in seven provinces. Note that not all municipalities or transect sites within those would have a full complement of hard coral cover data as well as reef fish abundance and biomass data through time. As a result, totals for each category (i.e., hard coral cover, reef fish abundance and reef fish biomass) are not the same. Thus percentages discussed hereon were derived separately for each category and based only on available data.

Overall, the hard coral cover for a majority of the reefs were in stable condition (i.e., 44%) while only 17% are increasing while 39% were decreasing. In terms of reef fish abundance, more than half (i.e., 53%) are decreasing, 27% are increasing and 20% are stable or no net change. The same trend can be seen for reef fish biomass, where 45% are decreasing, 36% are increasing and 18% are in stable condition.

Trends for hard coral cover, reef fish abundance and biomass per site-municipality-province are shown in Figures 1.2 to 1.4 and Appendices 1.1 to 1.4.

## 1.7 Future directions, Gaps and Recommendations

The greatest difficulty in summarizing data for such a large region is addressing the problems of scale in time and space. Some sites were more intensively sampled through time while for others only two points in time are available. As such, trends are more easily evaluated for two points in time (i.e., increasing or decreasing), but can become more difficult if the data at hand is more erratic through time.



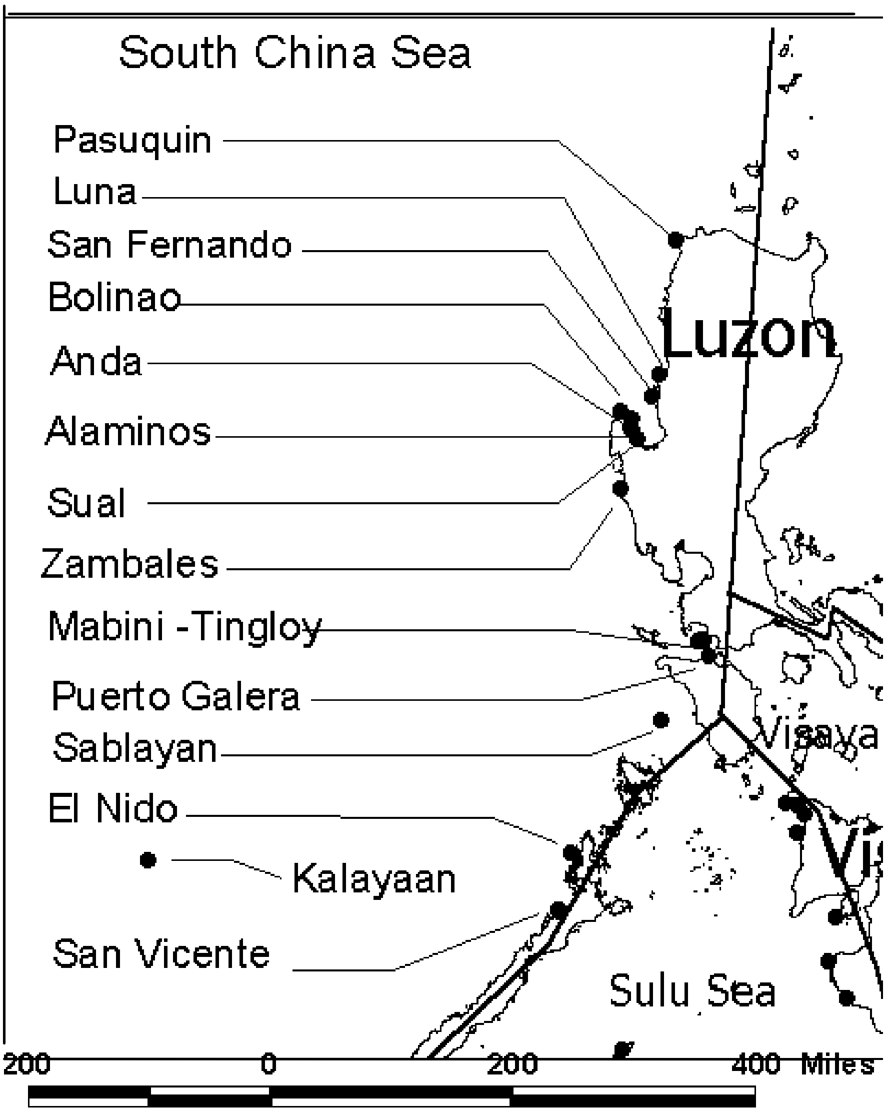




Fig. 1.1. Location of reef areas with temporal data in the South China Sea biogeographic area.

Reef surveys were also conducted at various spatial scales ranging from small reef areas (or parts of bays, islands, coastlines) to bays (e.g., Batangas and Bacuit ) to gulfs (e.g., Lingayen Gulf) and to offshore reef areas (e.g., Kalayaan Island Group). Some areas were intensively sampled spatially while other areas were not (e.g., Kalayaan Island Group).

For some areas, data was available for more than two points in time but may mean that transect sites surveyed may have been totally different from the previous sampling. Such a scenario arises when surveys are conducted for the purpose of addressing project objectives undertaken by various institutions or interest groups.

In addition to the problems related to scales, there were differences in the length and number of transects surveyed, methods used, depth and observers. Some would have fixed transect locations (i.e., using cement blocks) while others did not.

Given all the abovementioned problems in relation to evaluating the trends of coral and reef fish through time, it is recommended that regular national/regional training/ workshops be held regarding survey/monitoring methods, standardization and data analyses. This will ensure a more reliable comparison of results in the future.

It is fortunate that some level of protection is already in place for some reef areas (i.e., MPAs or fish sanctuaries). However, there is a need to continue to strengthen and expand the capabilities of coastal communities to monitor their marine habitats and evaluate the effectiveness of interventions (if any) that are currently in place. Moreover, management of reef areas should go beyond the establishment of "no take areas". The rates at which fish from "no take areas" are able to spillover and eventually increase municipal fish yields could take a longer time if fishing pressure outside the "no take area" is not minimized (Aliño pers. com.).

Table 1.1. List of marine protected areas or fish sanctuaries in the SCS bio-geographic region.

| MPA/Fish sanctuary | Year established | Size (ha.) | Municipal ordinance (MO) and/or existing laws |
|---|---|---|---|
| San Salvador Marine Sanctuary and Reservation Area<br>Masinloc, Zambales | 1989 | 127 | MO #30 Series of 1989 |
| Carot Fish Sanctuary<br>Anda, Pangasinan | 1999 | 13.3 | MO # 01 Series of 1999 |
| Balingasay Marine Protected Replacement Area Balingasay, Pangasinan | 1999 | 14.77 | MO # 02 Series of 1998 |
| Arthur's Rock Fish Sanctuary<br>Mabini, Batangas | 1991 | ≈25 | MO # 08 Series of 1990<br>MO # 09 Series of 1991<br>MO # 11 Series of 1992 |
| Cathedral Rock Fish Sanctuary<br>Mabini, Batangas | 1991 | ≈44 | MO # 08 Series of 1990<br>MO # 09 Series of 1991<br>MO # 11 Series of 1992 |
| Twin Rocks Fish Sanctuary<br>Mabini, Batangas | 1991 | 15 | MO # 08 Series of 1990<br>MO # 09 Series of 1991<br>MO # 11 Series of 1992 |
| Apo Reef Marine Reserve<br>Sablayan, Mindoro | 1983 | 27,469 | Resolution # 1108<br>Presidential Proclamation No. 868 (Sept. 6, 1996)<br>Presidential Proclamation No. 1801(1980) |
| Puerto Galera Biosphere Reserve | 1973 | 1000 | Presidential decree No. 354 (1973)<br>UNESCO's Man and Biosphere Programme (1977)<br>Presidential Proclamation No. 1801(1978) |
| El Nido-Taytay Managed Resource and Protected Area/ El Nido Marine Reserve<br>El Nido-Taytay, Palawan | 1991 | 90,321 (60% coastal) | DENR DAO No. 14 Series of 1991 |
| Port Barton Marine Park<br>San Vicente, Palawan | 1998 | 74483.25 | MO # 07 Series of 1997 |

Table 1.2. Summary of trends (i.e., Increasing, Decreasing and Stable condition or no net change) for coral cover and reef fish abundance and biomass for the SCS Biogeographic region.

| Province | Municipality | Data Source | # of transects | Point in time series | Time interval (years) | HARD CORAL (% cover) | | | REEF FISH Abundance | | | Biomass | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | I | D | S | I | D | S | I | D | S |
| Ilocos Norte | Pasuquin | A | 4 | 2 | 5 | | | x | x | | | x | | |
| Zambales | Masinloc | B | 5 (in MPA) | 3 | 1 | x | | | | x | | | x | |
| | | | 5 (out MPA) | 3 | 1 | | | x | | x | | | x | |
| La Union | Luna | A | 5 | 2 | 5 | | | x | x | | | x | | |
| Pangasinan | Balingasay | B | 3,5 (in MPA) | 4 | 1 | | | x | | x | | | x | |
| | | B | 3,5 (out MPA) | 4 | 1 | | | x | | | x | | x | |
| | Anda (Carot) | B | 3,4 (in MPA) | 3 | 1 | | | x | | | | | | |
| | | B | 3,4 (out MPA) | 3 | 1 | x | | | | | | | | |
| | Anda | C | 3 | 2 | 12 | | x | | | x | | | | |
| | Bolinao | C | 3 | 2 | 12 | | x | | | x | | | | |
| | Bolinao | D | 8-10 | 3 | 1 | | | | | | x | x | | |
| | Alaminos | A | 4 | 2 | 5 | x | | | | | | | | |
| Batangas | Mabini | E | 1-5 | 5 | 1,2,4 | | | x | | x | | | | |
| | Tingloy | E | 4 | 4 | 2,2,4 | | | x | | x | | | | |
| | Mabini (Twin Rocks) | B | 4 (in MPA) | 2 | 1 | | x | | x | | | x | | |
| | | B | 5 (out MPA) | 2 | 1 | | x | | | x | | | x | |
| Palawan | Taytay (El Nido) | F | 2-10 | 7 | 7,1,3,1 | | x | | | | | | | |
| | Taytay (El Nido) | F | 2-10 | 3 | 2 | | | | x | | | | | x |
| | Kalayaan | G | 4-25 | 4 | 3,1,1,1 | | x | | | | | | | |
| | Kalayaan | G | 3-6 | 3 | 1 | | | | | | x | | | x |
| | | | | Sub-total | | 3 | 7 | 8 | 4 | 8 | 3 | 4 | 5 | 2 |
| | | | | Total | | 18 | | | 15 | | | 11 | | |
| | | | | Percentage | | 17 | 39 | 44 | 27 | 53 | 20 | 36 | 45 | 18 |

DATA SOURCES:
[A]DENR CEP- Region 1
[B] UP-MSI, UPV-CAS, ZSCMST (2003)
[C] FRMP- UPMSI (2001)
[D] Uychiaoco et al. (1999).
[E]White et al. 2001
[F] LCR (1986), UP-MSI (1993), DENR- El Nido Marine Reserve (1994), EC-CERDS (1995) : Ten Knots and UP-MSI (1996)
[G] UP-MSI (1993): Tuan et al. (1996): UP-MSI (1999)

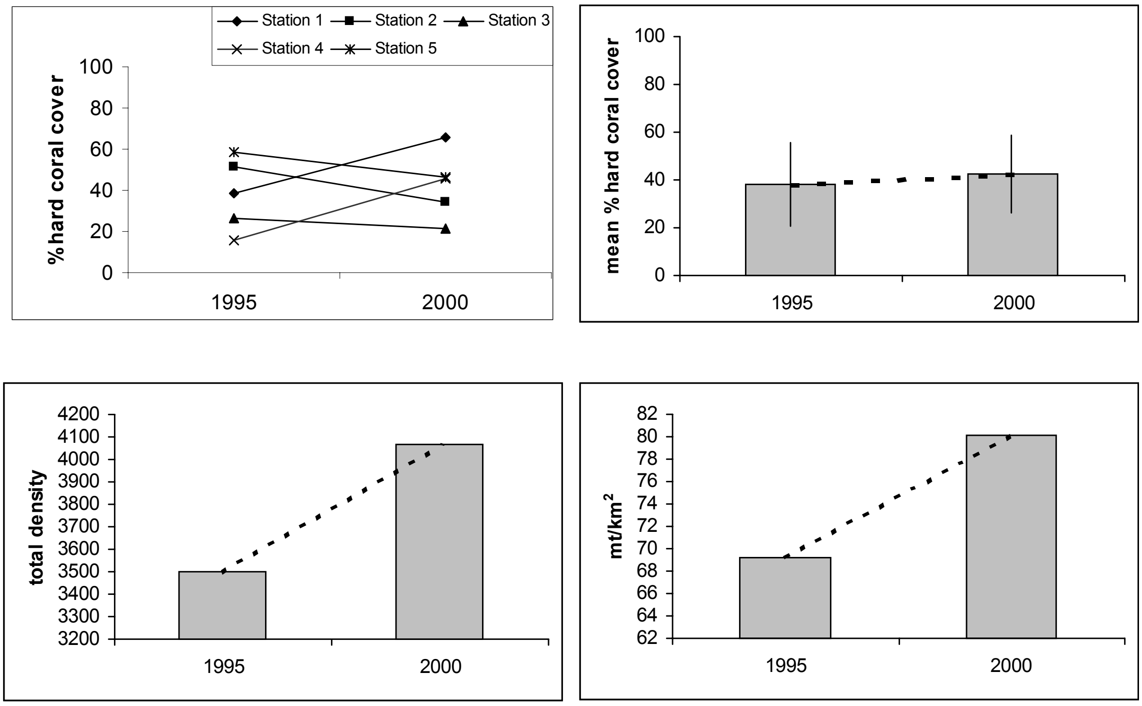
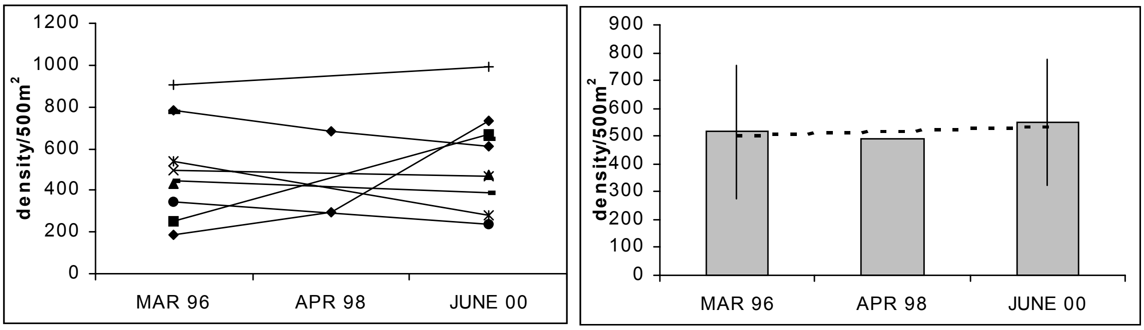



Fig. 1.2. Trends in hard coral cover (%) and reef fish abundance (total density) and biomass ($mt/km^2$) for Luna, La Union. Source: CEP Region I

A




B

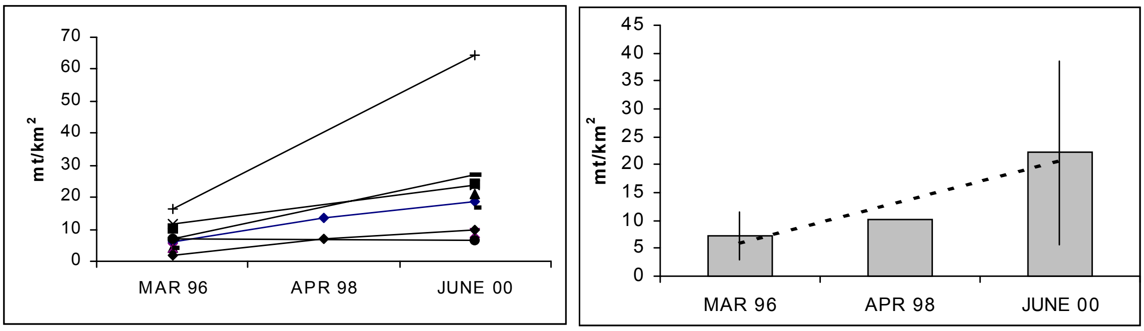



Fig. 1.3a-b. Trends in reef fish abundance ($density/500m^2$) (A) and biomass ($mt/km^2$) (B) for El Nido, Palawan

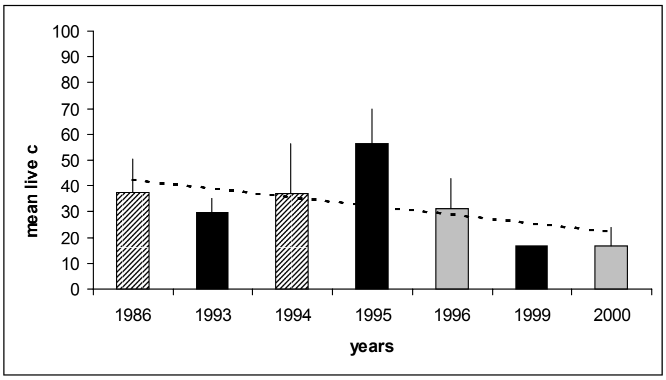
DATA SOURCES:

Ten Knots and UP-MSI (1996)

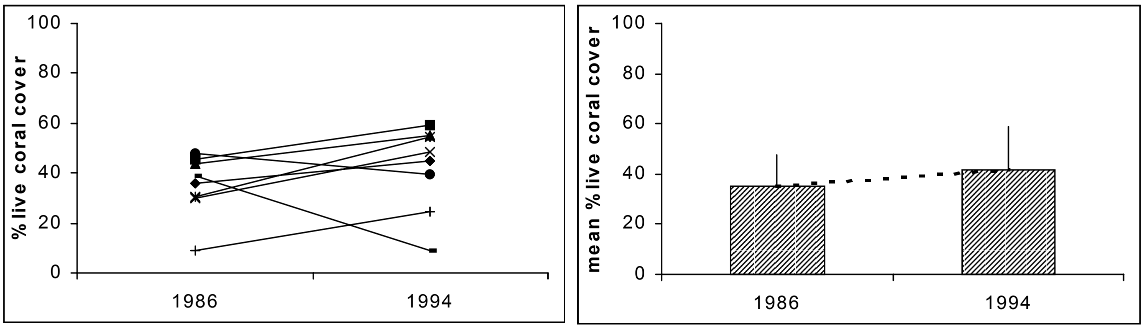
UP-MSI (1998)

URI-MERF Project (2000)

C.




D.




E.

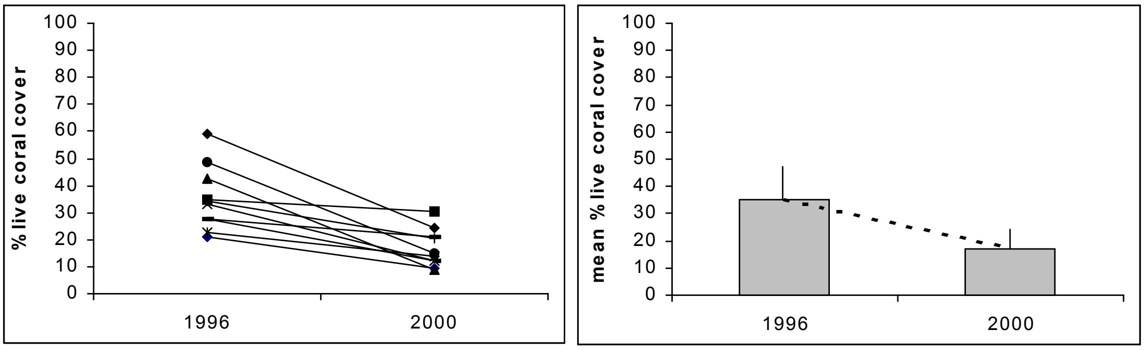
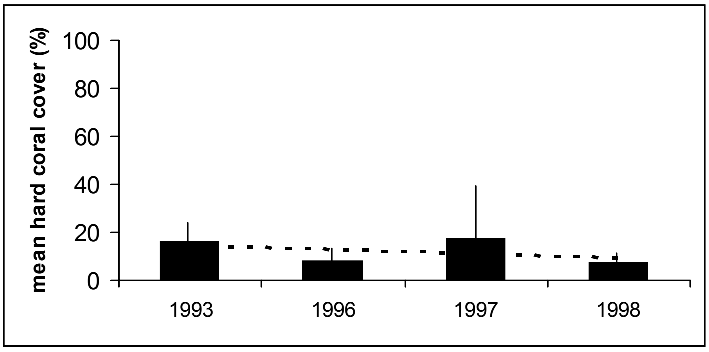



Fig. 1.3c-e. Trends in live coral cover (%) for El Nido, Palawan (C). Also comparisons between 1986 and 1994 (D), and 1996 and 2000 (E) data sets, which have common transect sites.

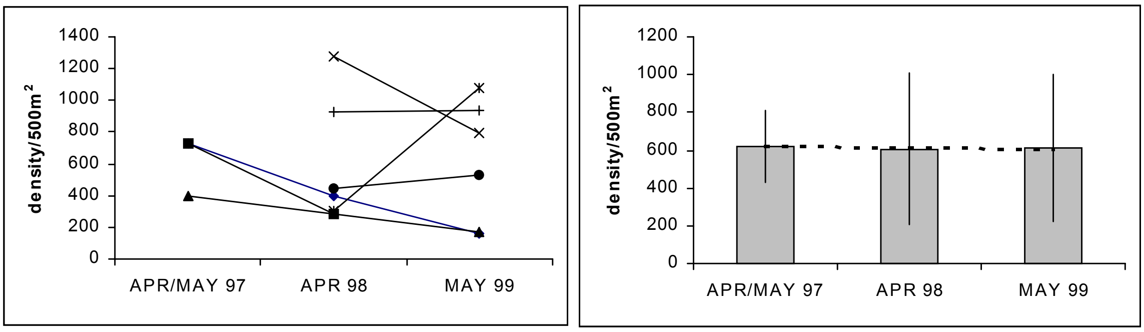
DATA SOURCES:

LCR (1986) ASEAN-LCR Project
MERF and Shell Exploration Philippines (1993)
DENR- El Nido Marine Reserve (1994)
EC-CERDS (1995)
Ten Knots and UP-MSI (1996)
UP-MSI (1999)
URI-MERF Project (2000)

A.




B.




C.

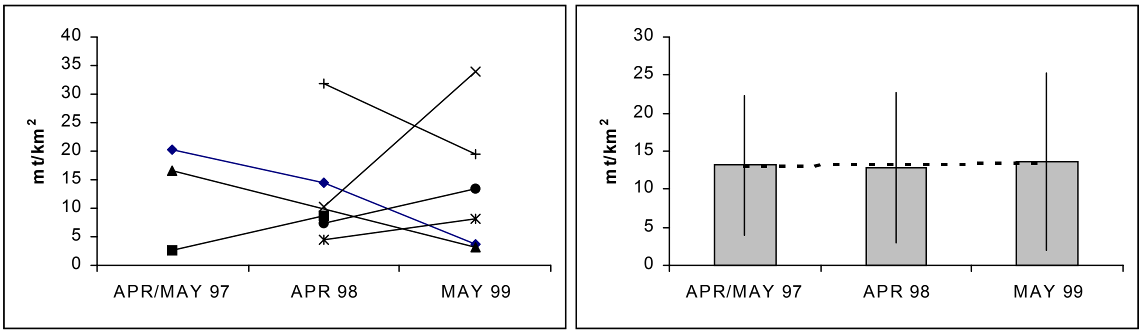



Fig. 1.4. Trends in mean hard coral cover (%) (A) and reef fish abundance (density/500m$^2$) (B) and biomass (mt/km$^2$) (C) for Kalayaan, Palawan.

DATA SOURCES:
UP-MSI (1993)
Tuan et al. (1996)
UP-MSI (1997): UP-MSI (1998)

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# CHAPTER 2 DAVILA, PASUQUIN, ILOCOS NORTE

Cesar A. Orallo, Marizel C. Calpito, Josephin C. Pagan, Flora Anacta,
Camilo Domingo Jr., Catalino Nacar II, Emerito Acosta and Dennis Milan

Coastal Environment Program
Department of Environment and Natural Resources (CEP-DENR) Region 1

## 2.1 Biophysical Setting

Davila was established as a Coastal Environment Program (CEP) site (now Coastal and Marine Management Office, CMMO) on August 1994. It is a village in the municipality of Pasuquin in the province of Ilocos Norte. Davila is in the northwestern seacoast of Luzon which is traversed by the mountain ranges of Quedabra and Pistolero from north to south. It is bounded in the north by the town of Burgos, in the east by Vintar, in the south by Bacarra and in the west by the South China Sea.

The site is an excellent tourist destination, suitable for the establishment of a marine park and fish sanctuary. It has commercial potential due to the presence of fish landing and access road. It is also suited for recreational activities such as fishing, snorkeling, scuba diving, camping and swimming.

The coral reefs are of the fringing type. The bay has low coral cover in the relatively exposed transect sites and good coral cover in the bay area. Its geographical coordinates are from 120° 24' to 120° 33' longitude and 18°17' to 18°30' latitude. Its total coral reef area is 164.64 hectares and mostly dominated by *Acropora*.

## 2.2 Socio-economic Setting

Based on 1994 census, Davila has a population of 477 in 97 households composed of 43% male and 57% female. The average family size is 5.

The dialect spoken is Ilocano. 85% of the population is Catholic and 15% is Protestant and *Iglesia ni Cristo*. Farming is the major source of livelihood (80%). 10% are hired laborers and 10% are engaged in fishing. Common fishing gears are gill net, hook and line, and mid-water gill net. The average family expenditure is PhP1,000-2,500 per month.

Davila has a community high school, 2 elementary schools and 1 day care center for pre-schoolers.

Davila is along the concrete national road going north to Cagayan Valley from Manila. A barangay plaza that was constructed serves as a meeting place.

## 2.3 Management

Fishers and farmers were organized into the Nagabugan Fishermen Association by the NGO, the Development and Management of Coastal Resources Organization (DEMACRO Inc). At present, the organization has already planted 25 hectares of mangroves. A fish landing was also constructed. All the established facilities, plantation and motorized boat are maintained and protected by the association. There are on-going alternative livelihood that were initiated namely banca operation and fishcage "malaga" (*Siganus guttatus*) culture. Management of coastal and marine resources activities were undertaken such as 1.) Coastal database establishment and planning which includes the: a.) identification of additional sites, b.) resource inventory and socio-economic and ecological assessment, c.) technical assistance to local government units & other stakeholders, and d.) establishment & updating/maintenance of national/regional coastal resources database. 2.) Maintenance and protection of coastal habitats which includes: a.) water quality monitoring, b.) community organization & mobilization, c.) support to alternative livelihood. 3.) Rehabilitation of degraded coastal habitats which include: a.) establishment and maintenance of multi-species mangrove nursery, b.) seedling production/procurement for distribution, c.) rehabilitation of mangrove areas, d.) maintenance and protection of existing mangrove stands. 4.) Advocacy building/information education and communication. 5.) Capability building and human resources development. 6.) Research and special projects and 7.) Support Gender-And-Development mainstreaming.

## 2.4 Issues and Threats

Nineteen genera of corals have been reported from Nagabugan Bay, Davila. Coral bleaching has been observed. Blast fishing has stopped since the implementation of the CEP program. Sporadic cyanide fishing still occurs. Pollution is still a problem. Overfishing is not a problem in the area due to some established alternative livelihood projects like aquaculture, livestock raising and farming. Based on the 2000 survey, large areas with encrusting and massive coral were observed near the transect stations. However, a deterioration on the condition of the corals sampled was observed. Possible reasons for the decrease in live coral cover were the strong typhoons that hit Northern Luzon in the previous years that caused siltation in the area.

## 2.5 Monitoring, Evaluation and Feedback

In the project site, a Community Organizer monitors the daily activities of the organization. PENRO/CENRO Coordinators were also assigned to the area. The CENRO coordinator stays in the project site 3 days per week. These coordinators are responsible for making monthly/quarterly reports to the Regional Project Manager/Leader. The Area Project Manager monitors the project 2 or 3 times per quarter, to assess monthly/quarterly accomplishments of the project.

There were 4 stations monitored from 1995 up to the present (Table 2.1, Fig. 2.1). Station 1, located inside the cove at 6-m depth, is characterized by a narrow coralline reef flat, and steep but shallow slope which levels off at about 18m. Station 2, located outside the cove at 7-m depth, is characterized by coralline substrate with large spur and groove formations. Horizontal visibility is 9-m. Coral growth is good. Station 3, located inside the cove, opposite station 1 at 6m depth, has poor coral cover. Station 4, is relatively exposed to strong waves located a few meters from the mouth of the cove at 6m depth and is characterized by a steep slope with a sandy substrate at the deeper portion.

Hard coral cover per station from 1995, 1999 and 2000 show different trends. One station shows an increasing trend, two stations increasing and then decreasing in the following year while another station decreasing and then stable (Fig. 2.1a, Table 2.1). However, the average hard coral cover shows a stable trend (Fig. 2.1a)

Fish catch is dominated by swordfish, flyingfish, round scads, carangids and fusiliers. Surveys have recorded 138 fish species belonging to 31 families. Both total density and biomass shows an increasing trend from 1995-2000 (Fig. 2.1b).

## 2.6 Future directions, Gaps and Recommendation

In order to sustain the project, it is important that the people's organization strengthen their links with other stakeholders and solicit more support from the rest of community. They should formulate strategies for the long-run sustainability and effectiveness of the policies. The threats should be addressed to lessen destruction of coral reefs, seagrass beds, mangroves and fisheries. The Monitoring and Evaluation System of the Project should be regularly implemented. With the strengthening of CEP through the creation of CMMO the protection, conservation and the community-based program could further be strengthened.

Table 2.1. Percent live hard coral cover

| Coordinates | | | | Year | | |
|---|---|---|---|---|---|---|
| Longitude | Latitude | Province | Municipality | 1995 | 1999 | 2000 |
| 120°34'03" | 18°29'06" | Ilocos Norte | Pasuquin | 62.00 | 35.20 | 34.40 |
| | | Ilocos Norte | Pasuquin | 31.74 | 52.61 | 68.70 |
| 120°34'04" | 18°28'55" | Ilocos Norte | Pasuquin | 35.84 | 40.80 | 22.46 |
| 120°34'01" | 18°28'58" | Ilocos Norte | Pasuquin | 42.02 | 55.00 | 34.24 |

## 2.7 Acknowledgments

We would like to acknowledge the assistance of the following: Dir. Florendo Barangan, Dexter Gumangan, Maria Theresa Espino, Edison Husana, Francisco Paciencia Jr, Emiliano Ramoran, Joselito Magat, Chester Casil and Ann Malano of DENR-CMMO.

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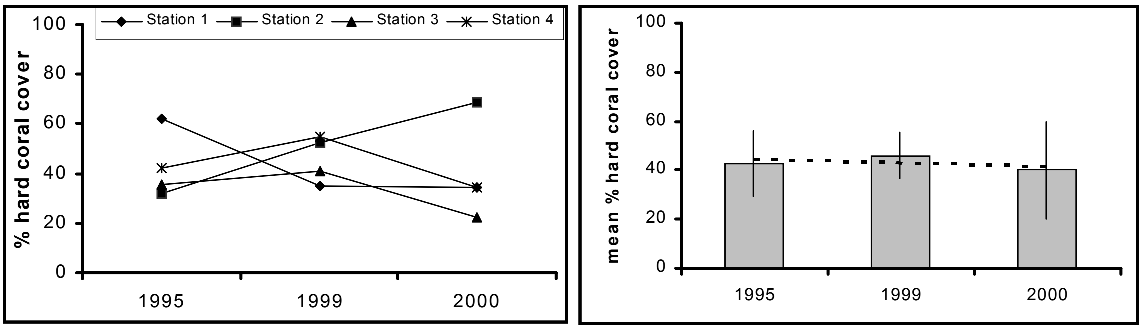
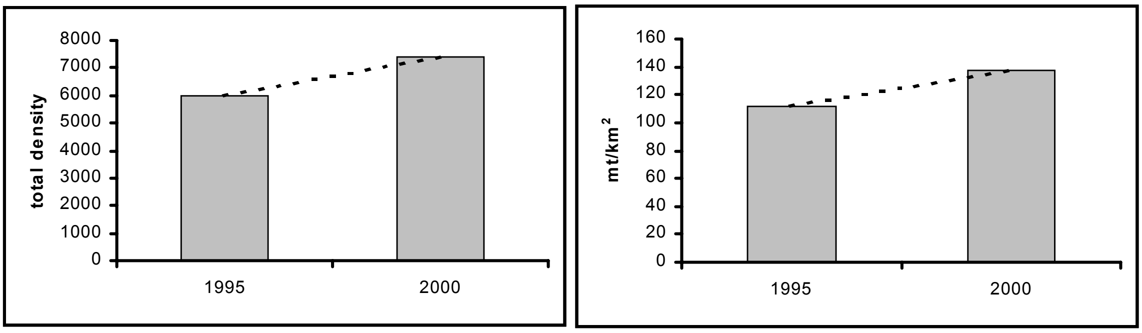



A.




B.

Fig.2.1. Trends in hard coral cover (%) (A) and reef fish abundance (total density) and biomass (mt/km$^2$) (B) for Pasuquin, Ilocos Norte.

# CHAPTER 3 LINGAYEN GULF, NORTHWESTERN PHILIPPINES

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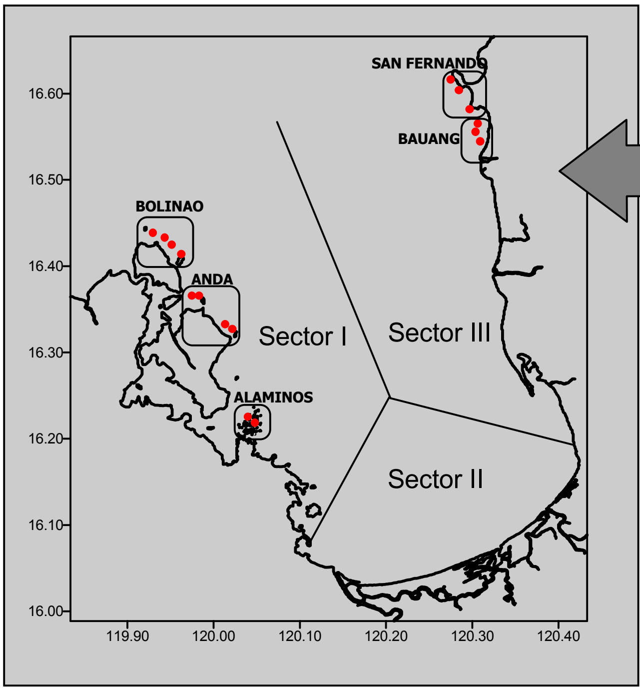
## 3.1 Biophysical Setting

Lingayen Gulf is located in northwestern Philippines between 16°1.2' and 16°40.2' N latitude, and 119°53.4' and 119°54.0' E longitude (Fig. 3.1). It is a large embayment (2,100 $km^2$) surrounded by 15 municipalities and 3 cities, in the provinces of Pangasinan and La Union. The Gulf has been classified into three sectors according to dominant coastal features (McManus and Chua 1998). The western section (Sector I) is dominated by fringing coral reefs. The southern section (Sector II) are mainly soft bottom areas where majority of the river systems of the Gulf drains off. The eastern section (Sector III) is lined mainly by sandy beaches with patchy coral reefs (i.e., fringing and shoal) on the northern portion.



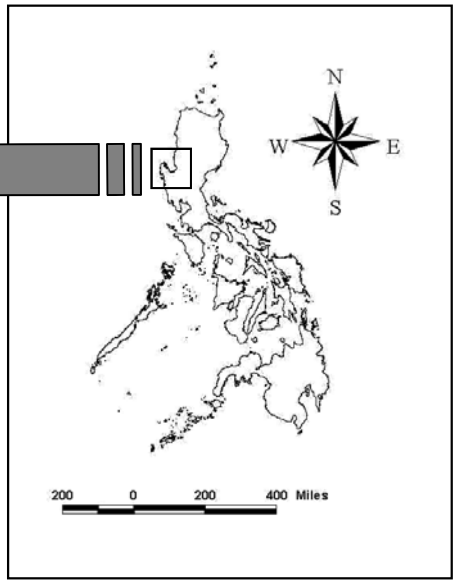




Fig. 3.1. Map of Lingayen Gulf showing the stations and the biogeographical divisions.

## 3.2 Socio-economic Setting

Overfishing, illegal fishing and pollution are the three major problems in the gulf. High fishing effort and dependence on fishery resources for livelihood of an even increasing population are among the socio-economics factors that cause these problems. Fishing is the primary occupation (92%) with monthly income below the poverty threshold level to support a family. Almost 80% of the people reside in the coastal areas and are engaged in fishing (FRMP 2001).

Lingayen Gulf has been a point of interest for researchers evaluating the status of Philippine reefs since 1978 (i.e., UPMSC 1978). Research in Coastal Resources Management (CRM) started with the participation of the Philippines in the ASEAN-US Coastal Resources Management Project (1986-1992). The declaration of the Gulf as an environmentally critical area (Presidential Decree 156) based on the information generated from the CRM project stimulated the move to manage the Gulf. This has led to the creation of the Lingayen Gulf Coastal Area Management Commission (LGCAMC), through Executive Order 171, which was the overall coordinating body for the management of the Gulf from 1994 to 2001 (McManus and Chua 1998). Recently, the Fisheries Resource Management Project (FRMP) has re-evaluated the status of coastal resources under the Resource and Social Assessment (RSA) component. The

RSA information was used to initiate the Monitoring, Evaluation, and Response Feedback (MERF) process in the gulf through a series of workshops.

## 3.3 Issues and Threats

Overfishing, illegal fishing, siltation and pollution are the major issues and threats in the Gulf. Capture fisheries with 23,000 fishermen exert very intense pressure in the Gulf. The number of fishers translates to about 7 fishers per meter of coastline or about 23 fishers per sq. km of municipal fishing ground (FRMP-2001). High fishing pressure is attributed to the steady increase of municipal fishers since 1976. Encroachment by commercial fishers (e.g., commercial trawl) is perceived as a major factor that caused the reduction in fishery production. Hence small-scale capture fisheries has become the most marginal occupation in the Gulf. The use of destructive fishing methods (i.e., dynamite, cyanide fishing and the use of fine mesh net fishing gear) has resulted in rapid habitat degradation and decline of the fishery stocks. Pollution in relation to mariculture activities (i.e., fishpens, fishcages and fishponds) and siltation from mine tailings, quarrying activities and erosion of agriculture lands have affected water quality and productivity. Bolinao, in the western side of the gulf was adversely affected by the 1998 bleaching event (Arceo et al. 2000).

## 3.4 Monitoring, Evaluation and Feedback

Broad area surveys of coral cover were conducted using the manta tow technique (English et al. 1997) in five municipalities. Cement blocks anchored by metal stakes were used to permanently mark the sites for subsequent monitoring. Sampling was done during the months of June to July for the southwest monsoon and November to February for the northeast monsoon. Both Video Transect and Line-Intercept Transect (LIT) together with Fish Visual Censuses (FVC) (English et al. 1997) were used in the coral reef assessment.

Manta tow surveys were conducted in 2000 covering the municipalities of Bolinao, Anda and Sual in Pangasinan and Bauang, and San Fernando in La Union. The average hard coral cover based on manta tow surveys range from very poor (Scale 1=1-10%) to poor (Scale 2=11-30%) (Fig.3.2). Seventy four percent (74%) of the tows in Bolinao showed very poor coral cover, 60% in Anda, 50% in Sual, 56% in Bauang and San Fernando. In contrast in the 1980s most of the tows conducted over the reefs of Bolinao and Anda showed fair (Scale 3=31-50%) and good (Scale 4=51-75%) coral cover. In 1998, tows showed poor coral cover. This reveals that coral cover in the Gulf has declined from fair to poor. These findings indicate coral cover in the gulf has decreased by an estimated 1/3 to 1/2 of its original state over the past twenty years (based on LIT and video methods Table 3.1). However, there are indications that the coral reefs throughout the gulf are on their way to recovery (FRMP 2001).

The results indicate fish abundance from 1988 to the late 90's did not show much difference (Table 3.2). However, from 1998 until 2000, fish abundance decreased to nearly half compared to the levels in the past decade (1988 to 1998). There is evidence that increased fishing pressure is responsible for some of the significant decline of fish diversity and biomass and changes in trophic structure in reef fishes (Nañola et al. 2000; Pastor et al. 2000). The reduction in fish number has been attributed to habitat degradation and overexploitation. The abrupt change in fish abundance in the gulf also coincided with the El Niño event in 1998 (Arceo et al. 2000). However, human induced pressures such as illegal fishing (e.g., blastfishing, cyanide and use of fine mesh net fishing gear), overfishing and siltation have been implicated as the main exacerbating stress factors. These contribute much to overexploitation of the resource as well as habitat degradation.

Live hard coral cover has decreased by 1/3 to 1/2 over the past two decades (Bautista et al. 2000) and with concordance to a decline in fish abundance by 1/2 as well (Deocadez et al. in press). Despite some indications of recovery in coral cover, this is not apparent in the associated reef fishes. This suggests that overfishing is the major factor in the decline of fisheries in the gulf. Siltation from deforestation, irresponsible agricultural practices and destructive fishing methods are still major problems in the gulf that need to be addressed if recovery of resources is desired. It is high time that the scientific and management efforts are put to good use for the benefit and future sustainable development of the stakeholders.

## 3.5 Future directions, Gaps and Recommendations

Considerable community organizing and development work is needed to overcome current environmental and socio-economic problems. Integrated Coastal Management, mangrove reforestation and establishment of marine sanctuaries are important interventions in these areas in order to mitigate the impacts of siltation, overfishing and illegal fishing, The deputization of local *bantay dagat* personnel and strict law enforcement measures need to be undertaken together with initiatives that enhance the political constituency through Information education campaigns (IEC) for fisheries management. With sufficient participation, involvement and organizational development, the community can be encouraged to establish marine sanctuaries.

Cross-cutting coastal management mechanisms can be undertaken through thematic programs such as capability-building and improved CRM implementation strategies. These components include the following: (a) undertaking Municipal Coastal Development Planning (CDP), harmonizing Integrated Municipal Fisheries Ordinance (IMFO) on the sectoral and gulfwide level; (b) integrating Monitoring Control Surveillance/Monitoring, Evaluation and Response Feedback system (MCS/MERFs) within an adaptive management approach to fisheries; (c) improving Information and Education Campaign (IEC) linked to Community Organizing (CO), Human Resource Development (HRD) and sustainable financing, (d) expanding policy, institutional and management reforms; and (e) innovating species and gear related intervention (e.g., reproductive reserves and sea ranching initiatives).

Marine ecosystems have always been considered as an open access common property. Hence, marginalization of the fishery results in a cycle of destruction of the habitats and a lowered quality of life. Proposed interventions should consistently address strategic directions of community development. Such interventions should include preferential rights and access arrangements in coastal zoning, mariculture and vesting greater stewardship rights to fishers people organizations (PO) akin to the granting of Community Based Mangrove Forest Stewardship Arrangement (CBMFSA).

Table 3.1. Percent live coral cover shows gradual decline over time, with the second half of the 1990's showing the greatest diminution.

| Year | Pangasinan | | | | La Union | |
|---|---|---|---|---|---|---|
| | Bolinao | Anda | Alaminos | Sual | Bauang | San Fernando |
| ICRP 1978 | 33.9 ± 6.0 | | | | | 23.0 ±18.0 |
| CRMP 1988 | 41.1 ± 4.8 | 41.4 ± 3.3 | 25-50 | | | |
| UNDP 1997 | 40.9 ± 14.2 | | | | | |
| UNDP 1998 | 26.1 ± 9.8 | | | | | |
| UNDP 1999 | 22.1 ± 0.5 | | | | | |
| SEPI 1999 | | | | 13.5 ± 2.1 | | |
| SEPI 2000 | | | | 12.0 ± 4.4 | | |
| FRMP 2000 | 21.5 ± 7.0 | 34.5 ± 16.6 | 31.9 ± 2.6 | | 40.2 ± 13.3 | 15.0 ± 11.8 |

Table 3.2. Fish abundance in counts per 1000 $m^2$ in Lingayen Gulf from 1988 – 2000.

| Year | Pangasinan | | | | La Union | |
|---|---|---|---|---|---|---|
| | Bolinao | Anda | Alaminos | Sual | Bauang | San Fernando |
| CRMP 1988 | 764 ± 88 | 588 ± 120 | | | | |
| CRSP 1992 | 800 ± 164 | | | | | |
| UNDP 1997 | 714 ± 202 | | | | | |
| UNDP 1998 | 610 ± 195 | | | | | |
| UNDP 1999 | 831 ± 106 | | | | | |
| SEPI 1999 | | | | 216 ± 52 | | |
| SEPI 2000 | | | | 319 ± 83 | | |
| FRMP 2000 | 315 ± 121 | 240 ± 78 | 347 ± 179 | | 200 ± 74 | 197 ± 54 |

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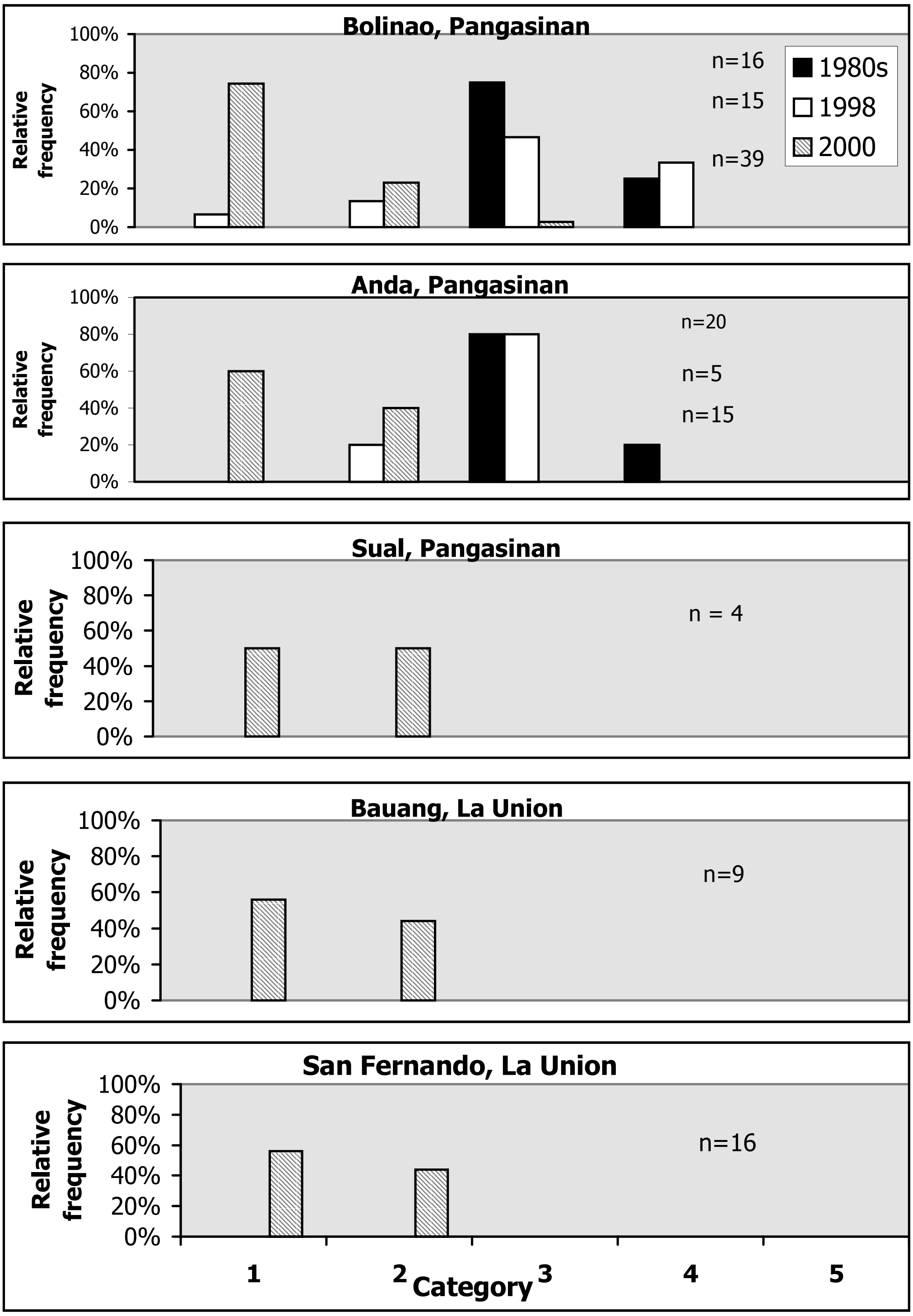


Fig. 3.2. Hard coral categories in five manta tow sites in Lingayen Gulf comparing data of 1980s, 1998 and this study. Category 1 (Scale 1= 1-10% hard coral cover), Category 2 (Scale 2 = 11-30%, Category 3 (Scale 3 = 31-50%), Category 4 (Scale 4=51-75% and Category 5 (Scale 5 = 76-100%).

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# CHAPTER 4 BOLINAO, PANGASINAN

A Decade of Bolinao Reef Fish and Fisheries: Part I. Fisheries

Prepared by: Andre J. Uychiaoco, Fernando I. Castrence, Jr. and Porfirio M. Aliño

(Data were collected from 1987-1993 by Wilfredo L. Campos, Rodolfo B. Reyes & Cleto L. Nañola under the supervision of John W. McManus and assisted by Annabelle Del Norte-Campos, Fernando I. Castrence, Elmer Dumaran and Jesse Cabansag. From 1996 to 2000, data were collected by Fernando I. Castrence under the supervision of Liana T. McManus, Porfirio M. Aliño, Cleto L. Nañola & Marie Antoinette Juinio-Menez with the help of Norberto Estepa, Davelyn Pastor & Severino Salmo. Data were databased & analyzed by Andre J. Uychiaoco under the supervision of Porfirio M. Aliño & with the assistance of Fernando I. Castrence)

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## 4.1 Biophysical Setting

The reef and seagrass habitats around Santiago and Cabaruyan Islands are the most extensive such habitats in Lingayen Gulf (McManus et al. 1990). As such, the municipalities of Bolinao and Anda of the province of Pangasinan are deemed to be critical nursery grounds for fisheries of the Gulf. Santiago Island is surrounded by 26 km$^2$ of reef flat and 42 km$^2$ of reef slope (McManus et al. 1992).

## 4.2 Socio-economic Setting

There were estimated to be 1,830 fishers in Bolinao in 1990 (Department of Agriculture 1990 as cited by McManus et al. 1992), 2,162 fishing households in 1992 (Elegores et al. 1992) and 3,154 fishers (Santiago Island only, Lagrossa unpub.) in 1998. This review compares Bolinao coral reef fisheries from 1986 to 1991 (Acosta and Recksiek 1989, McManus et al. 1992, Campos et al. 1994) with new data from 1996 to 2000.

## 4.3 Issues, Threats and Management

The Bolinao-Anda reef system is also perceived to be one of the most overfished reefs in the country because of its high density of fishers and the scarcity of fishes observed in underwater censuses (e.g., Del Norte et al. 1989, Nañola pers. obs., Hilomen et al. 2000). However, the patterns observed in the fisheries will not be due only to fisheries. Other major events in Bolinao during this period include a particularly severe storm in 1992, successive community-based coastal resource management (CB-CRM) initiatives since 1994 (Ferrer et al. 1996, Talaue-McManus et al. 1999), a major crackdown on dynamite fishing and the rise in milkfish grow-out pens since the tenure of Mayor Jesus Celeste (from 1998 to the present) and massive fish kills and bleaching during the 1998 El Nino-1999 La Nina event. Despite some difficulties, the CB-CRM initiatives here have been able to foster mangrove reforestation, several tiny (<1 km$^2$) marine fishery reserves, experimental sea urchin reseeding and grow-outs and a participatory coastal zoning plan which was passed into law on January 2000. The coastal zoning plan includes a highly recommended >1-km$^2$ fishery reserve in Malilnep though this has still not been implemented.

## 4.5 Monitoring, Evaluation and Feedback

Fishing grounds, effort, catch and catch composition were monitored. Sampling was concentrated on Santiago Island and on the most commonly used fishing gears.

<u>Fishing Grounds and Total Effort</u> The number of fishers (and their gear types including unmanned stationary fish corrals) out on the reef flat and slope of Santiago Island were counted once a week from 1987-1993 (McManus et al. 1993), twice a month in 1996 and once a month (including those along the mainland coast) from 1998-2000. The positions of most of these fishers were also estimated by triangulation. From 1987-1993, the Santiago Island reef slope and flat was observed from 0800 to 1400H while from 1996-2000, the reef slope was observed from 0900 to 1100H while the reef flat was observed from 1300 to 1500H. Fishing effort along the mainland was observed from 0900 to 1100H. Unfortunately, the mapping data from 1988-1993 except for reef slope observations from July 1988 to June 1989 can no longer be found.

A high estimate of total fishing effort from May 1987 to April 1988 was estimated from the maximum daily number of fishers per gear recorded by middlemen at each landing site Fig. 4.2 (Campos et al. 1994).

The number of fishers (using each type of gear) actually out fishing within the Santiago Island reef system at a single point in time (and thus also taking into consideration days when fishers don't go out to fish) were estimated from the fishing ground mapping (Fig. 4.1). Specifically, a single observation was taken from each month and these monthly estimates were mapped and averaged (Fig. 4.2).

Fishing gears most commonly being used by fishers in Santiago Island are handlines (hook and line without poles), drive-in "tabar" gillnets, drive-in "parisris" gillnets, spearguns (with or without the aid of compressors), fish corrals, fish traps and octopus jigs (Fig. 4.2). "Tabar" gillnet operations involve 1 to 4 fishers (usu. 2) repeatedly setting, slapping the water to scare fishes and retrieving gillnets moving extensively around the reef flat. Handlining is mostly done on the slopes though there are some who fish in the flats fronting Binabalian village. Free-diving spearfishers fish in the reef flats in front of their villages while spearfishers fishing with the aid of compressors fish on the reef slopes. Spearfishers usually fish at night with the aid of underwater flashlights. Fish corrals are mostly set in the reef flats fronting Goyoden village and are checked every day. Following the convention of Campos et al. (1994) one fisher is estimated per corral. Fish traps are deployed mostly in front of the village of Goyoden and around Silaki Island by fishers from those villages and are checked every morning.

It will be noticed that effort (except for spearfishing) in 1996-2000 is greater than the maximum estimated for 1988. Effort of spear fishing was underestimated in 1996-2000 because the method used does not record fishing effort during the night.

Catch and Effort Catch quantities per fisher or team of fishers were collected from purchasing records kept by middlemen. These middlemen buy the catch directly from the fishers at sea or at one of the 8 fish landing sites before being brought to the municipal market at Arosan or to Manila (Campos et al. 1994, Lagrossa unpub.). The 8 minor landing sites are Lucero, Silaki, Goyoden, Binabalian, Dewey and Pilar on Santiago Island and Trinchera and Picocobuan on the mainland facing Santiago Island (Fig. 4.1). The catch records considered here do not include the portion kept for home consumption. Middlemen sell the catches before paying the fishers so these records are kept carefully (Campos et al. 1994). This trading system was harnessed by providing and transcribing notebooks of a sample of these middlemen every month.

Records indicate the number of fishers, the types of fishing gear used, the types of catch being bought and the quantity of catch. Only landing site x fishing gear combinations that were well-represented in both 1988-1993 and 1996-2000 were included in this present analysis (Table 4.1). Records of the same fishing gears from different landing sites cannot simply be pooled as they generally represent catches from different fishing grounds. Though catches from corrals were consistently sampled in Goyoden, the main corral fishing ground, it was only since 1996, that fishing records include the catches from corrals in the concession area along the major rabbitfish migration route. Daily catch per fisher-trip (or per fish corral) were averaged to yield a value for each month for each landing x gear combination. Unfortunately, though middlemen also classified and recorded types of catches in their notebooks, their use of *sari-sari* (i.e. mixed) classification of catch which may or may not have included the defined types of catch rendered this catch composition information unusable.

Table 4.1. Combinations of gears and landing sites for which catch per unit effort and catch composition data is available both in the early-1990s and in the late-1990s:

| | Landing Site | | | | | | |
|---|---|---|---|---|---|---|---|
| Fishing Gear | Goyoden | Silaki | Binabalian | Lucero | Dewey | Pilar | Picocobuan |
| Traps | CPUE/comp | CPUE | | | | | |
| Spear | | | CPUE/comp | CPUE | | | CPUE |
| Corral | CPUE/comp | | | | | | |
| Bottom-set "Taba" Gillnet | | | | | CPUE | CPUE | |
| "Tabar" Gillnet | CPUE | | Comp | | CPUE | | |
| Handline | | | | | | | comp |

Moreover, the fishing records kept by the middlemen were seriously flawed by the lack of information about the length of time the fishing gears were actually deployed in the water and the actual fishing grounds from which these catches were collected. Thus, from 1987 to ca. 1990, several fishers per village (representing each of the fishing gear types for which catches were landed in the area) cooperated by recording their catch, the time they spent fishing each day and their fishing grounds. From this data were derived average times spent fishing on a fishing trip. Interviews on average time spent fishing each day were also repeated, though in a very cursory fashion, once in 1996 (Castrence pers. comm.), another time in 1998 (Lagrossa 1998) and again in 2000 (Pet-Soede 2000).

Since catch records did not include individual independent measures of fishing time but did include number of fishers involved, "person-trips" or "fisher-trips" was the unit of effort used to standardize catches. As stocks decline, fishers might be expected to increase their time out at sea as the cursory surveys of fishing times seem to indicate (Table 4.3); however, fishing hours are also constrained by the available daylight hours and by weather/tidal conditions.

| Table 4.3. Hours spent fishing | Monthly Averages | | From Interviews of a Few Fishers | |
|---|---|---|---|---|
| Gear | 1989 | 1996 | 1998 | 2000 |
| Handline | 3.2 to 6.7 | 7 to 10 | 5 to 16 | 6 to 7 |
| Hookah | 5 | 6 | 9 | 5 to 8 |
| Spear | 2.4 to 5.0 | 6 | | 5 to 7 |
| Octopus jig | 4.3 to 5.8 | 7 | | |
| Drive-in "parisris" gillnet | 5 to 8 | 8 | 7 to 14 | 4 |
| "balbalyon" gillnet | | 8 | 7 | |
| "taba" gillnet | 4 | 3 | | |
| "tabar" gillnet | 2.7 to 8.3 | 8 | | |
| Gillnet (type not specified) | | | 7 to 8 | 2 to 12 |

Aside from the higher catches from the triple-layer net version of "tabar", catch per fisher-trip from the 5 gears monitored did not seem to change consistently from mid-1988 to mid-2000 (Figure 4.3). Nevertheless, there were 4 landing x gear combinations that exhibit (highly) significant correlations (all positive) with time: Pilar-taba (increasing at the rate of +0.08 kg/trip/yr), Dewey-tabar (+0.27 kg/trip/yr), Goyoden-tabar (+0.29 kg/trip/yr) and Goyoden-traps (+0.04 kg/trip/yr). These trends show that 1988-1993 were similar to each other and lower than 1996-2000 which were also similar to each other and higher. The disparity in levels was quite clear for the first three landing x gear combinations.

The lower catches recorded for corrals and "tabar" landed in Goyoden from mid-1987 to early 1988 cannot be explained. These were not reported in McManus et al. (1992). Spearfishing catches landed in Binabalian and Lucero ranged from 2 to 4 kg/fisher-day from mid-1988 to mid-2000 while catches from Picocobuan (which may include compressor use) ranged from 3 to 6 kg/fisher-day. "Taba" catches ranged from 1.8-4 kg/fisher-day. There was a sustained rise in Pilar "taba" catches from late 1996 to late 1998 which resulted in a significantly positive correlation with time. Catches from "tabar" gillnets ranged from 3-6 kg/fisher-day from mid-1988 to mid-1993 and 5-7 kg/fisher-day from 1998 to mid-2000 when the triple-net version of the "tabar" was in use. Thus, "tabar" (both in Dewey and Goyoden) catch exhibited a significant positive correlation with time. Corral catches varied a lot from month to month, more so when the catches from the concession were included. Catches generally ranged from 2 to 3.5 kg/corral but could be as large as a few thousand kilograms for the 5 corrals in the Parayray concession area during the peak rabbitfish migration run months. Trap catches ranged from 2 to 3.3 kg/fisher-day both in Goyoden and Silaki. There was a significant positive correlation for Goyoden trap catches with time.

Catch Composition Finally, the species composition, standard lengths and weights of the actual catches or sub-samples thereof caught by fishers of various landing site x fishing gear combinations were also measured. Generally, one batch of catch per landing site x fishing gear combination was sampled once a week from 1988-1993 (McManus et al. 1993) and once a month from 1996-2000. Family-level composition of catch using various gears are graphed through time. Average sizes of taxa dominant in catches *Siganus fuscescens* (from Binabalian spear and tabar and Goyoden corral), parrotfishes (from Goyoden traps) and jacks (from Picocobuan handline) were also graphed through time.

Aside from an increase in parrotfishes and a decrease in wrasses in Goyoden traps, there did not seem to be any consistent changes through time in the composition of the catches of the landing x gear combinations examined (Fig. 4.4). Nonetheless, rabbitfishes dominated the catches of Binabalian "spear" and "tabar" gillnet catch. If the concession catches prior to 1996 were also to be considered, rabbitfishes would probably also dominate the Goyoden corral catches since concession catches normally make up a very large proportion of the total catch from corrals and these are virtually all *Siganus fuscescens*. Picocobuan handline catches were dominated by jacks.

It could not also be ascertained whether standard lengths of taxa dominant in catches (i.e., *Siganus fuscescens* and parrotfishes) declined or whether this was simply due to the lesser number of specimens being measured (i.e. smaller sample size, Fig. 4.5). The exception to this were jacks from handline catches landed in Picocobuan: there were more samples recorded from 1998 to 2000 than from 1989 to 1991, but aside from one occasion in May 1999, caught fishes were smaller in 1998 to 2000.

## 4.6 Future Directions, Gaps and Recommendations

Acosta and Recksiek (1989) have reported 0.59 kg/line-hr (0.32 to 0.94), 0.1 kg/trap-day and 1.3

kg/spearfisher-hr (0.9 to 2.0) for Bolinao from June to December 1986. Using the average efforts estimated in 1987-1988 of 4.5 hours handlining, 25 traps and 3.4 hours spearfishing gives 2.65, 2.5 and 4.4 kg per trip respectively. Trap and spear catches from 1986 are not much different from the figures reported here from 1987.

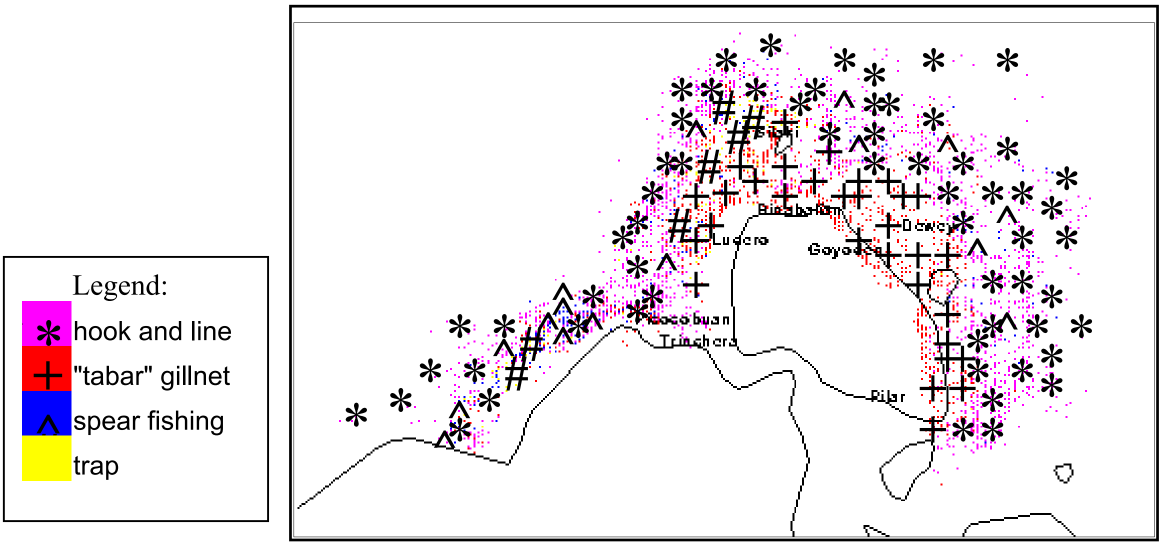


Figure 4.1. Map of fish landing sites and fishing grounds

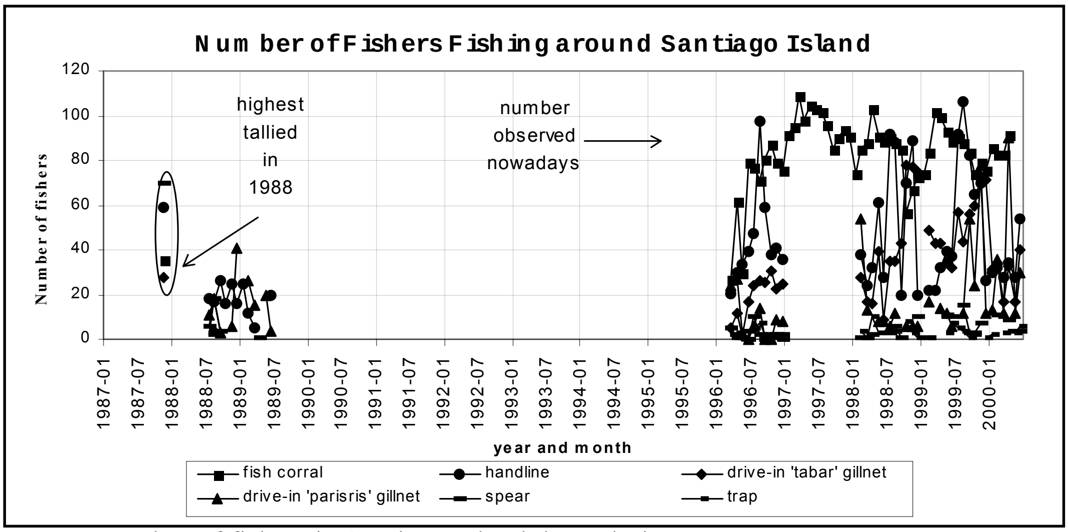


Figure 4.2. Number of fishers in Santiago Island through time.

Based strictly on data that is available from 1986 to 2000, it cannot be unequivocally concluded that catch has declined over the past decade. McManus et al. (1992) report that, aside from regular seasonal variation in slope fisheries catch rates, there were no apparent trends in total effort and catch rates from 1987 to 1991. In fact, it might even be argued that Pilar "taba" gillnet and Goyoden trap catch rates have increased between 1993 and 1996. On the other hand, though the shift in gear from single "tabar" gillnets to triple-nets resulted in higher catch rates, the shift in gear itself may be indicative of declining catches. McManus et al. (1992) also observed a decline in >30 cm fish caught by handlining. However, if only jacks (the major handline catch) were to be considered, this did not hold true if only because of the sixteen >30 cm individuals recorded in May 1999.

The above results do not seem to clearly indicate a decreasing trend *per se*. Nevertheless, many other indicators point to the severe overfishing in Bolinao: the scarcity of groupers, the sudden collapse of the corral catch of rabbitfish in 1999 (Pastor et al. 2000), fish species which have disappeared from the fish visual censuses (McManus et al. 1992, Nanola pers. comm.) and decrease of higher valued species relative to lower valued species also in the visual censuses (Arceo et al. 2000), among the lowest catch rates reported in the world (Dalzell 1996) and perception of fishers is that fish abundance has declined in comparison to decades past (e.g., Eleuterio Dumaran pers. comm.). It is proposed that Bolinao was overfished even before scientific fisheries monitoring was began and so abundance has already dropped and are merely fluctuating close to extinction (Aliño pers. comm.)

The current monitoring system has low sensitivity to change over a decade and requires a high level of effort to sustain. It is recommended that a more community-based fisheries monitoring system be put into place and that fewer parameters be collected but be collected more completely. Such a monitoring system has already been set-up in the village of Balingasay (also in Bolinao) and may be used as a model for the municipality.

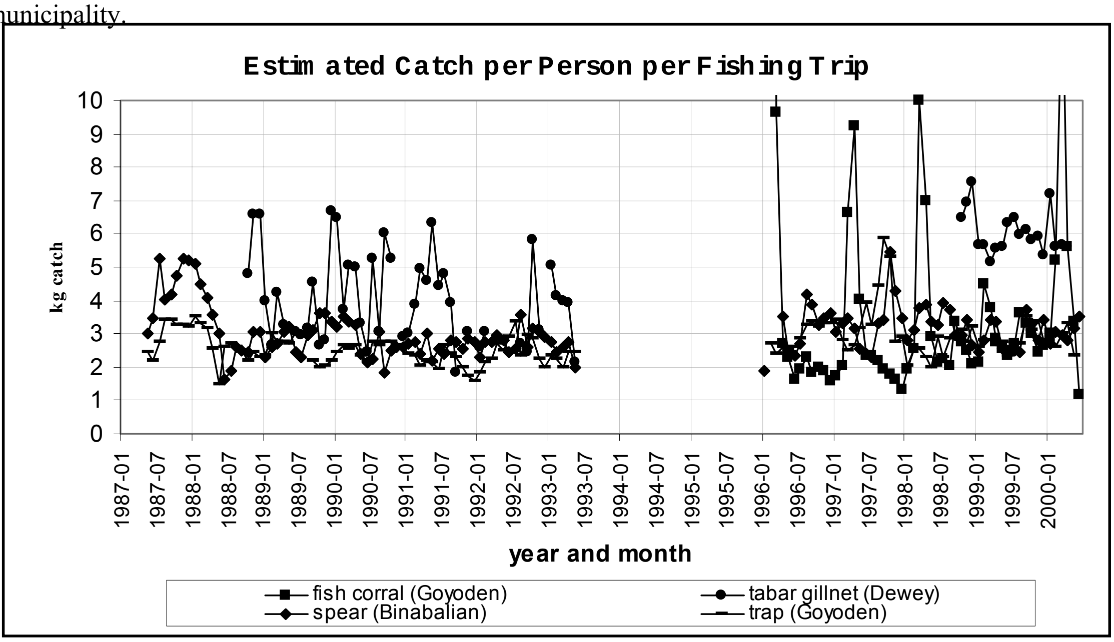


Figure 4.3. Catch per unit effort of various fishing gears based on records of buyers at particular landing sites in Bolinao through time (year & month)

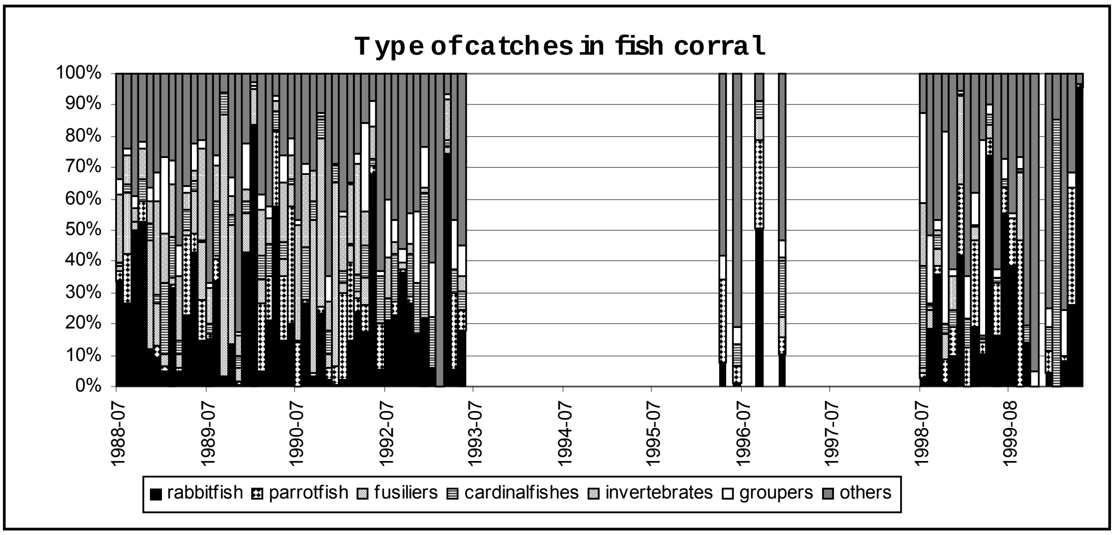


Figure 4.4. Typical catches in fish corral through time

## 4.3 Acknowledgements

Data collection from 1987-1992 was supported by the US-AID Fisheries Stock Assessment Collaborative Research Support Program, 1992-1993 by the Department of Agriculture-Fisheries Sector Program. Data collection from 1996-1998 was supported by the International Development Research Center-Canada while collection from 1998-2000 and data analysis was supported by the Dutch Embassy in Manila. Liana T. McManus and Annette Juinio-Menez helped to get this analysis done.

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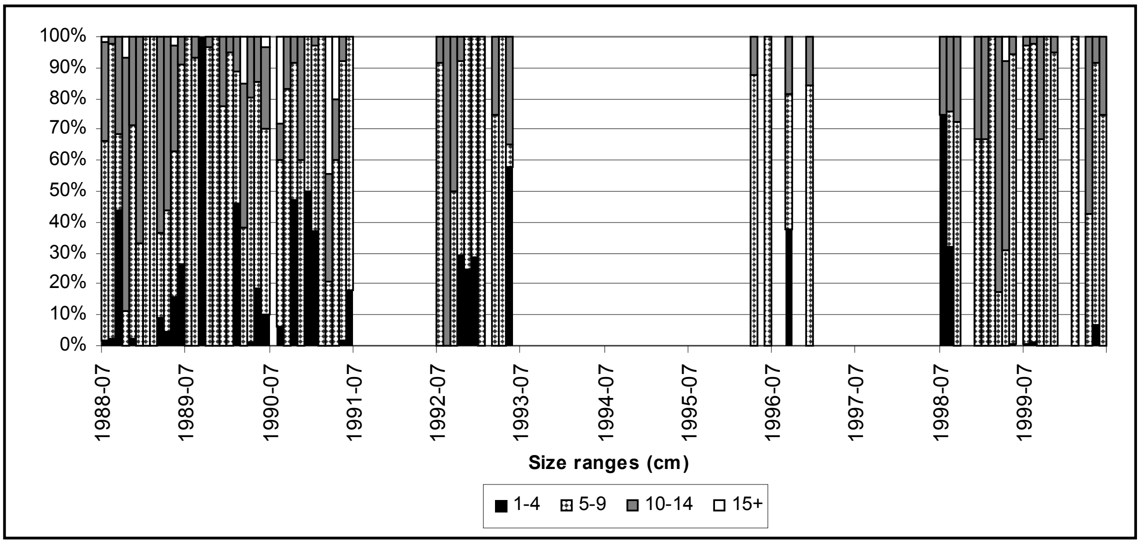


Figure 4.5. Size distribution (in centimeters) of rabbitfishes caught in fish corrals.

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# CHAPTER 5 TELBANG, ALAMINOS, PANGASINAN

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## 5.1 Biophysical Setting

Telbang was designated as a Coastal Environment Program (CEP) site (now Coastal and Marine Management Office, CMMO) in January 21, 1994. This village is part of the municipality of Alaminos province of Pangasinan. It is located east of Hundred Islands National Park. It is a small cove in Lingayen Gulf. The coastal area has potential for eco-tourism. The area boasts a variety of marine flora and fauna. The remaining live coral cover, which is found in the deeper portions, is ideal for snorkeling and diving. Its white sandy beaches invite a variety of recreational activities like swimming and picnicking.

The coral reefs are of the fringing type. The reef flat at Telbang is gradually sloping, wide and dominated by seagrass. Its coordinates are 120°04'08"N latitude 16°10'40"E, to 120°02'04"N to 16°10'59"E longitude. The total reef area is 273.88 hectares.

## 5.2 Socio-economic Setting

The *barangay* (village) of Telbang has a total population of 2,117 in 455 households. Ilocano is the major dialect used. There are no other ethic or tribal groups identified in the community. The majority of the people finished elementary and high school.

The populace is largely dependent on fishing and farming. There are 516 farmers and 48 fishers in the community. There are no existing industries in the locality. Commercial establishments consist of *sari-sari* (variety) stores, *palay* (unmilled rice) threshers and tractors, and rice mills.

There is no elaborate irrigation system in the community. The lone source of irrigation is a natural spring, which serves 45 households or some 50 farmers. Crop production is mainly rain-fed.

There are 48 fishermen and 26 fishpond operators. Twenty-five fishermen own motorized bancas and 35 own non-motorized bancas. The most common fishing gear used is gill net. Agricultural crops produced include rice, watermelon, vegetables and mung beans. Other sources of income are hog raising and salt making.

The village has a village hall, basketball court and multipurpose pavements. The village has 173 water-sealed toilets, 293 non-water sealed toilets and 33 households with no toilets facilities. It has a village elementary school with 15 classrooms. A guardhouse/watch tower was also constructed to help eradicate the rampant use of destructive fishing method such as blast and cyanide fishing.

A potable water facility complete with impounding reservoir, electric motor pump and service pipes are laid out and installed around the vicinity of the project site. Nine water faucets have been installed in several places in *sitio* (sub-village) Bolo to address the problem of water for domestic use.

## 5.3 Management

The local people have been organized under Bolo I – Young and Old Organization (BOLO I – YAO) in September 1994 which was registered with the Securities and Exchange Commission in March 1995. Livelihood activities initiated include a cooperative store, beach shed rentals and potable water. A mangrove nursery and a CEP multi-purpose hall were built. One water system was installed in cooperation with the US Peace Corps.

Activities being undertaken include trainings and seminars on value formation, leadership and capability building and regular dialogue/meetings to resolve conflict and to strengthen the operations of the organization. In the management of coastal and marine resources activities were done such as 1.) Coastal database management and planning which includes the: a.) identification of additional sites, b.) resource inventory and socio-economic and ecological assessment, c.) technical assistance to local government & other stakeholders, and d.) the establishment & updating/maintenance of national/regional coastal resources database. 2.) Maintenance and protection of coastal habitats that includes: a.) water quality monitoring b.) community organization & mobilization and c.) support to alternative livelihood. 3.) Rehabilitation of degraded coastal habitats that include: a.) establishment and maintenance of multi-species mangrove nursery, b.) seedling production/procurement for distribution, c.) rehabilitation of mangrove areas, d.)

maintenance and protection of existing mangrove stands. 4.) Advocacy building/information education and communication. 5.) Capability building and human resources development. 6.) Research and special projects and 7.) Support Gender-and-Development mainstreaming.

## 5.4 Issues and Threats

Forty-five genera of corals have been reported in Telbang. The last El Niño event resulted in mass bleaching of corals. Some residents and outsiders occasionally still practice cyanide fishing and trawl fishing. Sedimentation and siltation are problems.

## 5.5 Monitoring, Evaluation and Feedback

The monitoring and evaluation system is done on three levels. The first level is with the CEP Area Project Management. The second level of monitoring, which is concerned with the actual implementation of individual component projects, is done by the BOLO I – YAO officers. The third level is concerned with impact monitoring at the community level. Impacts of CRM interventions are evaluated with particular focus on the improvement in the fisheries stocks and marine biodiversity and in the community's socio-economic status. The first, second and third levels of monitoring are done quarterly, monthly and every 5 years, respectively.

The method that was used in the monitoring of coral reefs was line-intercept transect. Four stations were monitored from 1993 to 1998 (Table 5.1). Improvement in the condition of the corals was observed. Possible reasons for the decrease in live coral cover were the strong typhoons that hit Northern Luzon in the previous years which caused siltation in the area.

Table 5.1. Percent live coral cover.

| Coordinate | | | | Year | |
|---|---|---|---|---|---|
| Longitude | Latitude | Province | Municipality | 1993 | 1998 |
| 120°04'00" | 16°11'00" | Pangasinan | Alaminos | 12.00 | 67.60 |
| 120°04'15" | 16°11'05" | Pangasinan | Alaminos | 33.51 | 66.60 |
| 120°03'30" | 16°11'12" | Pangasinan | Alaminos | 28.88 | 74.00 |
| 120°03'00" | 16°11'15" | Pangasinan | Alaminos | 45.00 | 51.60 |

A total of 77 species of reef fishes belonging to 24 families were recorded in the area; 34% of these are commercially-important species. Fusiliers dominated, comprising 39% of the total counts.

## 5.6 Future directions, Gaps and Recommendation

For improved sustainability, the people's organization should strengthen their links with other stakeholders. They should formulate long-term strategies to address threats to coral reefs, seagrass beds, mangroves and fisheries.

## 5.7 Acknowledgments

We would like to acknowledge the assistance of the following: Dir. Florendo Barangan, Dexter Gumangan, Maria Theresa Espino, Edison Husana, Francisco Paciencia Jr, Emiliano Ramoran, Joselito Magat, Chester Casil and Ann Malano of DENR-CMMO.

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Results of the Monitoring and Assessment of Coral Reefs in CEP sites in Region 1
CMMD Mid-year report of Region 1

# CHAPTER 6 SAN SALVADOR ISLAND, MASINLOC, ZAMBALES

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## 6.1 Biophysical Setting

San Salvador is an island *barangay* (village) under the jurisdiction of the municipality of Masinloc, Zambales, in northwestern Luzon. The reefs in the northeastern part of the island are fringing, characterized by a vast reef flat with sudden drop-offs in the crest. Spur and groove formation is common along the reef crest, particularly in the area facing the South China Sea. A 127-hectare fish sanctuary was established in 1989.

## 6.2 Socio-economic Setting

Fishing is the major source of livelihood in the island. Most are deep-sea fishers, and thus are not highly dependent on reef resources. Many are also becoming increasingly engaged in aquarium fishing but this is not allowed around the island so they go to the surrounding islands.

## 6.3 Management

The fish sanctuary was established in July 1989 through Municipal Ordinance No. 30 series of 1989, with the assistance of Haribon Foundation and the U.S. Peace Corps. The sanctuary is a no-take zone for fishing although culturing and catching of marine resources for scientific research is allowed. Meanwhile the whole island is a reservation area where only traditional fishing methods and gleaning are allowed. It is being managed by the local people's organization, *Samahang Pangkaunlaran ng San Salvador* (Association for Progress of San Salvador), and the *Bantay Dagat* (Guardians of the Sea). There is also considerable support from the local government. A multi-partite monitoring team consisting of representatives from the local people's organization, the local government, National Power Corporation (NPC) and the Provincial Environment and Natural Resources Officer was organized mainly to address concerns on the effects of the power plant to the marine resources through regular monitoring. Their monitoring stations are located around the vicinity of the plant and a few in San Salvador.

## 6.4 Issues and Threats

Severe coral bleaching was observed in the area in 1998. High exposure to storms is another natural threat to the reefs. Heavy siltation from river and agricultural run-off is another major threat. Blast fishing is still occurring. Recently, aquarium fishers have slowly returned to fish in the reefs of San Salvador even though it is prohibited. In fact, several violators were observed while biophysical monitoring was going on. The extent of exploitation of aquarium fishes is a growing concern. Catch often includes juvenile fishes, and no limit in number or size has been set. Lastly, the presence of the NPC coal power plant has always been of some concern mainly due to the outflow of hot seawater from the facility.

## 6.5 Monitoring, Evaluation and Feedback

A monitoring program to evaluate the effectiveness of the San Salvador fish sanctuary was set up by the U.P. Marine Science Institute in 2000 and is still on going. Monitoring stations are located both inside and outside (adjacent to) the fish sanctuary. Substrate characteristics are obtained using underwater video transects and the line intercept technique. Changes in reef fish assemblage are determined using standard visual census methods.

Changes in substrate cover over time are presented in Table 6.1. Hard coral cover inside the fish sanctuary seems to be recovering in 2002 after a decrease was observed the previous year. Hard coral cover outside the sanctuary seems to show a decreasing trend (Fig.6.1). Christie et al. (1994) observed an increasing trend from 322 reef fish/500m$^2$ (May 1989, n=3) to 431 reef fish/500m$^2$ (March 1990, n=3) to 460 reef fish/500m$^2$ (April 1991, n=5) inside the marine sanctuary. Recently, reef fish density and biomass both inside and outside the fish sanctuary show decreasing trends (Figs. 6.2 and 6.3). A recent rapid survey (n=1 each) recorded 354 reef fish/500m$^2$ inside the marine sanctuary and 246 reef fish/500m$^2$ outside the marine sanctuary (Melchor Deocadez pers. comm.).

The local community has been trained in simplified methods of monitoring reefs.

## 6.6 Future directions, Gaps and Recommendations

Enforcement of the fish sanctuary seems to have weakened, especially with the growing tension between the people's organization and *Bantay Dagat*. Positive interference and more support from the local government may be needed to overcome this problem. Furthermore, the threat of overexploitation of marine resources should be addressed and controlled. Capacity-building on reef monitoring and evaluation for the stakeholders of the fish sanctuary (e.g., people's organization and local government) needs to be facilitated. So far, representatives from these sectors only observe and assist in the multi-partite monitoring activities. It is hoped that they will later become capable to do the monitoring themselves especially since they already have the equipment for this.

Table 6.1. Average percent cover of various benthic lifeforms inside and adjacent to San Salvador Fish Sanctuary, Zambales

| Benthic Lifeform | 1991* | INSIDE MPA | | | OUTSIDE MPA | | |
|---|---|---|---|---|---|---|---|
| | | Dec 2000 | Sep 2001 | Jan 2002 | Dec 2000 | Sep 2001 | Jan 2002 |
| Hard Coral (live) | 25.90 | 27.42 | 20.71 | 39.92 | 24.88 | 46.93 | 27.83 |
| Soft Coral | | 0.74 | 0.59 | 0.20 | 0.82 | 0.33 | 0.11 |
| Dead Coral | | 0.02 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 |
| Dead Coral w/ Algae | | 2.90 | 4.17 | 9.32 | 2.88 | 5.88 | 17.00 |
| Turf Algae | | 30.24 | 17.04 | 31.55 | 51.74 | 13.85 | 37.71 |
| Macroalgae | | 0.22 | 0.63 | 0.00 | 0.58 | 0.01 | 0.24 |
| Coralline Algae | | 14.56 | 5.28 | 3.57 | 7.06 | 3.26 | 0.79 |
| Seagrass | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Sponge | | 19.40 | 1 .14 | 6.91 | 9.58 | 27.08 | 5.06 |
| Other Animals | | 0.48 | 0.10 | 0.26 | 0.28 | 0.12 | 0.66 |
| Rubble | | 0.48 | 12.45 | 0.22 | 0.70 | 0.00 | 0.62 |
| Rock | | 1.16 | 0.33 | 0.00 | 0.06 | 0.01 | 0.00 |
| Sand/Silt | | 0.06 | 11.45 | 0.97 | 0.28 | 0.02 | 0.52 |

*Christie et. al.1991

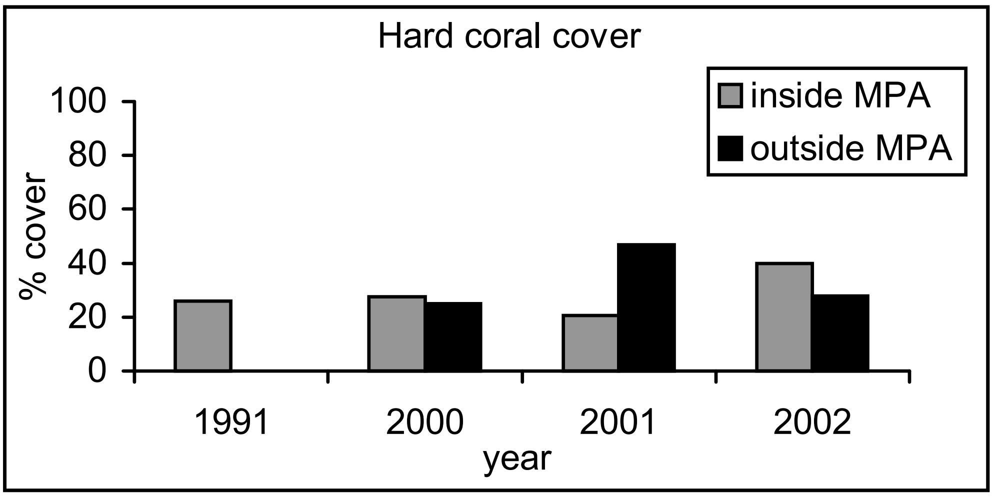


Figure 6.1. Hard coral cover inside and adjacent to San Salvador Fish Sanctuary

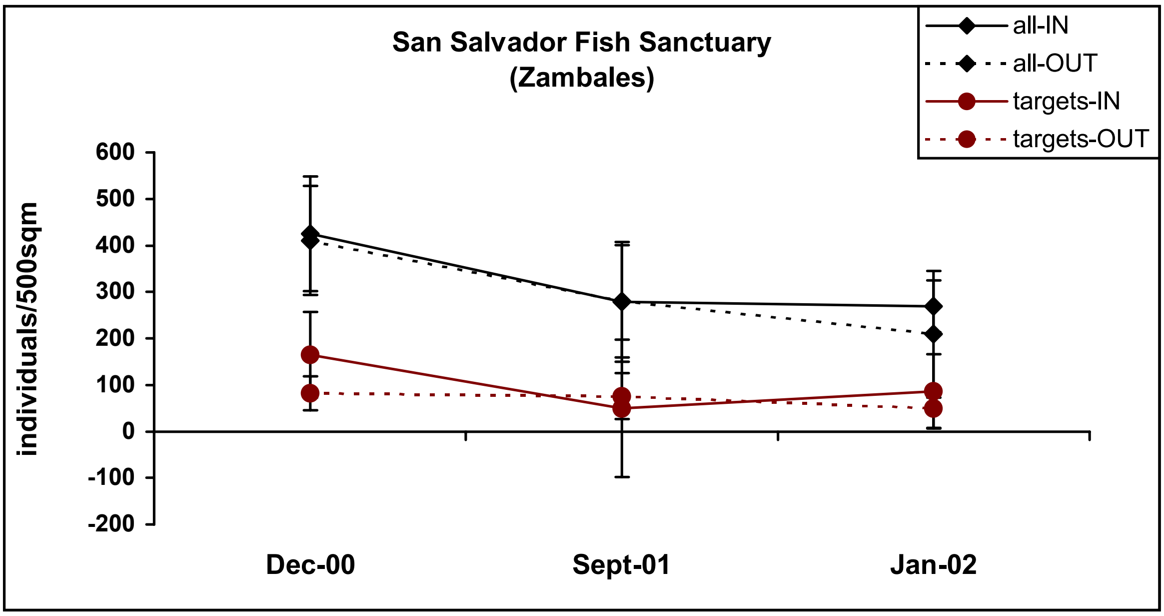


Figure 6.2. Trends in reef fish density (all species and target species) inside and adjacent to San Salvador Fish Sanctuary

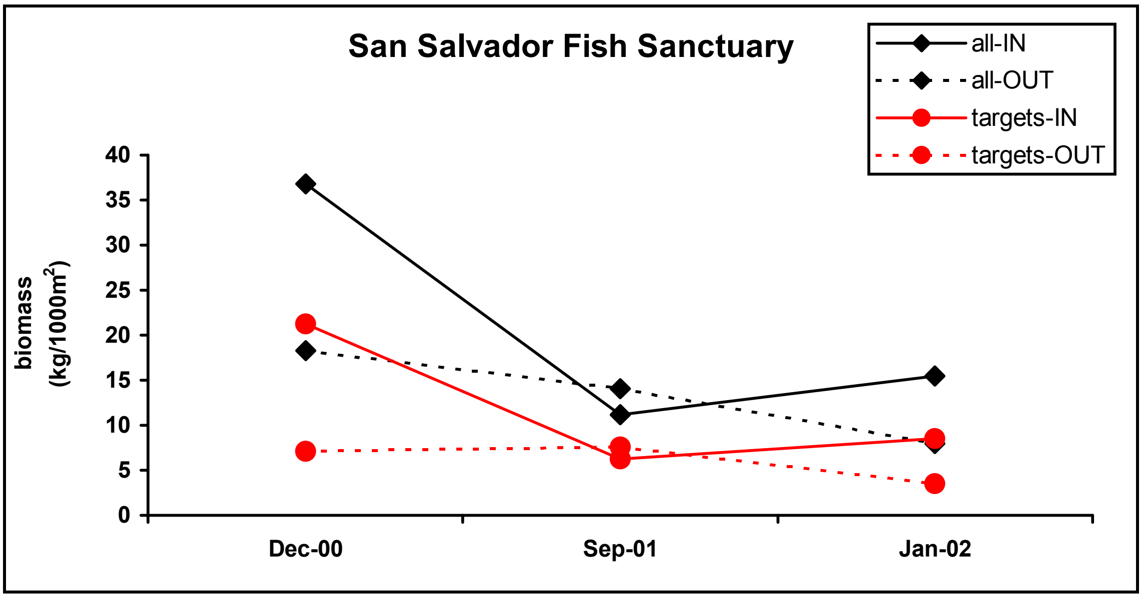


Figure 6.3. Trends in reef fish biomass (all species and target species) inside and adjacent to San Salvador Fish Sanctuary

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# CHAPTER 7 MABINI AND TINGLOY, BATANGAS

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## 7.1 Biophysical Setting

The diverse and abundant reefs in the Mabini and Tingloy area in the Province of Batangas, and Balayan Bay are known for their wealth of marine life. Bordering the Calumpan Peninsula containing Mabini municipality and Maricaban and Caban Islands of Tingloy municipality are many excellent fringing and patch coral reefs (Fig. 7.1). These reefs are famous for their natural productivity that supplies tons of fish to local communities. In addition, their color and diversity attract thousands of scuba divers and swimmers to the area every month of the year.

## 7.2 Management

The management of the coral reefs in this area is closely tied to the development of coastal tourism. The first advocates for protection of the coral reefs were scuba divers who began to frequent Mabini and Tingloy dive sites in the mid-1970s. One of the first diving resorts in the Philippines (Dive 7000) started operation in 1975 in the area and attracted many visitors. Some resorts were already concerned about the rampant illegal fishing occurring in those years. A national marine park was proposed to protect the reefs of Sombrero Island and parts of Caban and Maricaban Islands in 1982. Many other management events have occurred since and are listed below:

| | |
|---|---|
| 1970s | Diving tourism began in the area and brought divers and visitors |
| 1978 | Department of Tourism passed P.D. 1801 declaring the islands and reefs a tourism zone whereby restrictions were imposed on development and spearfishing using scuba |
| 1980 | Marine Parks Task Force of the National Environmental Protection Council surveyed the coral reefs and proposed Sombrero Island, Sepoc and Layag-Layag Points be included within a national marine park |
| 1982 | Proposed marine park was promoted but not made legal |
| 1982-88 | No effective management actions in the area except for sporadic attempts to stop illegal fishing; diving tourism increased substantially |
| 1988 | Haribon Foundation started a community-based conservation project along the shoreline of the villages of San Teodoro and Bagalangit, in Mabini Municipality |
| 1991 | First marine reserve declared by municipal ordinance in Mabini establishing three marine sanctuaries (Cathedral Rock, Arthur's Rock and Twin Rocks) within the one reserve restricting certain fishing and recreational activities |
| 1991 | First baseline data collected on sanctuary sites (UP-MSI/Haribon) |
| 1993 | First Earthwatch Expedition to survey coral reefs of the Mabini/Tingloy area |
| 1994 | Biodiversity Conservation Network supported the University of Rhode Island through the Haribon Foundation to plan a major conservation program and to conduct a socio-economic study (Telesis 1994) |
| 1995, 1996-97 | Second Earthwatch Expedition conducted (UP-MSI Coral reef monitoring) |
| 1997 | Third Earthwatch Expedition conducted |
| 1997 | Mabini and Tingloy Municipalities became expansion areas of the CRMP/USAID |
| 1997 | World Wildlife Fund began to support general conservation in the area |
| 1997 | The Mabini Tingloy Coastal Area Development Council (MaTinCADC) was formed |
| 1999 | CCE Foundation began a marine conservation project in Barangay Sto. Tomas, Tingloy |
| 2000 | The Friends of Balayan Bay Association was formed to address issues in area |
| 2001 | Fourth Earthwatch Expedition conducted |
| 2000-2002 | UP-MSI Coral reef monitoring |

## 7.3 Issues and Threats

Signs of destructive fishing of recent origin are not generally present as in years past. Storm damage of the late 1980s is disappearing and is being repaired with new coral growth although a storm in 2000 did overturn some coral heads at Sombrero, Arthur's and White Sand Reefs. The delicate balance of the coral growth versus destruction from natural and human caused events appears to be stable as evidenced in Figure 7.2. Nevertheless, for the reefs to continue to have improved coral growth, the human caused damage from anchors, fishing and scuba divers, must be addressed.Tourism activity is dominant and increasing. The number of local boats used for diving and travel by visitors has increased dramatically over the past ten years. Anchor damage is apparent on all the reefs except where the buoys are routinely used. Some damage may be attributed to novice and careless scuba divers.

The total lack of solid waste management is very evident in the area. At every site, the survey encountered floating debris. Plastics are more common than jellyfish! Sediment deposited from heavy rainfall events was evident on the reefs bordering the Calumpan Peninsula especially at Twin Rocks and at White Sand Reef. This reflects deforestation and building on land. The increasing construction along the shoreline is having negative impacts on the reefs in general. Most structures are not being setback from the high tide line by at least 20 meters as stipulated in the Land Management Act.

## 7.4 Monitoring, Evaluation and Feedback

### Methods for data collection

Snorkeling survey method was used to estimate benthic cover. While indicator fish species, species richness and density were recorded using both snorkeling survey and SCUBA. All survey methods used above were consistent with Uychiaoco et al. (2001) and with those used by the Reef Check Foundation. Each day some volunteers recorded observations on human use of the site being surveyed. These observations included fishing, boats, dropping of anchors, divers, shoreline development and any other activities with potential impacts.

### Summary of findings and trends

The overall physical condition of the reef sites surveyed appears somewhat stable over years past and since 1997. This conclusion, although not based on very long-term (more than 15 years) baseline information for the area, is surmised from the abundance of new coral growth and the lack of large-scale physical damage or other negative impacts of recent origin. The exception to this general improvement is the White Sand Reef bordering the El Pinoy Resort and White House. This reef was severely damaged by an infestation of crown-of-thorns seastars in 1999 and 2000 that left much of the shallow branching coral dead covered with algae. Living coral cover decreased on both the shallow and deep reef since 1997 at that site.

There is an alarming lack of target species in the Mabini sites in general suggesting that fishing pressure is too high. The only fish families with large numbers are the anthids and pomacentrids. These fish are abundant because they are of little food value to people and have not been depleted by either aquarium or food fish collectors. The reefs are over-fished and the fish community ecology is distorted from a normal balance. Haemulids, kyphosids and carangids were almost totally absent during the last survey in 2001. Serranids, a common and economically important food fish, are also missing. It appears also that recruitment to the sanctuaries is not very rapid or abundant indicating that there may be an overall failure in reproduction of fish in the wider Batangas and Balayan Bay area. This suggests the need for more and effective marine sanctuaries.

## 7.5 Recommendations

It is important that management in the Mabini and Tingloy area be continued and expanded. These efforts have started a process of conservation that is sustainable with immediate results. The management issues in Mabini and Tingloy are not much different than 10 years ago. Rather our perspective of the issues has changed and we have a better understanding of what is required to find and implement solutions. We are realizing that the solutions must be long term, require integrated and balanced approaches, and involve all stakeholders in a resource management process. The need for improved dialogue and conflict resolution between stakeholders will be essential for long-term success. Specific suggestions on conservation in the Mabini area based on the observations of the 1993, 1995,1997 and 2001 surveys are:

1). The Mabini Municipal marine reserve and sanctuary project and that of Dive and Trek in Bauan can be used as an example for areas on Maricaban, Caban and Sombrero Islands. The fishermen from the barangays of San Teodoro and Bagalangit can participate in workshops with fishermen from Tingloy and other communities. The process can spread the idea of sustainable use of the reefs to surrounding communities.

2). Destructive fishing and spear fishing using compressed air needs to be totally stopped around the island of Maricaban, Caban and Sombrero. This will set the tone for improved conservation in the area.

3). More anchor buoys are needed at every site. Anchor buoys are having positive effects on the sites where they are located and have made boatmen more conscious about breaking corals. They can serve as examples for heightened concern about coral reef protection and disturbance. Local community managed anchor buoys can be used as a source of revenue. Education and coordination with local communities needs to accompany placement of buoys.

4). Raising awareness about waste disposal is needed. The Municipalities of Mabini and Tingloy should complain to Batangas City about waste drifting from Batangas City to their beaches. Large ships should not be allowed to pass through the Maricaban Strait since they undoubtedly dump some of their waste in passage and risk grounding.

5). The Friends of Balayan Bay Association can play a larger role in the conservation efforts. It needs guidance and assistance with coordination between local and national government agencies and community concern.

6). An integrated management plan for the Mabini area should be drafted. This plan can serve as a focus of discussion of all stakeholders and be a topic for various workshops and educational programs.

Table 7.1. Mean percent of living and dead substrate cover for Mabini-Tingloy area* in Batangas, 1993, 1995,1997 and 2001, at deep (5-9 m) and shallow (2-4m) reefs

| BENTHOS | Deep | | | | Shallow | | | |
|---|---|---|---|---|---|---|---|---|
| | 1993 | 1995 | 1997 | 2001 | 1993 | 1995 | 1997 | 2001 |
| Hard Coral | 28.1 | 38.1 | 32.3 | 29.9 | 35.8 | 49.0 | 53.7 | 53.7 |
| Soft Corals | 16.6 | 19.2 | 19.9 | 14.1 | 10.9 | 12.4 | 12.5 | 8.4 |
| Algae and seagrass | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 3.4 |
| Abiotic | 53.1 | 41.2 | 43.2 | 45.6 | 52.0 | 36.2 | 29.1 | 23.6 |
| White Dead Standing Coral | 2.2 | 1.4 | 4.6 | 0.2 | 1.3 | 2.4 | 4.7 | 1.1 |
| Dead Coral With Algae | ~ | ~ | ~ | 8.2 | ~ | ~ | ~ | 9.7 |
| GRAND TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Other Relevant Information | | | | | | | | |
| Depth range (m) | 7-8 | 5-9 | 5-9 | 5-6 | 2-4 | 2-4 | 2-5 | 2-4 |
| Sample Size (50m-transects /1m$^2$ stations) | 22 | 25 | 66 | 142 | 373 | 600 | 1120 | 2205 |

9 reef sites surveyed (Twin Rocks, Arthur's Rock, Cathedral Rock, White Sand Reef, White House Reef, Sombrero Island, Layag-layag, Sepoc Point, and Pulang-Buli Reef).

Table 7.2. Mean fish abundance per 500 m$^2$ for Mabini-Tingloy area* in Batangas, 1991, 1992, 1993, 1995, 1997 and 2001, at 6-7 m depth

| | 1991[a] | 1992[a] | 1993[b] | 1995[c] | 1997[c] | 2001[c] |
|---|---|---|---|---|---|---|
| FAMILY | n=6 | n=6 | n=13 | n=22 | n=39 | n=44 |
| Rabbitfish (Siganidae)* | 0.5 | 0.0 | 2.6 | 1.4 | 3.2 | 2.6 |
| Fusiliers (Caesionidae)* | 56.0 | 274.0 | 15.7 | 2.4 | 29.4 | 23.0 |
| Groupers (Serranidae)* | 3.0 | 2.7 | 1.8 | 0.7 | 1.2 | 2.0 |
| Snapper (lutjanids)* | 0.5 | 3.3 | 0.7 | 4.1 | 5.5 | 6.1 |
| Jacks (Carangidae)* | 1.0 | 0.2 | 1.9 | 0.0 | 0.8 | 1.0 |
| Spinecheeks (Nemipteridae)* | 8.3 | 9.5 | 7.3 | 7.7 | 4.1 | 6.6 |
| Rudderfish (Kyphosidae)* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Emperors (Lethrinidae)* | 3.3 | 5.5 | 6.4 | 1.5 | 1.1 | 3.5 |
| Goatfish (Mullidae)* | 12.8 | 6.5 | 7.8 | 4.5 | 6.5 | 12.4 |
| Sweetlips (Haemulidae)* | 0.0 | 0.7 | 0.2 | 1.4 | 0.6 | 0.1 |
| Parrotfish (Scaridae)* | 26.3 | 8.0 | 13.1 | 10.3 | 12.0 | 10.5 |
| Surgeonfish (Acanthuridae) | 79.0 | 63.5 | 67.6 | 38.5 | 67.9 | 55.7 |
| Butterflyfish (Chaetodonidae) | 34.5 | 30.9 | 29.4 | 27.0 | 22.2 | 31.1 |
| Wrasses (Labridae) | 52.5 | 163.4 | 214.0 | 265.9 | 158.7 | 169.2 |
| Fairy Basslets (Anthiinae) | 464.0 | 344.5 | 1091.7 | 1445.8 | 1372.7 | 611.8 |
| Triggerfish (Balistidae) | 10.0 | 8.2 | 6.0 | 3.0 | 6.7 | 12.9 |
| Damselfish (Pomacentridae) | 695.5 | 1011.2 | 629.5 | 705.1 | 1522.3 | 1485.1 |
| Angelfish (Pomacanthidae) | 41.0 | 28.4 | 14.0 | 6.2 | 18.7 | 27.0 |
| Moorish Idols (Zanclidae) | 19.0 | 11.0 | 8.2 | 7.7 | 12.0 | 8.3 |
| Total (All reef species) | 1507.0 | 1971.2 | 2117.5 | 2533.2 | 3245.5 | 2469.4 |
| Total (Target reef species)* | 111.5 | 310.3 | 57.3 | 33.9 | 64.3 | 67.6 |

* Species sought by fishermen   a - Sites surveyed: Twin Rocks, Arthur's Rock

b - Sites surveyed: Twin Rocks, Arthur's Rock, Sombrero Island, Layag-layag, Pulang-buli, Sepoc Point c - Sites surveyed: Twin Rocks, Arthur's Rock, Sombrero Island, Layag-layag, Pulang-buli, Sepoc Point, White Sand

7). Guidelines need to be developed for all shoreline construction and development that has the potential for causing erosion or increasing pollution. Setbacks should be followed.

8). User fees need to be collected and managed by a credible local group to support sanctuaries, anchor buoys and other costs of conservation. The sustainability of localized management is dependent on user fees and taxes to cover management costs.

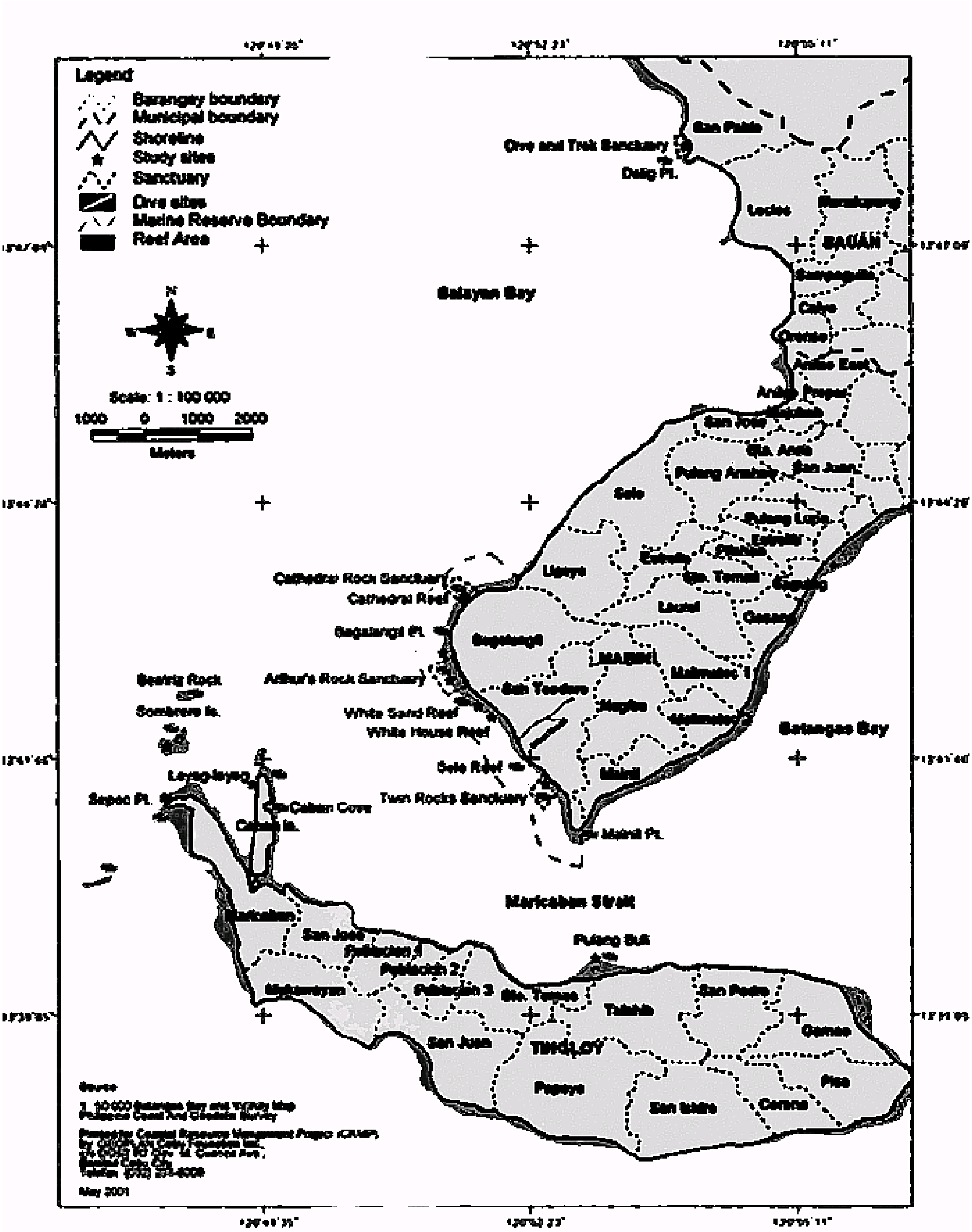


Figure 7.1. Expedition research area and study sites in Mabini, Tingloy and Bauan, Batangas.

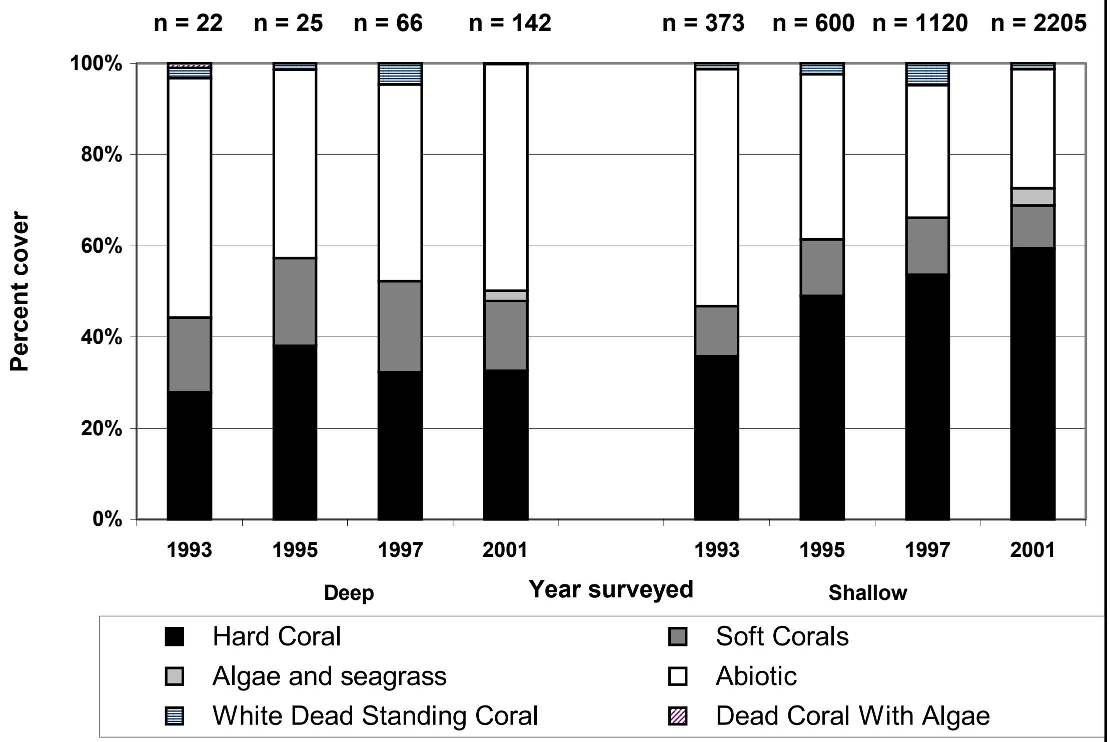


**Fig. 7. 2. Change in mean substrate cover for sites surveyed in Mabini-Tingloy, Batangas for deep (5-8m) and shallow (2-4m) reef areas**

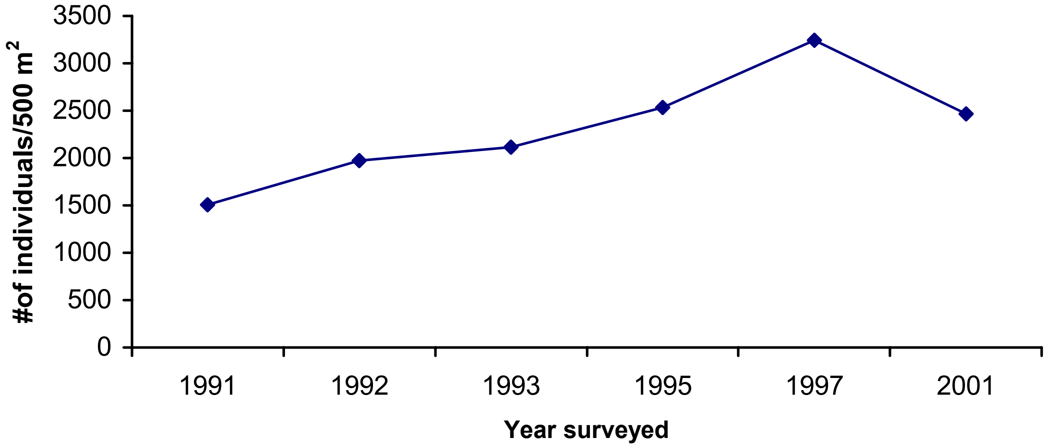


**Fig. 7.3. Mean fish abundance for all-reef species (19 species) per 500 $m^2$ for Mabini-Tingloy, Batangas at mean depth of 6-7 meters**

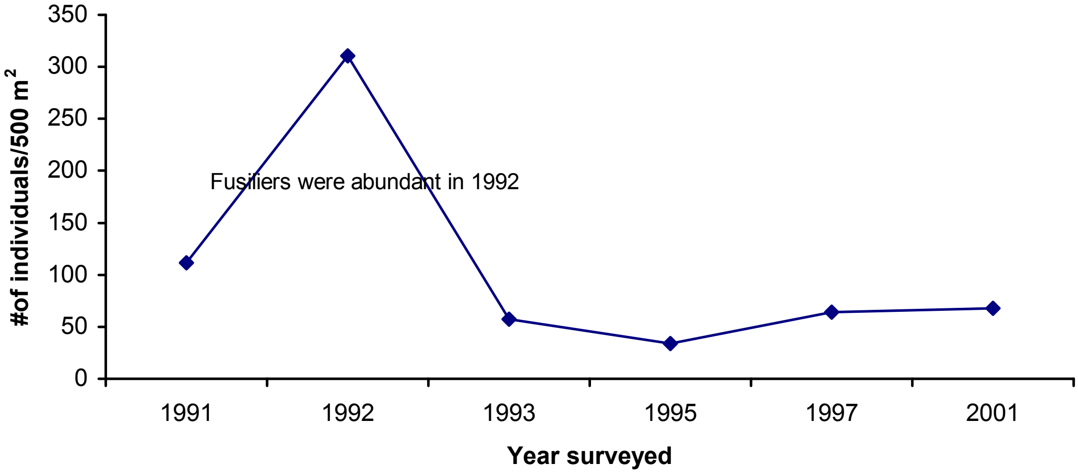


**Fig. 7. 4. Mean fish abundance for target reef species per 500 $m^2$ for Mabini-Tingloy, Batangas at mean depth of 6-7 meters**

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# CHAPTER 8 PUERTO GALERA, ORIENTAL MINDORO

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## 8.1 Biophysical Setting

Puerto Galera is a small northern peninsula north of the island of Mindoro, with coordinates between 13° 23' and 13° 32' N latitude, 120° 50' and 121° 50' E longitude. It is acknowledged as one of the most highly diverse coastal areas in the Philippines (Campos 2002). Coral reefs occur in shallow water, ranging from surface down to depths between 10 and 80 m (Fortes 1997). Three sites monitored from 1991 to 1993 by the Phase II of the LCRP are considered in this report. These are First Plateau (13° 30.683'N, 120° 57.317'E), Third Plateau (13° 32.033'N, 120° 57.100'E), and Escarceo Point (13° 31.450'N, 120° 59.433'E) (Fig. 8.1). The coral reef flats in these areas appear to be poor although the sloping portions with depths ranging from 7 to 15 m are rich with reef-building corals. First and Third Plateaus are characterized by pocilloporids, poritids and *Seriatopora*. While Escarceo Pt. and the deeper site of Third Plateau are dominated by soft corals (Atrigenio 1995). Of the sites surveyed, Third Plateau had the highest mean percentage of live coral at 33% (Campos 2002). Campos (2002) gives a more detailed account of the flora and fauna of the area.

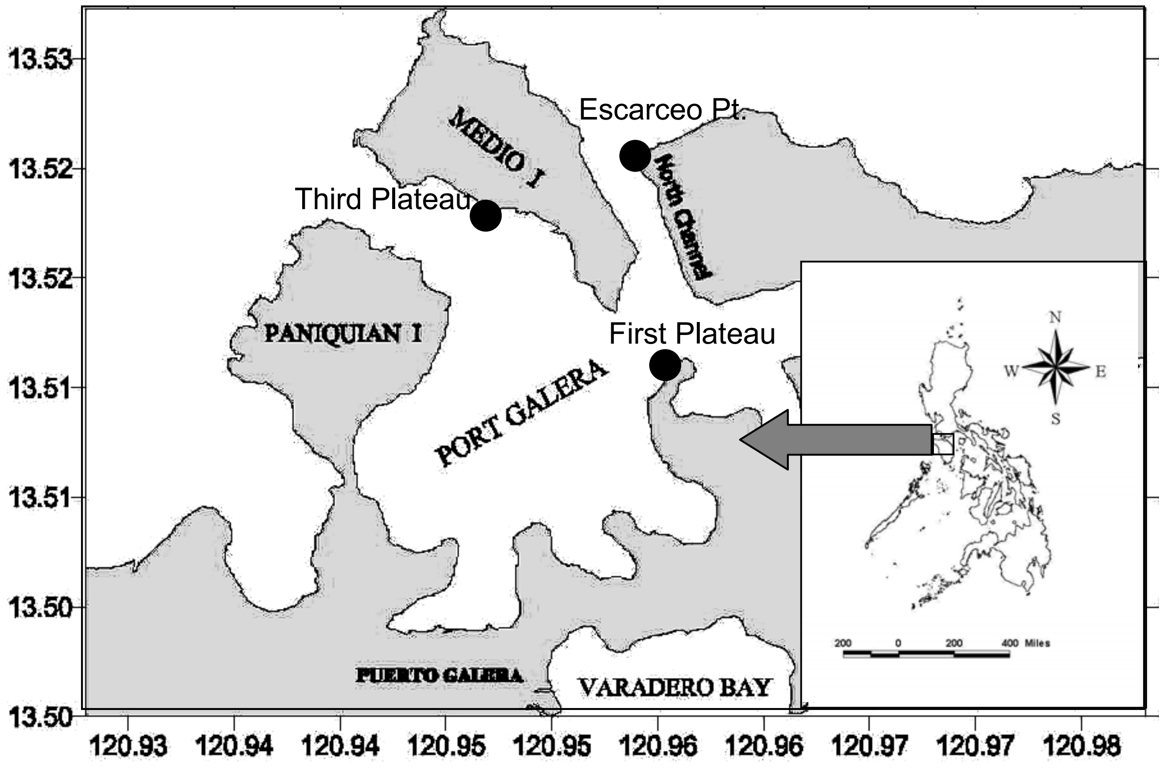



Fig. 8.1. Map of Puerto Galera showing the location of stations.

## 8.2 Socio-economic Setting

Until 1975, fishing was the main source of income of almost all the people in the lowlands (Fortes 1997). After the boom of tourism in the end of the 1970s, extraction of marine resources from the bay was no longer the main source of livelihood in the area. The town has become mainly a tourist area. Aquatic related tourism activities include SCUBA and skin diving, swimming, and beachcombing. Boats that abound in the waters of Puerto Galera are mainly used to ferry tourists rather than for fishing (Fortes 1997; 2001; Campos 2002).

## 8.3 Management

At present, no single body is in-charge of management and conservation measures in Puerto Galera. Although the area has been declared as a biosphere reserve in 1973, management of the marine environment is sadly lacking. The Philippine Tourism Authority (PTA) has been given some control and administrative powers on tourism-related activities in the area (Fortes 1997; Campos 2002)

## 8.4 Issues and Threats

A major threat to the reefs is sedimentation associated with the development of coastal settlements, marble mining and goldpanning and eutrophication brought by sewage outflows from resorts and coastal settlements (Fortes 1997; 2001). Water pollution may also have been brought about by discharges of watercraft plying the area. The lack of enforcement of existing laws and ordinances as well as weak community participation in conservation efforts (Fortes 2001) further aggravates the situation.

## 8.5 Monitoring, Evaluation and Feedback

Reef- associated fish were monitored from 1991 to 1993 using modified reef fish visual census technique (English et al. 1997). For each of the three sites, a shallow (6m) and a deep (12m) transect were surveyed. Based on the data available, there seems to be a general decrease in both numerical abundance and biomass of reef-associated fishes in the sites monitored (Figs. 8.2a & 8.2b). This could be an indication of reef degradation as well as overfishing.

## 8.6 Future directions, Gaps and Recommendations

The data available on reef fish and benthic cover is sadly in need of updating, especially given the importance of the area. More importantly, there is need for a community-based coastal management plan that should be implemented to conserve the marine environment of Puerto Galera. It is highly suggested that the plan include monitoring of the reefs in the area.

Table 8.1. Benthic cover (%) in 1993 (Atrigenio 1995).

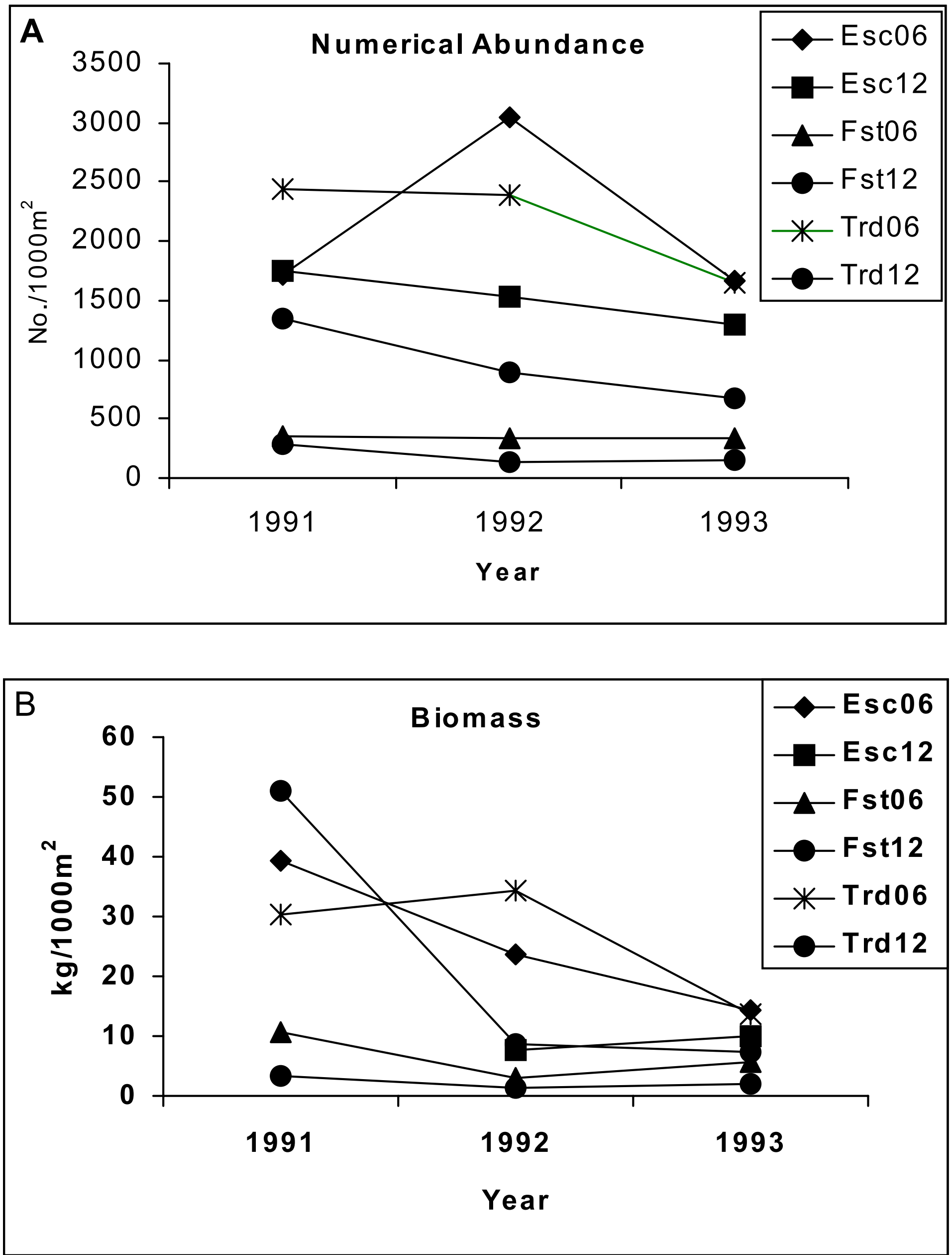
| Province | Municipality | Station | Hard Coral | Soft Coral | Algae | Dead Coral | Other fauna | Abiotic |
|---|---|---|---|---|---|---|---|---|
| Oriental Mindoro | Puerto Galera | Escarceo Pt.06 | 24.67 | 28.8 | 4.43 | 2.3 | 2.92 | 28.14 |
| Oriental Mindoro | Puerto Galera | Escarceo Pt.12 | 16.32 | 9.2 | 6.93 | 9.3 | 9.89 | 40.11 |
| Oriental Mindoro | Puerto Galera | First Plateau 06 | 7.33 | 0.00 | 2.67 | 7.0 | 6.73 | 56.80 |
| Oriental Mindoro | Puerto Galera | First Plateau 12 | 12.23 | 0.00 | 2.90 | 4.7 | 21.69 | 47.73 |
| Oriental Mindoro | Puerto Galera | Third Plateau 06 | 29.07 | 0.90 | 0.00 | 6.1 | 6.35 | 54.78 |
| Oriental Mindoro | Puerto Galera | Third Plateau 12 | 3.22 | 8.00 | 0.00 | 4.2 | 1.76 | 72.73 |

Table 8.2. Fish abundance in individuals/1000m$^2$

| Province | Municipality | Station | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| Oriental Mindoro | Puerto Galera | Escarceo Pt.06 | 1709 | 3052 | 1674 |
| Oriental Mindoro | Puerto Galera | Escarceo Pt.12 | 1747 | 1536 | 1297 |
| Oriental Mindoro | Puerto Galera | First Plateau 06 | 348 | 339 | 336 |
| Oriental Mindoro | Puerto Galera | First Plateau 12 | 279 | 133 | 148 |
| Oriental Mindoro | Puerto Galera | Third Plateau 06 | 2438 | 2396 | 1650 |
| Oriental Mindoro | Puerto Galera | Third Plateau 12 | 1341 | 895 | 677 |

Table 8.3. Fish biomass in kg/1000m$^2$

| Province | Municipality | Station | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|
| Oriental Mindoro | Puerto Galera | Escarceo Pt.06 | 39.45 | 23.63 | 14.40 |
| Oriental Mindoro | Puerto Galera | Escarceo Pt.12 | no data | 7.69 | 10.10 |
| Oriental Mindoro | Puerto Galera | First Plateau 06 | 10.78 | 3.14 | 5.76 |
| Oriental Mindoro | Puerto Galera | First Plateau 12 | 3.34 | 1.46 | 2.11 |
| Oriental Mindoro | Puerto Galera | Third Plateau 06 | 30.18 | 34.22 | 13.66 |
| Oriental Mindoro | Puerto Galera | Third Plateau 12 | 51.01 | 8.73 | 7.48 |




Figs. 8.2a & 8.2b Mean numerical abundance and biomass estimates in the sites surveyed in Puerto Galera, Mindoro from 1991 to 1993 (Esc06 = Escarceo Pt, 6m; Esc12 = Escarceo Pt. 12m; Fst06 = First Plateau, 6m; Fst12 = First Plateau, 12m; Trd06 = Third Plateau, 6m; Trd12 = Third Plateau, 12m)

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# CHAPTER 9 PORT BARTON MARINE PARK, SAN VICENTE, PALAWAN

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## 9.1 Biophysical Setting

Port Barton Marine Park is a 74,483-ha reserve that stretches from the south shore of Albaguen Island to the rest of the inner bay. It includes reefs fringing many islands as well as patch reefs. Underwater visibility is generally very good.

## 9.2 Socio-economic Setting

Port Barton is a village in the municipality of San Vicente, Palawan. Fishing, farming and tourism are the major economic activities in Port Barton. However, the kidnapping of guests from Dos Palmas in Honda Bay and the September 11 attacks on the World Trade Center have devastated the local tourism industry. A pearl farm also operates within the park.

## 9.3 Management

Southern Albaguen Is., Paraiso and Exotic were declared off limits to fishing since January 6, 1998 by Municipal Ordinance 97-03. However, enforcement only began when Albaguen (10°29'50.19"N, 119°8'13.03"E), Exotic Island and Manta Ray Reef (10°29'50.19"N, 119°9'5.62"E) were marked on April 26 to early May, 1999. These limited efforts were later reorganized in favor of a large park with various zones through the assistance of the US-AID/DENR Coastal Resource Management Project to the village government of Port Barton and the municipal government of San Vicente as part of the Port Barton Coastal Resource Management Plan. There are zones for recreation (including diving but not fishing), mariculture, communal fishing as well as core zones off limits to all activities except research.

Exotic and the southern portion of Albaguen Island that were originally part of the old ordinance, Manta Ray and Black Coral are the core zones of the proposed Port Barton Bay Marine Park. Aquarium, Oyster and Capsalay are proposed recreation zones. The ordinance for the formal establishment of the Park is still under review by the municipal legislative council but protection is already being enforced after buoys were deployed to mark the boundaries for the various zones. The interim Park Management Council is led more by the village and municipal government, boat operators and resort owners than by the local fishers' organization (e.g., Albaguen Fishermen's Association).

## 9.4 Issues and Threats

The area still has good coral cover and much fish but it is having difficulty recovering from a storm that followed right after a mass bleaching event in 1998.

## 9.5 Monitoring, Evaluation and Feedback

Despite changes in political leadership, some municipal employees (e.g., Mr. John Resurreccion, Mr.

Roberto Alarde and Ms. Cherry Pie Acosta) have managed to continue monitoring activities with the help of the US-AID/DENR Coastal Resource Management Program.

Hard coral was devastated after a storm (Typhoon Norming) followed a mass bleaching event (April-May) in 1998 (Marnee Comer, pers. comm.). Hard coral cover both inside and adjacent to the reserve have since seemed generally stable (Fig. 9.1) but target fish abundance inside and adjacent to the reserve seems to have dropped from 1999 to 2001 (Fig. 9.2). This decrease is also reflected in the major carnivores (groupers, snappers, emperors and sweetlips) and is more evident adjacent to rather than inside the reserve.

Figure 9.1 Hard coral cover inside and adjacent to the Port Barton Marine Park.

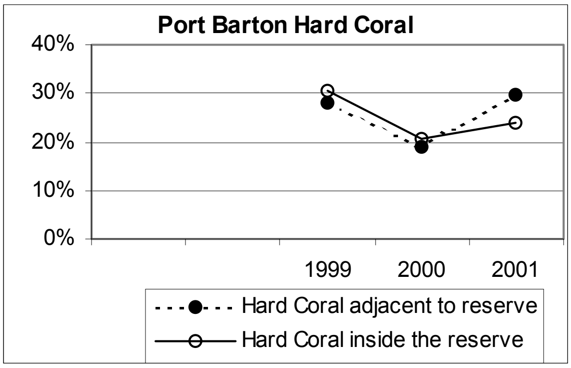


Figure 9.2 Fish count/500m$^2$ inside and adjacent to the Port Barton Marine Park.

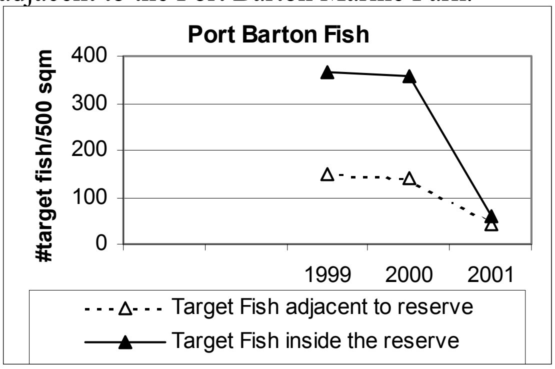


Table 9.1 Average % cover of benthic lifeforms inside and adjacent to the Port Barton Marine Park.

| Zone | adjacent | | | inside | | |
|---|---|---|---|---|---|---|
| Year | 1999 | 2000 | 2001 | 1999 | 2000 | 2001 |
| Hard Coral (live) | 27% | 19% | 30% | 30% | 21% | 24% |
| Soft Coral | 1% | 2% | | 2% | 3% | |
| Dead Coral | 1% | 2% | | 6% | 2% | |
| Coral w/ black band disease | | | | | | |
| Bleached (hard & soft) coral | | | | | | |
| Dead Coral w/ Algae | 21% | 14% | | 30% | 10% | |
| Turf Algae | 16% | 33% | | 1% | 26% | |
| Macroalgae | 8% | 16% | | 8% | 13% | |
| Coralline Algae | 6% | 6% | | 1% | 3% | |
| Seagrass | 0% | 0% | | | 0% | |
| Sponge | 0% | 0% | | | 3% | |
| Zoanthids | | 0% | | | 0% | |
| Other Animals | | 2% | | | 2% | |
| Rubble | 2% | 5% | | 4% | 6% | |
| Rock | | 0% | | 1% | 3% | |
| Sand/Silt | 3% | 1% | | 0% | 9% | |

## 9.6 Future directions, Gaps and Recommendations

Fishers could be given a greater role in the management of the park. Resort owners can increase their support for reef monitoring and can in turn use the reef monitoring results to better plan visitor itineraries.

Table 9.2 Average fish abundance per 500 m$^2$ inside and adjacent to the Port Barton Marine Park.

| zone | adjacent | | | inside | | |
|---|---|---|---|---|---|---|
| year | 1999 | 2000 | 2001 | 1999 | 2000 | 2001 |
| Epinephelinae* | 5.5 | 5.3 | 1.8 | 3.5 | 5.8 | 1.5 |
| Lutjanidae* | 3.5 | 5.7 | 0.2 | 4.5 | 11.8 | |
| Haemulidae* | 1.5 | 1.8 | 0.2 | 0.5 | 9.5 | 3.3 |
| Lethrinidae* | 2.2 | 3.0 | | 4.5 | 2.8 | |
| Carangidae* | | | | 1.0 | | |
| Caesionidae* | 97.7 | 93.2 | 32.2 | 320.8 | 288.8 | 26.3 |
| Nemipteridae* | 3.3 | 3.8 | 3.7 | 5.8 | 2.3 | 2.5 |
| Mullidae* | 1.3 | 0.5 | 0.2 | | | 1.5 |
| Balistidae | 0.8 | 0.7 | 0.2 | 1.0 | 4.0 | 1.0 |
| Chaetodontidae | 30.8 | 11.8 | 2.3 | 20.5 | 16.8 | 3.3 |
| Pomacanthidae | 3.0 | 10.3 | 2.8 | 3.8 | 58.0 | 3.5 |
| Labridae | 72.2 | 43.5 | 5.2 | 53.3 | 37.3 | 12.5 |
| Scaridae* | 18.8 | 16.7 | 3.7 | 18.0 | 13.8 | 9.0 |
| Acanthuridae* | 10.8 | 4.0 | 2.2 | 5.0 | 7.5 | 3.3 |
| Siganidae* | 2.5 | 5.0 | 0.5 | 4.3 | 13.5 | 4.8 |
| Kyphosidae* | | 0.8 | 0.2 | | | 6.5 |
| Pomacentridae | 431.0 | 165.7 | 40.0 | 409.5 | 321.3 | 52.3 |
| Anthiinae | | 2.2 | 18.0 | 2.5 | 0.8 | 29.8 |
| Zanclidae | 0.5 | 0.2 | | 4.8 | 1.3 | |

## 9.7 References and for Further Reading

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# CHAPTER 10 VISAYAN SEAS

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## 10.1 Biophysical Setting

The Visayan Seas covers the different seas within Central Philippines from Northern Mindanao, Bohol, Cebu, Eastern Negros, west coast of Samar and Leyte (Fig. 10.1). A total of 44 reef sites are included in this report covering the areas within the Visayan Seas (Fig. 10.1). Not enough data is available to support a general description or classification of the different reefs.

## 10.2 Management

The Visayan Seas bio-geographic region is known as an area where the most marine protected areas have been established in the country (see UPMSI/AFMA-MFR database). Most of the sample reefs monitored are marine protected areas. A few have been monitored since the 1980s (e.g., Sumilon Island, Apo Island), while the rest were generally monitored starting 1990s. The area hosts the first marine reserves or “no take areas” established in small islands managed by local communities. (i.e., Sumilon Island and Apo Island) (Alcala 2001). Some of the national projects in coastal management have been established in this region such as the Central Visayas Regional Project Nearshore Fisheries Component, Coastal Environment Program (CEP) of the Department of Environment and Natural Resources (DENR) and the DENR-Coastal Resources Management Project (CRMP) funded by the United States Agency for International Development (USAID).

## 10.3 Issues and Threats

The following are the common threats identified by the various workshop group participants (Appendix 10.2): poaching, destructive fishing and gleaning, unregulated deployment of FADs, siltation, pollution, habitat modification/destruction, tourism related activities, solid waste, crown-of-thorns starfish infestation, coral bleaching, illegal fishing (blast, poison, etc.).

Encroachment by commercial fishers within municipal waters, occasional opening of sanctuaries to fishers due to political interventions (e.g., Sumilon Is.; Baybay, Leyte and Hulaw-Hulaw, Panguil Bay) lack of environmental education, failure of the fisherfolks to monitor despite the training (Sogod Bay), perceptions of fisherfolks regarding MPAs: that the sanctuary is the root cause of the decline in the tuna and *bolinao* fisheries (e.g., Sogod Bay) were also reported.

Poaching was identified to be the most commonly reported threat to the reefs particularly in protected areas (27%). Siltation, tourism related activities and crown-of-thorns infestation were next in rank.

## 10.4 Monitoring, Evaluation and Feedback

Monitoring techniques used in most of the reefs were standard techniques using line intercept technique (LIT) for the coral lifeforms, and the visual census for fish structure and abundance (English et al. 1996). Other methods used were quadrat, Reef base’s "aquanaut" (see Ch 12 Negros Oriental) and more recently, video transects.

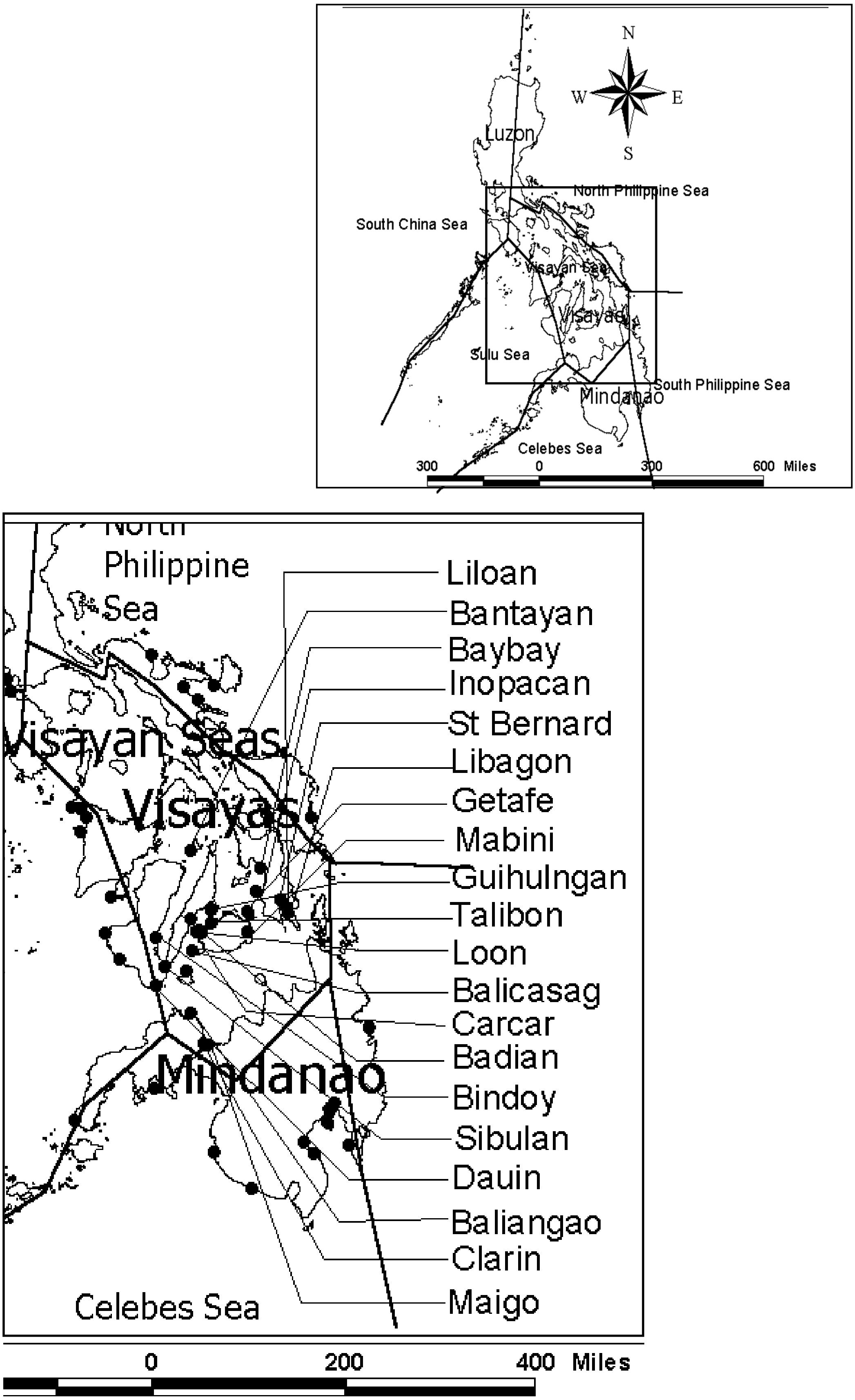


Fig. 10.1. Location of reef areas with temporal data in the Visayan Seas biogeographic area.

A total of 41 reef sites were monitored for live coral cover in the Visayan Seas region. Thirty-six percent of the reefs in this region show an increasing trend with an additional 13% reported to be recovering from past disturbance and 26% with no change or relatively stable (Fig. 10.2, Table 10.1). Only a small percentage show a decreasing trend (19%), mostly in the reefs outside of the protected areas. Some of the reef sites did not show any trend at all due to fluctuating values that can be due to differences in specific site monitored or the methods used.

Very few reefs, however, have detailed observations on fish structure. Only 21 reef sites have sufficient data to show trends (Fig. 10.3, Table 10.1). This limitation is mostly attributed to lack of skills in fish identification. Among the 21 reef sites, more than half (66%) shows an increasing trend in fish abundance, while only 5% shows a decreasing trend.

Table 10.1. Relative change in live coral cover and fish abundance with time in the different reef sites of the Visayan Seas region.

| TREND | CORAL | FISH |
|---|---|---|
| increasing | 17 | 14 |
| decreasing | 9 | 1 |
| recovering | 6 | 1 |
| stable (no net change) | 12 | 2 |
| no trend | 3 | 3 |

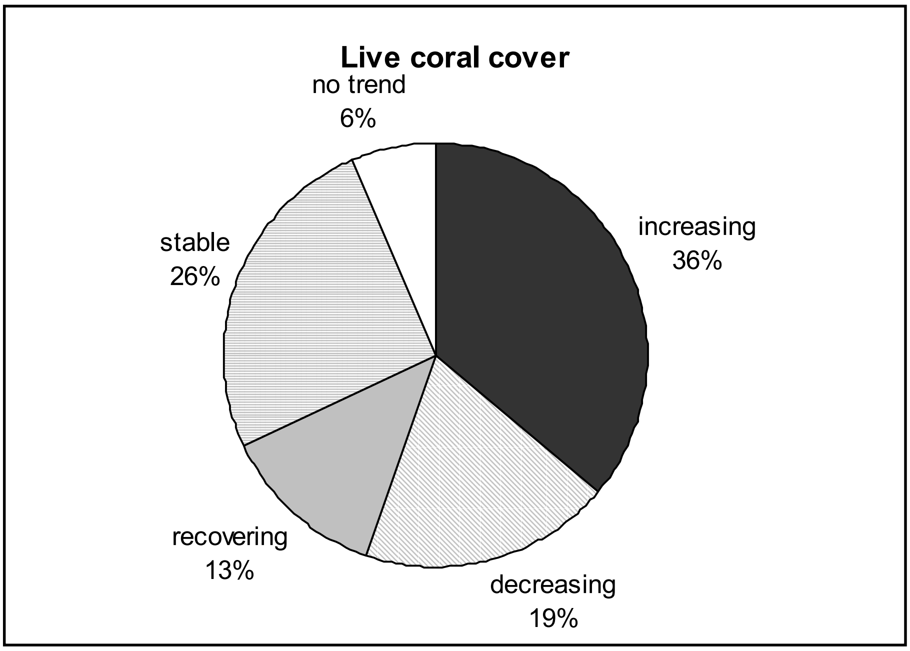


Fig. 10.2. Relative change in live coral cover with time in the different reef sites of the Visayan Seas region.

## 10.5 Future directions, Gaps and Recommendations

- very few reef sites reported diseases of corals - the reason being that it requires special skill to identify and study. conduct training on coral disease spotting
- very limited monitoring frequencies in most reef sites, assessment only done because of project/funding availability.
- strengthen monitoring skills of LGUs and local communities & stakeholders
- conduct monitoring with adequate replication and sample size
- more collaborative effort among research institutions, state universities & colleges, local government units, line agencies of the government

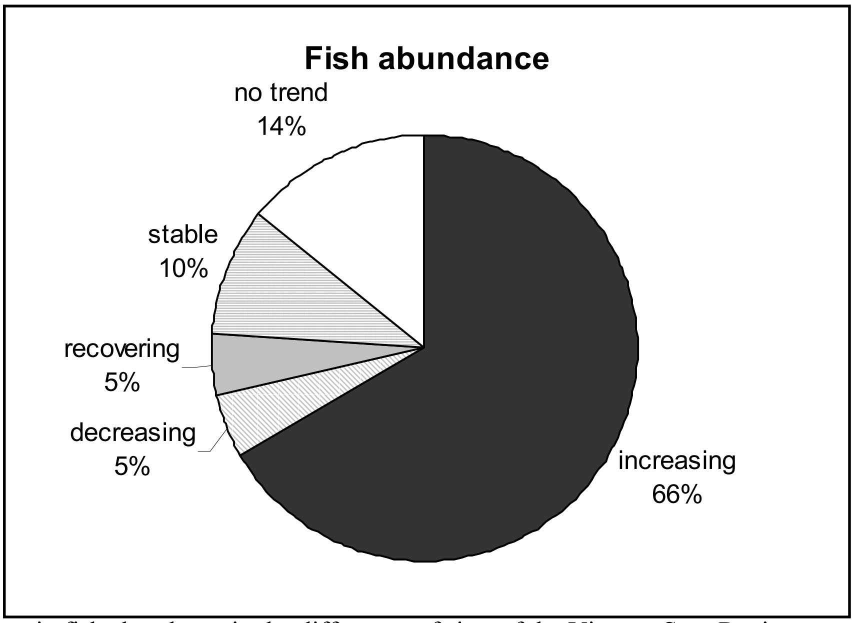


Fig. 10.3. Changes in fish abundance in the different reef sites of the Visayan Seas Region

## 10.6 Management Issues

Three major issues were identified. More than 50% of participants indicated weak community participation as the major failure for the Marine Protected Areas (MPA) management. This is followed by relatively strong political interference in management and policy decisions, including weak logistic/financial support resulting in weak community participation.

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# CHAPTER 11 CENTRAL VISAYAS

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## 11.1 Biophysical Setting

Central Visayas is composed of the island provinces of Cebu, Bohol, Negros Oriental and Siquijor in Central Philippines (Fig. 11.1). It host to the first marine sanctuary in the country Sumilon Island of Oslob, Cebu. Apo Island of Dauin, Negros Oriental, which won the first prize in the 1st "Search for Best Managed Reef in the Country" in 1998, is also in this region. Recently, the Zaragosa Island Marine Sanctuary in Badian, Cebu won third prize in the 2nd "Search for Best Managed Reef in the Country" sponsored by the Coral Reef Information Network of the Philippines (PHILREEFS).

The coral reefs in Central Visayas are mostly fringing with depths ranging from 1.5 to 12m. Corals in most of the sites are of massive growth form and a few are branching. Beyond 12m depth, substrate is sandy. Reefs in enclosed areas are characterized by muddy substrates due to siltation. Water visibility ranges from clear (in sites with open shoreline/seas) to turbid (in enclosed bays).

## 11.2 Socio-economic Setting

Most of the coastal dwellers in Central Visayas are marginal fishers who are heavily dependent on fishing. In 1994 when the Coastal Environment Program of the Department of Environment and Natural Resources (DENR) expanded their implementation to using the community-based approach in Coastal Resource Management, 8 additional sites were established in 4 provinces with one site in every Community Environment and Natural Resources Office (CENRO) field office. Through the Coastal Environment Program, the project beneficiaries have been provided with livelihood projects to minimize the fishing pressures in the area, lessen dependence on the coastal resources and address the problem of poverty. Under the program, a people's organization was organized in the site to mobilize the implementation of the project activities. The members of the organizations support the rehabilitation of the degraded coastal habitats through mangrove rehabilitation and management of marine sanctuary. Trainings and field exposures were provided to enhance their level of awareness and to gain knowledge in marine sanctuary management. Impact of project interventions were evident in some sites with successful project implementation. They disclosed that they have increased their sources of income and they have already improved their dwelling units and have acquired motor boats. Many fishers observed that their fish catch and yield of edible marine invertebrates have increased (in Magtongtong Marine Sanctuary, Zaragosa Marine Sanctuary and Apo Marine Sanctuary). The community observed that fish population density and diversity have increased in Zaragosa Marine Sanctuary, Magtongtong Marine Sanctuary, Apo Marine Sanctuary and Bongalonan Marine Sanctuary.

## 11.3 Management

Coral reefs under proclamation are managed by different entities based in the locality. In the case of marine sanctuaries proclaimed by the local government unit, logistics and legal enforcement are provided by the local communities. However, Protected Area Management Boards also have jurisdiction over those areas proclaimed pursuant to Republic Act 7586, otherwise known as the National Integrated Protected Areas Systems (NIPAS). In most cases, fish sanctuaries established within the NIPAS proclaimed area are delegated to the local people's organization to manage and enforce the local legislation. The people's organizations through their committee members enforce the protection of the area by conducting patrol and surveillance. A watchtower in a strategic location in each site is installed/constructed. Buoys are installed to serve as boundary marker and mooring buoy for boats. Some local government units are providing incentives to fish wardens to ensure 24-hour protection of the marine sanctuary. Local Philippine National Police officers are reinforcing the fish wardens during apprehension of illegal fishers within the municipal waters. The Department of Environment and Natural Resources (DENR), through the Coastal Environment Program, has provided the people's organization with motor boats to be used in the operation of the coastal resource management activities in the project site.

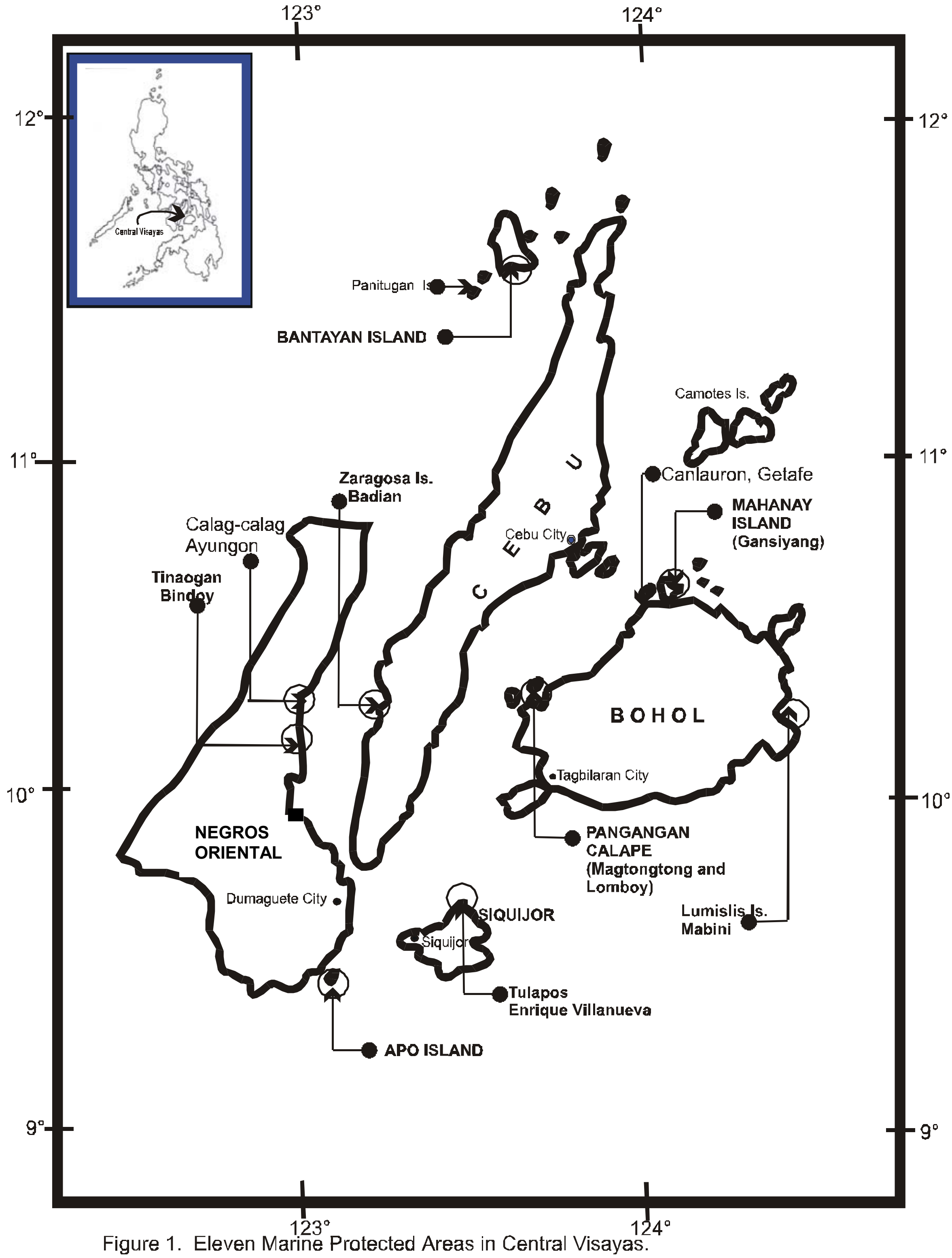


Figure 1. Eleven Marine Protected Areas in Central Visayas.

## 11.4 Issues and Threats

Encroachment within the marine sanctuary by some fishermen is a common threat experienced by marine sanctuaries in Central Visayas. However, there are some issues and threats that are specific to certain areas (Table 11.1).

Table 11.1. Identified issues and threats in some sites in Central Visayas, Philippines.

| SITE | ISSUES/THREATS |
|---|---|
| Apo Island, Dauin, Negros Oriental | Disturbance of designated fishing ground and damage of corals due to SCUBA divers |
| Zaragosa, Badian, Cebu | Offshore mariculture (installation of fish cages within Badian Bay) would threaten the marine sanctuary due to commercial feeds used by the operators |
| Lumislis, Concepcion, Mabini, Bohol | Sediment loads from different tributaries pose a threat to the coral reefs |
| Panitugan, Sulangan, Bantayan, Cebu | No sign of coral recovery has been observed after the whole area was affected by the El Niño event in 1998 |
| Canlauron, Marine Sanctuary | Sedimentation of the reef area and jurisdictional conflict between the villages of Alumar and Tuy-oran |
| Tulapos, E. Villanueva, Siquijor | Political interference has demoralized the local people's organization to manage the marine sanctuary. |

## 11.5 Monitoring, Evaluation and Feedback

Since 1996, when DENR staff were enabled to conduct the monitoring of the coral reefs by the Coastal Environment Program, monitoring of the coral reefs in Central Visayas have been done through the methods described by English et al. (1994). At least two 50-m transects were designated on the fringing reefs of each site. Line-intercept transect and 10-m width fish visual censuses were conducted. Fishes are counted and sizes are estimated to cm.

Sampling stations established in 1995 and 1996 were used in the succeeding years of monitoring using the coordinates established within the sampling site. Results of the monitoring were given to CENRO CEP Coordinators for them to disseminate to the end users and as bases to improve/enhance mechanisms for better reef management.

The results of the monitoring on fish species composition, population density and biomass are presented in Appendices 11.1 to 11.3 and the results of the coral reef monitoring in Appendix 11.4.

### Fish species abundance

The marine sanctuaries in Apo, Dauin, Negros Oriental; Zaragosa, Badian, Cebu; Magtongtong, Calape, Bohol; and Tulapos, Enrique Villanueva, Siquijor are more or less stable in terms of the number of fish species recorded during the annual monitoring (Figs 11.2 to 11.5). Tulapos and Apo including Zaragosa were found to have more number of fish species recorded compared to other sites in the region. In the latter part of the project implementation, two sites in Negros Oriental have been monitored since 1999 and were found to have more species documented. Bongalonan, Basay and Malusay, Guihulngan have declared marine sanctuaries. Almost all sites in the region were affected by the El Niño event in 1998. Three marine sanctuaries were badly affected by the extreme high temperature. These sites are located in Sulangan, Bantayan, Cebu; Canlauron Marine Sanctuary of Getafe and Lumislis Marine Sanctuary of Mabini, both in Bohol province. The impact was seen in 1999 after the El Niño event. It is obvious that fish species during the 1999 monitoring declined in most of the established sampling sites (Appendix 11.2). The data showed that recovery was noted in the ensuing years of monitoring, except in Sulangan, Canlauron and Lumislis. The Sulangan reefs showed no sign of recovery after the height of the El Niño event. It could be noted that the corals in this site were mostly branching *Acropora* and located in a shallow portion of the reef. The sites in Canlauron and Lumislis in Bohol are located in sheltered bays and the impact of the El Niño phenomenon has been exacerbated by sedimentation and fishing violations because of jurisdictional conflict (Canlauron) and the distance from the community (Lumislis Island).

### Fish population density

Fish densities as shown in Figs. 11.6 to 11.9 and Appendix 11.3 fluctuated and has no distinct pattern observed in most of the sampling area. Fish density in Apo Marine Sanctuary dropped significantly during the 1998 monitoring while other sites have high fish density. Fish densities in some sanctuaries also decreased but not as much as in Apo. The decline in densities was coincident with the coral bleaching of the 1998 El Niño event. Large assemblages of fish were not observed during these fish censuses. Managed reefs had abundant fish compared to fished areas and marine sanctuaries with very weak enforcement confirming observations by Meryll (undated) and Alcala and Russ (2000).

### Biomass estimates

Annual estimates of fish biomass in most coral reef sites in the region were fluctuating but showed a general declining trend (Figs. 11.10 to 11.13 & Appendix 11.4). Magtongtong, Lomboy, Apo, Calag-calag and Tulapos were stable. The fish biomass in Apo Marine Sanctuary was very high during the survey in 1998, yet the population density of this area compared to the other sampling sites was low (Appendix 11.4). This implies that larger fishes were observed.

### Coral cover status

During the El Niño event in 1998, sea temperatures reached up to 34 ºC causing coral bleaching. Mono-specific stands of *Acropora* in Sulangan Marine Sanctuary (Bantayan) were severely bleached and have not yet recovered. However, some sites in the region such as Zaragosa Marine Sanctuary which is dominated by massive corals, were only slightly affected (Alcaria 2001). Massive and submassive coral colonies are claimed to be more tolerant than branched colonies to high sea surface temperature (Van Woesik 2000). This sanctuary seems to be recovering from the bleaching event.

On the other hand, live hard coral cover in Apo Island decreased slightly in 1998. However, the increase in coral mortality in 1999 may be due to the post-bleaching event impact. Calumpong et al. (2000) also reported the extension of bleaching until June 1999 and the bleaching of 35% (0.37 $km^2$) of Apo Reef. Coral bleaching in Apo Reef had extended until June 1999. *Galaxea* had significantly the highest mean bleach cover (41% ± 5). Until 2001, most of the live hard corals have improved or recovered from 1.02% to 18.22%. The Lumislis Marine Sanctuary recorded the highest recovery rate of 18.22%, followed by Lomboy Marine Sanctuary with 16.60% cover and 14.19% in Magtongtong Fish Sanctuary.

The results of the six-year coral reef monitoring showed that four of the sampling sites declined with percent live hard coral cover of about 2 - 45%. The live hard coral in Dapdap Marine Sanctuary had decreased to 17.18%, followed by Apo Marine Sanctuary (14.73%). Six marine sanctuaries in the region have been observed to increase their coral cover about 1.35% to 23.87%. Lumislis Marine Sanctuary was observed to have high recovery rate with 23.87% increase in live hard coral cover. This was followed by Calagcalag Marine Sanctuary with 22.86 %, then Lomboy, Canlauron and Zaragosa with 13.39%, 5.81%, and 1.35%, respectively.

## 11.6 Future directions, Gaps and Recommendation

Monitoring of the coral reefs should be adopted by the local government. The present data would serve as bases in formulating a comprehensive coastal resource management plan that would provide future directions of the local stakeholders in the municipal level. Fish catch monitoring, which is lacking should be implemented to determine the impact of the coral reef management initiatives. Some reefs that have deteriorating coral cover and fish should be further studied to determine possible factors that may influence the biodiversity and productivity of reefs.

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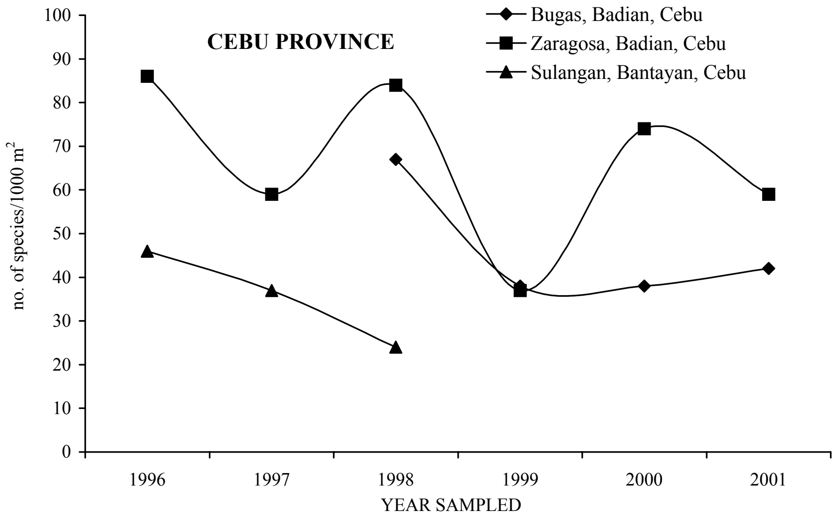



Fig.11. 2. Fish species diversity (no. of species/1000 $m^2$) found in the different coral reefs in Cebu Province, Philippines.

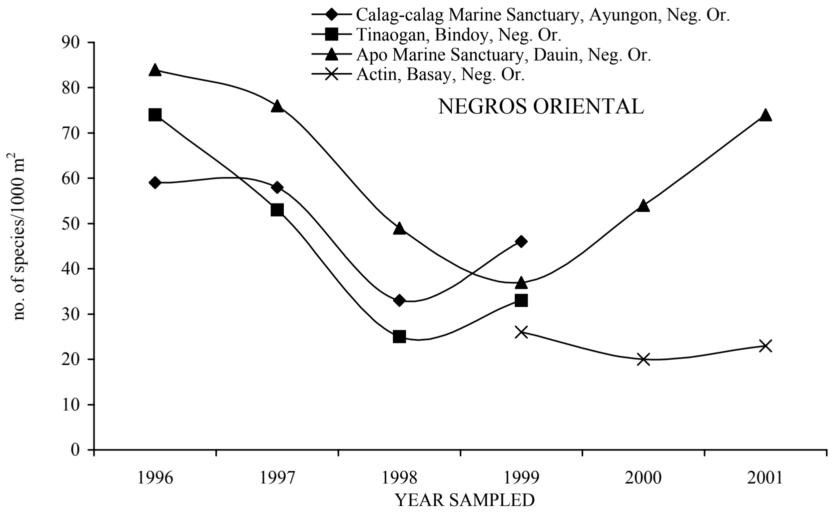



Fig. 11.4. Fish species diversity (no. of species/1000 $m^2$) found in the coral reef areas in Negros Oriental Province, Philippines.

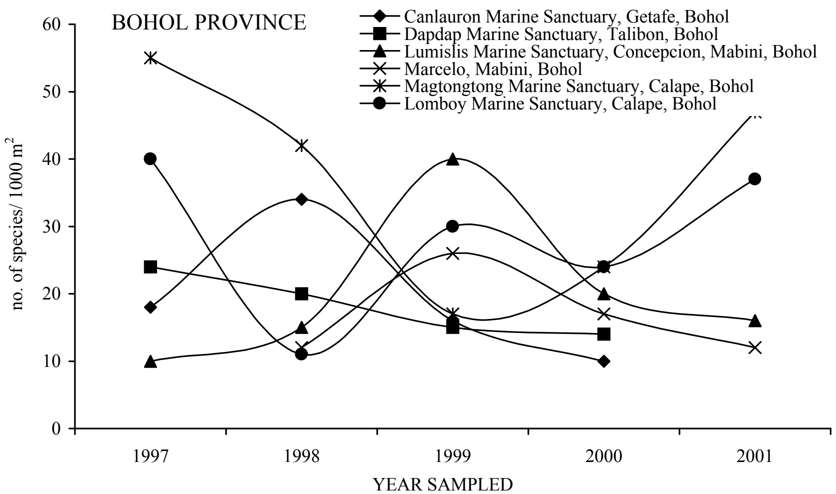



Fig. 11.3. Fish species diversity (no. of species/1000 $m^2$) found in the different coral reefs in Bohol Province, Philippines.

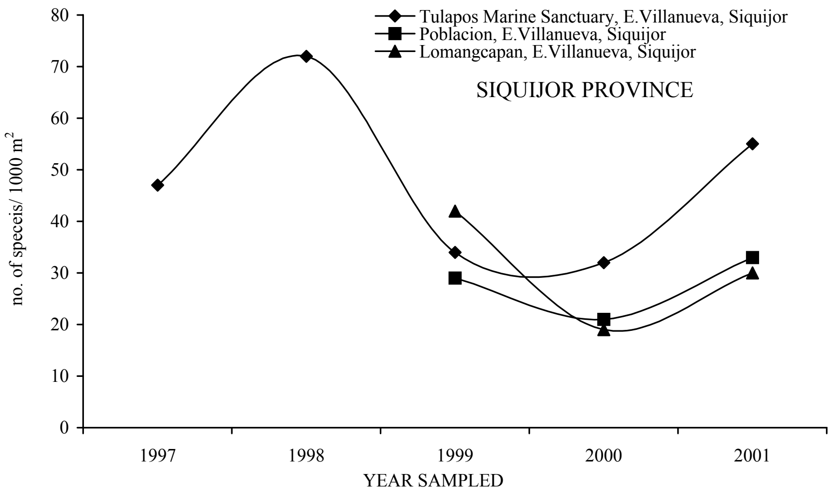
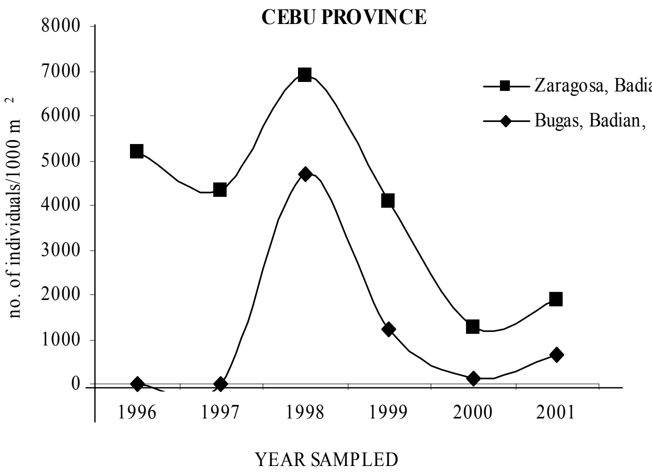



Fig.11.5. Fish species diversity (no. of species/1000 $m^2$) found in coral reef areas in Siquijor Province, Philippines.

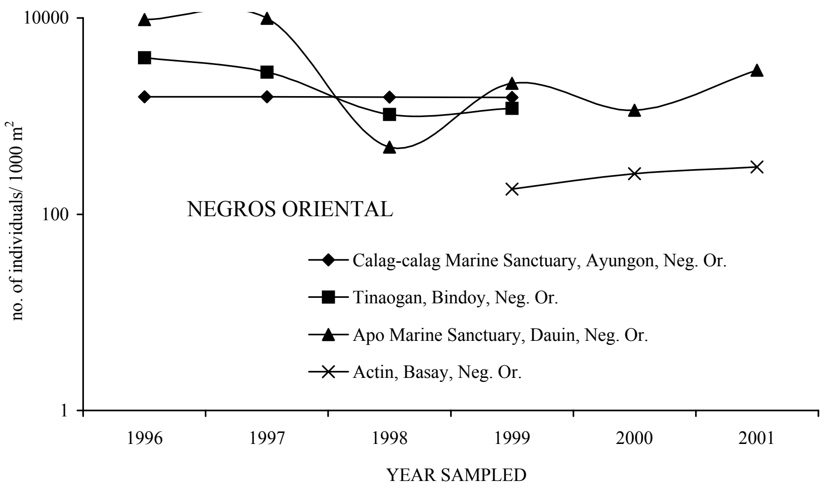
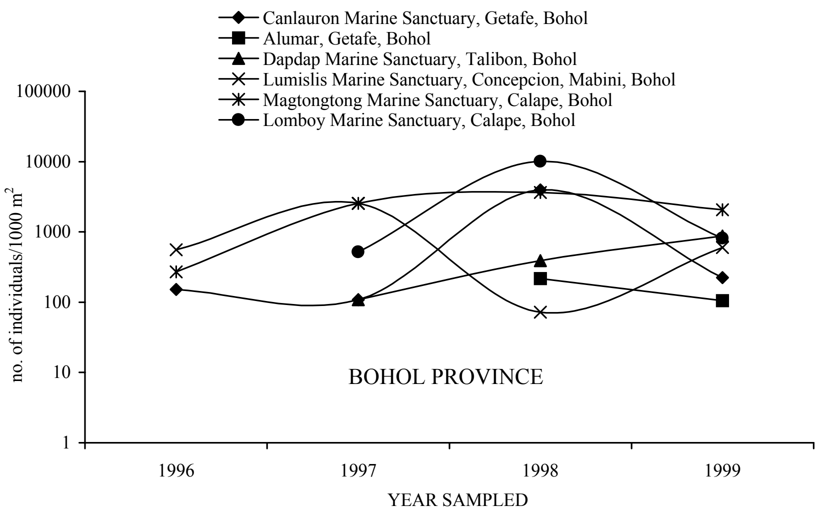




Fig.11.6. Fish densities in the coral reef areas of Cebu Province, Philippines.

Figure 11.8. Fish densities in the coral reef areas of Negros Oriental Province, Philippines.



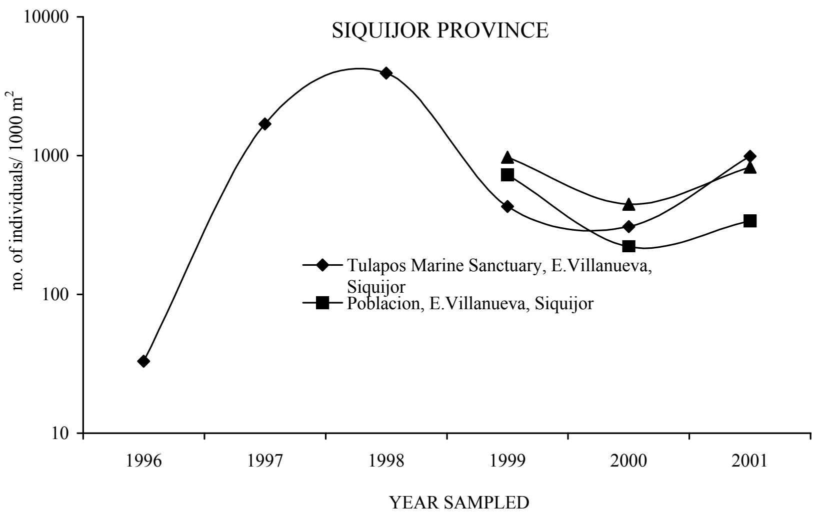




Fig. 11.7. Fish densities in the coral reef areas of Bohol Province, Philippines.

Fig. 11.9. Fish densities in the coral reef areas of Siquijor Province, Philippines.

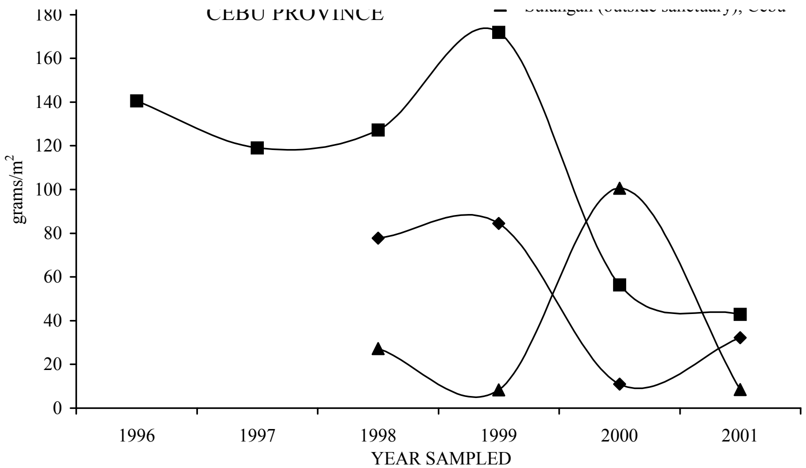




Fig. 11.10. Biomass estimates of fish in the coral reef areas of Cebu Province, Philippines.

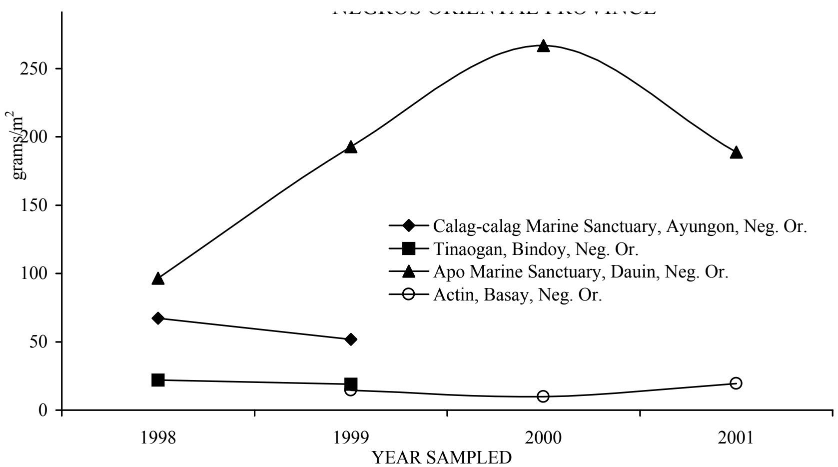



Fig. 11.12. Biomass estimates of fish in the coral reef areas of the Negros Oriental, Philippines.

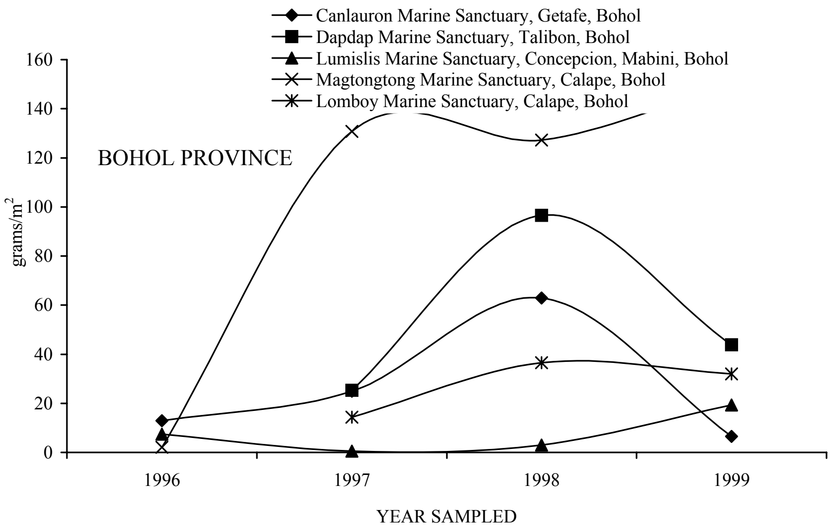



Fig. 11.11. Biomass estimates of fish in the coral reef areas of Bohol Province, Philippines.

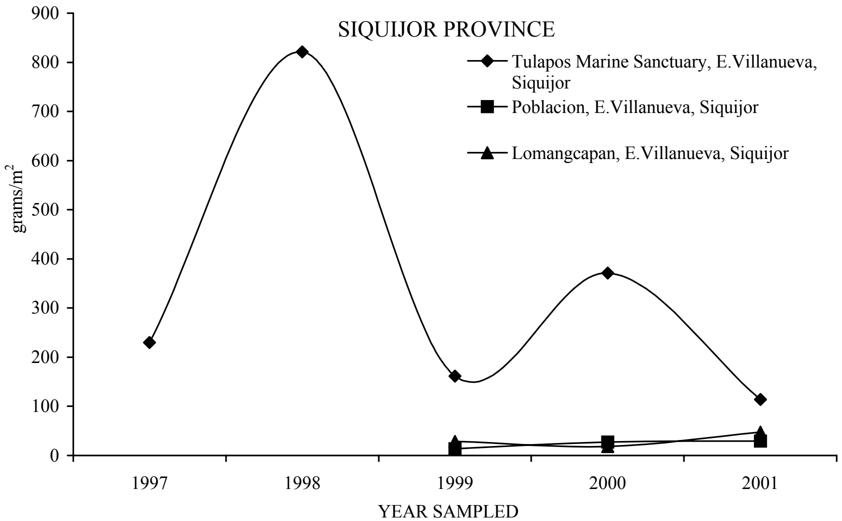
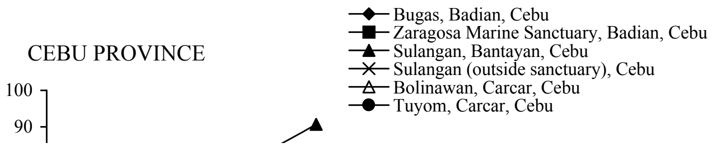
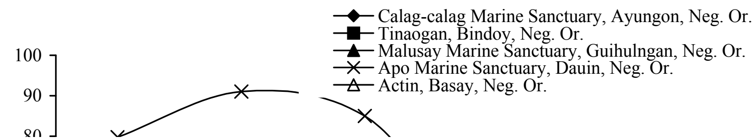



Fig. 11.13. Biomass estimates of fish in the coral reef areas of the Siquijor Province, Philippines.



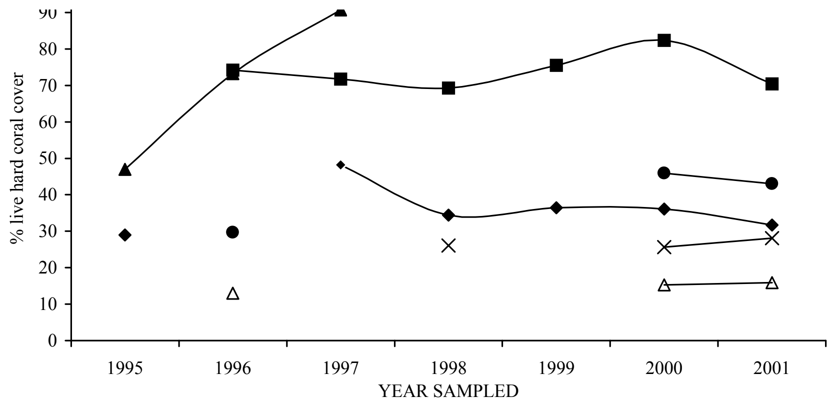



Fig. 11.14. The status of the live hard coral cover (%) in different reef areas of Cebu Province, Philippines.

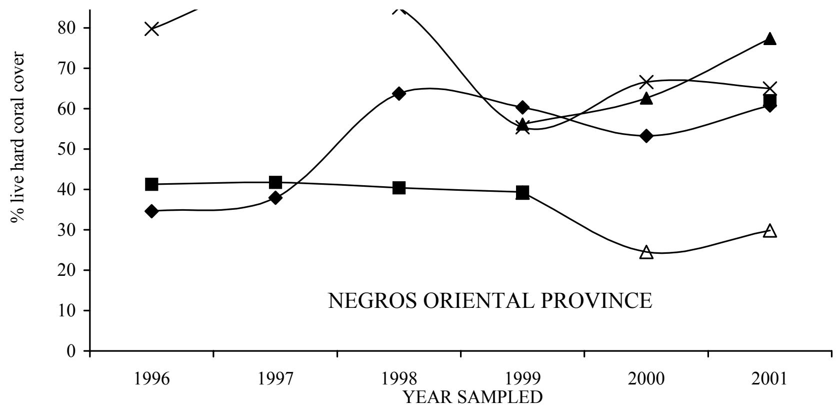



Fig. 11.16. The status of the live hard coral cover (%) in different reef areas of Negros Oriental Province, Philippines.

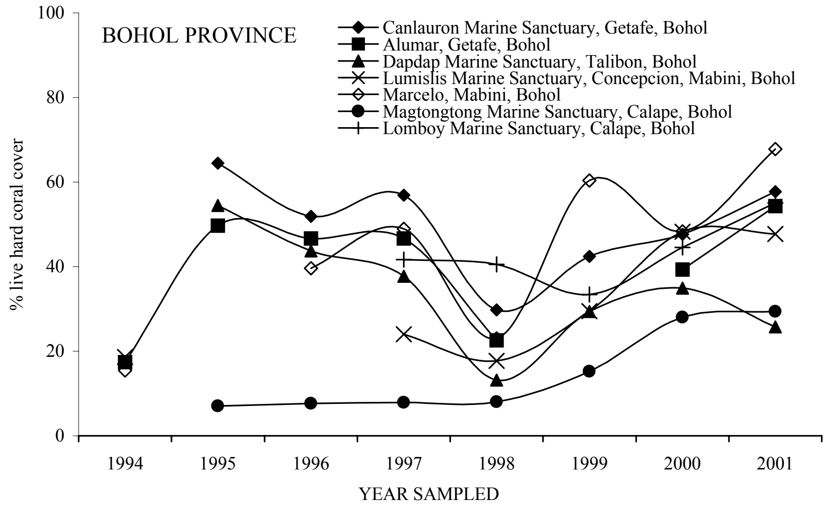



Fig. 11.15. The status of the live hard coral cover (%) in different reef areas of Bohol Province, Philippines.

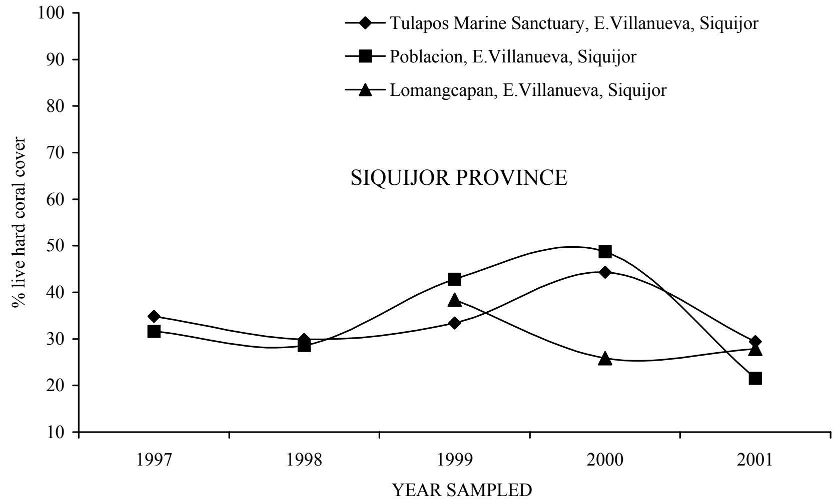



Fig. 11.17. The status of the live hard coral cover (%) in different reef areas of Siquijor Province, Philippines.

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# CHAPTER 12 NEGROS ORIENTAL

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## 12.1 Biophysical Setting

The Marine Reserves (MRs) or Marine Protected Areas (MPAs), established in close coordination with the Environment and Natural Resources Division (ENRD)-Office of the Governor of Negros Oriental, are located along the southernmost tip and northern part of Negros Oriental Island. Most of the reefs in the protected areas are fringing, except for three (3) sites, namely: Hilaitan, Guihulngan; Polo, Tanjay (not included in this report) and Bio-os, Amlan (not included in this report), which are approximately located 2.5 km off the shore. Of the 29 MPA sites of Negros Oriental, only 7 are included in this report.

## 12.2 Socio-economic Setting

Generally, fishing pressure off the coast of Negros Oriental Island was decreased through the introduction of alternative livelihood programs, ecotourism activities and continuous, massive information campaign.

## 12.3 Management

The MPAs are managed by the Fishermen's Association with strong support (in terms of legislation, enforcement and trainings) from the Barangay and Municipal Local Government Units (LGUs) of their respective areas.

Various participatory and strengthening activities, such as education and capability-building for project management (including coral reef monitoring), are continuously conducted to increase protection efforts and strengthen the *Bantay Dagat* groups thereby ensuring sustainability of MPA management. Land-based livelihood projects are also being initiated to provide supplemental income to the fishers. Support from concerned agencies is generated through functional linkage mechanisms.

## 12.4 Issues and Threats

- Alleged cutting of marker buoys by intruders
- Lack of funds to support protection efforts of *Bantay Dagat* groups
- Several problems are faced by the MPA of Tambobo: Infestation of crown-of-thorn starfish, locally known as "salanay" (in 1998), domestic pollution (plastic, fecal wastes), existence of yachts and commercial fishing vessels (who seek refuge during bad weather), and encroachment of SCUBA divers (spear fishers) from other localities
- In Malusay, sedimentation appeared to be a major threat not only in the MPA, but also to the whole reef area. Dynamite fishing was a problem in Hilaitan reef
- Poaching of seems to be the only threat in the other MPAs

## 12.5 Monitoring, Evaluation and Feedback

Scientific and participatory monitoring methods (e.g., Line Intercept, Quadrat, Fish Visual Census, Aquanaut and Fish Catch Monitoring) were used to quantify coral cover and fish abundance. Coral Reef and Fish Visual Census monitoring were conducted inside the MPAs only. The status in coral cover, fish abundance and fish catch through time is summarized in Table 12.1.

## 12.6 Future directions and Recommendations

### Future directions:

- Enhance the existing management plan and formulate a more comprehensive plan for each marine reserve site
- Provide incentives to *Bantay Dagat* (Fish Warden) Members

- Rehabilitation (from crown-of-thorns starfish damage) of MPA sites through coral transplantation and giant clam seeding

**Recommendations:**

- Capacitate People's Organization to conduct monitoring and to sustain protection and management
- Regular (quarterly) evaluation and feedbacking on the progress of the monitoring
- Improve functional linkages among concerned agencies and generate local government support
- Support livelihood mechanisms to provide supplemental income to project participants.

Table 12.1. Trend on the live coral cover, fish abundance and fish catch in the MPAs. (refer Appendix 12.1)

| MPAs | Live coral cover | Fish Abundance | Fish Catch | Remarks |
|---|---|---|---|---|
| Hilaitan, Guihulngan | Decreasing | Decreasing | No data | Reef has been devastated by dynamite fishing |
| Iniban, Ayungon | Increasing | Increasing | No data | |
| Cangmating, Sibulan | Increasing | Increasing | No data | |
| Masaplod Norte, Dauin | | | Increasing | |
| Tambobo, Siaton | Recovering | Recovering | No data | Crown-of-thorn starfish infestation in 1998 |
| Andulay, Siaton | | Increasing | Increasing | |
| Bongalonan, Basay | Increasing | | Increasing | |

## 12.7 References

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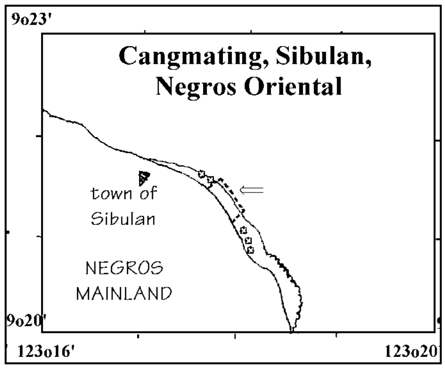
# CHAPTER 13 SIBULAN MARINE RESERVE, SIBULAN, NEGROS ORIENTAL

[1]Andre J. Uychiaoco (1997-99, 2001), [1]Hazel O. Arceo (1997-2000), [2,4]Erwin Dolumbal (1999-2001), [1]Paulyn A. Gaite (1998-2000), [1]Fernando I. Castrence Jr. (1997), Rene A. Abesamis (2000) [3]Jose Glendo Lazarte (1997-2001), [3]Annabelle Barillo (1997-1998) and [3]Lawton Alcala (2001)

[1]Marine Science Institute, University of the Philippines
[2]Coastal Resource Management Project (CRMP)
[3]Negros Oriental Environment & Natural Resources Management Division
[4]Ting Matiao Foundation Inc.

## 13.1 Biophysical Setting




The Sibulan Marine Reserve is a 6-hectare fish sanctuary on the coast of the village of Cangmating. The fish sanctuary mostly encloses a very gently sloping sandy bottom with patches of hard and soft coral colonies. The best coral reefs in the village are within the reserve's southern boundary. There is a small stream on the northwestern boundary of the village though not much silt is seen in the area. Seagrasses are found on this northwestern side of the village. The landmasses of Negros and Cebu on either side serve to protect the area from storms. However, currents tend to strengthen during the full moon and new moon and the seas become choppy during the northeastern monsoon.

## 13.2 Socio-economic Setting

The reserve is located in Cangmating, the village adjacent to and northwest of Maslog. Fishers deploy large (approx. 1-m) fish traps in the deeper slopes that they leave for a week before retrieving. There are several private beach houses and a couple of resorts on the village's coast.

## 13.3 Management

The Provincial Planning and Development Office's Resource Management Division (RMD) of Negros Oriental was organized to help sustain the initiatives began by the Central Visayas Regional Project. The RMD works closely with local communities (including upland communities). The RMD began working with the fishing community of Cangmating and organized the Bantay Dagat group in 1992. However, the fate of the RMD and especially that of its technical personnel (Mrs. Annabelle Barillo and Mr. Jose Glendo Lazarte among others) who are contractuals is always uncertain whenever the province's annual budget is being deliberated because the division has never been established by legislation. A few years ago, the division was renamed the Environment and Natural Resources Management Division (ENRMD) and was moved from the Provincial Planning and Development Office to the supervision of the Office of the Governor.

Later, more seminars were conducted in cooperation with a volunteer from the German Development Service (Maike Waltemath), the EU's Center for the Establishment of Marine Reserves in Negros Oriental (CEMRINO) project and the Provincial Agricultural Office. In 1996, the CEMRINO conducted a province-wide study to help recommend possible sites for the marine reserves, which included manta tows, coral cover estimates (using underwater video), fish visual census and interviews of fishers. Ninety-six percent of the residents of Cangmating and the nearby village, Agan-an, interviewed then favored the establishment of a marine reserve. More information drives and an open forum gave the fishermen's associations, local government and others the chance to discuss the idea of a reserve.

Notice of the approval of Sibulan municipal ordinance #14 (Series of 1997) was first brought to the community on July 1997. Neither fishing nor recreational diving is allowed within the sanctuary. The reserve was initially marked (9°21.353'N, 123°17.722'E and 9°21.258'N, 123°17.908'E) on August 30, 1997 as per the recommendations of CEMRINO. Since then, the original boundaries stipulated in the municipal ordinance have been changed by the local community from 200 m along the shore and 300 m seaward to 300 m along the shore and 200 seaward. This moved the sanctuary southeastward to include the richer coral cover in front of the informal guardhouse cum PO meeting place known as "talisay". The Bantay Dagat is enforcing these new boundaries even though the municipal legislative council has not yet taken up the proposed amendments to the ordinance.

Styrofoam buoys were used as boundary markers but most of them were stolen or were lost to the currents. A few wooden poles placed near the shore serve to demarcate the reserve boundaries for gleaners. These do not clearly mark the reserve boundaries and are only temporary. A signboard identifying the reserve and its rules, steel drums for use as buoys and cement weights for buoy anchors have been constructed. However, these have not yet been deployed due to the lack of manpower and a large enough boat.

The village captain is new, has been informed of and is supportive of these activities but does not generally get involved. In fact, many of the local government officials including the mayor, who were among the signatories of the municipal ordinance, were changed in the 1998 elections.

Despite these shortcomings, the Bantay Dagat members have been vigilant and have apprehended and warned several fishers who have wandered too close. They would also warn divers when they espy one within the reserve. In the past, the Bantay Dagat was using a boat entrusted to them by a Japanese national as a patrol boat, but this has since been taken back by the original owner. For a time they did not have any assigned boat for patrolling and used whatever boat was available when they needed to warn trespassers. They also did not have flashlights for guarding at night. In 1998, the Sibulan won a sum of money for being one of the Best Coastal Management Programs. The Bantay Dagat used this money to purchase a patrol boat and night vision equipment.

Supplementary livelihood activities (pig raising) are being facilitated by the ENRMD (e.g., Mrs. Arsenia Cariño). Silliman University has also reseeded giant clams in the area.

## 13.4 Issues and Threats

Slow or lack of reserve improvement exposed weaknesses in enforcement against poaching. Many of the regular violators of the marine reserve are policemen and local government officials. For example, two fish traps believed to have been owned by policemen were recovered from within the marine reserve during the 1999 monitoring activity. Through CRMP support, a councilor of the municipal legislative body was later charged for violation and the case forwarded to the Ombudsman. Poaching, however, decreased after the unexplained underwater death of a poacher.

There does not seem to be much mariculture or destructive (blast or poison) fishing in the area. Whatever solid waste could be observed here was mostly on the shore rather than in the sea. There also does not seem to be much commercial tourism even though there are at least two resorts here—Dive Sibulan and the Hotel Panorama—and numerous private beach houses. The diving industry seems to be uninvolved in the management of the reserve. Divers are of great concern to the fishers because divers sometimes bring spearguns and fish inside the marine reserve. Recently the view of the reserve from the homes of the sanctuary's Bantay Dagat ("Watch of the Sea") guards has been blocked by the construction of new rest houses on the shore.

## 13.5 Monitoring, Evaluation and Feedback

Mr. Maximo Decipolo, a village councilor, seems to be the Bantay Dagat's most enthusiastic member. He is the younger brother of the St. Joseph's Association president, Mr. Leoncio Decipolo. (St. Joseph's is a church-organized local association.) They compose, together with their sons and a few mostly young friends, the reserve's monitoring team. Only a couple of fishers are involved in the daily fish catch. The Cangmating Fishermen's Association (CAFA), organized by Department of Agriculture personnel, does not seem to be actively involved yet, even though many of the members of the CAFA are also members of St. Joseph.

The community is quite contented with the reserve. In fact, some of the fishers have reported that their fish catch (mainly from fish traps deployed in deeper waters) has increased since the establishment of the marine reserve. They have also reported seeing big fishes and sharks, which had become rare in the area. An elder fisher even reported seeing several bumphead parrotfishes, which he hasn't seen since 20 years ago! They are also appealing for more legal support and political force in apprehending transgressors, especially because they feel frustrated since some of the transgressors are in the police force themselves or have political connections.

Clearly more community members should be involved though many fishers also have other source of income (e.g., tricycle driver) and most are only free in the evening. There is also a women's group in the area.

Hard coral cover appears stable (Fig. 13.1). Dead coral with algae increased in 2001. Seagrass beds were common among the patches of coral and were sometimes traversed by the transects adjacent to the reserve (Table 13.1). Target fishes were rising from 1997 to 1998 then peaked in 1999 but seems to have gone back down to 1998-levels in 2000. Target fish abundance then recovered inside the reserve (not due to mobile pelagics) but not adjacent to the reserve (Fig. 13.2).

Figure 13.1. Hard coral cover inside and adjacent to the Sibulan Marine Reserve.

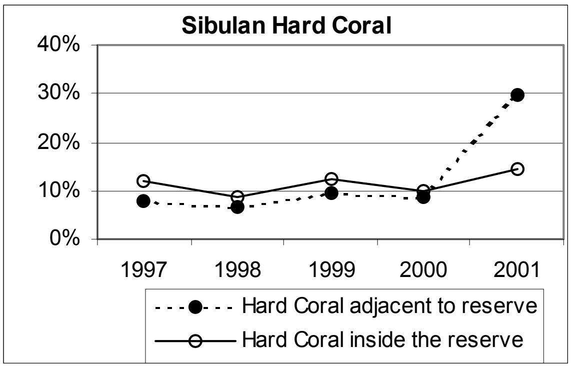



Figure 13.2. Fish count/500 $m^2$ inside and adjacent to the Sibulan Marine Reserve.

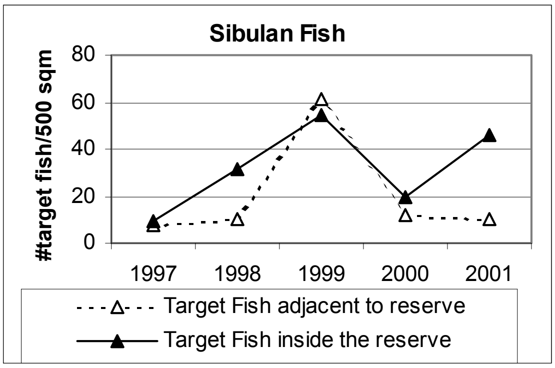



Table 13.1 Average % cover of benthic lifeforms inside and adjacent to the Sibulan Marine Reserve

| Zone | adjacent | | | | | inside | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1997 | 1998 | 1999 | 2000 | 2001 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Hard Coral (live) | 7% | 6% | 9% | 9% | 30% | 11% | 9% | 11% | 10% | 15% |
| Soft Coral | 14% | 2% | 8% | 14% | 11% | 28% | 12% | 12% | 10% | 22% |
| Dead Coral | 0% | 0% | 0% | 0% | 1% | 1% | 0% | 0% | 0% | 0% |
| Dead Coral w/ Algae | 1% | 1% | 1% | 1% | 7% | 5% | 2% | 2% | 3% | 7% |
| Turf Algae | 1% | 0% | 0% | 1% | 0% | 4% | 4% | 0% | 2% | 0% |
| Macroalgae | 1% | 0% | 0% | 0% | 0% | 3% | 2% | | 0% | 0% |
| Coralline Algae | 0% | | | 0% | 0% | | | | 0% | 0% |
| Seagrass | 4% | 15% | 5% | 1% | 18% | 0% | 1% | 2% | 0% | 1% |
| Sponge | 0% | 0% | 0% | 0% | 1% | | 0% | 0% | 1% | 1% |
| Zoanthids | | | 0% | 0% | 0% | | 0% | 0% | 0% | 0% |
| Other Animals | 1% | 0% | 0% | 0% | 0% | 1% | 0% | 0% | 0% | 0% |
| Rubble | 16% | 3% | 3% | 2% | 0% | 15% | 1% | 9% | 3% | 0% |
| Rock | 5% | 10% | 10% | 10% | 0% | 6% | 10% | 9% | 9% | 0% |
| Sand/Silt | 40% | 51% | 56% | 63% | 32% | 22% | 54% | 48% | 62% | 56% |

## 13.6 Future Directions, Gaps and Recommendations

There are plans to put up signboards to identify the reserve and billboards for the monitoring data. The experiences in Cangmating have served as a working example for neighboring villages who are interested in establishing marine reserves. For example, the village of Agan-an has already put up their own marine reserve and representatives have participated in trainings and monitoring activities in Cangmating.

## 13.7 References and for Further Reading

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Table 13.2 Average fish abundance per 500 m$^2$ inside and adjacent to the Sibulan Marine Reserve

| Zone | adjacent | | | | | inside | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1997 | 1998 | 1999 | 2000 | 2001 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Epinephelinae* | | | 1.0 | 0.5 | 1.0 | | | 1.3 | 1.0 | 1.8 |
| Lutjanidae* | 0.2 | | 0.5 | | 0.3 | | 1.0 | 1.3 | | 4.3 |
| Haemulidae* | | | | | | | | 0.5 | | 0.3 |
| Lethrinidae* | | | | | | | | | 0.5 | 0.5 |
| Carangidae* | | | 0.3 | 0.3 | | | | 0.3 | | 0.3 |
| Caesionidae* | | | 12.3 | | | | | 1.8 | | |
| Nemipteridae* | 3.4 | 2.5 | 7.3 | 4.3 | 1.8 | 2.0 | 2.3 | 9.3 | 4.8 | 6.5 |
| Mullidae* | 2.6 | 1.8 | 8.0 | 1.8 | 3.3 | 3.5 | 3.0 | 9.5 | 2.0 | 7.3 |
| Balistidae | 0.4 | | 0.8 | 0.3 | | | | 0.3 | 0.3 | 0.3 |
| Chaetodontidae | 1.6 | 2.3 | 5.8 | 7.0 | 5.0 | 3.5 | 3.0 | 4.8 | 4.0 | 10.3 |
| Pomacanthidae | 1.0 | 0.8 | 5.0 | 3.0 | 3.8 | 9.0 | 1.5 | 9.8 | 4.8 | 3.3 |
| Labridae | 25.0 | 67.8 | 82.0 | 58.5 | 48.0 | 29.0 | 67.8 | 68.3 | 55.5 | 37.8 |
| Scaridae* | 1.4 | 5.0 | 22.3 | 3.8 | 2.0 | 2.5 | 22.5 | 16.8 | 4.8 | 10.0 |
| Acanthuridae* | 0.2 | 1.0 | 8.5 | 0.8 | 2.3 | 1.5 | 2.5 | 14.0 | 6.5 | 12.5 |
| Siganidae* | 0.2 | | 1.3 | 0.5 | | | | | | 2.5 |
| Kyphosidae* | | | | | | | | | | |
| Pomacentridae | 794.4 | 392.3 | 891.3 | 598.8 | 524.0 | 725.5 | 195.0 | 755.5 | 573.5 | 749.0 |
| Anthiinae | 60.2 | 26.8 | 9.0 | 2.3 | 25.5 | 17.5 | 35.0 | 1.8 | 2.3 | 5.5 |
| Zanclidae | 0.2 | | | | | | | 0.3 | | 0.5 |

# CHAPTER 14. APO ISLAND MARINE SANCTUARY, DAUIN, NEGROS ORIENTAL

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[2]Project Seahorse-Haribon Foundation

## 14.1 Biophysical Setting

Apo Island (9°4'N, 123°16'E) is a 74-ha steep volcanic island, rising 200 m above sea level. It is located in the Mindanao Sea, 25 km south of Dumaguete City, the capital of Negros Oriental. It is surrounded almost entirely by a fringing reef covering 1.06 km$^2$ to the 60-m isobath. A no-take Marine Sanctuary is located along the southeast side, covering a 0.45 km stretch of reef. This sanctuary constitutes slightly less than 10% of the total reef area. Two small lagoons supporting sparse mangroves are also located inland of the beach on this part of the island. Apo has only brackish water, and residents buy water from the mainland.

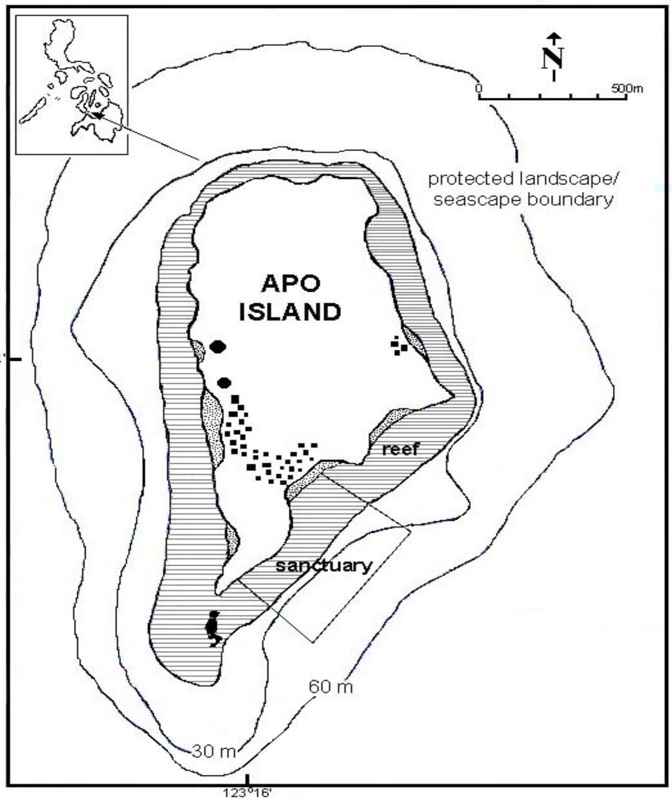


Figure 14.1 Map of Apo Island

## 14.2 Socio-economic Setting

There are two small settlements located along the periphery of the island (Figure 14.1), and at present there are approximately 700 inhabitants. The island falls under the political jurisdiction of the municipality of Dauin, the nearest town on the island of Negros (approximately 30 minutes by motorized pumpboat from Apo). Fishing is the main livelihood, though alternative livelihood opportunities have developed surrounding the tourism industry. The island houses two small resorts, both of which are staffed principally by Apo community members. Boat rentals for visitors, catering of meals, lodging, and the selling of handicrafts have provided additional income for many families.

## 14.3 Management

The marine sanctuary was formally protected in 1984, by Municipal Ordinance. At this point, the community set up the Marine Management Committee (MMC), composed of elected Apo residents. The community enforced prohibitions on fishing by non-Apo residents and the use of destructive fishing gear (Russ and Alcala 1999, Alcala 2001). Only hook-and-line, gill nets (within legal mesh sizes), fish traps, and spearfishing without SCUBA have been used within reef areas since this time. In 1994, Apo was declared part of the National Integrated Protected Areas System (NIPAS) and management was taken over by a Protected Areas Management Board (PAMB). Members of PAMB are appointed by the DENR, and consist of representatives of local government (both provincial and municipal), NGOs (represented by Silliman University), the Apo Barangay Captain, and representatives of Apo's People's Organizations (POs). Both management bodies set guidelines for prohibited activities on the reef, collection of visitor fees, and rules and regulations regarding activities on the island. The *Bantay Dagat* is deputized to enforce these rules. Today, all visitors are required to sign in at the PAMB station immediately upon arrival and pay the necessary fees. The fees are set according to whether visitors will swim/snorkel or dive, and students receive a student discount. Seventy-five percent of tourism revenue is allocated for the community, with 25% going to the national treasury.

Successful management of Apo's resources can be seen in the recent analysis of fish yields and catch per unit (CPUE) over time (Maypa *et al.* 2002; Figure 14.2). Reef and reef-associated catches have remained stable for 20 years, in the order of 15-30 t/km$^2$/yr, while non-reef catches declined from 6.21 t/km$^2$/yr to 1-2 t/km$^2$/yr. CPUE has increased from 0.13-0.17 kg/man/h in 1980/81 to 1-2 kg/man/h in 1997-2000, along with a decrease in fishing effort (Maypa *et al.* 2002). Fishers currently target reef and reef-associated species, which explains why pelagic catches have declined. This suggests that fishers are fishing in nearby coral reefs and have become increasingly dependent on their reefs for fish over time. This also suggests that fishers no longer need to spend as much for fuel for motorized boats since their fishing grounds are quite near. In Apo, the majority of the fishers use "bancas," paddle boats when fishing (pers obs., A. Maypa). The maintenance of high fish yields over 20 years suggests long-term sustainability in the fishery of the island and is likely to be attributed to the marine reserve and its management.

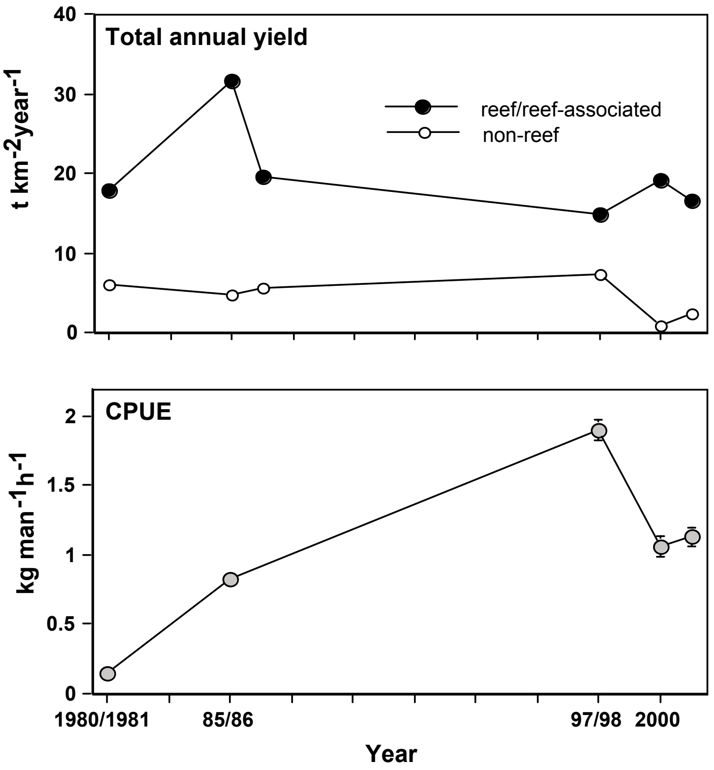


**Figure 14.2.** Fish catch data obtained from the Apo community over a twenty-year period (Maypa et al. 2002; graphs reprinted with permission from author).

## 14.4 Issues and Threats

- *Coral bleaching.* The 1997-98 El Niño bleaching event greatly impacted the reef around Apo, particularly the sanctuary (Raymundo and Maypa in press, Raymundo and Maypa in review). Coral cover has steadily declined since then (See Figure 14.3, below). Subsequent bleaching events of lesser magnitude has further decreased coral cover of the more susceptible species. It is predicted that these bleaching events will result in significant changes in reef community structure and species composition.

- *Tourism impacts.* The increase in tourism has resulted in a number of problems. Solid waste has increased, and disposing of it poses a problem on this small, mountainous island. Coral breakage due to fin and anchor damage has increased (Reboton and Calumpong 2000), even though mooring buoys are present and regulations exist to limit the maximum number of divers on each reef and the allow only experienced divers (>15 hrs) on the reef. In addition, tensions between tourists and divers have developed, as fishers claim large numbers of divers drive the fish away from prime fishing grounds and have reported incidences of fish traps being destroyed by tourists.

- *Tourism revenue time lag.* Since the institution of PAMB, fees collected have greatly increased (from a mean of \$116/mo under MMC management to \$3,741/mo under PAMB management; Cadiz and Calumpong in press). However, national law dictates that all revenue must be deposited into the national treasury prior to disbursement. This has resulted in a time lag for the release of tourism-generated income. Projects have had to be postponed, and several programs that used to be supported by tourism income have been stopped or put on hold. This has created a sense of distrust among community members for the efficacy of the PAMB, but it is hoped that the process of releasing funds back to the community will be streamlined in the future.

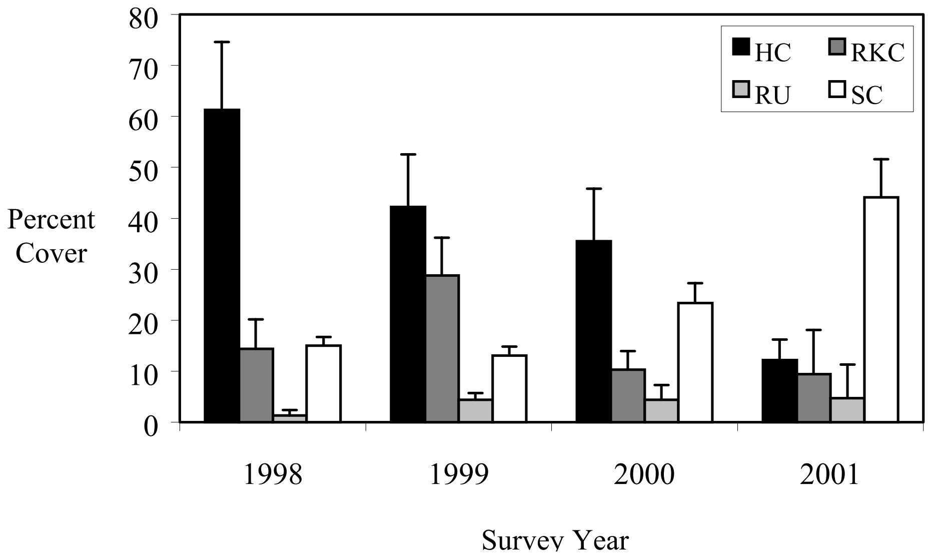


Figure 14.3. Changes in benthic composition along permanent transects in the Apo Marine Sanctuary. HC=Live Hard Coral; RU=Rubble; RKC=Recently-killed Coral; SC=Soft Coral. Data from Reef Check annual surveys, 1998-2001.

## 14.5 Monitoring, Evaluation, and Feedback

Apo has been the site of numerous monitoring and assessment programs since management began in 1984. The fishery has been monitored for one year periods in the course of several different projects; these data were recently summarized and reported Maypa *et al.* (2002). Biophysical assessments have been carried out periodically by teams from Silliman University Marine Laboratory, Earthwatch, Silliman University-Angelo King Center for Research and Environmental Management, and other NGOs. Reef Check has been monitoring the sanctuary along permanent transects annually since 1998, specifically targeting benthic composition, target species, and impacts to the reef. Tourism volume was monitored for one year after PAMB was instituted, and there are plans to continue a more detailed monitoring program during 2003. In addition, Apo has been used as a study site for several graduate students over the years, both local and international, and much of this type of data is incorporated in theses and dissertations.

Feedback to the community of the results of such work does not happen regularly, though this is expected to improve with the presence of PAMB. The Board now requires that all projects are presented first to the PAMB, so that the community is made aware of existing and ongoing research. Publications resulting from research conducted on the island are made available to interested parties; the owner of one of the resorts has begun to build a library of Apo-related publications and reports, for free reading to interested residents and visitors.

## 14.6 Future directions and Recommendations

As stated earlier, managers have recognized the need to reduce the lag time in returning revenue to the community, so proposed projects may be instituted on schedule. Efforts to streamline the process are urgently needed. This is an important issue, as it is directly linked with the shift from a purely community-based management scheme to one within the national network of protected areas. The time lag has had an impact on people's perceptions of the NIPAS/PAMB scheme. Prior to inclusion in NIPAS, tourism revenue was significantly smaller, but the entire amount collected was immediately available to the community.

Tourism impacts must be reduced at all levels. There is a need for greater enforcement of existing regulations governing how many, when and where tourists may dive. The community recently marked off a prime fishing area to exclude divers completely. Such actions reflect the need to respond to fishers' concerns and reduce tourism pressure, as fishing remains the main livelihood of the majority of residents. Results of tourism impact monitoring should be presented to the community as well as dive operators, so that regulations can be upgraded and tailored to address the specific problems identified.

## 14.7 Monitoring, Evaluation and Feedback

Monitoring of reef impacts using Reef Check will continue. This is the only annual monitoring scheme used on the island, as most monitoring projects are short-term. Reef Check surveys will continue to record bleaching impacts and changes in the benthic and reef fish community, and will be used to inform Apo residents regarding changes in the sanctuary reef.

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# CHAPTER 15 GILUTONGAN MARINE SANCTUARY, CORDOVA, CEBU

[1]Hazel O. Arceo (1998-2001), [1]Andre J. Uychiaoco (1998-1999), [2]Jonathan Apurado (1998-2001), [3,5]Timoteo Menguito (1998-2001), [4]Reggie Blanco, [1]Paulyn A. Gaite (1999-2000), [3]Rizalier Amolo (1998), [2]Joey Gatus (1998), [3]Annie Diola (1998), [3]Solon Bagalihog (1998), [4]Ma. Fe Portigo (1998-2001), [2]Dave Valles (2001) and [6]Alicon Garcia (1998)

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[2]University of San Carlos (USC)
[3]Department of Environment & Natural Resources (DENR-Region VII)
[4]Coastal Resource Management Project (CRMP)
[5]Village Government of Gilutongan , Cebu
[6]International Marinelife Alliance (IMA)

## 15.1 Biophysical Setting

The Gilutongan Marine Sanctuary is a 14.89-ha. "no take" marine reserve on the eastern side of Hilutangan Island. The marine sanctuary includes fringing reefs from the coastline across the reef flat and to a 20-80$^{o}$ slope. Underwater visibility is good. There are now many fishes including a school of batfishes.

## 15.2 Socio-economic Setting

Gilutongan is a village in the municipality of Cordova, Cebu. Most of the fishers here have now turned to seaweed farming. Many others live by peddling various goods to visiting tourists. Many tourists (especially divers) from nearby Cebu and Mactan visit the area.

## 15.3 Management

The Gilutongan Marine Sanctuary was established by the municipal legislative council (Municipal Resolution 91-83) by approving the recommendations made by the Cordova Resource Management Board (Board Resolution 01 series 1991). The sanctuary was the pilot site of the Cebu Resource Management Project (1991-1993). Through the help of the USAID/DENR Coastal Resource Management Project, the sanctuary ordinance was formally adopted by the Municipality of Cordova on March 24, 1999 through Resolution No. 30 Series of 1999, but was later found to be inadequate. Several inter-agency consultations suggested revisions so the marine sanctuary ordinance was amended May 31, 1999 through Resolution No. 47, Ordinance No. 3, Series of 1999 (increasing the sanctuary from 10 to 14 hectares) and Ordinance No. 8, Series of 1999 (defining the activities allowed, regulated and prohibited and prescribing penalties) (Morales 2000). Fishing (of any type) and any extractive activities are strictly prohibited. Boating and use of wave runners and jetskis are also prohibited. Diving, snorkeling and swimming inside the sanctuary may be allowed but are subject to certain management regulations.

The sanctuary was marked in June 1992 and well enforced by village secretary Timoteo Menguito from 1992 until he quit his voluntary efforts in 1995. Since then up to 1998, it was virtually unprotected. The boundaries were again marked on October 1999. Menguito, who is also the Barangay Fisheries and Aquatic Resources Management Council point person), is again the most active (sometimes the only) guardian and was hired in 2000 by the DENR as the sanctuary's keeper. A guardhouse is strategically located in the middle of the shore side of the sanctuary, and commands a good view of the whole area. A coastal clean-up was conducted in October 1998 and the village FARMC has been organized.

There is a management plan that includes mechanisms for collecting fees, multiple-use zoning, and other regulations. The sanctuary earns around P25, 000 per month from diving and snorkeling (user) fees and fines (LAP 2001) and a portion has recently been transferred to the village for development projects (Menguito pers. comm.). There are also plans to renovate the guardhouse. Very recently, other residents in the community now sometimes join Menguito in guarding the sanctuary.

## 15.4 Issues and Threats

The area is very close to Metro Cebu and so is potentially subject to shipping and coastal construction stresses. Though the community supports the sanctuary, until very recently only Mr. Menguito was actively involved in guarding.

## 15.5 Monitoring, Evaluation and Feedback

The community, including some village councilors, women and youths, has been relatively active in the reef monitoring activities though they have been less active in the guarding. The vendors (who sell souvenirs and snacks from small boats) have been organized and have been tapped to participate in guarding activities.

Fish abundance reportedly increased from 1992 to 1995 when the sanctuary was first established, and decreased when the sanctuary was not enforced (Timoteo Menguito pers. comm.). Target fishes have since increased in numbers once again inside the reserve (Fig. 15.2). A school of batfishes are among the most distinctive regulars within the sanctuary. On the other hand, the decreasing trend in target fish abundance adjacent to the sanctuary is mainly due to fusiliers and, to a lesser extent, to parrotfishes (Table 15.2). At the same time, hard coral cover and dead coral cover inside and adjacent to the sanctuary increased then decreased from 1999 to 2001 (Table 15.1 & Fig. 15.1). However, this observation was most probably due to placement of transects on sandy substrate in 2001; if this were to be taken into account, hard coral cover is probably stable.

Figure 15.1 Hard coral cover inside and adjacent to the Gilutongan Marine Sanctuary.

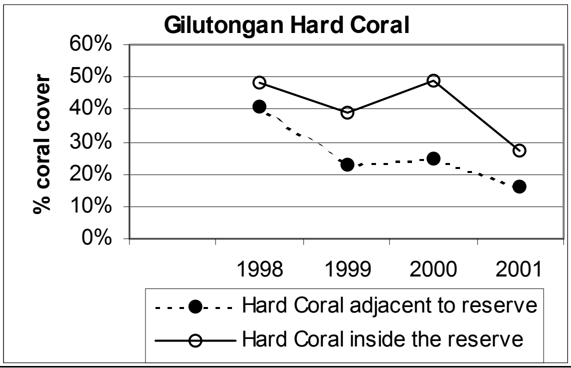


Figure 15.2 Fish count/500 $m^2$ inside and adjacent to the Gilutongan Marine Sanctuary.

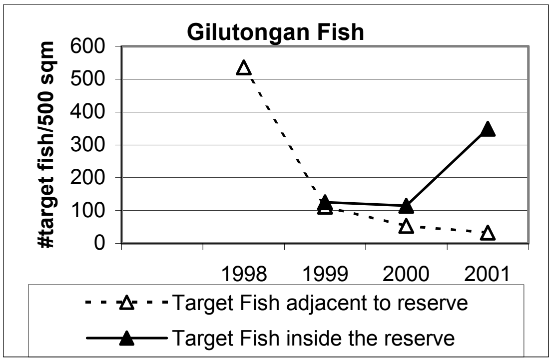


Table 15.1 Average % cover of benthic lifeforms inside and adjacent to the Gilutongan Marine Sanctuary

| Zone | Adjacent | | | | inside | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1998 | 1999 | 2000 | 2001 | 1998 | 1999 | 2000 | 2001 |
| Hard Coral (live) | 41% | 22% | 25% | 16% | 49% | 39% | 49% | 28% |
| Soft Coral | 6% | | 1% | 1% | 2% | 0% | 1% | 1% |
| Dead Coral | 12% | 3% | 9% | 3% | 24% | 7% | 15% | 6% |
| Dead Coral w/ Algae | | 10% | 3% | 3% | | 7% | 2% | 2% |
| Turf Algae | 1% | 0% | 1% | 1% | | 0% | 0% | 0% |
| Macroalgae | 1% | 4% | 9% | 10% | | 0% | 0% | 0% |
| Coralline Algae | | | 1% | 0% | | 0% | 0% | 0% |
| Seagrass | | 0% | 0% | 1% | | | 0% | 5% |
| Sponge | | 1% | 1% | 1% | | 1% | 1% | 1% |
| Zoanthids | | 0% | 0% | 0% | | 0% | 0% | 0% |
| Other Animals | 2% | 0% | 0% | 0% | 1% | 0% | 0% | 0% |
| Rubble | | 9% | 14% | 8% | | 9% | 17% | 4% |
| Rock | 15% | 8% | 13% | 12% | 11% | 15% | 3% | 8% |
| Sand/Silt | 23% | 32% | 25% | 45% | 14% | 13% | 13% | 44% |

Table 15.2 Average fish abundance per 500 $m^2$ inside and adjacent to the Gilutongan Marine Sanctuary

| zone | adjacent | | | | inside | | | |
|---|---|---|---|---|---|---|---|---|
| year | 1998 | 1999 | 2000 | 2001 | 1998 | 1999 | 2000 | 2001 |
| Epinephelinae* | 1.0 | 0.4 | 1.6 | 0.4 | | 2.2 | 5.0 | 11.6 |
| Lutjanidae* | | 3.0 | 0.2 | 0.4 | | 40.2 | 22.0 | 68.2 |
| Haemulidae* | 2.5 | | 0.4 | 1.2 | | 1.8 | 0.8 | 2.0 |
| Lethrinidae* | 0.5 | | 0.2 | 0.4 | | 0.2 | 7.0 | 21.4 |
| Carangidae* | 10.5 | | | | | | 0.2 | |
| Caesionidae* | 350.0 | 46.0 | 25.6 | | | 24.4 | 0.8 | 80.8 |
| Nemipteridae* | | 0.2 | 1.6 | 1.2 | | 4.6 | 1.2 | 4.8 |
| Mullidae* | 10.0 | 9.4 | 7.4 | 6.6 | | 8.8 | 16.4 | 36.8 |
| Balistidae | 4.0 | 0.8 | 2.6 | | | 2.6 | 8.2 | |
| Chaetodontidae | | 1.0 | 1.6 | 4.4 | | 12.8 | 7.2 | 11.0 |
| Pomacanthidae | 1.0 | 2.4 | 1.8 | | | 11.0 | 11.2 | |
| Labridae | 692.0 | 91.8 | 177.0 | 82.6 | | 42.6 | 161.2 | 36.6 |
| Scaridae* | 133.5 | 38.4 | 7.4 | 10.6 | | 20.6 | 19.4 | 47.0 |
| Acanthuridae* | 12.5 | 13.4 | 8.6 | 8.0 | | 18.2 | 39.0 | 74.8 |
| Siganidae* | 15.0 | 0.6 | | 1.6 | | 4.6 | 2.6 | 1.6 |
| Kyphosidae* | | | | 3.0 | | | | 0.4 |
| Pomacentridae | 1330.5 | 153.0 | 402.2 | | | 496.4 | 2462.8 | |
| Anthiinae | 687.5 | 19.8 | 256.2 | | | 258.8 | 227.4 | |
| Zanclidae | | | | | | 1.2 | 0.6 | |

## 15.6 Future directions, Gaps and Recommendations

A management body is yet to be created by the Municipality of Cordova in order to ensure the proper and responsible management of the sanctuary.

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# CHAPTER 16 SUMILON ISLAND, OSLOB, CEBU

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## 16.1 Introduction

Sumilon Island has a marine reserve occupying 25% of total reef area. Fish yield at Sumilon Island has been monitored eight times from 1976 to 2001. The results of the monitoring from 1976 to 1985/86 have been presented in Alcala (1981) and Alcala and Russ (1990). This brief paper adds to the published data the results of the monitoring in 2001. Only yields from traps are dealt with here. Yields from gill nets and hook and line (unpublished data) will be reported later.

## 16.2 Methods

Fishing effort in terms of number of bamboo traps used over the years did not differ significantly. At any one time, an estimated 60 to 90 traps were set underwater, the balance of about 100 traps being dried in the sun. Trapping activities occurred during the whole week, but one day (usually Friday) was the main "trapping" day when traps were checked for their catch. Catch from traps were weighed or estimated by eye and recorded on all days of the week.

## 16.3 Results and Discussion

The fish yield from traps placed outside the marine reserve in 1976-1983/84, and within the reserve and non-reserve in 1985/86 and 2001, showed an increasing trend from 1976 (four years after protection) to 1983-84, the period of protection of the reserve (Alcala and Russ 1990) (Fig. 16.1). The yield decreased in 1985/86 when protection broke down (white bar in Fig. 16.1), and decreased further in 2001 when there was much reduced protection of the reserve (cross-hatched bar in Fig.16.1). Fishing with hook and line and traps has been allowed in the reserve since 1995/96.

The simplest explanation for the trends in fish yield at Sumilon shown in Fig. 16.1 is that the large fish biomass in the reserve spilled over to the fished areas around the reserve (Alcala and Russ 1990). This conclusion is supported by the changes in fish biomass at the Sumilon reserve. After fishing in the reserve started, the fish biomass decreased. After fishing stopped, the biomass increased (Russ and Alcala 1999). In contrast, biomass continued to increase with years of protection at Apo Island (Russ and Alcala 1999).

One benefit that can be expected from marine reserves is the spillover of fish biomass to the fished areas outside reserves. However, our evidence points to the need for long-term (decadal) protection of reserves before fish export from reserves may be expected (Russ and Alcala 1996).

## 16.4 Conclusion

Marine reserves such as Sumilon are promising tools for fishery management. However, they can provide maximum benefits only after several years or decades of sustained protection. At Sumilon the gain in terms of increased fish yield over several years was wiped out by the withdrawal of protection.

## 16.5 Acknowledgments

I am pleased to acknowledge the assistance of Aileen Maypa for gathering the 2001 data and Jasper Leif Maypa for preparing the figure. This paper is part of our Pew Program in Marine Conservation. The National Research Council of the Philippines funded our initial marine reserve program.

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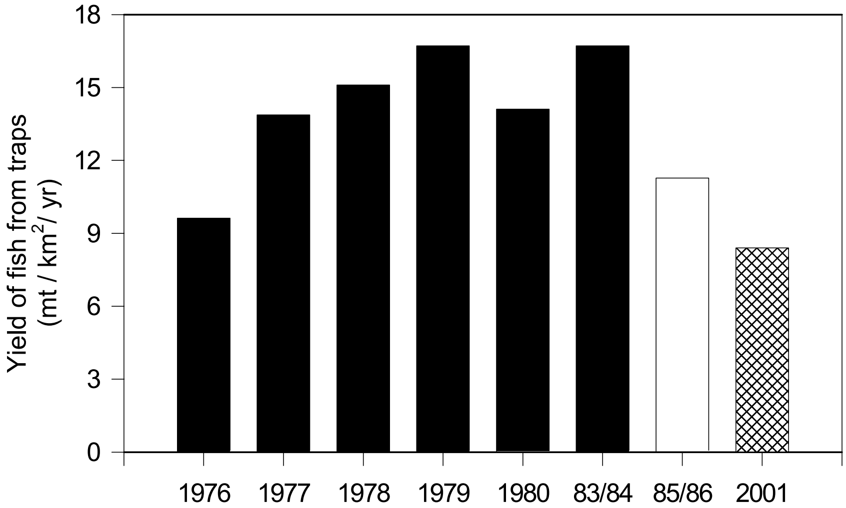


Figure 16.1. Yield of reef fishes (metric tons/km$^2$/yr) taken from bamboo traps at Sumilon non-reserve (fished area) in eight separate years. Black bars, during the period of reserve protection; white bar, 18 months after breakdown of protection; cross-hatched bar, during period of much reduced protection. Yield after breakdown of protection significantly less than the mean of the yields during protection (one-sample t-test, t=3.05, $p<0.05$; Alcala and Russ 1990).

# CHAPTER 17 BOHOL STRAIT

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## 17.1 Management

### Balicasag Island Fish Sanctuary

Balicasag Island Fish Sanctuary was established during the Marine Conservation Development Program of Silliman University in 1985-86 by ordinance in 1986. This was in response to rampant illegal and destructive fishing occurring in the area in the early 1980's. Since that time, diving tourism continues to grow and a 20-room resort started operation in 1992 facing the marine sanctuary.

A community based Marine Management Committee and a Philippine Tourism Authority operated resort on the island assist *purok* (sub-village) officials and *Bantay Dagat* in managing the sanctuary. It seems that management of the sanctuary has weakened in recent years as the community lost interest with the resort development.

### Pamilacan Island Fish Sanctuary

Pamilacan Sanctuary was established during the Marine Conservation Development Program (MCDP) of Silliman University in 1984-85. The first ordinance was passed in 1986. It was amended in 1994. The Silliman University and the World Wide Fund for Nature assisted the *Barangay* Council, *Bantay Dagat* and Pamilacan Island Dolphin and Whale Watching Organization (PIDWWO) in managing the sanctuary.

The sanctuary is well maintained as evidenced by the vigilance of the community members regarding visitors to the island. This vigilance is unusual in the Philippines and is commendable.

### Sumilon Island Fish Sanctuary

Sumilon Island Fish Sanctuary was established in 1974. By the late 1970s, fish yields had improved (Alcala in this volume). Problems began in 1980 following the election of a new mayor. He opposed the implementation of the policies for the reserve and allowed serious fishing violations. In 1992, all restrictions were lifted and uncontrolled fishing resumed.

The Municipality of Oslob needs to revive the sanctuary given the positive benefits measured in the early 1980's when the sanctuary was fully enforced.

## 17.2 Issues and Threats

The diverse and abundant reefs in Bohol provide many diving and photographic opportunities for scuba divers and snorkelers from foreign countries and the Philippines. Although still in relatively good condition, these coral reefs are coming under increasing pressure from over-fishing, occasional destructive fishing and careless tourism operations.

## 17.3 Monitoring, Evaluation and Feedback

A snorkeling survey method (White et al. 1999) was used to estimate benthic cover at 2-4 m depth of 1 to 1.5 km of reef while point-intercept transect (25-cm intervals) with the aid of SCUBA was used to estimate benthic cover at 6-8 m depth of 50-m transects. Reef fish by visual census, indicator fish and invertebrate species, rare or large marine life, and human activities were also recorded. All survey methods used were consistent with Uychiaoco et al. (2001) and with methods used by Reef Check.

The overall condition of reef substrate appears somewhat improved since the surveys in 1992 and 1984 (Table 17.1). One positive note is that there is no large-scale physical damage from either dynamite fishing or the use of poisons. However, there was a significant decrease of hard coral cover on shallow reefs (Fig. 17.1). Human-related damage now stems from dropping of anchors and too much fishing effort. Some damage may be attributed to novice scuba divers. This is especially true at Balicasag where many divers come on a daily basis. A natural impact of concern is the bleaching incident of late 1998.

The delicate balance between coral growth and destruction from natural and human-caused events appears to be more-or-less holding its own. Nevertheless, for the reefs to continue to have improved coral growth, the human-caused damage from anchors, fishing and scuba divers need to be significantly lessened.

There is an alarming decrease of target species in general suggesting that fishing pressure is too high. There is also a lack of ornamental fish at most sites indicating that aquarium fishes are also over-fished. The only fish families with high numbers are the fairy basslets and damselfishes (Table 17.2). These fish are abundant because they are of little food value to people and have not yet been depleted by aquarium collectors. The reefs are over-fished and the fish community ecology is distorted from a normal balance. Surveys done in 1999 and 2001 showed that grouper, spinecheeks, emperors, snappers and other important target species are almost totally absent.

Table 17.1. Mean percent of living and dead substrate cover for Balicasag, Pamilacan and Sumilon Islands, 1984, 1986, 1992 and 1999, in deep (4-8 m) and shallow (2-3 m) reefs

| | Deep | | | | Shallow | |
|---|---|---|---|---|---|---|
| BENTHOS | 1984* | 1986** | 1992* | 1999* | 1986** | 1999* |
| Hard coral | 21.1 | 25.2 | 20.3 | 25.3 | 30.9 | 19.5 |
| Soft corals | 12.3 | 11.1 | 12.3 | 10.0 | 14.0 | 9.2 |
| Abiotic | 66.6 | 55.7 | 63.4 | 54.2 | 48.2 | 60.6 |
| White dead standing coral | ~ | 8.2 | 4.0 | 1.8 | 6.9 | 2.3 |
| Dead coral with algae | ~ | ~ | ~ | 8.7 | ~ | 8.4 |
| GRAND TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Other information | | | | | | |
| Depth range (m) | ~ | ~ | 4-8 | 5-7.5 | ~ | 2-3 |
| Sample Size(50m-transects /1m$^2$ stations) | ~ | ~ | 63 | 84 | ~ | 2005 |

* Balicasag, Pamilacan and Sumilon Islands were surveyed
** Only Sumilon Island was surveyed during this year

Table 17.2. Mean fish abundance per 500m$^2$ for Balicasag, Pamilacan and Sumilon Islands

| FISH FAMILY | 1986[a] n=6 | 1992[b] n=10 | 1999[b] n=20 | 2001[c] n=2 |
|---|---|---|---|---|
| Surgeonfish (Acanthuridae)* | 152.5 | 184.5 | 56.7 | 40.5 |
| Rabbitfish (Siganidae)* | 0.0 | 0.5 | 2.3 | 0.0 |
| Groupers (Serranidae)* | 3.1 | 1.9 | 1.5 | 3.0 |
| Snapper (Lutjanidae)* | 19.6 | 13.0 | 13.2 | 2.0 |
| Sweetlips (Haemulidae)* | 0.1 | 1.3 | 0.1 | 0.0 |
| Emperors (Lethrinidae)* | ~ | 2.4 | 0.0 | 6.0 |
| Jacks (Carangidae)* | 16.0 | 7.3 | 11.5 | 2.5 |
| Fusiliers (Caesionidae)* | 1548.5 | 557.1 | 267.9 | 290.0 |
| Spinecheeks (Nemipteridae)* | ~ | 1.5 | 1.5 | 4.5 |
| Goatfish (Mullidae)* | 37.3 | 28.7 | 9.1 | 33.0 |
| Parrotfish (Scaridae)* | 117.9 | 67.1 | 52.5 | 66.0 |
| Rudderfish (Kyphosidae)* | 4.3 | 0.7 | 19.8 | 1.0 |
| Triggerfish (Balistidae) | 6.8 | 7.2 | 4.8 | 2.5 |
| Butterflyfish (Chaetodonids) | 20.6 | 22.5 | 18.9 | 19.5 |
| Angelfish (Pomacanthidae) | 15.5 | 31.2 | 11.3 | 28.0 |
| Wrasses (Labridae) | 71.9 | 91.7 | 63.6 | 45.5 |
| Damselfish (Pomacentridae) | 781.2 | 636.0 | 2384.1 | 1082.5 |
| Fairy Basslets (Anthiinae) | 2072.6 | 757.1 | 643.3 | 771.0 |
| Moorish Idols (Zanclidae) | 11.3 | 13.7 | 3.9 | 21.0 |
| Total (all reef spp.): | 4879.2 | 2425.4 | 3565.9 | 2418.5 |
| Total (target reef spp.): | 1899.3 | 866.0 | 436.1 | 448.5 |

a. Sites surveyed: Balicasag and Pamilacan Islands
b. Sites surveyed: Balicasag, Pamilacan and Sumilon Islands
c. Sites surveyed: Balicasag Island only, most recent survey, not included in Bohol Earthwatch Report
~ No data
* Species sought by fishermen

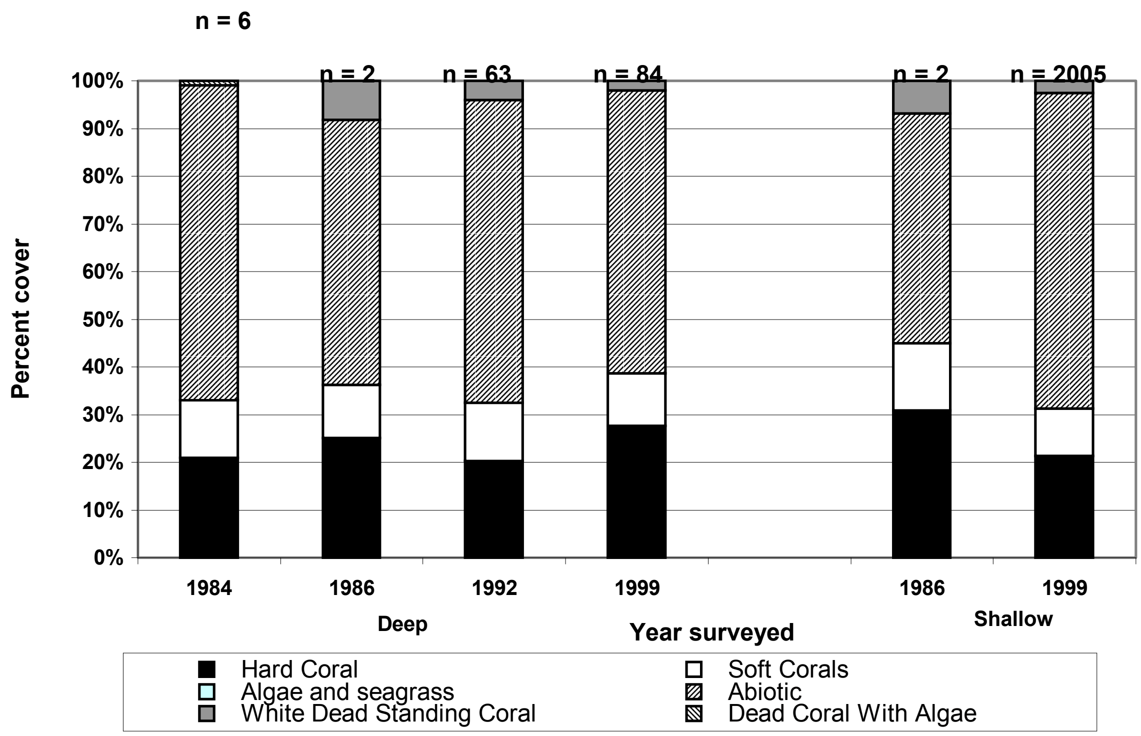


Fig. 17.1. Change in mean substrate cover in sites surveyed in 1984, 1986, 1992 and 1999 for deep (4-7 m) and shallow (2-3 m) reef areas

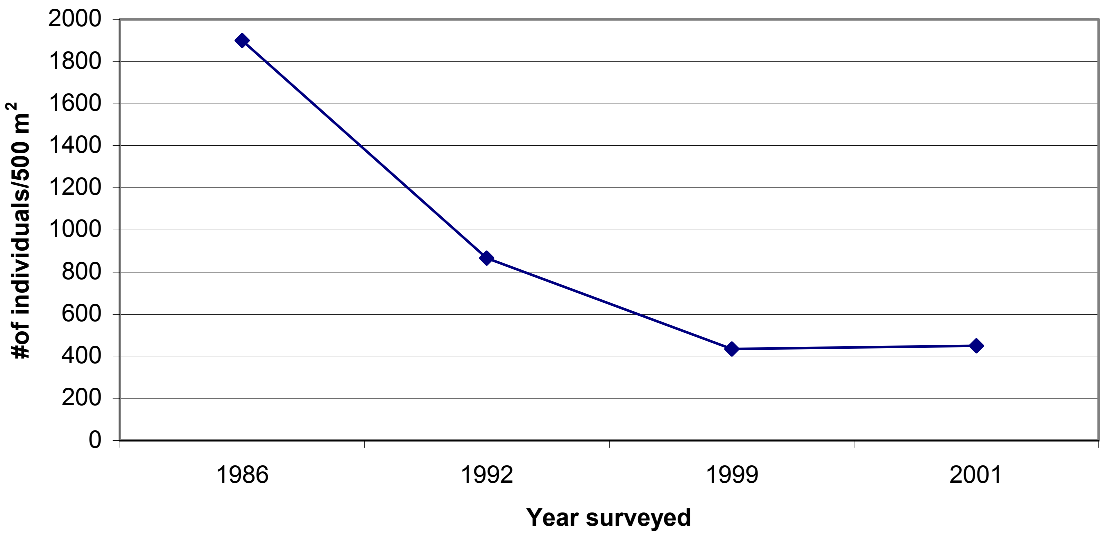


**Fig. 17.3. Mean fish abundance for target reef species per 500 m$^2$ for Balicasag, Pamilacan and Sumilon Islands at mean depth of 6-7 meters**

## 17.4 Future Directions, Gaps and Recommendations

It is important that management through the efforts of municipal governments, the *barangays* and several newly formed private organizations should be continued and expanded. These efforts have started a process of conservation that will be sustainable if continued.

An integrated management plan for the Bohol Marine Triangle (Balicasag, Panglao, and Pamilacan Islands) area should be drafted. This plan could be the focus of discussions of all stakeholders and be a topic for various workshops and educational programs. The Bohol Environment and Management Office can facilitate the planning process.

The Resort Owners Association of Alona Beach and the Philippine Tourism Authority (PTA) can play a larger role in the conservation efforts. The resorts of Panglao need to play a much more active role in the overall conservation of the area since their livelihood is fully dependent on the condition of the coral reefs in the area. Similarly, the PTA can facilitate the improved management of Balicasag marine sanctuary together with the island community.

Destructive and commercial fishing needs to be stopped. This will set the tone for improved conservation in the area and encourage residents to protect the reefs. More anchor and marker buoys are needed. Anchor buoys are having positive effects on the sites where they are located and have made boatmen more conscious about protecting the corals. They can serve to heighten concern for coral reef protection.

Guidelines need to be developed for all shoreline construction and development that has the potential for causing erosion or increasing pollution. Raising awareness about waste disposal is needed. Local waste disposal should be improved and pressure is needed on shipping companies to stop dumping in mid-water.

The sustainability of localized management is dependent on user fees and taxes to cover management costs. Users fees need to be collected and managed by credible local groups to support sanctuaries, maintenance of anchor buoys and other costs of conservation.

## 17.5 References

Uychiaoco, AJ., S.J. Green, M.T. de la Cruz, P.A. Gaite, H.O. Arceo, P.M. Aliño and A. White. 2001. Coral Reef Monitoring for Management. University of the Philippines, Marine Science Institute, United Nations Development Programme Global Environment Facility-Small Grants Program, Guiuan Development Foundation, Inc., Voluntary Service Overseas, University of the Philippines Center for Integrative and Development Studies, Coastal Resource Management Project and Fisheries Resource Management Project. 110 p.

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White, A.T., P. Christie and M.F. Divinagracia. 1999. Summary Field Report: Coral Reef Surveys for Conservation in Southwest Bohol, Earthwatch Expedition to the Philippines, May 1-10 and 13-22, 1999. Coastal Resource Management Project and the Sulu Fund for Marine Conservation Foundation, Inc., Cebu City, 79 p.

# CHAPTER 18 CABACONGAN FISH SANCTUARY, LOON, BOHOL

[1]Andre J. Uychiaoco (1997-1999, 2001), [1]Hazel O. Arceo (1998-2001), [3,4]Stuart J. Green (1997-2001), [1]Paulyn A. Gaite (1998-2000), [1]Fernando I. Castrence Jr. (1997), [1]Rene Abesamis (2000), [2]Jonathan Apurado (2001) and [2]Dave Valles (2001)

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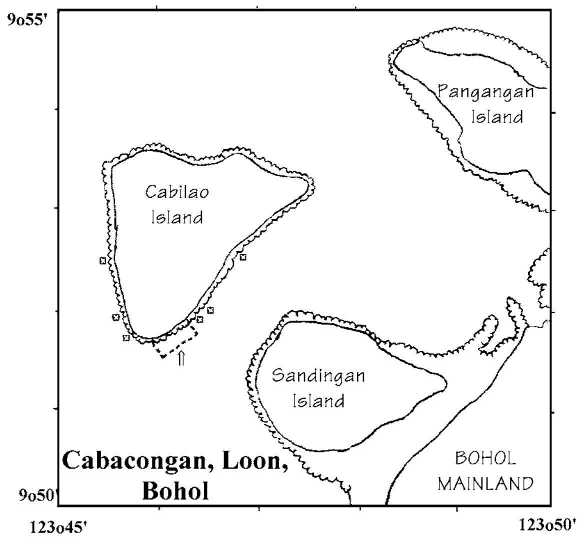
[2]University of San Carlos (USC)
[3]Voluntary Service Overseas, Philippines (VSO)
[4]Coastal Resource Management Project (CRMP)

## 18.1 Biophysical Setting

The Cabacongan Fish Sanctuary is an 11.8-ha. "no take" marine reserve slightly northeast of the southern tip of Cabilao Island. The fish sanctuary stretches from the coastline, across a narrow seagrass flat and to an 80° steep hard coral wall. The wall exhibits over 75% hard coral cover in some places. Underwater horizontal visibility is 25-30 m.




## 18.2 Socio-economic Setting

Cabacongan is a village of the municipality of Loon in the province of Bohol. Small-scale capture fisheries is one of the major economic activities in the village. The community historically had many problems with small- and large-scale illegal fishing in and around their island. They had, however, always managed to protect this one reef area from destructive fishing. It was therefore a prime site for the establishment of a marine sanctuary.

## 18.3 Management

The fishers of Cabacongan were initially skeptical about the potential benefits of a fish sanctuary. Initially a series of participatory coastal assessments were conducted in the area and then a series of small workshops and environmental activities were conducted by the Bohol Integrated Development Foundation, Inc. (BIDEF) and Voluntary Service Overseas (Stuart J. Green). The vocal fisherfolk organization *Nagkahiusa Gamay Mananagat sa Cabacongan* (NAGMACA) (United Small Fisherfolk of Cabacongan) helped inform and increase awareness on the proposed sanctuary. Local and town officials were very supportive and willing to support the first marine sanctuary in Loon. The sanctuary was finally established and markers deployed on November 1, 1997 by municipal ordinance 07, series of 1997. Fishing and recreational diving are prohibited within the reserve. Three bamboo poles lined up near the steep drop-off mark the breadth of the sanctuary along the coast. The actual extent of the sanctuary from the coast into the water is not marked since the outer portion of the sanctuary extends into the very deep water and is thus not easily marked.

A guardhouse was built on the cliff overlooking the sanctuary. Enforcement of the sanctuary since November 1, 1997 has been quite strict. A management committee was formed within NAGMACA to manage the fish sanctuary. Village council members and male members of NAGMACA guard the sanctuary at night. As fishes started to reappear in the sanctuary, the women's organization also volunteered to guard while weaving mats during the day. Observations are recorded on a logbook. The success of the reserve has prompted the local government to allocate a monetary monthly allowance to be shared among the local volunteer guards of the reserve.

## 18.4 Issues and Threats

There have been many intrusions into the sanctuary. At the start, gleaning was allowed within a 10-

meter buffer zone of the sanctuary due to the women's group becoming vocal about the loss of their gleaning habitat. However, one fisher caught a large fish and then collected sea urchins from the sanctuary to share with guests visiting the sanctuary. He was severely rebuked after this was brought to the attention of the village council and NAGMACA. It was since then agreed that gleaning would no longer be allowed in and around the 10-meter buffer zone of the sanctuary to avoid any further confusion.

Illegal entry of commercial fishing in and around the sanctuary is another problem. A Bantay Dagat ("Sea Patrol") group was formed by the municipal government to apprehend commercial fishing boats (prohibited within 15 km of the shore). Nevertheless, the community was greatly disheartened when a large commercial fishing vessel went well inside the marine reserve and harvested a large number of fish--possibly a spawning aggregation. Despite their existence for over 3 years only a few fishing violations have ended in arrests. The mayor amicably resolved most violations in his office. It was not until the provincial government created the coastal law enforcement councils for the first district of Bohol that a string of commercial fishers was arrested. These fishers were arrested even if a local priest owned one of the boats illegally fishing. The community also had a series of problems: one of their patrol boats was burned while the other one was stolen, its engine removed and was never returned. In 2001, the NAGMACA president (Mr. Natalio Lajera) and members also caught red handed 4 village residents who ran into the sanctuary and started collecting shells and fishes. They turned over the evidence to the Philippine National Police and filed a court case against the violators. However, due to an unclear affidavit and conflicting testimonies, the case was dismissed. The offenders then filed a counter-suit against the arresting parties citing they had no right to arrest them. This case was also dismissed.

The reports of dramatic increases in fish abundance have also attracted fishers and dive tourism to the reserve. The area was not originally a diving spot but suddenly became so after the establishment of the protected area. The fishers were very distressed about this and felt they had no control over the diving in the area, especially since a language barrier also made it more difficult to enforce the regulation. The cooperation of diving operators in the area had been requested to curb this problem. However, illicit diving continues. Some dive boats anchor on the boundary of the sanctuary. While technically they are still outside the boundary, the divers actually intrude underwater without being noticed by the guards, much to their further frustration.

## 18.5 Monitoring, Evaluation and Feedback

The local community has not been active in coral reef monitoring though several local residents have joined the bi-annual monitoring of the sanctuary reef biota conducted by the University of the Philippines Marine Science Institute, VSO and BIDEF supported by UNDP GEF-Small Grants Programme and DENR/US-AID Coastal Resource Management Project. Nonetheless, they are capable of conducting manta tows, snorkeling fish visual census and macroinvertebrate counts.

Monitoring seems to show that hard coral cover inside and adjacent to the reserve (Fig. 18.1) and target fish abundance adjacent to the reserve (Fig. 18.2) are somewhat stable. Target fish abundance inside the reserve is increasing (Fig. 18.2). Hard coral cover dipped then went back to 1997 levels, simultaneously "Rock" cover increased then went back to 1997 levels (Table 18.1). Cover of dead coral with algae increased slightly. The increase in target fish abundance inside the reserve is mainly due to schooling pelagic fusiliers (Table 18.2). Even though target fish abundance inside and adjacent to the reserve are both somewhat variable, increases inside tend to be sustained as compared to increases adjacent to the reserve (Table 18.2).

Figure 18.1 Hard coral cover inside and adjacent to the Cabacongan Fish Sanctuary.

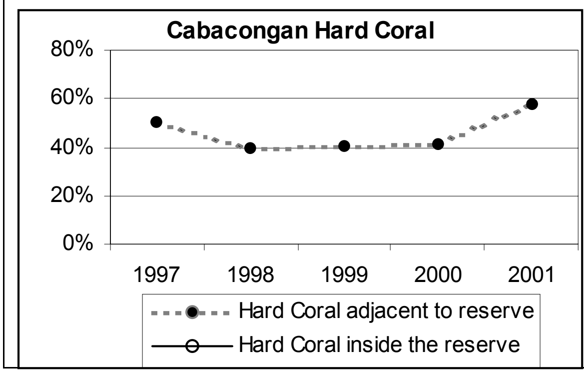



Figure 18.2 Fish count/500 $m^2$. inside and adjacent to the Cabacongan Fish Sanctuary.

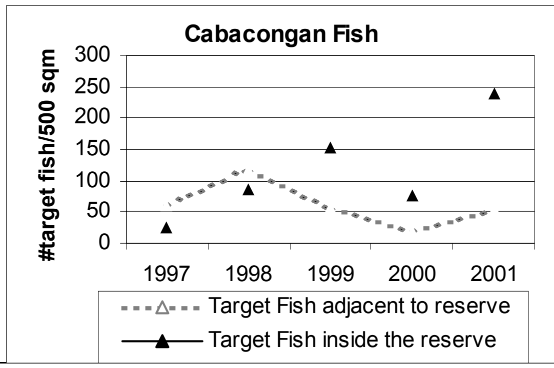


Table 18.1 Average % cover of benthic lifeforms inside and adjacent to the Cabacongan Fish Sanctuary

| zone | Adjacent | | | | | inside | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | 1997 | 1998 | 1999 | 2000 | 2001 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Hard Coral (live) | 50% | 38% | 38% | 41% | 59% | 69% | 52% | 64% | 63% | 72% |
| Soft Coral | 4% | 3% | 1% | 1% | 1% | 5% | 5% | 0% | 0% | 3% |
| Dead Coral | 5% | 1% | 1% | 0% | 2% | 5% | 3% | 1% | 1% | 2% |
| Dead Coral w/ Algae | 3% | 2% | 3% | 7% | 9% | 2% | 3% | 8% | 6% | 7% |
| Turf Algae | 0% | | 0% | 0% | 2% | | 0% | | 0% | 1% |
| Macroalgae | 0% | 1% | 0% | 0% | 0% | | 0% | 1% | 0% | 1% |
| Coralline Algae | | | 0% | 1% | 4% | | | 0% | 0% | 3% |
| Seagrass | | | | 0% | 0% | | | | 0% | 0% |
| Sponge | | 2% | 1% | 1% | 1% | | 1% | 1% | 0% | 1% |
| Zoanthids | | 0% | 0% | 0% | 0% | | 0% | | 0% | 0% |
| Other Animals | 3% | 0% | 0% | 1% | 0% | 2% | 0% | 0% | 1% | 0% |
| Rubble | 7% | 2% | 2% | 1% | 4% | 0% | 1% | 1% | 1% | 1% |
| Rock | 14% | 37% | 37% | 34% | 10% | 16% | 26% | 22% | 24% | 8% |
| Sand/Silt | 8% | 7% | 7% | 3% | 6% | 1% | 4% | 0% | 1% | 2% |

Table 18.2 Average fish abundance per 500 $m^2$ inside and adjacent to the Cabacongan Fish Sanctuary

| zone | adjacent | | | | | inside | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | 1997 | 1998 | 1999 | 2000 | 2001 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Epinephelinae* | 0.1 | 0.7 | 3.3 | 2.7 | 1.5 | | 0.3 | 4.5 | 3.8 | 6.0 |
| Lutjanidae* | | 0.3 | 3.0 | 0.2 | 1.7 | | | 1.8 | 0.3 | 5.0 |
| Haemulidae* | | | | | | | | | | |
| Lethrinidae* | 0.1 | | | | | | | 0.3 | | 0.3 |
| Carangidae* | | 0.3 | 1.3 | | 0.8 | | | 0.5 | | 2.3 |
| Caesionidae* | 57.4 | 66.0 | | 5.0 | 9.5 | | 42.8 | 34.8 | 2.3 | 117.0 |
| Nemipteridae* | 0.9 | 3.5 | 4.5 | 0.8 | 2.5 | 3.0 | 8.5 | 5.8 | 1.5 | 0.8 |
| Mullidae* | 1.4 | 7.0 | 5.5 | 1.7 | 4.0 | 1.0 | 10.3 | 7.3 | 4.0 | 6.5 |
| Balistidae | | 0.5 | 0.5 | | 2.0 | | 1.0 | 1.3 | 0.8 | 3.3 |
| Chaetodontidae | 4.6 | 9.7 | 16.5 | 7.3 | 11.5 | 9.0 | 12.8 | 29.0 | 20.0 | 36.8 |
| Pomacanthidae | 0.1 | 2.5 | 4.0 | 3.2 | 1.5 | 1.0 | 0.5 | 9.0 | 7.5 | 3.3 |
| Labridae | 30.4 | 65.3 | 59.8 | 38.3 | 37.2 | 31.0 | 31.0 | 60.5 | 70.8 | 46.8 |
| Scaridae* | 1.3 | 33.8 | 30.8 | 7.2 | 18.7 | 22.0 | 17.8 | 80.3 | 49.8 | 55.8 |
| Acanthuridae* | 0.4 | 3.3 | 3.8 | 0.3 | 4.8 | | 6.0 | 15.3 | 12.8 | 15.0 |
| Siganidae* | | 1.7 | 4.0 | 0.2 | 9.8 | | 0.8 | 4.0 | 3.3 | 3.0 |
| Kyphosidae* | | | | | 0.2 | | | | | 27.5 |
| Pomacentridae | 886.7 | 755.2 | 1309.5 | 997.2 | 1128.3 | 1563.0 | 641.3 | 1627.8 | 1177.0 | 1171.0 |
| Anthiinae | 582.9 | 202.0 | 202.5 | 170.3 | 240.8 | 1926.0 | 786.3 | 745.5 | 390.0 | 556.5 |
| Zanclidae | | 0.7 | | 0.2 | 0.7 | 1.0 | | | 0.5 | 3.5 |

## 18.6 Future directions, Gaps and Recommendations

Recently, the fishers have begun to look more favorably on divers especially as a source of income and in November 2001 visited the Gilutongan marine sanctuary in Cebu supported by the municipality of Cordova with assistance from the DENR and DENR/USAID Coastal Resource Management Project. Here they saw how to install a divers' fee system and have unanimously decided to charge a 50-pesos fee for divers or snorkelers wishing to visit their sanctuary. This money will be shared amongst the fisherfolk organization, the village and the municipal government for the maintenance of the marine sanctuary.

## 18.7 References and for Further Reading

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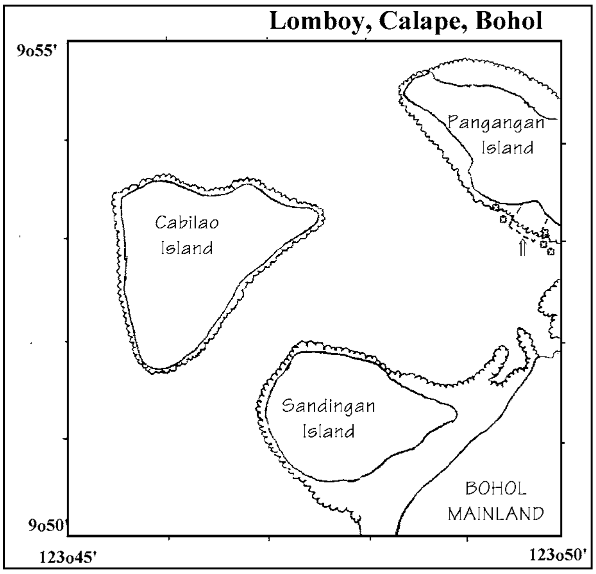
# CHAPTER 19 LOMBOY FISH SANCTUARY, CALAPE, BOHOL

[1]Andre J. Uychiaoco (1997-1999, 2001), [1]Hazel O. Arceo (1998-2001),
[3,4]Stuart J. Green (1997-2001), [1]Paulyn A. Gaite (1998-2000), [1]Fernando I. Castrence Jr. (1997),
[1]Rene Abesamis (2000), [2]Jonathan Apurado (2001) and [2]Dave Valles (2001)

[1]Marine Science Institute, University of the Philippines (UP-MSI)
[2]University of San Carlos (USC)
[3]Voluntary Service Overseas, Philippines (VSO)
[4]Coastal Resource Management Project (CRMP)

## 19.1 Biophysical Setting

The Lomboy-Kahayag Fish Sanctuary is an 8.6 ha. "no take" marine reserve within Calape Bay on the southern coast of Pangangan Island. The fish sanctuary encompasses seagrass beds, fringing coral reefs and is centered around a deep sandy depression locally known as an "aw". Local fishers claim fish spawning aggregations used to breed in the sandy depressions. The reefs haven't recovered from past devastation by storms and blast fishing. The water is often murky from sedimentation coming into the bay from the local rivers.




## 19.2 Socio-economic Setting

The sanctuary spans across the boundary of two adjoining villages—Lomboy and Kahayag—of the municipality of Calape in the province of Bohol. Small-scale capture fisheries used to be a major economic activity in the village. The *aw* was the traditional fishing area for bagnets used with strong attracting lights (*lawag*) while the surrounding area was a favored location for fish corrals (*bunsod*). However, many fishers have since moved into other occupations such as contractual construction jobs and carpentry. There are only about 10 full-time fishers and around 50 part-time fishers in Lomboy. A resort with some picnic tables has recently been built nearby.

## 19.3 Management

Village captain Benjamin Cuadrasal persisted in advocating for a fish sanctuary despite initial community opposition to the plan in 1993. A group who went on a cross-visit to established fish sanctuaries in Apo Island (Negros Oriental) and Siquijor, facilitated by the DENR-Coastal Environment Program and later the Bohol Integrated Development Foundation, Inc., later convinced the rest of the community of the benefits of a sanctuary. On March 1, 1995, Ordinance 95-11 supported by the Lomboy Farmers, Fishers and Carpenters Association (LFFCA), the village captain, the village council, and DENR-CEP set up the Lomboy-Kahayag Fish Sanctuary. In 1997, the NGO BIDEF (especially Mr. Patricio Samante), together with Voluntary Service Overseas (Stuart J. Green), also came to work in the area. Neither fishing (of any type) nor recreational diving is allowed within the core sanctuary. Hook and line fishing, fish traps, gleaning and daytime spearfishing are allowed in the buffer zone. The sanctuary boundaries are marked on both sides by a row of buoys, with two bigger buoys marking the outer two corners. A sign proclaims the sanctuary and its rules in Visayan. Initially, there was no clear buffer zone in the municipal ordinance. .However, the ordinance was amended in 1999 to include a 150-meter width buffer zone.

There are 35 unfished tire artificial reef units and an experimental seaweed culture set-up within the sanctuary. Groupers may occasionally leak from a nearby fish-raising facility into the sanctuary. Village officials have instituted a good replenishment program. Large shells found outside the sanctuary are transferred into the sanctuary rather than being eaten. A U.S. Peace Corps volunteer assigned to the CRMP (Eileen Miltenberger) helped the village obtain and put within the sanctuary area 3 species of giant clams. The clams are initially in ocean nursery cages but are eventually placed into the sanctuary once large enough.

The guardhouse on the shore commands a good view of the sanctuary. The community generally approves of the sanctuary though there are still some who oppose it. The village "tanod" and council members supposedly take turns guarding at night. There have been well over 35 apprehensions but only several offenders have been duly penalized (e.g., fines); the rest were just given a first warning, asked to register their name, boat and place of residence and sign a commitment not to return to the sanctuary.

## 19.4 Issues and Threats

The guardhouse was renovated and expanded to also serve as an education center—displaying photos and a brief history of the sanctuary and its benefits—even for cross-visits from other municipalities. However, enforcement by the people's organization LFCCA was weak because membership in LFCCA decreased from 40 to 28 (primarily after the previous head of LFCCA passed away) and because many members moved out of fishing.

Moreover, local fishers felt that the catch at nearby fish corrals was increasing even though catch from the area near the sanctuary remained low for other fishing gear types. Corrals are a passive fishing gear that is actually legal; however, Lomboy villagers were annoyed that one corral owner, a retired schoolteacher who is not even from the community, placed his fish corral right next to the core area of the marine sanctuary. The owner refused to move the corrals. Documentation and confirmation of the villagers' suspicions through participatory monitoring encouraged them to lobby the municipal government to remove these adjacent fish corrals managed by some residents of the adjacent village of Kahayag. After almost 2 years of problems, the corrals were removed early in 1999 after the original sanctuary ordinance was amended to include a buffer zone that disallowed any of these fish corrals within 150 m of the sanctuary. The corral owner, having many relations in the village of Kahayag, began poisoning the joint relations and guarding of the two villages weakening the joint management of the sanctuary.

Nonetheless, further monitoring showed that fish abundance still seemed to be increasing too slowly. After some accusations within the community, villagers began guarding more vigilantly at night and arrested many. A series of infringements by some residents of Kahayag deepened the divide between the two villages. Finally, the villagers of Kahayag withdrew their support of the fish sanctuary and wanted their own sanctuary instead. The municipal government seeing the problems merely removed Kahayag from the joint management of the sanctuary and handed complete control to Lomboy as they were more interested. The Kahayag community was encouraged to set up and manage their own sanctuary away from the Lomboy sanctuary effectively decreasing the size of the reserve.

Blast fishing has been minimized but still occurs while cyanide fishing seems to have proliferated in Calape. Water clarity in the sanctuary improved after the fish corrals were removed but siltation has since grown worse.

## 19.5 Monitoring, Evaluation and Feedback

Various member of the local community have participated in the coral reef monitoring of the sanctuary reef biota conducted by the University of the Philippines Marine Science Institute, VSO and BIDEF supported by the DENR/US-AID Coastal Resources Management Project. They are capable of conducting manta tows, snorkeling fish visual census and macroinvertebrate counts.

Hard coral cover adjacent to the reserve seemed to have suffered maybe as a result of poor water quality but seems to have recovered since 2000; hard coral cover inside is generally improving (Fig. 19.1). Cover of dead coral with algae adjacent to the reserve increased slightly. "Rock" generally decreased with time (Table 19.1). Target fishes was rising from 1997 to 1998 then 1999 but seems to have gone back down to 1998-levels in 2000; target fish abundance then recovered inside the reserve but not adjacent to the reserve (Fig. 19.2). Target fish abundance adjacent to the reserve is variable mainly due to fusiliers; whereas target fish abundance inside the reserve is due to more sedentary parrotfishes.

## 19.6 Future directions, Gaps and Recommendations

The municipal government has applied for World Bank funding through the Calape Community Based Resource Management project. Staff who used to work for CRMP (e.g., Mr. Zosimo Cuadrasal) have been absorbed by the municipal government for their skills. A program to arrest the sedimentation program is important now in order to help the corals rehabilitate. The village is also considering expanding the sanctuary to 20 hectares in size.

Figure 19.1 Hard coral cover inside and adjacent to the Lomboy Fish Sanctuary.

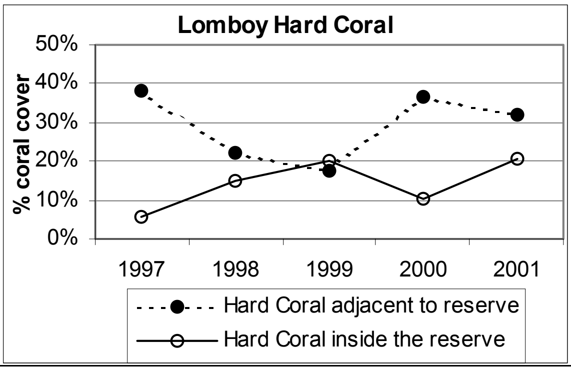



Figure 19.2 Fish count/500 $m^2$ inside and adjacent to the Lomboy Fish Sanctuary.

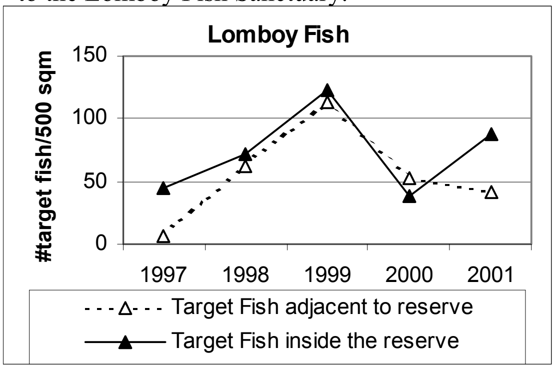



Table 19.1 Average % cover of benthic lifeforms inside and adjacent to the Lomboy Fish Sanctuary

| zone | adjacent | | | | | inside | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | 1997 | 1998 | 1999 | 2000 | 2001 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Hard Coral (live) | 38% | 20% | 16% | 36% | 33% | 5% | 12% | 18% | 11% | 21% |
| Soft Coral | 0% | 0% | | 0% | 0% | | 0% | 0% | 0% | 1% |
| Dead Coral | 3% | 1% | 0% | 1% | 0% | 1% | 0% | 0% | 0% | 2% |
| Dead Coral w/ Algae | 1% | 2% | 2% | 4% | 15% | | 1% | 3% | 1% | 4% |
| Turf Algae | 1% | 1% | 0% | 1% | 3% | 4% | 0% | 1% | 1% | 1% |
| Macroalgae | 0% | | 0% | 0% | 2% | 0% | 0% | | 4% | 0% |
| Coralline Algae | | | 0% | 5% | 2% | | | | 0% | 1% |
| Seagrass | | | | 0% | 0% | | | | 0% | 0% |
| Sponge | | 2% | 1% | 5% | 2% | | 1% | 1% | 1% | 1% |
| Zoanthids | | 0% | | 0% | 0% | | | | 0% | 0% |
| Other Animals | 1% | 0% | 0% | 2% | 1% | 1% | 0% | 0% | 0% | 0% |
| Rubble | 15% | 5% | 24% | 9% | 17% | 27% | 31% | 37% | 27% | 35% |
| Rock | 19% | 44% | 35% | 25% | 8% | 44% | 37% | 24% | 25% | 16% |
| Sand/Silt | 13% | 16% | 15% | 11% | 18% | 15% | 7% | 11% | 30% | 20% |

Table 19.2 Average fish abundance per 500 m$^2$ inside and adjacent to the Lomboy Fish Sanctuary

| zone | adjacent | | | | | inside | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| year | 1997 | 1998 | 1999 | 2000 | 2001 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Epinephelinae* | | 2.0 | 5.3 | 2.6 | 2.2 | | 1.0 | 5.0 | 4.6 | 2.3 |
| Lutjanidae* | | 1.0 | | | 0.8 | | | 0.8 | 1.0 | 0.5 |
| Haemulidae* | | | | 0.2 | 0.2 | | 0.6 | | | |
| Lethrinidae* | | | | | | | | 0.5 | 0.2 | |
| Carangidae* | | | | | 0.3 | | | | | 0.3 |
| Caesionidae* | | 34.2 | 73.5 | 40.8 | 23.5 | 25.0 | 40.0 | 7.5 | 0.2 | 15.5 |
| Nemipteridae* | | 1.0 | 4.8 | 0.8 | 1.8 | 1.0 | 1.8 | 8.0 | 2.2 | 4.5 |
| Mullidae* | 0.3 | 3.8 | 5.5 | 1.0 | 1.3 | 2.0 | 3.4 | 4.5 | 1.8 | 1.5 |
| Balistidae | | | | 0.2 | 0.5 | 0.5 | 0.4 | 2.0 | 0.6 | 0.8 |
| Chaetodontidae | 1.7 | 5.2 | 3.8 | 2.6 | 8.3 | 0.5 | 2.2 | 6.0 | 2.8 | 9.8 |
| Pomacanthidae | | 1.0 | 1.8 | 0.4 | 0.8 | | 1.2 | 1.5 | 1.2 | 0.3 |
| Labridae | 60.7 | 61.2 | 71.8 | 66.2 | 43.8 | 17.0 | 143.2 | 90.5 | 134.6 | 126.8 |
| Scaridae* | 4.3 | 18.4 | 20.0 | 6.2 | 9.7 | 13.5 | 24.0 | 90.5 | 27.6 | 58.3 |
| Acanthuridae* | 1.3 | 0.2 | 1.5 | | 0.2 | | 1.6 | 2.8 | 1.2 | 3.3 |
| Siganidae* | 0.3 | 1.4 | 3.3 | 0.8 | 0.8 | 3.0 | 0.2 | 3.0 | 0.2 | 1.0 |
| Kyphosidae* | | | | | | | | | | |
| Pomacentridae | 339.0 | 621.8 | 483.3 | 668.4 | 722.3 | 354.5 | 431.8 | 525.5 | 523.2 | 843.8 |
| Anthiinae | 75.0 | 161.4 | 45.5 | 137.0 | 87.8 | 50.0 | 35.6 | 13.3 | 37.6 | 18.3 |
| Zanclidae | | | | | | | | 0.3 | | 0.3 |

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# CHAPTER 20 LEYTE, EASTERN VISAYAS

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## 20.1 Biophysical setting

The islands (Cuatro Islas) of Apid (10°32.389; 124° 38.321), Mahaba (10°31.049; 125° 40.189) and Digyo (10°31.796; 124° 39.417) belong to Brgy Apid, Inopacan, Leyte (Fig.1A&B). Apid marine sanctuary (7.2ha) has a narrow reef platform followed by a steep slope; Mahaba marine sanctuary (7.8ha) has a shallow reef of around 100m span from the beach then plunges in a drop off while Digyo marine sanctuary (4.5ha) is characterized by a sloping fringing reef.

Baybay with an approximate coastline of 34 km is the largest town in the Western coast of Leyte fronting the Camotes Sea (Fig. 1C). Most of the coral reefs in town are of the fringing type except for Brgy. Palhi and Punta, which are relatively small off shore shoals.

The sanctuaries in St. Bernard, Southern Leyte (Fig. 1D) are also sloping fringing type of coral reefs. Big mounds of coral heads are common in Lipanto marine sanctuary while that of Himbangan harbors patchily distributed coral heads.

## 20.2 Socio-economic Setting

Based on the 1995 socio-demographic profile of three islands (Apid, Mahaba and Digyo), 81 households were counted with a total population of 603. Almost 50% of the total population resides in Brgy. Apid.

The survey in 1996 revealed that 18% of the coastal residents of Baybay are fishermen. The average family monthly income is about P2,000.00 and has an average of five households members. Most alternative livelihood is livestock production, which augments the income to P1000-5000 per month. Despite economic difficulty, some have been fishing in the area for almost 40 years.

## 20.3 Management

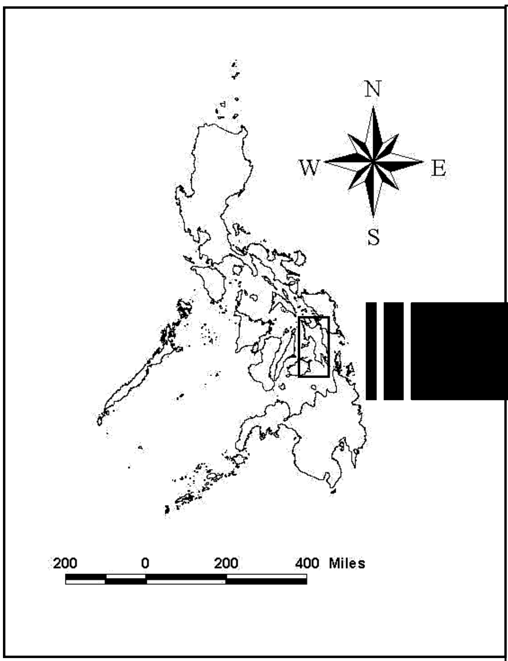
To rehabilitate the damage on the marine biota and to ensure the sustainable use of the remaining resources, various institutions in the Eastern Visayas region implemented community-based coastal resource management projects (CB-CRM). Both Cuatro Islas and Baybay initiated CB-CRM with the support of Visca-gtz Tropical Ecology Program while St. Bernard in Southern Leyte were undertaken by the South Pacific Integrated Area Development Foundation. The establishment of marine sanctuaries in suitable strategic areas was one of the focal activities. Aside from the biological status of the probable sites, considerations prior to establishment were taken to minimize impacts related to: potential hazards to navigation, reduction in gleaning activity in the area, and negative effects related to reduced fishing effort.

Before the establishment of the marine sanctuaries, the technical monitoring team from the academe undertook the assessment of the area and at the same time trained the fisherfolks on how to monitor their respective sanctuaries. The People's Organization (PO) in Cuatro Islas called "Barangayanong Aksyon ug Kusog sa Dagat" (BARADUDA) was formed for the management of the coastal resources.

In Baybay, one of the major activities of the Barangay Fisherfolk Aquatic Resource Management Council (BFARMC) was to maintain the sanctuaries.

## 20.4 Issues and Threats

The fisherfolks as empowered resource managers actively participated in the projects and performed their duties and responsibilities. However, the enthusiasm waned out after political interventions on behalf of apprehended violators were experienced. The vigilance of the stakeholders and refusal their refusal to be stymied by such intimidation, sent a strong signal of this willingness to uphold the policies in the implementation of the objectives and regulations of the sanctuaries.



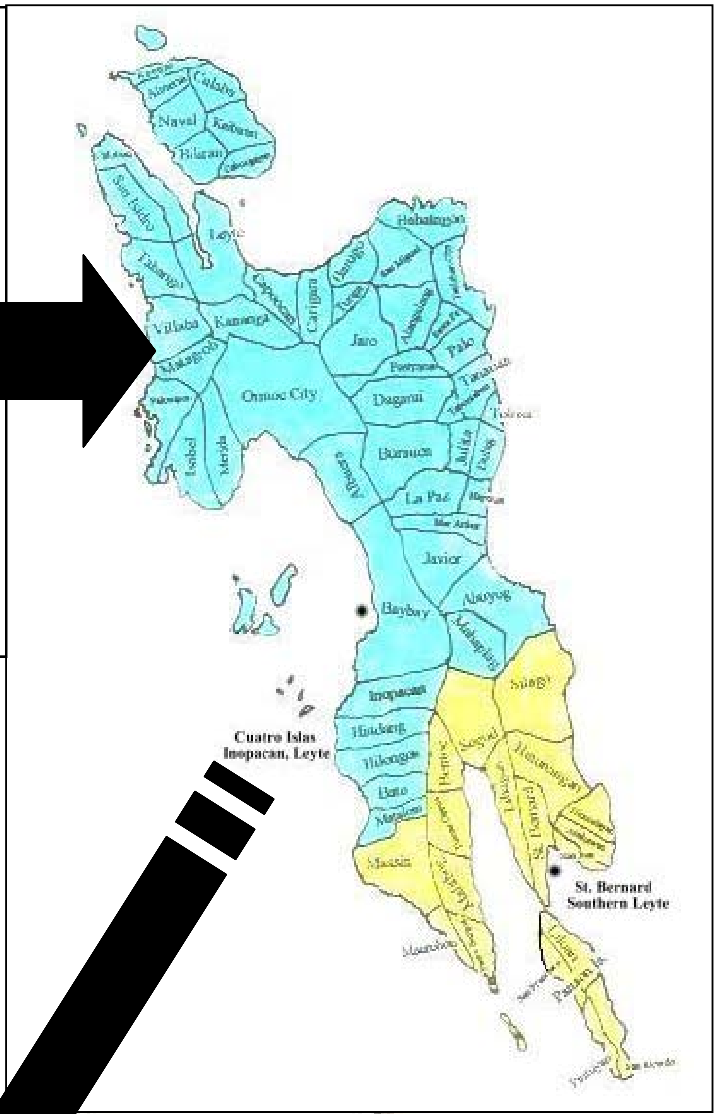




Fig.1A. Map of Leyte showing the location of monitored sites.

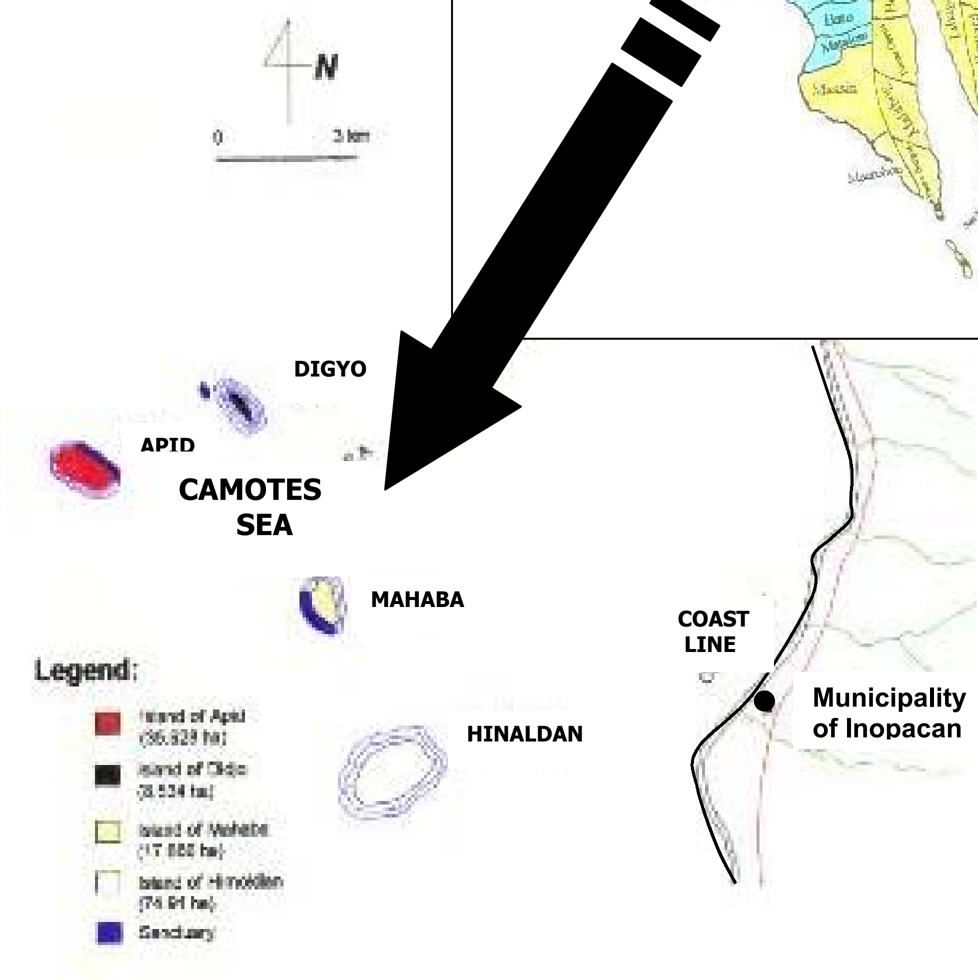



Fig. 1B. Map of Cuatro Islas, Inopacan, Leyte. Monitored from 1994-2002 the using transect quadrat method.

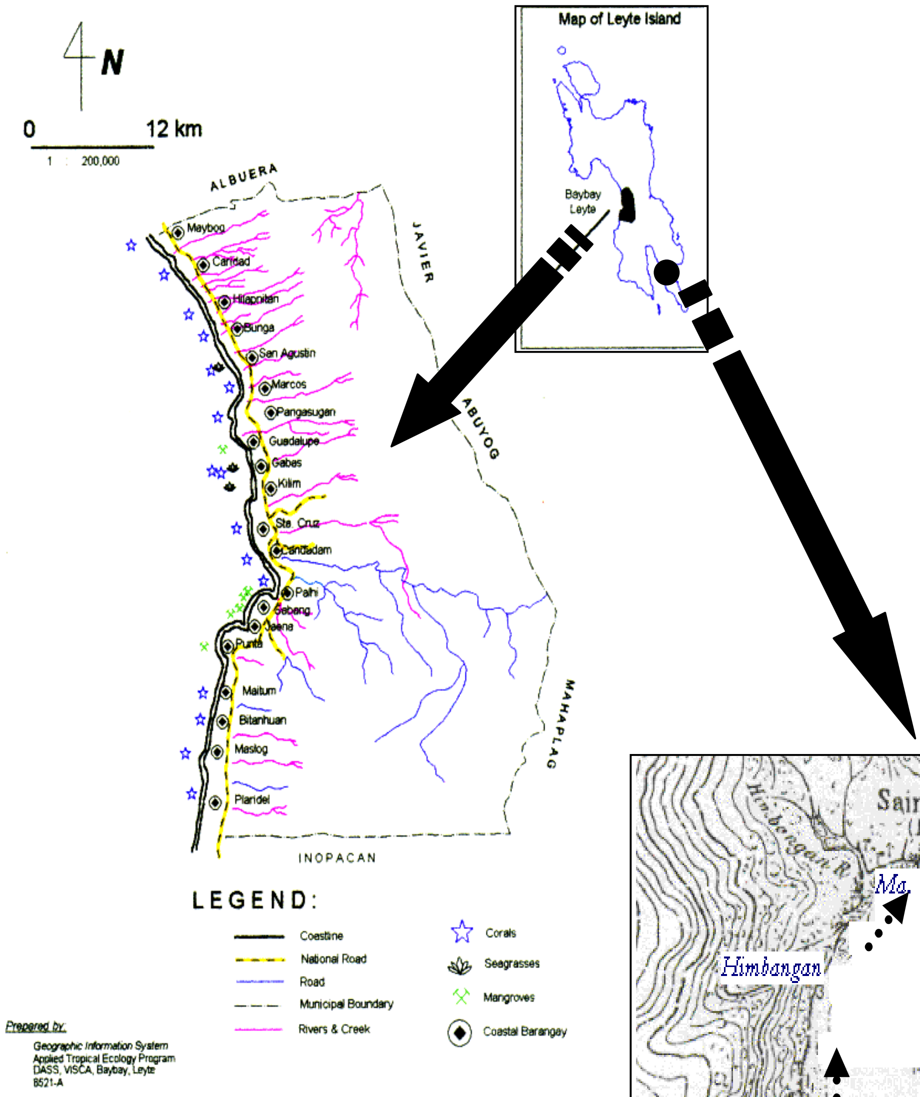



Fig.1C. Map of Baybay, Leyte. Monitored from 1996-2001 using the line intercept transect method.

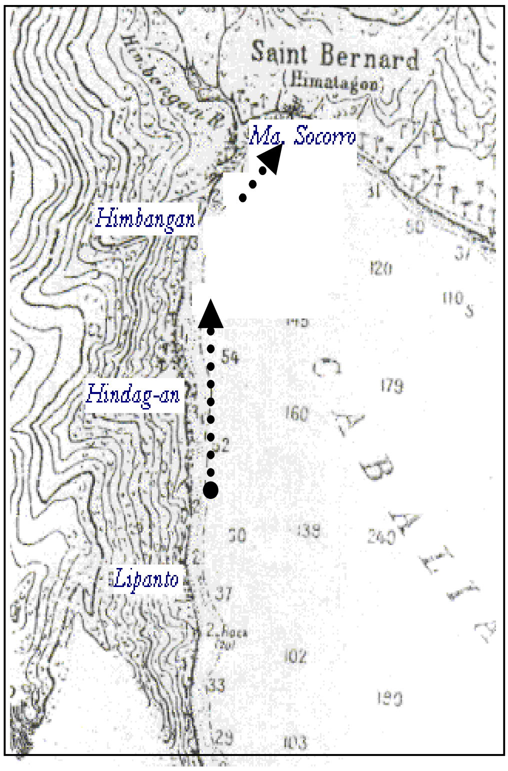



Fig.1D. Map of St.Bernard, Southern Leyte. Monitored from 1997-1999 using the line intercept transect method.

Some initiatives in good management are seen for example in Cuatro Islas where garbage was minimal perhaps due to their improved solid waste management practices. On the other hand, discarded clothes, plastics, fishing nets and lines covered several coral heads in Baybay specifically in areas that were observed to have reduced live coral cover. However, with the recent implementation of an ordinance on solid waste management by the Local Government Unit (LGU) of Baybay, reduction of trash in the reef areas was observed.

Fishing using poisonous alkaloids and blast fishing was being practiced. Although blast fishing is done offshore, this may still affect the reef as result of the reduction in the quantity of plankton (Porter et al. 1977), the food for reef-inhabiting organisms.

Since all these sanctuaries are near to human habitation, poaching was often cited as a problem. Encroaching inside the sanctuaries using the hookah diving has been reported.

## 20.5 Monitoring, Evaluation and Feedback

The marine resources in the different sites (Fig.1A) were generally assessed using the manta tow technique (English et al. 1994). Reef areas found with diverse resources were then investigated in detail using the transect quadrat method for Cuatro Islas, line intercept transect (LIT) methods in Baybay and Southern Leyte areas. The fish resources were determined using the fish visual census technique (English et al. 1994) in conjunction with the lifeform benthic survey.

### Cuatro Islas, Inopacan, Leyte

DENR Region VIII personnel assessed the islands of Apid, Digyo and Mahaba in 1994. The process eventually led to the establishment of marine sanctuaries (Fig.1B). The criteria for the establishment are outlined by Milan and Calomot (1999). During 1995-97 assessments both in the vertical and horizontal extent of corals were assessed while from 1998 onwards, only the horizontal cover was considered. The percentage cover in 1994 reflected the general status of the coral reefs of the island (Fig. 2A). In the succeeding years, the percentage cover reflected the status inside the respective sanctuaries (Fig. 2B). Digyo was monitored from 1996 since the sanctuary establishment was a year after that of Apid and Mahaba (i.e., 1995). The higher coral cover in 1995 in Apid and Mahaba was expected since these were originally established in relatively good coral cover. Three years of protection (1994-96) seemed not to have generated benefits since coral cover shows a decreasing trend (Fig.2). The main reasons were the 1998 *El Niño* event and infestation of crown-of-thorns starfish (*Acanthaster planci*) that left a devastating effect on the reef. The deleterious effect was evident in the total disappearance of the soft corals and coral tabular form, which before contributed 45%to the coral cover (Schoppe 1998). The abrupt increase in the population of corallivore *Acanthaster planci* in Mahaba led the community to harvest the starfish which yielded 106 individuals in 1995 and 462 individuals in 1996 (Small Islands Environmental Rehabilitation and Livelihood Program Terminal Report 1998). While Apid alone yielded 1,500 individuals in three days collection. Based on a 1998 survey, about 20,000 individuals/km$^2$ was estimated in Apid (Benliro et al. 1999). Considering that an excess of 6 individuals/km$^2$ can inflict heavy damage to a reef (Endean & Cameron 1990), these events were considered a severe infestation. *Acropora* coral is the favored food of *Acanthaster* but if the former is not plentiful *Acanthaster* may switch to other forms. The fact that they attack even the massive corals (Fraser et al. 2000) may also explain the disappearance of the soft corals. The southern part of Baybay town, facing the Cuatro Islas also suffered *Acanthaster* outbreak. Although no actual count was done, relatively high numbers of this starfish were observed in 1998.

Further aggravating the damage caused by crown-of-thorns outbreak was the anomalous increase in water temperature brought about by the global *El Nino* phenomenon felt in the Pacific rim in 1997-98. Affected reefs worldwide experienced a decline in live coral cover due to massive coral bleaching (Wilkinson 2000). The above-mentioned natural disasters and human-induced damage to the ecosystems could have resulted to the depauperate coral reefs. In Kuredu, Maldives *El Nino* devastated 90% of the reef. After this massive coral bleaching, it is postulated that 15 years may be required to rebuild the habitat. In the Philippines, 80% of the corals in Bolinao, Pangasinan were bleached (Chou 2000) in 1997-98. In the areas dealt in this paper, the management interventions to deal with human-induced stress on these habitats, might have buffered the otherwise deleterious consequences.

### Baybay, Leyte

In 1991 and 1992, an earlier assessment (Germano 1994) using the transect-quadrat method found Baybay to have an average coral cover of 59.1%. Then in 1996, the entire coastline was re-assessed using the line intercept transect method. Subsequently, 10 marine sanctuaries were eventually established.

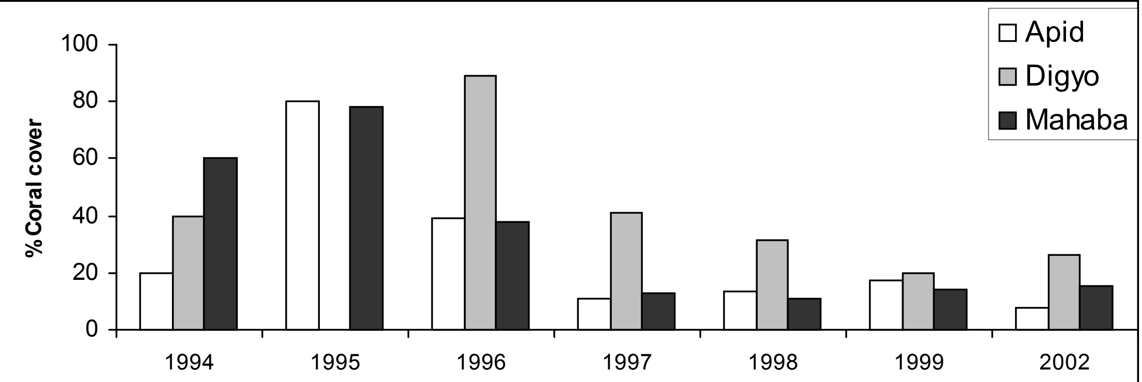



Fig. 2. Coral cover in the sanctuaries of Cuatro Islas, Inopacan, Leyte

Six out of ten sanctuaries showed an increase in live coral cover (Fig.3). Marine sanctuaries in Maybog, Caridad, Jaena, Bitanhuan, Punta, Bitanhuan and Plaridel showed the beneficial effect of the protective measure put in place in these areas. Maybog from its former poor category was elevated to fair condition; Caridad, Bitanhuan and Plaridel increased from fair to good while Jaena and Punta maintained their good category. However, Hilapnitan, San Agustin and Gabas that were formerly in good category decreased to fair category.

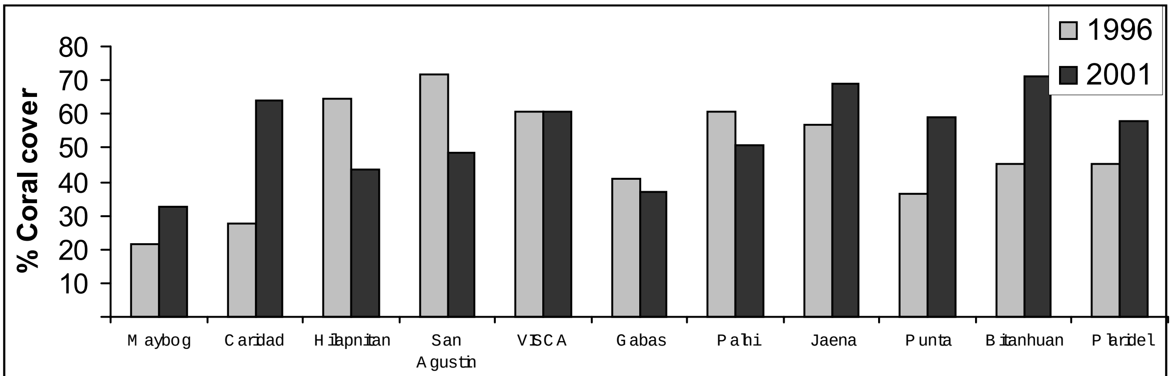



Fig. 3. Coral cover in the sanctuaries of Baybay, Leyte.

## Southern Leyte

The 2-year protection of the Lipanto sanctuary in St. Bernard, Southern Leyte effected an increase of coral cover from 26.41% to 44.5% (Fig. 4). Contrary to the expected increase of coral cover, a slight decrease in coral cover occurred in Himbangan sanctuary from 24.42% down to 18.25%. The decline was attributed to siltation resulting from the erosion of a cliff adjacent to the sanctuary which at the same time was recently utilized as a municipal dumping site.

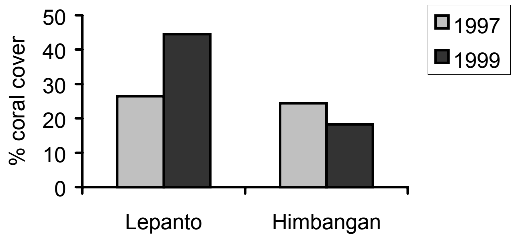



Fig. 4. Coral cover in the sanctuaries of St. Bernard, Southern Leyte (LIT method).

Increase in coral cover manifests the benefit of the implementation of complete 'no-take policy' inside the sanctuaries in Baybay (6 Sites) and in Southern Leyte (2 Sites). However, some areas did not show the expected improvement.

The number of fish species inside the sanctuaries in Cuatro Islas (Fig.5) and Southern Leyte (Fig.6) increased. In Baybay (Fig.7), 4 sites showed an increase; 3 slightly varied; and the rest decreased. These results were presented to the respective communities for validation. All results, except in Brgy. Gabas were confirmed to be the perceived status of the reef fish communities. The number of fish species in Gabas that plunged from 34 in 1996 to 10 in 2001 was not acceptable to the fisherfolks who insisted that they perceived that there was an increase of the fish population and diversity in the area after the establishment of the sanctuary. Moreover, the documented increase in Bitanhuan and Plaridel could have been higher, if only the members of the *bantay dagat* and BFARMC had maintained their vigilance in guarding the sanctuaries.

The increase in fish species inside the sanctuaries despite the reduced live coral cover in Cuatro Islas, Himbangan in Southern Leyte and some areas in Baybay might indicate the reefs use as a secure habitat and not just for feeding purposes. This could also support the claim of the advantage of natural over man-induced reef destruction, in which the coral polyps may be dead but coral heads are still intact. In a way, these can still be utilized as habitat which can be recolonized in contrast to irreversible destruction by blast fishing.

Despite the calamities and human-induced disturbances, fish communities inside protected areas still thrive. The conditioning and preference of fishes to frequent disturbance in the sanctuary could be an interesting research topic.

These findings will hopefully encourage the coastal residents to continue their vigilance in safeguarding and managing their coastal resources. The fruit of their sacrifice to allocate a portion of the reef to benefit the ecosystem at large is presented in this assessment. The benefits expressed in percent cover of resources, may be abstract but any fisherman knows by heart the correlation of coral cover to fish abundance. The experience of three to four years unwavering environmental protection towards sustainable use of the resource base had shown positive outcomes. It may be relatively small, but one of the pioneers in the establishment of marine sanctuaries in the Philippines, postulated that it may take up to 38 years to attain 50% rehabilitation of a destroyed marine habitat (Alcala in Yap and Gomez 1985).

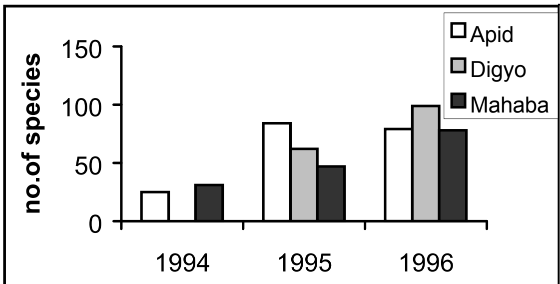



Fig. 5. Number of fish species in the sanctuaries of Cuatro Islas, Leyte.

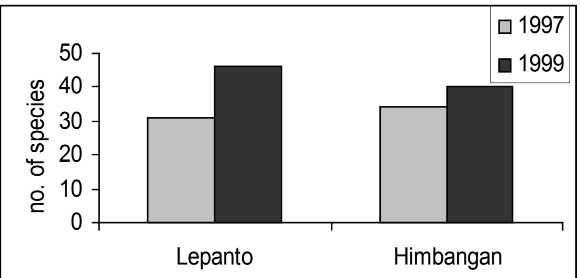



Fig.6. Number of fish species in the sanctuaries of St. Bernard, Southern Leyte

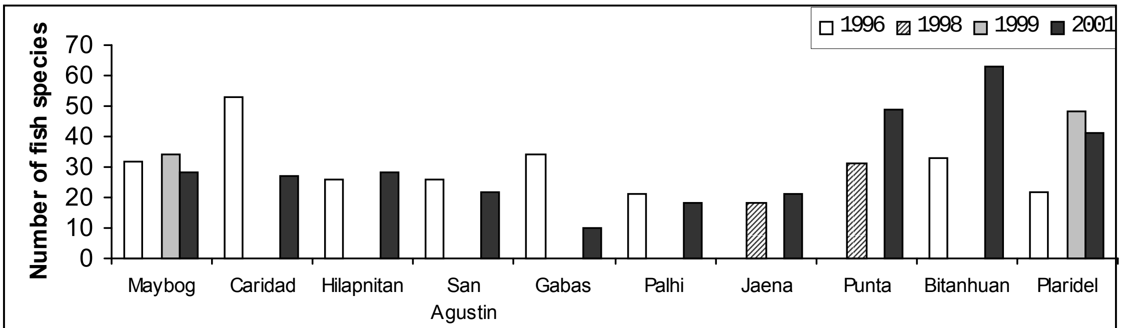



Fig. 7. Number of fish species in the sanctuaries of Baybay, Leyte.

## 20.6 Future directions, Gaps and Recommendation

The establishment of marine sanctuaries proved to be an effective tool to rehabilitate destroyed reef areas in the Eastern Visayas region. While natural calamities cannot be prevented, human disturbance can be controlled. Participatory monitoring of the resources of these protected areas should be done to sustain documentation of the status of the resources and adapt management to existing conditions, thereby encouraging the stakeholders to continuously protect these coastal resources.

After the registration of the fisherfolk organizations, financial assistance will be sourced out to increase existing alternative livelihoods to further decrease the extractive pressure on the resource base.

The existing strong partnership of all concerned local government units, SPIADFI and the Marine Laboratory of the Institute of Tropical Ecology continue to rally behind the management and revitalization of the stakeholders in the never-ending challenges for protecting and rehabilitating the environment though their respective marine protected areas.

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# CHAPTER 21 DANAO BAY REEF, MISAMIS OCCIDENTAL

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## 21.1 Biophysical Setting

Danao Bay lies in the northern part of Misamis Occidental within 8º 31' to 8º 39' E longitude and 123º 38' to 123º 39'N latitude. It is shallow with a large intertidal zone, reaching as far as 1.5 kilometers from the shoreline. About 54% of the bay area is composed of mangroves, mud flats, reefs and seagrass beds (Fig. 21.1). The reef is a fringing reef with a gradual slope. Corals abound mostly on the reef slope area with growing colonies in the intertidal zone.

Ninety percent of the bay is located in the municipality of Baliangao while the remaining 10% belongs to the municipality of Plaridel.

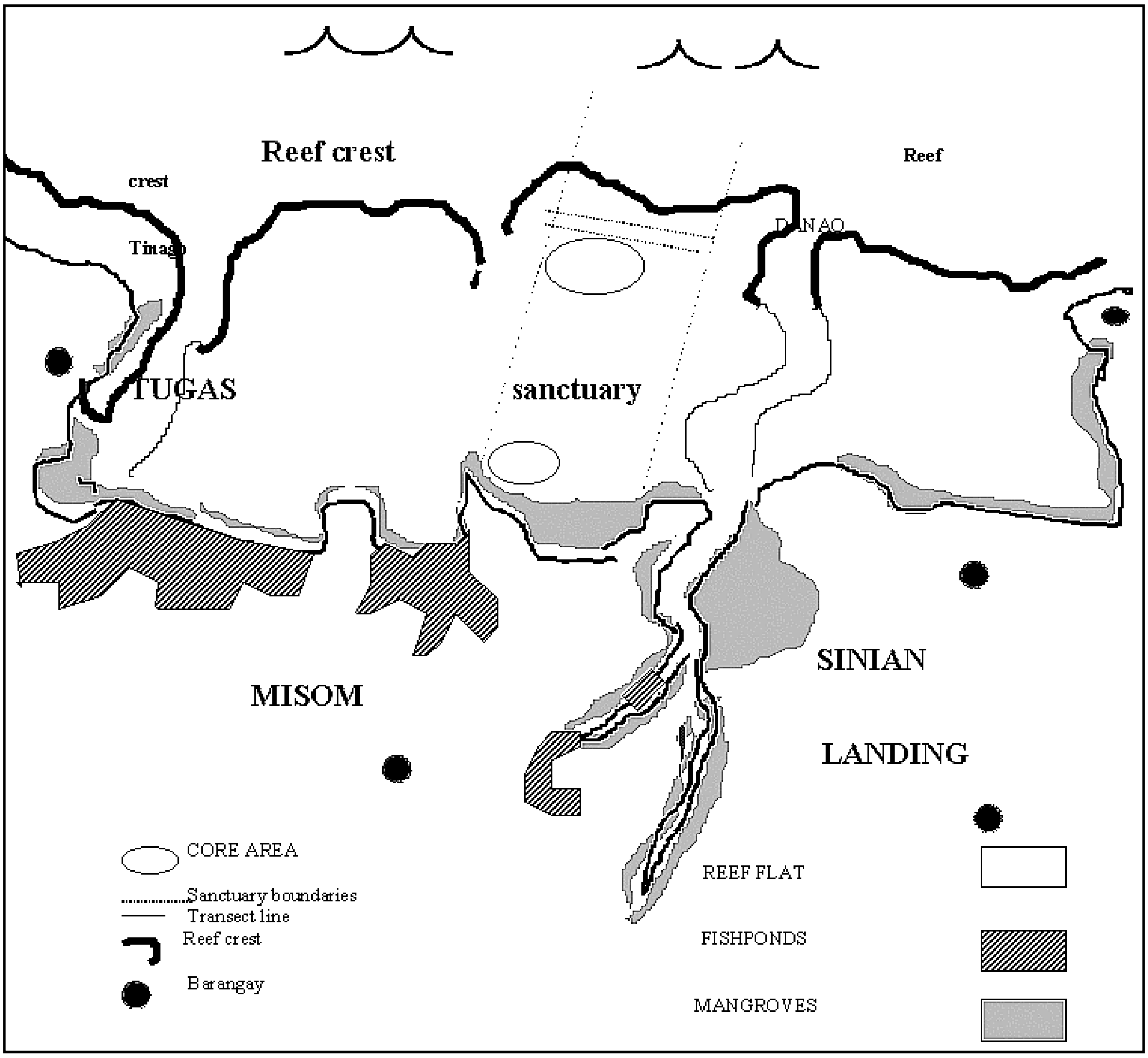


Figure 21.1. Map of Danao Bay.

## 21.2 Socio-economic Setting

Fishing is the main source of income for the people of Baliangao and Plaridel. The destruction of its resources (i.e., mangroves, seagrasses and corals) would also mean a decline in catch and income. The establishment of the sanctuary (BWP) for the protection and restoration of the resources was a big help in terms of income to the fishers. According to them, the sanctuary is like a "spring" or source of fish guaranteeing a steady fish catch. This is may be due to spill over effect of the sanctuary (Alcala 2001).

## 21.3 Management

When the sanctuary was established in 1991, only those coral reefs inside were fully protected, because the guards had no authority outside. Besides, they had no power vested in them by higher authority (e.g., Chief of Police). Their only weapon was in the power of speaking, talking to violators and letting them understand the true importance of the sanctuary. The municipalities of Baliangao and Plaridel undertook some steps to protect the coral reefs. Dynamite fishing was diminished and destructive gears (e.g., three-ply and trammel nets), which entangle coral heads were banned.

An important management measure was the implementation of the Ban period in 1988, specially intended to protect the rabbitfish (*Siganus fuscescens*). During bans no fishing is allowed, even in mangrove areas for gleaning, allowing the resource to recover.

From 1996 up to present, the bay is managed by DB-REMO (Danao Bay Resource Management Organization), an organization composed mainly of resource users of the bay.

## 21.4 Issues and Threats

The major issues confronting Danao Bay are the lack of political support and heavy siltation coming from Sinian River. The mayor and even local village officials don't express true support to the sanctuary. Siltation is a big problem in most coastal areas in northwestern Mindanao, due to the loss of topsoil in the upland areas. Planting more mangrove trees to hold more silt when floods occur and improving upland practices could help.

## 21.5 Monitoring, Evaluation and Feedback

At present DB-REMO has a stable structure, which is composed of different committees like research, finance, gender, education and enforcement (*Bantay Dagat*). The research committee handles the monitoring of the resource of the entire bay and also activities concerning the PO's or the organization. Mechanisms for feedback to the people and reporting schemes have been installed. However, there is a need to improve feedback mechanism. Pipuli recognizes such problems and is preparing to improve the skills of people composing the research committee. Skills that need to be developed include monitoring methodologies and analysis or interpretation of results.

Silliman University conducted the assessment from year 1993 to 1995 and Pipuli Foundation in 1997. There was an increase in fish species number and abundance through time. However, observations were not done outside the sanctuary.

Silliman assessed coral cover of the intertidal area inside the sanctuary in 1995. The results showed a high percentage of rocks and sand. Pipuli's survey of the reef (not the intertidal) in 1997 showed higher coral cover inside the sanctuary compared to the outside.

Table 21.1. Reef fish visual census summary from 1993-1997

| CRITERIA | 1993 | 1994 | 1995 | 1997 |
|---|---|---|---|---|
| Number of fish species | 48 | 75 | 85 | 93 |
| Number of individuals per 400 $m^2$ | 364 | 617 | 692 | 907 |
| Size range (cm) of reef fishes | 3-15 | 2-36 | no data | no data |
| Number of macrofaunal species (shells, sea cucumbers, sea urchin, etc.) | 28 | 48 | 74 | no data |

Table 21.2. Benthic cover

| BENTHIC | Year | 1995 | | | 1997 | |
|---|---|---|---|---|---|---|
| LIFEFORM | Transect | 1 | 2 | 3 | Inside | Outside |
| Live hard corals (LHC) | | 0 | 11 | 7 | 39 | 7 |
| Soft corals (SC) | | 0 | 0 | 0 | 4 | 5 |
| Dead corals (DC) | | 0 | 9 | 4 | 22 | 44 |
| Coral Rubble (CR) | | 0 | 3 | 8 | 15 | 37 |
| Rock / Sand (R/S) | | 0 | 78 | 82 | 20 | 8 |

Table 21.4 Declining catch of fishers from 1993-1998

| Fishing Gear | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| BS gillnet w/ plastic (*lampornas*) | 7.9 | 3.42 | 4.45 | 3.5 | 2.45 | no data |
| BS gillnet (three-ply) | 1.7 | 3.04 | 9.6 | no data | no data | no data |
| Pamu gill net | 8.05 | no data | no data | no data | no data | no data |
| Drift gill net (*pamalo*) | no data | no data | 4.5 | no data | no data | no data |
| Single hook & line | 0.75 | no data | 1.34 | no data | no data | no data |
| Hook & line (*pang-ibis, pasol*) | no data | no data | 3 | no data | no data | 2.8 |
| Speargun (*pana*) | 3 | 2.75 | 5.5 | no data | no data | 4 |
| *Sabay* | 6.15 | no data | no data | no data | no data | no data |
| *Baling* | 3 | 2.035 | no data | no data | no data | no data |
| Fish trap (*panggal*) | 2 | no data | 4.55 | no data | no data | no data |
| Fish pot (*bobo*) | no data | no data | 6.43 | no data | no data | no data |
| Bukatot / Pangbakasi | no data | no data | 4 | no data | no data | no data |
| Fish corral (*bungsod*) | 1.25 | 5.96 | 5.6 | 4.08 | 1.7 | no data |
| Scoop net (*pangito*) | 0.65 | 1 | no data | no data | no data | no data |
| Gleaning | 4.03 | 2.8 | no data | no data | no data | no data |
| Goso nga Bato | 1.13 | no data | no data | no data | no data | no data |
| Spear (*pambunog*) | no data | 2 | 1.16 | no data | no data | no data |
| Panglumot | no data | no data | 10 | no data | no data | no data |

## 21.6 Future Directions, Gaps and Recommendations

DB-REMO research committee must improve their skills and knowledge in conducting studies on the resources of the bay. They must also publish these to share their experiences and the impact of their management with others. There is a need to involve local government in the management of the sanctuary.

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# CHAPTER 22 PANGUIL BAY REEFS, NORTHWESTERN MINDANAO

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Renoir Abrea, Eugene Moleño, Evie Lumingkit and Tito Piloton (1995-96)

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## 22.1 Biophysical Setting

Panguil Bay is a relatively small but rich, traditional fishing ground in northwestern Mindanao. The Bay is bounded by the provinces of Misamis Occidental on the northwestern side, Lanao del Norte on the eastern side and Zamboanga del Sur on the southwestern portion of the Bay. Coral reefs are found only at the mouth of the Bay, due to the high degree of siltation in the inner portion of the Bay. Only two sites were monitored in Panguil Bay from 1991 to 1996. These are Hulaw-hulaw (8$^o$ 11' N; 123$^o$ 53' E) in the northwest, fronting the municipality of Clarin, Misamis Occidental. Hulaw-Hulaw is a small islet also known as Loculan Shoal, which has been declared a marine sanctuary. The other is a fringing reef located at the opposite end of the mouth of the Bay (northeastern coast, 8$^o$ 10' N; 123$^o$ 57' E) in the municipality of Maigo, Lanao del Norte.

## 22.2 Socio-economic Setting

Population growth rates are moderate in Clarin, Misamis Ocidental (1.2%) and Maigo, Lanao del Norte (2.1%). Fishing is the major livelihood among coastal residents. Majority (96%) of the fishermen in the Bay have barely completed elementary education. Most of them are between 30-45 years old, with an average of 4.4 dependents per family (MSU-N 1996).

## 22.3 Management

The Panguil Bay Development Council (PDBC), an integrated management group manages the whole bay, including the sanctuary. However, with the devolution of Department of Agriculture functions in 1991, the PDBC has become inactive. Several NGOs had been tasked to conduct community organizing in the area for coastal resource management plans. However, the projects generally ended upon termination of the contract and have not been sustained.

## 22.4 Issues and Threats

Among the critical issues that have remained unresolved and should be given priority consideration for the management of the Bay (MSUN 1996) are: a) political jurisdiction of contiguous regional areas; b) reduction of fishing pressure by provision of sustainable alternative livelihood and skills training programs; and c) law enforcement. Other concerns, particularly affecting the reefs, are resource use conflicts, poaching, pollution, siltation, blastfishing and fishing violations in the sanctuary.

## 22.5 Monitoring, Evaluation and Feedback

Assessment of the coral reef in both sampling periods (1991 & 1996) used the line intercept technique using lifeform categories, as recommended in Dartnall and Jones (1986) and further improved in English et al. (1997). Results of the two sampling periods in the coral reefs of the two sites are shown in Figure 22.1. Live hard coral cover apparently increased with time in the shallow reefs (3m) of Hulaw-hulaw but decreased in the deep station (10m) and in Maigo.

The relative abundance of opportunistic species such as soft corals and sponges, classified here as other fauna, increased with time. As competitors for space, they may have contributed to the reduction in live coral cover in the deeper portions. Particularly in Maigo, abiotic cover such as coral rubble and silt increased significantly, indicating open spaces, possibly facilitated by blastfishing, which was quite rampant in the area.

Total number of reef fish species identified in the two reefs increased from 50 species belonging to 22 families reported in 1991 (Uy & de Guzman 1992) to 160 species belonging to 32 families reported in 1996

(Abrea & Moleño 1996). The results seemingly indicate increasing species diversity with time. However, part of this change could be attributed to the improved skills of divers in identifying fish underwater. Recent surveys (Abrea & Moleño 1996) indicate that reef fish in the two sites were generally small (TL<10cm long) and large target fish species were rare. The most abundant fishes belong to the family of small, fast-growing species that contribute little to the biomass production of the reefs. The Hula-hulaw sanctuary (37.18 t/km$^2$), however, supports a relatively higher fish biomass than Maigo reef (25.86 t/km$^2$).

## 22.6 Future directions, Gaps and Recommendations

Hulaw-hulaw and Maigo reefs are small-sized reefs with relatively high faunal diversity. There are indicators that these reefs are generally "healthy", but at the same time there are also indications of ecological and anthropogenic stresses (e.g., siltation) that threaten these fragile ecosystems. The biological diversity in the two reefs would indicate their potential for increased productivity through management interventions.

It is believed that the pressure on these reefs will persist with the increasing population and development of agriculture, fisheries and aquaculture around the Bay. Multiple land use activities have increased the sediment load into the Bay. The reduction in mangrove forest cover has exacerbated the threat of heavy siltation on the reefs.

Hulaw-hulaw is a protected area or marine sanctuary established by the province of Misamis Occidental and the Department of Agriculture in the early 1990s. The observed reduction in coral cover since 1991, despite five years of management intervention, imply that legislative efforts by the local government unit to protect this reef, have not been enough. The management scheme currently adopted for the active protection of the coral reefs of Panguil Bay needs to be reviewed and improved in order to address the present problem more effectively.

Another post-monitoring survey of Panguil Bay is scheduled for implementation very soon. The project will be funded through the Fishery Resource Management Project of the Bureau Fisheries and Aquatic Resources.

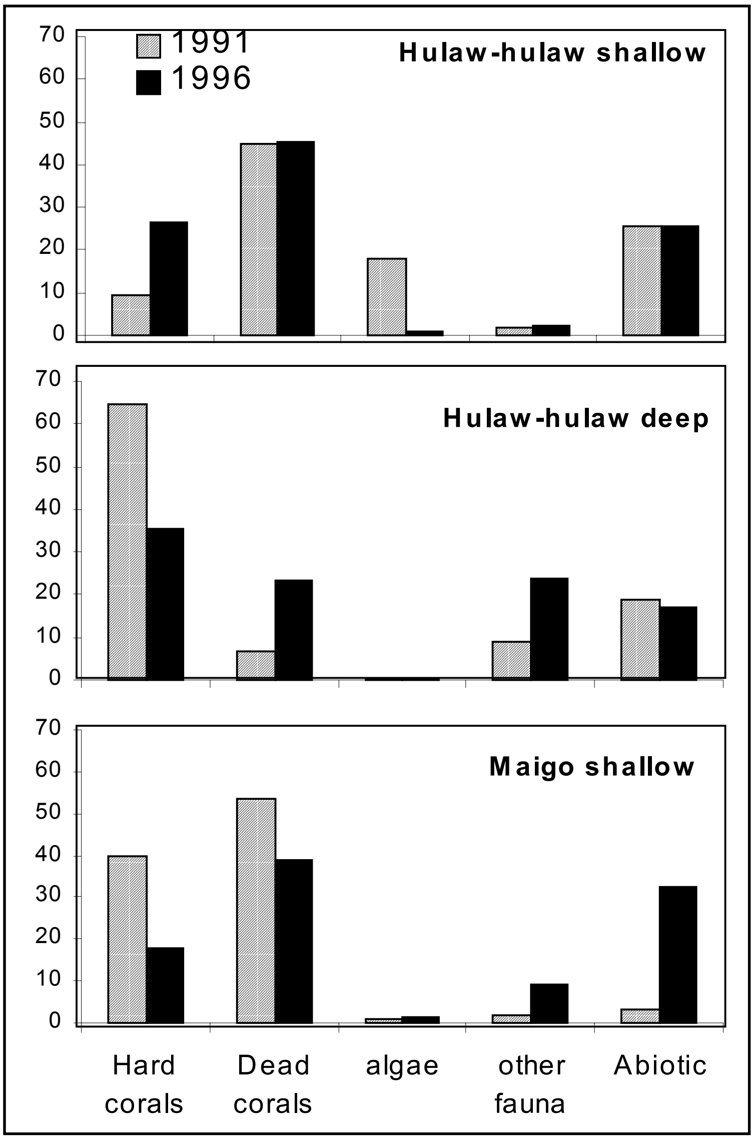


Fig. 22.1. Changes in percent cover of live hard corals and other parameters in Hulaw-hulaw and Maigo reefs during 1991 and 1996

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# CHAPTER 23 PHILIPPINE SEA REGION

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## 23.1 Introduction

The entire length of eastern Philippines is bounded by the Pacific Ocean. This sub-region of the country is hypothesized to comprise two biogeographic regions (the north and the south) (Fig. 23.1) (Aliño and Gomez 1993) yet the status of reef-associated resources is poorly known. There is a scarcity even of fundamental data on distributions and abundances, much more on the interdependencies of reefs that need to be understood in formulating management plans (Licuanan et al. 2001). The entire Pacific Ocean by itself is a vast region that is bounded by four continents from Australia to South America, encompassing the edges of the Indonesia-Philippine center of coral diversity in the far west where the sub-regions in the Philippine archipelago are included. It contains more coral reefs (40%) any other part of the world (Spalding et al. 2001). This summary overview only refers to the eastern margin of the archipelago facing the Pacific Ocean.

## 23.2 Biophysical Setting

The eastern Philippines lies on a subduction zone on the edge of a plate. The overlying Philippine Sea is hydrodynamically complex. The North Equatorial Current impinges it and bifurcates between 13° and 15° N. The bifurcation is at its northernmost in October and southernmost in February (Qiu and Lukas 1996) and produces complex hydrodynamic features that are coincident with areas of high biological production (Udarbe-Walker and Villanoy 2001). There is evidence that this bifurcation is coincident with population genetic isolations in the populations of the giant clam *Tridacna crocea* (Magsino et al. 2002). The Northern Bicol shelf, the second widest in the Philippines, is characterized by elevated chlorophyll and nutrient concentrations indicative of upwelling (Villanoy et al. 2001).

Tropical storms constitute a regular disturbance in this side of the country. The normal westward flow of surface waters is also disrupted by weakened trade winds, a phenomenon called 'El Niño'. This event has been correlated with coral bleaching due to elevated sea surface temperatures that has been recognized as a major disturbance to reefs.

Coral communities are most developed in the slopes of inlets and indentations unlike other reefs in the Philippines where development is more pronounced in wave-exposed sections (Licuanan et al. 2001). This is a very important region in terms of biodiversity yet is little studied. Based on limited information, a total of 309 reef fish species representing 36 families have been observed from visual censuses. The families Pomacentridae and Labridae are the most abundant, comprising 40% of all species observed. Approximately 111 species from 19 families of these are commercially important. Two species are endemic to the western Pacific (*Centropyge loricula* and *Choerodon fasciatus*). Fish biomass estimates range from 1.06 to 52.81 mt/km$^2$ which comprise the low to high range of relative estimates in the Philippines (Nañola et al. 2002). A total of 194 coral species belonging to 57 genera and 15 families have been reported (Licuanan et al. 2001).

Nine seagrass species and 171 seaweed species have been observed from 83 collection sites in 9 provinces. *Thalassia hemprichii* is the most widely distributed seagrass species. A rare seagrass species (*Halophila spinulosa*) has been recorded in the Pacific side. *Halimeda opuntia* is the most widely distributed algae (Licuanan et al. 2001). Some seaweed species are very limited in their distribution.

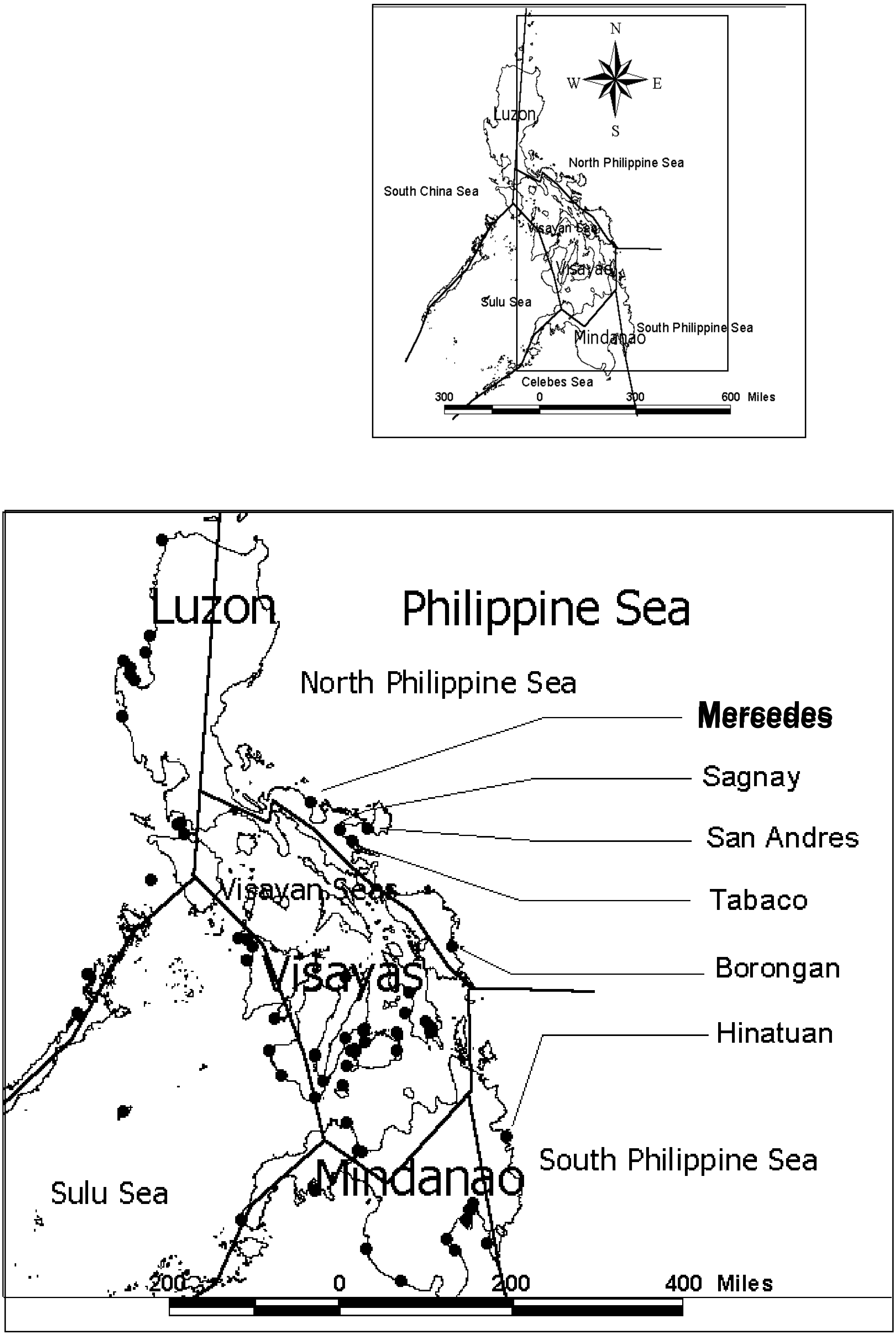


Fig. 23.1. Location of reef areas with temporal data in the Philippine Sea biogeographic area.


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## 23.3 Socio-economic Setting

There are approximately 18 provinces, 190 municipalities and 3,300 villages along the Pacific coast of the Philippines. These are some of the poorest provinces and economically depressed communities in the country. The population size of 190 municipalities ranges from 45,397 to 75,344 with a land area of 22,710 to 45,306 hectares. Farming and fishing are the primary sources of income in 90% of the communities. Most of the fishermen are involved in sustenance fisheries and fish near shore. Population growth rate is around 1.9% compared to the national's 2.4%. There is net emigration due to lack of economic opportunities (Samson and Licuanan 2002).

## 23.4 Management

With the promulgation of the Local Government Code, management of coastal resources has been devolved to the municipal and village levels. In some areas, partnerships of community cooperatives, local executives and sanctuary management council members have been crucial in the protection and the maintenance of protected areas. Partnerships provide the social bonding critical for cooperation. There are numerous marine fishery reserves and sanctuaries but the effectiveness of enforcement and management have yet to be assessed.

## 23.5 Issues and Threats

The issues and threats are typical of most highly populated coastal communities. The major threats are coastal development, marine-based pollution, sedimentation and pollution, overfishing, destructive fishing and various human activities (Burke et al. 2002). Natural disturbance include typhoons and coral bleaching. Destructive fishing methods include blasting and poisoning using sodium cyanide and use of fine mesh nets.

In some areas, majority of mangrove stands are secondary growths and constitute only 26% of its original cover (Vega et al. 1995). Seagrass beds have been disturbed or altered due to anthropogenic activities such as navigation, fish corral construction and mariculture (Mendoza et al. 2000). Poaching by fishermen from other villages is prevalent in many areas. There has been a perceived decline in catches and standards of living of fishers. Social services and public road infrastructure are inadequate in many coastal communities. The establishment of marine fishery reserves and sanctuaries has been perceived as a key strategy for management. Some areas have been declared mangrove forest reserves and reforested.

## 23.6 Monitoring, Evaluation and Feedback

Monitoring of coral reef resources has been limited. There is also a need to develop capacity among local communities and academic institutions in monitoring skills for data to be reliable. There is no information on how these collected data have influenced the management plans of the concerned villages and municipalities. Ideally, this information should be considered as feedback for adaptive management.

## 23.7 Data gaps, Future directions, and Recommendations

Trends cannot be assessed confidently with very limited temporal and spatial sampling. There is a need to understand natural variability vis-à-vis variability caused by human and/or natural disturbances. Obviously, there is a need to expand the spatial and temporal extent of sampling. There is also a need to standardize monitoring protocols through regular exercises for data to be reliable and to sample different reef types in different physical settings. Different reef environments may have different trends in coral and reef fish abundance and distributions through time. A comparative approach (fully-protected versus impact reefs) may also be used to ascertain the effect of natural versus human disturbances.

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# CHAPTER 24 SAN MIGUEL BAY, BICOL

International Center for Living Aquatic Resources Management and Bicol University College of Fisheries

## 24.1 Biophysical Setting

San Miguel Bay lies in the eastern coast of the Philippines, between 13º40' and 14º09' N latitude, and 122º59' and 123º20' E longitude (Fig. 24.1). The bay covers 1,115 $km^2$ and has a 188 km coastline. Ninety-five percent of the bay is composed of soft-bottom area (mud, sand and sandy-muddy substrates). Hard, coralline substrates are found off the northeast and northwest of the bay (Silvestre et al. 1992). The islands and coastal areas at the northeast and northwest of the bay are mostly bordered by fringing reefs with associated communities such as algal beds.

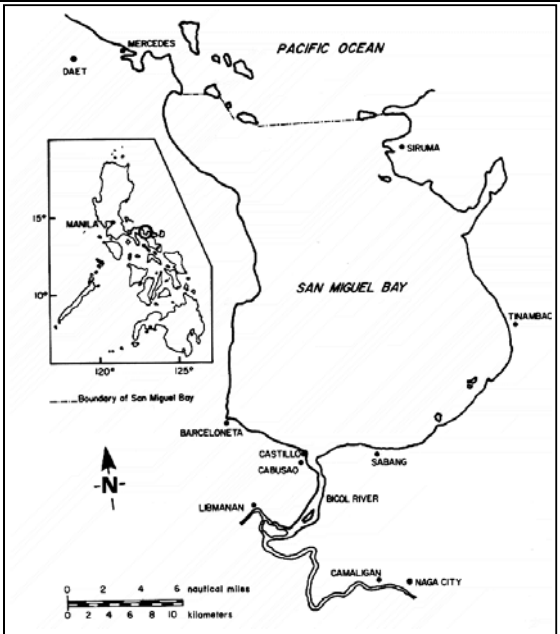


**Fig. 24.1. San Miguel Bay.**

## 24.2 Socio-economic Setting

There are approximately 7,000 resident and migrant fishers. The number of fishers has increased inspite of declining catches and standards of living. In view of this, it is clear that there remains a need to address the problem of overfishing and resource degradation.

## 24.3 Management

The barangay local government unit is the primary coordinating and development institution in the community. There is a need, however, for a unified and strong barangay council that genuinely aims for the development of their constituents, to enable other groups in the community to share and link with both internal and external organizations.

## 24.4 Issues and Threats

Excessive fishing effort, growth overfishing, destructive/illegal fishing, coral reef degradation, destruction of mangroves, pollution, and siltation are the major threats and issues in the bay.

## 24.5 Monitoring, Evaluation and Feedback

Please refer to Garces et al. 1994a & b, Mendoza and Basmayor 1999, and Hilomen et al. 2001.

Table 24.1. Percent live hard coral cover and reef fish abundance in San Miguel Bay

| | Hard Coral Cover | Reef Fish Abundance | | |
|---|---|---|---|---|
| Station | 1992-1993 | 1995-1996 | 1992 | 1993 |
| Apuao Grande (S) | 37.00 | no data | 85 | 397 |
| Canimo (SW) | 68.50 | 54.90 | 453 | 452 |
| Canton (SW) | 61.70 | 61.74 | | |
| Canton (S) | | | no data | 454 |
| Caringo (SW) | 61.20 | 42.95 | 631 | 270 |
| Malasugue (NW) | 66.10 | 31.35 | 153 | 349 |
| Malasugue (SW) | 64.70 | 57.87 | 227 | 262 |
| Quinapaguian (N) | 41.40 | 31.79 | no data | no data |
| Quinapaguian (NW) | 36.40 | 49.17 | 174 | 524 |

## 24.6 Future directions, Gaps and Recommendations

Environmental monitoring programs would quantify the causes of change, examine and assess acceptable ranges of change for the particular site and measure critical levels of impacting agents (McKenzie and Campbell 2002). Documentation of all the studies made would identify possible areas that may require conservation measures. In turn, responsive management, based on adequate information will help prevent any further significant areas and species being lost. In this case, environmental monitoring programs provide coastal management agencies with information and assist them to make decisions with greater confidence (Short et al. 2001).

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# CHAPTER 25 LAGONOY GULF, BICOL

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## 25.1 Biophysical Setting

Lagonoy Gulf is Bicol's largest fishing ground. Bordered by 15 towns of 3 provinces, covering 165 barrios with 7500 fishers. It lies approximately 123º31'37"E to 124º20'36"E longitude and 13º44'30"N to 13º10'33"N latitude (Fig. 25.1). More than half of its 3,071 km$^2$ area is 800-1400 m deep.

Coral reefs in the gulf are primarily fringing interspersed with patches of massive and submassive forms. They are extensive from the south in San Miguel Island to Tiwi (both in Albay), stretching west to narrow strips and patches in Camarines Sur at Atulayan Bay and Caramoan Peninsula, towards the north in San Andres, Catanduanes.

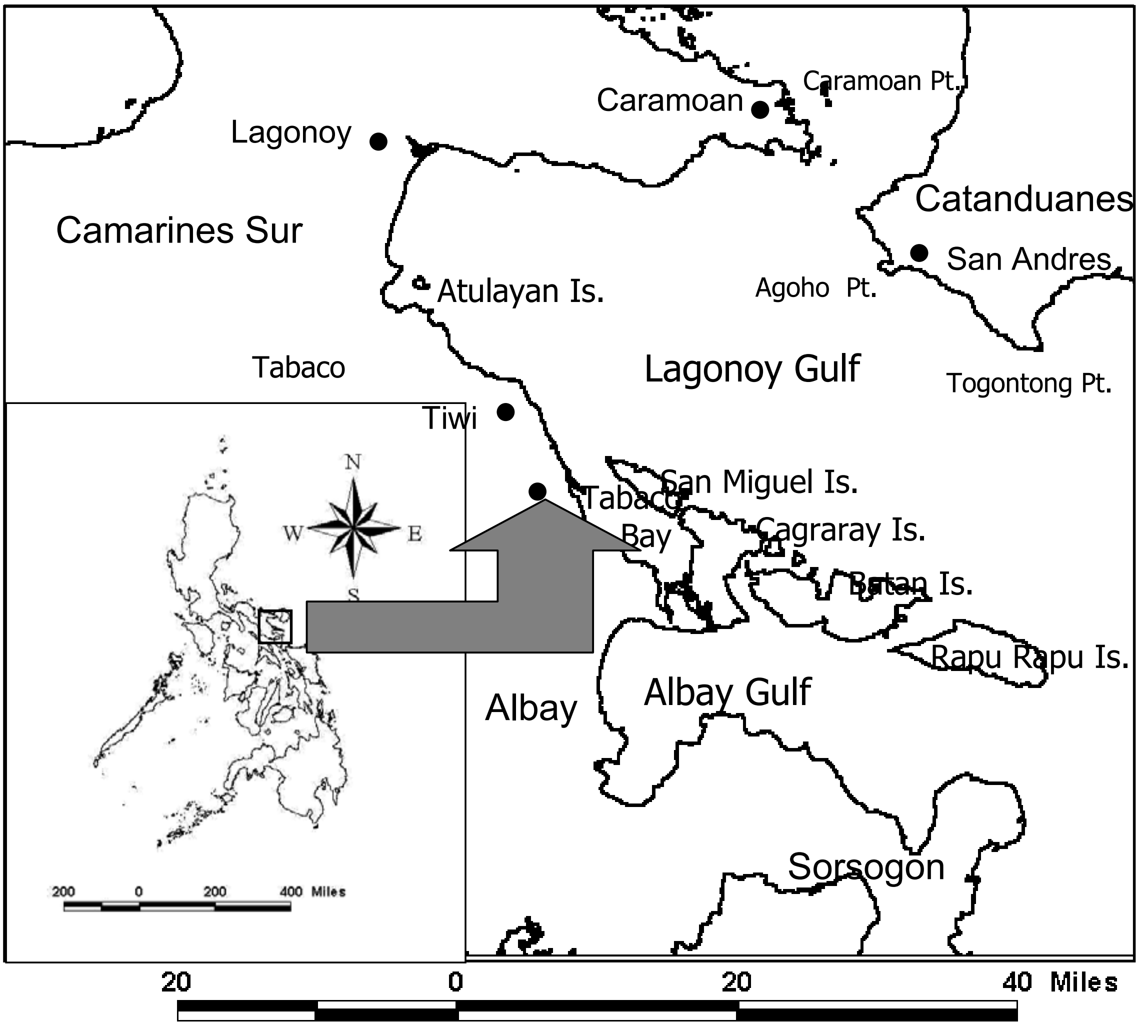


Figure 25.1. Map of Lagonoy Gulf, Bicol Region, Philippines.

## 25.2 Socio-economic Setting

Lagonoy Gulf features a multi-species, multi-gear fisheries dominated by the use of gill-nets and handlines catching tunas, small pelagic, large demersal and coral reef fishes. Lucrative fry fisheries targeting milkfish, siganids, and groupers prevail in the gulf. Tuna and tuna-like fishes constitute more than 50% of total annual catch of 21,000 mt.

More than 60% of the species caught in the gulf are reef residents, a basic rationale to protect and manage the gulf's reefs (Soliman et al. 1998). The east coast of Albay and about half of the long Caramoan Peninsula strip are relatively sheltered from strong winds of the southwest monsoon (June to October). During the northeast monsoon (November to March) these areas are exposed to strong winds and fishing in the areas off the gulf's northern portion and Catanduanes is good. Except for the latter, fishing is generally good in the gulf during the brief easterlies (April to May).

## 25.3 Management

Establishment of marine fishery reserves and sanctuaries is a key management strategy by the local government units, collaborating with various stakeholder groups (Soliman et al. 2000 and Mendoza et al. 2000). This fact should be a good rallying point to converge efforts and initiate sustainability mechanisms for coastal resource management.

Marine fishery reserves/sanctuaries (MFR/S) is a strategic response to address the dwindling marine resources in the gulf. Well-managed MFR's protect and help regenerate the floral and faunal species, hence rehabilitate the habitats. Of the 15 municipalities that border Lagonoy Gulf, five municipalities have established MFR and sanctuaries. These are the (1) Agojo MFR/S in San Andres, Catanduanes; (2) Atulayan MFR/S, Sagnay, Camarines Sur; (3) San Miguel Island MFR/S, Tabaco, Albay, (4) Gaba MFR/S in Rapu-rapu, Albay, and (5) Tiwi MFR/S in Tiwi, Albay. In the short-term, the total area of these MFR/S (c. 7 $km^2$) may be small (when compared to the whole gulf area of 3071 $km^2$) for the MFR/S to significantly support habitat rehabilitation and biodiversity protection.

## 25.4 Issues and Threats

Threats to the productivity of coral reefs include blast and cyanide fishing, high siltation due to watershed denudation, pesticide pollution from agricultural sites bordering the gulf and overfishing by seine and drag fishing gears.

## 25.5 Monitoring, Evaluation and Feedback

This contribution briefly describes the trend, threats and thrusts for management of coral reefs and the associated habitats in marine protected areas in the gulf. Data presented were generated from various researches implemented by the Coastal Resources Management Section of the Bicol University Tabaco Campus from 1995 to 2001 namely the Bicol Fish Biodiversity Program, the San Miguel Island Coastal Resources Management Project, and the Lagonoy Gulf Resource and Ecological Assessment. Trend is operationally defined here as direction (i.e., increasing, decreasing and stable) in the attributes discussed (e.g., living coral cover) covering at least two temporal data points spaced a year apart. With this criterion, the sites identified are San Miguel Island Marine Fishery Reserve (SMI-MFR), Atulayan Fish Sanctuary (ATFS) and Agojo Fish Sanctuary (AGFS). Field sampling procedures for coral reefs adapted those of English et al. (1994) and data collection was practically done by the same staff.

Table 25.1 shows up-trend in live coral cover in SMI and AGFS and downtrend in ATFS. For SMI, it showed increase from 48.60% in 1997, 57.47% in 2000 to 56.64% in 2001. Increase from 39.90% to 50.41% for AGFS was noted in 2000 to 2001. The up-trend can be generally attributed to the network of protection afforded by the management councils managing the MFR/S and the high level of support by municipal governments and local communities concerned. All are declared marine fishery reserves or sanctuaries (MFR/S) by virtue of municipal ordinances passed by respective local governments. Decrease was recorded in ATFS from 60.60% for 1999 to 40.82% for 2000. The downtrend is attributed by fishers and government officials to be due to the blast fishing and cyanide fishing which were reportedly rampant.

In SMI, the cooperative's working partnerships with the local executives of Tabaco, Albay, residents of the island villages and the SMI-MFR Management Council towards a co-community managed reserve have been crucial in protecting and maintaining the reserve. Forging early partnerships with the stakeholders provides the social bonding vital to drawing cooperation from one another. Translating the results of the fishery and coastal habitat assessments into useable inputs for establishing the reserve has been successful with the project framework adopted. In particular, the four-point criteria discussed with the community guided the establishment of the marine reserve. Stock assessment studies have provided bases for the monitoring mechanism in the reserve. Experiences from the project confirms that there is no substitute for education and information delivery for effecting sustained conservation initiatives and cooperation from the community and local executives. The regular experimental fishing inside the fish sanctuary has been an effective vehicle to increase fishers compliance to responsible fishing. Such strategy has also been key to opening a host of teaching opportunities on resource management for the stakeholders.

In the SMI-MFR/S, Soliman et al. (1997) reported a grade level 5 to describe the high degree of exploitation of the mangrove communities. Vega et al. (1995) estimated that majority of the mangrove stand in Lagonoy Gulf are under 30 years old or secondary growths. Mangroves remaining in the gulf were estimated to be 251.44 hectares or only 26 % (as of 1987) compared to its original cover in 1956 (Vega et al. 1995). Mangrove lost in this period was estimated to be 1,449.36 has or 74% of the total mangrove area. The main effort to rehabilitate mangrove has been reforestation. The Agojo Mangrove Forest Reserve of the ATFS is the only declared mangrove reserve. In 1995, three contractors (all non-government organizations) have been engaged in the mangrove reforestation program of the DENR in the region. Some 214 hectares have been planted out of the 242 hectares awarded. The seagrass beds are either disturbed or altered, attributable to anthropogenic activities such as navigation, construction of fish corrals and establishment of mariculture facilities (Mendoza et al. 2000).

Table 25.1. Mean percent cover of benthic lifeforms in Lagonoy Gulf, Bicol (south of Luzon)

| BENTHIC | San Miguel Island | | | Agoho, San Andres | | Atulayan | |
|---|---|---|---|---|---|---|---|
| LIFEFORM | 1997 | 2000 | 2001 | 2000 | 2001 | 1999 | 2000 |
| No. of Transects | 6 | 13 | 10 | 4 | 5 | 3 | 4 |
| Transect length (m) | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| HARD CORALS | **48.60** | **57.47** | **56.54** | **39.90** | **50.41** | **60.60** | **40.82** |
| ACB | 8.45 | 0.67 | 0.57 | 0.21 | | 1.28 | |
| ACS | 2.07 | 2.91 | 0.25 | 1.48 | | 6.36 | |
| ACT | 2.39 | 1.27 | 0.40 | 0.05 | | | |
| CB | 1.36 | 8.57 | 5.37 | 3.38 | 1.03 | 25.76 | 18.06 |
| CE | 9.39 | 16.42 | 18.52 | 10.30 | 3.63 | 2.76 | |
| CF | 3.91 | 0.76 | 1.30 | 0.61 | 0.99 | | |
| CM | 17.12 | 23.08 | 21.87 | 22.92 | 33.44 | 22.60 | 22.76 |
| CME | | | 0.14 | | | | |
| CMR | 1.15 | 1.60 | 3.12 | 0.45 | 1.53 | 1.40 | |
| CS | 2.77 | 2.17 | 5.00 | 0.49 | 9.80 | 0.44 | |
| **DEAD CORALS** | **26.61** | **29.95** | **34.10** | **36.87** | **34.75** | **32.20** | **30.88** |
| DC | 10.07 | 14.39 | 16.27 | 7.16 | 13.28 | 31.52 | 30.88 |
| DCA | 16.55 | 15.56 | 17.83 | 29.71 | 21.47 | 0.68 | |
| **ALGAE** | **4.56** | **4.23** | **0.94** | **12.02** | **4.88** | **0.00** | **0.00** |
| AA | 3.29 | 2.37 | 0.04 | 0.63 | 0.64 | | |
| HA | 1.27 | 1.51 | 0.51 | 8.72 | 4.24 | | |
| MA | | 0.35 | 0.39 | 2.67 | | | |
| **OTHER FAUNA** | **1.01** | **1.79** | **3.48** | **0.11** | **0.48** | **0.00** | **11.06** |
| OT | 1.01 | 1.12 | 1.77 | 0.11 | | | |
| SC | | 0.44 | 1.45 | | 0.48 | | 11.06 |
| SP | | 0.23 | 0.26 | | | | |
| **ABIOTIC** | **1.53** | **6.56** | **4.47** | **11.07** | **9.48** | **7.20** | **17.20** |
| R | | 4.09 | 2.83 | 3.22 | 2.60 | 4.64 | 6.56 |
| RCK | | | | | 5.13 | | |
| S | | 1.67 | 1.64 | 7.33 | 1.13 | 0.96 | 10.64 |
| SI | | 0.23 | | 0.52 | 0.61 | | |
| WA | 1.53 | 0.56 | | | | 1.60 | |

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# CHAPTER 26 BACON AND GUBAT, SORSOGON

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## 26.1 Biophysical Setting

### Municipality of Gubat

The coastal zones of Gubat, Sorsogon are large exposure areas due to the long northeastern monsoon and Pacific surges. Wave, current and tidal activity are relatively frequent in these areas. Facing northeast, this area is prone to Pacific surges, even affected by distant storms raging in the large Pacific Ocean. Relatively calm, large Pacific swells are common during the northeast monsoon season.

### Municipality of Bacon

The coastal zones of Bacon, Sorsogon are also somewhat exposed to Pacific swells and the northeast monsoon, but most parts are protected. The coral reefs of these parts are populated by species mostly found within lagoons or protected and relatively undisturbed areas. These areas are characteristically more prone to siltation due to the presence of mangrove stands along river mouths. These areas would also tend to be a haven for large pelagic fishes, which frequent coral reefs for feeding and/or breeding.

## 26.2 Socio-economic Setting

### Municipality of Gubat

Data on the ownership of the fishing implements shows that majority of fishers are engaged in small-scale fishing. There are 271 *bancas* (small boats) used by 1,248 fishers, out of which only 23 *bancas* are motorized. Peak season is from August to November. Low catch is during the first quarter of the year.

In 1998, average monthly income of fishers is about P2,500 while average expense is P3,000. Income is low during the first quarter of the year due primarily to bad fishing conditions. Expenses are high on the second quarter during school enrollment and fiesta celebrations. Common expenses are food, education and fishing-related. Borrowing is the most common option taken when they are short of money. This is usually handled by the wives of the fishers. They pay the creditor on a day-to-day basis usually with high interest.

Cooperatives have contributed a lot to the upliftment of the economic state of the farmers and fisherfolks. Target projects of cooperatives are usually concentrated on providing technology such as ricemill for farmers and fishing gear for fishers.

### Municipality of Bacon

There are 1,565 fishers in Bacon: 1,515 are full time and 50 are part time (NSO 1990). Of the 505 boats, 35 are motorized and 470 are non-motorized. In the coastal areas, majority of the households are involved in fishing or fishing-related activities. The third quarter of the year is the season where the largest catches are made. Lean period is during the first quarter of the year.

In 1998, monthly household income of fishers range from P3,000-P4,500. Monthly expenditure range from P1,000-P 4,500. Income is high (P4,500) in the months of September and October. Lowest income (P1,000) is in the month of December. Top three expenditure items are food, school expenses for their children and expenses related to fishing such as repair of gear.

Stakeholders that are directly involved in the management and exploitation of the coastal resources of Bacon are currently in disorder. The dominant sectors, institutions and organizations are those in the line of cooperative work, fish vendors or *rigoton*, the local government unit and the Department of Agriculture.

## 26.3 Issues and Threats

The sites were generally frequented by all types of fishing. Signs of natural and anthropogenic disturbances were noted. Evidence of blast fishing, using explosive and poison fishing using sodium cyanide on some areas were also observed. Sounds of blasting were also heard underwater during the surveys of these areas.

### Municipality of Gubat

The use of illegal fishing methods, mangrove cutting and overextraction of marine resources are the primary threats to marine degradation and biodiversity loss in the coastal communities of Gubat.

Illegal and destructive fishing methods include the use of cyanide, blasting and fine mesh net (<3 cm). Although fishers recognize that such practices are harmful to the environment and contributes to the decline in their catches, they still continue these practices because it yields the highest return in a short time.

Average income of fishers is 80 pesos per day, approximately 1/3 usually goes to fishing- related expenses while the remainder is allotted for living expenses. Fishing-related expenses include fuel, rent of fishing vessel and gear, and repair.

### Municipality of Bacon

Bacon still has relatively abundant marine resources. However, this is not stable primarily because of the increasing human pressure on the coastal resources.

Fishers from nearby towns and provinces as far as the Visayas region frequent the waters of Bacon. While there are different stakeholders involved, management of the resource is not sustainable or almost absent. Both the local communities and the local government remain inactive in the protection and promotion of the coastal environment.

On the other hand, fishers employ destructive fishing techniques to yield large catch. Mangroves are being cut for domestic purposes without due consideration of its possible effect. All of these had resulted to the decline of their fish catch. At the core of these problems is the abject poverty. Average monthly income of a fisher is P2,500. Compared to their average monthly expenses of P3,000, it is insufficient to meet their daily needs. Social services are unavailable to many coastal communities (e.g., in some areas, services such as health and public roads are absent).

Table 26.1. Benthic percent cover in Bacon and Gubat.

Gubat, Sorsogon

| Reef | *Barangay* | Transect depth (m) | *Acropora* | Non-*Acropora* | Total hard coral cover |
|---|---|---|---|---|---|
| Korneran | Bagacay | 7.61 | 0.00 | 38.90 | 38.90 |
| Botog-botog | Paco | 12.21 | 2.60 | 33.05 | 35.65 |
| Ogbos | Paco | 4.56 | 7.00 | 40.35 | 47.35 |
| Binaderahan | Tiris | 9.76 | 17.00 | 12.45 | 29.45 |

Bacon, Sorsogon

| Reef | *Barangay* | Transect depth (m) | *Acropora* | Non-*Acropora* | Total hard coral cover |
|---|---|---|---|---|---|
| Halabang Baybay, | Caricaran | 9.16 | 1.70 | 43.70 | 45.40 |
| Turayan | Bonga | 4.56 | 15.50 | 33.30 | 48.80 |
| Pagol | Bon-ot | 7.62 | 4.25 | 33.85 | 38.10 |
| Danuyan | Salvacion | 4.56 | 0.00 | 37.05 | 37.05 |
| San Juan | San Juan | 7.62 | 35.60 | 21.65 | 57.25 |
| Karawisan | Pobacion | 6.10 | 26.85 | 26.35 | 53.20 |

## 26.4 Monitoring, Evaluation and Feedback

The line-intercept transect (LIT) method was used to assess 20-m survey tapes, at depths of 3 m to 12 m; fish observations were made within a 5-m corridor. Summary of coral reef assessment, fish visual census and fish catch monitoring are shown in Tables 26.1, 26.2 and 26.3 respectively.

## 26.5 Future directions, Gaps and Recommendations

Tambuyog Development Center through its Sustainable Coastal Area Development program is currently assisting People's Organizations here through organizing, research, advocacy and training. Tambuyog also assists in the establishment of marine sanctuaries in both municipalities. Skills training in coral reef and fish catch monitoring is also being given to local fisherfolks.

Table 26.2. Reef fish visual census summary of Bacon and Gubat

Gubat, Sorsogon

| Reef | *Barangay* | Total individuals/100m$^2$ | Total species | Total families |
|---|---|---|---|---|
| Korneran | Bagacay | 100 | 9 | 10 |
| Botog-botog | Paco | 68 | 24 | 10 |
| Ogbos | Paco | 180 | 22 | 10 |
| Binaderahan | Tiris | 199 | 11 | 7 |

Bacon, Sorsogon

| Reef | *Barangay* | Total individuals/100m$^2$ | Total species | Total families |
|---|---|---|---|---|
| Halabang Baybay, | Caricaran | 112 | 19 | 9 |
| Turayan | Bonga | 187 | 17 | 5 |
| Pagol | Bon-ot | 136 | 18 | 7 |
| Danuyan | Salvacion | 136 | 14 | 9 |
| San Juan | San Juan | 54 | 21 | 7 |
| Karawisan | Pobacion | 165 | 11 | 5 |

Table 26.3 Average fishing catch per unit effort (kg/manhr).

| | 1999 | | 2000 | | | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Place | Aug | Sep | Mar | Apr | May | Jul | Aug | Jan | Feb | Mar |
| Baldahan | 0.29 | | | | | | | 0.63 | 1.04 | 1.69 |
| Banao | | | | | | | | 1.31 | 0.90 | |
| Bato | | | | | | | | 1.12 | 0.50 | 1.35 |
| Danuyan | | | | | | | | | 1.38 | 0.37 |
| Gatbo | | | | | | | | 0.58 | | |
| Maigang | 0.29 | | | | | | | | 1.77 | 1.58 |
| Mananga-tanga | | | | | | | | | 0.70 | |
| Poblacion | 0.45 | 0.39 | | | | | | | | |
| Rawis | | | 1.21 | 0.80 | | 0.83 | 0.61 | | | |
| Sta. Lucia | | | | | | | | 0.88 | 2.25 | |
| Sugod | 0.13 | 0.29 | | | 0.16 | 0.52 | 0.58 | | | 2.25 |
| Turayan | | | | | | | | 0.63 | 1.20 | 1.73 |

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# CHAPTER 27 BORONGAN FISH SANCTUARY, EASTERN SAMAR

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## 27.1 Borongan Fish Sanctuary at Monbon Island, Eastern Samar.

| Year | Manta Tow category | % Live coral cover | Fish abundance (#/ha.) | Fish Biomass (kg/ha) |
|---|---|---|---|---|
| 1997 | 2 | - | - | - |
| 2000 | 3 | 46.94 | 1,600 | - |
| 2001 | 3 | 55.86 | 3,180 | 98 |

# CHAPTER 28 HINATUAN, SURIGAO DEL SUR

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## 28.1 Bio-physical setting

Hinatuan, of Surigao del Sur, is located at the mouth of the Hinatuan River at the eastern seacoast of Northeastern Mindanao. It is bounded on the east by the Pacific Ocean, has an irregular coastline, and 13 islets. It is located only a few nautical miles off the Philippine deep, which supplies the town with a rich diversity of fish catch and marine products.

Hinatuan has a number of fringing reefs, isolated coral areas and coral atolls near surrounding coastal and offshore islands. It has 8 fish sanctuaries located at Barangays, Tidman, Loyola, Municipal Sanctuary (Barangay Poblacion), San Juan Mahaba Island, Talisay, Cambatong, and Port Lamon. Some of these have been in existence since 1998, but all formally declared in 1999. Hinatuan consists of 42,000 hectares of inshore waters. The 8 sanctuaries only cover less than 500 hectares. A combination of corals and seagrass is found in most of the sanctuaries although some sanctuaries are mainly extensive seagrass beds. Data is available for some of the coral areas inside the sanctuaries. The data on San Juan and Mahaba Island fish sanctuaries are presented here. San Juan Fish Sanctuary is a fringing reef while Mahaba Island Fish Sanctuary is a group of isolated coral areas.

## 28.2 Socio-economic setting

There is extensive and growing dependence on marine resources in Hinatuan Bay. Fishermen repeatedly relate that there are more fishers seeking fewer fish.

## 28.2 Management

The Center for Empowerment and Resource Development, Inc. (CERD) initiated the management of the 8 sanctuaries in collaboration with the local people's organizations it facilitates and the local government units. The people's organizations carry out the day-to-day management of the sanctuaries with the help of CERD. CERD patrols the sanctuaries with people's organization members' apprehending illegal fishers; illegal fishers have been considerably reduced. However, poaching of the protected areas has been increasing.

Since 1998, 3 marine biologists (Rowan Byrne and Maeve Nightingale from the Voluntary Service Overseas (VSO) and a volunteer from the Australian Agency for International Development (AusAID) have conducted resource inventories and detailed monitoring on some of the sanctuaries in Hinatuan. Nightingale played a key role in site identification together with the local stakeholders. Their aim to train the people's organization for sustainable monitoring is a slow but progressive process. At present, nearly all areas have a guardhouse, marked sanctuary boundaries, patrols, radio communication and frequent aid from CERD but all also have poaching.

In 2002, the local government received funding from the World Bank/Department of Finance's Community-Based Resource Management Project (CBRMP). It has selected five *barangays* in Hinatuan (including San Juan and Mahaba Islands) for the managing and sustaining of fisheries and enhancing coral areas through proper sustainable management and support. This project will run for 3 years. The CBCRMP team, together with the local people's organizations, and to a lesser extent CERD, is managing the sanctuaries and other marine-based livelihood projects.

## 28.3 Monitoring, Evaluation and Feedback

The present monitoring and inception of current projects has been facilitated by "outside" volunteer marine biologists from VSO and AusAID. Very little has been done at the local level. Manta tow, fish visual census, line intercept and video transects, photos, etc. have been used for monitoring the sanctuaries. The author is now addressing the previous lack of uniformity in sampling sites and lack of permanent site markers. However, changes in sanctuary protection and size (e.g., from 50 ha. to 15 ha.) are beyond the control of monitoring investigators.

### Mahaba Island Fish Sanctuary

Mahaba Island is an extensive reef of about 19.5 hectares. It has a sandy bottom with extensive seagrass bed. Sedimentation is a problem in Mahaba Sanctuary but there are definite healthy patches of coral. There is a high diversity and abundance of fish but their sizes are small. Main fish species recorded both in 2000 & 2001 are from the families Scaridae, Acanthuridae, Labridae, Pomacentridae, Serranidae and Chaetodontidae. The main coral genera recorded in 2000 were *Acropora, Pavona* and *Porites*, in 2001, main coral genera recorded were *Millepora, Acropora, Porites, Fungia* and gorgonia.

Table 28.1. Benthic cover (%) in Hinatuan

| Longitude | Latitude | Municipality | Details | 2000 | 2001 |
|---|---|---|---|---|---|
| 126º 22.88'E | 08º 24.06'N | Mahaba Island | Hard Coral | 50% | 60% |
| | | | Soft Coral | No data | 30% |
| 126º 22.46'E | 08º 25.40'N | San Juan Island | Hard Coral | 54% | 35% |
| | | | Soft Coral | 36% | 45% |

No fish data available

### San Juan Fish Sanctuary

San Juan fish sanctuary is a fringing reef of about 20.5 hectares, which is comprised of small patches of seagrass and extensive coral cover. Its boundaries are to be extended soon. It has excellent coral cover and good water exchange with the Pacific Ocean. If properly managed, the sanctuary has the potential to be a very productive source of fish for adjacent reefs.

Major fish families that have been recorded here in 2000 and 2001 include Scaridae, Acanthuridae, Labridae, Pomacentridae, Serranidae, Chaetodontidae; Carangidae was also recorded in 2000. The main coral genera that have been recorded include *Acropora*, *Pavona*, *Porites*, *Fungia*, *Dendronephthya*, and Gorgonia. The main coral genera recorded in 2000 were *Acropora, Pavona, Porites* and the soft coral *Dendronephthya*, in 2001, main coral genera recorded were *Millepora, Acropora, Porites, Fungia* and the soft corals gorgonia and *Dendronephthya*.

## 28.3 Future directions, Gaps and Recommendations

The main problem is sedimentation from mangrove and terrestrial forest deforestation, extensive use of fishponds, and tiger prawn farming. There is little enforcement of fishery laws and patrolling of protected areas. Protected areas are especially threatened by poachers during the wet season. The seagrasses are deteriorating rapidly due to sedimentation. Destructive fishing methods, scaring devices (*dombol*) and fish corrals are used near or around coral reefs and seagrass beds.

At present the author is negotiating with local government officials to extend the area by one hectare to include an area where the IUCN endangered dugongs (*Dugong dugon*) and sea turtles are known to reside. Mahaba Island has excellent coral growth and regeneration, and has benefited from being a protected area. Very little crown of thorns starfish have been observed in Hinatuan Bay even though they have been documented in nearby Lianga Bay (UP-MSI/PCAMRD Pacific Seaboard Project). Crown of thorns starfish have recently (April 2002) been observed by the author in Port Lamon Anchorage.

More help is needed for the potentially productive corals and seagrasses of Hinatuan Bay, otherwise its future is in question.

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# CHAPTER 29 PUJADA BAY, DAVAO ORIENTAL

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## 29.1 Biophysical Setting

Pujada Bay is located on the southeastern most part of the Philippine archipelago between 6°48’04” and 6°54’25”N latitude and between 126°9’08” and 126°19’33”E longitude. It is about 157 km east-southeast of Davao City. It encloses an area of approximately 168 $km^2$. The bay is under the territorial jurisdiction of 10 villages of the municipality of Mati, Davao Oriental (Figs. 29.1).

The Bay is U-shaped and opens at the south-southeastern portion. At its mouth lie three islands: Pujada Island, the largest at 1.1 $km^2$, and the smaller Oak and Ivy Islands. North of this island group lies another small island called Juanivan with an area of approximately 0.09 $km^2$. The surrounding landmass on the northern and western portion ranges from hilly to mountainous, while it is generally flat to hilly on the eastern portion. Coconuts dominate the lowland and lower slope while residual forest can be found along the grooves of the mountain slope. The inner portion of the bay is lined by mangrove forest, mostly *Sonneratia* and *Avicennia*. The eastern portion of the bay, where most good beachers are, is mostly white sand. The substrate on the western portion is mostly rocky while the inner portion of the bay is muddy.

The area has no dry season and typhoons are infrequent. Rainfall is abundant and evenly distributed throughout the year. Annual temperature ranges from 20-30°C.

The coral reef is fringing and extends some 20-30 m from the shoreline to a depth of 10-20 m. In 1993-1994, 22% of 50 sampled stations had excellent coral cover, 30% good, 20% fair and 28% poor coral cover (ZSCMST & DENR 1994).

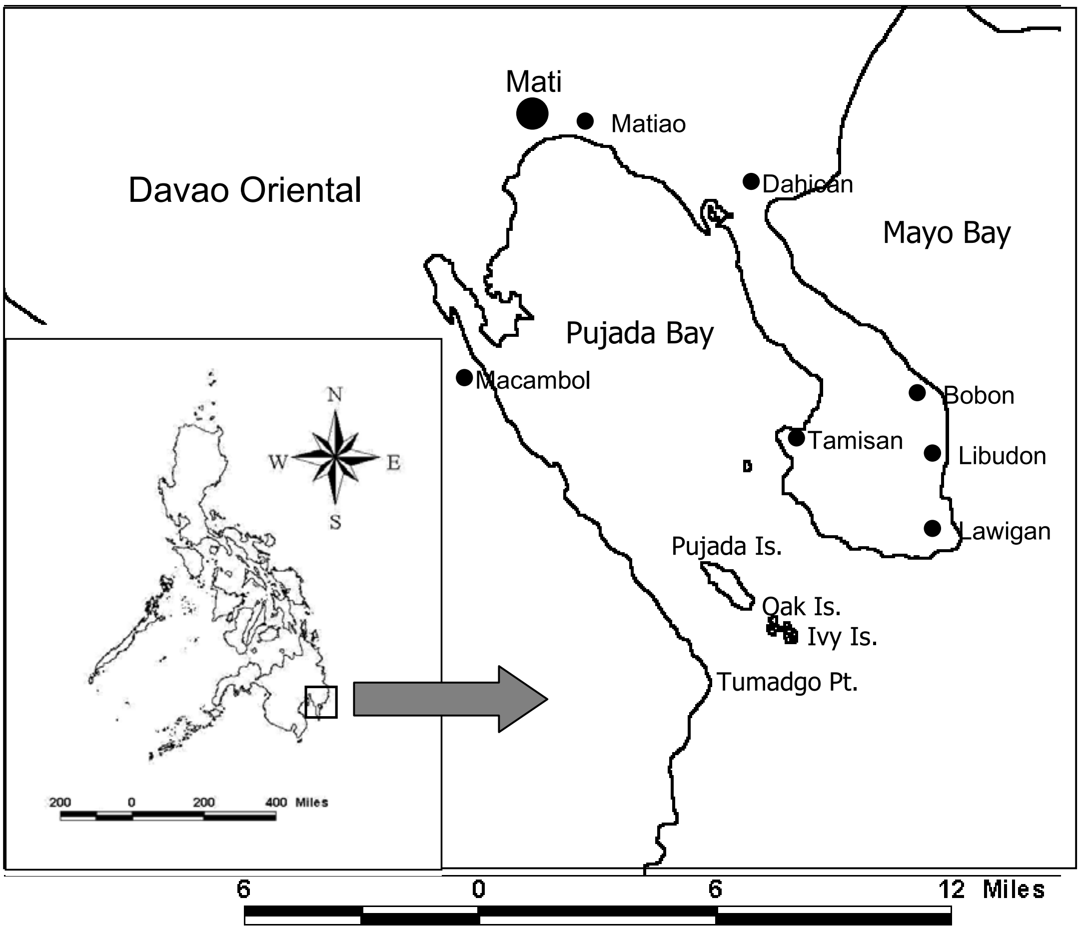


Figure 27.1. Map of Pujada Bay.

## 29.2 Socio-economic Setting

Pujada Bay has been and is one of the major fishing grounds of marginal fishermen. It is the source of food and livelihood for about 75% of the population of the 10 coastal *barangays* (DENR Report 1996; DENR-CEP Primer).

## 29.3 Management

In 1993, the area was put under the Community-based Coastal Environmental Program (CB-CEP) of the DENR by virtue of Department Administrative Order No. 19 and was the program's model site in the region. CB-CEP provided some alternative livelihood projects to the coastal communities. Its impact on the level of dependence of the coastal communities on the coastal and marine resources cannot be determined since no studies were made to evaluate the project (DENR Report 1996; Pajarillaga, pers. com.).

The CB-CEP launched in 1993 was the first resource management project in the area. DENR was the lead agency, overseeing the whole program and coordinating with various government agencies and non-government sectors including the coastal communities as represented by their respective *barangay* captains and councils (DENR Report 1996).

Resource assessment and management, coastal resource rehabilitation/protection, community organizing, information, education and communication campaign, identification and development of alternative livelihood projects, establishment of protected seascape, coastal pollution assessment and monitoring, environmental research and special projects, and management of endangered marine fauna were implemented under the program (DENR Report 1996).

Coral reef, seagrass and mangrove resources were assessed in 1993-1994. Coastal resource rehabilitation/protection focused on mangrove reforestation continues up to the present. The program provided technical and seed fund assistance for the development of alternative livelihood projects. A total of ten CEP organized cooperatives have been established and each provided with a seed fund of P50,000.00 for their identified livelihood project. Only few, however, have successfully developed their projects to the present as seen by its low turnover of the seed fund to the program. No evaluation study has been made to determine whether such effort has eased the dependence on marine resources (DENR Report 1996).

The organization of CEP associations/cooperatives and the formation of *Bantay Dagat* attest to the project's community organizing, information, education and communication campaigns. There has been no evaluation of the cooperatives.

Zoning was proposed when Pujada Bay was declared a protected landscape/seascape through Presidential Proclamation No. 43 on July 31, 1994 (DENR Report 1996), but this has not yet been realized. Present problems include the legality of the establishments (e.g., beach resorts) and the construction of structures along the bay.

Under the development, testing and application of new technologies and methodologies for facilitating the understanding of coastal environment and their associated resource systems, only research on the growth variations of *Rhizophora* sp. planted in the area were conducted (DENR Report 1996).

The once famous *Pawikan* (sea turtle) Rehabilitation Project, that rehabilitated and tagged marine turtles, is presently not functioning well but the DENR-PENRO plans to revive it (D. Pajarillaga pers. comm.). Since its establishment in 1999, the Marine Park at Guang-guang, where the turtle pens are sited, have collected entrance fees.

The DA-Fisheries Division of Mati, together with the local government, initiated fish sanctuary establishment in Pujada Island and the nearby waters surrounding smaller islands but some problems were encountered with the private owner of the island. Instead, 297.53 hectares of seagrass beds and coral reefs was declared Mangihay Fish Sanctuary in 1995 (Table 29.1). However, there has been no management, guarding or monitoring of the area. Other coral reefs in Davao Oriental facing Davao Gulf were also declared fish sanctuaries but only one has a clear management plan and implementation (DA-Fisheries Division). The impact of artificial reefs deployed by DA-Fisheries (Mati) last 1994 have also not been assessed.

A strong community-based and church-initiated Interfaith Movement for Peace and Development (IMPEDE) works for the environmental conservation of Balete Bay, a smaller bay within Pujada Bay. In 2000, IMPEDE launched the multi-stakeholder "Balete Bay Biodiversity Conservation and Resource Management" (BBBCRM) project to address the degradation of Balete Bay coastal ecosystem and the marginalization of its inhabitants. Agriculture and Marine Science faculty-researchers of the Davao Oriental State College of Science and Technology (DOSCST) actively participate and readily respond to BBBCRM's requests for technical assistance. The BBBCRM project is now influencing other nearby coastal towns in Mati on Biodiversity Conservation and Resource Management.

The municipality also has regulations on the gathering/harvesting of kapis shell (*Placuna placenta*) and grouper fry and fingerlings, establishment and operation of fish cages, and the ban on the use of compressors in spearfishing (DENR-PENRO Report 1996). However, some of these are not strictly implemented (if at all).

## 29.4 Issues and Threats

Local fishers perceive that the degradation of the coral reefs resources in Pujada Bay continues despite management initiatives. Fish catch is still declining, fishing effort increasing, and destructive fishing remains unabated. Key informants (e.g., DENR, DA-Fisheries) reveal opposing views.

DENR-PENRO (Pajarillaga pers. comm.) revealed problems on delineation of functions between their office and the local government with respect to the Pujada Bay CB-CEP. Program sustainability is bleak due to the lack of technical capability and finances. In spite of this, the status of coral reef resources in the area seems to be improving due to the management interventions.

High resource extraction is a primary concern. High erosion and siltation in some parts of the bay may be due to poor farming practices, forest denudation, road construction, mining, quarrying and land encroachment/land conversion. Increasing human settlement along the coastal area contributes to domestic pollution that may be related to the frequent occurrence of red tide in some parts of the bay (Jimenez et al. 2002).

Law enforcement on matters like illegal logging, illegal and destructive fishing, and illegal mining/quarrying operations is weak (Jimenez et al. 2002). Some commercial fishing boats illegally fish in Pujada Bay, which is within the 15-km zone exclusively for municipal fishing. Local politicking also contributes to poor resource management (F.J. Montera [Provincial Fisheries Office] pers. com.).

## 29.5 Monitoring, Evaluation and Feedback

The lack of consistent and comprehensive monitoring, evaluation and feedback of CB-CEP implementation is a weakness. Since the rapid resource assessment in 1993-1994, no further monitoring have been done except for occasional studies by undergraduate students of the Davao Oriental State College of Science and Technology (DOSCST). The majority were baseline data collection on seagrass and seaweed resources, few studies were on mangroves, and practically none were on corals and its associated resources (but see Table 29.2). Thus, the general trend of the resources is unknown. However, the Provincial Fisheries Officer revealed that, except in the areas near the mouth of the bay, coral cover is generally poor and decreasing.

The Office of the Provincial Planning and Development provided data on fish production from the 1999 Socio-economic Profile of Davao Oriental (Tables 29.3 and 29.4)(data collection methods unknown). According to the Provincial Fisheries Officer, there is no fish catch monitoring in the bay; however, his frequent contact with local fishers reveals a declining catch.

Table 29.1. Status of established fish sanctuaries in Davao Oriental waters as of June 2000.

| Station | Site | Area (has.) | Mun. Ord. number | Source of fund | Est. cost (PhP) | Issues and concerns |
|---|---|---|---|---|---|---|
| Mapagba | Maputi, | 131.48 | 05 S. 1997 | National | 150,000.00 | No mgt. plan |
| | Banaybanay | | | PLGU | 8,000.00 | Lack of equipment |
| | | | | MLGU | 13,000.00 | for monitoring |
| Borot | Montserrat, | 50.00 | 03 s. 1998 | National | 150,000.00 | -- do -- |
| | Gov. Generoso | | | PLGU | 10,000.00 | |
| | | | | MLGU | 12,000.00 | |
| Burias- | La Union, | 120.00 | 117 s. 1996 | National | 150,000.00 | -- do -- |
| Tinaytay | San Isidro | | | PLGU | 7,000.00 | |
| | | | | MLGU | 15,000.00 | |
| Panggubaan | Ilangay, | 50.00 | | National | 150,000.00 | -- do -- |
| | Lupon | | | PLGU | 7,000.00 | |
| | | | | | 15,000.00 | |
| Mangihay | Mangihay, | 297.53 | 11 s. 1995 | National | 150,000.00 | -- do -- |
| | Dahican,Mati | | | PLGU | 5,000.00 | |
| | | | | | 15,000.00 | |

Table 29.2. Coral benthic cover (%) in three sites/barangays of Mati, Davao Oriental.

| Station | Details | 1993 | 2001 | 2002 |
|---|---|---|---|---|
| Botwasan | hard coral | | | 44.57 |
| | soft coral | | | 1.10 |
| | living | 75-100 | | 3.18 |
| | nonliving | | | 51.15 |
| Mangihay | hard coral | | 85.58 | |
| | soft coral | | 0.48 | |
| | living | 25-50 | 0.58 | |
| | nonliving | | 15.50 | |
| Dawan | hard coral | | 49.95 | |
| | soft coral | | 0 | |
| | living | 25-50 | 62.44 | |
| | non-living | | 30.05 | |

Table 29.3. Fish production (tuna-like species in metric tons) in Mati, Davao Oriental from 1996-1997

| Type of Fishing | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|
| Commercial | 180.00 | 174.60 | 169.40 | 164.30 |
| Sustenance | | | | |
| deep-sea fishing | 2030.40 | 1969.40 | 1910.40 | 1853.00 |
| offshore fishing | 3045.60 | 2954.20 | 2865.60 | 2779.60 |
| Inland fishing (lakes, rivers, fishponds, etc.) | 65.16 | 76.67 | 90.20 | 106.12 |

Source: Office of the Provincial Agriculturist - Fishery Division Mati, Davao Oriental thru the PPDO

Table 29.4. Fish production per municipalities of Davao Oriental from 1996-1997 (in metric tons)

| Municipality | Commercial fishing | | | | Sustenance fishing | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | deep sea fishing | | | | offshore fishing | | | |
| | 1996 | 1997 | 1998 | 1999 | 1996 | 1997 | 1998 | 1999 | 1996 | 1997 | 1998 | 1999 |
| Baganga | ncf | | | | 510.4 | 495.1 | 480.3 | 465.9 | 765.7 | 742.7 | 720.4 | 698.8 |
| Banaybanay | ncf | | | | 468 | 453.9 | 440.3 | 427.1 | 702 | 680.9 | 660.5 | 640.6 |
| Boston | ncf | | | | 111.6 | 108.2 | 105 | 101.8 | 167.4 | 162.3 | 157.5 | 152.7 |
| Caraga | ncf | | | | 185.7 | 180.1 | 174.7 | 169.5 | 278.6 | 270.2 | 262.1 | 254.2 |
| Cateel | ncf | | | | 78.8 | 76.4 | 74.1 | 71.9 | 118.2 | 114.6 | 111.2 | 107.8 |
| Gov. Generoso | 135 | 131 | 127 | 123 | 1,401.4 | 1,359.4 | 1,318.6 | 1,279.0 | 2,102.2 | 2,039.1 | 1,977.9 | 1,918.6 |
| Lupon | 450 | 437 | 423 | 411 | 315 | 305.5 | 296.3 | 287.4 | 472.5 | 458.3 | 444.5 | 431.2 |
| Manay | ncf | | | | 171.3 | 166.2 | 161.2 | 156.2 | 257 | 249.2 | 241.8 | 234.5 |
| Mati | 180 | 175 | 169 | 164 | 1,030.4 | 1,969.4 | 1,910.4 | 1,853.0 | 3,045.6 | 2,954.2 | 2,865.6 | 2,779.6 |
| San Isidro | ncf | | | | 622.8 | 604.1 | 585.9 | 568.4 | 934.2 | 906.1 | 878.9 | 852.6 |
| Tarragona | ncf | | | | 120.9 | 117.3 | 113.8 | 110.3 | 181.4 | 175.9 | 170.6 | 165.5 |
| TOTAL | 765 | 742 | 720 | 698 | 6,016.3 | 5,835.6 | 5,660.6 | 5,490.6 | 9,024.8 | 8,753.5 | 8,491 | 8,236.1 |

ncf = no commercial fishing

Source: Office of the Provincial Agriculturist, Fishery Division, Mati, Davao Oriental through PPDO

## 29.6 Future directions, Gaps and Recommendations

The CEP in Pujada Bay aimed to lessen, if not total stop, the degradation of coastal and marine resources. The bottom-up approach used by the program has resulted in the positive attitude of the coastal communities to CEP activities in Pujada Bay area. However, the lack of program evaluation should be given attention since future management actions must be guided by feedback from the previous processes.

Linkages with the community must be strengthened, capabilities developed, and local communities empowered, including making them research partners, so that monitoring may be sustained.

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# CHAPTER 30 SULU SEA REGION

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## 30.1 Introduction

The Sulu Sea occupies a large basin at the southwestern part of the Philippines. It is surrounded by island areas with an atoll at the center of the basin (Fig. 30.1). This atoll, known as the Tubbataha Reef is the Philippine's first national marine park established in 1988 and inscribed as a UNESCO World Heritage Site in 1993.

This sub-region is known to have high species diversity (Alcala 1993). Nañola et al. (unpublished) found this area to have the highest reef fish species richness among the 6 biogeograhic sub-regions identified by Aliño and Gomez (1994).

## 30.2 Biophysical Setting

The Sulu Sea is bounded on the north by the island of Mindoro, on the south by Sabah (Malaysia) and the Sulu Archipelago, on the east by the islands of Panay, Negros and Zamboanga Peninsula and on the west by Palawan Is. The northern portion is predominantly exposed to the Northeast monsoons during the months of December to March but the southern portion is almost free from typhoons. It has a climatic condition of Type I (pronounced dry and wet season, dry during the months of November to April) at the northern portion and Type III (no pronounced dry and wet season but relatively dry during the months of November to April) at the southern portion. Rainfall is about 1,000 to 2,000 mm per year. There are about 9 major rivers that drain into Sulu Sea: Busuanga R., Caguray R., Lumintao R (Mindoro); Pagatban R. and Sipalay R. (Negros); Pajdahan R (Palawan); Lituban R. and Sindangan R (Zamboanga del Sur); and Sandakan R. and its tributaries (Sabah). The latter (Sandakan R. and its tributaries) having the largest discharge load to the Sulu Sea.

The marine waters of the Sulu Sea is influenced by the South China Sea and North Equatorial Current coming from Surigao Strait. Its bottom topography a shallow portion at the middle of the basin, the Tubbataha Reef Atoll. The section of the basin west of Tubbataha parallel to Palawan Is. reaches a maximum depth of 2,000 m with an average depth of 1,800 m. While the eastern section parallel to the coast of Zamboanga Peninsula reaches a maximum depth of 5,000 m with an average depth of 4,000 m.

The reef area for this sub-region is estimated to be around 870 $km^2$ (estimates from CI-Philippines unpublished) or 8% of the country's reef area. Seventy percent (70%) of its reefs are in the northeast to the southwest half of the sub-region.

## 30.3 Socio-economic Setting

There are about 48 coastal municipalities and 3 cities belonging to 8 coastal provinces within the sub-region excluding the towns in Sabah. On the Philippine side, the coastal populations of municipalities range from 6,000 to 83,000. Fifty percent (50%) of the coastal towns have populations from 20,000 to 40,000, 30% have 40,000 to 60,000 and 12% have above 60,000. Majority of the coastal villagers rely on fishing as their source of livelihood.

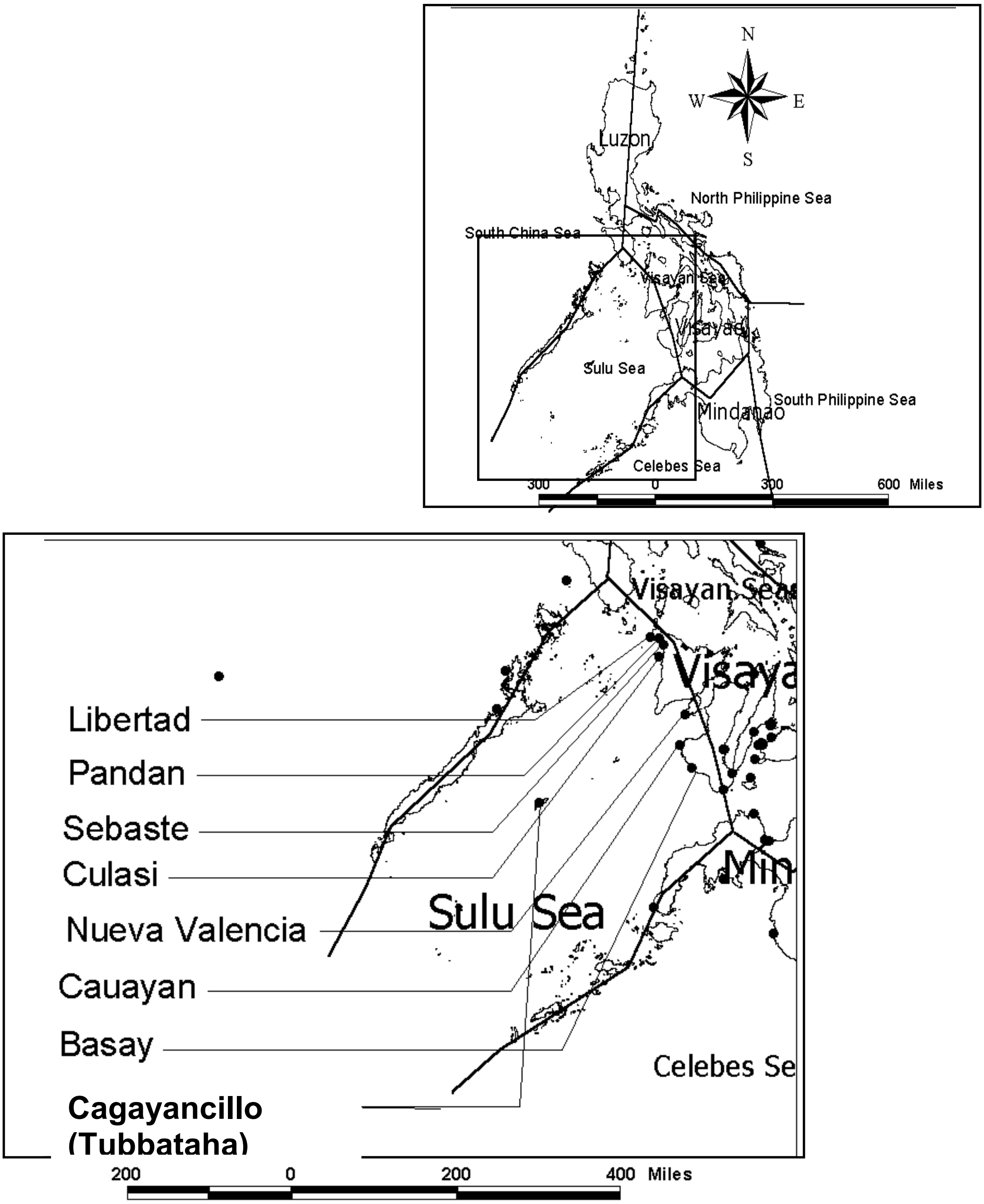


Fig. 30.1. Location of reef areas with temporal data in the Sulu Sea biogeographic area.

## 30.4 Management

There are several marine protected areas (see Table 30.2) in the sub-region

## 30.5 Issues and Threats

Table 30.2 presents the most common issues and threats identified for the sub-region. The issue of overfishing has often been cited for the sub-region though very few scientific data are available to support it. In 1998, a large proportion of the reef area in the sub-region was affected by the El Niño Southern Oscillation (ENSO) event. Tubbataha Reef easily recovered from the bleaching effect (Quibilan et al. 2000). For the other areas, there is not much information available.

Table 30.2. Summary of most common issues and threats identified for Sulu Sea sub-region.

| Issues and Threat | Area | Source |
|---|---|---|
| Destructive fishing practices | Prevalent in almost all coastal areas of the sub-region. | DeVantier, L. and C. Wilkinson (in press). |
| Over-fishing | In almost all coastal barangays | DeVantier, L. and C. Wilkinson (in press). |
| Harvesting of turtle eggs and killing of turtles | Tawi-tawi | |
| Sedimentation from land-use | Sandakan River (Malaysia), Sindangan River and the rest of other major rivers (Philippines) | DeVantier, L. and C. Wilkinson (in press). |
| Pollution (oil spill, industrial and domestic waste) | Sandakan (Malaysia), all cities and municipalities (Philippines) | DeVantier, L. and C. Wilkinson (in press). |
| Climatic change (ENSO) | Tubbataha Reef, Puerto Princesa and Honda Bays | Ledesma and Mejia (2000) Arceo et al. (2000) |

## 30.6 Monitoring, Evaluation and Feedback

Honda Bay, Puerto Princesa Bay, Turtle Islands, Tubbataha Reef National Park, Pandan Bay, Maralison Is., Taklong Island National Marine Reserve and Danjugan Island Marine Reserve and Sanctuaries are some of the reef areas in the Sulu Sea sub-region have been regularly monitored. Tubbataha coral cover and reef fish information can be traced back from 1984 (see Figs. 30.2a and 30.2b). The values in the figures are averaged data per year. There is a very gradual decline in hard coral cover particularly in the deeper areas. Reef fish density and biomass estimates are highly variable because of the presence of schooling fishes and sharks, respectively. Similar declining coral trend and variable fish trend was observed for Turtle Islands and Jessie Bezley but these areas had fewer sampling points.

Overall, there was a declining trend of hard coral cover for the Sulu Sea sub-region.

## 30.7 Future directions, Gaps and Recommendations

There is a need to establish baseline information for many marine protected areas. A monitoring, evaluation and feedback program should be established with lessons learned in the management of Tubbataha Reef serving as a guide.

There is a need also to survey and monitor non-protected reef areas such as the southern coast of Palawan and the coast of Zamboanga del Norte.

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Table 30.1. List of established/proposed marine protected areas or fish sanctuaries in the Sulu Sea Sub-region (source: UPMSI/AFMA-MFR Database)

| MPA/Marine Sanctuary | Year Established | Size (ha) | Legal basis |
|---|---|---|---|
| **Occidental Mindoro** | | | |
| Ambulong-Ilin Island Municipal Coral Reef Park, Magsaysay | | | |
| Bo. Labangan to Calalayuan Point, Ilin Is. (Mindoro), Magsaysay | 1981 | | RP.#2152 |
| **Oriental Mindoro, Bulalakao** | | | |
| Aslom Island, Bulalakao Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Batalasan Cove Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Bating Peninsula Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Buyayao Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Libago Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Maasim Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Mangroves at the western side of Casiliga River Island of Soguicay | 1981 | | PP. # 2152 |
| Opao Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Pambaron Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Pocanel Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Sibalat Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Sugulcay Island Tourist Zone Marine Reserve | 1978 | | PP. #1801 |
| Sukol River to Soquicay Island MSFR | 1981 | | PP. # 2152 |
| **Palawan** | | | |
| Balabac Island Tourist Zone and Marine Reserve | 1978 | | PP. #1801 |
| Panata Cay Marine Turtle Sanctuary, Balabac | | | MNR AO #8 |
| Ursula Island, Batarasa | 1960 | | AO #14 |
| Cagayan Islands, Cagayancillo | | | PP #219 |
| Tubbataha Reef National Marine Park, Cagayancillo | 1988 | 33,200 | PP #306 |
| Coron Island Tourist Zone and Marine Reserve | 1978 | 7700 | PP #1801 |
| Cuyo Group of Islands | | | |
| Entire Province of Palawan | | | |
| Puerto Princesa Tourist Zone and Marine Reserve | | | PP #1801 |
| Taytay Bay Protected Seascape | | | |
| Canaron Island Tourist Zone and Marine Reserve | 1978 | 3,901 | PP #1801 |
| Halog Is. Marine Turtle Sanctuary | 1982 | | MNR AO #8 |
| Kota Is. Marine Turtle Sanctuary | 1982 | | MNR AO #8 |
| Solitario Island Tourist Zone and Marine Reserve | 1978 | | PP #1801 |
| **Negros Oriental** | | | |
| Municipal Waters of Bayawan Negros Oriental | | 18,750 | MO #5 & PR #496 |
| Lutoban Marine Reserve, Zamboanguita | 1993 | 8 | BR |
| **Negros Occidental** | | | |
| Danjugan Island Marine Reserve and Sanctuaries | Dec. 1999 | 102.4 | MO #99-52 |
| **Panay** | | | |
| Taklong Island National Marine Reserve | 1990 | 1143.45 | PP. #525 |
| **Antique** | | | |
| Nogas Island Fish Sanctuary | | 65 | |
| Semirara Marine Sanctuary | | 530 | |
| Malalison Is. MPA | | 149 | Mun. Ord. #5-90 |
| Tabuc Marine Sanctuary | 1999 | 2 | |
| Mag-aba Marine Sanctuary | 1997 | 2 | |
| **Zamboanga del Norte** | | | |
| Caracol Fish Sanctuary | | 10 | MO. #19 |

Note: see UPMSI/AFMA-MFR Database

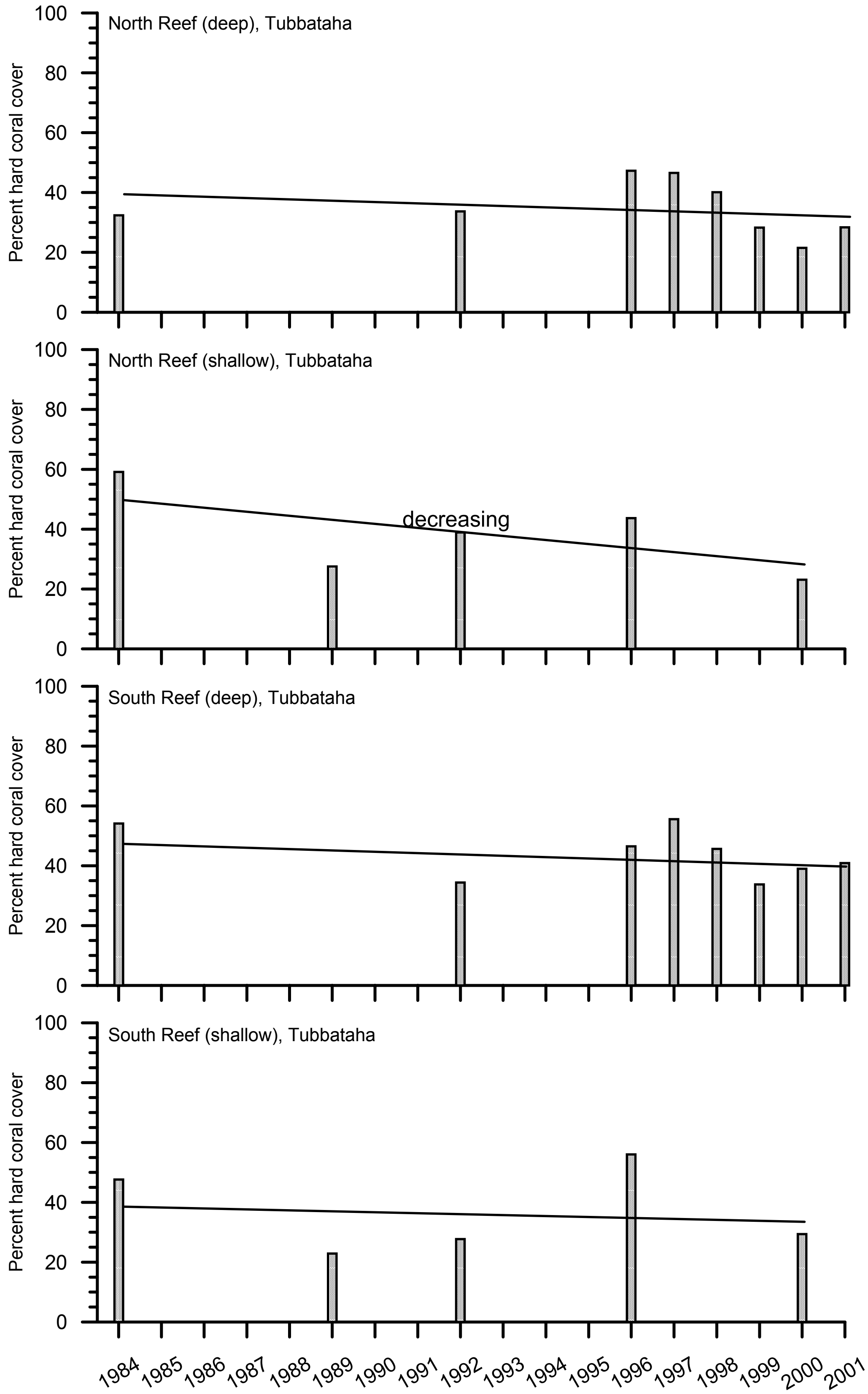


Figure 30.2a. Trends of percent hard coral cover in north and south reefs of Tubbataha. Solid lines represent the linear relationship.

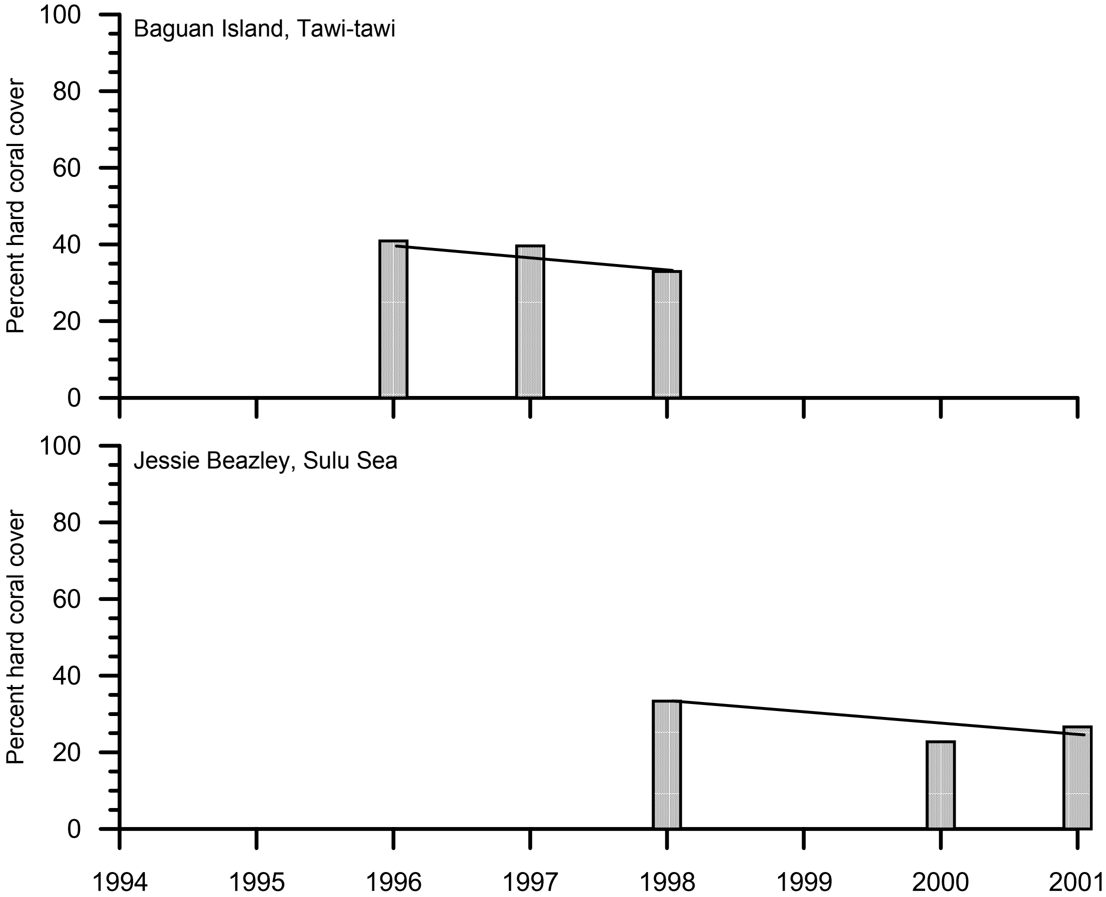


Figure 30.2b. Trends of percent hard coral cover in other parts of Sulu Sea.
Solid lines represent the linear relationship.

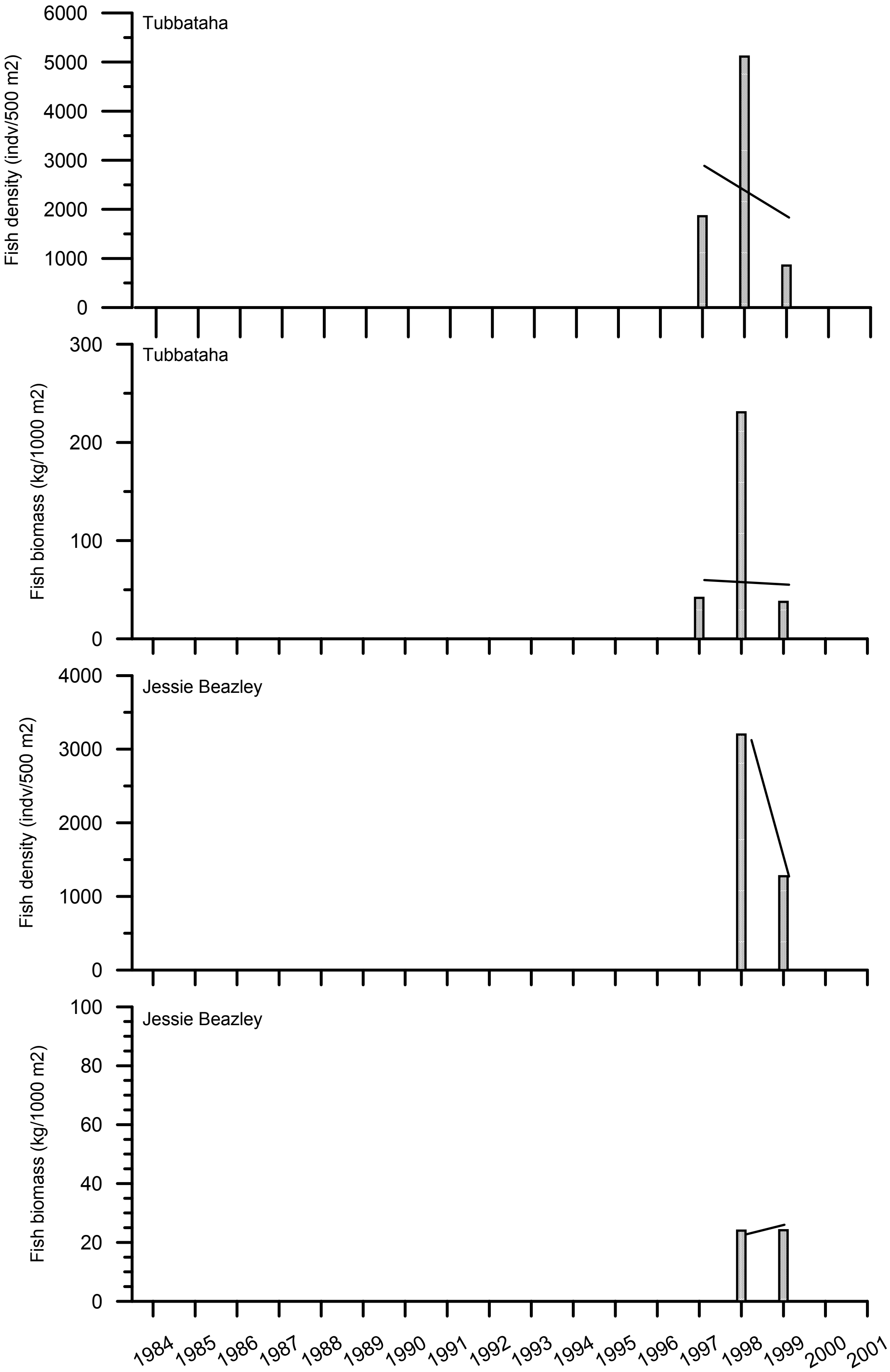


Figure 30.3. Trends of fish density (indv/500 m2) and biomass (kg/1000 m2) in Sulu Sea. Solid lines represent the linear relationship.

# CHAPTER 31 PANDAN BAY, ANTIQUE

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## 31.1 Biophysical Setting

Pandan Bay is located northwest of Antique and along the municipalities of Libertad, Pandan, Sebaste and Culasi. This region is known for its great biodiversity, not only due to the vast coral reefs of the bay but also because of the rich wildlife of Madia-as Mountain at the northeastern border.

The coastal area of Pandan Bay is generally narrow, due to the hilly and rugged terrain of the region. It has numerous freshwater outflows including several major river systems. The shores are usually gravelly and characterized with dark and coarse sand. Some areas, particularly in the north, have white beaches. The vast reefs can be found at the northern part, fringing the towns of Libertad and Pandan. Going south, to the municipalities of Sebaste and Culasi, the reef formations become more staggered. Sebaste has a shoal located 7 kilometers offshore. Culasi has three island barangays – Mararison, Batbatan and Maniguin – all bordered with diverse coral reef. Among them, Maniguin is the farthest and about two-hour boat ride from Boracay that is why it has become a favorite diving site of Boracay tourists. The Bay region is moderately affected by the southwest monsoon.

## 31.2 Socio-economic Setting

Majority of the population in the bay region is engaged in fishing, crop farming and livestock production. Most fishers are artisanal, using only hook and line gears and non-motorized boats. Commercial fishing methods, such as *otoshi-ami*, purse seines, and ring nets, are also being practiced within the bay, mainly by non-locals. Fishers are able to fish within an average of 11 months per year. For the rest of the year, they are engaged either in agriculture or post harvest activities. Fishery products (both fresh and processed) are commonly sold within Antique, Iloilo, Capiz and Aklan. Shark oil is also marketed from Antique, and Sebaste shoal is one of the famous hunting areas of sharks. Other livelihoods are fry gathering, making nipa shingles and seaweed (*Eucheuma* sp. and *Kappapychus* sp.) farming. Seaweed farming is more common in the islands of Batbatan and Maniguin. The dried seaweeds are sold in Cebu.

## 31.3 Management

Pandan Bay is currently being managed by the LIPASECU Baywide Management Council. This is a unified council composed of the four municipalities (Libertad, Pandan, Sebaste, and Culasi), institutionalized in 1997 to address the common problems of illegal fishing and environmental degradation in the area. The council is supported by Antique Integrated Area Development Foundation (ANIAD) in terms of technical, operational framework and funding.

LIPASECU BMC has seven programs for Pandan Bay, namely:

(1) Law enforcement and sea patrol – law enforcement composite team per municipality
(2) Resource regeneration – projects related to protection and rehabilitation of marine and coastal resources
(3) Livelihood enhancement – mainly through Grameen approach and credit cooperatives
(4) Institutional building – fisherfolk organizing into BFARMCs and MFARMCs
(5) Research and databanking – municipal coral reef monitoring team
(6) Waste management – proper disposal of solid and liquid waste material
(7) Ecotourism

Under the program of resource regeneration, each municipality has established several MPAs, managed by the LGU and LIPASECU. To date, there are already 15 sanctuaries established within the four municipalities.

## 31.4 Issues and Threats

The encroachment of commercial fishers is still rampant within the bay. There are also other forms of illegal fishing operated by small fishermen, such as blast and cyanide fishing. Poaching of sanctuaries is common. Solid waste and siltation are also common problems, especially in those areas with dense population and settlements. Solid waste management is now being implemented in the municipalities. Unless a sound agricultural and terrestrial management is developed, sediment loading from the uplands cannot be minimized. Seepage and washouts of chemical applications in agriculture are also potential threats, since farming near shorelines is common in the region. Organic farming is not yet well known in the area.

## 31.5 Monitoring, Evaluation and Feedback

The baseline data collection in Libertad, Pandan and Sebaste was conducted in 1997. The islands of Batbatan and Maniguin in Culasi were surveyed in 1999. There was only one follow-up monitoring activity conducted in all the sites, which was in January-February, 2000. The monitoring activities were carried out in 11 sites: Libertad (5), Pandan (3), Sebaste (1), and Culasi (2). The line intercept transect (LIT) method was used for the coral and benthic survey and belt transects for the visual census of the reef fishes (English et al. 1997).

Based on the results of the coral and benthic survey, 5 sites slightly decreased in live coral cover, two sites decreased by more than 20%. The remaining four sites had slightly increased coral cover (Fig. 31.1, Appendix 31.1). Fish count, increased slightly in 1 site but decreased by more than 50% in 6 sites (Fig. 31.2, Appendix 31.2). The fish biomass showed no specific trend in relation to fish count (Fig. 31.3, Appendix 31.2). Generally, there was not much change in the coral category (live and dead) of the reef sites. Other key benthic components, such as the abiotic and algal composition, changed remarkably. The change might indicate stress and other impacts of disturbances that have occurred in the past years. The reef fish data did not show a direct relationship with sanctuary management; also the baseline was conducted at the onset of the southwest monsoon while the follow-up monitoring was conducted in the middle of the southwest monsoon. However, the limited temporal sampling precludes any conclusive trend on the reef. Thus, monitoring should be continuous to establish a trend.

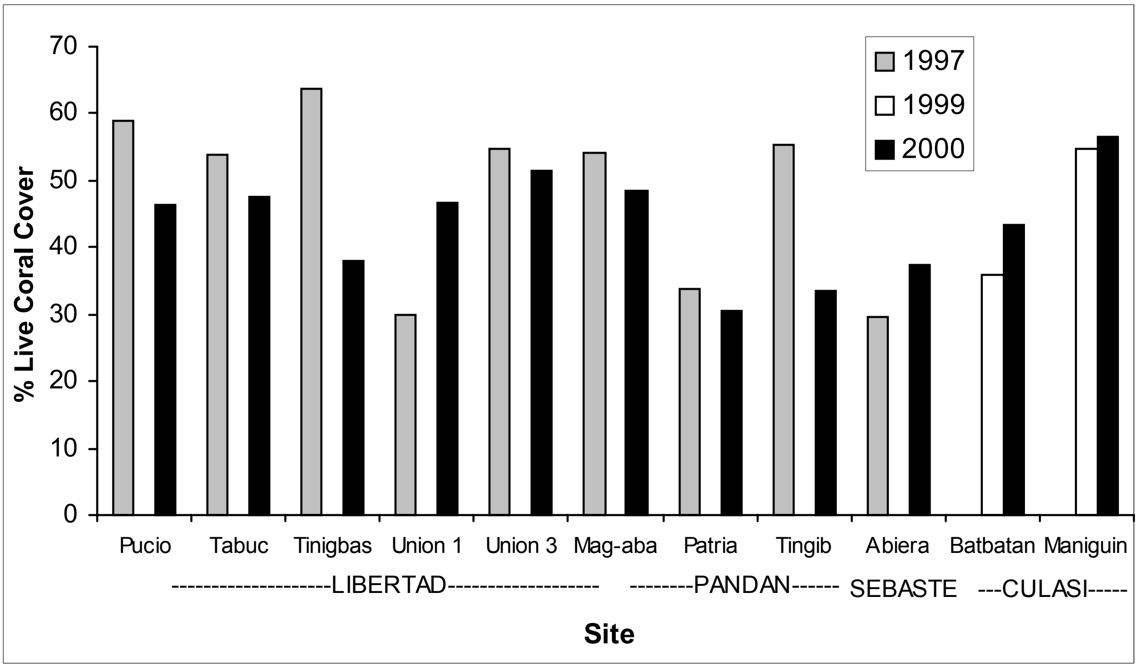


Figure 31.1. Live hard coral cover in Pandan Bay.

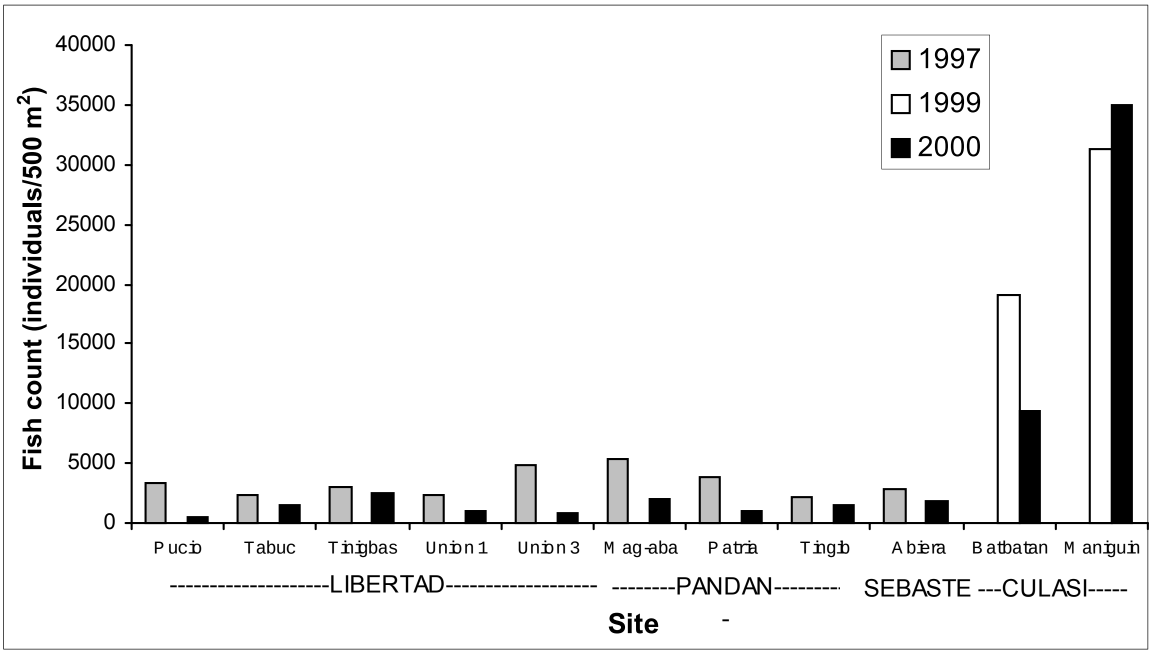


Figure 31.2. Fish count (individuals/500 m$^2$) in Pandan Bay.

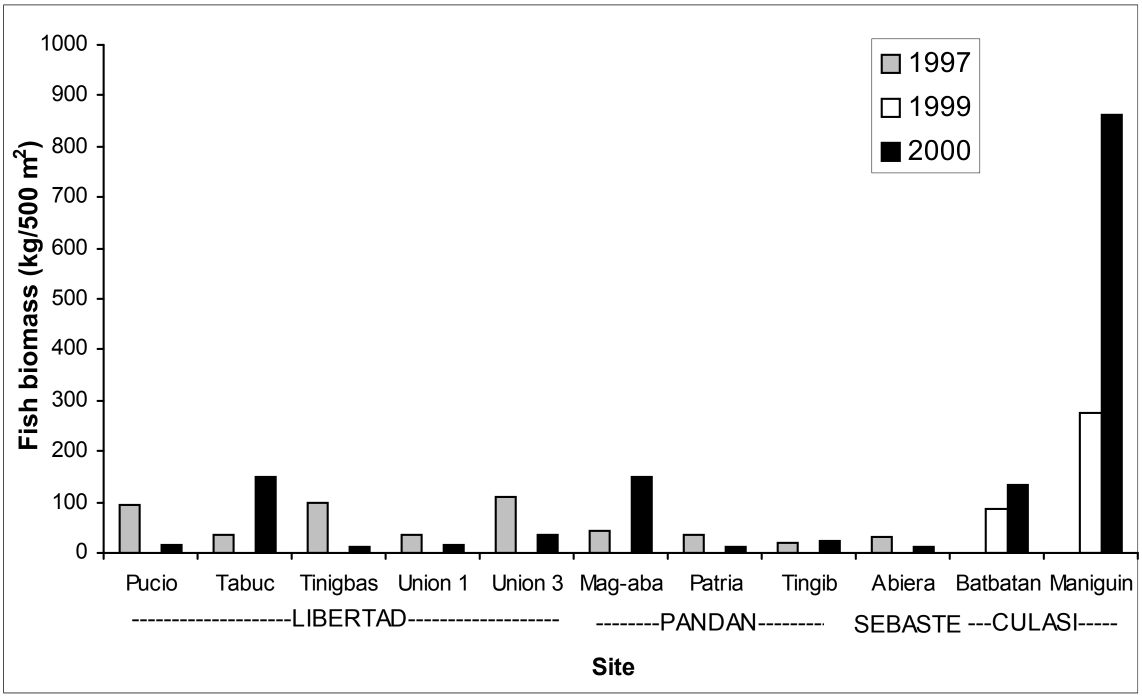


Figure 31.3. Fish count (Kg/500 m$^2$) in Pandan Bay.

## 31.6 Future direction, Gaps and Recommendation

Strict law enforcement should be prioritized, not only within the bay in general, but also particularly within the established sanctuaries. Seminars/forum on existing fishery-related laws (both national and local) and paralegal training could help. This must be complemented with the strengthening of existing surveillance system through increased support to fish wardens and other authorized law enforcers of the local government. Support should include additional surveillance equipment, capability-building activities and financial rewards.

The management system of the sanctuaries should also be strengthened through establishment of local monitoring system and local monitors. Currently, LIPASECU has formed a 7-man team (who are also certified SCUBA divers) trained to conduct monitoring activities in all the sanctuaries established within the bay. The existing system was found out to be ineffective. A monitoring team composed of the community members should be organized to ensure the regularity of the activity and to encourage greater support and participation of the concerned communities.

Areas with problems in siltation commonly have bare shorelines and loose banks due to absence of vegetation. Planting of mangroves and other suitable foliage to denuded shorelines and riverbanks is recommended.

Some areas with existing ecotourism activities lack a sound management system. This usually leads to resource exploitation. Therefore, a well-planned management framework must first be developed. Establishment of local tourism council (barangay) is also suggested to facilitate the proper monitoring and feedbacking system, and to regularly and effectively respond to site-specific issues and concern.

Lastly, the partnership among the community, LIPASECU and other identified supporters of CRM should be strengthened to improve the implementation of the projects that address sustainable use, conservation, development and management of resources.

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# CHAPTER 32 MARARISON ISLAND, CULASI, ANTIQUE

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## 32.1 Introduction

Together with mangrove and seagrass ecosystems, coral reefs are an important resource for many coastal communities in the Philippines, providing sustenance through fishery livelihoods in these communities. Unfortunately, increasing population levels among coastal dwellers has imposed enormous pressure on these coastal ecosystems to provide food beyond their capacities. Various initiatives to curtail the pressure, particularly on reef fishery resources, have been undertaken in many localities. This report briefly describes the initiatives that were instituted in the fishing village of Mararison Island in the municipality of Culasi, Antique province to manage the island's reef resources.

## 32.2 Biophysical Setting

Mararison Island lies 4 km off the west coast of Culasi municipality in northern Antique, separated from Panay Island by a narrow Salangan channel (Fig. 32. 1). It is situated at 11$^{o}$25' N latitude and 122$^{o}$01' E longitude. A fairly extensive fringing reef and several small coral shoals with an area of 2.33 km$^2$ surround the 0.65 km$^2$ low island (Amar et al. 1996). A small islet named Nablag is separated from the western tip of the island facing Cuyo East Pass by a shallow lagoon and a small sandbar. Nablag shoal nearby is a popular fishing ground of island fishers and covers an area of a little less than 0.8 km$^2$. Also on the eastern tip of Mararison Island facing Culasi is a prominent sandbar. Spur and groove formations mark the fringing reef on the north side of the island. A fairly extensive shallow reef flat that slopes gradually to the reef crest to a depth of 5-10 m fringes the island's south side where the lone village lies.

## 32.3 Socio-economic Setting

In 1995, the island village's total population was 512 in 94 households, an increase of 22% from 1990 levels (Agbayani et al. 2000; Baticados and Agbayani 2000). The annual birth rate of about 4% is double the national average. The average household size is 5-6 members. A 1991 census of the island population showed that 63%, aged 8 years old and above, had elementary education, 26% high school, and 6% college. About 5% did not attend school. Native Ilonggos who were born on the island comprised 97% of the population and the rest were migrant residents (typically Cebuanos) who are noted for their fishing skills. Fishing remains the dominant occupation, with 73% being artisanal fishers and gleaners. Island fishers employ a variety of gears such as hook and line, spear, gill nets, and compressor (hookah) using motorized (22%) and non-motorized boats (78%) under 3 gross tons. Acanthurids and caesionids are the dominant catch of the island's reef fishery. 53% of the catch is usually sold on the island and the rest in the Culasi municipal market. About 75% of the population live below the poverty line, earning an annual income of only Php15,000.

## 32.4 Management

Before 1990, reef resource conservation in the island community was non-existent. The island's reef fishery was typically open-access, with fishers from the island and from neighboring barangays engaged in illegal and destructive fishing. This scenario changed in 1991 when the institution of advocacy and capacity-building among fishers, through an organized fisherfolk association, was initiated with the assistance of SEAFDEC and a local NGO (non-government organization). In subsequent years, the fisherfolk association and the island barangay's FARMC (Fisheries and Aquatic Resources Management Council) succeeded in lobbying the Culasi municipal council to establish an exclusive fishery zone of one square kilometer in municipal waters. The entire waters of Mararison Island was declared the island fishers' exclusive use, banning the entry of commercial fishers and the use of destructive fishing gears. In 1995, the 28-ha Gui-ob reef was declared a no-take marine reserve. Concrete artificial habitats were deployed in the reef reserve and in a nearby reef open to regulated fishing. SEAFDEC has played a major role in promoting advocacy and management initiatives in the island. Biological and sociological data gathered by researchers were critical inputs to the island fishers' attempts to formulate reef resource-use policies. To date, the Gui-ob reef reserve has not been violated. The fisherfolk association and the island village's FARMC have continued to be legitimate venues for resolving conflicts in the use and management of the island's reef resources. Reef resource monitoring by SEAFDEC has continued on the island, albeit on a limited scale.

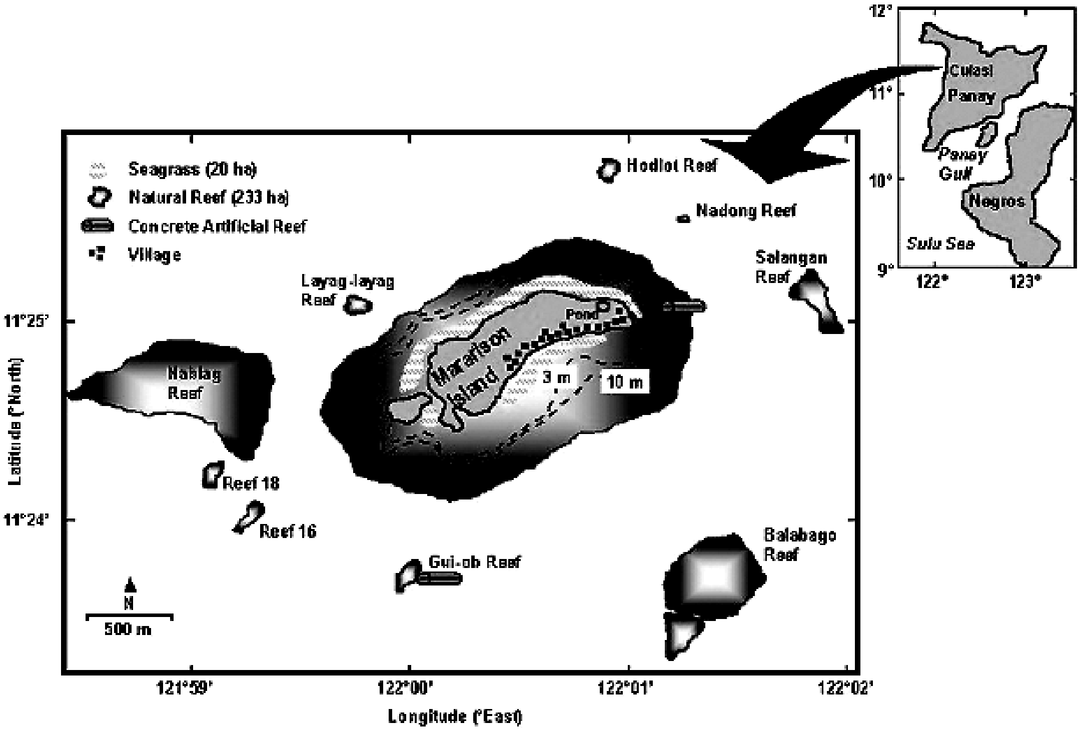


Fig. 32.1. Map of Mararison Island.

## 32.5 Issues and Threats

Island fishers and those from neighboring communities generally accepted the declaration of a no-take reserve in Gui-ob reef in 1995. The other alternative then was to close to any form of fishing the extensive Nablag shoal, an important fishing ground. Other management measures instituted by the fisherfolk association that were initially opposed by some island fishers included the restriction of gill net mesh sizes to a certain limit and the banning of hookah fishing in the island. In time, fishers recognized that these two fishing gears have been contributing to low fishery yields in the island and therefore eventually supported these restrictions. While these management initiatives, particularly the no-take reserve status of Gui-ob reef, continue to be enforced, a certain degree of apathy among fisherfolk association members have been noted since SEAFDEC and the local NGO have reduced their presence in the island in 1998. The lack of capital to initiate land-based livelihoods in the island has likewise hindered entrepreneurial initiatives of island fishers.

## 32.6 Monitoring, Evaluation, and Feedback

The entry of SEAFDEC to Malalison Island in 1991 to implement a development-oriented research project required some sociological and biological baseline studies (Siar et al. 1992; Amar et al. 1996). Reef fishes were visually censused underwater (English et al. 1994). At the 10 m depth, mean abundance of target reef fishes in the fringing reef in 1997 rebounded to 1994 levels of 238 individuals/500 m$^2$, after declining to 25-32 individuals/500 m$^2$ in 1995 and 1996 (Table 32.1). With a modified underwater visual census method (Bohnsack and Bannerot 1986) in 1997, mean abundance of target fishes in Nablag shoal decreased from 841 individuals/500 m$^2$ in 1997 to 23 individuals/500 m$^2$ in 1999. At the 20 m depth, the mean abundance of target fishes in the Gui-ob reef reserve varied over the years, but compared with the other nearby reefs censused, target fishes in the reserve, except in 2000, have been two- to fifteen-fold more abundant. From 1994 to 1997, the mean of the "first estimate" of target fish biomass in the fringing reef also varied, increasing in 1995 to 4.5 kg/500 m$^2$, declining in 1996 but regaining 1994 levels of about 3.5 kg/500 m$^2$ in 1997 (Table 32.2). Mean biomass of target fishes in Nablag shoal (10 m depth) declined from

20.5 kg/500 $m^2$ in 1997 to 0.97 kg/500 $m^2$ in 1999. A similar trend was also observed among target reef fishes' biomass in Nablag shoal (20 m depth) from 2000 (4.4 kg/500 $m^2$) to 2001 (0.57 kg/500 $m^2$). In contrast, mean biomass of target reef fishes in the Gui-ob reef reserve in 1997, or a year after the reef was declared a no-take reserve, increased to 308 kg/500 $m^2$, and became stable at 10-15 kg/500 $m^2$ in subsequent years. Large-sized individuals of acanthurids and caesionids in the reserve made up the major part of the estimated biomass. Coral cover was determined by line-intercept transect (English et al. 1994). Mean cover of live hard corals in the fringing reef (10 m depth) declined from 36% in 1994 to 21% in 1998, with a corresponding increase in dead coral cover also in 1998 (Table 32.3). Live hard coral cover in the Gui-ob reef reserve (20 m depth) doubled to 46% in 1996 but declined to 1994 levels of about 25% in 1998. These declines may be due to prolonged warm sea surface temperatures, a manifestation of the El Niño-induced climate change in 1998. The status of the island's reef fishery was also monitored from 1991-1992, then intermittently from 1996 to date. Monthly surveys of fish landed by island fishers were conducted to determine catch composition and estimate fishing effort, catch, and yield data for each fishing gear. Yield by hookah, set gill net, and drift gill net fishing doubled in 1996. Whereas, hook and line and drive-in gill net catch declined by at least half their levels in 1991 (Table 32.4). The annual reef fishery yield has remained at 6-7 t/$km^2$. Overall, the reef resources of Malalison Island appear to have improved and should continue to do so as along as management initiatives crafted over the years remain in effect.

Table 32.1. Mean abundance (±SD) of target reef fishes (per 500 $m^2$) in Mararison Island, Culasi, Antique[1]

| Reef | N, Lat./ E Long. | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| Fringing reef, 10m | 11°25.5'/ 122°01.5' | 238 (±265) | 32 (±5) | 25 (±5) | 238 (±260) | nd | nd | nd | nd |
| Nablag shoal, 10m | 11°24.6'/ 122°0.8' | nd | nd | nd | 841 (±1390) | nd | 23 (±10) | nd | nd |
| Gui-ob reef reserve, 20m | 11°24.1'/ 122°0.8' | 468 (±201) | 76 | 432 | 3527 (±2248) | 211 | nd | 93 (±41) | 139 (±77) |
| Nablag shoal, 20m | 11°24.6'/ 122°0.8' | nd | nd | nd | nd | nd | nd | 194 (±112) | 19 (±11) |

[1] Target reef fishes are censused species belonging to Family Acanthuridae, Caesionidae, Carangidae, Chanidae, Lethrinidae, Lutjanidae, Serranidae (Epinephelinae), Scaridae, and Sphyraenidae, which form the bulk of the island's reef fishery catch over the years (Amar et al. 1996).
[2] nd = no data.
[3] Underwater visual census (uvc) of reef fishes was conducted in seven permanent stations in the fringing reef of Mararison Island along a fixed 50x10m transect line set at the 10-14m depth contour of each station. The uvc method was modified from the protocol described by English et al. (1994).
[4] A modification of the stationary point-count method of Bohnsack and Bannerot (1986) was followed to census reef fishes in Nablag shoal and in Gui-ob reef reserve from 1997 to date.
[5] Gui-ob reef was declared a no-take reserve in May 1996.

Table 32.2. Mean (±SD) of "first estimate" of target reef fish biomass (kg / 500 $m^2$)

| Reef | N Lat. / E Long. | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|---|---|
| Fringing reef, 10m | 11°25.5'/ 122°01.5' | 3.2 (±3.7) | 4.5 (±0.3) | 0.78 (±0.2) | 3.5 (±3.4) | nd | nd | nd | nd |
| Nablag shoal, 10m | 11°24.6'/ 122°0.8' | nd | nd | nd | 20.5 (±29.5) | nd | 0.97 (±0.6) | nd | nd |
| Gui-ob reef reserve, 20m | 11°24.1'/ 122°0.8' | 4.5 (±1.5) | 2.7 | 3.0 | 308 (±294) | 11.67 | nd | 15.4 (±9.7) | 10.30 (±6.5) |
| Nablag shoal, 20m | 11°24.6'/ 122°0.8' | nd | nd | nd | nd | nd | nd | 4.4 (±1.3) | 0.57 (±.16) |

Table 32.3. Mean (±SD) of reef benthic cover (%) in Mararison Island in Culasi, Antique

| Location | N,Latitude/ E,Longitude | Benthic trait | 1994 | 1996 | 1998 |
|---|---|---|---|---|---|
| Fringing reef, 10m | 11°25.5'/122°01.5' | Live hard coral | 36.0 (±26.0) | 36.9 (±22.3) | 21.0 (±6.6) |
| | | *Acropora* | 6.0 (±7.8) | 7.2 (±8.9) | 0.7 (±0.8) |
| | | Non-*Acropora* | 30.0 (±19.7) | 29.7 (±14.0) | 20.2 (±6.8) |
| | | Dead coral | 13.7 (±6.9) | 8.1 (±5.3) | 33.7 (±9.3) |
| | | Algae | 3.0 (±1.5) | 8.7 (±4) | 12.9 (±5.5) |
| | | Other fauna | 2.3 (±2.1) | 4.7 (±2.9) | 2.1 (±1.6) |
| | | Abiotic | 47.6 (±29.9) | 41.6 (±20.9) | 30.0 (±11.3) |
| Gui-ob reserve, 20m | 11°24.1'/122°0.8' | Live hard coral | 24.5 | 46.1 | 25.14 |
| | | *Acropora* | 0.8 | 4.3 | 0 |
| | | Non-*Acropora* | 23.5 | 41.8 | 25.14 |
| | | Dead coral | 13.1 | 3.6 | 28.5 |
| | | Algae | 5.9 | 14.1 | 4.8 |
| | | Other fauna | 3.0 | 3.0 | 0.8 |
| | | Abiotic | 53.4 | 33.2 | 39.0 |

A line-intercept transect method described by English et al. (1994) was followed to assess reef benthic traits. A permanent 50m transect line following the depth contour in each of the 5 to 7 stations was employed. Refer to Table 32.1 for other details.

Table 32.4. Reef fisheries catch (kg / fisher / hour) in Mararison Island, Culasi, Antique

| Fishing gear | 1991 | 1996 |
|---|---|---|
| Hook and line | 10.7 | 0.7 |
| Speargun | 1.1 | 1.2 |
| Compressor (hookah) with speargun | 1.4 | 2.8 |
| Set gill net | 0.4 | 1.3 |
| Drive-in gill net | 2.4 | 1.3 |
| Drift gill net | 1.2 | 2.3 |

[1] From Amar et al. (1996).

## 32.7 Future directions, Gaps, and Recommendations

The promotion of reef resource management initiatives over the years has become a learning experience to both fishers in Malalison Island and SEAFDEC researchers. Initiatives were implemented by organizing fishers and linking with local government agencies. These initiatives have transformed the island into a small-scale model that neighboring municipalities in northern Antique have attempted to follow to enhance coastal resource management in the area. The phasing out of a SEAFDEC research project in the island in 1998 may result in some "back-sliding" of island fishers' attitudes to fishery resource-use. This is indicated in a recent survey showing a degree of ambivalence towards breaking already promulgated policies on resource management. Likewise, there is a dearth of funds to continue entrepreneurial and research activities that have been initiated in the island. Nonetheless, the presence of an organized fisher's organization, inputs of biologists and sociologists, and regular consultations with the fisher's have been valuable lessons learned in reef resource management, which may be applicable to other coastal communities in the Philippines.

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# CHAPTER 33 TAKLONG ISLAND NATIONAL MARINE RESERVE, GUIMARAS

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## 33.1 Biophysical Setting

The Taklong Island National Marine Reserve (TINMAR) was established in 1990 through Presidential Proclamation number 525. The reserve is located in the municipality of Nueva Valencia, Guimaras in Western Visayas and is bordered by the two coastal barangays of La Paz and San Roque. It includes the two major islands of Taklong and Tandog, and about 37 small limestone islets which are collectively known as the South Point Islands (10º24' to 10º26'N latitude and 122º29' to 122º31.15' E longitude) (Fig. 33.1). This coastal portion of southern Guimaras borders the much deeper Panay Gulf to the southwest, which in turn opens to the Sulu Sea. The marine reserve covers an area of about 11km$^2$, roughly a tenth of which is comprised of reef flats and fringing reefs.

Water visibility in the reserve is generally poor throughout the year due to high levels of suspended material. The physical complexity of reefs in the area varies with respect to depth (3-5m to 15-20m), degree of slope (0 to > 60º), and bottom relief (low relief to spur & groove, to walls). Inspite of apparently high suspended load in the water, considerable coral growth has been observed in some areas (e.g., UP Channel east of Taklong Is.) where silt resistant acroporids dominate.

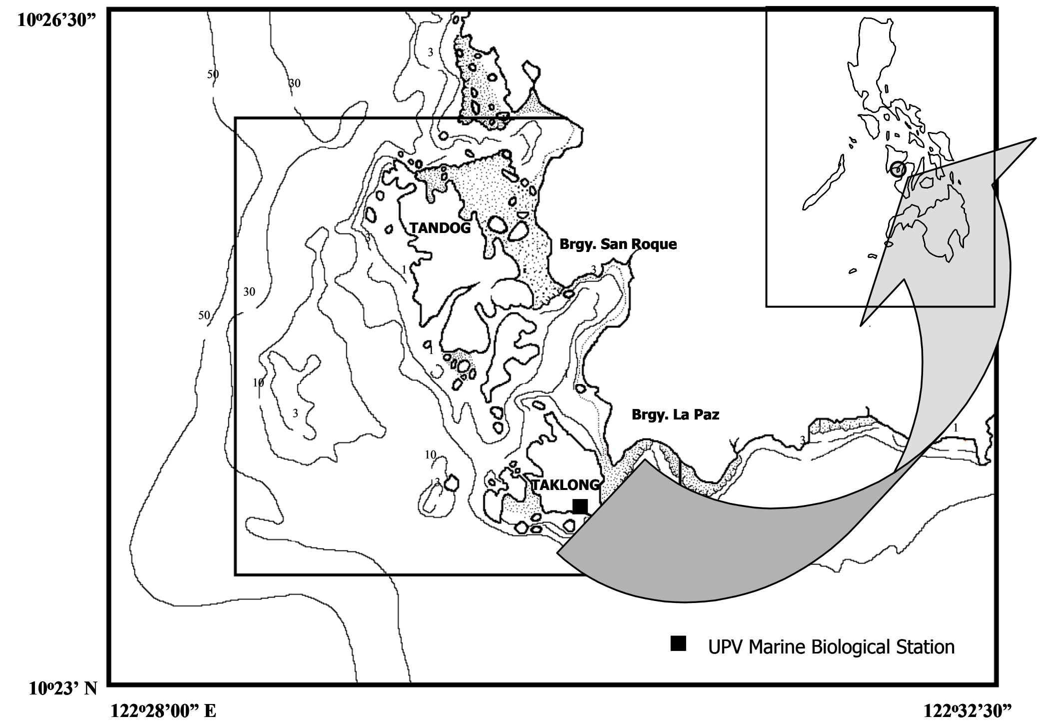



Figure 33.1. Map of Taklong Island National Marine Reserve (TINMAR) showing the relative extent of its boundaries, the major islands of Taklong and Tandog, and the location of the UPV Marine Biological Station.

## 33.2 Socio-economic Setting

The socio-economic profile of the two coastal *barangays* (villages) bordering TINMAR, Brgy. La Paz and Brgy. San Roque, reflects the degree of dependence of these communities to the resources of the marine reserve. The data presented herein were derived from secondary sources such as barangay profiles, survey by Save the Children Foundation and data from the National Statistics Office (NSO) as collated by Seraspe et al. (1998), and from the rapid appraisal of coastal marine habitats of Guimaras by Babaran and Ingles (1996).

Brgy. La Paz is composed of 8 *sitios* (sub-villages) with a total land area of 590.6 ha., while Brgy. San Roque has 6 sitios with a total land area of 514.8 ha. From 1975 – 1997 population density in both barangays increased from 223 to 302 persons / $km^2$ (35%, La Paz), and 144 to 265 persons / $km^2$ (84%, San Roque) respectively.

As of 1997, Brgy. La Paz and San Roque had 338 and 253 households respectively. The majority of the household heads have attained elementary level education. Fishing is the main source of income. Sixty eight percent (68%) of the community in Lapaz indulges in fishing as a source of income while 11.4% are engaged in farming. In Brgy. San Roque, 49% of the community derives income from fishing while 22% indulge in farming (Seraspe et al. 1998). Improved road conditions and electrification (particularly in Brgy. San Roque) have helped facilitate the marketing of fishery products coming from both *barangays*. However, such developments might result in increased pressure on the marine resources.

Farming and livestock raising are limited considering the topography of the land in both areas. Hence, these communities rely heavily on marine resources. The establishment of schools and daycare centers may soon increase the educational level in these communities and decrease the dependence on the marine resources as the main source of income. Increased environmental awareness, specifically among the younger members of the community, may enhance responsible use of natural resources.

Aside from anecdotal accounts from local fishers, there is no information on fishing activities within the reserve before or immediately after its establishment in 1990. Perhaps the most relevant of such accounts is that blastfishing, which was once rampant in the area, has been rarely observed in recent years. Systematic monitoring of fisheries in 1997-98 showed that an average of 10.3 boats (s.d. = 4.2) fished within the shallow portion of the reserve each day, extracting an estimated 3.8 mt/$km^2$ of reef-associated fisheries resources annually (Subade and Campos 1999).

## 33.3 Management

A Protected Area Management Board (PAMB) with representatives from the people's organizations, local government units, DENR, NGOs, and from the University of the Philippines in Visayas, was established in 1993. Among its utmost concerns is to reduce the extent of resource extraction, particularly that of coral reef resources, within the marine reserve. The formulated zonation plan designated special management zones, including buffer, habitat management, restoration and sustainable use zones. The latter includes most of the inner shallow portion of the reserve (reef flat). All fishing activities (i.e., only passive fishing gears) within the reserve are supposedly restricted to this zone. While a strict "no-take" zone has been designated, this is rarely, if at all, enforced or complied with. A path crossing the inner shallow portion and providing access to deeper waters has also been designated as the right of way for local fishermen.

To date, the aforementioned special management zones have remained on paper and have yet to be implemented. The discussions at the apparently regular monthly PAMB meetings have yet to be disseminated effectively. The refusal of some stakeholders to endorse the planned programs of the PAMB adds to this problem. The PAMB has a patrol boat stationed in Brgy. Lapaz but the lack of guidelines on its use makes it useless.

## 33.4 Issues and Threats

Since the establishment of the reserve, program implementation has been confronted with poor coordination between the various stakeholder sectors and the PAMB. The strongest hindrance has been the refusal to endorse the proposed management plan by one of the barangays. Although the local communities are sufficiently aware of the general goal of protecting the area, there is little resolve on their part to support the proposed program. While destructive fishing practices, such as blast fishing have been greatly reduced, the enforcement of gear-area restrictions has been very poorly implemented. Poaching from neighboring coastal and inland barangays remains a problem. Furthermore, there is an apparent laxity on the part of the PAMB in ensuring that only activities in consonance with the intended purposes of the reserve be permitted. In recent years, fish corrals and fish aggregating lift nets have been set up in major channels of exchange between the inner reef flat reserve area and the outside. Expansion of fish ponds/pens has encroached on critical seagrass and replanted mangrove areas, as well as the main navigational channel.

There have been several efforts to enable the barangays to implement some of their programs. These include organizing pumpboat operators in one of the barangays and charging entrance fees to the reserve. It seems that increased participation of the stakeholders should play a key role if program implementation is to be successful.

## 33.5 Monitoring, Evaluation and Feedback

Baseline data on reefs in the area were collected during a comprehensive survey conducted by the DENR-CEP 6 and PAWB in August 1990, shortly after the establishment of the reserve (Palaganas et al. 1990). The information available includes summary descriptions of the 30 sites surveyed, percent (%) cover of major bottom type categories, and a general account of fish species composition (i.e., for all stations combined). Unfortunately, the raw data are no longer available, precluding in-depth comparisons with data from the more recent surveys. Post-establishment data are available from Nievales (1997) and from Campos (2002).

Benthic cover was determined using Line Intercept Transect, while data on reef fishes were gathered using Fish Visual Census (English et al. 1997). Differences in the number and location of sites surveyed in the various studies limit comparisons. In the most recent survey (Campos 2002) sites were chosen using descriptions and maps from previous studies, although only a few of the previous sites were included due to differences in monitoring goals. Systematic monitoring of fishing activities within the reserve was initiated only in 1997 (Subade and Campos 1999) and is being continued in the current survey. Estimates of landed catch are taken from buyers' logs while roving (intercept). On-site interviews were conducted to get more accurate estimates of catch rates (CPUE) for various gear types commonly used by local fisherfolk.

Average live hard coral cover increased from 13.8% at the time of establishment (1990) to 18.8% in 1997 and to 33.3% in 2001 (Table 33.1, Fig. 33.2, Appendix 33.1). Fish density also showed an increase from 1.04 individ./$m^2$ in 1997 to 1.93 individ/$m^2$ in 2001. Fish biomass estimates appear to have declined from 47.7 mt/$km^2$ in 1997 to 38.5mt/$km^2$ in 2001. The latter estimates, however, should be taken with caution, since the surveys were conducted by different groups. Mean individual weight was 56.6g in 1997, about 3 times the mean individual weight in 2001. Personal observations in the area from 1997 to the present do not support the apparent indication of an increase in fish size. The difference in biomass estimates is therefore more likely to be an artifact of overestimating fish sizes underwater rather than a real increase. Mean fish density is less subject to differences between observers.

In 1990, 26 families of reef-associated fish were recorded from 30 stations. Thirty-two families were recorded from 7 stations in 1997, while 27 families were recorded from 8 time-site combinations (4 sites surveyed in 2 months but within the same season) in 2001. The data suggest an increase in number of fish families observed within the reserve from 1990 to 1997. The apparent decrease in 2001 may be attributed to the low number of stations (4) surveyed for the particular season.

There are no consistent trends in the fisheries data (Figs. 33.3a & 33.b). Catch rates for drive-in gill nets decreased in 2001 to half the 1997 estimate, while set gill net catch rates increased 5-fold. Hook and line catch rates increased by 75% in 2001 and that for spear-fishing remained the same from 1997 to 2001. It is likely that the ranges of estimates covered are well within the range of real variability of catch rates from the various gear types, and do not necessarily reflect a cause and effect relationship between protection and catches. What would have been more meaningful is a comparison of catch rates before and after establishment of the reserve area. Overall the catch rate data are in the low end of ranges recorded in other similarly exploited areas (Campos et al.1994). For all gear types, the estimates are consistently lower outside of the reserve. These data suggest a certain degree of replenishment of fish stocks within the protected area. Together with increased fish density and variety, possibly also augmentation of diversity due to conservation.

In summary, live coral cover, fish diversity (family level) and density data generally showed increases to the present, strongly suggestive of an environment on the way to recovery. While low fishery catch rates are inconsistent with such a scenario, it is possible that catch rates in earlier years were even lower and that current estimates are "on the rise". It seems then that even in the absence of proper implementation of the management plan as a whole, or even the establishment of "no take" zones, the drastic reduction in destructive practices and commercial fishing within the reserve may be sufficient to allow some recovery of its reef resources. The lack of detailed baseline data precludes any further comparisons than those given above. Data on catch rates of the fishery would allow us to discern and perhaps trace back any potential trends if monitoring is to be continued for the next several years.

Table 33.1. Summary of reef parameters from surveys conducted in 1990, 1997 and 2001 in the Taklong Island National Marine Reserve. Mean % live hard coral was computed using data from 2 stations which were sampled in all 3 surveys. All other parameters are means computed from the total no. of stations sampled in each of the surveys.

| | YEAR 1990 | 1997 | 2001 |
|---|---|---|---|
| Reference | Palaganas et al. (1990) | Nievales (1997) | Campos (2002) |
| Month of survey | August | September | June & October |
| No. of stations surveyed | 30.00 | 7.00 | 4.00 |
| Live Hard Coral Cover (%) | 13.75 | 18.75 | 33.30 |
| No. of fish families | 26.00 | 32.00 | 27.00 |
| Mean ind. weight (g) | n.d. | 56.60 | 18.10 |
| Biomass (mt/km$^2$) | n.d | 47.73 | 38.47 |
| Density (ind/m$^2$) | n.d | 1.04 | 1.93 |

Table 33.2. Summary of catch rates for various gear types used within the inner reserve area (TINMAR) and non-protected adjacent areas (Outside) from 1997 and 2001. The effort units for the different gear are shown in parentheses.

| | 1997-98 | 2001 | |
|---|---|---|---|
| Area fished | TINMAR | TINMAR | Outside |
| Reference | Subade & Campos (1999) | Campos (2002) | |
| Drive-in gill net (seg-man-hr) | 0.30 | 0.15 | 0.13 |
| Set gill net (seg-hr) | 0.08 | 0.39 | 0.11 |
| Seine (man-hour) | 1.37 | n.d. | n.d. |
| Hook & Line (man-hour) | 0.41 | 0.74 | 0.40 |
| Spear (man-hour) | 0.46 | 0.46 | 0.30 |
| Longline (per 100 hooks) large | n.d. | 0.56 | 0.53 |

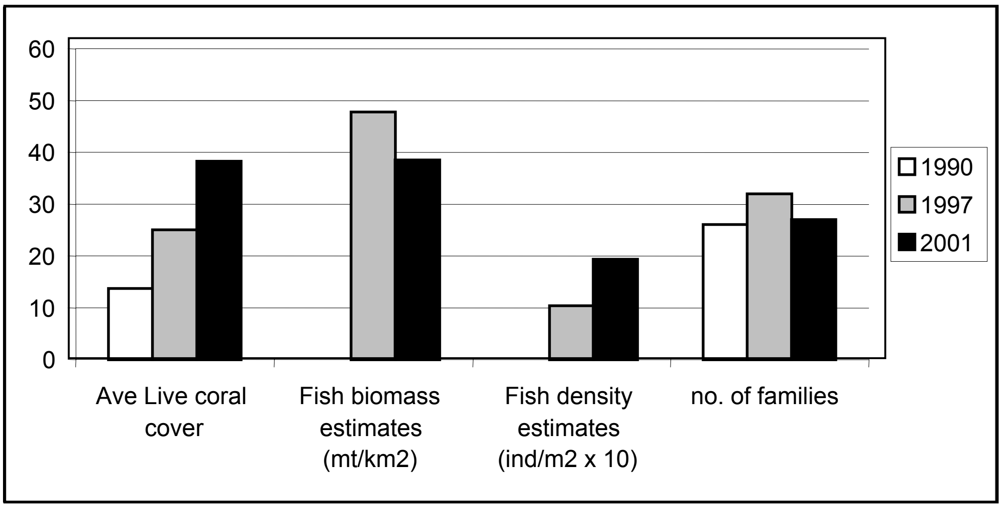
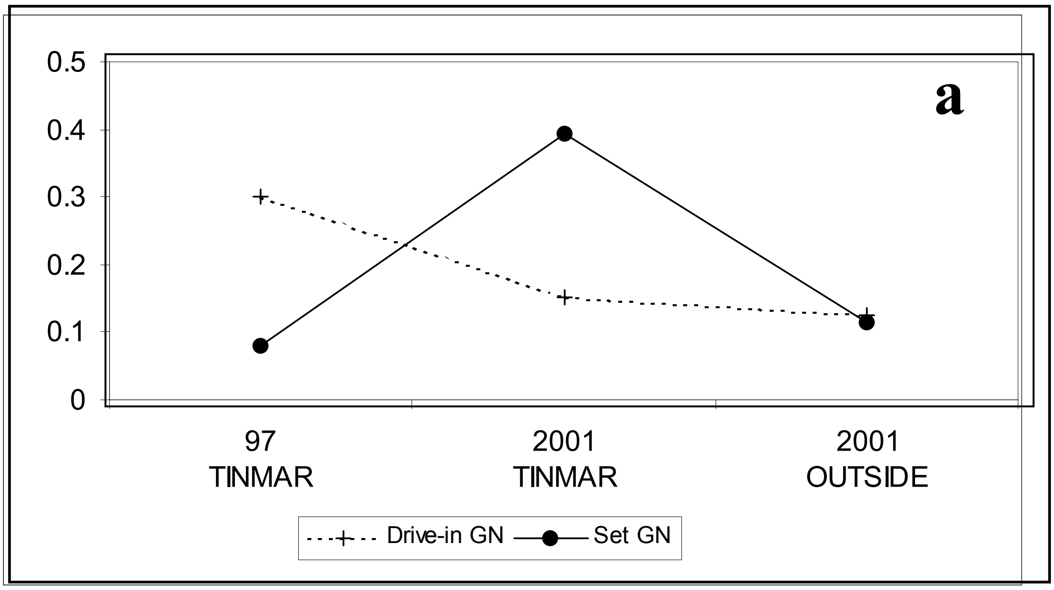



Fig. 33.2. Comparison of reef parameters in Taklong Island National Marine Reserve for the years 1990, 1997 and 2001.

## 33.6 Future directions, Gaps and Recommendations

The Marine Biological Station of U.P. in the Visayas has served as the base for various past and on-going research undertakings in the reserve. Current efforts form part of a national program on marine protected areas in the country. Present activities include monitoring reef resources and fishing activities within the reserve and in adjacent non-protected areas. There are also on-going studies on ecologically dominant consumers in the reserve's seagrass beds. Other activities include determination of sedimentation rates, coral recruitment, hydrography and fish larval flux rates in and out of the reef flat area. The information generated by these researches should be used as baseline data in formulating and implementing regulations set by the Protected Area Management Board. However, the current laxity in enforcing regulations has paralleled the erratic and oftentimes perceived as politically-tainted decision-making process. The inevitable result is more than a decade of sand lion existence of the reserve. Ultimately, the success of a fully implemented Taklong Island National Marine Reserve is in the hands of the locals themselves. An improvement in the active involvement and participation of the stakeholders will be necessary for TINMAR serve its purpose.



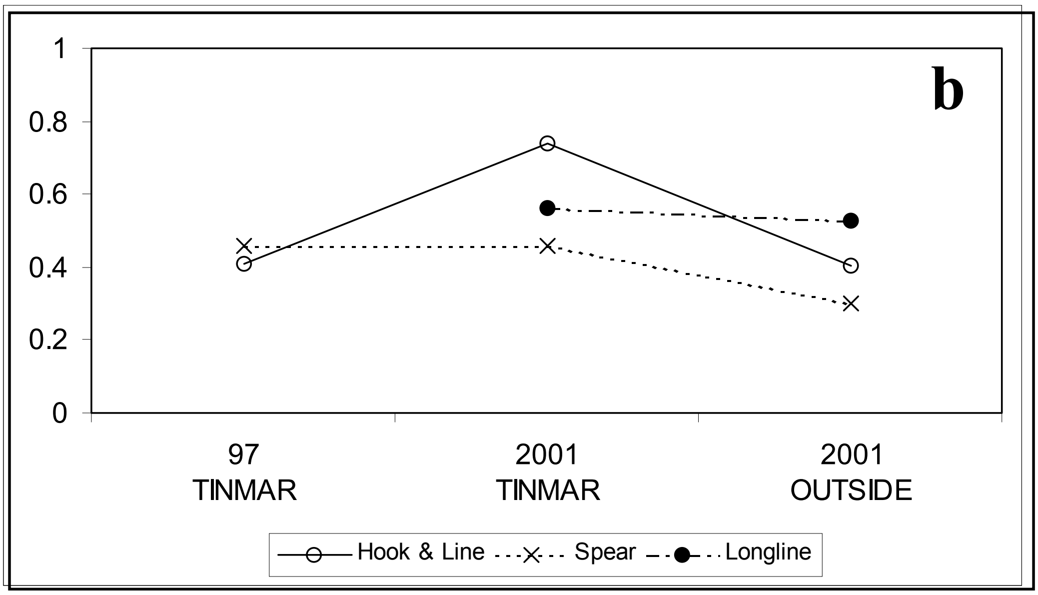




Fig. 33.3. Comparison of catch rates of various gear types used within and outside the reserve area, 1997 and 2001.

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# CHAPTER 34 DANJUGAN ISLAND MARINE RESERVE AND SANCTUARIES, NEGROS OCCIDENTAL

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## 34.1 General Information

| | |
|---|---|
| Marine Protected Area Name: | Danjugan Island Marine Reserve and Sanctuaries |
| Barangay, Municipality, Province: | Brgy. Bulata, Cauayan, Negros Occidental |
| Area: | 102.4 has. (3 sanctuaries no take zones) and approximately 100 has. (reserve around the island) |
| Local People's Organization | Handum MPC, FiFa MPC, Payao2 MPC, Bulata MPC |
| On-site Development Organization (contact person) | Philippine Reef and Rainforest Conservation Foundation, Inc. (PRRCFI)<br>Mr. Gerardo L. Ledesma, President |
| Established: | Mun. Ord. 99-52 Passed by Municipal Council, Dec, 1999<br>Mun. Ord. 99-52 Approved by Provincial Board, Feb. 2000 |
| Boundaries Marked/Signs Posted | April 2000 |
| Enforcement | April 2000 |
| Management: | Danjugan Island Marine Reserve and Sanctuaries Management Board and field personnel |
| Enforcement by: | DIMRS Wardens, Bantay Dagat Volunteers and PRRCFI Island Warden |
| Award/Recognition: | Best Managed Reef for 2002 by PhilReefs, DA and DENR |

## 34.2 Biophysical setting

The baseline and monitoring surveys of Danjugan Island were undertaken by PRRCFI and Coral Cay Conservation Ltd. (CCC) personnel and volunteers in 1995-96 and 1999-2002. The fringing reefs of DIMRS have at least 240 sclerectinians (hard corals) and hydrocorals representing 72 genera with 20 species regarded as being rare in the Philippines. There are 387 fish species belonging to 139 genera. Commercially important fish species such as snappers (Lutjanidae), groupers (Serranidae), emperors (Lethrinidae), and endangered and threatened species like the giant manta ray (*Manta birostris*), Napoleon wrasse (*Cheilinus undulatus*) and whale sharks (*Rhincodon typus*) have been observed around the island. There are 43 genera of macro-algae (seaweeds), 4 genera of blue-green algae and 8 species of seagrasses in the intertidal zones.

Commercially important marine invertebrates like giant clams (*Tridacna crocea*, *T. squamosa* and *Hippopus hippopus*), abalone (*Haliotis asinina*), lobsters (*Panulirus* spp.) have been noted in the surrounding reefs. While coconut crabs (*Birgus latro*) still abound in the coastal and mangrove forest of the island. The beaches of the island are known to be nesting sites of hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*).

The remaining limestone forest of the island is host to 68 species of birds with a pair of White Breasted Sea Eagles guarding the island. The threatened Tabon scrubfowl (*Megapodius freycinet*) is also abundant around the island. The 6 lagoons surrounded by mangrove forest with 13 mangal species serve as an important breeding ground for the Rufous Night (*Nyticorax calendonicus*). Aside from the forest, the caves found all over the island serve as resting places for 9 species of bats.

These diverse reef and forest resources in Danjugan Island meet the ecological criterion for Marine Protected Areas (reserves and sanctuaries) as set by the World Conservation Union (IUCN). The Municipality of Cauayan (Mun. Ord. No. 99-52) has declared the waters surrounding Danjugan Island (500m from the shore) as a marine reserve with three "no-take" marine sanctuaries covering 102.4 hectares (fig 34.1). This makes the Danjugan Island Marine Reserve and Sanctuary (DIMRS) as the first island marine reserve and sanctuary in southern Negros Occidental. The forests and lagoons on the island are considered as a wildlife refuge for birds, bats and other wildlife.

## 34.3 Socio-economic setting

Barangay Bulata belongs to the southern municipality of Cauayan, Negros Occidental. It is located 151 km south of Bacolod City, the capital of Negros Occidental and 38 km from the municipal center of Cauayan. The barangay has a total land area of 2,337 hectares including two islands, Danjugan and Agutayan Islands. In 2000, the total population of the barangay was 4,900 from 817 households and an average household size of 7 persons.

Fishing and fishing related activities (including gleaning) is the number one occupation in the community followed by farming and retailing. Majority have non-motorized boats, some have motorized outriggers. A typical fishing boat would carry around 2-4 persons. The most common fishing gear are gill nets (63%), hook and line (28%), spearfishing (8%) and fish traps (1%). Fishing activities start at dawn until night time. Fishing grounds are located in front of the village less than 2 km, from Danjugan Island (on the reserve where fishing is permitted), Agutayan Island and the neighboring barangays of Inayauan and Elihan. Seasonal fisheries in the area include flying fish (*Cypsulurus* spp.), reef needlefish (Tylosauridae) and halfbeaks (Hemirampidae). The year round catch is mostly reef fishes and pelagic fishes such as tunas and jacks and occasionally octopus and squid. The average catch per fisherman is around 1-3 kilos per day. When they are not fishing, most of them have no other source of income while others would resort to farming, construction work, working as hired labor and retail stores.

A Barangay Fisheries and Aquatic Resources Management Council (BFARMC) was formed and *Bantay Dagat* volunteers were deputized in 2000 through the efforts of the foundation. The DIMRS Management Board was also created through the municipal ordinance and is supported by the foundation in terms of capability-building and organizational-strengthening.

## 34.4 Management

The DIMRS Management Board, created by the same Municipal Ordinance establishing the DIMRS, operates and manages DIMRS. The DIMRS-MB has 12 members as follows: Municipal Mayor Jerry Tabujara (Chair), Brgy. Capt. Abraham Montes (vice-chair), Municipal Agriculture Officer, Municipal Planning and Development Officer, Municipal Chief of Police, Municipal Council Chair on Fisheries and the Environment, representatives from the Department of Environment and Natural Resources (DENR), the Principal of the Bulata Elementary School, PRRCFI as NGO representative, 2 representatives from the Fisherfolks Organization and a representative from the 4th Regional Mobile Group based in Brgy. Bulata.

Aside from the management board, there are 7 field personnel to manage the day to day implementation of the DIMRS which is composed of one park superintendent, treasurer/secretary and 5 wardens. Enforcement of the DIMRS rules and regulations, municipal fishery ordinance and national laws is carried out by DIMRS field personnel with support from the local *Bantay Dagat* volunteers and PRRCFI personnel. Funding is generated from the entrance fees to the reserve, donations, project grants and government funds.

## 34.5 Issues and Threats

Financial sustainability to operate and manage the reserve is the current problem of the management board of the DIMRS. There are still no fund releases from the municipality to purchase equipment and for operations. At present the reserve is relying on the limited funds generated from the visitor entrance fees and donations. This can not keep up with the expenses for patrolling and monitoring, thus making the reserve susceptible to illegal fishers.

At present, destructive fishing activities such as cyanide and blast fishing are no longer observed around the DIMRS including areas outside the reserve. However, compressor "hookah" fishers from a neighboring municipality were reported entering the reserve.

Natural threats are mostly crown-of-thorns infestations whose population is being monitored regularly. During the El Niño phenomena in 1998, coral bleaching affected almost 80% of one reef in the DIMRS. Since then, bleaching monitoring surveys, including permanent quadrats for coral recovery, have been carried out regularly after the bleaching event.

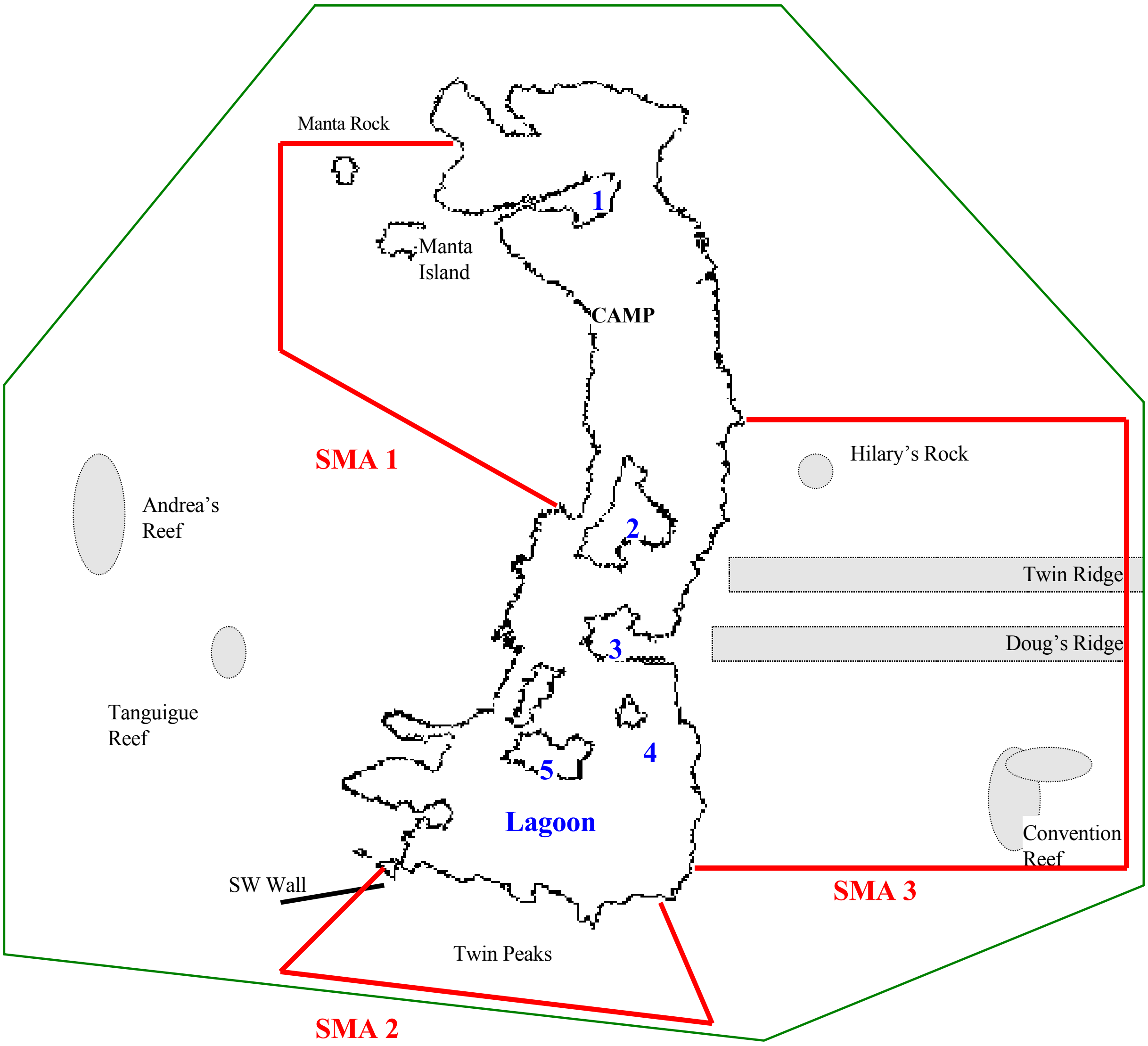


Fig. 34.1. Map of Danjugan Island with DI Marine Reserve (outer boundary), three "no-take" Special Management Areas (thick lines), main coral reef sites, and lagoon.

## 34.6 Monitoring, Evaluation and Feedback

The PRRCFI scientific team, trained locals, the University of the Philippines Marine Science Institute (UP-MSI) and foreign experts carry out scientific monitoring of the reserve through the assistance of the foundation. The monitoring includes fish population using Fish Visual Census, and benthic cover using Point and Line Intercepts and Video transects.

Monitoring of sedimentation through sediment traps was done around the reserve and in the mainland coastline of Cauayan, Neg. Occ. and monitoring of Crown of Thorns (COT) infestation within the DIMRS.

Visiting local and foreign scientists have helped survey and monitor: Dr.Edgardo Gomez (UP-MSI) for giant clam seeding and nursery, Dr. Porfirio Aliño (UP-MSI) for coral, fish and fish juvenile recruits, Dr. Vincent Hilomen (University of the Philippines Los Baños) for fish tagging experiment, Dr. Doug Fenner (James Cook University) for coral inventory, Ms. Ma. Beger (James Cook University) for fish and benthic cover and Mr. Willi White (University of Edinburgh) for reef mapping.

Coral bleaching recovery monitoring employing permanent 1 $m^2$ quadrat at three depths (i.e., 6, 8,and 12 m) was conducted since the outbreak of bleaching in 1998. The monitoring was done in Hillary's and Convention Reefs: 2-weeks (September 1998), 12-months (September 1999) and 24 months (August 2000) post bleaching (Table 34.5).

Table 34.1. Fish population and benthic cover survey methodologies for DIMRS, Cauayan, Negros Occ.

| Date | Methodology | Sites | Conducted by |
|---|---|---|---|
| April 2000 | 50-m x 5-m x5-m for Fish Survey<br>50-m Point Intercept for Benthic Survey<br>15 m depth | 15 transects in three SMA's (inside) and 15 transects in three control sites within the reserve | PRRCFI |
| Feb 16-19, 2001 | 50-m x 10-m x 5-m for (Fish Survey)<br>Manta Tow and Video Transect (Benthic Survey)<br>6-7 m depth | 4 transects inside the SMA's and transects outside the SMA's | UP-MSI |
| March 2001 | 50-m x 5-m x 5-m for Fish Transect<br>50-m Point Intercept for Benthic Survey<br>15 m depth | 15 transects in three SMA's (inside) and 15 transects in three control sites within the reserve | PRRCFI |
| Sept 25-28, 2001 | 50-m x 10-m x 5-m for (Fish Survey)<br>Video Transect (Benthic Survey)<br>6-7 m depth | 5 Transects inside the SMA's and 5 located outside the SMA's | UP-MSI |

Table 34.2. Average abundance of reef fish (individuals / 1,000 $m^2$), DIMRS, Cauayan, Negros Occ.

| Fish family | Inside MPA | | | | Outside MPA | | | |
|---|---|---|---|---|---|---|---|---|
| | Apr-00 | Feb-01 | Mar-01 | Sept-01 | Apr-00 | Feb-01 | Mar-01 | Sept-01 |
| Acanthuridae | 151.2 | 134.00 | 154.08 | 131.60 | 124.28 | 72.00 | 78.92 | 78.04 |
| Chaetodonidae | 42.92 | 42.50 | 16.64 | 51.20 | 45.6 | 32.00 | 8.8 | 39.60 |
| Labridae | n.d. | 74.50 | n.d. | 108.40 | n.d. | 88.00 | n.d. | 136.40 |
| Pomacentridae | n.d. | 680.00 | n.d. | 1224.0 | n.d. | 743.00 | n.d. | 753.60 |
| Scaridae | 22.92 | 23.50 | 22.68 | 49.60 | 23.2 | 52.00 | 19.72 | 25.60 |
| Serranidae* | 9.88+ | 390.00 | 6.8+ | 714.40 | 8.52+ | 186.00 | 12.8+ | 220.40 |
| Transect n = | 15 | 4 | 15 | 5 | 15 | 2 | 15 | 5 |
| Depth | 15 m | 6-7 m | 15 m | 6-7 m | 15 m | 6-7 m | 15 m | 6-7 m |

*includes Anthiases, + only groupers; n.d. – no data available

Table 34.3. Average biomass of reef fishes (Kg/ 1,000 $m^2$), DIMRS, Cauayan, Negros Occ.

| Fish Family | Inside MPA | | | | Outside MPA | | | |
|---|---|---|---|---|---|---|---|---|
| | Apr-00 | Feb-01 | Mar-01 | Sept-01 | Apr-00 | Feb-01 | Mar-01 | Sept-01 |
| Acanthuridae | 9.76 | 15.48 | 9.93 | 6.02 | 5.55 | 3.42 | 3.22 | 1.93 |
| Chaetodonidae | 0.47 | 2.35 | 0.44 | 1.17 | 0.19 | 1.33 | 0.17 | 0.68 |
| Labridae | n.d. | 1.35 | n.d. | 1.42 | n.d. | 1.02 | n.d. | 0.89 |
| Pomacentridae | n.d. | 7.66 | n.d. | 6.39 | n.d. | 8.29 | n.d. | 2.66 |
| Scaridae | 6.47 | 2.71 | 2.03 | 3.02 | 1.75 | 0.69 | 2.67 | 0.77 |
| Serranidae | +0.99 | *3.99 | +0.33 | *3.09 | 0.85+ | *1.65 | 0.76+ | *0.56 |
| Transect n = | 15 | 4 | 15 | 5 | 15 | 2 | 15 | 5 |
| Depth | 15 m | 6-7 m | 15 m | 6-7 m | 15 m | 6-7 m | 15 m | 6-7 m |

*includes Anthiases, + only groupers, n.d. – no data available

## 34.7 Future directions, Gaps and Recommendation

The DIMRS with assistance from the PRRCFI is looking for funding to source their activities through grants and donations from private individuals and corporations. It also envisions an integrated eco-tourism development program for the reserve to sustain management activities.

Table 34.4. Benthic cover, DIMRS, Cauayan, Negros Occ.

| Benthic Category | Inside MPA | | | | Outside MPA | | | |
|---|---|---|---|---|---|---|---|---|
| | 3-00 | 3-01 | 4-01 | 9-01 | 3-00 | 3-01 | 4-01 | 9-01 |
| Hard Corals | 29.93 | 25.86 | 28.46 | 36.00 | 23.87 | 26.75 | 25.80 | 24.67 |
| Soft Corals | 2.33 | 1.38 | 1.36 | 2.3 | 3.87 | 0.45 | 1.98 | 3.33 |
| Dead Corals | n.d. | 0.03 | 0.00 | n.d. | n.d. | 0.08 | 0.00 | n.d. |
| Dead Coral Algae | 19.13 | 0.20 | 21.98 | 12.67 | 8.4 | 0.58 | 7.55 | 5.67 |
| Algae | 26.6 | 47.73 | 13.81 | 22.3 | 35.67 | 47.8 | 20.83 | 34.33 |
| Abiotic | 32.93 | 4.33 | 12.06 | 22.0 | 45.40 | 12.21 | 31.42 | 28.67 |
| Transect n = | 15 | 4 | 5 | 15 | 15 | 2 | 5 | 15 |
| Depth | 15 m | 6-7 m | 6-7 m | 15 m | 15 m | 6-7 m | 6-7 m | 15 m |

Table 34.5. Coral Bleaching Recovery Results from 1998 – 2000, DIMRS, Cauayan, Neg. Occ.

| 6 months (1998) | 1 year (1999) | 2 years (2000) |
|---|---|---|
| Significant recovery of coral tissues from 10% to 20-25% at 18 m in both sites<br>Increase in algal cover between 25-82% in all sites | Live coral cover has 5-18% change at 12 m and 3-30% at 18 m in all sites<br>Decrease in algal cover due to fish herbivory<br>Branching corals (Acroporids), *Porites* and soft corals never recovered | Increase of live coral cover 60% (new recruits) and 55% increase in coral tissue of *Pavona clavus* (submassive type)<br>Encrusting algae dominant followed by *Halimeda* spp.<br>Coral recruits of acroporids, pocilloporids and fungids were observed in the affected areas |

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# CHAPTER 35 TUBBATAHA REEFS NATIONAL MARINE PARK, PALAWAN

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## 35.1 Biophysical Setting

The Tubbataha Reefs National Marine Park (Fig. 35.1) lies in the middle of the Sulu Sea, about 150 km away from Puerto Princesa City, Palawan. The reef structure consists of both fringing and atoll reefs and harbors a diversity of marine life equal to or greater than any other such area in the world. The 33,200-hectare Tubbataha Reefs National Marine Park is home to at least 372 coral species (Fenner 2001 unpublished) and at least 379 species of fish, including 6 species of sharks (White and Arquiza 1999). In 2000, 448 species from 57 families of fish were recorded (White et al. 2000). There are at least 7 species of seagrasses and 79 species of algae (White and Arquiza 1999) and at least 6 species of cetaceans found in the park (Dolar and Alcala 1993; SU 1995). The islets of the park are breeding sites of at least 5 out of the 12 species of seabirds (Manamtam 1996), and nesting sites for 2 species of sea turtles.

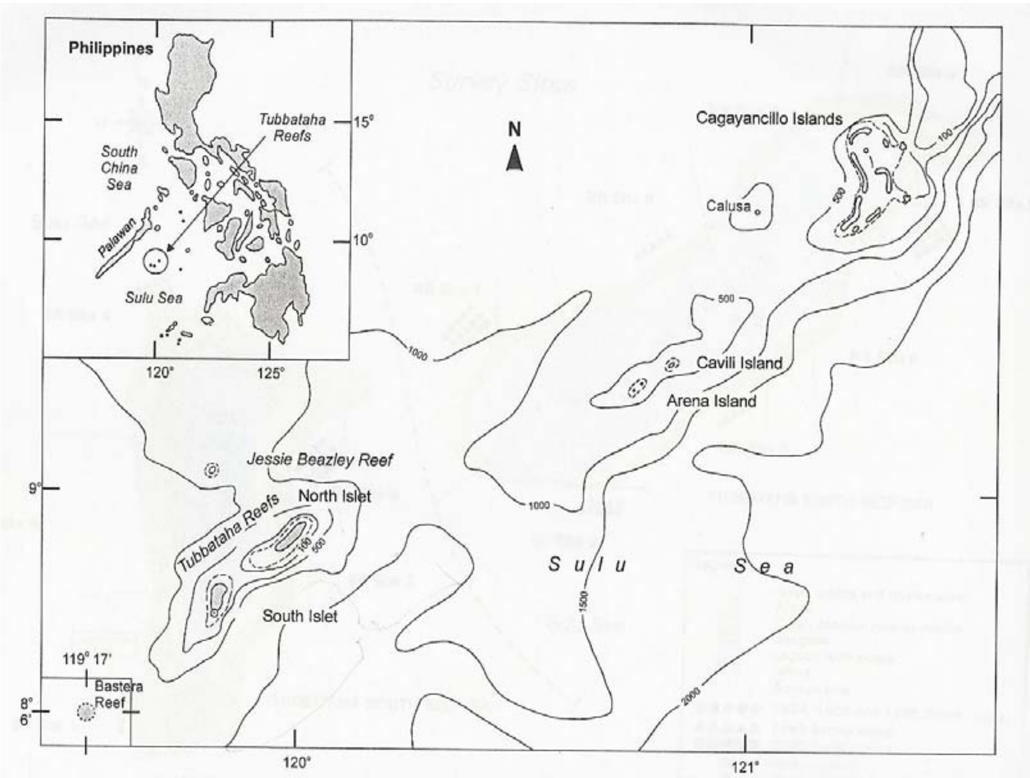


Figure 35.1. Tubbataha reefs

Despite its remoteness, in the late 1980's the condition of the once pristine reefs of Tubbataha deteriorated due to the destructive fishing methods used by fishermen. These were carried out not only by local fishermen but also by migrant fishermen from the South and Central Philippines and from Taiwan and China. Though these fishing activities were limited due to monsoon winds, the extent of living coral on the outer reef flats was surveyed to have decreased by 24% within 5 years. The introduction of seaweed farming in 1989 also threatened the reef but was stopped in 1991.

The reef then became a center of interest to many conservationists and enthusiasts for protection. It became the first National Marine Park in 1988 and a UNESCO World Heritage Site in 1994. A management plan was developed and slowly conservation actions were undertaken. Now, Tubbataha is considered to be relatively intact and one of the last large reefs in the Philippines that has healthy corals with an abundant and diverse association of organisms.

## 35.2 Socio-economic Setting

The closest human settlement is the Municipality of Cagayancillo 70 km north. It is distinct from other cultures in the Philippines and the inhabitants live independently from the mainstream of the country. It is mostly self sufficient and is physically separated from modern existence. Cagayancillo is a 6$^{th}$ class municipality and most of its inhabitants are self employed. Until about 1986 fishing was the primary source of income whilst farming was a secondary source. Seaweed culture became widespread in the late 1980's replacing fishing as the main source of cash income. In 1989, 63% of the population was involved in seaweed farming while 67% relied on fishing. 35% of the population depended on agricultural farming and 2% were government employees. Though fishing and farming still provided income their purpose became relegated to subsistence and home consumption.

## 35.3 Management history

A timeline of management events up to the present follows:

| | |
|---|---|
| 1988 | Park declared by Presidential Decree |
| 1989 | First draft of park management plan based on limited information |
| 1990 | Sporadic patrols started to stop illegal and destructive fishing |
| 1991 | Illegal seaweed farm removed from the Park |
| 1992 | Several research expeditions collected baseline data on the coral reef |
| 1993 | Park management plan re-drafted; illegal activities increase |
| 1994 | World Heritage status declared |
| 1995 | Presidential Task Force set up to implement management and provide funds; Philippine Navy assigned to guard park |
| 1996 | Coastal Resource Management Project (CRMP) refines management plan together with Japan International Cooperation Agency (JICA) support, Department of Environment and Natural Resources (DENR), Palawan Council for Sustainable Development (PCSD), World Wide Fund for Nature (WWF) and stakeholders in Palawan and Cagayancillo |
| 1997 | CRMP initiates study of legal basis for Protected Area Management Board (PAMB) to become functional together with DENR, PCSD and WWF; JICA sponsors planning and supports educational tour for media together with CRMP |
| 1998 | PAMB formed based on DENR/CRMP recommendations; management plans endorsed in a workshop with all stakeholders with support from PCSD, DENR, WWF, CRMP; coral bleaching event kills more than 20% of living coral cover |
| 1999 | PAMB becomes operational with a park manager appointed and supported by WWF based on management plan; Global Environment Facility (GEF) 5-year funding approved for park management based on management plan; Marine Parks Center of Japan engaged CRMP and the Sulu Fund to facilitate the construction of a Park ranger station |
| 2000 | Management plan fully endorsed by the PAMB for implementation and fee structure designed based on willingness-to-pay study of WWF; revenue of between US$50,000 and 100,000 to be collected; CRMP and the Sulu Fund jointly implement reef monitoring funded by volunteer divers |
| 2001 | WWF continues planning with management activities |

## 35.4 Issues and Threats

Destructive fishing methods such as the use of explosives, sodium cyanide and large scale extraction of sea turtles, precious and common shell, and giant clams have had a detrimental effect on the ecosystem as a whole in years past. Fish trawling, long lining for tuna and boat anchor damage have also affected the reef ecosystem and the abundance of fish but is now being minimized. The primary current threats are the difficulty for Park managers to maintain constant surveillance in Tubbataha to deter the threat of illegal entry of fishermen from the Philippines and other Asian countries. Also, the need to maintain good anchoring facilities and visitor control is crucial for the increasing number of dive vessels entering the Park.

## 35.5 Monitoring, Evaluation and Feedback

### Methods (1984-2000)

A snorkeling survey method (White et al. 1999) was used to estimate benthic cover at 2-4 m depth of 1 to 1.5 km of reef while point-intercept transect (25-cm intervals) with the aid of SCUBA was used to estimate benthic cover at 6-8 m depth of 50-m transects. Reef fish by visual census, indicator fish and invertebrate species, rare or large marine life, and human activities were also recorded. All survey methods used were consistent with Uychiaoco et al. (2001) and with methods used by Reef Check.

### Methods (1997-2001)

Initial surveys using manta tow were used to select sites marked with cement blocks spiked into the substratum. Four sites in the North Atoll and 3 sites in the South Atoll were established and monitored in October 1997 and have been monitored every summer (March-May) since then (Fig. 35.2).

Benthic communities were monitored using video (English et al. 1997); Benthos Point – Intercept Method (McManus et al. 1997) was used as an alternative method due to some technical difficulties in years 1999 and 2001. Some transect sites were also not monitored in certain years for the same reason (Table 35.1). Fish visual census (English et al. 1997) of 100-m transects were done in conjunction with coral reef benthos assessment.

Table 35.1. Summary of methods used per year and the sampling months (Ledesma 2001)

| Site | 1997<br>April | 1998<br>May | 1999<br>March | 2000<br>April | 2001<br>April |
|---|---|---|---|---|---|
| North Atoll (site #1) | Video | Video | Point-Intercept | Video | Point-Intercept |
| North Atoll (site #2) | Video | Video | No data | Video | Point-Intercept |
| North Atoll (site #3) | Video | Video | Point-Intercept | Video | Point-Intercept |
| North Atoll (site #4) | Video | No data | Point-Intercept | Video | Point-Intercept |
| South Atoll (site #5) | Video | Video | Point-Intercept | Video | Point-Intercept |
| South Atoll (site #6) | No data | Video | Point-Intercept | Video | Point-Intercept |
| South Atoll (site #7) | Video | Video | No data | Video | Point-Intercept |

### Summary of Trends and Findings

Table 35.2 shows summaries of the mean percent of reef substrate from the 7 sites surveyed from 1984 to 2000. SCUBA transect data collected at 5-7 m showed an increase in coral cover up to 1996 and then a decline in 2000 due to coral bleaching. There was little evidence of large-scale physical damage from either dynamite fishing or the use of sodium cyanide in the year 2000. The natural impact of concern is the major bleaching incident of late 1998 during which coral all over the Philippines was affected. Improvements in living coral cover up to 1996 can be mostly attributed to improved management and protection.

### Benthic Community Structure

The mean hard coral cover for the whole Tubbataha Reef (North and South Atoll) recorded in 1999 was 18.76% lower than in 1997. From 1999 to 2001, the mean hard coral cover remained relatively constant or showed no significant changes (Table 35.3). Similarly, soft coral cover also decreased from 1997 to 1999 by 6.5%, and from 1999 to 2001 it remained relatively constant showing no significant changes. Coincident with the decline in coral cover, algal cover showed an increase of 27.5% from 1998 - 1999. Dead coral with algae (DCA) also increased by 11.55% from 1999–2000. The changes in DCA from 2000–2001 was not significant.

The South Atoll sites displayed higher hard coral cover than the North Atoll sites. Hard coral cover in the North Atoll displayed a decreasing trend from 1997 – 2000 while in the South Atoll, hard coral cover increased in 2000. The soft coral cover in the South Atoll was relatively constant over the last five years. Both sites displayed an increase in algae in 1999 and a decrease in coral cover between years 1997 – 1999.

Six of the seven coral reef areas surveyed (1984-2000) are legally protected from fishing; only Bastera reef is outside the park (Table 35.4). The fish abundance survey reflects the relative success of Tubbataha Park management since the abundance of fish per unit area (density) in 2000 is 26% higher on average than in 1996. Increases in the fish densities are statistically significant in some cases. Significant increases in certain target families such as grouper, emperor breams, jacks and several others in particular sites can be attributed to the lack of fishing pressure over the last 10 years.

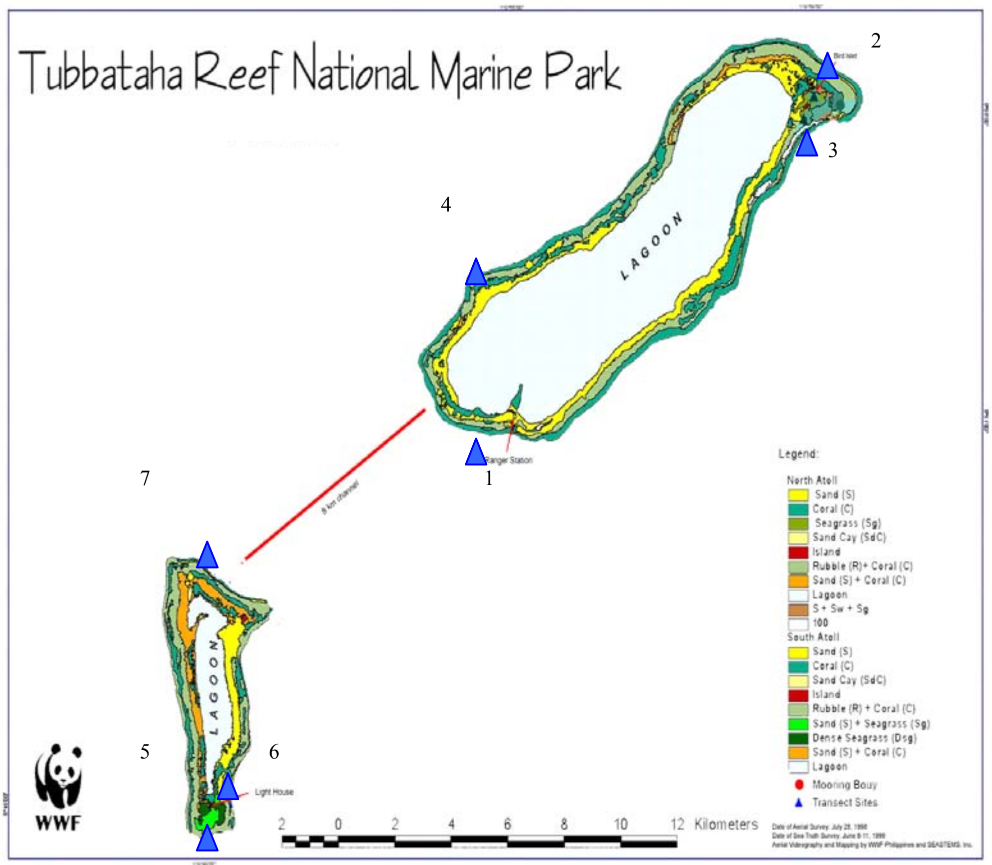


Figure 35.2. Location of transect sites

Table 35.2. Mean percent of living and dead substrate cover for the 7 study sites, 1984 to 2000, at deep (1.5-15 m) and shallow (1-7 m) reef areas (White et al. 2000)

| **BENTHOS** | **Deep** | | | | **Shallow** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1984** | **1992** | **1996** | **2000** | **1984** | **1989** | **1992** | **1996** | **2000** |
| Hard Coral | 39.6 | 34.1 | 47.2 | 27.1 | 48.2 | 25.1 | 33.2 | 46.8 | 24.6 |
| Soft Coral | 7.4 | 20.6 | 16.9 | 5.1 | 7.6 | 13.4 | 7.2 | 3.2 | 1.8 |
| Abiotic | 49.0 | 41.6 | 33.4 | 51.8 | 40.2 | 52.6 | 55.8 | 38.1 | 65.8 |
| Dead Coral | 4.0 | 3.8 | 2.5 | 1.4 | 4.0 | 8.8 | 3.8 | 11.9 | 2.1 |
| Dead Coral with Algae | ~ | ~ | ~ | 14.7 | ~ | ~ | ~ | ~ | 5.6 |
| **GRAND TOTAL** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** | **100** |
| Depth Range (m) | 1-15 | 2-15 | 5-10 | 5-7 | 2-7 | 2-7 | 1-7 | 1-3 | 2-3 |
| Sample Size (50-m transects/1m²stations) | 3 | 15 | 29 | 120 | 4 | 10 | 30 | 9 | 79 |

Table 35.3. Mean percentages of the benthic categories (Ledesma 2001).

| Benthos | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|
| Hard Coral | 49.56 | 42.87 | 30.80 | 31.95 | 32.30 |
| Soft Coral | 15.00 | 15.30 | 8.50 | 9.15 | 7.68 |
| Abiotic | 24.24 | 28.62 | 25.40 | 27.48 | 20.82 |
| Algae | 1.28 | 0.32 | 27.80 | 1.15 | 0.60 |
| Dead Coral with Algae | 2.40 | 0.55 | 2.10 | 13.65 | 17.38 |
| Other Fauna | 7.50 | 12.34 | 5.70 | 16.61 | 14.61 |

Table 35.4. Mean fish abundance (individuals/500 $m^2$) 1992 to 2000. (White et al. 2000)

| FISH FAMILY | 1992 5 sites n=5 | 1996 5 sites n=11 | 2000 7 sites n=36 |
|---|---|---|---|
| Surgeonfish (Acanthuridae)* | 213.20 | 120.8 | 178.39 |
| Rabbitfish (Siganidae)* | 1.20 | 4.4 | 2.67 |
| Groupers (Serranidae)* | 9.80 | 9.0 | 17.07 |
| Snapper (Lutjanidae)* | 29.00 | 15.8 | 10.94 |
| Sweetlips (Haemulidae)* | 3.00 | 1.9 | 4.56 |
| Emperors (Lethrinidae)* | 1.80 | 3.6 | 8.04 |
| Jacks (Carangidae)* | 7.20 | 2.1 | 9.84 |
| Fusiliers (Caesionidae)* | 148.80 | 76.5 | 57.99 |
| Spinecheeks (Nemipteridae)* | 0.60 | 24.7 | 7.71 |
| Goatfish (Mullidae)* | 53.40 | 44.3 | 18.99 |
| Parrotfish (Scaridae)* | 90.60 | 56.4 | 64.09 |
| Rudderfish (Kyphosidae)* | 0.00 | 1.7 | 8.26 |
| Triggerfish (Balistidae) | 139.20 | 51.9 | 289.07 |
| Butterflyfish (Chaetodontidae) | 55.00 | 44.6 | 43.93 |
| Angelfish (Pomacanthidae) | 28.80 | 7.9 | 32.10 |
| Wrasses (Labridae) | 160.80 | 94.4 | 115.34 |
| Damselfish (Pomacentridae) | 1012.20 | 1653.2 | 1837.02 |
| Fairy Basslets (Anthiinae) | 955.80 | 787.7 | 924.12 |
| Moorish Idols (Zanclidae) | 17.40 | 20.2 | 9.27 |
| **Total (all reef species)** | **2927.80** | **3020.6** | **3639.40** |
| **Total (Target reef species)** | **558.60** | **360.8** | **388.51** |

* Target species sought by fishermen

## Fish abundance, biomass and diversity

The changes in the estimated total fish biomass recorded in Tubbataha Reef from 1998 to 1999 was significant ($F_{3,24}$=6.125, P=0.003). The total fish biomass was divided into two groups, demersal fish species and pelagic and outlier (transient species and chance encounters) species (Table 35.5). The pelagic fish species and outliers greatly influenced the biomass recorded, making up the majority of the biomass in 1999 and 2000. Large schools of jacks (Carangidae), fusiliers (Caesionidae) and unicornfish (Acanthuridae, Subfamily Nasinae) were chanced upon in some sites. In 2001 on the other hand, demersal fishes made up the majority of the fish biomass. The recorded changes in demersal fish biomass from 1998 to 1999 was significant ($F_{3,24}$=9.317, P=0.000).

The total number of fish species recorded in 5 years and compiled for Tubbataha Reef was 417 species (56 families). Species richness in the preceding years (1997 – 2000) is presented in Table 35.4.

Some commercially important species, such as groupers (Serranidae), parrotfishes (Scaridae) and wrasses (Labridae) displayed increasing trends in biomass, however, the density showed a decrease in 2001. The increase in biomass from 1998 to 2001 of both groupers ($F_{3,24}$= 4.915, P=0.008) and wrasses ($F_{3,24}$= 7.206, P=0.001) were statistically significant, both displaying an increasing trend. The changes in density however, were not significant. Parrotfishes did not show significant changes in either biomass or density.

Butterflyfishes showed a decrease in both biomass and density in 2001. The change in biomass over the years was not statistically significant. Surgeonfishes/unicornfishes on the other hand displayed and increase in density and biomass in 1999 (Table 35.6). Unicornfishes made up the majority of the family biomass in 1999, while surgeonfishes gradually increased from 1998 to 2001. This increase in 1999 however was not significant since large groups of unicornfishes were chanced upon only in some sites. Damselfish (Pomacentridae) biomass on the other hand changed significant ($F_{3,24}$=3.28, P=0.038) between 1998 to 2000.

## Biomass of different trophic groups

The increase in biomass was true for almost all major trophic groups after 1998. The trophic groups, which greatly influenced the total biomass in 1999 and 2000, were the zooplanktivores and nekton feeders. In the nekton-feeding trophic group, jacks (Carangidae) and sharks (Hemigaleidae & Carcharhinidae) made up the majority of the biomass, while in the zooplanktivorous trophic group, it was the fusilers and unicornfishes. Carnivores and zoobenthos feeders, which also increased after 1998, however decreased from 2000 to 2001. Herbivores were the only group that displayed an increasing trend from 1998 to 2001.

Table 35.5. Summary of fish diversity, density (1000 $m^2$) & biomass (kg/1000$m^2$) (Ledesma 2001)

| | YEAR (n=7) | | | | |
|---|---|---|---|---|---|
| | 1997 | 1998 | 1999 | 2000 | 2001 |
| No. of species | 161 | 237 | 211 | 227 | 183 |
| No. of families | 29 | 31 | 35 | 31 | 26 |
| Total Density | 6272 | 2359 | 7614 | 6438 | 5084 |
| Biomass | | | | | |
| Pelagics & outliers | | 34.16 | 184.14 | 209.22 | 29.83 |
| Demersal | | 26.44 | 128.72* | 88.37 | 71.69 |
| **Total** | | **60.60** | **312.86*** | **297.60** | **101.52** |

***Significant to P≤0.05; values were log (10) transformed**

Table 35.6. Mean biomass (kg/1000 $m^2$) of groupers, parrotfishes, wrasses, butterflyfishes, damselfishes and surgeonfishes & unicornfishes (Ledesma 2001)

| | Year | | | |
|---|---|---|---|---|
| Fish Family | 1998 | 1999 | 2000 | 2001 |
| Groupers | 1.41 | 3.33 | 6.94 | 8.64* |
| Parrotfishes | 3.42 | 2.92 | 7.14 | 9.83 |
| Wrasses* | 0.57 | 1.00 | 1.42 | 2.77 |
| Butterflyfishes | 2.49 | 1.9 | 3.19 | 1.79 |
| Damselfishes* | 4.05 | 7.73 | 20.50 | 15.07 |
| Surgeonfishes & Unicornfishes | 8.87 | 105.36 | 27.16 | 23.61 |

***Significant to P≤0.05**

### Discussion

The decline in coral cover in Tubbataha reef was attributed to the bleaching event caused by the El Niño phenomenon. The increase in sea surface temperatures (SST) associated with the El Niño – La Niña change in climate from 1997 to 1998 resulted in extensive coral bleaching in large parts of the Indian Ocean and Southeast and East Asia (Wilkinson 2000). Current studies have suggested that there was no immediate decline in fisheries after the bleaching event, partly because reef fish communities are slow to respond to environmental change (Westmancott et al. 2000). In Tubbataha, fish biomass and density increased after the bleaching event in 1999 and 2000 and subsequently declined in 2001. Species richness also declined the same year. However, density and biomass recorded in 2001 were still higher than in 1998. Most of the trophic groups declined in 2001. On a degraded reef, dead coral is supposedly quickly overgrown by algae that are in turn eaten by herbivores such as parrotfishes and surgeonfishes that would increase (Westmancott et al. 2000). The same increase in fish biomass after the bleaching event was recorded in El Nido and Bolinao (Cesar et al. 2000), primarily due to the increase in herbivores. However, in Tubbataha, almost all major trophic groups increased in biomass after the bleaching event. The increase in these herbivores helps keep the algal growth in check. According to Cesar et al. (2000), the increase in fish biomass and abundance may only be a short-term effect of the bleaching event and may be attributed to the sudden increase in food resources, such as algae.

## 35.6 Future directions, Gaps and Recommendations

The management issues in Tubbataha National Marine Park have evolved substantially from 10 years ago. This is a welcome turn of events because Tubbataha is being managed and protected and the management plan endorsed in 1999 is being implemented. This is a change from 1989 when the reefs were at their lowest point and illegal fishing was rampant. There are still many things to do to improve the protection of Tubbataha so that it is long lasting and effective. Specific needs to improve conservation of Tubbataha from observations of 2000, 1996, 1992 and 1989 are:

- Active patrols are the single most important deterrent to prevent illegal fishermen and boats from entering the park.
- The Park Navy personnel can take a more active role in park management.
- More and better anchor buoys are needed to moor visiting boats.
- Improved management of tourism in general to Tubbataha is essential.
- More diver and boat operator education is needed
- Raising awareness about waste disposal is needed

- User fees, once collected, need to be managed credibly and made transparent and allocated for park management.
- Monitoring and evaluation information needs to be shared among all stakeholders.

In conclusion, the only mitigating measure for the expected increasing intensity and frequency of elevated sea surface temperatures related to the "El Niño" phenomena that occurred in 1998 is improved management of coral reefs. Tubbataha Reefs lost more than 20% living hard coral cover in 1998 due to warm water bleaching. Bleaching impacts were equally devastating on pristine and remote reefs as on reefs already under anthropogenic stresses (Wilkinson 2000). Such disturbance to reefs is almost impossible to control. The issue is global climate change. Coral reefs have been relatively resilient to this phenomenon in the past. However, reefs are now faced with a combination of threats from over-fishing, pollution and other human activities, global climate change is accelerating at a rate which may make it difficult for coral reefs to adapt (Westmancott et al. 2000). The only option is careful management to prevent all other negative impacts on the reef. For Tubbataha, its "no-take" policy should be strictly enforced and the park should be completely guarded from poachers and illegal fishermen. The reefs can recover this loss if they are protected from human impacts.

In a time when fisheries in the Philippines have surpassed sustainable levels of effort, the fish biomass data recorded in Tubbataha still exceeds what most coral reefs produce. Compared to other unprotected sites in the Philippines, Tubbataha has 4 to 10 times more fish biomass despite the decreases in coral cover. Marine reserves such as Tubbataha may be the only viable option available to maintain levels of spawning stock biomass necessary to sustain reef fisheries (Russ and Alcala 1996).

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Editor's note:

Tubbataha National Marine Park is being monitored from time to time by the following organizations: Coastal Resource Management Project (CRMP), Department of Environment and Natural Resources (DENR), Earthwatch, Marine Science Institute (MSI), Silliman University Marine Laboratory (SUML), Coastal Conservation and Education Foundation, Inc and Kabang Kalikasan ng Pilipinas (KKP). Currently, the Palawan Council for Sustainable Development (PCSD) together with the Tubbataha task force and KKP are the most active in the area (Nañola pers. com.).

# CHAPTER 36 TURTLE ISLANDS, TAWI-TAWI

Coral Monitoring in the Philippine Turtle Islands

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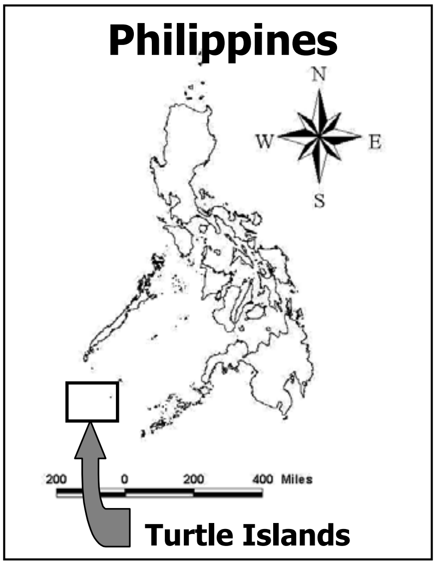
## 36.1 Biophysical Setting




The Philippine Turtle Islands is a municipality in the southwest Sulu sea, composed of six islands with an aggregate land area of 308 ha. The land area of each islands ranges from 7 ha. on Langaan to 116 ha in Taganak. The islands have a characteristic tadpole-shape, elongated along the northeast-southwest direction, with the higher portion located towards the northeast. This orientation follows the submerged Cagayan "Mapun" ridge, elongated along the northeast-southwest direction, and also runs parallel to Palawan Island as well as the Sulu archipelago. This ridge was submerged to present levels due to the rise in sea levels which occurred about 15,000 years before the present. The highest elevation is found in Taganak Island which is approximately 148 meters above sea level while Langaan Island the smallest, is relatively flat nested on an extensive coral reef platform (Bate, 1998). A unique feature is the presence of mud extrusions/volcanos on Bakkungan, Boan and Lihiman Islands. Due to more violent mud extrusions, Lihiman has the most prominent mud crater, forming a 20 m wide and 20 m deep at top of the hill in the northeastern corner of the island.

Five of the islands have permanent inhabitants: Boan, Bakkungan, Langaan, Lihiman and Taganak. On these houses or other structures dominate land cover. Typical of other rural areas in the Philippines, agricultural land is scattered amongst the living areas. Most of the areas used for agriculture are planted with coconuts, but small areas are also planted with subsistence food crops, including corn, cassava, banana and watermelon at certain times of the year.

The six islands in the Philippine Turtle Islands are part of a single, well-defined rookery of green turtles shared with the Sabah Turtle Islands. The Philippine-Sabah Turtle Islands and Berau, Indonesia support the only major (more than 1,000 nesters annually) green sea turtle breeding aggregations in the world. It is estimated that up to 5,400 nesters lay their eggs every year on these islands. Green sea turtles migrate to feeding grounds throughout the ASEAN region and then migrate back to breed in the Turtle Islands. Aside from the marine turtles, the area supports a diverse population of marine fauna (corals and fishes) as well as several species of birds.

## 36.2 Socio-economic Setting

The population is dominated by the Jama Mapuns and the Tausugs. The population of the Turtle Islands by migration of Jama Mapun from Cagayan de Tawi-Tawi to the area began in the 1940's. The Jama Mapun is a subgroup of an etho-linguistic group referred to as Samal. They began to spill into the islands and land to population ratio in Cagayan de Tawi-Tawi shrank from 3.3 hectares per capita in 1883 to 1.1 hectares in 1948 (Casino, 1976 in Cola 1998). Land was vital because the Jama Mapun combined farming and fishing for subsistence.

The protracted war in Mindanao from 1970 to 1990 sent refugees to Turtle Islands --- Tausug from Sulu, Yakan from Basilan and Maranao from Lanao. Tension with Malaysia due to the Philippine's claim that Sabah was part of the Sulu sultanate brought in civil servants and military personnel from Luzon (Cola, 1998). Some settled in the islands for good. There were also crew members of fishing fleets from Luzon and Visayas who did the same. Malaysia's phenomenal economic growth from 1980 to 1995 attracted Filipinos seeking jobs and opportunities who used the islands as a jumping point to Sabah. By 2002, the island's population had grown to 3930 (PCP, 2001).

Marine resources are the main source of income in Turtle Islands. It has the greatest contribution to household income and more households derive income from it than from any other source. Fishing contributes about 62 percent to total income.

Turtle egg collection contributes 37% of the total income from marine resource extraction. This shows that while the level of dependence of local households on turtle eggs is significant, that it is not as critical as was initially perceived (Cola, 1998). Such significance is further reduced to 23% relative to the total income. Moreover, turtle egg collection benefits only 11% of the households in a year or much lower than the percentage served by fishing (Cola, 1998).

Previously, eggs were collected through a scheme implemented by the DENR, however with the promulgation of the Wildlife Act of 2001, legal collection of eggs is now prohibited under the Law.

## 36.3 Management

The Turtle Islands is considered the most important nesting habitat of green turtles in the Philippines. As early as the 1980's the DENR through the Pawikan Conservation Project (PCP) implemented research and management activities to conserve sea turtles. Much of the work done by the PCP in the Turtle Islands is the management of Baguan Island Marine Turtle Sanctuary including the protection of its surrounding waters and reefs. The area as a significant nesting habitat for green turtles is part of the Turtle Islands Heritage Protected Area (TIHPA). The TIHPA is considered the world's first transborder protected area for sea turtles and was established in 1996. Along with the bilateral agreement for sea turtles the area was declared as the Turtle Islands Wildlife Sanctuary under the National Integrated Protected Areas System in 1999. Under the TIWS a Protected Area Management Board (PAMB) was established to oversee the activities of the protected area. However, activities under the Protected Area Office were considerably affected by the ending of the World Bank Funded project supporting the operations of the TIWS last June 2002.

An integrated approach was implemented by WWF-Philippines to address the long-term conservation needs of the area. A social analysis was undertaken to understand and identify conservation and development opportunities. Upon completion of the Social Analysis, the results were feedback to the community. The feedback of the results of the analysis became the venue to identify problems and to collectively find ways to address these problems in the context of conservation and development. Through this method, a framework for an Integrated Conservation and Development Program was developed. The ICDP framework focused on the following components: livelihood, enforcement, health and education. Under the enforcement component, the protection of coral reefs has been identified as a priority activity.

## 36.4 Issues and Threats

The Turtle Islands as in most of the marine protected areas in the Philippines is under grave threat. The continued harvest of turtle eggs by locals as a traditional source of livelihood already experienced a decline in egg production of not less than 80% over the last 50 years. Aside from this, there exist a number of external factors threatening the sea turtles, their habitats and the communities in the area. The increase of human population both by migration and natural birth recruitment is alarmingly high. With a rate twice that of the national average and with a population density almost twice the national average, this can pose a grave threat to the near pristine resource base of the area. The intrusion of commercial fishing vessels in near-shore areas is not only destroying productive reef areas and causing mortalities of sea turtles but also marginalizing the small fishers in the area. The use of dynamite and cyanide in fishing is also reported to be prevalent in the area. It is in this context that there is an urgent need to address the issues of conservation in an integrated manner as stipulated in the concept of ICDP.

## 36.5 Monitoring, Evaluation, Feedback and Response

### Methods

Reef benthos was monitored on October 24-27, 2002 following the same video methodology used in the monitoring visits that started in October 1996 for the three Baguan Island sites, and in April 1997 for the Bakungaan, Langaan, and Taganak Island sites. Since the onset, concrete blocks were used as markers to increase precision of cover measurements, and deployed at every 5m along four haphazardly deployed 25-meter transects in each monitoring station.

Transects were sampled using two Sony digital cameras (in mini DV and digital 9 formats) in underwater housings following the general methods described in English et al. (1997). This involves recording the reef area beneath 100m of transects per site, with the camera perpendicular to and about 30 cm from the bottom. In the laboratory, the images were then digitized ("framegrabbed") from the video tape at 5 second intervals into a series of still photographs (jpeg files) using a PC-mounted Firewire card. The scoring of a systematically chosen subset of at least 30 frames per 25m line was then done by identifying and counting the life-form (Table 36.1) underneath five marks (one in the middle and four near the corners). The relative frequencies of the lifeforms counted was then used as an estimate of their percentage cover.

## Results and Discussion

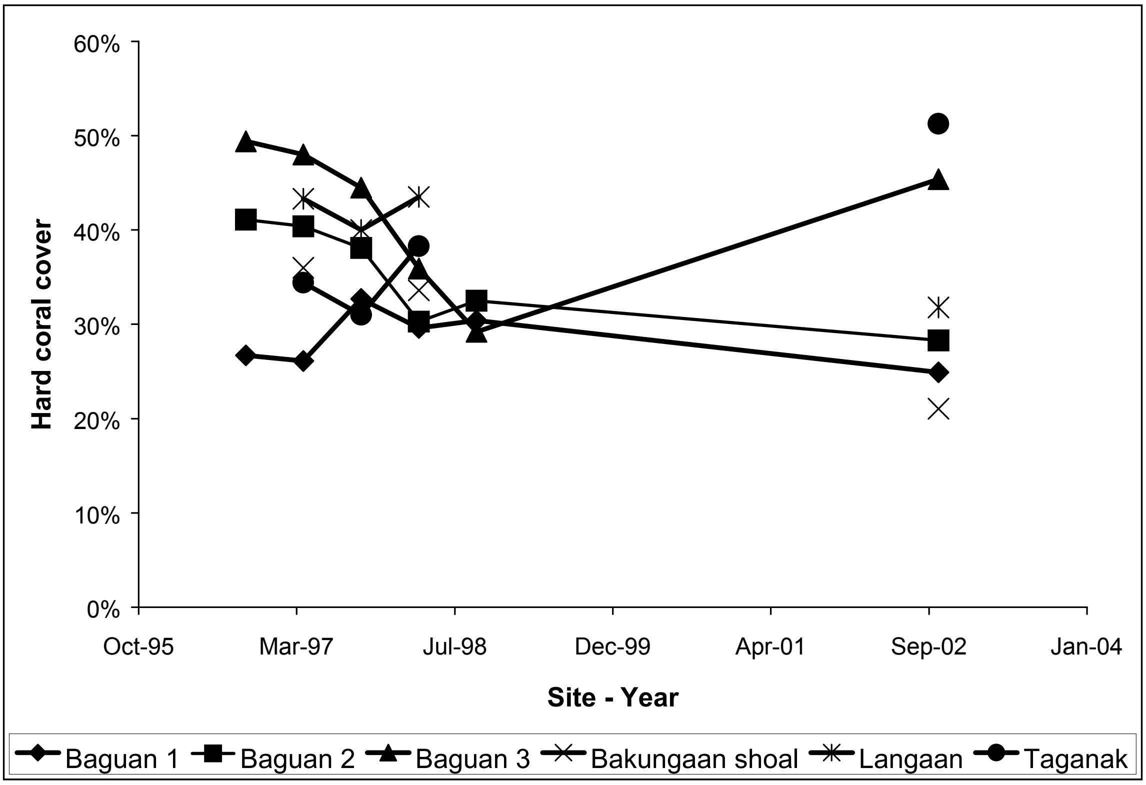



Figure 36.1. Hard coral cover for the six sites monitored over time. Data points for most sites were collected on October 1996, April 1997, October 1997, April 1998, October 1998, and October 2002.

Results of the monitoring visit to the Turtle Islands, four years after the last visit show mixed results in terms of changes in the abundance of corals. Coral cover have increased in two sites (Baguan Site 3 and Taganak), and is likely fluctuating but stable in one (Baguan Site 1), but has declined in three others (Baguan Site 2, Bakungaan, and Langaan) especially in the last two where impact of sedimentation, and reportedly, of blast fishing is [illegible]test. Comments for individual sites are indicated below:

**Baguan Site 1** Coral cover here has fluctuated only by a maximum of 8% over the past six years suggesting the community here is changeable but cover has remained about the same. The community will likely survive the recent decline of 5.5% over the past four years as this is about the error level expected from the video monitoring method used, and since examination of cover of individual life-forms (Table 36.2) suggests no important change in dominance or diversity patterns. As before, branching *Acropora* (mostly *A. bruegemanni*) are the most dominant corals. Soft corals (mostly xeniids) now were not as abundant as in October 1998 but remains within previous cover levels.

**Baguan Site 2** Coral cover here has fluctuated by 13% over the past six years but the largest change occurred between October 1996 and October 1998, and not recently. There is no sign of a recovery however, unlike in Baguan Site 3. Note the decreasing trend in cover of massive corals, which are important framework builders (see Table 36.3 and Figure 36.2). These do not grow as fast as the branching *Acropora* that is common in Sites 1 and 3 and hence the loss of massive corals (although not recent) is cause for concern.

**Baguan Site 3** has shown the largest fluctuations (20% in six years) in coral cover among the three sites in the island, including a decline (like in Baguan Site 2) between October 1996 and October 1998. However, this site shows a recovery of 16% in the last four years. Note the expected smaller fluctuations in massive coral cover as compared to branching *Acropora* (Table 36.4) showing how the fast growth of the latter explains much of the variability in cover data from Baguan Sites1 and 3.

Table 36.1. Average cover (from four replicate 25m transect lines) of individual lifeforms during the last six monitoring visits in Baguan Island Site 1 (NE of the island).

| Apr-97 | | Oct-97 | | Apr-98 | | Oct-98 | | Oct-02 | |
|---|---|---|---|---|---|---|---|---|---|
| Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover |
| R | 29.5% | R | 36.2% | R | 36.3% | SC | 21.1% | R | 34.9% |
| S | 18.8% | ACB | **16.7%** | ACB | **11.5%** | R | 15.2% | AA | 13.3% |
| SC | 13.9% | SC | 11.2% | SC | 10.1% | AA | 12.9% | ACB | **10.6%** |
| ACB | **10.3%** | S | 9.1% | S | 8.5% | ACB | **8.2%** | S | 10.4% |
| AA | 5.2% | AA | 6.8% | AA | 7.8% | CM | **8.2%** | SC | 8.6% |
| CM | **4.1%** | ACS | 4.5% | ACS | 6.7% | S | 8.2% | CB | 4.8% |
| ACS | 3.9% | CE | 4.0% | CM | **3.6%** | CB | 4.7% | DCA | 4.3% |
| CS | 3.2% | CHL | 4.0% | CS | 3.6% | CHL | 3.5% | CM | **3.2%** |
| CB | 2.7% | CB | 3.8% | CHL | 3.0% | CMR | 3.5% | CE | 2.6% |
| CE | 2.0% | CM | **2.9%** | CB | 2.4% | DCA | 2.9% | ACS | 1.4% |
| DCA | 1.9% | CMR | 0.7% | CE | 1.8% | SP | 2.9% | CME | 1.4% |
| CA | 1.3% | | | DCA | 1.8% | ACS | 1.8% | CA | 1.3% |
| CHL | 1.3% | | | SP | 1.2% | CE | 1.8% | CS | 1.1% |
| SP | 1.3% | | | TA | 0.6% | CF | 1.8% | ACT | 0.6% |
| OT | 0.8% | | | CME | 0.6% | CME | 1.2% | SP | 0.5% |
| | | | | OT | 0.6% | CA | 0.6% | CF | 0.3% |
| | | | | | | CS | 0.6% | CMR | 0.3% |
| | | | | | | MA | 0.6% | MA | 0.2% |
| Hard coral cover | | | | | | OT | 0.6% | OT | 0.2% |
| | **26.1%** | | **32.7%** | | **29.6%** | | **30.4%** | | **24.9%** |

Table 36.2. Average cover (from four replicate 25m transect lines) of individual lifeforms during the last six monitoring visits in Baguan Island Site 2 (SW of the island).

| Oct-96 | | Apr-97 | | Oct-97 | | Apr-98 | | Oct-98 | | Oct-02 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover |
| CM | **26.2%** | CM | **28.6%** | CM | **22.3%** | R | 20.6% | CM | **20.8%** | AA | 27.1% |
| S | 14.8% | AA | 14.3% | R | 17.4% | AA | 17.1% | R | 15.6% | R | 20.7% |
| AA | 13.4% | SC | 11.6% | AA | 14.8% | CM | **15.7%** | AA | 12.3% | CM | **17.6%** |
| R | 12.5% | R | 10.4% | S | 8.1% | S | 14.6% | SC | 11.0% | S | 7.8% |
| OT | 10.7% | OT | 10.3% | OT | 7.0% | OT | 9.0% | S | 8.4% | DCA | 7.1% |
| SP | 3.8% | SP | 6.6% | SC | 5.7% | ACB | 4.0% | DCA | 7.1% | CB | 2.5% |
| CE | 3.0% | CB | 3.1% | SP | 5.0% | SP | 3.6% | CB | 5.2% | SP | 2.4% |
| CS | 2.2% | CA | 3.0% | CB | 4.7% | CB | 3.0% | OT | 4.5% | CE | 2.1% |
| ACB | 2.1% | CE | 2.6% | ACB | 4.0% | SC | 2.4% | SP | 4.5% | ACB | 1.8% |
| CF | 2.1% | DCA | 1.9% | CE | 2.5% | CF | 1.6% | ACB | 3.9% | ACT | 1.8% |
| CB | 2.0% | CMR | 1.9% | CMR | 1.6% | DCA | 1.6% | CA | 3.2% | SC | 1.6% |
| DCA | 2.0% | CS | 1.8% | DCA | 1.6% | CS | 1.6% | CE | 1.9% | OT | 1.6% |
| CMR | 1.9% | ACB | 1.5% | ACT | 1.6% | CE | 1.5% | ACT | 0.6% | ACX | 1.3% |
| ACT | 1.6% | CF | 0.8% | CF | 1.5% | CMR | 1.5% | DC | 0.6% | CF | 1.3% |
| CHL | 0.5% | CME | 0.8% | CA | 0.8% | ACT | 1.4% | | | CS | 0.9% |
| SC | 0.5% | CHL | 0.7% | CHL | 0.8% | CHL | 0.8% | | | ACD | 0.6% |
| CA | 0.4% | | | CME | 0.7% | | | | | CMR | 0.6% |
| MA | 0.4% | | | | | | | | | | |
| Hard coral cover: | | | | | | | | | | | |
| | **41.1%** | | **40.4%** | | **38.1%** | | **30.3%** | | **32.5%** | | **28.3%** |

**Taganak** has shown a steady increase in the cover of encrusting corals (mostly *Echinopora*) over the last 5.5 years leading to a 13% increase in coral cover over the past four years. Whether this change is due to some sort of reduced illegal fishing here (as a result of proximity to the municipal center) can probably be judged on the basis of increases in fish biomass. Massive coral cover has remained fairly stable though, suggesting that there has been no major environmental impact in the area during the last five and half years.

**Bakungaan Shoal**: The site is marked by the loss of 15% coral cover over five and a half years time, including the loss of half the coverage of massive corals. As mentioned earlier, these framework builders typically do not change cover much over time unless there is a strong environmental impact on the area. Blast fishing activity is reportedly heavy here, but the high sedimentation levels are also partly to blame.

**Langaan,** like Bakungaan and in contrast to Taganak, has lost 12% cover over the same period, and is largely a result of the loss in massive coral cover, which as mentioned earlier indicates a strong environmental impact on the monitored site, probably because of blast fishing and sedimentation. Its proximity to Bakungaan suggests the same things are happening to both these sites. Many photographs of partially dead and bleached corals were taken in this site.

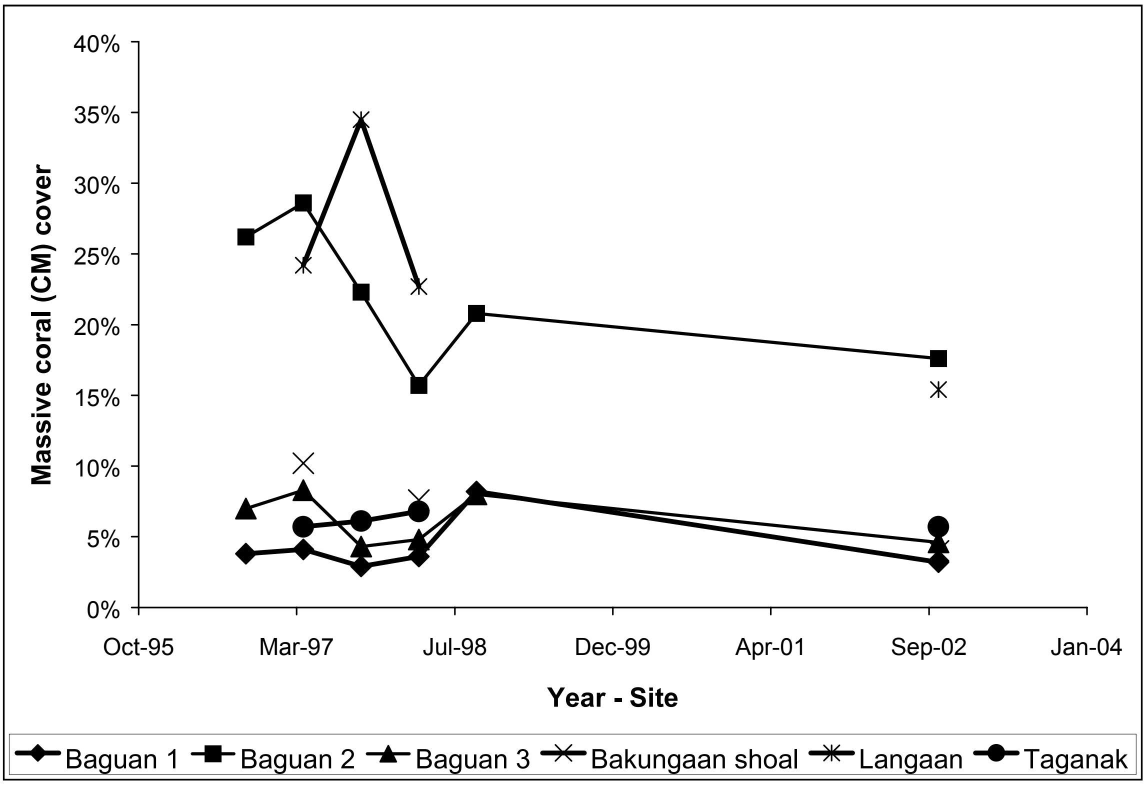



Figure 36.2. Massive coral (CM) cover for the six sites monitored over time. This is a subset of data shown in Figure 36.1 and shows the abundance of these slow-growing framework-building corals.

## 36.6 Future directions, gaps and recommendations

The present studies clearly indicate that there have been changes in the reef communities of the Turtle Islands, most especially the declines in reef cover in at least the westernmost sites (Langaan and Bakungaan Shoal). However, on-site personnel are in a better position to indicate what the causes of these are, despite the deployment of temperature loggers (thermistors) in some of the sites. Although further study could be recommended (especially to document the actual changes in coral species diversity in the affected sites), resources are better spent in doing some protective management in the reefs other than those in Baguan Island. At the very least, the results from the latter site illustrate (to the extent that this site is comparable to the others) what the benefits of some level of protective management are.

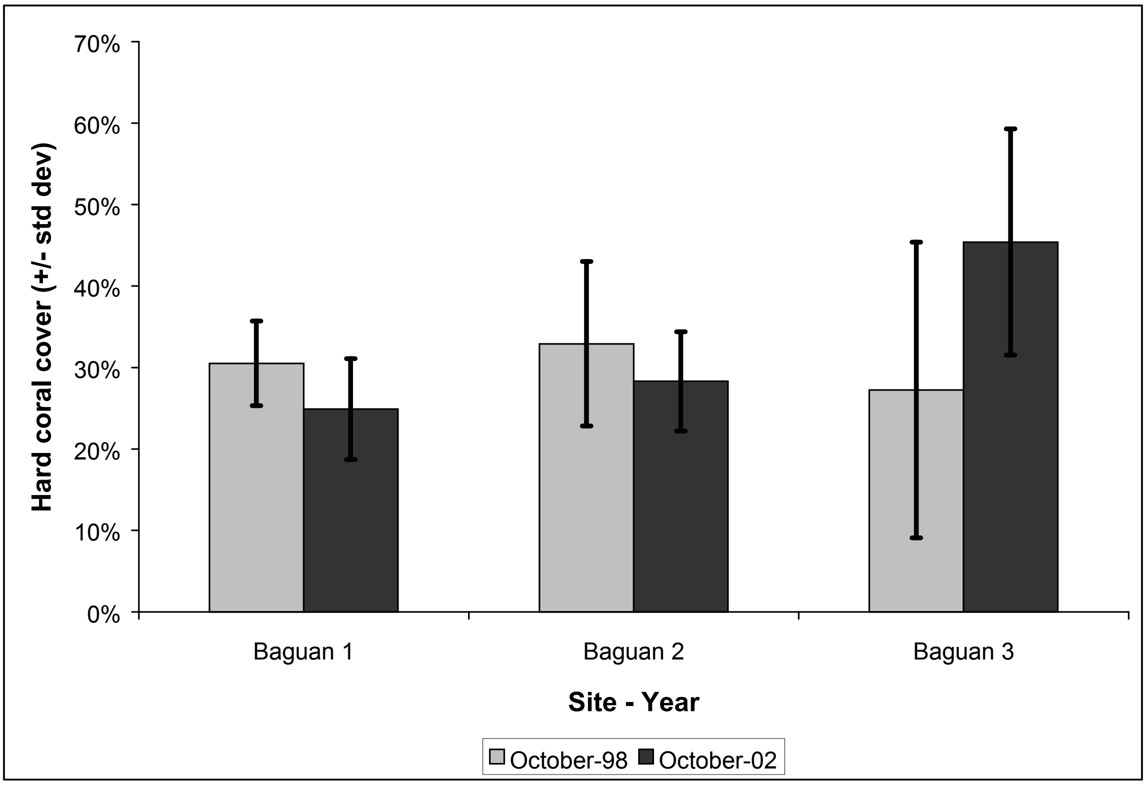



Figure 36.3. Comparison in total hard coral cover in the three Baguan Island sites over a four year period. Differences between between 1998 and 2002 are not significant.

Table 36.3. Average cover (from four replicate 25m transect lines) of individual lifeforms during the last six monitoring visits in Baguan Island Site 3 (NE of the island, near Site 1).

| Oct-96 | | Apr-97 | | Oct-97 | | Apr-98 | | Oct-98 | | Oct-02 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover |
| ACB | **30.3%** | ACB | **26.6%** | ACB | **30.8%** | SC | 26.8% | SC | 42.5% | ACB | **27.7%** |
| SC | 27.4% | SC | 23.5% | SC | 25.6% | ACB | **20.6%** | R | 13.3% | R | 17.4% |
| R | 7.1% | R | 10.6% | R | 11.6% | R | 16.7% | ACB | **9.7%** | SC | 14.9% |
| CM | **7.0%** | CM | **8.3%** | AA | 7.5% | DCA | 9.1% | CM | **8.0%** | AA | 10.7% |
| AA | 5.5% | S | 6.4% | CM | **4.3%** | AA | 6.8% | CB | 6.2% | ACS | 4.6% |
| S | 5.2% | AA | 5.1% | DCA | 3.9% | CM | **4.8%** | AA | 5.3% | CM | **4.6%** |
| CB | 4.7% | DCA | 5.0% | ACS | 3.6% | CB | 4.3% | DCA | 4.4% | S | 4.3% |
| CE | 2.4% | CB | 4.4% | S | 3.6% | S | 3.6% | S | 2.7% | ACT | 3.8% |
| DCA | 2.1% | CS | 3.1% | CB | 2.2% | ACS | 3.2% | ACS | 1.8% | CB | 3.0% |
| ACS | 1.8% | ACS | 2.7% | ACT | 1.4% | CS | 1.2% | CA | 1.8% | DCA | 2.7% |
| ACT | 1.7% | ACT | 2.2% | DC | 1.1% | CE | 0.7% | CMR | 1.8% | CE | 2.3% |
| CHL | 1.7% | OT | 1.0% | TA | 1.1% | CMR | 0.6% | ACT | 0.9% | CS | 1.2% |
| CMR | 1.0% | CE | 0.7% | ZO | 1.1% | OT | 0.6% | CE | 0.9% | CA | 0.6% |
| OT | 0.6% | ZO | 0.4% | CE | 1.1% | ACT | 0.6% | MA | 0.9% | SP | 0.6% |
| CA | 0.5% | | | CMR | 1.1% | CHL | 0.6% | | | CME | 0.6% |
| CS | 0.5% | | | | | | | | | CMR | 0.5% |
| SP | 0.5% | | | | | | | | | ACX | 0.3% |
| Hard coral cover: | | | | | | | | | | | |
| | **49.4%** | | **48.0%** | | **44.5%** | | **35.9%** | | **29.2%** | | **45.4%** |

Table 36.4. Life-form composition and average cover (from four replicate 25m transect lines) during the last four monitoring visits in Taganak (NE of the island).

| Apr-97 | | Oct-97 | | Apr-98 | | Oct-02 | |
|---|---|---|---|---|---|---|---|
| Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover |
| R | 21.3% | SC | 23.2% | CE | **19.0%** | CE | **32.8%** |
| AA | 16.4% | AA | 19.9% | AA | 17.0% | AA | 17.8% |
| SC | 14.3% | R | 18.2% | R | 14.9% | R | 14.6% |
| CE | **14.1%** | CE | **15.6%** | SC | 11.3% | SC | 8.9% |
| SP | 6.2% | CM | **6.1%** | OT | 6.9% | CB | 5.8% |
| CM | **5.7%** | CB | 5.9% | CM | **6.8%** | CM | **5.7%** |
| DCA | 5.0% | DCA | 3.6% | CB | 6.5% | CA | 4.2% |
| ACS | 5.0% | ACS | 2.5% | TA | 5.2% | ACT | 2.9% |
| CB | 4.8% | SP | 1.7% | DCA | 4.5% | ACB | 1.7% |
| CF | 2.9% | OT | 1.6% | ACB | 2.3% | CS | 1.1% |
| CHL | 1.2% | CMR | 0.8% | ACS | 1.3% | MA | 1.1% |
| ACT | 1.1% | TA | 0.8% | S | 1.3% | SP | 1.1% |
| CMR | 0.5% | | | CMR | 1.2% | CF | 1.0% |
| CME | 0.4% | | | CF | 0.6% | DCA | 0.9% |
| ACB | 0.4% | | | SP | 0.6% | CMR | 0.4% |
| S | 0.4% | | | CS | 0.6% | CME | 0.2% |
| CA | 0.4% | | | | | | |
| Hard coral cover: | | | | | | | |
| | **34.4%** | | **31.0%** | | **38.3%** | | **51.3%** |

Table 36.5. Life-form composition and average cover (from four replicate 25m transect lines) in Bakungaan Shoal in April 1997, April 1998, and October 2002.

| Apr-97 | | Apr-98 | | Oct-02 | |
|---|---|---|---|---|---|
| Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover |
| AA | 26.8% | R | 20.0% | R | 36.3% |
| SC | 13.6% | AA | 17.8% | AA | 19.7% |
| CM | **10.2%** | SC | 10.4% | S | 6.1% |
| CB | 9.5% | CM | **7.6%** | CB | **5.2%** |
| R | 7.1% | CB | 7.0% | SC | 5.2% |
| DCA | 4.9% | S | 6.6% | CM | **4.0%** |
| CF | 4.5% | CHL | 5.9% | CMR | 4.0% |
| CMR | 4.0% | ACB | 5.0% | CF | 3.7% |
| ACB | 3.7% | CMR | 5.0% | CME | 3.5% |
| CE | 3.2% | CF | 4.9% | CHL | 2.9% |
| S | 3.1% | CE | 2.2% | DCA | 2.5% |
| SI | 3.1% | OT | 2.2% | ACB | 1.3% |
| CHL | 3.0% | CS | 1.9% | CS | 1.2% |
| OT | 0.8% | DCA | 1.4% | CE | 1.2% |
| MA | 0.8% | CME | 0.8% | DC | 0.9% |
| CS | 0.8% | SP | 0.8% | SP | 0.8% |
| CME | 0.8% | MA | 0.7% | OT | 0.7% |
| | | | | CA | 0.4% |
| | | | | ACT | 0.3% |
| | | | | MA | 0.2% |
| | | | | ACS | 0.2% |
| Hard coral cover: | | | | | |
| | **36.0%** | | **33.6%** | | **21.1%** |

Table 36.6. Life-form composition and average cover (from four replicate 25m transect lines) in Langaan in April 1997, October 1997, April 1998, and October 2002.

| | Apr-97 | | Oct-97 | | Apr-98 | | Oct-02 |
|---|---|---|---|---|---|---|---|
| Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover | Benthos | Mean cover |
| CM | **24.2%** | CM | **34.5%** | SC | 24.6% | AA | 27.0% |
| SC | 23.1% | SC | 23.2% | CM | **22.7%** | SC | 24.4% |
| AA | 16.2% | AA | 13.7% | AA | 13.8% | CM | **15.4%** |
| CE | 9.7% | OT | 6.5% | CE | 9.2% | CE | 9.8% |
| S | 8.4% | S | 6.0% | SP | 6.2% | S | 4.1% |
| CF | 3.5% | SP | 3.8% | S | 5.8% | R | 3.2% |
| SP | 2.9% | DCA | 3.2% | CF | 3.2% | CF | 2.2% |
| R | 2.7% | CE | 3.1% | ACB | 3.0% | SP | 2.0% |
| ACB | 2.6% | R | 2.9% | OT | 2.4% | MA | 1.9% |
| CB | 2.1% | ACB | 1.5% | CMR | 2.3% | DCA | 1.3% |
| DCA | 1.4% | CB | 0.9% | R | 2.2% | OT | 1.3% |
| OT | 1.2% | CME | 0.8% | ACT | 2.0% | CB | 1.2% |
| CMR | 1.1% | | | CHL | 1.5% | ZO | 1.1% |
| MA | 0.4% | | | CS | 1.1% | ACT | 1.0% |
| SI | 0.4% | | | | | CME | 0.9% |
| | | | | | | CMR | 0.9% |
| | | | | | | SI | 0.7% |
| | | | | | | CS | 0.7% |
| | | | | | | CA | 0.6% |
| | | | | | | ACB | 0.3% |
| | | | | | | ACX | 0.3% |
| | | | | | | ACD | 0.2% |
| Hard coral cover: | | | | | | | |
| | **43.3%** | | **40.0%** | | **43.5%** | | **31.8%** |

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# CHAPTER 37 CELEBES SEA REGION

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## 37.1 Biophysical Setting

The Celebes Sea is the southernmost sub-region of the Philippine biogeographic regions identified by Aliño and Gomez (1994). This area is one of the least studied sub-regions (Fig. 37.1).

The area is bounded on the north by the island of Mindanao, on the east by the Pacific Ocean, on the west by Sulu Archipelago and on the south by Sulawesi, Indonesia. Its eastern side starts from the southern tip of Davao Gulf, Cape San Agustin and the western side ends at the southern tip of Sitangkai encompassing all the bays (from east to west: Sarangani, Linao, Illana, Pagadian, Maligay, Dumanguilas, Locsico, Sibuguey, Tungauan), gulfs (Davao, Moro) and sea (Mindanao Sea) within it.

The area is located away from the typhoon belt but is exposed to the southwest monsoon from June to September. It experiences Types III and IV climatic conditions suggesting no pronounced wet and dry season with rainfall evenly distributed throughout the year. In addition, Type III has a relatively dry season from November to April. These include the areas of the southern portion of Zamboanga peninsula and the Provinces of Lanao del Norte and Sur. Average annual rainfall is 1000-2000 mm per year. There are about 20 major rivers that drain into the Celebes Sea. The largest rivers are Davao R., Libuganon R., and Mindanao R.

The marine waters of the Celebes Sea is mainly influenced by the North Equatorial Current passing through the east coast of Mindanao and deflected towards the west as it reaches the southern most tip of Mindanao. The Celebes Sea is also influenced by the waters from the Sulu Sea that passes through Basilan Strait and in between the islands of the Sulu Archipelago.

The bottom topography of the area starting from the shoreline is steep and reaches to a maximum depth of 5,000 m near the middle of the basin. Coral reef area is confined to the shallower depths of less than 40 m. A considerable portion of the entire coast of Mindanao and Sulu Archipelago are fringed with coral reefs at different levels of development. In Mindanao, wider reef areas are concentrated in Zamboanga del Sur, though its eastern section is relatively more narrow than the western section. In the Sulu Archipelago, reef extents are wider. The reef area for the entire sub-region is estimated to be 811 $km^2$ or 7% of the total reef area for the country (CI-Philippines unpublished).

## 37.2 Socio-economic Setting

The Celebes Sea sub-region encompasses 12 coastal provinces, 65 coastal municipalities and 8 cities. The most dense-populated city is Davao City. The population of coastal municipalities here ranges from 37,000 to 700,000. The highest populated province is Zamboanga del Sur because it is composed of 24 coastal municipalities. Sultan Kudarat and Lanao del Sur have lowest populations with less than 50,000 persons each. Both provinces have only 2 coastal municipalities. The rest of the provinces have more than 100,000 persons (NSO 1995).

Industrialized areas are found in almost all of the 8 cities. Davao City has the largest per capita income. The rest of the cities have almost the same range of income. In terms of income derived from fishing, Davao and General Santos Cities contribute the highest revenues. These two areas have considerably well-developed fish ports and are the main landing sites of tuna and other pelagic fishes caught in the Celebes Sea and even from the adjoining seas (e.g., Indonesian Seas).

Majority of the coastal villages rely on fishing as their source of livelihood.

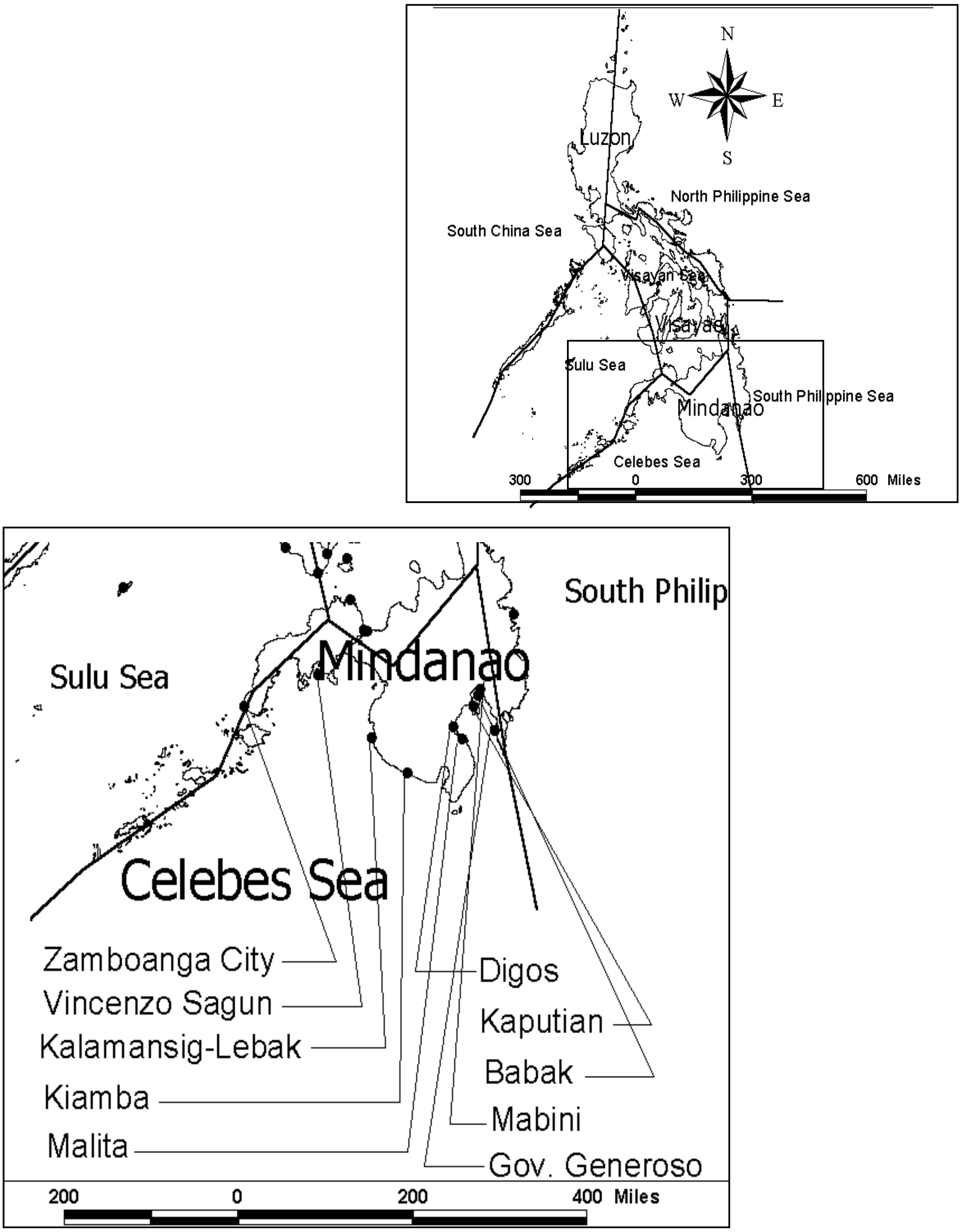


Fig. 37.1. Location of reef areas with temporal data in the Celebes Sea biogeographic area.

## 37.3 Management

Management intervention or responses in the coastal ecosystems of the sub-region varies from one municipality/city to another. The initiatives either coming from the national or local (municipal/barangay) government through national proclamation and municipal/barangay ordinances respectively. Tables 37.1a and 36.1b present the list of established and proposed marine protected areas respectively. Data were taken from AFMA-MFR database as of 2002 (UPMSI/AFMA-MFR 2002) updated from the Haribon Review of MPAs compiled in 1998.

There is a dearth of information on the majority of the protected areas established or proposed in this sub-region. Only 6 (Talicud Fish Sanctuary, Davao del Norte; Burias Reef, Davao del Sur; Malalag Fish Sanctuary, Davao del Sur; Tuka Fish Sanctuary, Sarangani; Little Sta. Cruz Is. Fish Sanctuary, Zamboanga City and Triton Is. Fish Sanctuary, Zamboanga del Sur) were known to have been monitored. Three (Malalag, Talicud and Tuka Reef fish sanctuaries) of which were monitored almost on a regular basis due to the presence of a coastal resource/fishery assessment project in the area (e.g., Coastal Resource Management Program (CRMP)-Department of Environment and Natural Resources (DENR), Fishery Resources Management Project (FRMP)-Department of Agriculture (DA)). Hopefully, the training provided by these projects in Sarangani Bay and Davao Gulf) will sustain monitoring.

## 37.4 Issues and Threats

Table 37.1 presents the most common issues and threats identified for the sub-region. The issue of overfishing is often cited but few scientific data are available to support it. Well documented studies have been done in Davao Gulf and Sarangani Bay. Likewise, the use of destructive methods in fishing particularly the use of cyanide and blasting devices remains to be assessed. Siltation has been a major problem and has to be addressed seriously. Pollution is not at a critical level but poses a major threat to the marine flora and fauna. In 1998, a large proportion of the reef area in the sub-region was affected by the El Niño Southern Oscillation (ENSO). However, very few studies were able to monitor the extent of the damage brought about by this event.

## 37.5 Monitoring, Evaluation and Feedback

A wider scope of coral reef surveys had been done in the area sometime in 1995. Although there had been surveys conducted as early as 1991, the area coverage had been limited (i.e., Sitangkai). However in terms of monitoring activities, only limited reliable monitoring on a regular basis have been undertaken. Those that were repeatedly surveyed were made possible through the projects from the Department of Agriculture-Fishery Sector Program (DA-FSP) and United States of Agency for International Development-Coastal Resources Management Project (USAID-CRMP) such as Davao Gulf and Sarangani Bay. Unfortunately, constraints on revisiting of the actual sites surveyed limits the reliability of data interpretation. These sites were mostly established or proposed protected areas (see Fig. 37.2 and 37.3).

The values reflected in the figures are the actual or average (for areas with more than one sites) scores per sampling period. Most of it were only visited once for the entire year. To conservatively count a trend (e.g., increasing or decreasing) for hard coral and fish biomass estimate, a minimum difference of at least 15% or nearly one order of magnitude, respectively was used.

Of the total 24 sites with temporal data, 33% showed a decrease, 21% showed an increase and 46% showed no clear trend. Majority (sites with increasing trend plus with no trend) of the existing/proposed sanctuaries for this region have been protected or activities have been regulated for the past 7 years (1995 to 2001). However, there is insufficient information on fish abundance. Only three (3) sites have temporal data. Two of them (Malalag and Kopiat Is.) showed no trend and one (Talicud Is.) showed a decline in fish biomass estimate. The latter site (Talicud Is.) showed a decline for both hard coral cover and fish biomass estimate. All of these observations suggest that the areas' condition for the past 7 years have been generally declining.

## 37.6 Future directions, Gaps and Recommendations

At present, many small scale coastal habitat (i.e., corals, reef fishes, mangroves, seagrass) studies have been conducted in the various reefs in the area. Except for Davao Gulf and Sarangani Bay which were studied on a larger scale, only few integrated assessments have been made.

There is also a need to consolidate all of the efforts (e.g., monitoring, surveys and management) to be able to identify the gaps and future directions. For now, there is a need to establish an integrated monitoring program. For example, from the so many established and proposed sanctuaries in the sub-region, these areas can serve as a good source of information on the recovery of the benthos and spill over effects (e.g., fishes) in varying reef types (fringing, shoal reefs), conditions (exposure to monsoons) and management schemes.

Furthermore, these should be evaluated and provide feedback mechanisms to ensure better management programs.

Table 37.1. Summary of most common issues and threats identified for Celebes Sea sub-region.

| Issues and Threat | Area | Source |
|---|---|---|
| Destructive fishing practices | Lebak and Kalamansig, Sultan Kudarat.<br>Also reported in almost all coastal areas of the sub-region. | CEP DENR Region XII |
| Over-fishing | Davao Gulf, Sarangani Bay (no information for the other gulf and bays) | MSU-Naawan (1995), UPV (2001), SUML (1997) |
| Sedimentation from land-use (clearing for housing projects, | Davao R., Libuganon R., Mindanao R. and other major rivers | Sulu-Celebes Sea Sub Region 56-GIWA (in press) |
| Pollution (oil spill, industrial and domestic waste) | All cities and municipalities with population >100,000 | Sulu-Celebes Sea Sub Region 56-GIWA (in press) |
| Climatic change (ENSO) | Tuka Marine Sanctuary, Kiamba, Sarangani | Uychiaoco et al. (in this volume) |

Table 37.2a. List of proposed marine protected areas or fish sanctuaries in the Celebes Sea sub-region (source: UPMSI/AFMA-MFR Database).

| MPA/Fish Sanctuary | Size (ha) |
|---|---|
| **Compostela Valley** | |
| Mabini Protected Landscape and Seascape, Mabini | 5,138 |
| Bucana Fish Sanctuary, Maco | 3 |
| **Davao City** | |
| Davao City | |
| **Sarangani** | |
| Gumasa Fish Sanctuary, Glan | 11 |
| Tuka Reef Marine Park, Kiamba | 20 |
| Mabay Fish Sanctuary, Maitum | 7 |
| Poblacion Fish Sanctuary, Malapatan | 5 |
| Lower Lasang Fish Sanctuary, Malapatan | 5 |
| Ladol Community Based Marine Protected Area | |
| **Tawi-tawi** | |
| Lamion, Bongao | |
| Pahut, Bongao | |
| Sanga-sanga, Bongao | |
| **Surigao del Norte** | |
| Unidad Rizal and Gamut, Barobo Fish Sanctuary | 20 |
| **Zamboanga del sur** | |
| Sumalig, Tambulig Fish Sanctuary | 100 |

Note: see UPMSI/AFMA-MFR Database

Table 37.2b. List of established marine protected areas or fish sanctuaries in the Celebes Sea sub-region (source: UPMSI/AFMA-MFR Database).

| MPA/Fish Sanctuary | Year Established | Size (ha) | Legal basis |
|---|---|---|---|
| **Davao del Norte** | | | |
| Samal Island Tourist Zone and Marine Sanctuary | 1978 | | PP 1801, 2152 |
| Talicud Island Tourist Zone and Marine Reserve | 1978 | | PP 1801 |
| Ligid Island Tourist Zone and Marine Reserve | 1978 | | PP 1801 |
| Maliputo Island Tourist Zone and Marine Reserve | 1978 | | PP 1801 |
| **Davao del Sur** | | | |
| Prape Fish Sanctuary, Padada | | 50 | MO # 6 |
| Davao Oriental | | | |
| Sigaboy Island, Governor Generoso | | | PD 704, FAO |
| Tinaytay & Burias Reef, San Isidro | | | 155 |
| **Sarangani** | | | |
| Kawas Fish Sanctuary Cabang to Libacon, Alabel | | 10 | MR #29 |
| Kawas Mun. Fish Sanctuary, Alabel | | 12 | MO |
| Batulaki Fish Sanctuary, Glan | | 16 | BR #40, BO |
| Kabug Marine Reserve, Glan | | 9.5 | #11 |
| Dongon and Tamparan Fish Sanctuary | | 10 | BO #15 |
| Sarangani Bay Protected Seascape | 1996 | 215,950 | BO #1 |
| | | | PP #756 |
| **Sultan Kudarat** | | | |
| Lebak-Kalamansing (Moro Gulf)/CEP | | 9,600 | |
| **Zamboanga City** | | | |
| Ayala, San Ramon Tourist Zone and Marine Reserve | 1978 | | PP # 1801 |
| Malanipa Island Tourist Zone and Marine Reserve | 1978 | | PP # 1801 |
| Sacol Island Tourist Zone and Marine Reserve | 1978 | | PP # 1801 |
| Sangali Cove Sacol Island Tourist Zone and Marine | 1978 | | PP # 1801 |
| Reserve | 1978 | | PP # 1801 |
| Small Sta. Cruz Island Tourist Zone and Marine Reserve | 1981 | | PP # 2152 |
| Vitali Island Marine Swamp Forest Reserve | | | |
| Zamboanga City East Cost | 1981 | 8,500 | PP # 2152 |
| Tictauan Island Marine Swamp Forest Reserve | | | |
| **Zamboanga del Sur** | | | |
| Mangrove areas from Malubog Point up to the | 1981 | | PP #2152 |
| municipality of Sambalawan including the Island of | | | |
| Pisan, Dimataling | | | |
| Ticala Islands Government Bangus fry Reservation | | | |
| Area, San Pablo | | 20,300 | SBR #036-94 |
| Brgys. Abong-abong, San Sebastian, San Andres | | | |
| Malim, Concepcion, Manicaan & Baganian, Tabina | 1981 | | PP #2152 |
| Marine Reserve | | | |
| Mangrove areas from the mun. of Tagalisay to the | | | |
| mouth of Tigbao River including east of Vitali Is. | 1981 | | PP #2152 |
| (Sibuguay Bay, Zamboanga del Sur), Tungawan | | | |
| Mangrove areas in Tumalong Bay, Baong River and | | 25,948 | PP #158 |
| Pongao Bay, Tungawan | | 75 | |
| Dumanquillas Protected Landscape/Seascape, Vicenzo | | 50 | |
| Sagun | | 100 | BFAR-AO |
| Danan Fish Sanctuary, Vicenzo Sagun | | 80 | BBAR-AO |
| Layangan Fish Sanctuary, Vicenzo Sagun | | | |
| Monching Siay Artificial Coral Reef | | | |
| Monching Siay Artificial Reef Expansion | | | |

Note: see UPMSI/AFMA-MFR Database

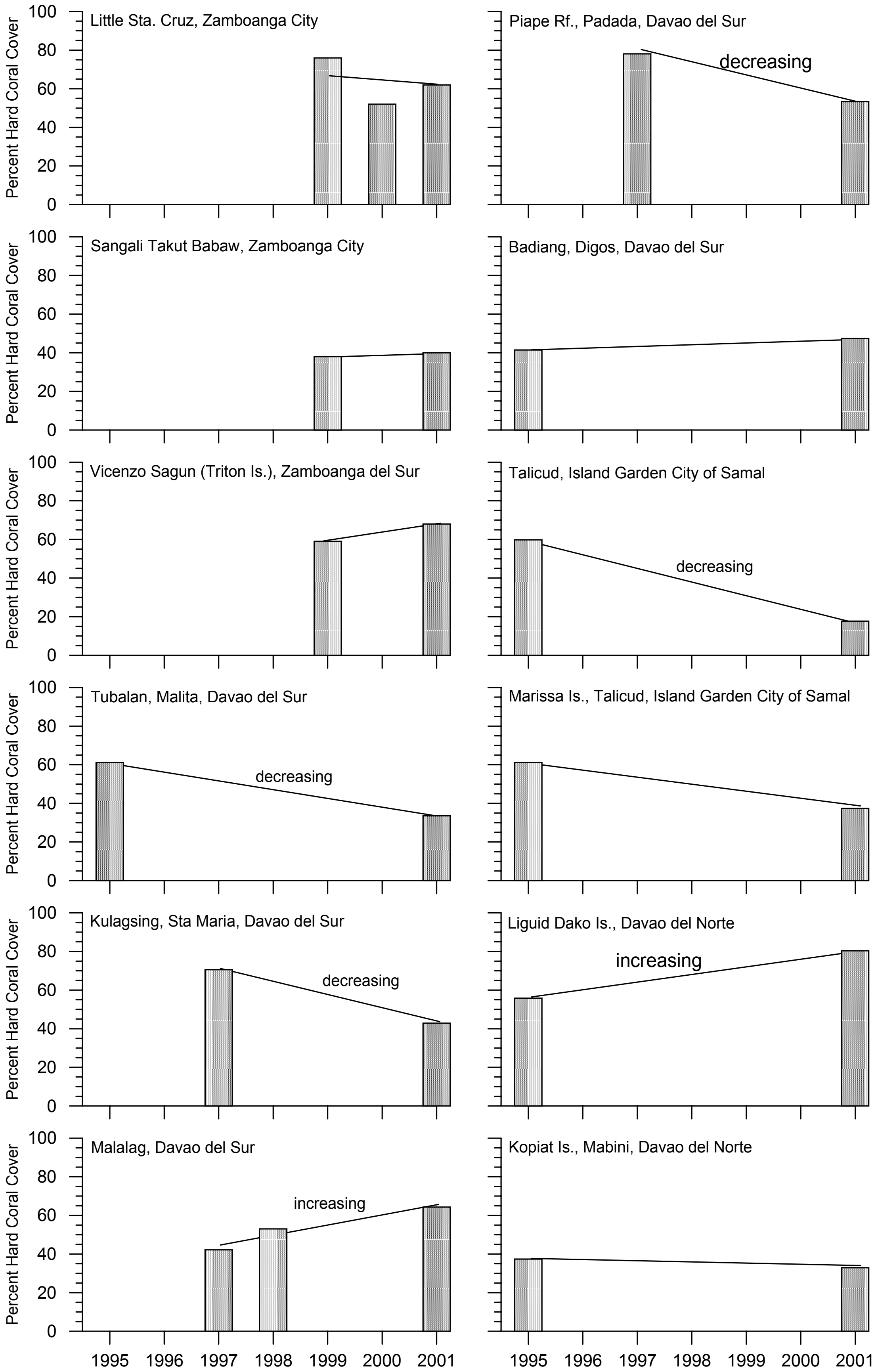


Figure. 37.2. Percent hard coral cover through time for Celebes Sea sub-region. Solid lines represent the linear relationship among points.

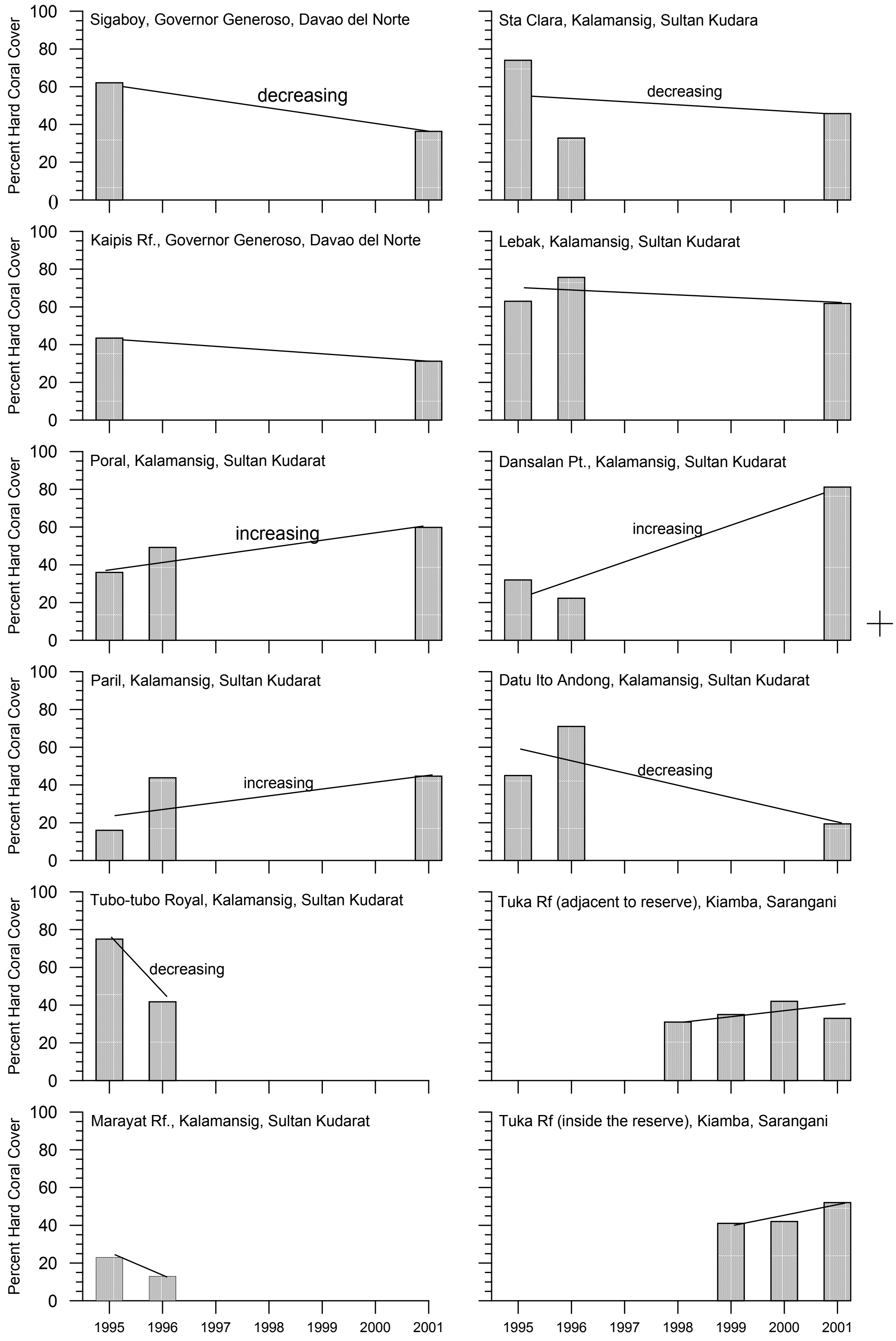


Figure. 37.2 (continued)

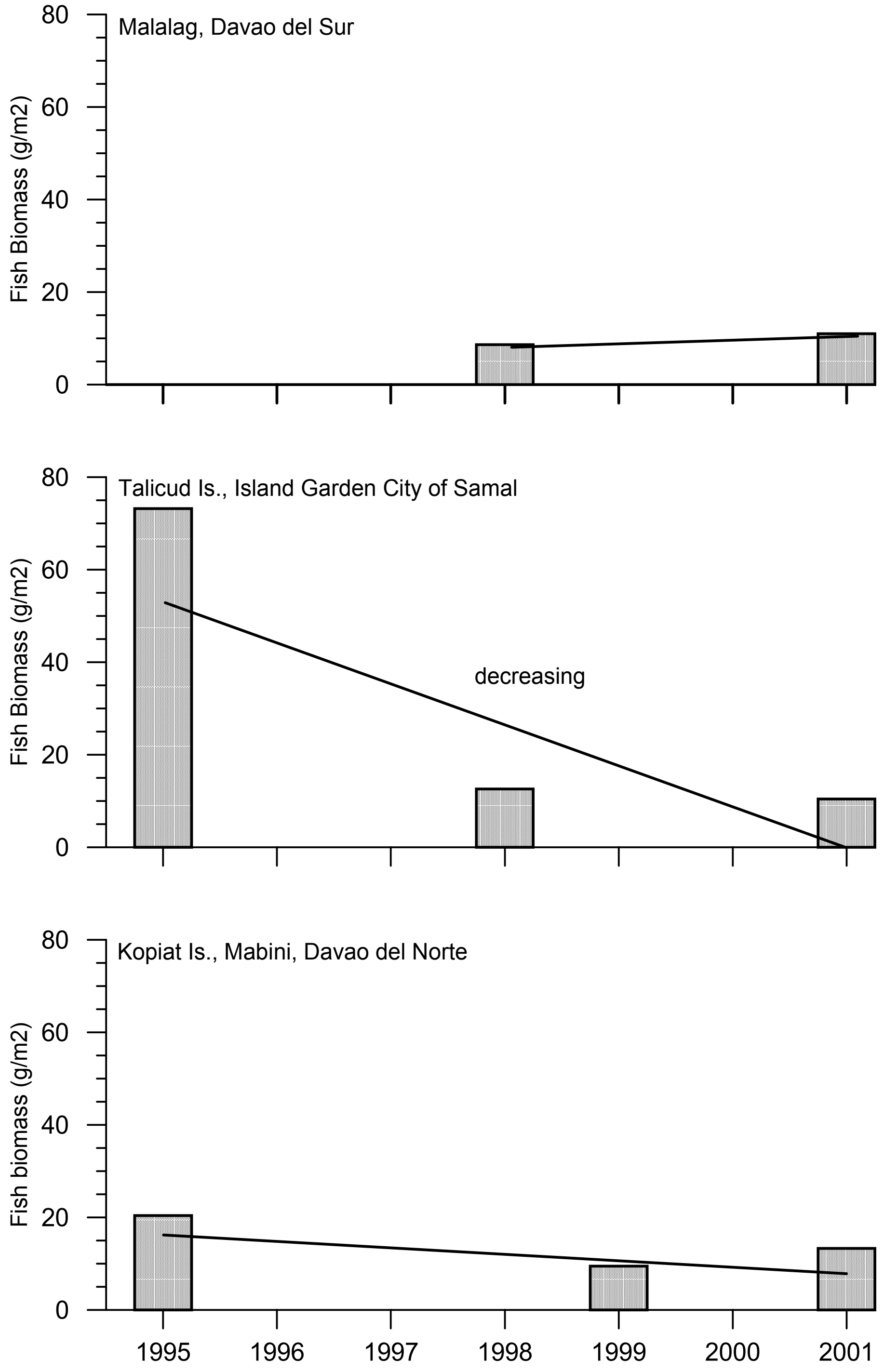


Figure 37.3. Fish biomass estimate (g/m$^2$) through time for Celebes Sea sub-region. Solid lines represent the linear relationship among points.

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# CHAPTER 38 KALAMANSIG-LEBAK, SULTAN KUDARAT

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## 38.1 Biophysical Setting

Kalamansig (15 villages) and Lebak (28 villages), in the province of Sultan Kudarat, was established as a Coastal Environment Program (CEP) (now Coastal and Marine Management Office, CMMO) model site in 1995. It is the only CEP model site in Region XI. Kalamansig-Lebak has a total area of 9,600 hectares and a coastline of 54.50 km. The coral reefs are mainly fringing.

## 38.2 Socio-economic Setting

*Barangay* Paril (Kalamansig) has a total household (along coastal areas) of 200. The primary sources of income are fishing, farming, boat operating, trading/retailing, carpentry, military service and working as hired laborer. Fishing is the most common source of income in the area. Most of the residents are Catholics; Muslims and Protestants comprise the rest of the populace. Water is from pump/faucet, open well, spring and sometimes rainwater. Sources of light are kerosene, petromax and generator, while firewood and kerosene is used for cooking. Survey shows that the people of Paril are aware of threats to the mangroves, seagrasses and coral reefs and are willing to help the government efforts in conservation.

## 38.3 Management

The Coastal Environment Program is implemented by the CENROs and PENROs in coordination with NGOs and an organized core group. Management of coastal and marine resource management activities include: 1.) Coastal database mgmt. and planning which includes the: a.) identification of additional sites, b.) resource inventory and socio-economic and ecological assessment, c.) technical assistance to LGUs & other stakeholders, and d.) establishment & updating/maintenance of national/regional coastal resources database. 2.) Maintenance and protection of coastal habitats which includes: a.) water quality monitoring, b.) community organization & mobilization [trainings and seminars on value formation, leadership and capability building and regular dialogue/meetings to resolve conflicts and to strengthen the organization], c.) support to alternative livelihood [boat operating, fish (*malaga*) culture, cooperative store]. 3.) Rehabilitation of degraded coastal habitats which include: a.) establishment and maintenance of multi-species mangrove nursery, b.) seedling production/procurement for distribution, c.) rehabilitation of mangrove areas, d.) maintenance and protection of existing mangrove stands. 4.) Advocacy building/information education and communication. 5.) Capability building and human resources development. 6.) Research and special projects and 7.) Support gender-and-development mainstreaming.

## 38.4 Issues and Threats

The site has been affected by *muro-ami*, trawl fishing and El Niño-related coral bleaching. Blast fishing and cyanide fishing have been reduced in the Kalamansig-Lebak CEP model site.

## 38.5 Monitoring, Evaluation and Feedback

At least 37 coral genera have been recorded in Kalamansig-Lebak, 20 genera in Paril, Kalamansig and 17 in Lebak. The 3 most common genera observed were *Porites*, *Montipora* and *Acropora*. Line-Intercept Transect was used to monitor marked sites, though transect lines could not be laid exactly on the same points during every assessment and some markers were difficult to relocate. Coral cover from 1995-2001 appears stable (Table 38.1). Some stations could not be monitored due to peace and order problems.

## 38.6 Future directions, Gaps and Recommendation

The people's organization should strengthen their links with other stakeholders for improved sustainability. They should formulate long-term strategies to address threats to coral reefs, seagrass beds, mangroves and fisheries. The Project should be regularly monitored and evaluated.

Table 38.1. Percent live hard coral cover in Kalamansig-Lebak, Sultan Kudarat

| Coordinates | | | Year | | |
|---|---|---|---|---|---|
| Longitude | Latitude | Site Name | 1995 | 1997 | 2001 |
| 124° 02.08' | 6° 34.42' | Poral Point | 43 | 52 | 71 |
| 124° 02.11' | 6° 33.24' | Paril Point | 26 | 60 | 49 |
| 124° 02.00' | 6° 33.00' | Tubo-Tubo Royal | 84 | 57 | no data |
| 124° 02.62' | 6° 32.44' | Marayat Reef (Shoal) | 54 | 67 | no data |
| 124° 02.00' | 6° 33.00' | Tubo-Tubo Grande, Santa Clara | 74 | 37 | 48 |
| 124° 00.72' | 6° 31.41' | Lebak Point | 66 | 83 | 73 |
| 124° 01.18' | 6° 31.26' | Dansalan Point | 47 | 49 | 81 |
| 124° 01.76' | 6° 32.27' | Sitio Linek, Datu Ito Andong | 52 | 20 | 23 |
| | | AVERAGE | 55.75±12.77 | 53.13±13.16 | 57.50±17.26 |

## 38.7 Acknowledgments

We would like to acknowledge the assistance of the following: Dir. Florendo Barangan, Maria Theresa Espino, Francisco Paciencia Jr, Emiliano Ramoran, Joselito Magat, Chester Casil and Ann Malano of CMMO, DENR, Visayas Avenue, Diliman, Quezon City for integrating the data.

## 38.8 References

Comprehensive Profile of CEP Site Region XI
Results of the Monitoring and Assessment of Coral Reefs in CEP sites in Region XI
CMMD Mid-year report of region XI

# CHAPTER 39 TUKA MARINE SANCTUARY, KIAMBA, SARANGANI PROVINCE

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[2]Municipal Government of Kiamba
[3]Department of Environment & Natural Resources (DENR-Region XI)
[4]Coastal Resource Management Project (CRMP)
[5]University of the Philippines Mindanao (UP-Mindanao)

## 39.1 Biophysical Setting

The Tuka Marine Sanctuary is an approximately 10-ha. "no take" reef area spanning 2 small coves south of Buko Mountain. The proposed sanctuary includes fringing reefs with a 20-70$^{o}$ slope. Underwater visibility is moderate. The water gets murkier east of the sanctuary where seagrasses dominate.

## 39.2 Socio-economic Setting

The sanctuary is located in the village of Poblacion (i.e., the population center) of the municipality of Kiamba in the province of Sarangani. In Sarangani province, agriculture accounts for 70% of the labor force while fishing accounts for 8% (de Jesus et al. 2001). Not many (especially foreign) tourists come here.

## 39.3 Management

The marine park is a local government initiative. The local government is very enthusiastic about the marine park. The municipality even bought snorkeling equipment and had their personnel trained in SCUBA. The municipal staff (e.g., Mr. Venancio Banquil, Mr. Emmanuel Fabre, Mr. Carmelo Velasco and Mr. Miguelito Balicaco) are quite capable of underwater monitoring of the marine reserve. But as of April 2001, the ordinance to establish the Tuka Park was still being reviewed by the municipal legislative council. However, a 50-m buffer from the proposed core zone has been set up, and marker buoys have been deployed. It is proposed that only hook-and-line fishing will be allowed in the buffer zone. Though not yet passed into law, the park is being enforced. There is even a high-speed motor boat used for the park's enforcement.

Local fishers and the rest of the community do not appear to be actively involved in managing the park perhaps because the local government is generally well-liked and seems to be doing its job anyway.

## 39.4 Issues and Threats

The reefs bleached slightly during the 1998-1999 El Niño-La Niña event. The park has not yet been declared by law.

## 39.5 Monitoring, Evaluation and Feedback

Target fish abundance, hard coral cover and soft coral cover inside and adjacent to the reserve generally seem to be rising (Figs. 39.1 and 39.2). However, this conclusion was reached after: (1) adjusting the hard coral cover adjacent to the reserve by the relative increase in placement of such transects in the sand in 2001, and (2) ignoring the extraordinarily large number of snappers reportedly observed inside the reserve in 2000 (Table 39.1 and 39.2). The data seems to show that target fish composition is changing from surgeonfishes to parrotfishes to more carnivorous types but this needs validation (Table 39.2).

## 39.6 Future directions, Gaps and Recommendations

Though there does not seem to be much of any opposition to the park, it is time that the park be legally declared.

Figure 39.1 Hard coral cover inside and adjacent to the Tuka Marine Park.

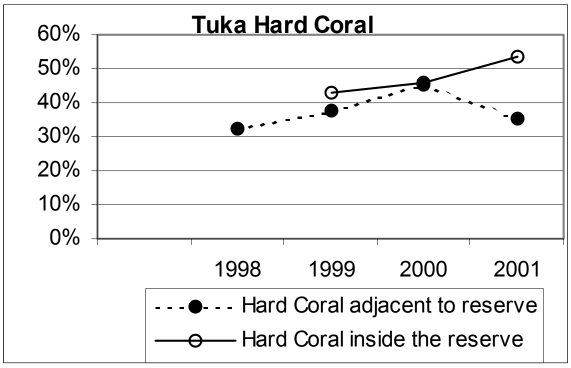


Figure 39.2 Fish count/500 m$^2$ inside and adjacent to the Tuka Marine Park.

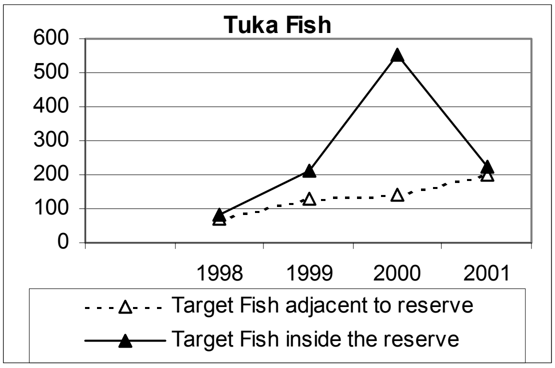


Table 39.1 Average % cover of benthic lifeforms inside and adjacent to the Tuka Marine Park

| Zone | Adjacent | | | | Inside | | |
|---|---|---|---|---|---|---|---|
| Year | 1998 | 1999 | 2000 | 2001 | 1999 | 2000 | 2001 |
| Hard Coral (live) | 33% | 37% | 45% | 36% | 43% | 46% | 54% |
| Soft Coral | 1% | 4% | 6% | 8% | 2% | 3% | 6% |
| Dead Coral | 27% | 2% | 10% | 7% | 2% | 5% | 9% |
| Dead Coral w/ Algae | | 21% | 13% | 12% | 14% | 18% | 13% |
| Turf Algae | | 5% | 2% | 1% | 2% | 1% | 1% |
| Macroalgae | | 11% | 1% | 2% | 12% | 0% | 1% |
| Coralline Algae | 11% | 1% | 0% | 5% | 0% | 0% | 2% |
| Seagrass | | | 0% | 0% | | 0% | 0% |
| Sponge | 2% | 2% | 2% | 4% | 2% | 4% | 0% |
| Zoanthids | | 0% | 0% | 0% | 0% | 0% | 0% |
| Other Animals | 2% | 0% | 1% | 0% | 0% | 1% | 0% |
| Rubble | 26% | 2% | 6% | 5% | 11% | 3% | 3% |
| Rock | | 2% | 0% | 3% | 1% | 3% | 1% |
| Sand/Silt | | 1% | 15% | 19% | 3% | 16% | 10% |

Table 39.2 Average fish abundance per 500 m$^2$ inside and adjacent to the Tuka Marine Park

| Zone | Adjacent | | | | Inside | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1998 | 1999 | 2000 | 2001 | 1998 | 1999 | 2000 | 2001 |
| Epinephelinae* | | 2.4 | 10.2 | 9.4 | 0.3 | 3.6 | 8.6 | 8.2 |
| Lutjanidae* | | 4.4 | 1.2 | 14.2 | | 3.2 | 400.0 | 10.4 |
| Haemulidae* | | 0.4 | 2.2 | 2.2 | | | 2.8 | 17.8 |
| Lethrinidae* | | 0.6 | 6.4 | 6.8 | 1.0 | 4.6 | 8.2 | 15.8 |
| Carangidae* | | 0.6 | | 22.8 | 0.5 | 2.4 | | 15.6 |
| Caesionidae* | 22.5 | 9.6 | 8.0 | 24.8 | 39.5 | 0.2 | 18.2 | 33.8 |
| Nemipteridae* | 1.0 | 4.2 | | 10.0 | 2.0 | 6.2 | 0.2 | 11.2 |
| Mullidae* | 14.0 | 21.2 | 6.8 | 15.4 | 15.0 | 10.2 | 4.0 | 25.2 |
| Balistidae | 4.0 | 28.2 | 92.2 | 2.8 | 5.2 | 21.2 | 7.8 | 14.4 |
| Chaetodontidae | 16.5 | 50.4 | 41.4 | 66.8 | 29.3 | 41.6 | 31.4 | 77.4 |
| Pomacanthidae | 1.0 | 15.6 | 7.4 | 66.0 | 6.5 | 18.0 | 10.4 | 56.6 |
| Labridae | 156.0 | 103.0 | 30.6 | 26.4 | 111.5 | 216.0 | 29.8 | 117.2 |
| Scaridae* | 1.5 | 5.0 | 41.6 | 12.2 | 3.8 | 16.0 | 71.4 | 22.2 |
| Acanthuridae* | 29.0 | 80.2 | 64.4 | 66.6 | 22.3 | 160.0 | 41.8 | 41.8 |
| Siganidae* | 2.5 | 1.4 | | 7.8 | 0.2 | 4.8 | | 9.4 |
| Kyphosidae* | | | | 7.0 | | 0.2 | | 10.0 |
| Pomacentridae | 358.0 | 979.2 | 1107.0 | 598.2 | 977.3 | 725.4 | 947.4 | 626.2 |
| Anthiinae | 38.5 | 18.2 | 31.4 | 17.0 | 47.8 | 5.4 | 16.0 | 18.2 |
| Zanclidae | 1.0 | 2.6 | 8.8 | 7.6 | 7.7 | 5.4 | 4.0 | 8.6 |

## 39.7 References and for Further Reading

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# CHAPTER 40 DAVAO GULF, DAVAO PROVINCE

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## 40.1 Biophysical Setting

Davao Gulf is located in the southeastern part of Mindanao Island, Philippines (Fig. 40.1). It lies approximately between 6°7′ and 7°21.5′ N latitude, and between 125°22′ and 126°11.5′ E longitude (MSU-Naawan 1995). The Gulf has about 412 km length of coral reefs (Board of Technical Surveys and Maps 1961; NAMRIA maps 1989). Fringing and patch reefs lie approximately less than 0.5 to 4 km from the shore. Extensive coral reefs were also located in the coastal areas of the mainland Davao Oriental and Davao del Sur and in the shoals and islands in Davao del Norte province (MSU-Naawan 1995).

## 40.2 Socio-economic Setting

The soil surface of Davao region is generally clay and loam type which is favorable to farming activities, attract multinational and domestic investments in plantation crops (banana, pomelo, cacao, black pepper, durian, mangosteen, coconut and other agricultural crops); cut flowers and orchid industry; livestock food processing; and mining of metallic (gold) and non-metallic minerals (MSU-Naawan 1995). Samal Island and Talikod Island are the principal recreational areas in Davao Gulf.

## 40.3 Management

A total of 691 artificial reefs made of rubber tires were deployed in 5 districts of Davao City. Some reefs have also been designated as protected areas (e.g., Pearl Farm at Adecor, Kaputian, Davao Oriental) and sanctuaries (e.g., Kopiat Island in Mabini, Davao del Norte). However, lack or poor management of artificial reefs is a problem (MSU-Naawan 1995).

## 40.4 Issues and Threats

The increasing population, development and industry, agriculture, fisheries and aquaculture greatly affect the Davao Gulf coral reef ecosystem. The present land use method leads to considerable soil erosion and flushing through the river system. Sedimentation due to deforestation and reclamation may become an increasing problem in the area. The use of chemical fertilizers and pesticides would have negative impact on the marine resources. The local folks are using unsustainable fishing practices on the reefs. The reduction of mangrove may contribute indirectly to the reduction of live coral cover. Pollution sources (e.g., cement industries, domestic effluents from urban areas and oil pollution from vessels) would greatly aggravate the deterioration of the area.

## 40.5 Monitoring, Evaluation and Feedback

There are only two monitoring studies conducted in Davao Gulf (Fig. 40.2).

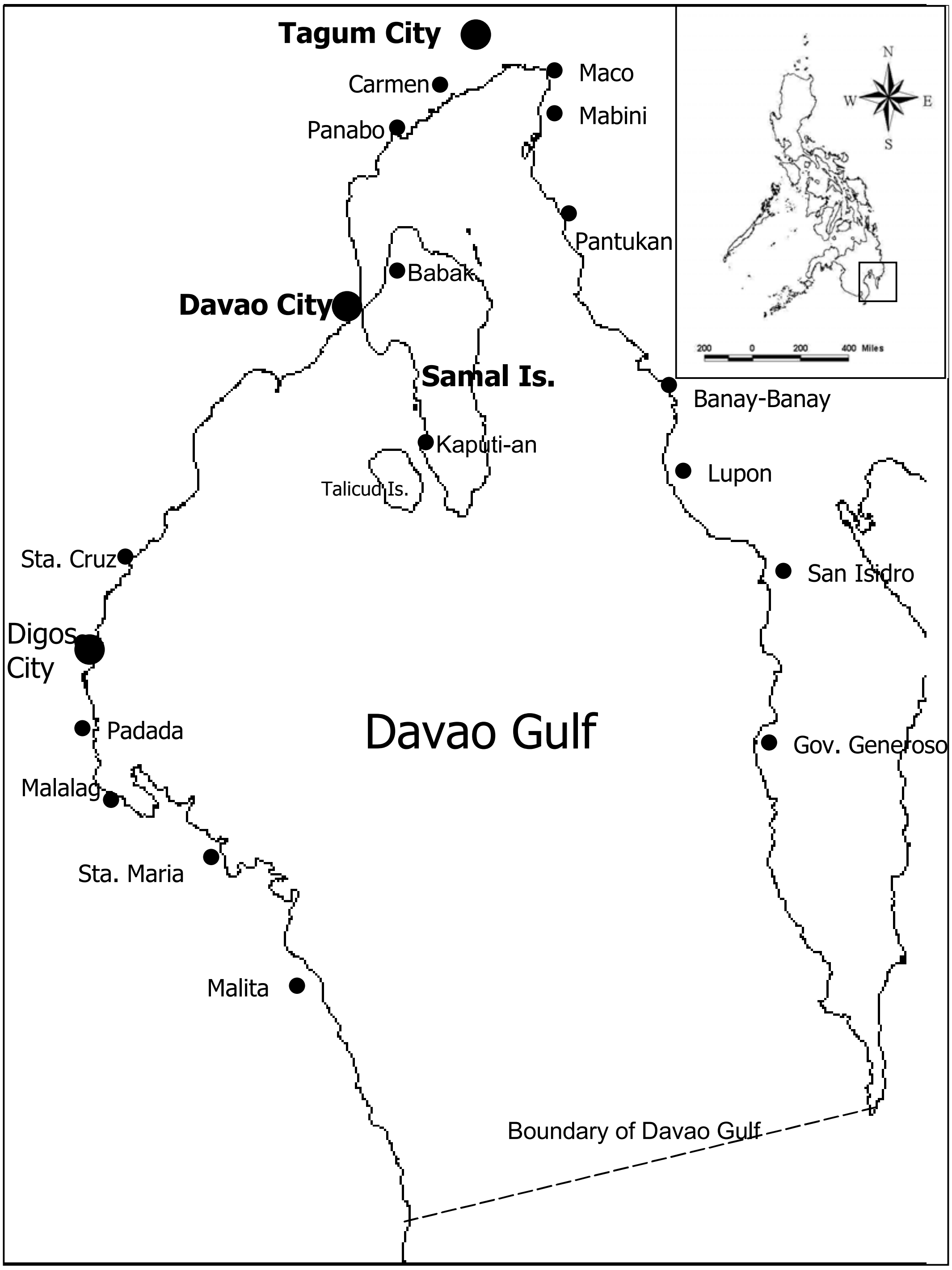


Fig. 40.1. Map of Davao Gulf.

## 40.6 Future directions, Gaps and Recommendations

It is high time to rehabilitate and conserve the coral reefs in Davao Gulf. Establishment of protected areas as “no take zones” would rehabilitate the area (UPV 2001). Appropriate data should be collected and packaged by the academe and other research institutions into forms which management can readily use to address management needs. Certain approaches, practices, principles and conditions should be the guide to make the system sustainable, namely: participatory process, multi-sectoral involvement, integrated approach, capacity development and at all levels, and establishment of sustainable financing mechanisms (Apura 2001).

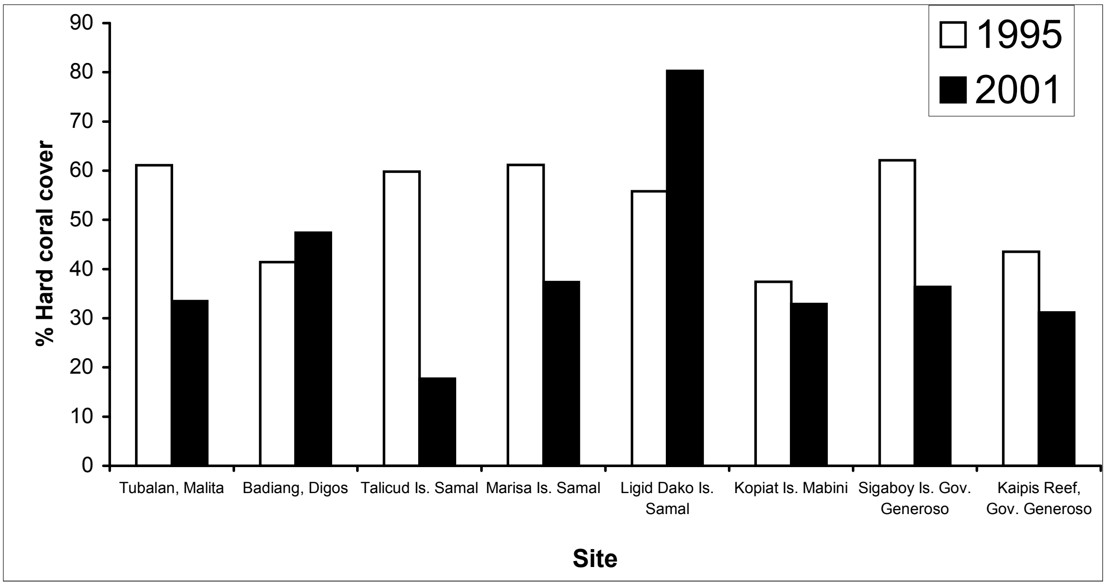


Fig. 40. 2. Hard coral cover (%) in selected area in Davao Gulf. (Source: MSU-Naawan 1995; UPV 2001)

## 40.7 References

Apura, B.A. 2001. Environmental Hot Spots (risks) Assessment and Management for Davao Gulf: A Concept Paper. Paper presented during the Davao Gulf Management Council Meeting at the Apo View Hotel, Davao City on November 29, 2001.

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University of the Philippines-Visayas. 2001. Task 4a The Coral Reefs of Davao Gulf. In Results Highlights Resource and Social Assessment of Davao Gulf. Bureau of Fisheries and Aquatic Resources, Region XI, Davao City.

# CHAPTER 41 ZAMBOANGA

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## 41.1 Biophysical Setting

The Little Santa Cruz Island with its fringing reef is located at 6°53.17' N and 122°02.5' E under the political jurisdiction of Zamboanga City. Sangali fish sanctuary is an 8-hectare platform reef at 7°10.55' N and 121°55.44' E east coast of Zamboanga City (Fig. 41.1). The Triton Island fish sanctuary is located at 7°29.5' N and 123°8.67' E within the municipality of Vincenzo Sagun, Zamboanga del Sur (Fig. 41.1).

## 41.2 Socio-economic Setting

Municipal fisherfolks from the east and west coasts of Zamboanga City and the residents in the Big Sta. Cruz depend on the marine resources surrounding the islands particularly on fish and commercial invertebrates for food and corals for tourists. The Takut Babaw is one of the main sources of fish in Sangali (population ~15,320).

The coastal barangays of Vincenzo Sagun and Margosatubig are the main exploiters of the marine resources in Triton Island. Exploitation diminished with the establishment of Sta. Cruz and Triton Island sanctuaries due to the added vigilance of Sta. Cruz fisherfolks and the presence of Riverine outpost in the Big Sta. Cruz Island. The Triton Island *Bantay Dagat* and Civilian Armed Forces Geographical Units (CAFGU) have been very strict with the implementation of the municipal ordinance.

## 41.3 Management

Conservation and management of the various resources in Sta. Cruz Island was given to the Zamboanga State College of Marine Sciences and Technology (ZSCMST) as embodied in a Memorandum of Agreement between the Philippine Tourism Authority (PTA) and ZSCMST. This sanctuary is being managed by the Sta. Cruz Community Fisherfolks Association in cooperation with the Riverine outpost of the AFP and Naval Command.

The Takut Babaw fish sanctuary is being managed by the BFARMC, *Bantay Dagat* and *Barangay* officials. While Triton fish sanctuary in Vincenzo Sagun is being managed by the Danan Community Fisherfolks Association together with the LGU, NGO (MuCard/Cossed) and the *Barangay* Council of Danan.

## 41.4 Issues and Threats

Blast fishing is still being practiced although greatly minimized due to the increased vigilance of the Riverine outpost and the residents of the island. In Takut Babaw (Sangali) the problem is more pronounced because is accessible to neighboring coastal villages. Unlike Sta. Cruz and Triton Island, it has no permanent residents but has a military outpost that monitors illegal activities. Crown-of-thorns starfish (COTS) infestation has recently caused the death of corals in the Big Sta. Cruz Island. So far, no one in the region is studying the causes of COTS outbreaks. If the outbreak is not controlled, live coral cover will significantly diminish.

## 41.5 Monitoring, Evaluation and Feedback

Monitoring activities in Little Sta. Cruz Island is being done every other month to document all possible changes in the fish fauna, corals and other marine resources. Fish fauna was surveyed using Fish Visual Census techniques, while benthic cover was using the Line Intercept Transect (LIT) (English et al.1994). Fishery based data is also gathered to complement research based data. Sampling from fishery catch is done for the study of spawning season and duration. Important reef species were collected, measured and weighed and the gonado-somatic index (GSI) for each species was also recorded.

Fish catch monitoring in barangays bordering the sanctuaries is continuously done for at least 10 consecutive days in a month. The total number of fishermen, gear and vessel used, species composition and other important information (fishing location, duration of fishing, length & weight) were gathered. Intercept sampling of fishermen catch in Sta. Cruz Island is conducted thrice a week.

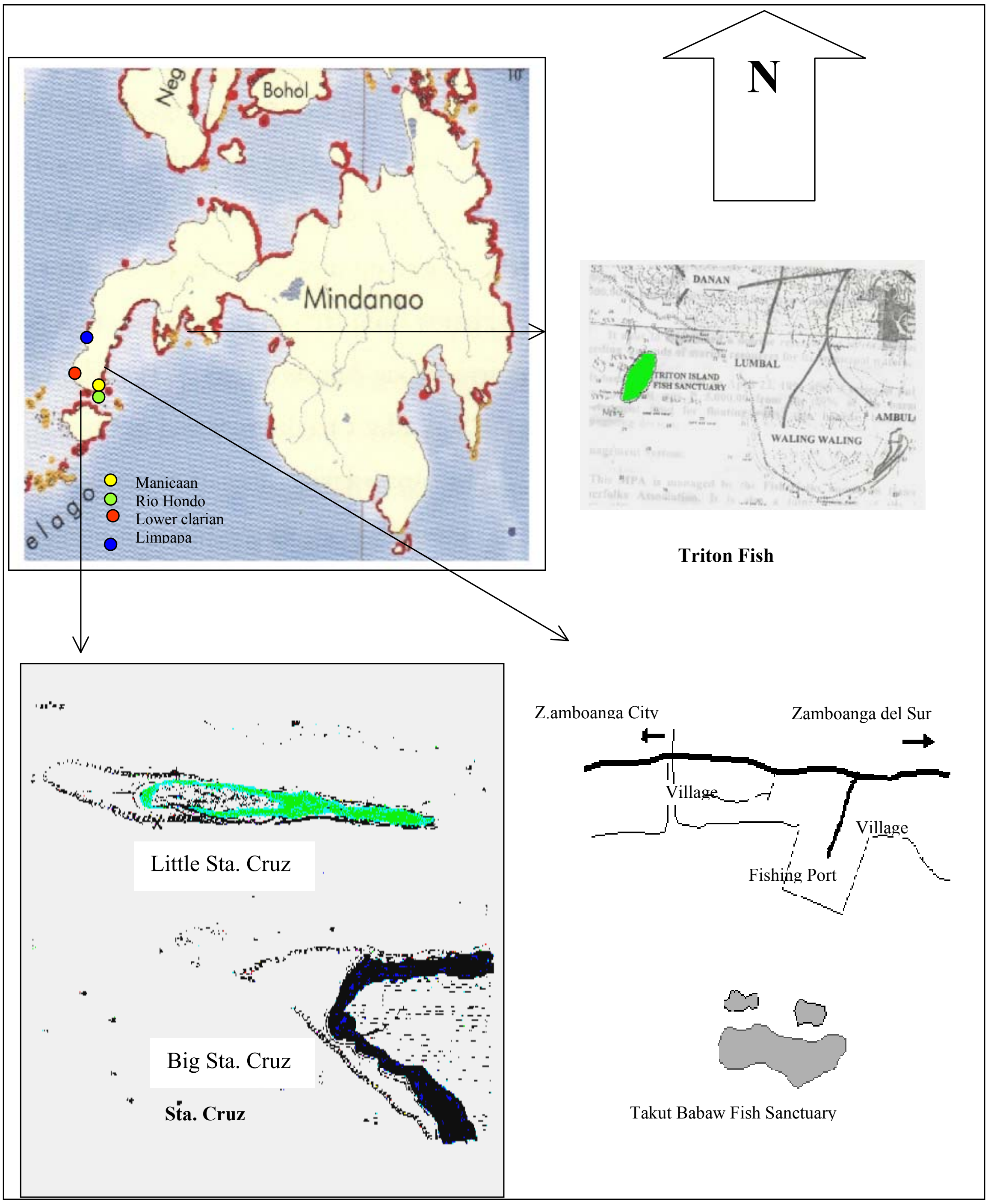


Figure 41.1. Map of fish sanctuaries / project sites in Region 9.

## 41.6 Future direction, Gaps and Recommendation

The common objective of the ZSCMST and the local governments is the sustainable management of the marine resources. Public consultations of proposed fishery ordinances are being undertaken.

Selected local communities have already been trained and their cooperation and participation has shown some improvement in the past year. The activities and the future benefits that these selected local communities will get in terms of sustaining their marine resources has reached other areas particularly in Zamboanga City. Consequently, the same training is expected by other concerned coastal communities. However, administrative and financial resources are minimal that the BFAR Regional Fishermen Training Center had already been tapped to support its requirements. It is also evident that even this will not be enough since other agencies also have their own priorities and targets to accomplish. In addition, alternative livelihood and continuing enhancement of community capabilities must also be addressed.

On the other hand, coordination between the academe, the local government and the DENR should be enhanced. The activities and strategies of these agencies must revolve around the principles of integrated coastal zone management.

Table 41.1. Hard coral cover (%) and fish abundance (target species) in marine fish sanctuaries in Zamboanga del Sur, Region 9.

| | | | Hard coral cover (%) | | | | Fish abundance (target species, fish/250m$^{2}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Longitude | Latitude | Municipality/(site) | 1999 | 2000 | 2001 | 2002 | 1999 | 2000 | 2001 | 2002 |
| 122$^{o}$02.5’ | 6$^{o}$53.16’ | Zamboanga City (Little Sta. Cruz Island) | 75.90 | 51.72 | 61.75 | 74.00 | 39 | 123 | 280 | 181 |
| 122 $^{o}$ 02.42‘ | 6 $^{o}$ 53.16’ | Zamboanga City (Big Sta. Cruz Island*) | | | 44.33 | 63.00 | | | 76 | 85 |
| 121$^{o}$55.43’ | 7$^{0}$10.55’ | Zamboanga City (Takut Babaw, Sangali) | 37.84 | | 39.50 | 16.26 | 21 | | 49 | 51 |
| 122$^{o}$ 13.28’ | 7 $^{o}$ 1.22’ | Zamboanga City (Manicahan*) | 75.77 | | | 39.58 | 31 | | | 42 |
| 121 $^{o}$ 55.43 | 7$^{o}$ 0.57 | Zamboanga City (Limpapa*) | 28.50 | | | 47.76 | 21 | | | 27 |
| | | Zamboanga City (Gulf*) | 49.08 | | | 13.02 | | | | |
| | | Zamboanga City (Lower Calarian*) | | | | | 19 | | | 27 |
| 122 $^{o}$ 05.03’ | 6$^{o}$ 4.36’ | Zamboanga City (Rio Hondo*) | 28.60 | | | 41.54 | 17 | | | 19 |
| 123$^{o}$8.66’ | 7$^{0}$29.50’ | Vincenzo Sagun (Triton Island) | 59.38 | | 67.50 | 69.05 | 126 | | 363 | 378 |

Legend: * Proposed fish sanctuary

Table 41.2. Data of Fish catch rate in marine fish sanctuaries in Region 9.

| FISH CATCH RATE | | | | | Year | | | |
|---|---|---|---|---|---|---|---|---|
| Longitude | Latitude | Province | Municipality | details | 1999 | 2000 | 2001 | 2002 |
| 122$^{0}$2.50 | 6$^{0}$53.17 | Zamboanga del Sur | Zambo. City (Sta. Cruz Island) | BGN (kg/hr) | | 1.05 | 2.48 | |
| | | | | BLL (kg/hr) | | 0.76 | 2.06 | |
| | | | | SF (kg/hr) | | 1.10 | 2.51 | |
| | | Zamboanga del Sur | Vincenzo Sagun | TGN (kg/hr) | | | 1.10 | |
| 123$^{o}$8.67 | 7$^{0}$29.50 | | | BLL (kg/hr) | | | 1.20 | |
| 121$^{0}$55.38 | 7$^{0}$10.55 | Zamboanga del Sur | Zambo. City (Sangali) | BGN (kg/hr) | | 3.08 | 3.48 | |
| | | | | LL (kg/hr) | | 2.97 | 3.58 | |
| | | | | BLL (kg/hr) | | 3.92 | 3.32 | |

# METADATA

## A. Reef Check Coral Reef Monitoring in the Philippines: 1997-2001

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### Introduction

The Reef Check Global Coral Reef Assessment Program began in 1997, as a "snapshot" view of the world's coral reefs. The methods used were simple, and easily taught to lay recreational divers. Lay divers and scientists volunteered their time to obtain data from what were considered to be reefs in the best condition in a given area, and data were pooled into a single database. This resulted in a report presented on the Reef Check website (www.reefcheck.org), and included in Wilkinson (1998). Although it was initially planned as a single global survey, enthusiasm and participation was high enough to consider another survey the following year. Reef Check has now become an annual event, resulting in a rapidly-expanding database, and relying on a pool of committed marine scientists and recreational divers, many of whom participate on a yearly basis. Data are available as country summaries on the website, or by a direct request for data per site from Ms. Jennifer Liebeler at the International Headquarters, at rcheck@ucla.edu. At present, Dr. L. Raymundo is the National Coordinator for Reef Check, Philippines. She can coordinate obtaining individual data sets from the International Headquarters, if necessary.

The Philippines began its involvement in 1997 as well, though few sites have been surveyed repeatedly. This report will present the metadata on sites for which there is more than one survey year, as well as selected sites of particular importance which may be resurveyed in the future. To date, there are three individuals regularly organizing Reef Check surveys on an annual basis:

**Dr. Alan White** (awhite@mozcom.com), with the Coastal Resources Management Project and the Coastal Conservation and Education Foundation, Inc., based in Cebu City, Cebu. Dr. White usually applies Reef Check survey methods using Earthwatch volunteer teams, and has surveyed in the Batangas area, Tubbataha, and the Central Visayas.

**Mr. Michael Ross** (mikeross@mozcom.com), based in Cebu City. Mr. Ross is a dive shop operator, who has organized Reef Check surveys in northern Cebu and Leyte. Mr. Ross has organized groups from DENR, BFAR and the Coast Guard auxiliary to help with surveys, and has been instrumental in using the Reef Check surveys to have a portion of the reef on Gilatangaan Island, northern Cebu declared a Marine Protected Area.

**Dr. Laurie Raymundo** (lauriejr@dgte.mozcom.com), with Silliman University Marine Laboratory, Dumaguete City, Negros Oriental. Dr. Raymundo has conducted annual surveys within the Apo Island Marine Reserve, and on other reefs along the coast of Negros Oriental. Volunteers are from the Silliman University student body, Peace Corp, and local dive shop operators and dive guides.

Reef Check Methods: What Data Are Collected?

Because Reef Check relies heavily on volunteer divers, thereby keeping survey costs at a minimum, the methods employed are straightforward and easy to teach to certified, experienced divers. The focus is on collecting data that will provide information regarding a variety of stresses that a reef may be subjected to. Data are gathered along two 100m transect lines, one at a shallow depth (3-4 m is recommended) and a deep depth (10 m is recommended). If the reef bathymetry or size is not conducive to both, then a single transect may be laid. If the site is to be revisited, permanent transect markers are placed. Four 20 m segments are read from each line, with 5 m spaces between each, which allows for replication along each transect. Four categories of data are collected:

*Site data:* a form is completed describing each site visited that includes information such as GPS readings for transects, weather, population size, proximity to a river mouth, protection status of the site, signs of pollution or stress, etc. One form is filled out per site per year.

**Substrate data:** on each of the 20 m segments along the transect lines, data on substrate categories is read at 0.5 m intervals. The following categories are used: Live Hard Coral (HC), Soft Coral (SC), Recently-Killed Coral (RKC; defined as coral that died within the past year, where the skeleton is still discernible and only slightly weathered), Rock (RO; this may include coral that has been dead for some time, where the skeleton is highly weathered), Fleshy or Bed-forming Algae (FS), Sponges (SP), Coral Rubble (RU), Sand (SD), Silt/clay (SI), Other benthic encrusting forms (OT). These data may reveal specific stresses such as algal overgrowth, eutrophication, anchor damage or blast fishing, bleaching, or siltation. Other signs of such activities are also noted on the data sheet. Presence of garbage, abandonded fish nets, etc. are also noted, with some estimate of their quantity per 20 m segment. Individual teams are encouraged to collect additional data, if they choose, such as coral growth form, but it is not required that such data be submitted to the international database.

**Benthic Invertebrate data:** belt transects are used (a 5 m belt on either side of the transect, for 4 20 m lengths) to identify and count specific benthic invertebrates that are either targeted for harvesting or associated with specific forms of reef stress. Species that are likely to be targeted for harvesting are as follows: giant clams (*Tridacna* spp.), tritons *(Charonia tritonis),* edible sea cucumbers, slate pencil urchins *(Heterocentrotus mammilatus),* lobster, banded shrimp *(Stenopus hispidus)*. Those that may indicate imbalance or stress are the following: (*Diadema setosum,* Crown-of-Thorns starfish, *Acanthaster planci*). Divers may take with them an underwater key to help with identification; both common and scientific names are used. Again, individual teams may elect to collect additional data for their own use.

*Target Fish data:* Belt transects as described above are also used for fish visual census, but certain species are counted even if they are outside the belt (such as groupers, parrotfish). Again, the emphasis is on fish that are targeted for harvesting, primarily at either the family or genus level: Sweetlips (Haemulidae), snappers (Lutjanidae), Barramundi cod, groupers (Serranidae; only those >30 cm in length), humphead wrasse, Bumphead parrotfish, other parrotfish >20 cm, and moray eels. Butterfly fish (Chaetodontidae) that are associated with reef health and diversity are also counted. Additional rare species (sharks, rays, turtles, etc.) are also noted, if observed anywhere on the reef during the dive.

Reef Check Survey Sites for the Philippines: Metadata

A major feature of Reef Check data is that many sites are surveyed only once. This is a limitation of the reliance on volunteer divers; few teams return to the same sites on a yearly basis, unless the team organizer is particularly committed to regularly monitoring specific reefs. While such data sets are useful for examining broad scale trends, annual surveys are more useful for examining changes over time in individual sites. The sites that have been Reef Check surveyed for at least two years are summarized in Table 1. Sites with a high probability of being resurveyed in the future, or those of particular interest, are also included. The contact person for the survey team is included, as well as information on the exact location of the sites. A complete data set, as described above, is available for each of these sites from the International Headquarters in UCLA.

## Reference List

The following is a list of references where Reef Check data have been used or compiled.


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Wilkinson C. (ed.) 2000. Status of Coral Reefs of the World: 2000. Australian Inst. of Mar. Sci.. Townsville, Australia


## B. Other Coral Reef Sites That Have Been Monitored


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- Edmundo Enderez: Balayan Bay, Center for Empowerment and Resource Development Inc. (CERD)
- Michael Atrigenio: Sierra Madre 1999 & 2000 , WB-GEF-CPPAP 2000-2003 (Plan International, Pacific Seaboard Project); Batanes, Apo Reef & Siargao 1991 & 1999 (UB-GEF-IPAS & WB-GEF-CPPAP)

Table 1. Metadata for sites around the Philippines surveyed using Reef Check methods, 1997-2001.

| Survey Years | Site Location | Name of Reef(s) | No. Transects | (Contact Person), Groups Involved |
|---|---|---|---|---|
| 1998-2001 | Dauin, Negros Oriental | Apo Island Marine Reserve | 2 | (L. Raymundo) SUML |
| 1997-2001 | Danjugan Is., Negros Occ. | Big Manta Rock, Hilaries, North Wall | 2 | (no contact name) Coral Cay |
| 1997, 1998 | Sipalay, Negros Occidental | Campomanes Bay | 2 | (no contact name) Coral Cay |
| 2000 | Northern Cebu | Capitancillo | 2 | (M. Ross) CRMP, Coast Guard |
| 2000 | Bantayan Island, Cebu | Gilatangaan | 2 | |
| 1997, 2001 | Mabini, Batangas, Luzon | Cathedral Rock, Brgy. Bagalangit | 13 | (A. White) Earthwatch, CRMP, |
| | | Arthur's Rock, Brgy. Bagalangit | 37 | Coastal Cons. & Educ. Found. |
| | | White Sand Reef, Brgy. San Teodoro | 8 | Inc. (formerly Sulu Fund) |
| | | White House Reef, Brgy. San Teodoro | 4 | |
| | | Twin Rocks Reef, Brgy. San Teodoro | 20 | |
| | Tingloy, Batangas, Luzon | Pulang Buli Reef, Brgy. Sto. Tomas | 18 | |
| | | Layag-layag Reef, Brgy. Sto. Tomas | 16 | |
| | | Sepoc Pt., Brgy. Sto. Tomas | 12 | |
| | | Sombrero Reef, Brgy. Sto. Tomas | 27 | |
| | Bauan, Batangas, Luzon | Dive & Trek Sanctuary, Brgy. San Pablo | 16 | |
| 1999 | Cebu | Sumilon Island Marine Reserve | 10 transects | (A. White) Earthwatch, CRMP |
| 1999 | Bohol | Panglao Island | total over 3 | |
| 1999 | Bohol | Pamilacan Island | sites | |
| 2000 | Tubbataha, Cagayancillo | Tubbataha Marine National Park | 120 over 8 | (A. White) Earthwatch, CRMP, |
| | | | sites | Coastal Cons. & Educ. Found. |
| 2001 | Moalboal, Cebu | Pescador Island, Brgy. Basdiot | 10 | (A.White), Coastal Cons. & |
| | | Saavedra Fish Sanctuary, Brgy. Saavedra | 9 | Educ. Found. |

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Appendix 1.1 Summary of hard coral cover (%) data for selected reef areas located along the South China Sea Bio-geographic region

| Entry no. | Longitude | Latitude | Province | Municipality | Data sources | Site | Depth | Method | No. of transects |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 120o34'03" | 18o29'06" | Ilocos Norte | Pasuquin | CEP- region 1 | Station 1 | 6 - 7m | LIT | 1 |
| 2 | | | Ilocos Norte | Pasuquin | CEP- region 1 | Station 2 | 6 - 7m | LIT | 1 |
| 3 | 120o34'04" | 18o28'55" | Ilocos Norte | Pasuquin | CEP- region 1 | Station 3 | 6 - 7m | LIT | 1 |
| 4 | 120o34'01" | 18o28'58" | Ilocos Norte | Pasuquin | CEP- region 1 | Station 4 | 6 - 7m | LIT | 1 |
| 5 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | LIT/VIDEO | 5 (in MPA) |
| 6 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | LIT/VIDEO | 5 (out MPA) |
| 7 | | | La Union | Luna | CEP- region 1 | Station 1 | | | 1 |
| 8 | | | La Union | Luna | CEP- region 1 | Station 2 | 6 - 7m | | 1 |
| 9 | | | La Union | Luna | CEP- region 1 | Station 3 | | | 1 |
| 10 | | | La Union | Luna | | Station 4 | | | 1 |
| 11 | | | La Union | Luna | CEP- region 1 | Station 5 | 7 - 8m | | 1 |
| 12 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | LIT/VIDEO | 3,5 (in MPA) |
| 13 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | LIT/VIDEO | 3,5 (out MPA) |
| 14 | | | Pangasinan | Bolinao | UPMSI - MFRMP | Balingasay MPRA | | | (in MPA) |
| 15 | | | Pangasinan | Bolinao | UPMSI - MFRMP | Balingasay MPRA | | | (out MPA) |
| 16 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | LIT/VIDEO | 3,4,4 (in MPA) |
| 17 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | LIT/VIDEO | 3,4,4 (out MPA) |
| 18 | 119°55.771’ | 16°27.282’ | Pangasinan | Bolinao | UPMSI-FRMP | Silaqui | | LIT/VIDEO | |
| 19 | 119°56.120’ | 16°27.407’ | Pangasinan | Bolinao | UPMSI-FRMP | Malilnep | | LIT/VIDEO | |
| 20 | 119°58.657’ | 16°27.283’ | Pangasinan | Bolinao | UPMSI-FRMP | Dewey | | LIT/VIDEO | |
| 21 | 119°59.768’ | 16°22.777’ | Pangasinan | Anda | UPMSI-FRMP | Cangaluyan | | LIT/VIDEO | |
| 22 | 119°58.649’ | 16°24.061’ | Pangasinan | Anda | UPMSI-FRMP | Cabungan | | LIT/VIDEO | |
| 23 | 120°01.822’ | 16°20.454’ | Pangasinan | Anda | UPMSI-FRMP | Tandoyong | | LIT/VIDEO | |
| 24 | 120o04'00" | 16o11'00" | Pangasinan | Alaminos | CEP- region 1 | Site 1A (Eastern Telbang) | | | 1 |
| 25 | 120o04'15" | 16o11'05" | Pangasinan | Alaminos | CEP- region 1 | Site 1B (Eastern Telbang) | | | 1 |
| 26 | 120o03'30" | 16o11'12" | Pangasinan | Alaminos | CEP- region 1 | Site 2 (Northern Telbang) | | | 1 |
| 27 | 120o03'00" | 16o11'15" | Pangasinan | Alaminos | CEP- region 1 | Site 3 (Western Telbang) | | | 1 |
| 28 | 120o53.259' | 13o42.539' | Batangas | Mabini | White et al. 2001 | Arthur's Rock Fish Sanctuary | 6 - 8m | SCUBA | 3,(?),11,37 |
| 29 | 120°53.233’ | 13°41.564’ | Batangas | Mabini | White et al. 2001 | Twin Rocks Fish Sanctuary | 6 - 9m | SCUBA | 4,(?),10,20 |
| 30 | | | Batangas | Mabini | White et al. 2001 | Selo Point/reef | 6 -10m | SCUBA | |
| 31 | | | Batangas | Mabini | White et al. 2001 | White-House Reef | | | |
| 32 | | | Batangas | Mabini | White et al. 2001 | White Sand Reef | | SCUBA | |
| 33 | | | Batangas | Tingloy | White et al. 2001 | Pulang-Buli Reef | | SCUBA | |
| 34 | | | Batangas | Tingloy | White et al. 2001 | Sepoc Point | 6 - 8m | SCUBA | |
| 35 | | | Batangas | Tingloy | White et al. 2001 | Layag-Layag, Caban Island | 6 - 8m | SCUBA | |
| 36 | | | Batangas | Tingloy | White et al. 2001 | Sombrero Island | | SCUBA | |
| 37 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | VIDEO | 4,4 (in MPA) |
| 38 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | VIDEO | 4,4 (out MPA) |
| 39 | 120o23'46" | 12o44'47" | Mindoro | Sablayan | White et al. 2001 | Apo Reef Marine Reserve | | | |
| 40 | | | Palawan | Taytay | see below | | | | |
| 41 | | | Palawan | Taytay | ASEAN-LCR 1986 | 4 reef areas in Bacuit Bay | | LIT | 10 |
| 42 | | | Palawan | Taytay | SPEX 1993 | 4 reef areas in Bacuit Bay | | LIT | 4 |
| 43 | | | Palawan | Taytay | DENR-ENMR 1994 | 4 reef areas in Bacuit Bay | | LIT | 10 |
| 44 | | | Palawan | Taytay | EC-CERDS 1995 | 4 reef areas in Bacuit Bay | | LIT | 7 |
| 45 | | | Palawan | Taytay | TKDC-MERF 1996 | 10 reef areas in Bacuit Bay | | LIT | 20 |
| 46 | | | Palawan | Taytay | KAL-SCS PROG 1999 | 2 reef areas in Bacuit Bay | | LIT | 2 |
| 47 | | | Palawan | Taytay | URI-MERF 2000 | 10 reef areas in Bacuit Bay | | LIT | 10 |
| 48 | | | Palawan | Kalayaan | see below | | | | |
| 49 | | | Palawan | Kalayaan | Licuanan et al. 1993 | 6 reef areas in the KIG | | LIT | 6 |
| 50 | | | Palawan | Kalayaan | Tuan et al. 1997 | 4 reef areas in the KIG | | LIT | 4 |
| 51 | | | Palawan | Kalayaan | Quibilan et al. unpb 1997 | 7 reef areas in the KIG | | LIT | 25 |
| 52 | | | Palawan | Kalayaan | Quibilan et al. unpb 1998 | 5 reef areas in the KIG | | LIT | 11 |

Contn. Appendix 1.1

| Entry no. | Transect length | Year 1979 | 1983 | 1986 | 1988 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | TRENDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | 62.00 | | | | 35.20 | 34.40 | | | decrease |
| 2 | | | | | | | | | | 31.74 | | | | 52.61 | 68.70 | | | increase |
| 3 | | | | | | | | | | 35.84 | | | | 40.80 | 22.46 | | | decrease |
| 4 | | | | | | | | | | 42.02 | | | | 55.00 | 34.24 | | | decrease |
| 5 | 50m | | | | | | | | | | | | | | 27.42 | 20.71 | 39.92 | increase |
| 6 | 50m | | | | | | | | | | | | | | 24.88 | 46.93 | 27.83 | stable |
| 7 | | | | | | | | | | 38.56 | | | | | 63.56 | | | increase |
| 8 | | | | | | | | | | 51.76 | | | | | 34.48 | | | decrease |
| 9 | | | | | | | | | | 26.38 | | | | | 21.30 | | | decrease |
| 10 | | | | | | | | | | 16.00 | | | | | 45.44 | | | increase |
| 11 | | | | | | | | | | 58.84 | | | | | 46.48 | | | decrease |
| 12 | 50m | | | | | | | | | | | | | | | 29.71 | 30.58 | stable |
| 13 | 50m | | | | | | | | | | | | | | | 21.56 | 23.89 | stable |
| 14 | | | | | | | | | | | | | | 34.46 | 36.47 | | | stable |
| 15 | | | | | | | | | | | | | | 24.06 | 26.33 | | | stable |
| 16 | 50m | | | | | | | | | | | | | | 27.43 | 30.73 | 34.55 | increase |
| 17 | 50m | | | | | | | | | | | | | | 15.99 | 39.56 | 39.47 | increase |
| 18 | | | | | 25.60 | | | | | | | | | | 9.50 | | | decrease |
| 19 | | | | | 38.60 | | | | | | | 41.00 | 32.00 | 14.00 | 21.60 | | | decrease |
| 20 | | | | | 29.50 | | | | | | | | | | 29.40 | | | stable |
| 21 | | | | | 38.30 | | | | | | | | | | 32.90 | | | decrease |
| 22 | | | | | 35.70 | | | | | | | | | | 9.60 | | | decrease |
| 23 | | | | | 29.10 | | | | | | | | | | 20.70 | | | decrease |
| 24 | | | | | | | | 12.00 | | | | | 67.60 | | | | | increase |
| 25 | | | | | | | | 33.51 | | | | | 66.60 | | | | | increase |
| 26 | | | | | | | | 28.88 | | | | | 74.00 | | | | | increase |
| 27 | | | | | | | | 45.00 | | | | | 51.60 | | | | | increase |
| 28 | 50m | | | | | | | 26.60 | | 34.00 | | 29.10 | | | | 34.60 | | stable |
| 29 | 50m | | | | | | | 12.90 | | 31.30 | | 24.00 | | | | 30.70 | | increase |
| 30 | 50m | | | | | | | 40.70 | | 40.20 | | | | | | | | stable |
| 31 | 50m | | | | | | | | 18.30 | 37.40 | | 29.90 | | | | 12.30 | | ? |
| 32 | 50m | | | | | | | 21.60 | | 30.70 | | 31.20 | | | | 19.00 | | ? |
| 33 | 50m | | | | | | | 21.00 | | 24.40 | | 10.50 | | | | 14.90 | | decrease |
| 34 | 50m | | | | | | | 43.10 | | 57.60 | | 49.30 | | | | 52.00 | | stable |
| 35 | 50m | | | | | | | 34.20 | | 27.00 | | 29.40 | | | | 39.20 | | ? |
| 36 | 50m | | 45.90 | | | | | 37.60 | | 62.70 | | 53.00 | | | | 36.40 | | ? |
| 37 | 50m | | | | | | | | | | | | | | 21.05 | 25.20 | | stable |
| 38 | 50m | | | | | | | | | | | | | | 14.76 | 26.48 | | increase |
| 39 | | 50.00 | | | | | | | 33.00 | | | | | | | | | decrease |
| 40 | | | 37.37 | | | | | 29.89 | 36.89 | 56.26 | 31.01 | | | 16.50 | 16.83 | | | decrease |
| 41 | ? | | 37.37 | | | | | | | | | | | | | | | |
| 42 | 100m | | | | | | | 29.89 | | | | | | | | | | |
| 43 | ? | | | | | | | | 36.89 | | | | | | | | | |
| 44 | 30m | | | | | | | | | 56.26 | | | | | | | | |
| 45 | 30m | | | | | | | | | | 31.01 | | | | | | | |
| 46 | 30m | | | | | | | | | | | | | 16.50 | | | | |
| 47 | 30m | | | | | | | | | | | | | | 16.83 | | | |
| 48 | | | | | | | | 16.28 | | | 7.86 | 17.07 | 7.26 | | | | | decrease |
| 49 | 150m | | | | | | | 16.28 | | | | | | | | | | |
| 50 | 60-100m | | | | | | | | | | 7.86 | | | | | | | |
| 51 | 30m | | | | | | | | | | | 17.07 | | | | | | |
| 52 | 30m | | | | | | | | | | | | 7.26 | | | | | |

Appendix 1.2 Summary of associated reef fish data (abundance and biomass) for selected reef areas located along the South China Sea Bio-geographic region.

| Entry no. | Longitude | Latitude | Province | Municipality | Data source | Site | Depth | Method | No. of transects | transect length |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 120°34'03" | 18°29'06" | Ilocos Norte | Pasuquin | CEP- region 1 | | | | 4 ? | |
| 2 | | | Ilocos Norte | Pasuquin | CEP- region 1 | | | | 4 ? | |
| 3 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (in MPA) | 50m |
| 4 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (in MPA) | 50m |
| 5 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (out MPA) | 50m |
| 6 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (out MPA) | 50m |
| 7 | | | La Union | Luna | CEP- region 1 | | | | 5 ? | |
| 8 | | | La Union | Luna | CEP- region 1 | | | | 5 ? | |
| 9 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (in MPA) | 50m |
| 10 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (in MPA) | 50m |
| 11 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (out MPA) | 50m |
| 12 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (out MPA) | 50m |
| 13 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (in MPA) | 50m |
| 14 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (in MPA) | 50m |
| 15 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (out MPA) | 50m |
| 16 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (out MPA) | 50m |
| 17 | 119°55.771' | 16°27.282' | Pangasinan | Bolinao | UPMSI-FRMP | Silaqui | | FVC | 1 | |
| 18 | 119°56.120' | 16°27.407' | Pangasinan | Bolinao | UPMSI-FRMP | Malilnep | | FVC | 1 | |
| 19 | 119°58.657' | 16°27.283' | Pangasinan | Bolinao | UPMSI-FRMP | Dewey | | FVC | 1 | |
| 20 | 119°59.768' | 16°22.777' | Pangasinan | Anda | UPMSI-FRMP | Cangaluyan | | FVC | 1 | |
| 21 | 119°58.649' | 16°24.061' | Pangasinan | Anda | UPMSI-FRMP | Cabungan | | FVC | 1 | |
| 22 | 120°01.822' | 16°20.454' | Pangasinan | Anda | UPMSI-FRMP | Tandoyong | | FVC | 1 | |
| 23 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240601 | | FVC | 1 | 50m |
| 24 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240602 | | FVC | 1 | 50m |
| 25 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240603 | | FVC | 1 | 50m |
| 26 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240604 | | FVC | 1 | 50m |
| 27 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240605 | | FVC | 1 | 50m |
| 28 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240606 | | FVC | 1 | 50m |
| 29 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240607 | | FVC | 1 | 50m |
| 30 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240608 | | FVC | 1 | 50m |
| 31 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240609 | | FVC | 1 | 50m |
| 32 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240610 | | FVC | 1 | 50m |
| 33 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240601 | | FVC | 1 | 50m |
| 34 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240602 | | FVC | 1 | 50m |
| 35 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240603 | | FVC | 1 | 50m |
| 36 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240604 | | FVC | 1 | 50m |
| 37 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240605 | | FVC | 1 | 50m |
| 38 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240606 | | FVC | 1 | 50m |
| 39 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240607 | | FVC | 1 | 50m |
| 40 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240608 | | FVC | 1 | 50m |
| 41 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240609 | | FVC | 1 | 50m |
| 42 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240610 | | FVC | 1 | 50m |
| 43 | 120°53.259' | 13°42.539' | Batangas | Mabini | White et al. 2001 | Arthur's Rock Fish Sanctuary | | | 3,5,6 | |
| 44 | 120°52.365' | 13°43.566' | Batangas | Mabini | White et al. 2001 | Pulang-Buli Reef | | | 2,2,2,6 | |
| 45 | 120°53.264' | 13°41.530' | Batangas | Mabini | White et al. 2001 | Twin Rocks Fish Sanctuary | | | | |
| 46 | | | Batangas | | White et al. 2001 | Selo Point | | | 1,2 | |
| 47 | | | Batangas | | White et al. 2001 | Sepoc Point | | | 1,4,8,4 | |
| 48 | | | Batangas | | White et al. 2001 | White Sand Reef | | | 2,4,3 | |
| 49 | | | Batangas | | White et al. 2001 | Layag-Layag, Caban Island | | | 2,2,8 | |
| 50 | | | Batangas | | White et al. 2001 | Sombrero Island | | | 2,2,6,8 | |
| 51 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (in MPA) | 50m |
| 52 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (in MPA) | 50m |
| 53 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (out MPA) | 50m |
| 54 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (out MPA) | 50m |
| 55 | | | Palawan | Taytay | TKDC-MERF 1996 | 5313BS | | FVC | 1 | 50m |
| 56 | | | Palawan | Taytay | | 5313FM | | FVC | 1 | 50m |
| 57 | | | Palawan | Taytay | URI-MERF 2000 | 5313PC | | FVC | 1 | 50m |
| 58 | | | Palawan | Taytay | | 5313PY | | FVC | 1 | 50m |
| 59 | | | Palawan | Taytay | | 5313Pp | | FVC | 1 | 50m |
| 60 | | | Palawan | Taytay | | 5313SE | | FVC | 1 | 50m |
| 61 | | | Palawan | Taytay | | 5313SM | | FVC | 1 | 50m |
| 62 | | | Palawan | Taytay | | 5313TM | | FVC | 1 | 50m |
| 63 | | | Palawan | Taytay | | 5313TR | | FVC | 1 | 50m |
| 64 | | | Palawan | Taytay | | 5313WM | | FVC | 1 | 50m |
| 65 | | | Palawan | Taytay | | | | | | |

Contn. Appendix 1.2.

| Entry no. | Details | 1979 | 1983 | 1986 | 1988 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | TRENDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total density | | | | | | | | | 6004 | | | | | 7377 | | | increase |
| 2 | FB ($mT/km^2$) | | | | | | | | | 112.0 | | | | | 137.6 | | | increase |
| 3 | FD ($ind/500m^2$) | | | | | | | | | | | | | | 440.8 | 292.8 | 274.2 | decrease |
| 4 | FB ($mT/km^2$) | | | | | | | | | | | | | | 36.8 | 11.2 | 15.4 | decrease |
| 5 | FD ($ind/500m^2$) | | | | | | | | | | | | | | 424.0 | 296.8 | 232.4 | decrease |
| 6 | FB ($mT/km^2$) | | | | | | | | | | | | | | 18.3 | 14.1 | 8.0 | decrease |
| 7 | Total density | | | | | | | | | 3502.0 | | | | | 4070.0 | | | increase |
| 8 | FB ($mT/km^2$) | | | | | | | | | 69.2 | | | | | 80.1 | | | decrease |
| 9 | FD ($ind/500m^2$) | | | | | | | | | | | | | 463.7 | | 278.7 | 234.0 | decrease |
| 10 | FB ($mT/km^2$) | | | | | | | | | | | | | | | 13.6 | 8.0 | decrease |
| 11 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | 182.3 | 187.8 | increase |
| 12 | FB ($mT/km^2$) | | | | | | | | | | | | | | | 8.2 | 5.3 | decrease |
| 13 | FD ($ind/500m^2$) | | | | | | | | | | | | | | 139.0 | 228.5 | 384.3 | increase |
| 14 | FB ($mT/km^2$) | | | | | | | | | | | | | | 5.7 | 6.8 | 5.8 | stable |
| 15 | FD ($ind/500m^2$) | | | | | | | | | | | | | | 141.7 | 117.8 | 155.3 | increase |
| 16 | FB ($mT/km^2$) | | | | | | | | | | | | | | 4.4 | 3.9 | 5.4 | stable |
| 17 | FD ($ind/1000m^2$) | | | | 1024 | | | | | | | | | | 291 / 136 | | | |
| 18 | FD ($ind/1000m^2$) | | | | 666 | | | | | | | 446.0 | 444.0 | 644.0 | 452 / 362 | | | stable |
| 19 | FD ($ind/1000m^2$) | | | | 608 | | | | | | | | | | 428 / 308 | | | decrease |
| 20 | FD ($ind/1000m^2$) | | | | 500 | | | | | | | | | | 256 / 286 | | | decrease |
| 21 | FD ($ind/1000m^2$) | | | | 454 | | | | | | | | | | 479 / 234 | | | increase |
| 22 | FD ($ind/1000m^2$) | | | | 372 | | | | | | | | | | 242 / 219 | | | decrease |
| 23 | FD ($ind/500m^2$) | | | | | | | | | | | 183 | 276 | 311 | | | | |
| 24 | FD ($ind/500m^2$) | | | | | | | | | | | 136 | 191 | 318 | | | | |
| 25 | FD ($ind/500m^2$) | | | | | | | | | | | 180 | 151 | 549 | | | | |
| 26 | FD ($ind/500m^2$) | | | | | | | | | | | 122 | 817 | 170 | | | | |
| 27 | FD ($ind/500m^2$) | | | | | | | | | | | 377 | 776 | | | | | |
| 28 | FD ($ind/500m^2$) | | | | | | | | | | | 672 | | 408 | | | | |
| 29 | FD ($ind/500m^2$) | | | | | | | | | | | 222 | 245 | 192 | | | | |
| 30 | FD ($ind/500m^2$) | | | | | | | | | | | 170 | 300 | 196 | | | | |
| 31 | FD ($ind/500m^2$) | | | | | | | | | | | 389 | 376 | 117 | | | | |
| 32 | FD ($ind/500m^2$) | | | | | | | | | | | 286 | | 340 | | | | |
| 33 | FB ($mT/km^2$) | | | | | | | | | | | 0.90 | 2.33 | 3.45 | | | | |
| 34 | FB ($mT/km^2$) | | | | | | | | | | | 0.73 | 1.75 | 2.34 | | | | |
| 35 | FB ($mT/km^2$) | | | | | | | | | | | 1.34 | 1.26 | 2.99 | | | | |
| 36 | FB ($mT/km^2$) | | | | | | | | | | | 1.15 | 2.12 | 6.23 | | | | |
| 37 | FB ($mT/km^2$) | | | | | | | | | | | 1.64 | 5.19 | | | | | |
| 38 | FB ($mT/km^2$) | | | | | | | | | | | 3.84 | | 4.15 | | | | |
| 39 | FB ($mT/km^2$) | | | | | | | | | | | 1.11 | 2.78 | 2.83 | | | | |
| 40 | FB ($mT/km^2$) | | | | | | | | | | | 0.86 | 2.85 | 3.57 | | | | |
| 41 | FB ($mT/km^2$) | | | | | | | | | | | 1.61 | 1.83 | 2.36 | | | | |
| 42 | FB ($mT/km^2$) | | | | | | | | | | | 0.86 | | 1.89 | | | | |
| 43 | FB ($mT/km^2$) | | | | | | | 1466.8 | | | | 1786.6 | | | | 1931.5 | | increase |
| 44 | FD ($ind/500m^2$) | | | | | | | 2347.5 | | 5235.5 | | 4930.0 | | | | 2362.9 | | ? |
| 45 | FD ($ind/500m^2$) | | | | | 1075.0 | 2639.0 | 2595.7 | | 1466.6 | | 3194.2 | | | | | | ? |
| 46 | FD ($ind/500m^2$) | | | | | | | 1618.0 | | 3161.5 | | | | | | | | increase |
| 47 | FD ($ind/500m^2$) | | | | | | | 874.0 | | 1293.0 | | 3459.0 | | | | 2559.0 | | ? |
| 48 | FD ($ind/500m^2$) | | | | | | | | | 1602.0 | | 3599.0 | | | | 2123.0 | | ? |
| 49 | FD ($ind/500m^2$) | | | | | | | 1797.0 | | 2201.3 | | 2196.0 | | | | 1578.4 | | ? |
| 50 | FD ($ind/500m^2$) | | | | | | | 3624.0 | | 4302.5 | | 3552.0 | | | | 3884.4 | | ? |
| 51 | FD ($ind/500m^2$) | | | | | | | | | | | | | | 946.5 | 2064.5 | | increase |
| 52 | FB ($mT/km^2$) | | | | | | | | | | | | | | 31.0 | 73.2 | | increase |
| 53 | FD ($ind/500m^2$) | | | | | | | | | | | | | | 1769.5 | 1038.3 | | decrease |
| 54 | FB ($mT/km^2$) | | | | | | | | | | | | | | 29.0 | 30.2 | | increase |
| 55 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 56 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 57 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 58 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 59 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 60 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 61 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 62 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 63 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 64 | FD ($ind/500m^2$) | | | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | | | |

Appendix 1.1 Summary of hard coral cover (%) data for selected reef areas located along the South China Sea Bio-geographic region

| Entry no. | Longitude | Latitude | Province | Municipality | Data sources | Site | Depth | Method | No. of transects |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 120°34'03" | 18°29'06" | Ilocos Norte | Pasuquin | CEP- region 1 | Station 1 | 6 - 7m | LIT | 1 |
| 2 | | | Ilocos Norte | Pasuquin | CEP- region 1 | Station 2 | 6 - 7m | LIT | 1 |
| 3 | 120°34'04" | 18°28'55" | Ilocos Norte | Pasuquin | CEP- region 1 | Station 3 | 6 - 7m | LIT | 1 |
| 4 | 120°34'01" | 18°28'58" | Ilocos Norte | Pasuquin | CEP- region 1 | Station 4 | 6 - 7m | LIT | 1 |
| 5 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | LIT/VIDEO | 5 (in MPA) |
| 6 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | LIT/VIDEO | 5 (out MPA) |
| 7 | | | La Union | Luna | CEP- region 1 | Station 1 | | | 1 |
| 8 | | | La Union | Luna | CEP- region 1 | Station 2 | 6 - 7m | | 1 |
| 9 | | | La Union | Luna | CEP- region 1 | Station 3 | | | 1 |
| 10 | | | La Union | Luna | | Station 4 | | | 1 |
| 11 | | | La Union | Luna | CEP- region 1 | Station 5 | 7 - 8m | | 1 |
| 12 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | LIT/VIDEO | 3,5 (in MPA) |
| 13 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | LIT/VIDEO | 3,5 (out MPA) |
| 14 | | | Pangasinan | Bolinao | UPMSI - MFRMP | Balingasay MPRA | | | (in MPA) |
| 15 | | | Pangasinan | Bolinao | UPMSI - MFRMP | Balingasay MPRA | | | (out MPA) |
| 16 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | LIT/VIDEO | 3,4,4 (in MPA) |
| 17 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | LIT/VIDEO | 3,4,4 (out MPA) |
| 18 | 119°55.771' | 16°27.282' | Pangasinan | Bolinao | UPMSI-FRMP | Silaqui | | LIT/VIDEO | |
| 19 | 119°56.120' | 16°27.407' | Pangasinan | Bolinao | UPMSI-FRMP | Malilnep | | LIT/VIDEO | |
| 20 | 119°58.657' | 16°27.283' | Pangasinan | Bolinao | UPMSI-FRMP | Dewey | | LIT/VIDEO | |
| 21 | 119°59.768' | 16°22.777' | Pangasinan | Anda | UPMSI-FRMP | Cangaluyan | | LIT/VIDEO | |
| 22 | 119°58.649' | 16°24.061' | Pangasinan | Anda | UPMSI-FRMP | Cabungan | | LIT/VIDEO | |
| 23 | 120°01.822' | 16°20.454' | Pangasinan | Anda | UPMSI-FRMP | Tandoyong | | LIT/VIDEO | |
| 24 | 120°04'00" | 16°11'00" | Pangasinan | Alaminos | CEP- region 1 | Site 1A (Eastern Telbang) | | | 1 |
| 25 | 120°04'15" | 16°11'05" | Pangasinan | Alaminos | CEP- region 1 | Site 1B (Eastern Telbang) | | | 1 |
| 26 | 120°03'30" | 16°11'12" | Pangasinan | Alaminos | CEP- region 1 | Site 2 (Northern Telbang) | | | 1 |
| 27 | 120°03'00" | 16°11'15" | Pangasinan | Alaminos | CEP- region 1 | Site 3 (Western Telbang) | | | 1 |
| 28 | 120°53.259' | 13°42.539' | Batangas | Mabini | White et al. 2001 | Arthur's Rock Fish Sanctuary | 6 - 8m | SCUBA | 3,(?),11,37 |
| 29 | 120°53.233' | 13°41.564' | Batangas | Mabini | White et al. 2001 | Twin Rocks Fish Sanctuary | 6 - 9m | SCUBA | 4,(?),10,20 |
| 30 | | | Batangas | Mabini | White et al. 2001 | Selo Point/reef | 6 -10m | SCUBA | |
| 31 | | | Batangas | Mabini | White et al. 2001 | White-House Reef | | | |
| 32 | | | Batangas | Mabini | White et al. 2001 | White Sand Reef | | SCUBA | |
| 33 | | | Batangas | Tingloy | White et al. 2001 | Pulang-Buli Reef | | SCUBA | |
| 34 | | | Batangas | Tingloy | White et al. 2001 | Sepoc Point | 6 - 8m | SCUBA | |
| 35 | | | Batangas | Tingloy | White et al. 2001 | Layag-Layag, Caban Island | 6 - 8m | SCUBA | |
| 36 | | | Batangas | Tingloy | White et al. 2001 | Sombrero Island | | SCUBA | |
| 37 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | VIDEO | 4,4 (in MPA) |
| 38 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | VIDEO | 4,4 (out MPA) |
| 39 | 120°23'46" | 12°44'47" | Mindoro | Sablayan | CCEF MPA Database | Apo Reef Marine Reserve | | | |
| 40 | | | Palawan | Taytay | see below | | | | |
| 41 | | | Palawan | Taytay | ASEAN-LCR 1986 | 4 reef areas in Bacuit Bay | | LIT | 10 |
| 42 | | | Palawan | Taytay | SPEX 1993 | 4 reef areas in Bacuit Bay | | LIT | 4 |
| 43 | | | Palawan | Taytay | DENR-ENMR 1994 | 4 reef areas in Bacuit Bay | | LIT | 10 |
| 44 | | | Palawan | Taytay | EC-CERDS 1995 | 4 reef areas in Bacuit Bay | | LIT | 7 |
| 45 | | | Palawan | Taytay | TKDC-MERF 1996 | 10 reef areas in Bacuit Bay | | LIT | 20 |
| 46 | | | Palawan | Taytay | KAL-SCS PROG 1999 | 2 reef areas in Bacuit Bay | | LIT | 2 |
| 47 | | | Palawan | Taytay | URI-MERF 2000 | 10 reef areas in Bacuit Bay | | LIT | 10 |
| 48 | | | Palawan | Kalayaan | see below | | | | |
| 49 | | | Palawan | Kalayaan | Licuanan et al. 1993 | 6 reef areas in the KIG | | LIT | 6 |
| 50 | | | Palawan | Kalayaan | Tuan et al. 1997 | 4 reef areas in the KIG | | LIT | 4 |
| 51 | | | Palawan | Kalayaan | Quibilan et al. unpb 1997 | 7 reef areas in the KIG | | LIT | 25 |
| 52 | | | Palawan | Kalayaan | Quibilan et al. unpb 1998 | 5 reef areas in the KIG | | LIT | 11 |

Contn. Appendix 1.1

| Entry | Transect | Year | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no. | length | 1979 | 1983 | 1986 | 1988 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | TRENDS |
| 1 | | | | | | | | | | 62.00 | | | | 35.20 | 34.40 | | | decrease |
| 2 | | | | | | | | | | 31.74 | | | | 52.61 | 68.70 | | | increase |
| 3 | | | | | | | | | | 35.84 | | | | 40.80 | 22.46 | | | decrease |
| 4 | | | | | | | | | | 42.02 | | | | 55.00 | 34.24 | | | decrease |
| 5 | 50m | | | | | | | | | | | | | | 27.42 | 20.71 | 39.92 | increase |
| 6 | 50m | | | | | | | | | | | | | | 24.88 | 46.93 | 27.83 | stable |
| 7 | | | | | | | | | | 38.56 | | | | | 63.56 | | | increase |
| 8 | | | | | | | | | | 51.76 | | | | | 34.48 | | | decrease |
| 9 | | | | | | | | | | 26.38 | | | | | 21.30 | | | decrease |
| 10 | | | | | | | | | | 16.00 | | | | | 45.44 | | | increase |
| 11 | | | | | | | | | | 58.84 | | | | | 46.48 | | | decrease |
| 12 | 50m | | | | | | | | | | | | | | | 29.71 | 30.58 | stable |
| 13 | 50m | | | | | | | | | | | | | | | 21.56 | 23.89 | stable |
| 14 | | | | | | | | | | | | | | 34.46 | 36.47 | | | stable |
| 15 | | | | | | | | | | | | | | 24.06 | 26.33 | | | stable |
| 16 | 50m | | | | | | | | | | | | | | 27.43 | 30.73 | 34.55 | increase |
| 17 | 50m | | | | | | | | | | | | | | 15.99 | 39.56 | 39.47 | increase |
| 18 | | | | | 25.60 | | | | | | | | | | 9.50 | | | decrease |
| 19 | | | | | 38.60 | | | | | | | 41.00 | 32.00 | 14.00 | 21.60 | | | decrease |
| 20 | | | | | 29.50 | | | | | | | | | | 29.40 | | | stable |
| 21 | | | | | 38.30 | | | | | | | | | | 32.90 | | | decrease |
| 22 | | | | | 35.70 | | | | | | | | | | 9.60 | | | decrease |
| 23 | | | | | 29.10 | | | | | | | | | | 20.70 | | | decrease |
| 24 | | | | | | | | 12.00 | | | | | 67.60 | | | | | increase |
| 25 | | | | | | | | 33.51 | | | | | 66.60 | | | | | increase |
| 26 | | | | | | | | 28.88 | | | | | 74.00 | | | | | increase |
| 27 | | | | | | | | 45.00 | | | | | 51.60 | | | | | increase |
| 28 | 50m | | | | | | | 26.60 | | 34.00 | | 29.10 | | | | 34.60 | | stable |
| 29 | 50m | | | | | | | 12.90 | | 31.30 | | 24.00 | | | | 30.70 | | increase |
| 30 | 50m | | | | | | | 40.70 | | 40.20 | | | | | | | | stable |
| 31 | 50m | | | | | | | | 18.30 | 37.40 | | 29.90 | | | | 12.30 | | ? |
| 32 | 50m | | | | | | | 21.60 | | 30.70 | | 31.20 | | | | 19.00 | | ? |
| 33 | 50m | | | | | | | 21.00 | | 24.40 | | 10.50 | | | | 14.90 | | decrease |
| 34 | 50m | | | | | | | 43.10 | | 57.60 | | 49.30 | | | | 52.00 | | stable |
| 35 | 50m | | | | | | | 34.20 | | 27.00 | | 29.40 | | | | 39.20 | | ? |
| 36 | 50m | | 45.90 | | | | | 37.60 | | 62.70 | | 53.00 | | | | 36.40 | | ? |
| 37 | 50m | | | | | | | | | | | | | | 21.05 | 25.20 | | stable |
| 38 | 50m | | | | | | | | | | | | | | 14.76 | 26.48 | | increase |
| 39 | | 50.00 | | | | | | | 33.00 | | | | | | | | | decrease |
| 40 | | | 37.37 | | | | | 29.89 | 36.89 | 56.26 | 31.01 | | | 16.50 | 16.83 | | | decrease |
| 41 | ? | | 37.37 | | | | | | | | | | | | | | | |
| 42 | 100m | | | | | | | 29.89 | | | | | | | | | | |
| 43 | ? | | | | | | | | 36.89 | | | | | | | | | |
| 44 | 30m | | | | | | | | | 56.26 | | | | | | | | |
| 45 | 30m | | | | | | | | | | 31.01 | | | | | | | |
| 46 | 30m | | | | | | | | | | | | | 16.50 | | | | |
| 47 | 30m | | | | | | | | | | | | | | 16.83 | | | |
| 48 | | | | | | | | 16.28 | | | 7.86 | 17.07 | 7.26 | | | | | decrease |
| 49 | 150m | | | | | | | 16.28 | | | | | | | | | | |
| 50 | 60-100m | | | | | | | | | | 7.86 | | | | | | | |
| 51 | 30m | | | | | | | | | | | 17.07 | | | | | | |
| 52 | 30m | | | | | | | | | | | | 7.26 | | | | | |

Appendix 1.2 Summary of associated reef fish data (abundance and biomass) for selected reef areas located along the South China Sea Bio-geographic region.

| Entry no. | Longitude | Latitude | Province | Municipality | Data source | Site | Depth | Method | No. of transects | transect length |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 120°34'03" | 18°29'06" | Ilocos Norte | Pasuquin | CEP- region 1 | | | | 4 ? | |
| 2 | | | Ilocos Norte | Pasuquin | CEP- region 1 | | | | 4 ? | |
| 3 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (in MPA) | 50m |
| 4 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (in MPA) | 50m |
| 5 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (out MPA) | 50m |
| 6 | | | Zambales | Masinloc | UPMSI - DA-BAR | San Salvador Fish Sanctuary | 6 - 7m | FVC | 5 (out MPA) | 50m |
| 7 | | | La Union | Luna | CEP- region 1 | | | | 5 ? | |
| 8 | | | La Union | Luna | CEP- region 1 | | | | 5 ? | |
| 9 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (in MPA) | 50m |
| 10 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (in MPA) | 50m |
| 11 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (out MPA) | 50m |
| 12 | | | Pangasinan | Bolinao | UPMSI - DA-BAR | Balingasay MPRA | 6 - 8m | FVC | 3,5 (out MPA) | 50m |
| 13 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (in MPA) | 50m |
| 14 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (in MPA) | 50m |
| 15 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (out MPA) | 50m |
| 16 | | | Pangasinan | Anda | UPMSI - DA-BAR | Carot Fish Sanctuary | 5 - 7m | FVC | 3,4,4 (out MPA) | 50m |
| 17 | 119°55.771’ | 16°27.282’ | Pangasinan | Bolinao | UPMSI-FRMP | Silaqui | | FVC | 1 | |
| 18 | 119°56.120’ | 16°27.407’ | Pangasinan | Bolinao | UPMSI-FRMP | Malilnep | | FVC | 1 | |
| 19 | 119°58.657’ | 16°27.283’ | Pangasinan | Bolinao | UPMSI-FRMP | Dewey | | FVC | 1 | |
| 20 | 119°59.768’ | 16°22.777’ | Pangasinan | Anda | UPMSI-FRMP | Cangaluyan | | FVC | 1 | |
| 21 | 119°58.649’ | 16°24.061’ | Pangasinan | Anda | UPMSI-FRMP | Cabungan | | FVC | 1 | |
| 22 | 120°01.822’ | 16°20.454’ | Pangasinan | Anda | UPMSI-FRMP | Tandoyong | | FVC | 1 | |
| 23 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240601 | | FVC | 1 | 50m |
| 24 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240602 | | FVC | 1 | 50m |
| 25 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240603 | | FVC | 1 | 50m |
| 26 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240604 | | FVC | 1 | 50m |
| 27 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240605 | | FVC | 1 | 50m |
| 28 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240606 | | FVC | 1 | 50m |
| 29 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240607 | | FVC | 1 | 50m |
| 30 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240608 | | FVC | 1 | 50m |
| 31 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240609 | | FVC | 1 | 50m |
| 32 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240610 | | FVC | 1 | 50m |
| 33 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240601 | | FVC | 1 | 50m |
| 34 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240602 | | FVC | 1 | 50m |
| 35 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240603 | | FVC | 1 | 50m |
| 36 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240604 | | FVC | 1 | 50m |
| 37 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240605 | | FVC | 1 | 50m |
| 38 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240606 | | FVC | 1 | 50m |
| 39 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240607 | | FVC | 1 | 50m |
| 40 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240608 | | FVC | 1 | 50m |
| 41 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240609 | | FVC | 1 | 50m |
| 42 | | | Pangasinan | Bolinao | UPMSI-UNDP-GEF | 240610 | | FVC | 1 | 50m |
| 43 | 120°53.259' | 13°42.539' | Batangas | Mabini | White et al. 2001 | Arthur's Rock Fish Sanctuary | | | 3,5,6 | |
| 44 | 120°52.365' | 13°43.566' | Batangas | Mabini | White et al. 2001 | Pulang-Buli Reef | | | 2,2,2,6 | |
| 45 | 120°53.264’ | 13°41.530’ | Batangas | Mabini | White et al. 2001 | Twin Rocks Fish Sanctuary | | | | |
| 46 | | | Batangas | | White et al. 2001 | Selo Point | | | 1,2 | |
| 47 | | | Batangas | | White et al. 2001 | Sepoc Point | | | 1,4,8,4 | |
| 48 | | | Batangas | | White et al. 2001 | White Sand Reef | | | 2,4,3 | |
| 49 | | | Batangas | | White et al. 2001 | Layag-Layag, Caban Island | | | 2,2,8 | |
| 50 | | | Batangas | | White et al. 2001 | Sombrero Island | | | 2,2,6,8 | |
| 51 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (in MPA) | 50m |
| 52 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (in MPA) | 50m |
| 53 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (out MPA) | 50m |
| 54 | | | Batangas | Mabini | UPMSI - DA-BAR | Twin Rocks Fish Sanctuary | 6 - 7m | FVC | 4,4 (out MPA) | 50m |
| 55 | | | Palawan | Taytay | TKDC-MERF 1996 | 5313BS | | FVC | 1 | 50m |
| 56 | | | Palawan | Taytay | | 5313FM | | FVC | 1 | 50m |
| 57 | | | Palawan | Taytay | URI-MERF 2000 | 5313PC | | FVC | 1 | 50m |
| 58 | | | Palawan | Taytay | | 5313PY | | FVC | 1 | 50m |
| 59 | | | Palawan | Taytay | | 5313Pp | | FVC | 1 | 50m |
| 60 | | | Palawan | Taytay | | 5313SE | | FVC | 1 | 50m |
| 61 | | | Palawan | Taytay | | 5313SM | | FVC | 1 | 50m |
| 62 | | | Palawan | Taytay | | 5313TM | | FVC | 1 | 50m |
| 63 | | | Palawan | Taytay | | 5313TR | | FVC | 1 | 50m |
| 64 | | | Palawan | Taytay | | 5313WM | | FVC | 1 | 50m |
| 65 | | | Palawan | Taytay | | | | | | |

Contn. Appendix 1.2.

| Entry no. | Details | 1979 | 1983 | 1986 | 1988 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | TRENDS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Total density | | | | | | | | | 6004 | | | | | 7377 | | | increase |
| 2 | FB (mT/km$^2$) | | | | | | | | | 112.0 | | | | | 137.6 | | | increase |
| 3 | FD (ind/500m$^2$) | | | | | | | | | | | | | | 440.8 | 292.8 | 274.2 | decrease |
| 4 | FB (mT/km$^2$) | | | | | | | | | | | | | | 36.8 | 11.2 | 15.4 | decrease |
| 5 | FD (ind/500m$^2$) | | | | | | | | | | | | | | 424.0 | 296.8 | 232.4 | decrease |
| 6 | FB (mT/km$^2$) | | | | | | | | | | | | | | 18.3 | 14.1 | 8.0 | decrease |
| 7 | Total density | | | | | | | | | 3502.0 | | | | | 4070.0 | | | increase |
| 8 | FB (mT/km$^2$) | | | | | | | | | 69.2 | | | | | 80.1 | | | decrease |
| 9 | FD (ind/500m$^2$) | | | | | | | | | | | | | 463.7 | | 278.7 | 234.0 | decrease |
| 10 | FB (mT/km$^2$) | | | | | | | | | | | | | | | 13.6 | 8.0 | decrease |
| 11 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | 182.3 | 187.8 | increase |
| 12 | FB (mT/km$^2$) | | | | | | | | | | | | | | | 8.2 | 5.3 | decrease |
| 13 | FD (ind/500m$^2$) | | | | | | | | | | | | | | 139.0 | 228.5 | 384.3 | increase |
| 14 | FB (mT/km$^2$) | | | | | | | | | | | | | | 5.7 | 6.8 | 5.8 | stable |
| 15 | FD (ind/500m$^2$) | | | | | | | | | | | | | | 141.7 | 117.8 | 155.3 | increase |
| 16 | FB (mT/km$^2$) | | | | | | | | | | | | | | 4.4 | 3.9 | 5.4 | stable |
| 17 | FD (ind/1000m$^2$) | | | | 1024 | | | | | | | | | | 291 / 136 | | | |
| 18 | FD (ind/1000m$^2$) | | | | 666 | | | | | | | 446.0 | 444.0 | 644.0 | 452 / 362 | | | stable |
| 19 | FD (ind/1000m$^2$) | | | | 608 | | | | | | | | | | 428 / 308 | | | decrease |
| 20 | FD (ind/1000m$^2$) | | | | 500 | | | | | | | | | | 256 / 286 | | | decrease |
| 21 | FD (ind/1000m$^2$) | | | | 454 | | | | | | | | | | 479 / 234 | | | increase |
| 22 | FD (ind/1000m$^2$) | | | | 372 | | | | | | | | | | 242 / 219 | | | decrease |
| 23 | FD (ind/500m$^2$) | | | | | | | | | | | 183 | 276 | 311 | | | | |
| 24 | FD (ind/500m$^2$) | | | | | | | | | | | 136 | 191 | 318 | | | | |
| 25 | FD (ind/500m$^2$) | | | | | | | | | | | 180 | 151 | 549 | | | | |
| 26 | FD (ind/500m$^2$) | | | | | | | | | | | 122 | 817 | 170 | | | | |
| 27 | FD (ind/500m$^2$) | | | | | | | | | | | 377 | 776 | | | | | |
| 28 | FD (ind/500m$^2$) | | | | | | | | | | | 672 | | 408 | | | | |
| 29 | FD (ind/500m$^2$) | | | | | | | | | | | 222 | 245 | 192 | | | | |
| 30 | FD (ind/500m$^2$) | | | | | | | | | | | 170 | 300 | 196 | | | | |
| 31 | FD (ind/500m$^2$) | | | | | | | | | | | 389 | 376 | 117 | | | | |
| 32 | FD (ind/500m$^2$) | | | | | | | | | | | 286 | | 340 | | | | |
| 33 | FB (mT/km$^2$) | | | | | | | | | | | 0.90 | 2.33 | 3.45 | | | | |
| 34 | FB (mT/km$^2$) | | | | | | | | | | | 0.73 | 1.75 | 2.34 | | | | |
| 35 | FB (mT/km$^2$) | | | | | | | | | | | 1.34 | 1.26 | 2.99 | | | | |
| 36 | FB (mT/km$^2$) | | | | | | | | | | | 1.15 | 2.12 | 6.23 | | | | |
| 37 | FB (mT/km$^2$) | | | | | | | | | | | 1.64 | 5.19 | | | | | |
| 38 | FB (mT/km$^2$) | | | | | | | | | | | 3.84 | | 4.15 | | | | |
| 39 | FB (mT/km$^2$) | | | | | | | | | | | 1.11 | 2.78 | 2.83 | | | | |
| 40 | FB (mT/km$^2$) | | | | | | | | | | | 0.86 | 2.85 | 3.57 | | | | |
| 41 | FB (mT/km$^2$) | | | | | | | | | | | 1.61 | 1.83 | 2.36 | | | | |
| 42 | FB (mT/km$^2$) | | | | | | | | | | | 0.86 | | 1.89 | | | | |
| 43 | FB (mT/km$^2$) | | | | | | | 1466.8 | | | | 1786.6 | | | | 1931.5 | | increase |
| 44 | FD (ind/500m$^2$) | | | | | | | 2347.5 | | 5235.5 | | 4930.0 | | | | 2362.9 | | ? |
| 45 | FD (ind/500m$^2$) | | | | | 1075.0 | 2639.0 | 2595.7 | | 1466.6 | | 3194.2 | | | | | | ? |
| 46 | FD (ind/500m$^2$) | | | | | | | 1618.0 | | 3161.5 | | | | | | | | increase |
| 47 | FD (ind/500m$^2$) | | | | | | | 874.0 | | 1293.0 | | 3459.0 | | | | 2559.0 | | ? |
| 48 | FD (ind/500m$^2$) | | | | | | | | | 1602.0 | | 3599.0 | | | | 2123.0 | | ? |
| 49 | FD (ind/500m$^2$) | | | | | | | 1797.0 | | 2201.3 | | 2196.0 | | | | 1578.4 | | ? |
| 50 | FD (ind/500m$^2$) | | | | | | | 3624.0 | | 4302.5 | | 3552.0 | | | | 3884.4 | | ? |
| 51 | FD (ind/500m$^2$) | | | | | | | | | | | | | | 946.5 | 2064.5 | | increase |
| 52 | FB (mT/km$^2$) | | | | | | | | | | | | | | 31.0 | 73.2 | | increase |
| 53 | FD (ind/500m$^2$) | | | | | | | | | | | | | | 1769.5 | 1038.3 | | decrease |
| 54 | FB (mT/km$^2$) | | | | | | | | | | | | | | 29.0 | 30.2 | | increase |
| 55 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 56 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 57 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 58 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 59 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 60 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 61 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 62 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 63 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 64 | FD (ind/500m$^2$) | | | | | | | | | | | | | | | | | |
| 65 | | | | | | | | | | | | | | | | | | |

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Appendix 10.1. Changes in coral cover and fish abundance in the different sites of the Visayas Seas region

| Province | Municipality/ site | Coral cover change | Fish Abundance | Fish Species | Date started | Longitude N | Latitude E | Source* |
|---|---|---|---|---|---|---|---|---|
| Leyte | Cuatro Islas | decreasing due to COT | | increasing | | | | Cesar, Ch 20 |
| Leyte | Baybay | mostly increasing (Cesar) | | stable | | | | Cesar, Ch 20 |
| Southern Leyte | St. Bernard | increasing | | increasing | | | | Cesar, Ch 20 |
| Southern Leyte | Lilo-an (Sugod Bay) | increasing | | increasing | | | | Cesar, Ch 20 |
| Camiguin | White Is. | suspected to be stable | stable | limited data | | | | Alcala, Ch16 |
| Mis. Or. | Maigo | decreasing | limited data | limited data | 1991 | $8^{o}$ 10' | $123^{o}$ 59' | Uy, Ch 22 |
| Mis. Occ | Hulaw-hulaw reef | decreasing | limited data | limited data | 1991 | $8^{o}$ 11' | $123^{o}$ 53' | Uy, Ch 22 |
| Mis. Occ | Baliangao | recovering from 1998 EN | 1993-97 increasing inside sanctuary | 1993-97 increasing inside sanctuary | | | | Fraser, Ch 23 |
| Bohol | Panggangan Island | increasing | stable | | | | | Alcaria Ch11 |
| Bohol | Canlauron MS, Getafe | fluctuating/stable | | | 1995 | $10^{o}$ 10.9' | $124^{o}$ 32.4' | Alcaria Ch11 |
| Bohol | Alumar, Getafe | fluctuating/stable | | | 1994 | $10^{o}$ 10.9' | $124^{o}$ 32.4' | Alcaria Ch11 |
| Bohol | Dapdap MS, Talibon | recovering after 1998 | | | 1995 | $10^{o}$ 00' | $124^{o}$ 00' | Alcaria Ch11 |
| Bohol | Lumislis MS, Mabini | increasing | | | 1994 | $9^{o}$ 54.2' | $124^{o}$ 34.2' | Alcaria Ch11 |
| Bohol | Marcelo, Mabini | increasing | | | 1994 | $9^{o}$ 52.1' | $124^{o}$ 32.4' | Alcaria Ch11 |
| Bohol | Magtongtong MS, Calape | increasing | | | 1995 | $9^{o}$ 5' | $124^{o}$ 03' | Alcaria Ch11 |
| Bohol | Lomboy MS, Calape | stable / but recovering | fluctuating | | 1997 | | | Uychiaoco, Ch19 |
| Bohol | Cabilao | stable | increasing | | | | | White, Ch 17 |
| Bohol | Cabacongan MS | stable inside & outside | increasing | | 1997 | | | Uychiaoco, Ch18 |
| Bohol | Balicasag | Both S & NS increasing, but more in Sanctuary | increasing (1992-99) | increasing (1992-99) | 1984 | | | White, Ch 17 |
| Bohol | Bolod | stable but low cover | limited data | limited data | | | | White, Ch 17 |
| Bohol | Doljo | decreasing | limited data | limited data | | | | White, Ch 17 |
| Cebu | Gilutongan MS | decreasing | increasing | | 1998 | | | Uychaoco, Ch17 |

Cont'n Appendix 10.1

| Province | Municipality/ site | Coral cover change | Fish Abundance | Fish Species | Date started | Longitude N | Latitude E | Source* |
|---|---|---|---|---|---|---|---|---|
| Cebu | Zaragosa | stable | increasing | | 1996 | 9º 51' | 123º 23' | Alcaria, Ch11 |
| Cebu | Bugas, Badian | stable | | | 1995 | 9º 43' | 123º 23.1' | Alcaria, Ch11 |
| Cebu | Sulangan MS, Bantayan | increasing | | | 1995 | 11º 6.5' | 123º 40.9' | Alcaria, Ch11 |
| Cebu | Bolinawan, Carcar | stable | | | 1996 | | | Alcaria, Ch11 |
| Cebu | Tuyom, Carcar | increasing | | | 1996 | | | Alcaria, Ch11 |
| Southern Cebu | Sumilon | decreased from 1974 - 84; has not fully recovered since | erratic inside and outside S depending on degree of protection but never equaled abundance during max. protection | | | | | Alcaria, Ch11 |
| Negros Occ. | Carbin Reef | increasing slowly for past 10 years | increasing inside; no data outside | | | | | Alcala, Ch16 |
| Negros Or. | Apo Island | recovering from 1998 EN; higher coral cover inside sanctuary; | increasing inside; stable in fished areas but lower | 200 | | | | Alcala, Ch16 |
| Negros Or. | Calag-Calag, Ayungon | increasing | | | 1996 | 9º 47.3' | 123º 9.5' | Alcaria, Ch11 |
| Negros Or. | Tinaogan, Bindoy | increasing | | | 1996 | 9º 47' | 123º 9.1' | Alcaria, Ch11 |

Note: source = data source generally from workshop participants unless cited as Chapter

Cont'n. Appendix 10.1

| Province | Municipality/ site | Coral cover change | Fish Abundance | Fish Species | Date started | Longitude N | Latitude E | Source* |
|---|---|---|---|---|---|---|---|---|
| Negros Or. | Malusay MS, Guihulngan | increasing | | | 1999 | | | Alcaria Ch11 |
| Negros Or. | Actin, Basay | stable | | | 1999 | | | Alcaria Ch11 |
| Negros Or. | Bungalonan MS, Basay | stable | | | 2000 | | | Alcaria Ch11 |
| Negros Or. | Bolisong, Manjuyod | increasing | increasing inside | | | | | Barillo Ch12 |
| Negros Or. | Tambobo, Siaton | recovering | recovering | | 1995 | 9° 3' | 123° 6' | Barillo Ch12 |
| Negros Or. | Iniban, Ayungon | recovering from COT | increasing | | 1996 | 9° 53' | 123° 8' | Barillo Ch12 |
| Negros Or. | Calag-Calag, Ayungon | slightly decreasing | | | | | | Barillo Ch12 |
| Negros Or. | Hilaitan, Guihulngan | decreasing | decreasing | | 1995 | 10° 14' | 123° 19' | Teves, Ch12 |
| Negros Or. | Cangmating, Sibulan | increasing | increasing | | 1995 | 9° 21' | 123° 17' | Teves, Ch12 |
| Negros Or. | Masaplod, Norte, Dauin | | | | 1995 | 9° 44.9' | 123° 15' | Teves, Ch12 |
| Negros Or. | Andulay, Siaton | no data | increasing | | 1994 | | | Teves, Ch12 |
| Negros Or. | Bongalonan, Basay | increasing | increasing | | 1994 | | | Teves, Ch12 |
| Siquijor | Tulapos MS, E.Villanueva | stable | | | 1996 | 9° 17' | 123° 28' | Alcaria Ch11 |
| Siquijor | Poblacion, E. Villanueva | fluctuating | | | 1994 | | | Alcaria Ch11 |
| Siquijor | Lomangcopan, E. Villanueva | decreasing | | | 1997 | 9° 17.2' | 123° 37.6' | Alcaria Ch11 |

Appendix 10.2. Threats and management issues in the different sites of the Visayas Seas region

| | | | | | THREATS | | | | | MGT ISSUES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | COT outbreaks | Bleaching | Tourism | Pollution | Coral disease | Quarrying | Destructive Fishing | Poaching | Codes* |
| Bohol | Panggangan Island | | | | | | | | + | |
| Bohol | Balicasag | + | | + | | | | | | 3 |
| Bohol | Mabini | | | | siltation | | | | | 3 |
| Bohol | Cabilao | | | + | | | | | | 3 |
| Bohol | Pamicalan | | | | siltation | * | | ** | | |
| Bohol | Danao | * | | | * | | | * | | |
| Bohol | Bolod | | * | | | | | * | | |
| Bohol | Doljo | | * | | | | | * | | |
| Camiguin | White Is. | | | | | | | | | |
| Cebu | Gilutungan | | | + | | | | | | 3 |
| Cebu | Zaragosa | | | | | | | | | |
| Leyte | Cuatro Islas | + | + | + | | | | | + | 1,3 |
| Leyte | Baybay | + | + | | solid waste | | | | + | 1,3 |
| Mis. Occ | Hulaw-hulaw reef | | | | siltation | | | + | + | 2,3 |
| Mis. Occ | Baliangao | | + | | siltation | | | | + | 1 |
| Mis. Or. | Maigo | | | | siltation | | | + | + | 1,3 |
| Negros | Apo Island | | + | + | | + | | | | |
| Negros Occ. | Carbin Reef | | | | | | | | | 3 |
| Negros Or. | Bolisong, Manjuyod | | | | | | | | | |
| Negros Or. | Tambobo, Siaton | + | | | solid waste | | | | + | |
| Negros Or. | Iniban, Ayungon | + | | | | | | | | |
| Negros Or. | Calag-Calag, Ayungon | + | | | siltation | | | | | 3 |
| Negros Or. | Hilaitan, Guihulngan | | | | siltation | | | + | + | |
| Siquijor | Enrique Villanueva | | | | solid waste | | | | + | 1,3 |
| Southern Cebu | Sumilon | | | + | | | | + | | 1,3 |
| Southern Leyte | St. Bernard | + | | | solid waste | | | | + | 2,3 |
| Southern Leyte | Lilo-an (Sugod Bay) | | | | siltation | | + | | + | 2,3 |

*Legend: 1= political interference 2= logistics/financial 3= weak communiy participation

Appendix 11.1. Fish species abundance (no. of species/ 1000 $m^2$) recorded in the different coral reef areas in Central Visayas, Philippines (1995-2001).

| SITE | | | YEAR (no. of species/1000 $m^2$) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Longitude | Latitude | BRGY/MUNICIPALITY/PROVINCE | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| 123°23.1' | 9°43' | Bugas, Badian, Cebu | 71 | | | 67 | 38 | 38 | 42 |
| 123°23' | 9°51' | Zaragosa, Badian, Cebu | | 86 | 59 | 84 | 37 | 74 | 59 |
| 123°40.9' | 11°6.5' | Sulangan, Bantayan, Cebu | | 46 | 37 | 24 | | | |
| | | Sulangan (outside sanctuary), Cebu | | | | | 25 | | 19 |
| | | Bolinawan, Carcar, Cebu | | 25 | | | | 20 | 28 |
| | | Tuyom, Carcar, Cebu | | 36 | | | | 30 | 51 |
| 124°32.4' | 10°10.9' | Canlauron Marine Sanctuary, Getafe, Bohol | | 37 | 18 | 34 | 16 | 10 | |
| 124°32.4' | 10°10.9' | Alumar, Getafe, Bohol | | | | 24 | 10 | 7 | |
| 124°00' | 10°00' | Dapdap Marine Sanctuary, Talibon, Bohol | 22 | | 24 | 20 | 15 | 14 | |
| 124°34.2' | 9°54.2' | Lumislis Marine Sanctuary, Concepcion, Mabini, Bohol | | | 10 | 15 | 40 | 20 | 16 |
| 124°34.27' | 9°52.1' | Marcelo, Mabini, Bohol | | | | 12 | 26 | 17 | 12 |
| 124°003' | 9°5.0' | Magtongtong Marine Sanctuary, Calape, Bohol | | 33 | 55 | 42 | 17 | 24 | 47 |
| | | Lomboy Marine Sanctuary, Calape, Bohol | | | 40 | 11 | 30 | 24 | 37 |
| | | | | | | | | | |
| 123°9.5' | 9°47.24' | Calag-calag Marine Sanctuary, Ayungon, Neg. Or. | | 59 | 58 | 33 | 46 | | 43 |
| 123°9.1' | 9°47.00' | Tinaogan, Bindoy, Neg. Or. | | 74 | 53 | 25 | 33 | | 35 |
| | | Malusay Marine Sanctuary, Guihulngan, Neg. Or. | | | | | 35 | | 52 |
| 123°9.1' | 9°4.10' | Apo Marine Sanctuary, Dauin, Neg. Or. | 78 | 84 | 76 | 49 | 37 | 54 | 74 |
| | | Actin, Basay, Neg. Or. | | | | | 26 | 20 | 23 |
| | | Bungalonan Marine Sanctuary, Basay, Neg. Or. | | | | | | 39 | 78 |
| 123°28' | 9°17' | Tulapos Marine Sanctuary, E.Villanueva, Siquijor | | | 47 | 72 | 34 | 32 | 55 |
| | | Poblacion, E.Villanueva, Siquijor | | | | | 29 | 21 | 33 |
| 123°37.62' | 9°17.16' | Lomangcapan, E.Villanueva, Siquijor | | | | | 42 | 19 | 30 |

Appendix 11.2. Fish population densities (no. of individuals/1000 $m^2$) in the different coral reefs in the Central Visayas region (1996-2001).

| SITE | | | YEAR (no. of individuals/1000 $m^2$) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Longitude | Latitude | BRGY/MUNICIPALITY/PROVINCE | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| 123°23.1' | 9°43' | Bugas, Badian, Cebu | | | 4,693 | 1,213 | 114 | 659 |
| 123°23' | 9°51' | Zaragosa, Badian, Cebu | 5,182 | 4,327 | 2,205 | 2,876 | 1,150 | 1,207 |
| 123°40.9' | 11°6.5' | Sulangan, Bantayan, Cebu | 665 | 66 | | | | |
| | | Sulangan (outside sanctuary), Cebu | | | 197 | 175 | | 138 |
| | | Bolinawan, Carcar, Cebu | 84 | | | | | 58 |
| | | Tuyom, Carcar, Cebu | 578 | | | | | 1,800 |
| 124°32.4' | 10°10.9' | Canlauron Marine Sanctuary, Getafe, Bohol | 151 | 109 | 3,972 | 224 | | |
| 124°32.4' | 10°10.9' | Alumar, Getafe, Bohol | | | 217 | 105 | | |
| 124°00' | 10°00' | Dapdap Marine Sanctuary, Talibon, Bohol | | 109 | 388 | 875 | | |
| 124°34.2' | 9°54.2' | Lumislis Marine Sanctuary, Concepcion, Mabini, Bohol | 558 | 2,554 | 72 | 599 | | 106 |
| 124°32.4' | 9°52.1' | Marcelo, Mabini, Bohol | | | 54 | 261 | | 23 |
| 124°003' | 9°5.0' | Magtongtong Marine Sanctuary, Calape, Bohol | 269 | 2,554 | 3,645 | 2,072 | | 2,136 |
| | | Lomboy Marine Sanctuary, Calape, Bohol | | 518 | 10,056 | 814 | | 1,282 |
| 123°9.5' | 9°47.24' | Calag-calag Marine Sanctuary, Ayungon, Neg. Or. | 1,575 | 1,575 | 1,561 | 1,551 | | 1,447 |
| 123°9.1' | 9°47.00' | Tinaogan, Bindoy, Neg. Or. | 3,947 | 2,801 | 1,043 | 1,203 | | 642 |
| | | Malusay Marine Sanctuary, Guihulngan, Neg. Or. | | | | 574 | | 2,121 |
| 123°9.1' | 9°4.10' | Apo Marine Sanctuary, Dauin, Neg. Or. | 9,647 | 9,896 | 484 | 2,151 | 1,143 | 2,928 |
| | | Actin, Basay, Neg. Or. | | | | 181 | 258 | 302 |
| | | Bungalonan Marine Sanctuary, Basay, Neg. Or. | | | | | 397 | 880 |
| 123°28' | 9°17' | Tulapos Marine Sanctuary, E.Villanueva, Siquijor | 33 | 1,690 | 3,938 | 430 | 308 | 988 |
| | | Poblacion, E.Villanueva, Siquijor | | | | 729 | 220 | 338 |
| 123°37.62' | 9°17.16' | Lomangcapan, E.Villanueva, Siquijor | | | | 974 | 446 | 824 |

Appendix 11.3. Biomass (grams/$m^2$) of fish species in the different coral reef areas in Central Visayas (1996-2001).

| SITE | | | YEAR (grams/$m^2$) | | | | | |
|---|---|---|---|---|---|---|---|---|
| Longitude | Latitude | BRGY/MUNICIPALITY/PROVINCE | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| 123°23.1' | 9°43' | Bugas, Badian, Cebu | | | 78 | 84 | 11 | 32 |
| 123°23' | 9°51' | Zaragosa, Badian, Cebu | 141 | 119 | 127 | 172 | 56 | 43 |
| 123°40.9' | 11°6.5' | Sulangan, Bantayan, Cebu | 12 | 28 | | | | |
| | | Sulangan (outside sanctuary), Cebu | | | 27 | 8 | 101 | 8 |
| | | Bolinawan, Carcar, Cebu | 1 | | | | 84 | 3 |
| | | Tuyom, Carcar, Cebu | 32 | | | | 20 | 38 |
| 124°32.4' | 10°10.9' | Canlauron Marine Sanctuary, Getafe, Bohol | 13 | 25 | 63 | 7 | | |
| 124°32.4' | 10°10.9' | Alumar, Getafe, Bohol | | | 47 | 5 | | |
| 124°00' | 10°00' | Dapdap Marine Sanctuary, Talibon, Bohol | | 25 | 97 | 44 | | |
| 124°34.2' | 9°54.2' | Lumislis Marine Sanctuary, Concepcion, Mabini, Bohol | 7 | 0 | 3 | 19 | | 4 |
| 124°32.4' | 9°52.1' | Marcelo, Mabini, Bohol | | | 1 | 13 | | 3 |
| 124°003' | 9°5.0' | Magtongtong Marine Sanctuary, Calape, Bohol | 2 | 131 | 127 | 150 | | 105 |
| | | Lomboy Marine Sanctuary, Calape, Bohol | | 14 | 37 | 32 | | 57 |
| 123°9.5' | 9°47.24' | Calag-calag Marine Sanctuary, Ayungon, Neg. Or. | 86 | 84 | 67 | 52 | | 79 |
| 123°9.1' | 9°47.00' | Tinaogan, Bindoy, Neg. Or. | 85 | 82 | 22 | 19 | | 24 |
| | | Malusay Marine Sanctuary, Guihulngan, Neg. Or. | | | | 96 | | 57 |
| 123°9.1' | 9°4.10' | Apo Marine Sanctuary, Dauin, Neg. Or. | 1950 | 1299 | 97 | 193 | 267 | 189 |
| | | Actin, Basay, Neg. Or. | | | | 15 | 10 | 19 |
| | | Bungalonan Marine Sanctuary, Basay, Neg. Or. | | | | | 108 | 94 |
| | | | | | | | | |
| 123°28' | 9°17' | Tulapos Marine Sanctuary, E.Villanueva, Siquijor | | 230 | 821 | 161 | 371 | 114 |
| | | Poblacion, E.Villanueva, Siquijor | | | | 14 | 27 | 29 |
| 123°37.62' | 9°17.16' | Lomangcapan, E.Villanueva, Siquijor | | | | 29 | 18 | 48 |

Appendix 11.4. Percent live hard coral cover of the different coral reef areas in Central Visayas (1994-2001).

| SITE | | | YEAR | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Longitude | Latitude | BRGY/MUNICIPALITY/PROVINCE | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| 123$^{o}$23.1' | 9$^{o}$43' | Bugas, Badian, Cebu | | 29 | | 48 | 34 | 36 | 36 | 32 |
| 123$^{o}$23' | 9$^{o}$51' | Zaragosa Marine Sanctuary, Badian, Cebu | | | 74 | 72 | 69 | 76 | 82 | 70 |
| 123$^{o}$40.9' | 11$^{o}$6.5' | Sulangan (inside sanctuary), Bantayan, Cebu | | 47 | 73 | 91 | | | | |
| | | Sulangan (outside sanctuary), Cebu | | | | | 26 | | 26 | 28 |
| | | Bolinawan, Carcar, Cebu | | | 13 | | | | 15 | 16 |
| | | Tuyom, Carcar, Cebu | | | 30 | | | | 46 | 43 |
| 124$^{o}$32.4' | 10$^{o}$10.9' | Canlauron Marine Sanctuary, Getafe, Bohol | | 64 | 52 | 57 | 30 | 42 | 48 | 58 |
| 124$^{o}$32.4' | 10$^{o}$10.9' | Alumar, Getafe, Bohol | 17 | 50 | 47 | 47 | 23 | | 39 | 54 |
| 124$^{o}$00' | 10$^{o}$00' | Dapdap Marine Sanctuary, Talibon, Bohol | | 54 | 44 | 38 | 13 | 29 | 35 | 26 |
| 124$^{o}$34.2' | 9$^{o}$54.2' | Lumislis Marine Sanctuary, Concepcion, Mabini, Bohol | 19 | | | 24 | 18 | 30 | 48 | 48 |
| 124$^{o}$32.4' | 9$^{o}$52.1' | Marcelo, Mabini, Bohol | 15 | | 40 | 49 | 23 | 60 | 48 | 68 |
| 124$^{o}$003' | 9$^{o}$5.0' | Magtongtong Marine Sanctuary, Calape, Bohol | | 7 | 8 | 8 | 8 | 15 | 28 | 29 |
| | | Lomboy Marine Sanctuary, Calape, Bohol | | | | 42 | 41 | 33 | 45 | 55 |
| 123$^{o}$9.5' | 9$^{o}$47.24' | Calag-calag Marine Sanctuary, Ayungon, Neg. Or. | | | 35 | 38 | 64 | 60 | 53 | 61 |
| 123$^{o}$9.1' | 9$^{o}$47.00' | Tinaogan, Bindoy, Neg. Or. | | | 41 | 42 | 40 | 39 | | 62 |
| | | Malusay Marine Sanctuary, Guihulngan, Neg. Or. | | | | | | 56 | 63 | 77 |
| 123$^{o}$9.1' | 9$^{o}$4.10' | Apo Marine Sanctuary, Dauin, Neg. Or. | | | 80 | 91 | 85 | 55 | 67 | 65 |
| | | Actin, Basay, Neg. Or. | | | | | | 39 | 25 | 30 |
| | | Bungalonan Marine Sanctuary, Basay, Neg. Or. | | | | | | | 79 | 69 |
| 123$^{o}$28' | 9$^{o}$17' | Tulapos Marine Sanctuary, E.Villanueva, Siquijor | | | 29 | 35 | 30 | 33 | 44 | 29 |
| | | Poblacion, E.Villanueva, Siquijor | 10 | | 26 | 32 | 29 | 43 | 49 | 22 |
| 123$^{o}$37.62' | 9$^{o}$17.16' | Lomangcapan, E.Villanueva, Siquijor | | | | 35 | | 38 | 26 | 28 |

Appendix 12.1. Summary data sheet of Negros Oriental

| Site, Municipality | Size [ha] | Boundaries of MPA | Year | Live Coral Cover: Hard & soft [%] | Method | Area surveyed [$m^2$] | Fish Abundance [individual/$m^2$] | # Fish Species | Area surveyed [$m^2$] | Diversity | Fish catch rate [kg/h*trip] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hilaitan, Guihulngan | 6 | N 10º14'20.9"/E 123º19'42.5" | 1995 | > 12 HC<br>< 10 SC | Videoimage analysis, manta tow | | 26679 | 114 | 1500*<br>5 m+ 10m | 0.70 | |
| | | | 1998 | 3.4 HC | Aquanaut | 80 | 1687 | 18 | 500 | | |
| Iniban, Ayungon | 8 | Northern Boundary:<br>N 09º53'26.2"/E 123º08'50.3"<br>Southern Boundary:<br>N 09º53'17.6"E 123º08'52.0" | 1996 | 29 | Videoimage analysis, manta tow | | 5836 | 86 | 1500*<br>5 m+ 10m | | |
| | | | 1998 | 37.8 HC | Aquanaut | 160 | 3430 | 33 | 1000 | | |
| Cangmating, Sibulan | 6 | NW position:<br>N 09º21'21.2"/E 123º17'43.3"<br>SW position:<br>N 09º21'15.5"/E 123º17'54.5" | 1995 | 19 | Videoimage analysis, manta tow | | 4786 | 114 | 1500*<br>5 m+ 10m | 1.65 | |
| | | | 1998 | 25.0 HC | Aquanaut | 80 | 2460 | 9 | 500 | | |
| Masaplod Norte, Dauin | 6 | NE position:<br>N 09º10'44.9"/E 123º15'27.5"<br>NW position:<br>N 09º10'37.2"/E 123º15'20.8" | 1995 | | | | | | | | 1.64 (from June) |
| | | | 1996 | | | | | | | | 2.16 |
| | | | 1997 | | | | | | | | 1.67 (until April) |
| | | | 1998 | 71.3 HC | Aquanaut | 160 | | | 1000 | | |
| | | | 2000 | 32.5 HC<br>5.6 SC | Quadrat[depth: 4-36 ft.] | 10 | | | | | |
| Tambobo, Siaton | 8.6 | NE: 09º03'10"/123º06'57"<br>SE: 09º03'04"/ 123º06'57"<br>NW: 09º03'10"/ 123º06'42"<br>SW: 09º03'04"/ 123º06'42" | 1995 | 28 | Videoimage analysis | | 6053 | 114 | 1500 | 1.47 | |
| | | | 2000 | 26.9 HC | Quadrat[depth: 5-40 ft.] | | 672 | 43 | | | |
| Andulay, Siaton | | | 1994 | | | | | | | | 1.14 (from May) |
| | | | 1995 | | | | | | | | 1.50 |
| | | | 1996 | | | | | | | | 1.05 |
| | | | 1997 | | | | | | | | 1.51 (until May) |
| | | | 1998 | 31.1 HC | Aquanaut | 160 | 3022 | 24 | 1000 | | |
| | | | 2000 | | | | 1707 | 42 | 500 | | |
| Bongalonan, Basay | | | 1994 | | | | | | | | 1.24 (from July) |
| | | | 1995 | | | | | | | | 1.18 |
| | | | 1996 | | | | | | | | 1.26 |
| | | | 1997 | | | | | | | | 1.42 (until April) |
| | | | 1998 | 20.9 HC | Aquanaut | 80 | | | 500 | | |
| | | | 2000 | 48.8 HC | Quadrat[depth: 3-30 ft.] | | | | | | |

* combined 5-m & 10-m

Appendix 31.1. Benthic and coral data (% cover) of the reef sites in Pandan Bay.

| Muni-cipality | LIBERTAD | | | | | | | | | | PANDAN | | | | | | SEBASTE | | CULASI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Pucio | | Tabuc | | Tinigbas | | Union 1 | | Union 3 | | Mag-aba | | Patria | | Tingib | | Abiera | | Batbatan | | Maniguin | |
| Year | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1999 | 2000 | 1999 | 2000 |
| Live Coral | 58.82 | 46.50 | 53.94 | 47.64 | 63.62 | 37.86 | 29.88 | 46.52 | 54.66 | 51.44 | 54.06 | 48.54 | 33.80 | 30.46 | 55.34 | 33.44 | 29.57 | 37.38 | 35.86 | 43.29 | 54.70 | 56.54 |
| Dead Coral | 18.88 | 20.18 | 32.24 | 20.58 | 10.78 | 25.46 | 19.82 | 16.98 | 8.34 | 20.42 | 21.40 | 19.86 | 43.28 | 19.90 | 12.70 | 16.38 | 0.00 | 28.64 | 28.57 | 17.01 | 21.30 | 26.51 |
| Algae | 0.00 | 22.18 | 0.90 | 21.78 | 0.00 | 15.04 | 0.44 | 25.18 | 0.00 | 17.86 | 0.40 | 21.10 | 0.00 | 32.80 | 0.66 | 27.92 | 0.00 | 13.32 | 17.39 | 26.06 | 7.50 | 3.76 |
| Others | 2.34 | 4.08 | 4.68 | 6.26 | 3.40 | 1.96 | 4.20 | 3.96 | 9.90 | 6.28 | 3.78 | 3.58 | 3.02 | 5.50 | 9.76 | 17.20 | 21.50 | 14.15 | 1.82 | 6.20 | 4.60 | 10.13 |
| Abiotic | 19.96 | 8.58 | 8.24 | 3.74 | 22.20 | 19.68 | 45.66 | 7.36 | 27.10 | 4.00 | 20.36 | 6.92 | 19.90 | 11.34 | 21.54 | 5.06 | 48.93 | 6.51 | 16.31 | 7.44 | 12.80 | 3.08 |

Appendix 31.2. Reef fish data of Pandan Bay.

| Mui-cipality | LIBERTAD | | | | | | | | | | PANDAN | | | | | | SEBASTE | | CULASI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Site | Pucio | | Tabuc | | Tinigbas | | Union 1 | | Union 3 | | Mag-aba | | Patria | | Tingib | | Abiera | | Batbatan | | Maniguin | |
| Year | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1997 | 2000 | 1999 | 2000 | 1999 | 2000 |
| Species | 59 | 49 | 64 | 72 | 56 | 50 | 64 | 50 | 76 | 60 | 68 | 62 | 65 | 48 | 45 | 47 | 39 | 32 | 120 | 99 | 117 | 130 |
| Count | 3,384 | 503 | 2,299 | 1,527 | 2,931 | 2,458 | 2,408 | 980 | 4,894 | 852 | 5,290 | 2,015 | 3,781 | 922 | 2,180 | 1,570 | 2,903 | 1,891 | 19,037 | 9,433 | 31,303 | 34,920 |
| Ave. biom. (kg) | 95.83 | 14.55 | 37.00 | 150.1 | 97.26 | 11.78 | 34.78 | 14.65 | 111.4 | 36.36 | 42.25 | 149.5 | 33.74 | 11.63 | 20.12 | 22.03 | 31.12 | 10.61 | 85.13 | 132.4 | 273.81 | 863.87 |