Summary Field Report: Saving Philippine Reefs

Coral Reef Surveys for Conservation In Mabini and Tingloy, Batangas, Philippines March, 2005

A joint project of:

Coastal Conservation and Education Foundation, Inc.
and the
Fisheries Improved for Sustainable Harvest (FISH) Project

with the participation and support of the Expedition volunteers

Coastal Conservation and Education Foundation, Inc.

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"Saving Philippine Reefs"

Coral Reef Monitoring Expedition to
Mabini and Tingloy,
Batangas, Philippines
March 19 – 27, 2005

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(Formerly Sulu Fund for Marine Conservation, Inc.)

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With the participation and support of the

Expedition Volunteers

Principal investigators and primary researchers:

Alan T. White, Ph.D.
Fisheries Improved for Sustainable Harvest (FISH) Project
Tetra Tech EM Inc., Cebu, Philippines

Aileen Maypa, M.Sc.
Coastal Conservation and Education Foundation, Inc.
Cebu, Philippines

Sheryll C. Tesch
Brian Stockwell, M.Sc.
Anna T. Meneses
Evangeline E. White
Coastal Conservation and Education Foundation, Inc.

Thomas J. Mueller, Ph.D.
Expedition Volunteer

Summary Field Report: “Saving Philippine Reefs”
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Produced by the Coastal Conservation and Education Foundation, Inc. and the Fisheries Improved for Sustainable Harvest (FISH) Project

Cebu City, Philippines

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Coastal Conservation and Education Foundation, Inc. (CCE Foundation) is a nonprofit organization concerned with coral reef conservation through marine protected areas.

The Fisheries Improved for Sustainable Harvest (FISH) Project operates in selected areas in the Philippines to assist local and national government to develop coastal resource management plans and to facilitate their implementation.

Cover photo by Julia Cichowski

All communications to

The Coastal Conservation and Education Foundation, Inc.
3rd Floor, PDI Condominium, Archbishop Reyes Avenue, Banilad,
Cebu City, Philippines
Or
7 Aquamarine Street, St. Michael’s Village, Banilad,
Cebu City, Philippines

Phones: 6332-233-6909, 6332-233-6947 or 6332-231-1075
Fax: 6332-233-6891
Email: ccef@mozcom.com or awhite@mozcom.com

Or the

Fisheries Improved for Sustainable Harvest (FISH) Project,
5th Floor, CIFC Tower, North Reclamation, Cebu City, Philippines

Phones: 6332-232-1821 to 22
Fax: 6332-232-1825

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ABSTRACT

The Saving Philippine Reefs Project of the Coastal Conservation and Education Foundation, Inc., assessed and updated the coral reef condition at selected sites in Mabini-Tingloy, Batangas. Information on the changes in coral cover, other substratum, fish fauna, invertebrates, possible causes of coral damage over time, patterns and trends exhibited and reef health is provided. Recommendations are made for improved conservation and management of coral reefs to the Mabini-Tingloy management bodies, stakeholders, local government units and line agencies working in the area.

Live hard coral (LHC) cover in Mabini and Tingloy areas ranges from poor to excellent (20.3% in White Sand Reef to 75.3% in Cathedral Reef Sanctuary at 7 to 8 meter depths). The overall physical condition of surveyed reefs appears improved in the shallow areas and an increasing trend is exhibited as seen in Cathedral that showed a 25.4% increase, from 53.8% in 2001 to 67.5% LHC cover. In contrast, a slightly decreasing trend is seen in deeper areas. Most decreases were observed in non-MPA sites. Surveys overtime indicated that human impact has largely contributed to changes in LHC cover rather than natural perturbations. In most non-MPA dive sites, boat anchor damage was apparent and this contributes to rubble.

Fish diversity, abundance of target species and biomass are higher in MPAs compared to non-MPAs. This reflects the overall good management and enforcement of these sanctuaries. For instance, Batalang Bato (formerly Pulang Buli Sanctuary) had the highest biomass (93.87 kg/500m^2) compared to the rest of the sites. However, abundance and diversity of butterflyfish and angelfish appeared lower compared to previous years in certain sites such as Cathedral Rock where only 5 species were spotted as compared to the 19 species seen in 2001. The highest increase in species was at Sombrero Island, with 17 species (in 2001) to 23 existing species identified this year. These patterns indicate the possibility of poaching inside some sanctuaries and/or high fishing pressure of both target and aquarium fish in adjacent fishing grounds. Overall, more fish species were listed from 327 species in 2001 to 368 species in 2005.

In non-MPA sites, although LHC cover may be fair to good, there is an alarming lack of target species as well as a lack of large fish. Target species were especially low in density in most areas with the lowest at White House Reef (non MPA) 18.0 individuals/500m^2 and the highest at Batalang Bato Sanctuary (MPA) 267.2 individuals/500m^2. Results showed that although most sites showed increases in all reef fish; size decreases (Cathedral Reef Sanctuary, for example, had a 77.3% decline in target fish since 2001). It was only in a well-managed sanctuary as Batalang Bato (Pulang Buli) that the target fish showed a 153.2% increase since 2001. Despite this, there was still a significantly higher biomass of target fish in MPA sites as compared to non-MPA sites. Overall, the survey expedition documented the MPAs, and new MPAs, with important changes in their reef health and fish abundance and species diversity.

Recommendations for improved and sustained management include the need to: (1) enhance management efforts in Cathedral Rock and Arthur's Rock sanctuaries, (2) educate and inform dive resorts, dive guide and tourist divers about CRM and the proper use of marine sanctuaries (3) install more anchor and mooring buoys in Layag-layag, Sombrero island and Sepoc Point Reef, (4) establish more sanctuaries to provide benefits of recovery to heavily fished areas, (5) develop an integrated, long-term management plan for the Mabini and Tingloy area combined.

ACKNOWLEDGEMENTS

This Saving Philippine Reefs Expedition and its outcome are credited to the 9 volunteers (see Appendix 2) from the United States, United Kingdom, Australia and the Philippines who dedicated their time and funding to the research work. Equally important are the Coastal Conservation and Education Foundation staff, partners and volunteers (see Appendix 2) that prepared for the trip, worked long hours and have all done their part in the overall successful completion of the Expedition. They include: Aileen Maypa, Co-principal investigator; Sheryll Tesch, Data and logistics coordinator; Anna Meneses, Researcher; Brian Stockwell, Scientific dive coordinator; and Vangie White, Overall project coordinator for the trip.

The Fisheries Improved for Sustainable Harvest Project (FISH) supported by the United States Agency for International Development operates in selected areas in the Philippines has provided the overall context for the project to successfully proceed with support for the Principal Investigator.

Dive Solana Resort, in San Teodoro, Mabini, Batangas and its resort manager, Joel Uichico, for being committed to marine conservation and sustainable development, who provided excellent service, accommodations, food and diving services and assistance with traditional Filipino hospitality.

Jinki Macalintal and Diane Campañano contributed in the collection of the community perception data (Appendix 5). Jong Rojas, Bhing Toyong and Voltaire Cerna for assisted in field logistics and data collection during the trip.

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

Alan T. White
Principal Investigator

LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
BBMC	Batalang Bato Management Council
CA	coralline algae
CB	branching coral
CCEF	Coastal Conservation and Education Foundation, Inc.
CFD	flat/encrusting coral
CFO	foliose/cup coral
CM	massive coral
CRM	coastal resource management
CRMP	Coastal Resource Management Project
DA	white dead standing coral
DC	white dead standing coral
DCA	dead coral with algae
FISH	Fisheries Improved for Sustainable Harvest Project
FVC	fish visual census
LC	live coral
LGU	local government unit
LHC	live hard coral
m	meters
MA	fleshy algae / macroalgae
MOA	Memorandum of agreement
MPA	marine protected area
N/A	not applicable
NL	non-living
NS	not significant
OT	other animals
PD	Presidential Decree
R	coral rubble
RCK	rock and block
SC	soft coral
SD	standard deviation
SG	seagrass
SE	standard error
S	sand
SI	silt
SP	sponges
spp.	species
SPR	Saving Philippine Reefs
TA	turf algae
UVC	underwater visual census
USAID	United Stated Agency for International Development
WWF	World Wide Fund for Nature

SAVING PHILIPPINE REEFS PROJECT
A Coral Reef Monitoring Expedition to
Mabini and Tingloy,
Batangas, Philippines

INTRODUCTION

The Saving Philippine Reefs (SPR) Project is a reef monitoring expedition initiated in the early 1980s by Dr. Alan White and colleagues. The primary goal of this project is to improve the quality and quantity of information available on coral reefs for use in improving management and creation of appropriate policies for protection and sustainable use of coastal resources. The SPR Project has been doing regular coral reef monitoring assessments mostly within the vicinity of marine protected areas (MPAs) located in selected sites in the provinces of Cebu, Negros Oriental, Siquijor, Bohol, Batangas and Palawan since 1992.

One of these sites is located in the diverse and abundant reefs of the Mabini and Tingloy area of Batangas Province and Balayan Bay (Figure 1). Bordering the Calumpang Peninsula, containing Mabini Municipality and Maricaban and Caban Islands of Tingloy Municipality, are many excellent fringing and patch coral reefs known for the wealth in their marine life. These reefs are famous for their natural productivity that supplies tons of fish to local communities. In addition, their color and diverse life attracts thousands of scuba divers and swimmers to the area year round.

Management History of Study Sites in Mabini and Tingloy, Batangas

The management of the coral reefs in this area is closely tied to the development of diving and coastal tourism. The first advocates for protection of the coral reefs were 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 were 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. The following shows a timeline of the Mabini and Tingloy coastal area management history:

1970s	Diving tourism began in the area and brought many 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 spear-fishing 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 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 San Teodoro and Bagalangit, Barangays 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

1993	First Earthwatch Expedition to survey coral reefs of the Mabini/Tingloy area
1994	Biodiversity Conservation Network supported Haribon Foundation to plan a major conservation program and to conduct a socio-economic study (Telesis 1994)
1995	Second Earthwatch Expedition conducted
1997	Third Saving Philippine Reefs Earthwatch Expedition conducted
1997	Mabini and Tingloy Municipalities became expansion area 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) formed
1999	Sulu Fund began a marine conservation project in Barangay Sto. Tomas, Tingloy
2000	The Friends of Balayan Bay Association formed to address issues in area
2001	Fourth Saving Philippine Reefs Earthwatch Expedition conducted
2002	Batalang-bato Reef was declared a marine sanctuary (no fishing and no diving)
2002	Mabini CRM Board was created
2003	Mabini Conservation Fee System was launched and implemented
2004	WWF facilitated the formulation of a bay-wide ICM Plan adopted and endorsed by Provincial Development Council
2004	Conservation fee system fully operational. Budget for CRM allocated.
2004	WWF, CCE Foundation, SCOTIA and LGU collaboration for CRM in Mabini and Tingloy
2005	Fifth Saving Philippine Reefs Expedition conducted
2005	MOA to be signed for the unified collection of conservation fee for Mabini and Tingloy
2005	Assessment by the CRM Board of the conservation fee system for improved management
2005	Review of existing ordinances pertaining to coastal management

The development of a stronger consensus for coastal management in Mabini and Tingloy is progressing. The Municipality of Tingloy has become active in developing a coastal resource management plan and in implementing laws to ban illegal fishing and the use of compressor for fishing. In particular, Barangay Sto. Tomas has become very active in implementing and enforcing the new marine sanctuary at the Pulang Buli Reef or Batalang Bato Marine Sanctuary, off Maricaban Island. Mabini, through barangay actions, continues to implement the three marine sanctuaries and the marine reserve along its shoreline and a *Bantay Dagat* patrol (local law enforcement group) watches the area for infractions.

In 2004, the conservation fee system for the Mabini area was fully operational with a budget allocated to coastal resource management. Due to the fact that many of the dive sites are located in the Tingloy area, the Mayors of the municipalities of Mabini and Tingloy agreed to share the proceeds of the user-fee for management expenses and have planned to sign a memorandum of agreement (MOA) for the unified collection between the two municipalities. Currently, the two municipalities, through the CRM Board, have increased interest in coastal resource management and plan to review ordinances involving CRM and channeling their energies in improved coastal resource management.

THIS EXPEDITION –2005

This coral reef monitoring project in Mabini and Tingloy was comprised of one team of 9 volunteers, 4 staff volunteers and 6 full-time staff. The teams surveyed 9 sites in the Mabini and Tingloy area and accomplished the projects' objectives.

The team monitored the condition of the coral reef substrate cover, fish diversity and abundance, indicator species and human activities affecting the area. These observations have been compiled and are presented in this report. Where possible, trends in environmental condition or human activities are noted and compared with previous research data from the area in 1983, 1991, 1992, 1993, 1995, 1997 and 2001.

The volunteer team resided at Solana BEZO Resort in San Teodoro, Mabini. The location proved to be very convenient for daily trips to the survey sites coupled with the exceptional service provided by the resort staff on site and at the resort. The weather and conditions were good for the expedition, and the resort provided for a good 8 days of excellent service, relaxation, and worry-free diving.

Data Collected and Methods

The volunteers

Nine volunteers participated in the "Saving Philippine Reefs (SPR) Expedition" in Mabini and Tingloy, Batangas from April 19–27, 2005. They made financial contributions which covered their travel, accommodation and subsistence costs. The volunteers came from different backgrounds including a medical student, biologists, entrepreneurs, business consultants and managers, a journalist and a computer science engineer. They are all experienced scuba divers and most had participated in previous SPR expeditions.

Study site

Mabini -Tingloy dive area (Figure 2) is popularly called "Anilao," due to the association of this fishing village to the former two municipalities (Solandt *et al.* 2003). This historically rich and famous dive site is only three hours from Manila. It is frequented by Korean, Japanese and Filipino tourists since the fall in western tourist numbers. This site is an important fishing ground for artisanal and tuna fishery (White et al. 2001). Surveys were carried out in four marine protected areas (MPAs) and five non-protected areas (non-MPA):

Mabini municipality

1. Arthur's Rock Sanctuary (MPA)
2. White Sand Reef (Dive Solana/El Pinoy; non-MPA)
3. White House Reef (non-MPA)
4. Cathedral Rock Sanctuary and Rock (MPA)
5. Twin Rocks Sanctuary (MPA)

Tingloy municipality

6. Sombrero Island (non-MPA)
7. Sepoc Point (non-MPA)
8. Layag-layag (non-MPA)
9. Batalang Bato Sanctuary / Pulang Buli Sanctuary (MPA)

Data collection methods

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

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

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

Scuba surveys were carried out in the deep area (6 -10 m) parallel to the reef crest using a systematic point-intercept method. Transects were laid on sections of a reef flat, reef crest or slope. Substrate was evaluated at 25 cm intervals along a 50 m transect. Data gathered during scuba surveys were the same type as those collected during snorkel surveys. Distance between transects were 5 – 10 m, however, were closer in some areas where the reef extent was narrow.

Fish estimates. Fish abundance and diversity were estimated using a 50 x 10 m visual census (UVC; n = 3 – 6) technique done by three fish visual census specialist (A. White, A.P. Maypa and B. Stockwell). Substrate transects were utilized during UVC. The abundance of target species, indicator species and numerically dominant and visually obvious were all counted. Biomass of target species was computed using Fishbase 2000 constants.

Data Analyses

Substrate cover. Live hard coral cover was compared between sites for shallow and deep areas in the year 2005 using a one-way Analysis of Variance (1-ANOVA). For between years (i.e., between 2001 and 2005 since no raw data was available in other years) a Mann – Whitney U test was used since data was non-normal even after transformation. All percentage data was log transformed and normality was tested using Kolmogorov's Test. Levene's Test for homogeneity of variances was also used.

Fish biomass. Fish biomass was computed using the formula: $\mathbf{a} \cdot \mathbf{L}^{\mathbf{b}}$ (Fishbase 2000) and using the *a* and *b* constants in the same software. Biomass of target fish species were computed on the species level and summed up per family, based on 13 selected families: Acanthuridae, Balistidae, Caesionidae, Carangidae, Haemulidae, Labridae (only the the larger species were included, e.g*, Bodianus, Cheilinus and Hemigymnus*), Lethrinidae, Lutjanudae, Nemipteridae, Mullidae, Scaridae, Siganidae and Serranidae.

Comparisons between familial biomass within sites and between sites used 1-ANOVA or Kruskal Wallis Test. Non-normal data were squareroot or log transformed. In instances where data was still non-normal after a transformation, Kruskal Wallis Test was used in lieu of 1-ANOVA. Normality was tested using Kolmogorov's Test and Levene's test for homogeneity of variances.

Daily Log of Human Activities. Each day, assigned buddy teams 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.

Community Interviews. For each site surveyed, at least two interviewers were dropped off at the shore to interview local residents, divers, resort owners, or local fishers in their general perception of the area throughout the years in terms of human activities and natural impacts, marine protected area management, fishing practices, and laws pertaining to the dive site or protected area.

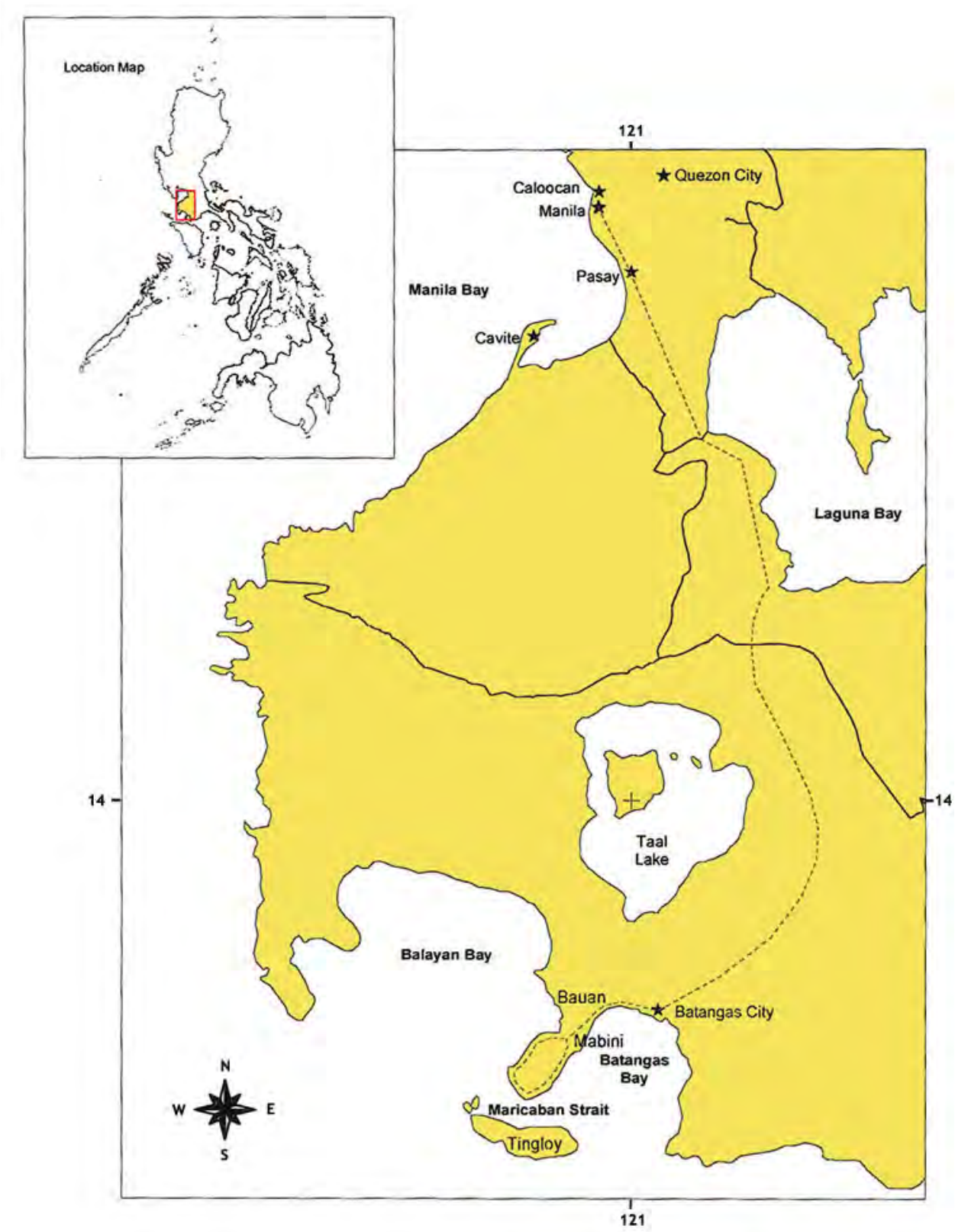


Figure 1. Expedition research area in Mabini and Tingloy, Batangas in relation to Manila.

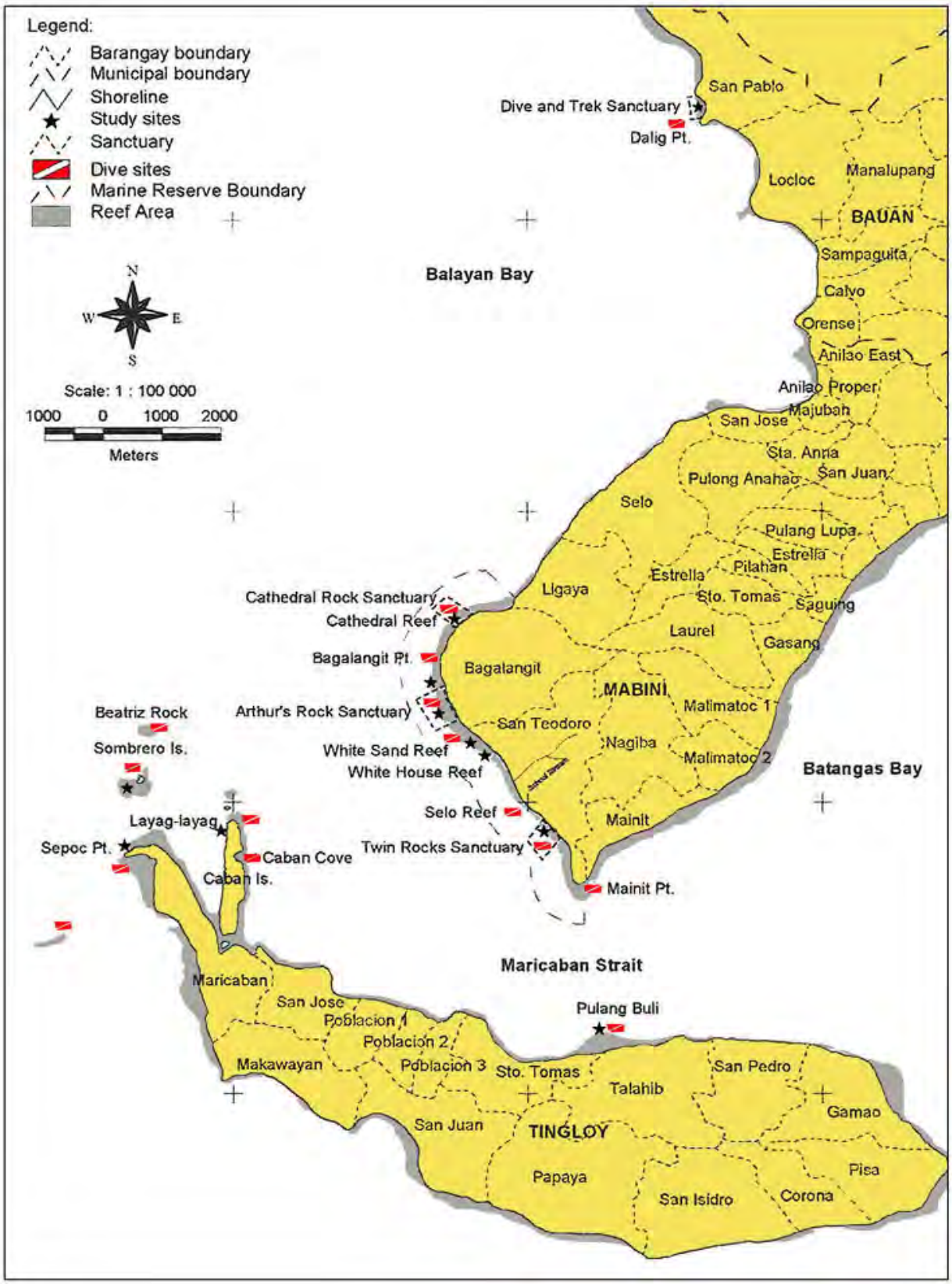


Figure 2. Expedition research area, study sites and other important dive sites in Mabini and Tingloy, Batangas.

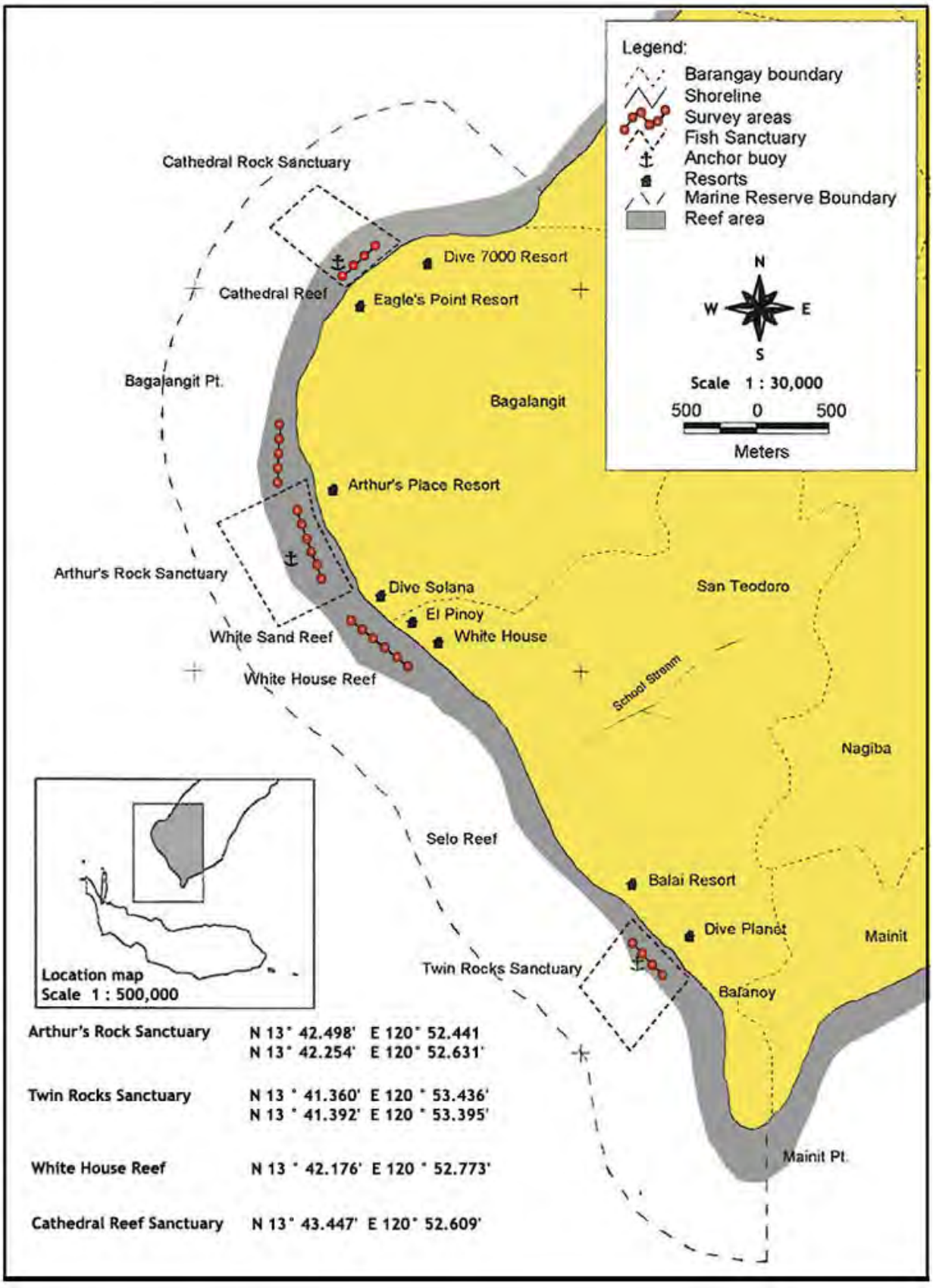


Figure 3. Study sites within the Mabini Marine Reserve, Mabini, Batangas.

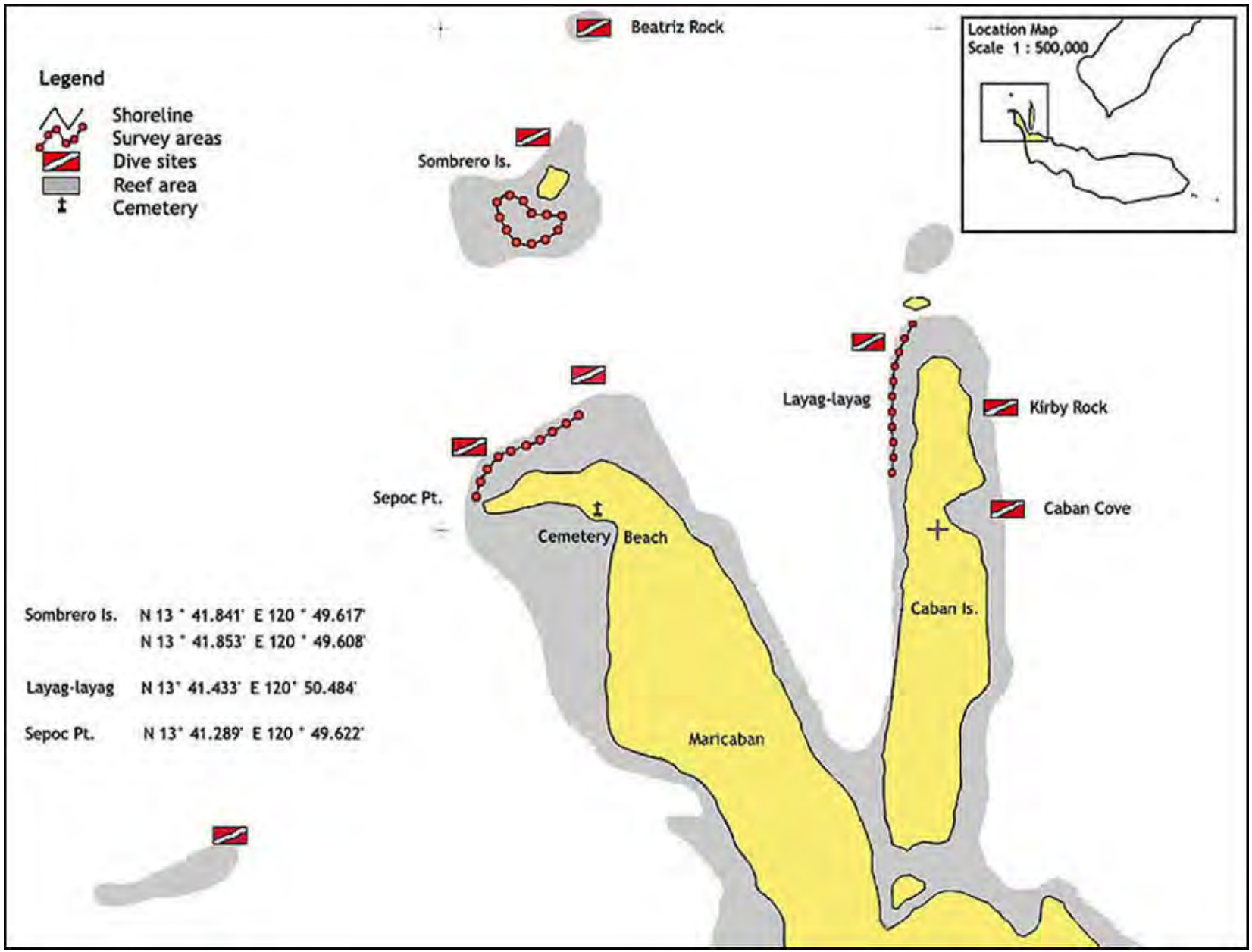


Figure 4. Study sites and other dive sites at north ends of Maricaban and Caban Islands, Tingloy, Batangas.

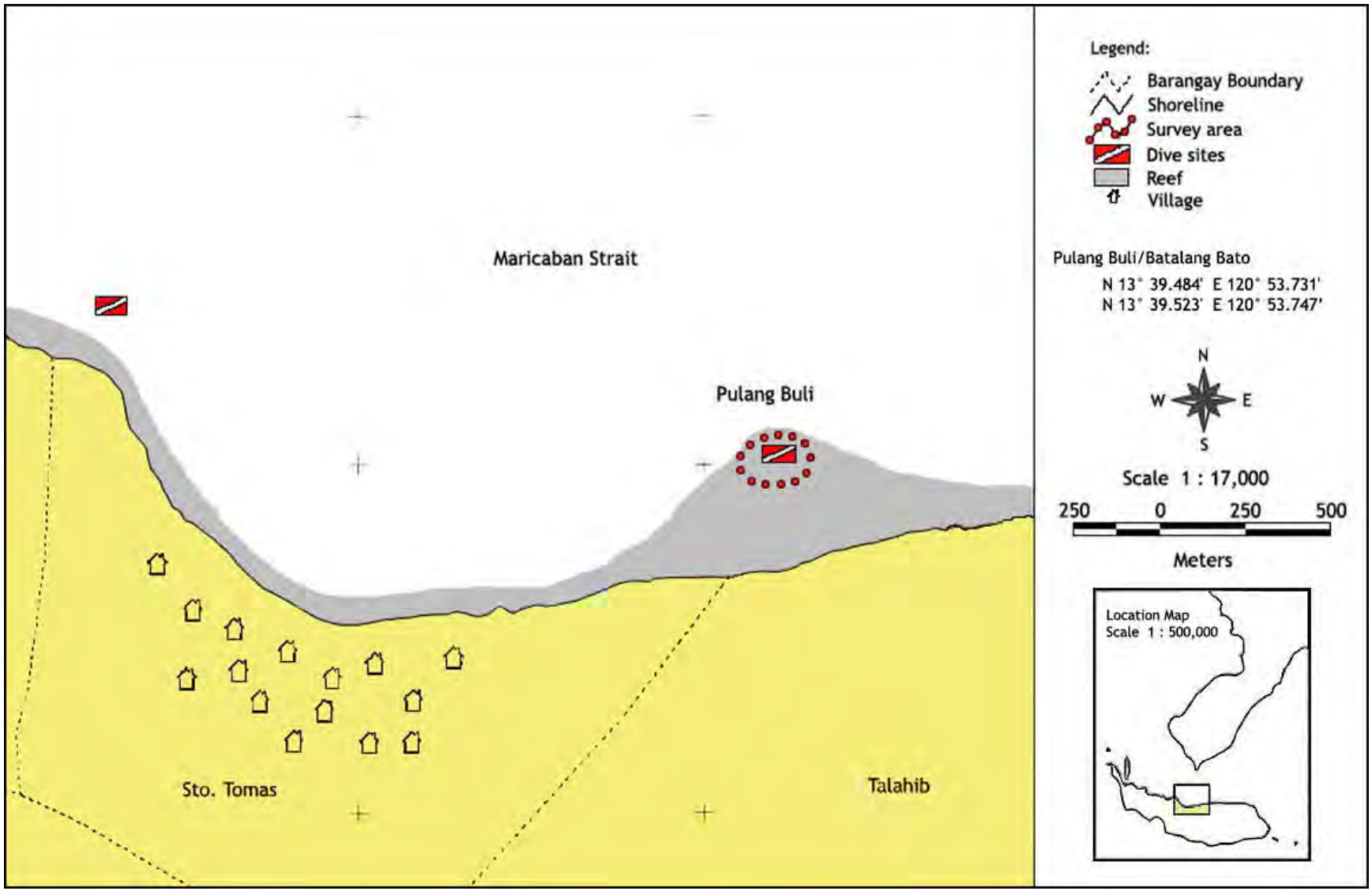


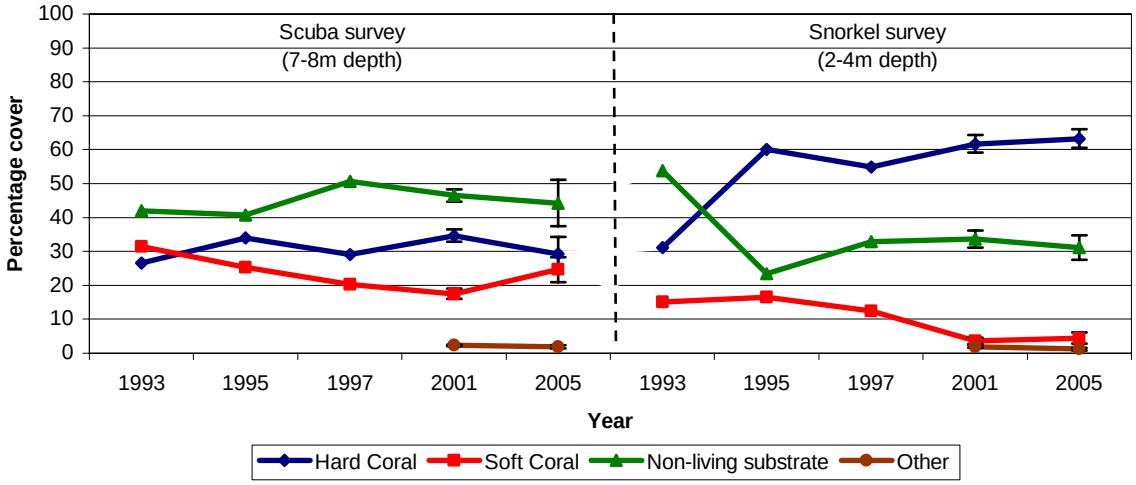
Figure 5. Study site in Barangay Sto. Tomas, Tingloy, Batangas.

OVERVIEWS AND RESULTS OF SITES SURVEYED

Arthur's Rock Sanctuary

This marine protected area (MPA) was established in 1991 by a municipal ordinance of Mabini (Solandt *et al*. 2003). Table 1 and Figure 6 shows that the live coral cover of Arthur's sanctuary is fair – good and appears to be consistent over the years since 1995. However, statistical comparisons between the years 2001 and 2005 indicate a significant increase ($p \leq 0.0001$, Table 46) in the shallow in the latter year (63.3 ± 5%). This is coupled with a significant decrease ($p \leq 0.0001$) in cover in the deeper portion (29.3 ± 5%). The low coral cover in the deeper area may be attributed to lower visibility at these depths. Arthur's Rock Sanctuary among those sites in the area with a fairly high coral cover ($p \leq 0.0001$, Table 45).

Figure 6. Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2005



The most abundant target fish in Arthur's sanctuary is one species of fusilier (*Pterocaesio pisang:* 25 ± 25 individuals/500m^2; Table 5). This density appears to be consistent from 1991 to 1995. The high variation reflects the variable distribution of the species within the area. In this survey, out of four fish transects surveyed, *P. pisang* was only observed in one. Density of primary target fish such as groupers, snappers and emperors are low (0.3 – 0.8 individuals/500m^2; Fig. 8). Similarly, indicator species abundance and density (Chaetodontidae) appears to exhibit a declining pattern over the years (1991:51 individuals/500m^2; 2005: 17.5 ± 2.98 individuals/500m^2; Table 5). Biomass of scarids, caesionids and acanthurids appear highest within this sanctuary (Table 42), however, did not differ significantly ($p = 0.0743$, $F = 2.0785$; Table 43) compared with the rest of the selected 13 target families.

Consistent coral cover, over the years, similar target fish abundance and a declining pattern in butterfly fish densities and diversity indicate some degree of sanctuary protection, however, it may not be strictly enforced. The maintenance of fair-good coral cover can be attributed to the presence of two mooring buoys which prevents boats from dropping anchors in the area.

Arthur's Rock corals have recovered from storm damage and illegal fishing in the past (White *et al*. 2001). However, the lack of improvement in target fish densities and decrease in species diversity within 14 years (1991 – 2005; Table 4) may indicate a high fishing pressure from adjacent fishing grounds both for target fish species and aquarium trade, or a possibility of poaching. This MPA may benefit more from enhancing the protection and enforcement efforts from the management body.

Figure 7. Mean (±SE) number of species/500m^2 at Arthur's Rock Sanctuary from 1991 to 2005.

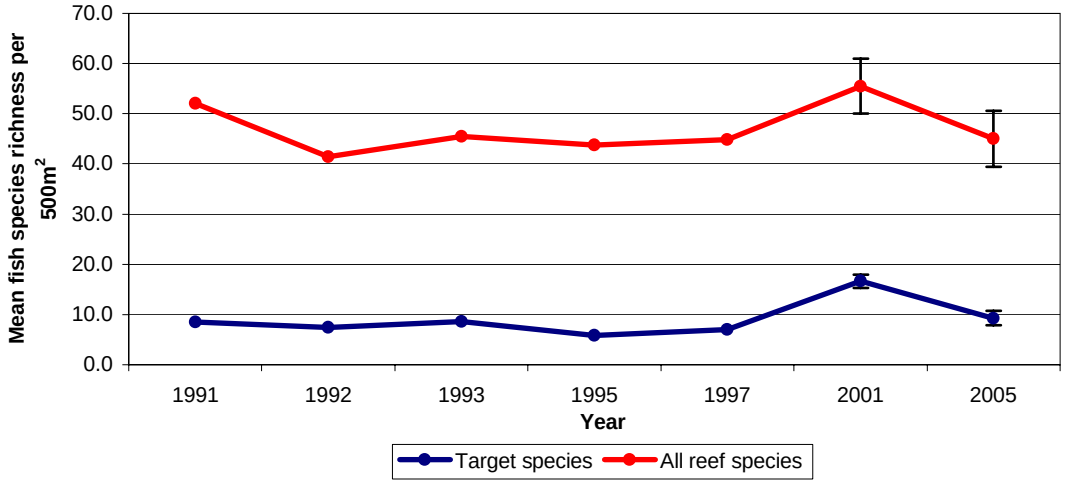
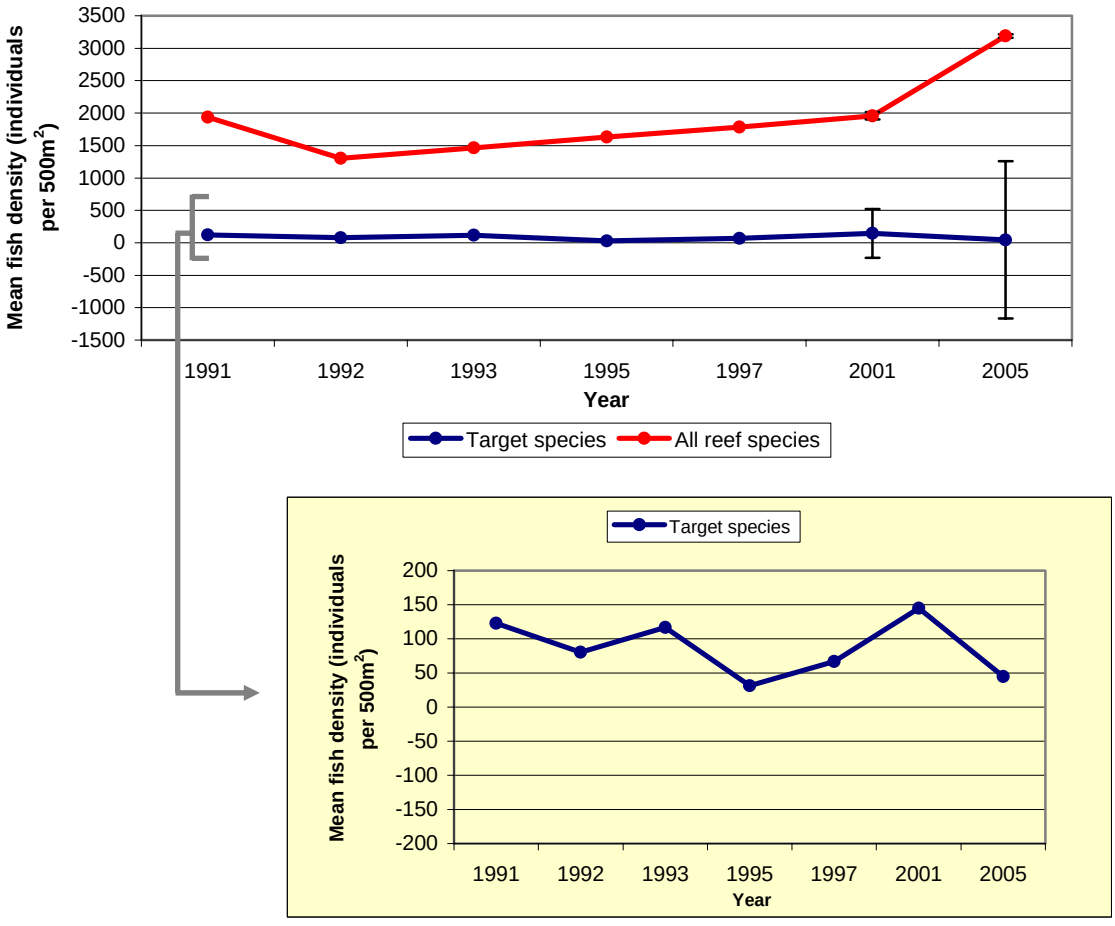


Figure 8. Mean (±SE) density (individuals/500m^2) at Arthur's Rock Sanctuary from 1991 to 2005.

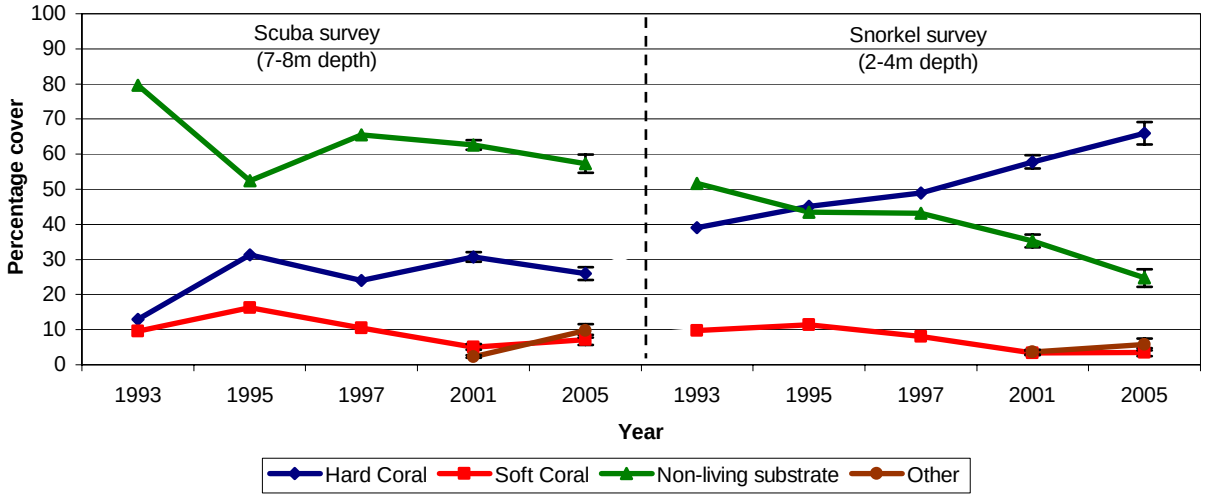


Twin Rocks Sanctuary

Twin Rocks sanctuary was established in 1991 at the same year Arthur's and Cathedral Sanctuaries were (Solandt *et al.* 2003). This sanctuary is well protected and appears to be benefiting from closure to fishing by (White *et al.* 2001). The community of Balanoy manages the area.

Live hard coral cover in the shallow appears to be increasing consistently after 1993, indicating that this MPA has benefited from protection immediately after establishment. However, a slight significant decrease ($p \leq 0.0001$, Table 45) in live hard coral cover from 2001 (30.7 ± 1.3%) to 2005 (26 ± 1.8%) was observed in the deeper area.

Figure 9. Changes in substrate (%mean ±SE) in Twin Rocks Sanctuary from 1993 to 2005.



Both diversity and abundance of all fish species can be classified as moderate (Table 7, Fig. 10 & 11) based on the classification of Hilomen et al. (in review) within a 1000 m^2 area. Target fish density (130.8 ± 69.5 individuals/500m^2) and biomass (30851.0 ± 11726.9 g/500 m^2) of target fish in this MPA appears higher compared to other areas, except Pulang Buli Sanctuary (93865.1 ± g/500 m^2). Statistically, however, the total target fish biomass of this MPA is only significantly higher than White Sand Reef/Dive Solana Reef (p =0/0062, Table 44). Among the numerically dominant target families are: Fusiliers (78 ± 68.2 individuals/500m^2), Surgeonfishes (17.4 ± 4.3 5 individuals/500m^2), Snappers (12.2 ± 3 5 individuals/500m^2) and Rabbitfishes (6.2 ± 2.8 individuals/500m^2). Grouper density is also fairly high (4.2 ± 1.6 5 individuals/500m^2) compared to other MPAs in the area, except Balatalang Bato (6.3 ± individuals/500m^2). A Reef Check survey in 2002, documented that Twin Rocks Sanctuary significantly supports a greater number of checkered snapper (*Lutjanus decussatus*) compared to Cathedral Rock and Arthur's Sanctuary (Solandt *et al.* 2003). This agrees with our current results. Twin Rocks Sanctuary supports a significantly higher ($p = 0.0007$, $F = 4.926$, Table 44) biomass of Lutjanids (4823.87 ± 2767.78 g/500 m^2) and Nemipterids (427.30 ± 157.98 g/500 m^2). Grouper biomass (669.43 ± 315.8 g/500 m^2) in this MPA is also significantly higher ($p = 0.001$, $x^2 = 25.619$, Table 43) compared to other sites, except Pulang Buli. It appears that grouper abundance started to increase in 2001 compared to previous years (Table 9, Fig 11), however, the absence of raw data in the previous years limit our ability to conclude whether this increase is significant or not. Among the numerically abundant fish groups are Pomacentrids and Anthids.

Figure 10. Mean (±SE) number of species/500m^2 at Twin Rocks Sanctuary from 1991 to 2005.

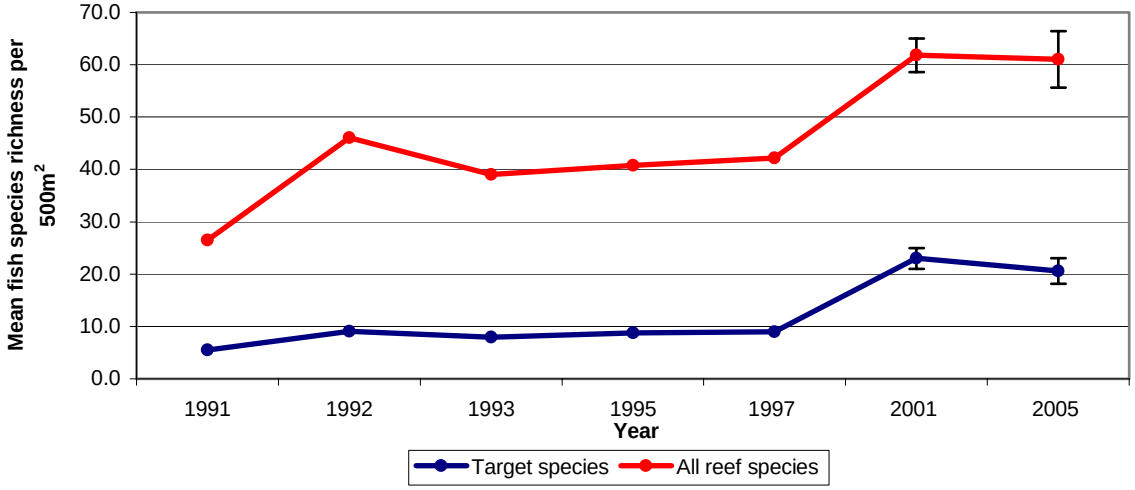
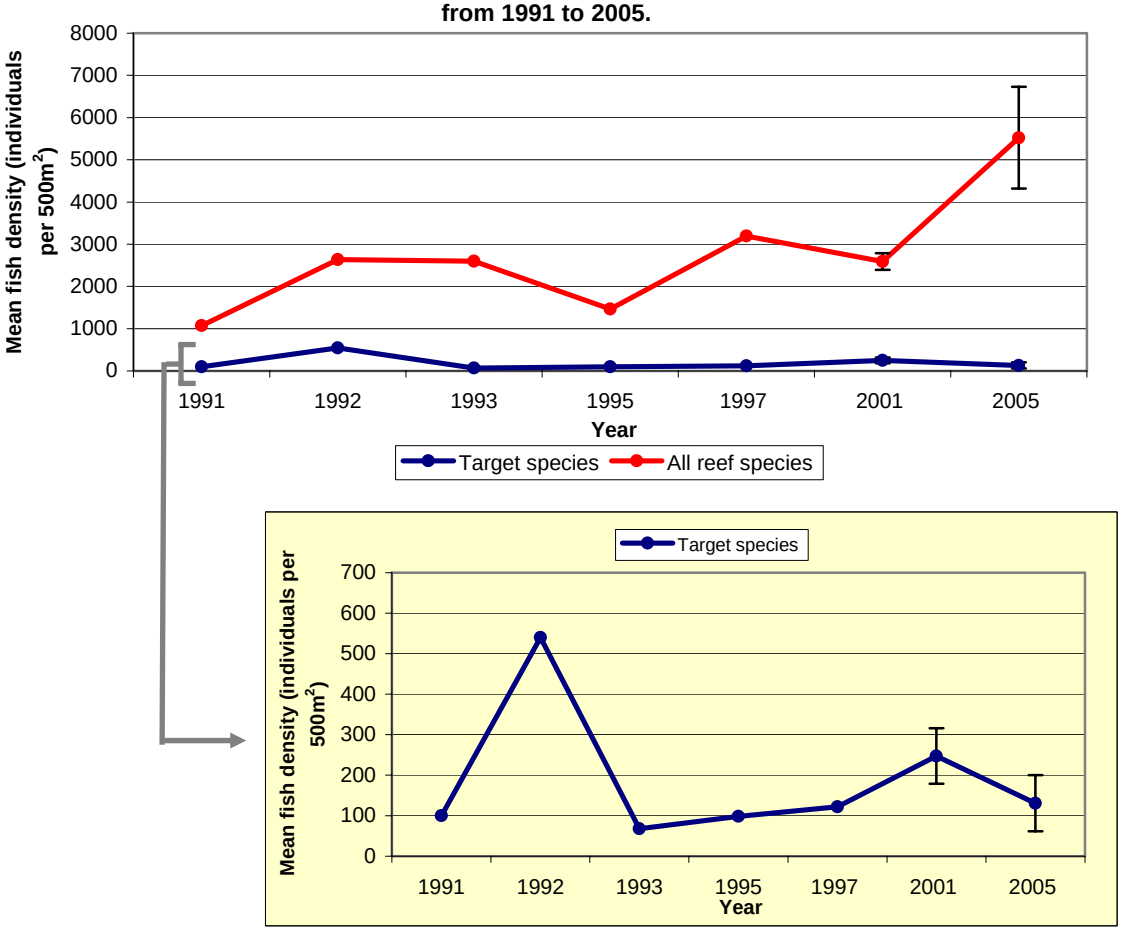


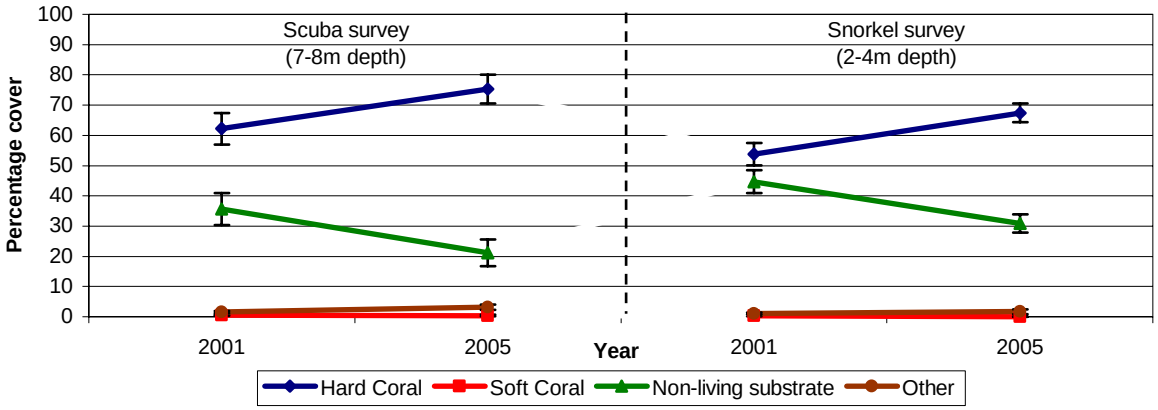
Figure 11. Mean (±SE) density (individuals/500m^2) at Twin Rocks Sanctuary from 1991 to 2005.



Cathedral Reef Sanctuary and Cathedral Rock

This marine protected area was established in 1991 at the same time Twin Rocks and Arthur's Rock Sanctuaries were established in 1991 (Solandt *et al.* 2001). Cathedral Rock and Reef Sanctuary was first surveyed in 2001 by the SPR-Earthwatch team. Fish on the Rock/Cross are abundant, especially the butterfly fish, *Chaetodon kleinii* (581 individuals/200 m^2; n =1). The fish are tame in the area and fish feeding was evident.

Figure 12. Changes in substrate composition (%mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2005



Cathedral reef, a fringing reef from the land side of the Cathedral Rock has an excellent coral cover (75.3 ± 4.8%) at 7-8 m and a good cover at 2-4 m (67.5 ± 3.1%). Comparisons in live coral cover between 2001 and 2005 show the latter coral cover is significantly higher ($p \leq 0.001$) compared to 2001 for both shallow and deep areas (Table 46, Figure 12). This sanctuary has benefited from several anchor buoys, thus maintaining its excellent coral reef condition despite the frequency of dive boats in the area.

The numerically abundant major fish families include the damsels (4031.6 ± 798.7 individuals/500 m^2) and Fairy Basslets (1673.8 ± 504.4 individuals/500 m^2). Among the target fish families, the fusiliers had the highest density (226.0 ± 195.4 individuals/500 m^2) and biomass (9811.28 ± 9811.28 g/500 m^2). However, no significant differences ($p = 0.127$, $F= 2.2696$) were found between familial biomass of selected target fish within the sanctuary. Cathedral Rock and Reef Sanctuary target fish abundance and biomass may improve more from consistent protection.

Figure 13. Mean (±SE) number of species/500m^2 at Cathedral Reef Sanctuary and Cathedral Rock from 2001 to 2005.

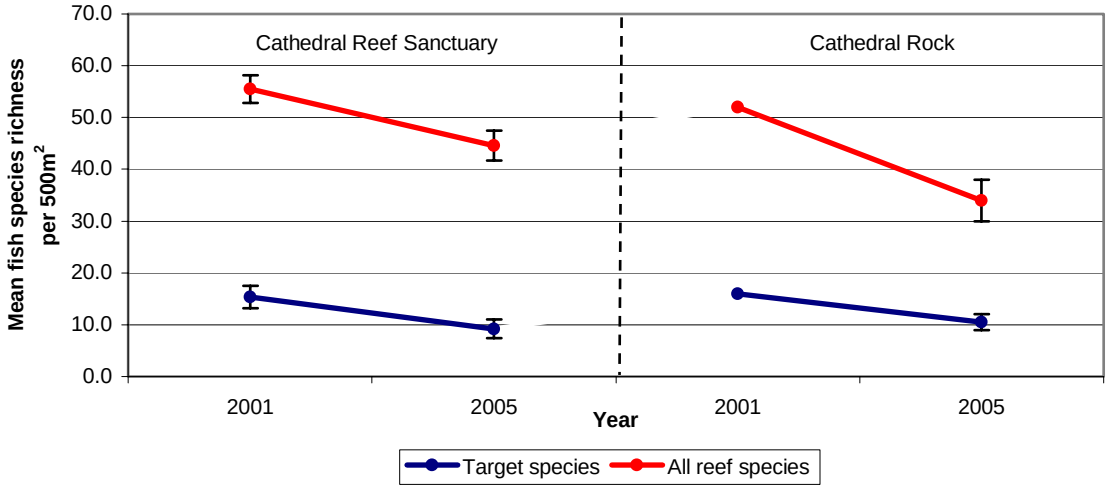
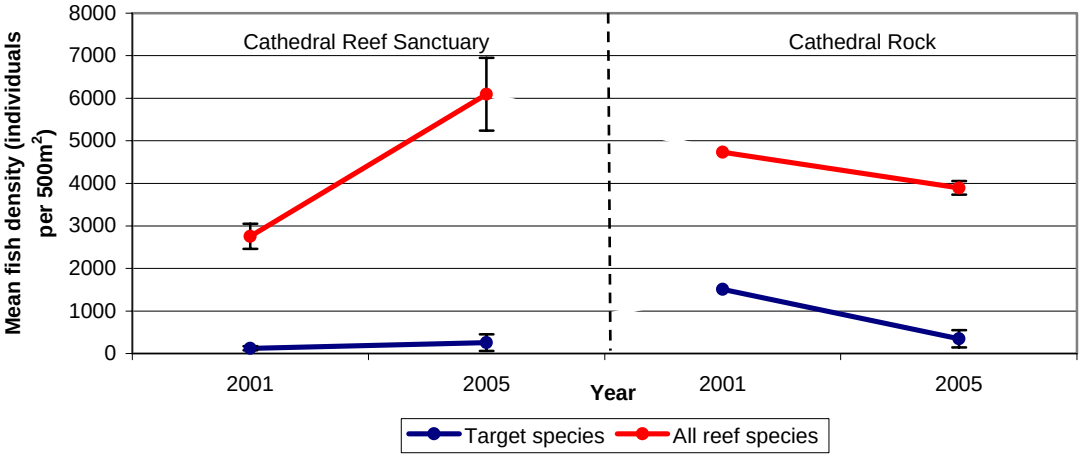


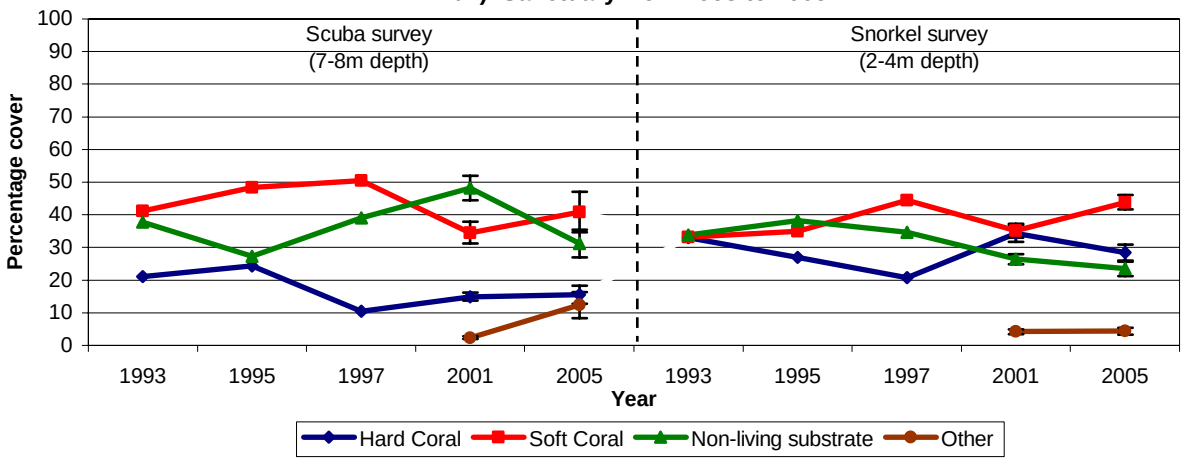
Figure 14. Mean (±SE) density (individuals/500m^2) at Cathedral Reef Sanctuary and Cathedral Rock from 2001 to 2005.



Batalang Bato Sanctuary (Pulang Buli Sanctuary)

Batalang Bato Sanctuary, formerly known as Pulang Buli, is a shoal located offshore from Maricaban Island. This sanctuary was established in 2002 and managed by the Batalang Bato Management Council (BBMC).The reef is dominated by soft corals which comprises 40.9 ± 6.1% to 43.8 ± 2.2%. Total live hard coral is poor (15.6 ± 2.8% at 7-8 m) to fair (28.4 ± 2.4% at 3-4 m).

Figure 15. Changes in substrate composition (%mean ±SE) in Batalang Bato (Pulang Buli) Sanctuary from 1993 to 2005.



Total live hard coral cover is depauperate. Despite the significant slight decrease ($p \leq 0.001$) in the shallow from the year 2001 to 2005, there was a significant increase ($p \leq 0.001$) in the deep from 14. 9 – 15.6% (Table 45, Fig. 12). The shallow area shows a phase shift from hard coral to soft coral cover. There is an increase in soft coral from 35.1% to 43.8% and a decrease in live hard coral cover from 34.3% in 2001 to 28.4% in 2005 in the deeper reef. This sanctuary harbors the highest grouper density (6.3 ± 1.0 individuals/500 m^2) and significantly higher biomass ($p = 0.001$, $F = 25.619$; 491.21 ± 0 individuals/500 m^2) of groupers compared with the rest of the sites (Table 17). Biomass of other target fishes such as Acanthurids, Lutjanids, Nemipterids, Scarids are also fairly high compared to other sites. This unusual pattern of high target fish biomass despite low live coral cover may be attributed to strict protection/enforcement and good MPA management. It was noted that the *Bantay Dagat* (MPA wardens) in the area was not hesitant to approach and question dive boats anchored within the area. The same *Bantay Dagat* member had an M-16 rifle on his shoulder while patrolling. This tight enforcement is clearly reflected in the fish fauna status of the area.

Figure 16. Mean (±SE) number of species/500m^2 at Batalang Bato (Pulang Buli) Sanctuary from 1993 to 2005.

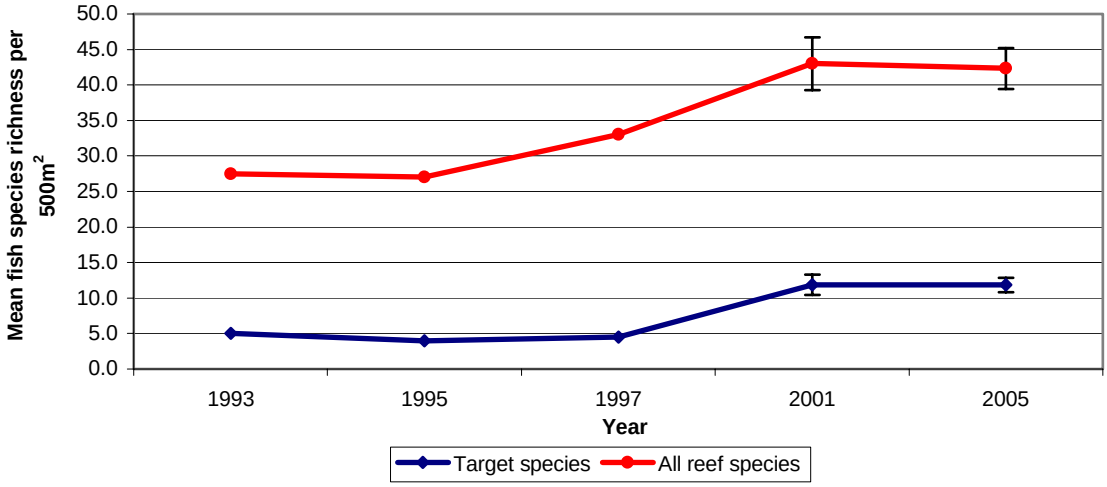
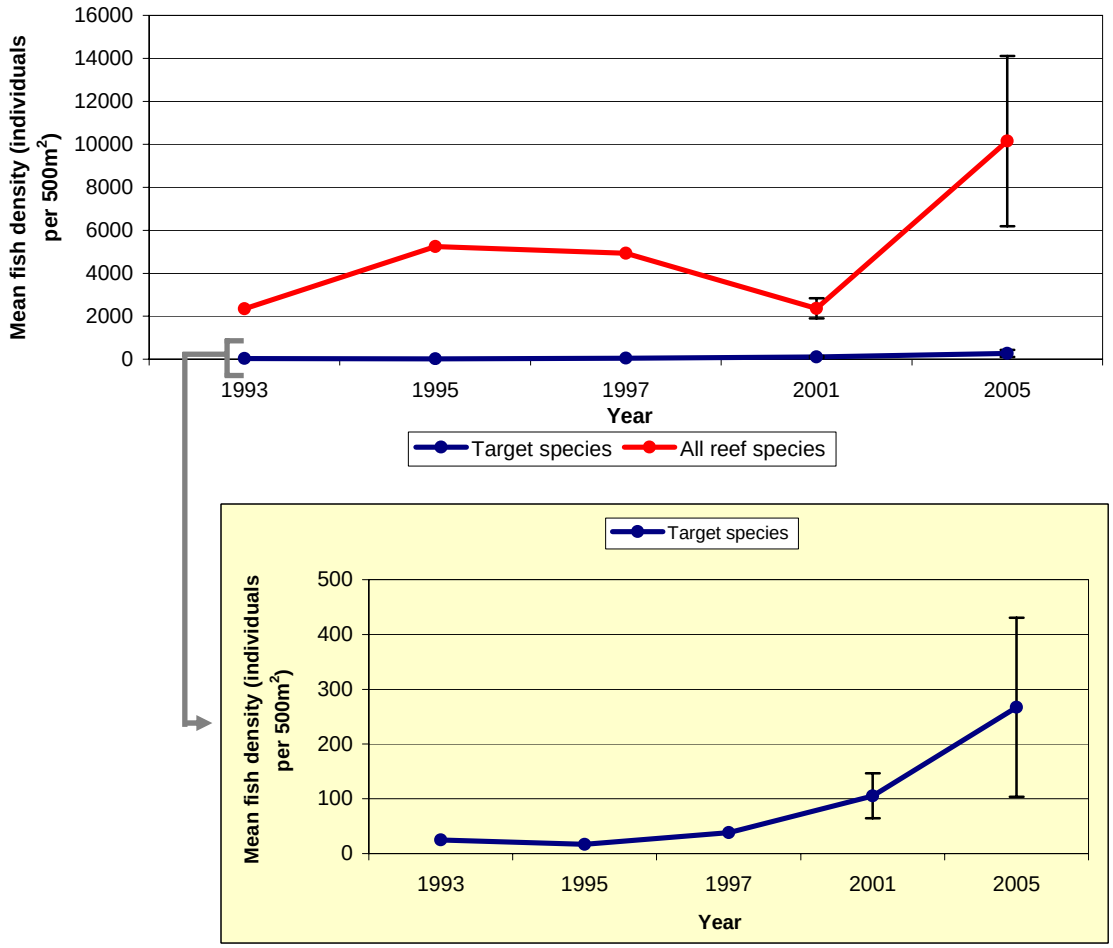


Figure 17. Mean (±SE) density (individuals/500m^2) at Batalang Bato (Pulang Buli) Sanctuary from 1993 to 2005.

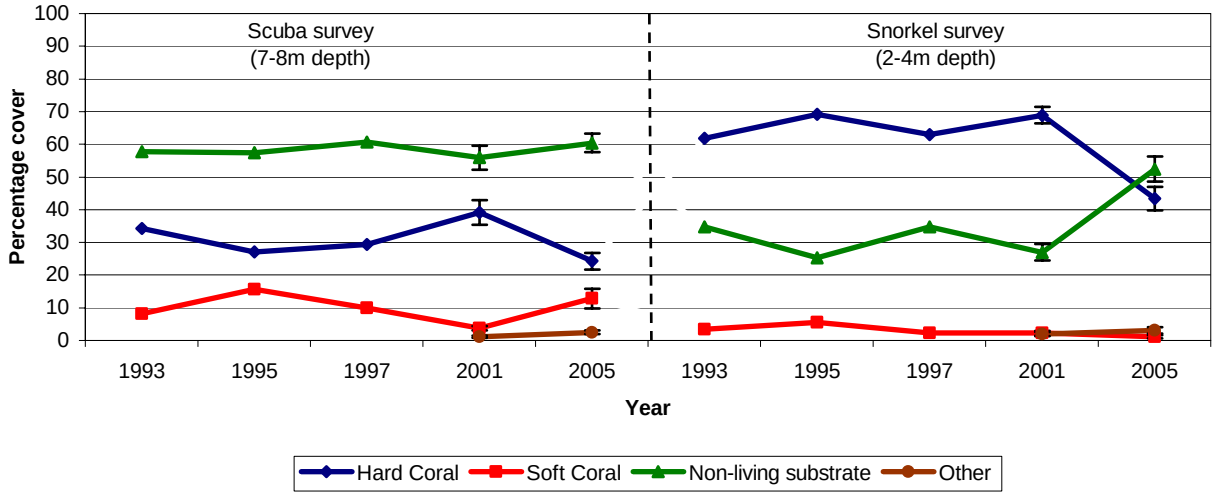


Layag-Layag Reef

Layag-layag Reef is a popular destination for scuba divers and snorkelers (White et al. 2001). Coral cover is good (43.4 ± 3.7%) in the shallow and fair in the deep (24.3 ± 2.5%; Table 26, Fig 18). This lower coral cover in the deeper area was attributed to physical damage due to anchors in the year 2001 (White *et al.* 2001). Further, comparisons in live coral cover between 2001 and 2005 show the latter coral cover is significantly lower ($p \leq 0.001$) compared to 2001, for both shallow and deep areas (Table 46). This significant decrease in live hard coral cover from 68.9 ± 2.5% (2001) to 43.4 ± 3.7% (2005) is coupled by a marked increase in coral rubble from 8.0 ± 1.5% in 2001 to 15.8 ± 2.4% in 2005, indicating more physical damage in the area.

Target fish diversity, abundance and biomass is low in Layag-layag including butterfly and angel fishes (Tables 2 & 19). This may be the consequence of the frequent fishing and collecting of aquarium fish by fishers nearby Tingloy village (White *et al.* 2001).

Figure 18. Changes in substrate composition (%mean ±SE) at Layag-layag from 1993 to 2005.



Continued signs of physical damage from anchors are observed in Layag-layag Reef. The placement of mooring buoys may greatly improve the condition of the reef, especially in the deeper areas. Further, this area is a potential site for a sanctuary due to its location. Layag-layag encompasses the northern tip of Caban Island and Kirby Rock on the east side. Both are exposed to currents and may play a role in larvae distribution in the area (White *et al.* 2001).

Figure 19. Mean (±SE) number of species/500m^2 at Layag-layag from 1993 to 2005.

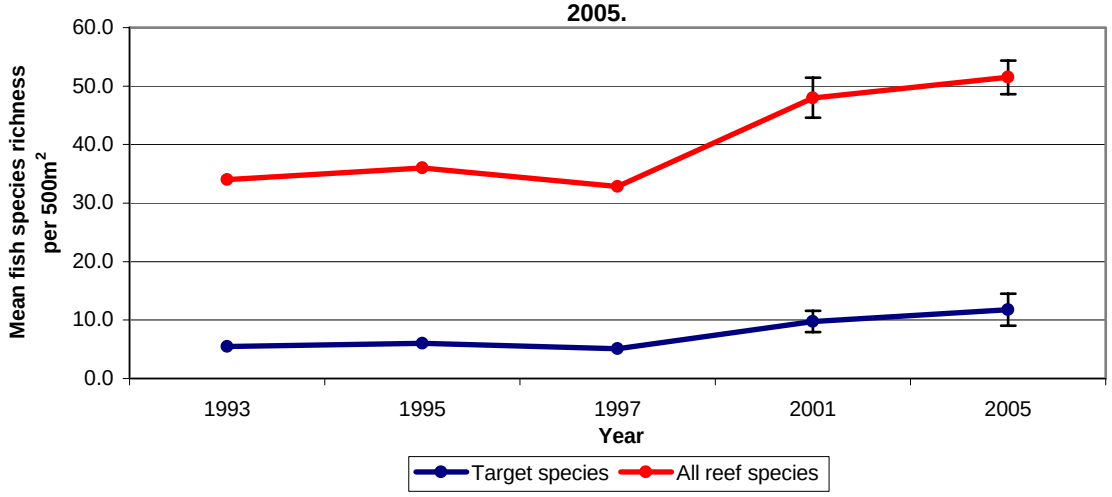
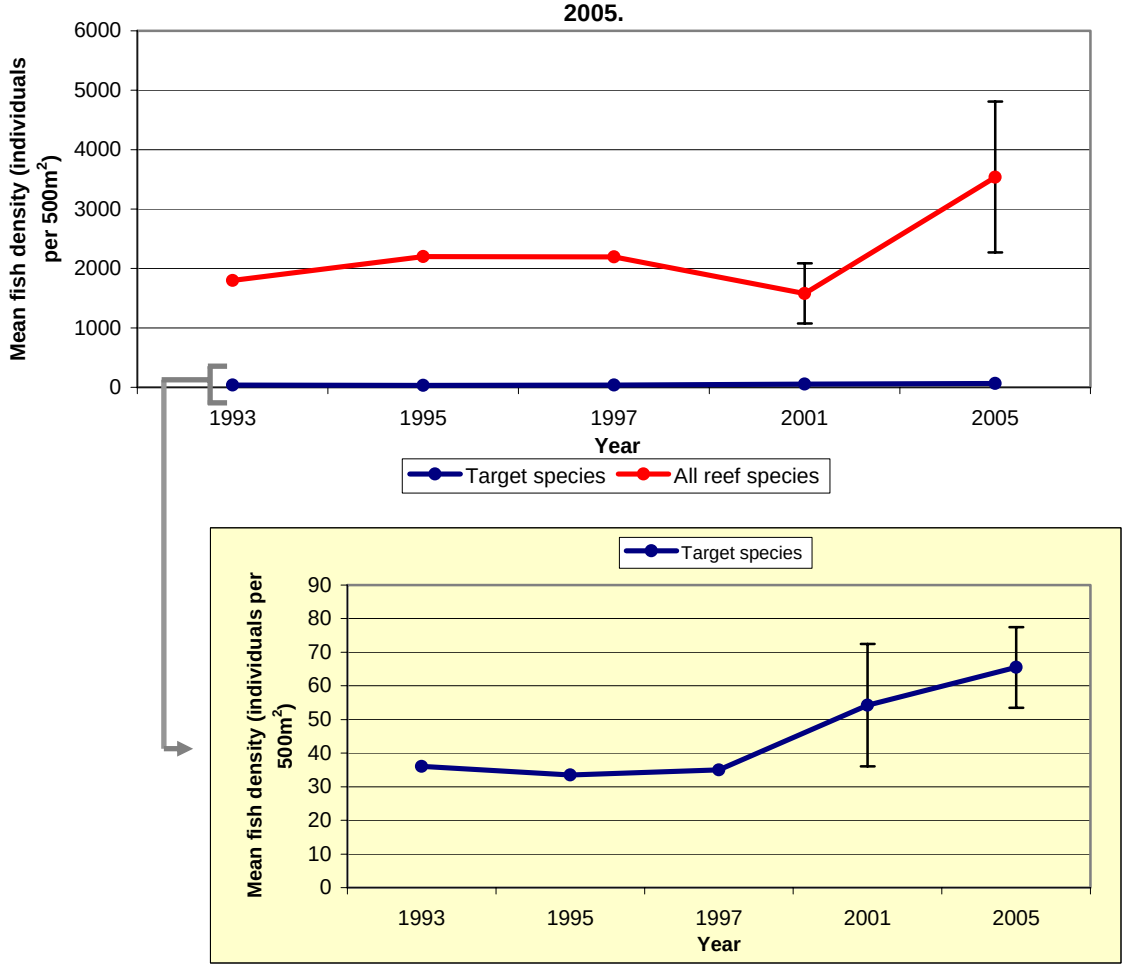


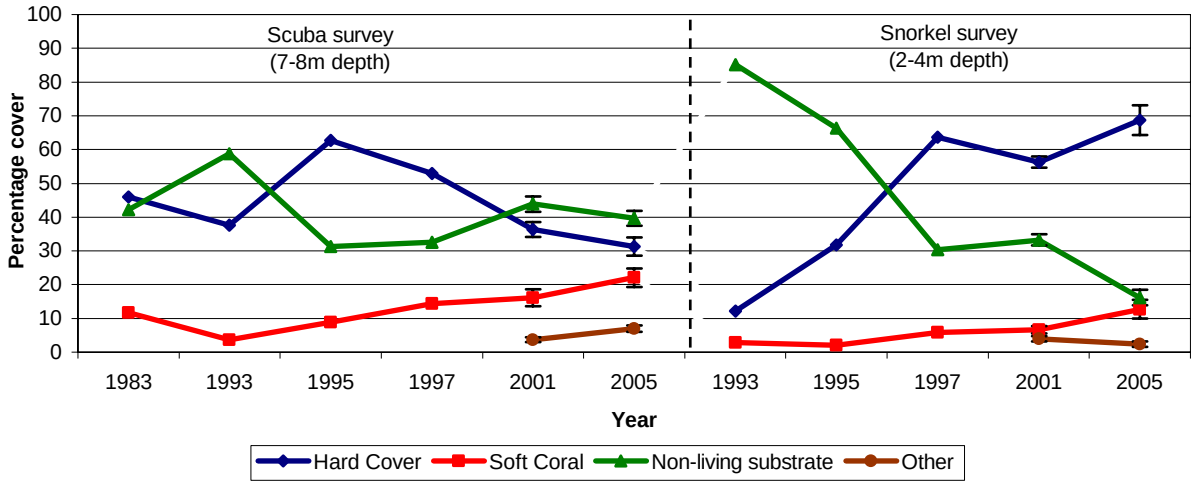
Figure 20. Mean (±SE) density (individuals/500m^2) at Layag-layag from 1993 to 2005.



Sombrero Island

Figure 21 shows the changes in substrate composition of Sombrero Island from 1983 to 2005. Live hard coral cover appears to be poor in the shallow (2-4 m) in 1993. This has been attributed to the severe storm damage in 1988 (White *et al.* 2001). In the following years, coral cover has been consistently increasing. In the year 2005, coral cover is good (68.8 ± 4.4%), and is significantly higher ($p < 0.001$, Table 46) compared to the year 2001. In contrast, coral cover in the deeper area is fair (31.3 ± 2.7%) and appears to be decreasing since 1995. The island is frequented by divers and snorkelers (White e*t al.* 2001) and gill net fishing was observed. These factors may have contributed to physical coral damage. Further, an increase in soft coral cover was observed from the year 2001 (16.1 ± 2.6%) to 2005 (22.1 ± 2.8%) which indicates a phase shift in substratum dominance from live hard coral to soft coral.

Figure 21. Changes in substrate composition (%mean ±SE) at Sombrero Island from 1983 to 2005.



Abundance and diversity of major families/groups, such as Pomacentrids, Anthids and Labrids are high, however target fish diversity, abundance and biomass are low (Table 23, Fig 25 & 26). Further, the density of Acanthurids, a major target fish species in the area appears to be declining over the years. The observed high abundance of small non-target species and the absence of larger target species indicate high fishing pressure and the use of selective fishing. This was confirmed by informal, unstructured interviews from boatmen (by A.P. Maypa). Spear-fishing which targets larger sizes, is apparently a popular form of fishing in the area.

Figure 22. Mean (±SE) number of species/500m^2 at Sombrero Island from 1993 to 2005.

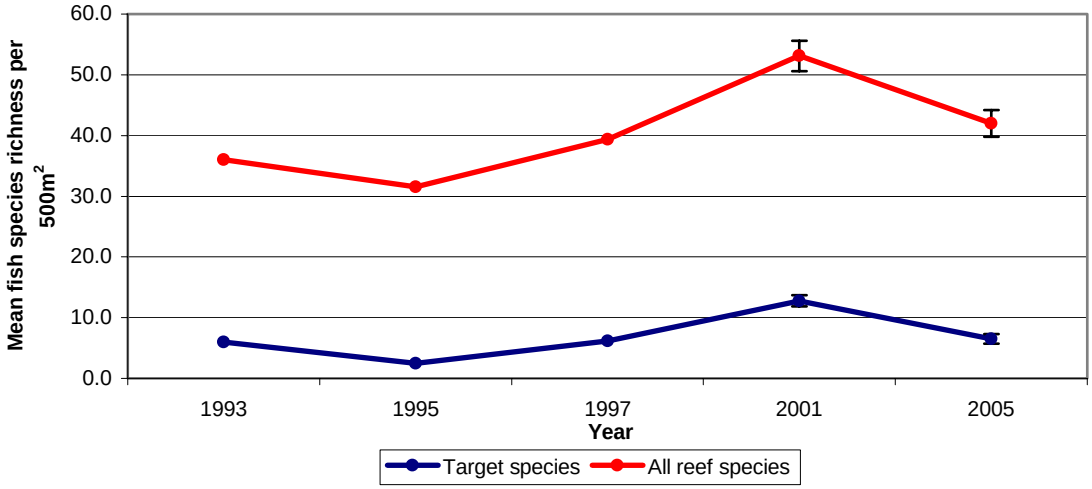
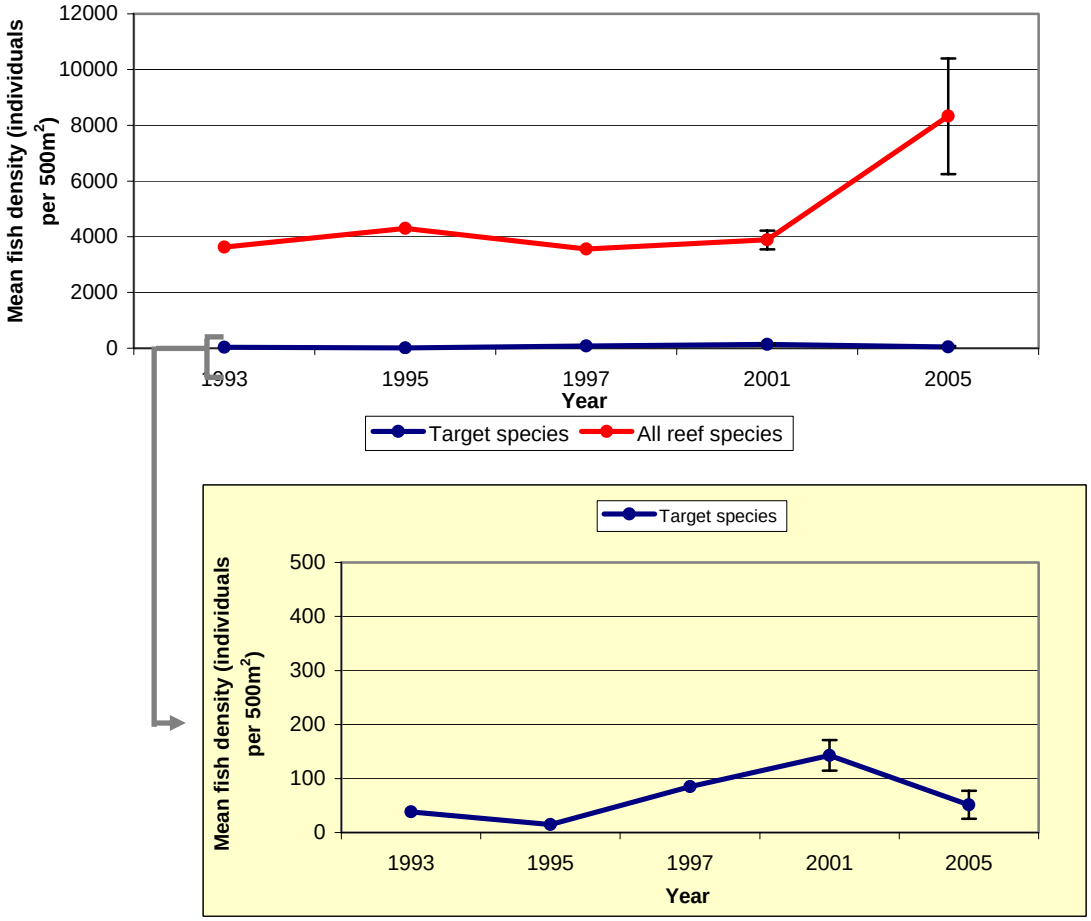


Figure 23. Mean (±SE) density (individuals/500m^2) at Sombrero Island from 1993 to 2005.

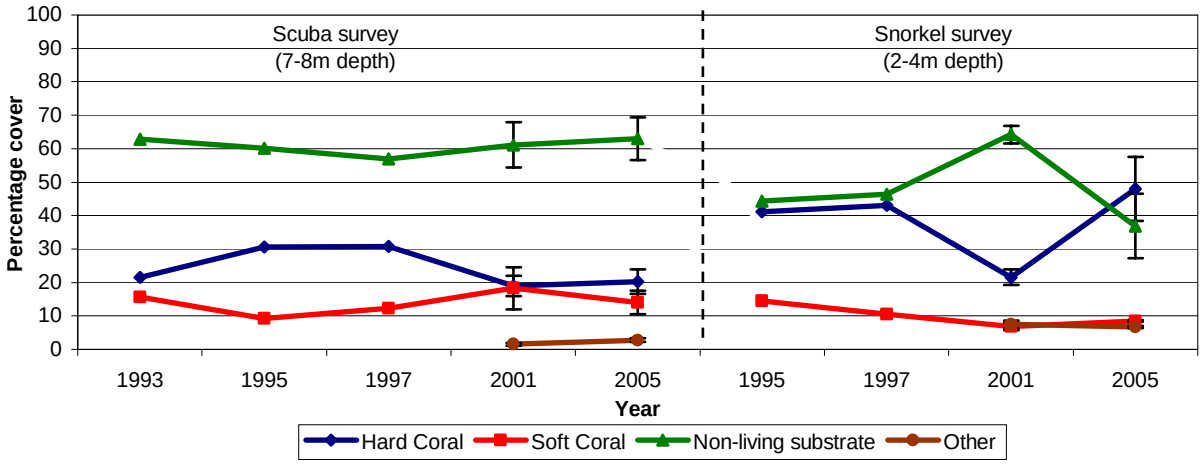


This area may benefit more if anchor buoys are placed. Further, we encourage the Tingloy municipality to follow up the 1980 proposal of the Marine Parks Task force to include Sombrero Island as part of the Anilao Marine Park complex (White *et al.* 2001).

White Sand Reef (Dive Solana/El Pinoy Reef)

White sand reef is adjacent to the south end of Arthur's Rock sanctuary fronting Dive Solana and El Pinoy resorts. This reef is heavily used by boats that anchor close to the beach for recreation and physical damage to corals is evident even in the presence of anchor buoys (White et al. 2001). Hard coral cover is poor in the deeper area (19 ± 3.1%) and fair in the shallow (48 ± 9.5%). The dominant substrates are sand (< 30%) at 7-8 m and live hard corals at 2-4 m. Among the sites surveyed in 2005, it is only White Sand Reef that appeared affected by the 1998 El Niño mass bleaching event. The presence of dead coral with algae during the 2001 survey, especially in the shallow area (22.7 ± 3.1%), suggests this. However, there was also a recorded infestation of Crown-of-thorns starfish in1999 and 2000, which is more likely the major cause of the observed live hard coral cover in 2001 (White et al. 2001).

Figure 24. Changes in substrate composition (%mean ±SE) at White Sand Reef from 1993 to 2005.



Fish diversity, abundance and biomass are low in this reef compared to most sites (Table 27, Fig. 25 & 26) where live coral cover is higher. The most numerically dominant fish families/groups are Pomacentrids and Anthids. Among target fish families, a few Acanthurids were observed in the area.

Figure 25. Mean (±SE) number of species/500m^2 at White Sand Reef from 1995 to 2005.

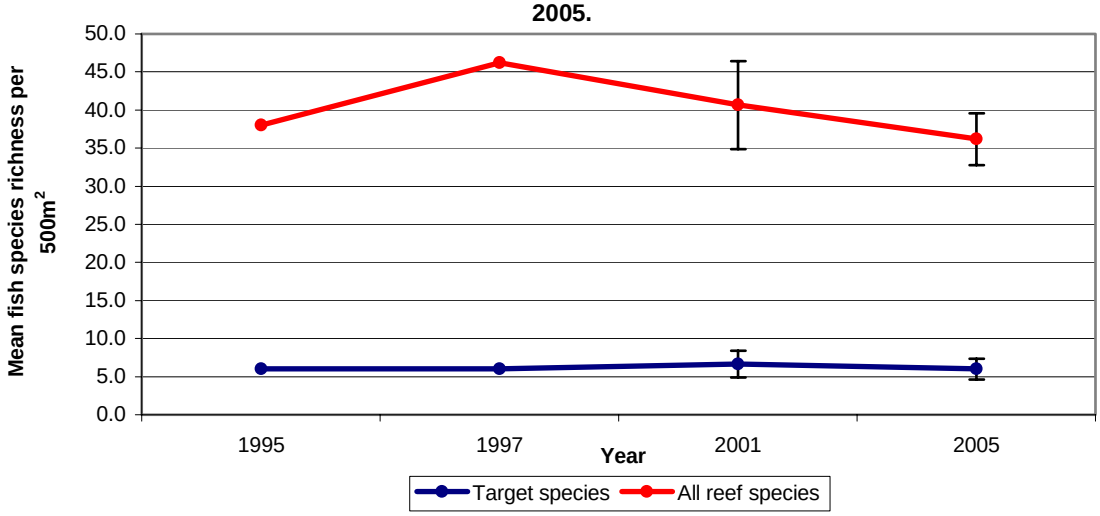
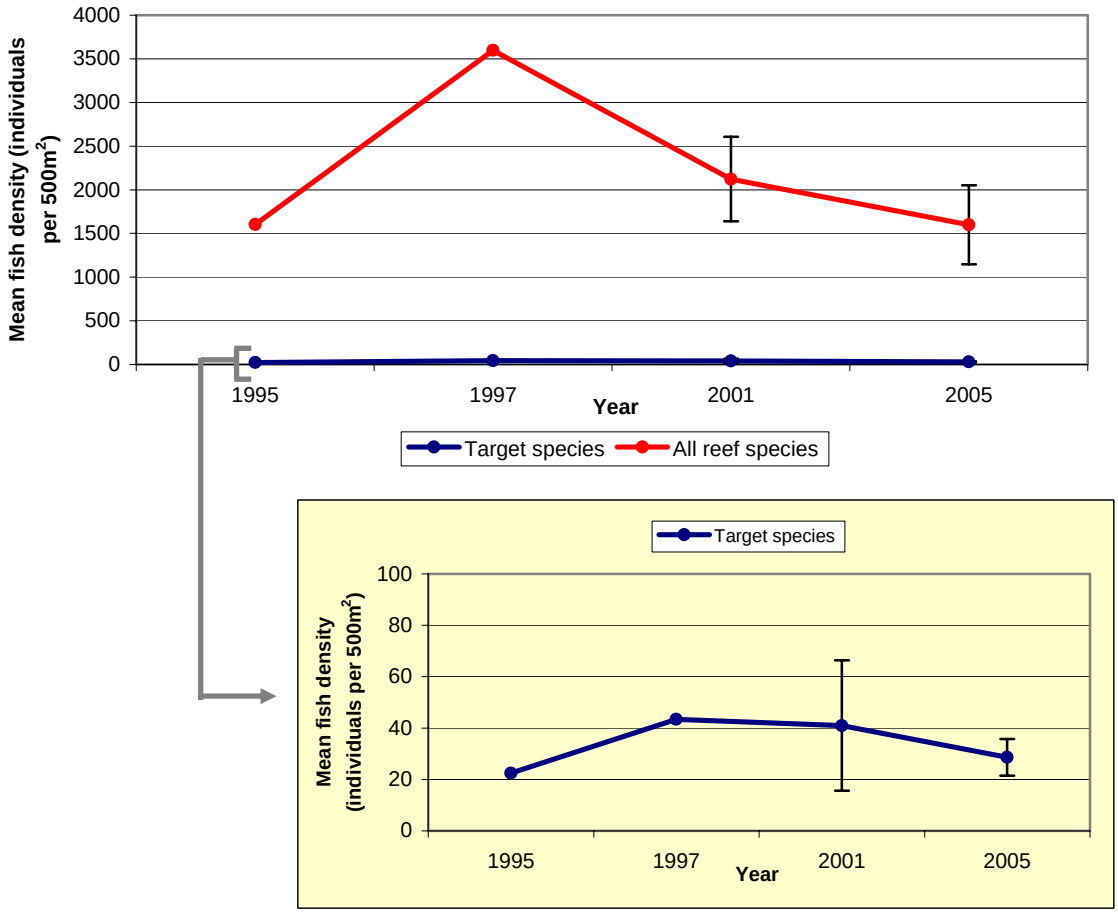


Figure 26. Mean (±SE) density (individuals/500m^2) at White Sand Reef from 1995 to 2005.

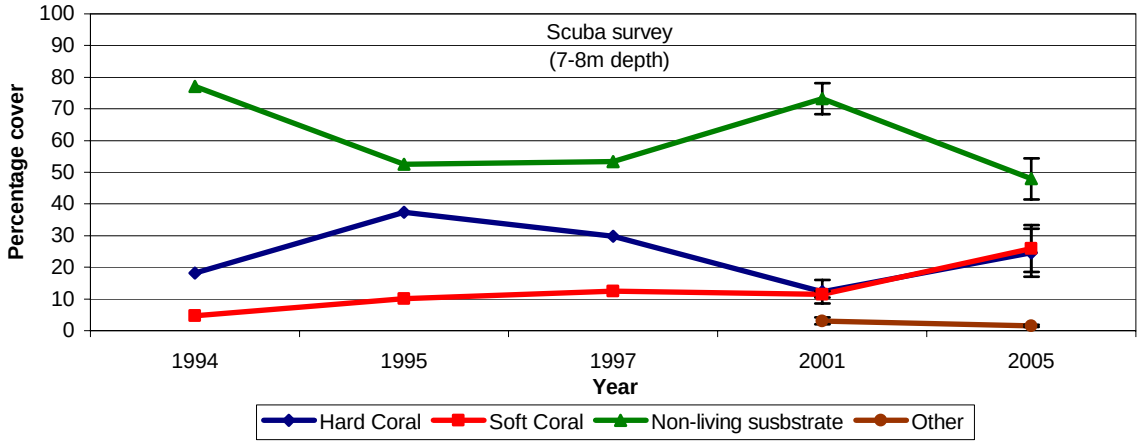


This reef is heavily used for recreation and sedimentation is also observed. Nevertheless, the shallow reef is generally improving with much new growth of Acropora corals.

White House Reef

This site is adjacent to the White Sand Reef fronting the "White-house." Coral cover is poor (24.6 ± 7.6), and much of the coral damage recorded in 2001 was due to Crown-of-thorns starfish infestation and freshwater run-off in the previous years (White *et al.* 2001).

Figure 27. Changes in substrate composition (%mean ±SE) at White House Reef from 1994 to 2005.



Fish diversity, abundance and biomass are comparably low to White Sand Reef. Target fish species are especially rare. Sedimentation was also observed in the area. Placement of an anchor buoy in this reef may prevent further physical damage.

Figure 28. Mean (±SE) number of species/500m^2 at White House Reef from 2001 to 2005.

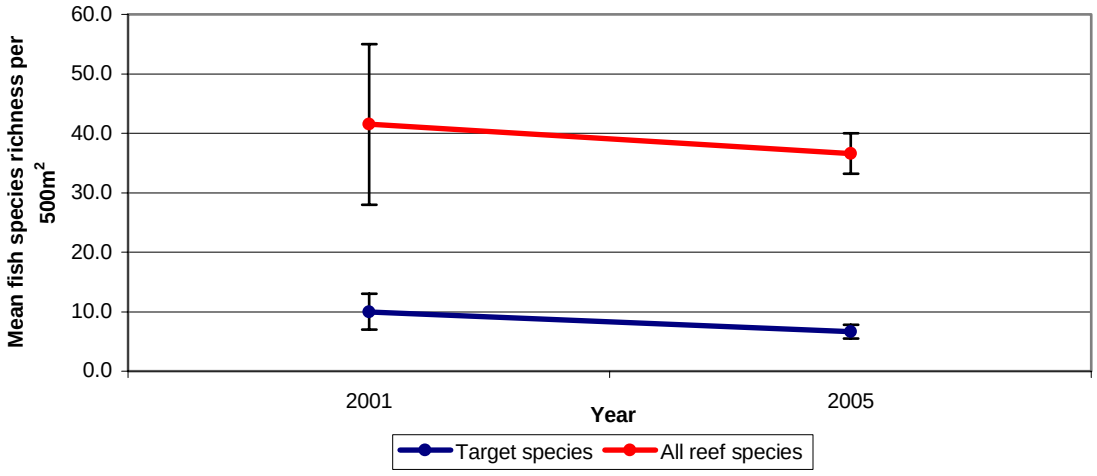
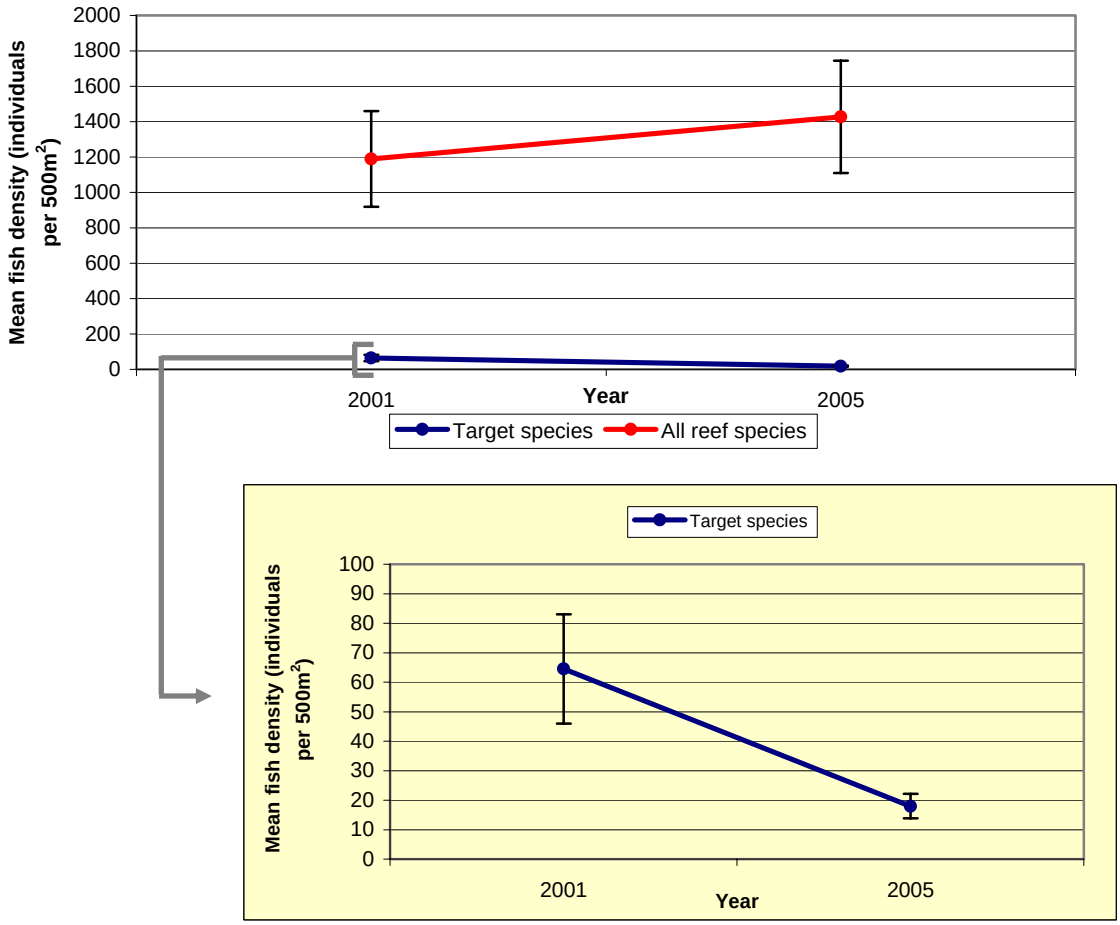


Figure 29. Mean (±SE) density (individuals/500m^2) at White House Reef from 2001 to 2005.

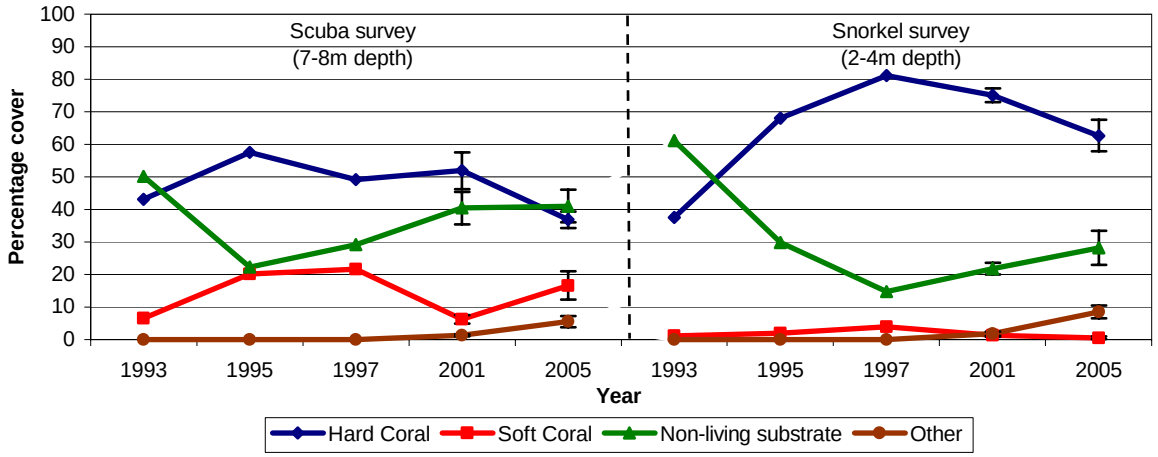


Sepoc Point Reef

Live hard coral cover in Sepoc Point Reef is good (62.7 ± 4.8%) in the shallow and fair (36.8 ± 2.5%) in the deeper area (Table 34, Fig 30). Both shallow and deep coral covers significantly decreased ($p \leq 0.001$, Table 46) from 2001 to 2005. This reef is a popular diving location and physical damage from anchor buoys were observed in the deeper area.

Despite the healthy live hard coral in the area, fish diversity density and biomass of all species and target fish is low (Table 35, Fig 28 & 29) which may be a reflection of heavy fishing pressure. The proximity of this site to the village of Tingloy makes it very a very accessible fishing ground. Large wrasses were observed to be also absent in the site. Further, both butterfly fish diversity and abundance in the year 2005 appeared to be lower compared to 2001 (Table 2 & 35). Among the numerically abundant fish are the Anthids and Pomacentrids.

Figure 30. Changes in substrate composition (%mean ±SE) at Sepoc Point from 1993 to 2005.



Sepoc reef is a healthy reef in terms of live hard coral cover, but desperately needs management to prevent degradation. It is both used heavily for recreation and fishing. Fragile branching corals comprise 19 to 48% of the substrate of the area, thus additional anchor buoys are urgently needed in the area. The shallow reef was also infested with hundreds of Crown-of-Thorns seastars. Many dive boats were observed to drop their anchors on branching corals and compound the damage they have created by dragging these anchors. Dive resorts staff, boat operators and tourists divers in the area need to be aware and educated on coastal resource management.

Figure 31. Mean (±SE) number of species/500m^2 at Sepoc Point from 1993 to 2005.

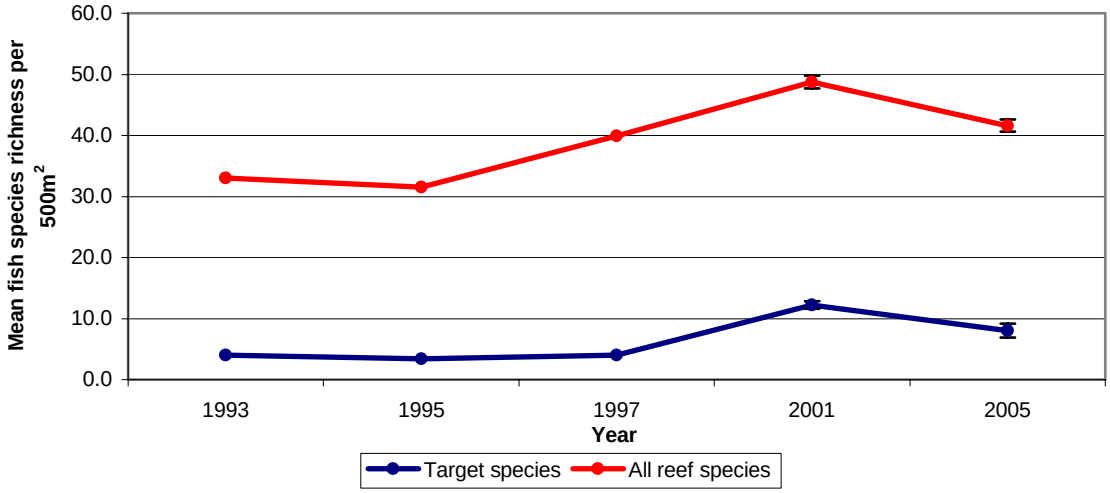


Figure 32. Mean (±SE) density (fish/500m^2) at Sepoc Point from 1993 to 2005.

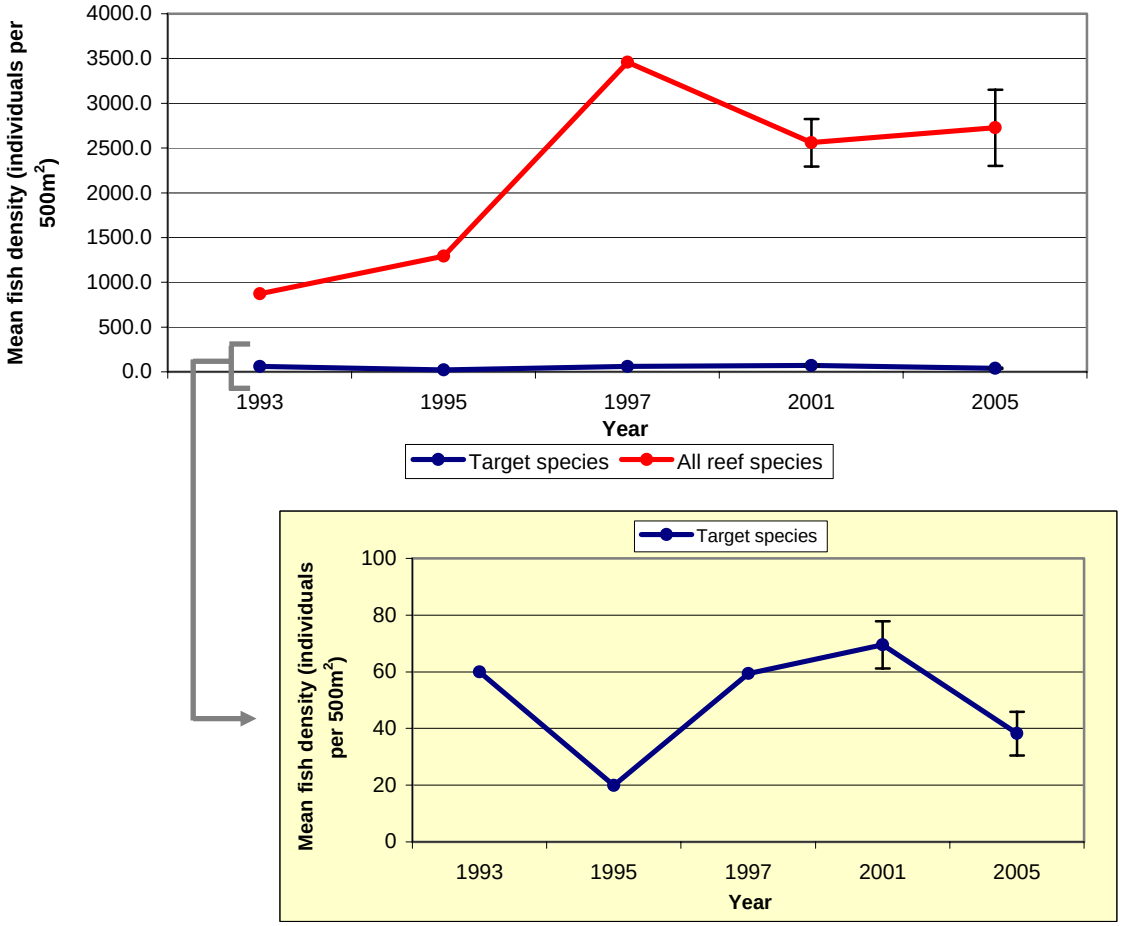


Table 1. Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2005.

	SCUBA SURVEYS:						SNORKEL SURVEYS:					
	1993	1995	1997	2001	2005	% Change 2001-2005	1993	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
SUBSTRATE COVER												
Sand (S) & silt (SI)	13.6	6.6	18.8	12.3	20.3	64.1	25.4	6.5	9.3	3.2	4.4	35.4
Coral rubble (R)	18.3	31.9	23.0	16.4	16.6	1.6	11.7	9.0	9.3	5.2	6.4	24.4
Rock & block (RCK)	7.4	1.9	5.0	8.2	4.1	-50.2	14.6	7.6	9.7	16.0	15.2	-5.2
White dead standing coral (DA)	2.7	0.3	3.8	0.2	0.4	141.6	2.0	0.3	4.6	1.0	1.3	28.7
Dead coral with algae (DCA)	~	~	~	9.5	2.9	-69.6	~	~	0.0	8.2	3.8	-53.8
Subtotal non-living substrate	***42.0***	***40.7***	***50.6***	***46.5***	***44.3***	-4.9	***53.7***	***23.4***	***32.8***	***33.6***	**31.1**	-7.6
Branching (CB)	5.5	11.5	7.1	5.6	4.3	-24.7	12.2	39.9	27.1	34.4	23.0	-33.2
Massive (CM)	10.1	15.4	11.1	16.6	13.5	-18.7	10.8	11.9	15.1	13.2	16.6	25.5
Flat/Encrusting (CE)	7.5	5.4	4.8	4.3	8.1	90.6	5.9	5.3	9.0	5.7	8.1	41.2
Foliose/Cup (CF)	3.5	1.7	6.2	8.1	3.4	-58.6	2.2	3.0	3.6	8.4	15.7	86.7
Total Hard Coral	**26.6**	**34.0**	**29.1**	**34.6**	**29.3**	-15.6	**31.1**	**60.1**	**54.8**	**61.7**	**63.3**	2.5
Total Soft Coral	**31.4**	**25.3**	**20.3**	**17.5**	**24.6**	40.7	**15.1**	**16.5**	**12.3**	**3.6**	**4.5**	23.5
Subtotal Coral	***58.0***	***59.3***	***49.4***	***52.2***	***53.9***	3.3	***46.2***	***76.6***	***67.2***	***65.3***	**67.7**	3.7
Sponges (SP)	~	~	~	1.4	0.5	-64.3	~	~	~	1.0	0.1	-85.8
Other animals (OT)	~	~	~	~	0.8	N/A	~	~	~	~	0.3	N/A
Algae												
Fleshy (MA)	~	~	~	0.6	0.1	-77.4	~	~	~	0.6	0.2	-63.9
Turf (TA)	~	~	~	0.3	0.3	15.6	~	~	~	0.3	0.3	-25.5
Coralline (CA)	~	~	~	0.1	0.1	15.6	~	~	~	0.0	0.3	+
Seagrass (SG)	~	~	~	~	0.0	N/A	~	~	~	~	0.0	N/A
Subtotal Others	**~**	**~**	**~**	***2.3***	***1.9***	-19.6	**~**	**~**	**~**	***2.0***	**1.2**	-38.8
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters												
Mean Slope (degrees)	**~**	**~**	12	5.5	5.0	-9.1	~	~	9	3	5.2	73.3
Mean Topography (m)*	**~**	**~**	1.5	1.6	0.8	-47.9	~	~	1.5	1.8	2.0	11.1
Mean Depth/Range (m)	7-8	6-9	6-8	6.3	7.3	15.1	3-4	2-4	3-4	3.5	2.6	-25.4
Horizontal Visibility (m)	15	15	15	15.5	13.6	-12.1	12	14	15	17.9	13.9	-22.3
No. of 50 m Transects	3	5	11	37	8.0		80[a]	80[a]	190[a]	210[a]	12.0	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 2. Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2005.

Butterflyfish species	Common name	ARTHUR'S ROCK SANCTUARY							TWIN ROCKS SANCTUARY						
		1991	1992	1993	1995	1997	2001	2005	1991	1992	1993	1995	1997	2001	2005
Chaetodon adiergastos	Philippine butterflyfish	S	O	W	X		Z			O					A
Chaetodon auriga	Threadfin butterflyfish	S	O	W	X	Y	Z	A				X	Y	Z	
Chaetodon baronessa	Eastern triangular butterflyfish	S	O	W	X		Z	A	S	O	W	X	Y	Z	A
Chaetodon citrinellus	Speckled butterflyfish	S	O	W	X	Y	Z	A	S						
Chaetodon ephippium	Saddle butterflyfish							A							
Chaetodon kleinii	Klein's butterflyfish	S	O	W	X	Y	Z	A	S	O	W	X	Y	Z	A
Chaetodon lineolatus	Lined butterflyfish						Z							Z	A
Chaetodon lunula	Raccoon butterflyfish	S	O	W	X	Y	Z	A	S	O		X	Y	Z	A
Chaetodon lunulatus	Pacific redfin butterflyfish	S	O	W	X	Y	Z	A	S		W	X	Y	Z	A
Chaetodon melannotus	Blackback butterflyfish	S	O	W	X	Y	Z	A		O	W		Y	Z	A
Chaetodon mertensii	Merten's butterflyfish	S	O	W			Z			O					
Chaetodon ocellicaudus	Spottail butterflyfish				X	Y	Z	A				X		Z	A
Chaetodon octofasciatus	Eightband butterflyfish	S	O	W	X	Y	Z	A		O	W	X	Y	Z	A
Chaetodon ornatissimus	Ornate butterflyfish					Y	Z	A							
Chaetodon oxycephalus	Spot-nape butterflyfish						Z	A						Z	A
Chaetodon plebeius	Blueblotch butterflyfish	S	O		X	Y	Z								
Chaetodon punctatofasciatus	Spotband butterflyfish	S	O	W	X	Y	Z	A		O	W		Y	Z	A
Chaetodon rafflesi	Latticed butterflyfish	S	O	W	X	Y	Z	A			W			Z	A
Chaetodon selene	Yellowdotted butterflyfish	S	O	W	X	Y	Z		S	O	W		Y	Z	A
Chaetodon speculum	Mirror butterflyfish	S	O	W	X	Y	Z	A						Z	A
Chaetodon trifascialis	Chevron butterflyfish	S	O	W	X	Y	Z	A	S	O	W		Y	Z	A
Chaetodon unimaculatus	Teardrop butterflyfish	S	O	W	X	Y	Z	A							
Chaetodon vagabundus	Vagabond butterflyfish	S	O	W	X	Y	Z	A	S		W	X	Y	Z	A
Chaetodon xanthurus	Pearscale butterflyfish			W	X	Y	Z	A			W	X	Y	Z	A
Forcipiger flavisimmus	Forcepsfish	S	O	W	X	Y	Z	A		O	W	X	Y	Z	A
Forcipiger longirostris	Longnose butterflyfish						Z								A
Hemitaurichthys polylepis	Pyramid butterflyfish	S													
Heniochus acuminatus	Pennant coralfish						Z			O			Y	Z	A
Heniochus chrysostomus	Threeband penantfish	S	O	W	X	Y	Z				W	X	Y	Z	
Heniochus singularius	Singular bannerfish	S	O		X			A						Z	A
Heniochus varius	Horned bannerfish	S	O	W	X	Y	Z	A	S	O	W	X	Y	Z	A
Coradion chrysozonus	Goldengirdled coralfish						Z								
Total number or species/site		**23**	**22**	**21**	**23**	**22**	**29**	**22**	**8**	**13**	**14**	**12**	**16**	**22**	**22**

Total number of species observed in all sites surveyed in 1991: 24
Total number of species observed in all sites surveyed in 1992: 22
Total number of species observed in all sites surveyed in 1993: 25
Total number of species observed in all sites surveyed in 1995: 26
Total number of species observed in all sites surveyed in 1997: 27
Total number of species observed in all sites surveyed in 2001: 31
Total number of species observed in all sites surveyed in 2005: 32

Table 2. Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2005.

Butterflyfish species	Common name	CATHEDRAL ROCK					CATHEDRAL REEF		BATALANG BATO/PULANG-BULI REEF						WHITE HOUSE
		1991	1993	1995	2001	2005	2001	2005	1991	1993	1995	1997	2001	2005	2005
Chaetodon adiergastos	Philippine butterflyfish				Z		Z	A			X	Y	Z	A	
Chaetodon auriga	Threadfin butterflyfish	S			Z			A			X			A	
Chaetodon baronessa	Eastern triangular butterflyfish	S	W	X	Z		Z	A	S	W	X	Y	Z	A	A
Chaetodon citrinellus	Speckled butterflyfish											Y		A	
Chaetodon ephippium	Saddle butterflyfish														
Chaetodon kleinii	Klein's butterflyfish	S	W	X	Z	A	Z	A	S	W	X	Y	Z	A	A
Chaetodon lineolatus	Lined butterflyfish							A						A	
Chaetodon lunula	Raccoon butterflyfish		W		Z		Z	A	S			Y	Z	A	A
Chaetodon lunulatus	Pacific redfin butterflyfish	S		X	Z		Z	A		W	X			A	A
Chaetodon melannotus	Blackback butterflyfish	S							S	W	X	Y			A
Chaetodon mertensii	Merten's butterflyfish	S			Z				S						
Chaetodon ocellicaudus	Spottail butterflyfish				Z			A				Y		A	A
Chaetodon octofasciatus	Eightband butterflyfish									W		Y			A
Chaetodon ornatissimus	Ornate butterflyfish				Z		Z								
Chaetodon oxycephalus	Spot-nape butterflyfish														
Chaetodon plebeius	Blueblotch butterflyfish														
Chaetodon punctatofasciatus	Spotband butterflyfish	S	W	X	Z		Z	A			X		Z	A	
Chaetodon rafflesi	Latticed butterflyfish				Z		Z	A				Y	Z	A	A
Chaetodon selene	Yellowdotted butterflyfish		W	X	Z	A	Z	A					Z	A	
Chaetodon speculum	Mirror butterflyfish							A			X	Y	Z	A	A
Chaetodon trifascialis	Chevron butterflyfish	S					Z	A		W	X		Z	A	A
Chaetodon unimaculatus	Teardrop butterflyfish						Z	A			X	Y	Z	A	
Chaetodon vagabundus	Vagabond butterflyfish		W	X	Z		Z	A	S	W	X	Y	Z	A	A
Chaetodon xanthurus	Pearscale butterflyfish		W	X	Z		Z	A							
Forcipiger flavisimmus	Forcepsfish	S	W	X	Z	A	Z	A	S				Z	A	
Forcipiger longirostris	Longnose butterflyfish				Z	A	Z	A						A	
Hemitaurichthys polylepis	Pyramid butterflyfish	S	W	X	Z	A		A							
Heniochus acuminatus	Pennant coralfish	S			Z			A					Z		
Heniochus chrysostomus	Threeband penantfish						Z		S	W			Z	A	A
Heniochus singularius	Singular bannerfish						Z							A	
Heniochus varius	Horned bannerfish	S	W		Z		Z	A					Z	A	
Coradion chrysozonus	Goldengirdled coralfish							A							
Total number or species/site		**12**	**10**	**9**	**19**	**5**	**18**	**22**	**8**	**8**	**11**	**12**	**15**	**21**	**12**

Total number of species observed in all sites surveyed in 1991: 24
Total number of species observed in all sites surveyed in 1992: 22
Total number of species observed in all sites surveyed in 1993: 25
Total number of species observed in all sites surveyed in 1995: 26
Total number of species observed in all sites surveyed in 1997: 27
Total number of species observed in all sites surveyed in 2001: 31
Total number of species observed in all sites surveyed in 2005: 32

Table 2. Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2005.

Butterflyfish species	Common name	WHITE SAND REEF						LAYAG-LAYAG REEF					
		1991	1993	1995	1997	2001	2005	1991	1993	1995	1997	2001	2005
Chaetodon adiergastos	Philippine butterflyfish							S					A
Chaetodon auriga	Threadfin butterflyfish	S		X	Y				w	X	Y		A
Chaetodon baronessa	Eastern triangular butterflyfish	S	w	X	Y	Z	A	S	w	X	Y	Z	A
Chaetodon citrinellus	Speckled butterflyfish			X	Y			S	w				A
Chaetodon ephippium	Saddle butterflyfish												
Chaetodon kleinii	Klein's butterflyfish	S	w	X	Y	Z	A	S	w	X	Y	Z	A
Chaetodon lineolatus	Lined butterflyfish				Y								
Chaetodon lunula	Raccoon butterflyfish				Y					X	Y		
Chaetodon lunulatus	Pacific redfin butterflyfish		w	X	Y	Z	A	S	w	X	Y	Z	A
Chaetodon melannotus	Blackback butterflyfish	S			Y	Z	A	S	w	X			A
Chaetodon mertensii	Merten's butterflyfish							S					
Chaetodon ocellicaudus	Spottail butterflyfish				Y	Z			w	X		Z	A
Chaetodon octofasciatus	Eightband butterflyfish	S	w	X	Y	Z	A		w		Y		
Chaetodon ornatissimus	Ornate butterflyfish		W										
Chaetodon oxycephalus	Spot-nape butterflyfish												
Chaetodon plebeius	Blueblotch butterflyfish									X			
Chaetodon punctatofasciatus	Spotband butterflyfish		w	X	Y	Z	A	S	w	X	Y	Z	A
Chaetodon rafflesi	Latticed butterflyfish	S		X	Y		A	S					A
Chaetodon selene	Yellowdotted butterflyfish		w			Z			w	X		Z	A
Chaetodon speculum	Mirror butterflyfish				Y	Z			w	X		Z	A
Chaetodon trifascialis	Chevron butterflyfish			X	Y		A	S	w	X	Y	Z	
Chaetodon unimaculatus	Teardrop butterflyfish		w		Y	Z		S					A
Chaetodon vagabundus	Vagabond butterflyfish	S		X	Y	Z			w	X	Y	Z	A
Chaetodon xanthurus	Pearscale butterflyfish		W	X	Y				w	X	Y		A
Forcipiger flavisimmus	Forcepsfish		w	X	Y	Z	A	S		X		Z	A
Forcipiger longirostris	Longnose butterflyfish						A						
Hemitaurichthys polylepis	Pyramid butterflyfish												
Heniochus acuminatus	Pennant coralfish										Y		
Heniochus chrysostomus	Threeband penantfish							S	w		Y	Z	A
Heniochus singularius	Singular bannerfish				Y								
Heniochus varius	Horned bannerfish	S	w	X	Y	Z		S	w	X	Y	Z	A
Coradion chrysozonus	Goldengirdled coralfish											1	
Total number or species/site		**8**	**11**	**14**	**20**	**14**	**10**	**14**	**16**	**16**	**13**	**13**	**18**

Total number of species observed in all sites surveyed in 1991: 24
Total number of species observed in all sites surveyed in 1992: 22
Total number of species observed in all sites surveyed in 1993: 25
Total number of species observed in all sites surveyed in 1995: 26
Total number of species observed in all sites surveyed in 1997: 27
Total number of species observed in all sites surveyed in 2001: 31
Total number of species observed in all sites surveyed in 2005: 32

Table 2. Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2005.

Butterflyfish species	Common name	SOMBRERO ISLAND						SEPOC POINT				
		1991	1993	1995	1997	2001	2005	1993	1995	1997	2001	2005
Chaetodon adiergastos	Philippine butterflyfish				Y	Z	A	W	X		Z	
Chaetodon auriga	Threadfin butterflyfish						A			Y	Z	
Chaetodon baronessa	Eastern triangular butterflyfish	S	W	X	Y	Z	A	W	X	Y	Z	A
Chaetodon citrinellus	Speckled butterflyfish					Z	A	W	X	Y		
Chaetodon ephippium	Saddle butterflyfish											
Chaetodon kleinii	Klein's butterflyfish	S	W	X	Y	Z	A	W	X	Y	Z	A
Chaetodon lineolatus	Lined butterflyfish			X						Y		A
Chaetodon lunula	Raccoon butterflyfish						A			Y	Z	
Chaetodon lunulatus	Pacific redfin butterflyfish		W	X	Y	Z	A	W	X	Y	Z	A
Chaetodon melannotus	Blackback butterflyfish					Z	A	W	X	Y	Z	A
Chaetodon mertensii	Merten's butterflyfish	S				Z						A
Chaetodon ocellicaudus	Spottail butterflyfish			X	Y		A		X	Y		A
Chaetodon octofasciatus	Eightband butterflyfish				Y			W		Y		
Chaetodon ornatissimus	Ornate butterflyfish						A					A
Chaetodon oxycephalus	Spot-nape butterflyfish											
Chaetodon plebeius	Blueblotch butterflyfish				Y	Z	A	W		Y		
Chaetodon punctatofasciatus	Spotband butterflyfish	S	W	X	Y	Z	A	W	X	Y	Z	A
Chaetodon rafflesi	Latticed butterflyfish					Z	A			Y	Z	A
Chaetodon selene	Yellowdotted butterflyfish		W		Y	Z		W	X		Z	A
Chaetodon speculum	Mirror butterflyfish			X	Y		A			Y	Z	
Chaetodon trifascialis	Chevron butterflyfish		W	X	Y	Z	A	W	X	Y	Z	A
Chaetodon unimaculatus	Teardrop butterflyfish				Y	Z	A			Y	Z	A
Chaetodon vagabundus	Vagabond butterflyfish					Z	A	W	X	Y	Z	A
Chaetodon xanthurus	Pearscale butterflyfish						A		X	Y		A
Forcipiger flavisimmus	Forcepsfish						A	W	X	Y	Z	A
Forcipiger longirostris	Longnose butterflyfish						A					
Hemitaurichthys polylepis	Pyramid butterflyfish				Y		A					
Heniochus acuminatus	Pennant coralfish					Z			X			A
Heniochus chrysostomus	Threeband penantfish	S				Z	A	W	X	Y	Z	A
Heniochus singularius	Singular bannerfish											
Heniochus varius	Horned bannerfish	S		X	Y	Z	A	W	X	Y	Z	A
Coradion chrysozonus	Goldengirdled coralfish											
Total number or species/site		**6**	**6**	**9**	**14**	**17**	**23**	**16**	**16**	**21**	**17**	**19**

Total number of species observed in all sites surveyed in 1991: 24
Total number of species observed in all sites surveyed in 1992: 22
Total number of species observed in all sites surveyed in 1993: 25
Total number of species observed in all sites surveyed in 1995: 26
Total number of species observed in all sites surveyed in 1997: 27
Total number of species observed in all sites surveyed in 2001: 31
Total number of species observed in all sites surveyed in 2005: 32

Table 3. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Arthur's Rock Sanctuary in 20

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.0	0.4	4.3	7.3	3.0	0.0	14.5	1.9
Rabbitfish (Siganids)*	0.3	0.3	0.5	0.0	0.0	0.0	0.5	0.5
Groupers (Serranids)*	0.3	0.3	0.0	0.3	0.0	0.0	0.3	0.3
Barramundi cod; senorita	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.8	0.5	0.0	0.3	0.3	0.3	0.8	0.5
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.3	0.3	0.0	0.3	0.0	0.0	0.3	0.3
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.3	0.3	0.0	25.0	0.0	0.0	25.0	25.0
Spinecheeks (Nemipterids)*	1.8	0.5	0.3	3.5	0.3	0.0	4.0	2.3
Goatfish (Mullids)*	1.0	0.4	0.5	0.5	0.0	0.0	1.0	0.4
Parrotfish (Scarids)*	1.8	0.6	0.0	0.5	0.8	1.5	2.8	1.3
Bumphead parrotfish; taungan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.8	0.5	0.3	0.5	0.0	0.0	0.8	0.5
Butterflyfish (Chaetodonids)	5.8	0.8	14.0	3.5	0.0	0.0	17.5	2.9
Angelfish (Pomacanthids)	2.0	0.4	3.3	0.3	0.0	0.0	3.5	1.3
Wrasses (Labrids)	7.8	1.0	204.5	0.0	0.0	0.0	204.5	50.4
Humphead wrasse; ameng	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	17.8	2.5	1462.5	0.0	0.0	0.0	1462.5	471.2
Fairy Basslets (Anthids)	1.5	0.3	1450.0	0.0	0.0	0.0	1450.0	719.7
Moorish Idols (Zanclids)	0.3	0.3	0.5	0.0	0.0	0.0	0.5	0.5
Total (target reef species)*	**9.3**	**1.4**	**1.3**	**37.5**	**4.3**	**1.8**	**44.8**	**26.8**
Total (all reef species)	**45.0**	**5.6**	**3140.5**	**41.8**	**4.3**	**1.8**	**3188.3**	**1211.2**

* Target species/families

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

Table 4. Mean (±SE) fish species (species/500m^2) and percentage change between years in Arthur's Rock Sanctuary from 1991 to 2005

FAMILY	(N=4) 1991	(N=3) 1992	(N=3) 1993	(N=5) 1995	(N=5) 1997	(N=6) 2001	(N=4) 2005	% Change 2001-2005
	species		species	species	species	species	species	
Surgeonfish (Acanthurids)*	4.5	3.0	3.7	3.2	3.4	5.8	3.0	-48.6
Rabbitfish (Siganids)*	0.5	0.0	0.0	0.4	0.2	0.5	0.3	-50.0
Groupers (Serranids)*	2.3	2.0	2.3	1.2	2.2	1.5	0.3	-83.3
Barramundi cod	~	~	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.8	0.7	0.7	1.0	0.6	1.7	0.8	-55.0
Sweetlips (Haemulids)*	0.3	0.0	0.3	0.0	0.0	0.5	0.0	-100.0
Emperors (Lethrinids)*	0.3	0.7	0.7	0.0	0.4	0.5	0.3	-50.0
Jacks (Carangids)*	0.3	0.3	0.3	0.0	0.2	0.5	0.0	-100.0
Fusiliers (Caesionids)*	1.0	1.3	1.3	0.2	0.2	1.0	0.3	-75.0
Spinecheeks (Nemipterids)*	1.0	1.0	1.0	1.0	1.2	1.5	1.8	16.7
Goatfish (Mullids)*	1.0	0.7	1.0	1.0	1.0	1.5	1.0	-33.3
Parrotfish (Scarids)*	1.0	0.7	1.0	1.0	1.0	1.7	1.8	5.0
Bumphead parrotfish	~	~	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	2.0	1.3	1.3	1.0	1.0	1.5	0.8	-50.0
Butterflyfish (Chaetodonids)	11.0	9.0	10.0	8.2	9.0	10.5	5.8	-45.2
Angelfish (Pomacanthids)	3.8	1.7	2.3	2.0	2.2	3.2	2.0	-36.8
Wrasses (Labrids)	7.0	3.3	5.0	6.8	6.0	6.0	7.8	29.2
Humphead wrasse	~	~	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	12.5	12.7	12.3	13.8	13.4	15.2	17.8	17.0
Fairy Basslets (Anthids)	1.8	2.0	1.3	2.0	1.8	1.5	1.5	0.0
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	1.0	1.0	0.3	-75.0
Total (target reef species)*	**8.5**	**7.4**	**8.6**	**5.8**	**7.0**	**16.7**	**9.3**	-44.5
Total (all reef species)	**52.1**	**41.4**	**45.5**	**43.8**	**44.8**	**55.5**	**45.0**	-18.9

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1991 to 1997, surgeonfish not included as a target species

Table 5. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years in Arthur's Rock Sanctuary from 1991 to 2005.

FAMILY	(N=4) 1991 Density	(N=3) 1992	(N=3) 1993 Density	(N=5) 1995 Density	(N=5) 1997 Density	(N=6) 2001 Density	(N=4) 2005 Density	% Change 2001-2005
Surgeonfish (Acanthurids)*	132.0	67.0	58.3	55.0	49.8	116.5	14.5	-87.6
Rabbitfish (Siganids)*	1.0	0.0	0.0	1.2	6.6	0.8	0.5	-40.0
Groupers (Serranids)*	3.0	3.7	6.0	1.4	3.4	2.5	0.3	-90.0
Barramundi cod	~	~	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	3.3	1.0	1.4	7.4	4.7	0.8	-83.9
Sweetlips (Haemulids)*	0.0	0.0	0.3	0.0	0.0	0.8	0.0	-100.0
Emperors (Lethrinids)*	2.0	6.0	1.3	0.0	0.6	2.0	0.3	-87.5
Jacks (Carangids)*	2.0	0.3	11.0	0.0	0.2	5.8	0.0	-100.0
Fusiliers (Caesionids)*	27.0	34.0	68.0	1.8	25.8	37.0	25.0	-32.4
Spinecheeks (Nemipterids)*	15.0	15.0	5.0	3.8	2.4	7.5	4.0	-46.7
Goatfish (Mullids)*	21.0	4.0	7.0	3.2	7.8	10.7	1.0	-90.6
Parrotfish (Scarids)*	51.0	14.0	17.0	18.6	12.6	10.7	2.8	-74.2
Bumphead parrotfish	~	~	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	15.0	5.3	7.3	8.8	15.0	7.8	0.8	-90.4
Butterflyfish (Chaetodonids)	51.0	32.7	35.7	27.0	29.4	42.8	17.5	-59.1
Angelfish (Pomacanthids)	75.0	27.0	31.6	8.6	15.0	17.3	3.5	-79.8
Wrasses (Labrids)	97.0	28.7	129.0	161.4	160.4	218.8	204.5	-6.5
Humphead wrasse	~	~	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	887.0	837.3	811.3	750.0	1091.2	1123.7	1462.5	30.2
Fairy Basslets (Anthids)	538.0	218.0	268.0	573.0	347.6	340.7	1450.0	325.6
Moorish Idols (Zanclids)	21.0	7.0	9.0	16.0	11.4	7.8	0.5	-93.6
Total (target reef species)*	**123.0**	**80.3**	**116.6**	**31.4**	**66.8**	**145.0**	**44.8**	-69.1
Total (all reef species)	**1939.0**	**1303.3**	**1466.8**	**1631.2**	**1786.6**	**1958.0**	**3188.3**	62.8

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 100

(-) = decrease

(+) = increase

From 1991 to 1997, surgeonfish not included as a target species

Table 6. Changes in substrate composition (% mean ±SE) in Twin Rocks Sanctuary from 1993 to 2005.

	SCUBA SURVEYS:						SNORKEL SURVEYS:					
	1993	1995	1997	2001	2005	% Change 2001-2005	1993	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
SUBSTRATE COVER												
Sand (S) & Silt (SI)	54.3	12.8	27.6	34.2	26.3	-23.0	32.1	21.5	22.0	9.8	5.5	-44.3
Coral Rubble (R)	11.4	28.3	21.5	14.0	20.1	43.9	3.5	5.8	2.4	2.9	4.2	42.6
Rock & Block (RCK)	11.8	10.2	14.2	6.8	6.0	-11.2	15.9	14.5	16.3	13.8	7.4	-45.9
White Dead Standing Coral (DA)	2.1	1.1	2.2	0.1	0.2	207.7	0.1	1.6	2.4	1.1	1.0	-12.3
Dead Coral with Algae (DCA)	~	~	~	7.6	4.6	-39.6	~	~	~	7.7	6.7	-13.1
Subtotal Non-living Substrate	***79.6***	***52.4***	***65.4***	***62.6***	***57.3***	-8.6	***51.6***	***43.4***	***43.1***	***35.3***	***24.7***	-29.9
Branching (CB)	2.8	7.4	4.4	9.4	7.5	-19.8	17.6	21.7	22.4	31.9	41.2	29.0
Massive (CM)	4.2	8.7	10.5	15.3	7.8	-48.9	18.3	17.6	19.3	20.6	15.7	-23.8
Flat/Encrusting (CE)	5.0	12.5	7.6	3.9	7.8	97.9	1.0	3.6	4.9	3.5	2.8	-21.2
Foliose/Cup (CF)	0.9	2.7	1.5	2.1	2.9	39.0	2.1	2.3	2.2	1.8	6.4	249.2
Total Hard Coral	**12.9**	**31.3**	**24.0**	**30.7**	**26.0**	-15.2	**39.0**	**45.2**	**48.9**	**57.8**	**66.0**	14.1
Total Soft Coral	**9.5**	**16.3**	**10.5**	**5.1**	**7.1**	39.4	**9.7**	**11.4**	**8.0**	**3.3**	**3.6**	6.2
Subtotal Coral	***22.4***	***47.6***	***34.6***	***35.8***	***33.1***	-7.5	***48.7***	***56.6***	***56.9***	***61.2***	***69.5***	13.7
Sponges (SP)	~	~	~	0.7	1.9	174.7	~	~	~	0.7	2.2	211.2
Other animals (OT)	~	~	~	~	4.7	N/A	~	~	~	~	0.8	N/A
Algae												
Fleshy (MA)	~	~	~	0.6	0.5	-9.1	~	~	~	1.7	1.7	-4.2
Turf (TA)	~	~	~	0.2	1.8	686.3	~	~	~	0.8	0.4	-44.4
Coralline (CA)	~	~	~	0.1	0.8	515.4	~	~	~	0.4	0.7	82.8
Seagrass (SG)	~	~	~	0.7	0.0	-100.0	~	~	~	~	0.0	N/A
Subtotal Others	**~**	**~**	**~**	***2.3***	***9.7***	315.2	**~**	**~**	**~**	***3.6***	***5.8***	61.0
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters												
Mean Slope (degrees)	**~**	**~**	14	17.0	34.2	101.0	~	~	15	6.0	18.3	205.6
Mean Topography (m)*	**~**	**~**	1.8	1.4	1.4	-1.8	~	~	1.0	1.3	1.4	5.8
Mean Depth/Range (m)	7-8	7-8	6-9	6.2	6.6	6.7	3-4	2-4	2-4	2.6	3.0	13.8
Horizontal Visibility (m)	16	15	13	13.5	15.2	12.8	14	13	10	13.7	11.0	-19.7
No. of 50 m Transects	4	3	10	20	13.0	-35.0	60[a]	60[a]	210[a]	405[a]	14.0	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 7. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Twin Rocks Sanctuary in 2005

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	4.6	0.6	1.6	6.0	3.6	6.2	17.4	4.3
Rabbitfish (Siganids)*	2.0	0.5	0.0	3.8	2.0	0.4	6.2	2.8
Groupers (Serranids)*	2.6	0.5	1.0	1.8	1.0	0.4	4.2	1.6
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	2.6	0.4	0.0	3.0	4.0	5.2	12.2	3.0
Sweetlips (Haemulids)*	1.2	0.7	0.0	0.0	1.0	0.2	1.2	0.7
Emperors (Lethrinids)*	0.6	0.2	0.0	0.4	0.2	0.2	0.8	0.4
Jacks (Carangids)*	0.2	0.2	0.0	0.0	0.2	0.0	0.2	0.2
Fusiliers (Caesionids)*	0.6	0.2	0.0	78.0	0.0	0.0	78.0	68.2
Spinecheeks (Nemipterids)*	2.0	0.0	0.0	3.6	0.8	0.0	4.4	0.7
Goatfish (Mullids)*	1.0	0.4	0.0	0.6	0.6	0.0	1.2	0.6
Parrotfish (Scarids)*	3.2	1.0	0.0	2.6	2.2	1.8	6.6	2.2
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	1.2	0.4	0.0	1.4	0.0	0.0	1.4	0.4
Butterflyfish (Chaetodonids)	5.6	0.8	14.6	0.0	0.0	0.0	14.6	2.9
Angelfish (Pomacanthids)	2.6	0.5	7.4	0.0	0.0	0.2	7.6	2.4
Wrasses (Labrids)	10.2	2.4	255.2	0.0	0.0	0.0	255.2	116.8
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	18.2	1.5	2267.6	0.0	0.0	0.0	2267.6	1028.8
Fairy Basslets (Anthids)	1.6	0.2	2844.0	0.0	0.0	0.0	2844.0	587.1
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	2.2	0.0	0.0	0.0	2.2	0.6
Total (target reef species)*	**20.6**	**2.4**	**1.0**	**99.8**	**15.6**	**14.4**	**130.8**	**69.5**
Total (all reef species)	**61.0**	**5.4**	**5393.6**	**101.2**	**15.6**	**14.6**	**5525.0**	**1202.9**

* Target species/families

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

Table 8. Mean (±SE) fish species (species/500m^2) and percentage change between years in Twin Rocks Sanctuary from 1991 to 2005.

FAMILY	(N=2)	(N=3)	(N=3)	(N=5)	(N=6)	(N=10)	(N=5)	% Change 2001-2005
	1991	1992	1993	1995	1997	2001	2005	
	species		species	species	species	species	species	
Surgeonfish (Acanthurids)*	2.0	5.3	2.7	3.6	3.0	5.3	4.6	-13.2
Rabbitfish (Siganids)*	0.0	0.0	1.0	0.8	0.5	2.5	2.0	-20.0
Groupers (Serranids)*	2.0	1.3	1.3	1.4	1.5	2.6	2.6	0.0
Barramundi cod	~	~	~	~	~	0.0	0.0	
Snapper (Lutjanids)*	0.0	1.7	1.7	2.0	1.3	3.3	2.6	-21.2
Sweetlips (Haemulids)*	0.0	0.7	0.3	0.0	0.0	0.0	1.2	+
Emperors (Lethrinids)*	0.5	1.0	1.0	0.8	0.8	1.4	0.6	-57.1
Jacks (Carangids)*	0.0	0.0	0.3	0.0	0.3	0.7	0.2	-71.4
Fusiliers (Caesionids)*	1.5	2.0	0.0	0.8	0.8	1.4	0.6	-57.1
Spinecheeks (Nemipterids)*	0.5	0.7	1.0	1.0	1.3	2.1	2.0	-4.8
Goatfish (Mullids)*	0.5	1.0	0.3	1.0	1.0	2.0	1.0	-50.0
Parrotfish (Scarids)*	0.5	0.7	1.0	1.0	1.3	1.6	3.2	100.0
Bumphead parrotfish	~	~	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-100.0
Triggerfish (Balistids)	0.5	1.7	1.7	1.6	2.0	1.8	1.2	-33.3
Butterflyfish (Chaetodonids)	3.5	7.3	5.7	7.2	6.7	8.1	5.6	-30.9
Angelfish (Pomacanthids)	1.5	3.0	2.0	2.6	3.0	2.6	2.6	0.0
Wrasses (Labrids)	2.0	4.0	4.0	4.0	4.7	7.1	10.2	43.7
Humphead wrasse	~	~	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	8.5	13.0	12.0	10.0	11.0	16.0	18.2	13.8
Fairy Basslets (Anthids)	2.0	1.7	2.0	2.0	1.8	2.2	1.6	-27.3
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
Total (target reef species)*	**5.5**	**9.1**	**7.9**	**8.8**	**9.0**	**23.0**	**20.6**	-10.4
Total (all reef species)	**26.5**	**46.1**	**39.0**	**40.8**	**42.2**	**61.8**	**61.0**	-1.3

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1991 to 1997, surgeonfish not included as a target species

Table 9. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years in Twin Rocks Sanctuary from 1991 to 2005.

FAMILY	(N=2) 1991 density	(N=3) 1992 density	(N=3) 1993 density	(N=5) 1995 density	(N=6) 1997 density	(N=10) 2001 density	(N=5) 2005 density	% Change 2001-2005
Surgeonfish (Acanthurids)*	26.0	60.0	42.7	29.2	42.3	57.5	17.4	-69.7
Rabbitfish (Siganids)*	0.0	0.0	2.3	1.4	1.8	16.7	6.2	-62.9
Groupers (Serranids)*	3.0	1.7	1.7	2.2	2.3	7.8	4.2	-46.2
Barramundi cod	~	~	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	3.3	2.7	24.8	29.0	35.1	12.2	-65.2
Sweetlips (Haemulids)*	0.0	1.3	0.7	0.0	0.0	0.0	1.2	+
Emperors (Lethrinids)*	4.5	5.0	25.0	5.8	3.8	9.9	0.8	-91.9
Jacks (Carangids)*	0.0	0.0	0.3	0.0	0.7	2.6	0.2	-92.3
Fusiliers (Caesionids)*	85.0	514.0	0.0	15.2	55.5	107.2	78.0	-27.2
Spinecheeks (Nemipterids)*	1.5	4.0	9.0	18.6	13.0	16.1	4.4	-72.7
Goatfish (Mullids)*	4.5	9.0	11.0	17.0	7.0	17.8	1.2	-93.3
Parrotfish (Scarids)*	1.5	2.0	15.0	13.8	9.0	10.1	6.6	-34.7
Bumphead parrotfish	~	~	~	~	~	0.0	0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-100.0
Triggerfish (Balistids)	5.0	11.0	9.0	5.4	6.3	7.8	1.4	-82.1
Butterflyfish (Chaetodonids)	18.0	29.0	24.7	34.0	23.8	26.5	14.6	-44.9
Angelfish (Pomacanthids)	7.0	29.7	19.3	15.4	18.0	23.8	7.6	-68.1
Wrasses (Labrids)	8.0	298.0	226.3	85.2	120.3	168.2	255.2	51.7
Humphead wrasse	~	~	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	504.0	1185.0	1173.0	739.6	1271.2	1456.5	2267.6	55.7
Fairy Basslets (Anthids)	390.0	471.0	1026.0	450.0	1581.0	619.8	2844.0	358.9
Moorish Idols (Zanclids)	17.0	15.0	7.0	9.0	9.0	7.6	2.2	-71.1
Total (target reef species)*	**100.0**	**540.3**	**67.7**	**98.8**	**122.2**	**247.0**	**130.8**	-47.0
Total (all reef species)	**1075.0**	**2639.0**	**2595.7**	**1466.6**	**3194.2**	**2591.1**	**5525.0**	113.2

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 100

(-) = decrease

(+) = increase

From 1991 to 1997, surgeonfish not included as a target species

Table 10. Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2005.

	SCUBA SURVEYS:			SNORKEL SURVEYS:		
	2001	2005	% Change 2001-2005	2001	2005	% Change 2001-2005
	% cover	% cover		% cover	% cover	
SUBSTRATE COVER						
Sand (S) & silt (SI)	10.1	5.2	-48.6	3.4	4.1	20.9
Coral rubble (R)	4.3	1.2	-72.4	1.7	1.0	-43.9
Rock & block (RCK)	12.3	5.8	-52.7	32.6	19.8	-39.4
White dead standing coral (DA)	0.2	0.8	275.0	1.3	0.7	-46.2
Dead coral with algae (DCA)	8.7	8.2	-5.9	5.7	5.3	-7.2
Subtotal non-living substrate	**35.6**	**21.1**	-40.7	**44.7**	**30.8**	-31.1
Branching (CB)	40.2	59.7	48.5	29.9	50.9	70.3
Massive (CM)	11.8	7.1	-39.6	16.1	9.5	-41.2
Flat/Encrusting (CE)	4.6	5.7	23.6	6.0	4.5	-24.7
Foliose/Cup (CF)	5.6	2.8	-49.8	1.8	2.5	40.9
Total Hard Coral	**62.2**	**75.3**	21.1	**53.8**	**67.5**	25.4
Total Soft Coral	**0.6**	**0.4**	-37.5	**0.4**	**0.0**	-100.0
Subtotal Coral	**62.8**	**75.7**	20.5	**54.2**	**67.5**	24.5
Sponges (SP)	0.6	0.4	-27.1	0.3	0.7	121.2
Other animals (OT)	0.0	0.1	+	0.0	0.1	+
Algae						
Fleshy (MA)	0.4	0.9	134.4	0.5	0.3	-45.5
Turf (TA)	0.2	1.1	431.3	0.1	0.2	81.8
Coralline (CA)	0.4	0.7	71.9	0.2	0.5	172.7
Seagrass (SG)	0.0	0.0	N/A	0.0	0.0	N/A
Subtotal Others	**1.6**	**3.2**	99.2	**1.1**	**1.7**	57.9
TOTAL	**100.0**	**100.0**		**100.0**	**100.0**	
Environmental Parameters						
Mean Slope (degrees)	24.0	28.8	19.8	6.4	15.0	134.4
Mean Topography (m)*	1.8	1.1	-38.9	1.6	1.4	-15.2
Mean Depth/Range (m)	6.4	6.5	1.6	2.5	2.6	2.0
Horizontal Visibility (m)	14.2	17.5	23.2	14.0	14.6	4.3
No. of 50 m Transects	13	8		270[a]	11	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 11a. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Cathedral Reef Sanctuary in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	2.6	0.7	8.4	4.6	0.2	0.0	13.2	6.2
Rabbitfish (Siganids)*	0.4	0.2	0.6	0.0	0.0	0.4	1.0	0.6
Groupers (Serranids)*	1.0	0.3	0.2	0.6	0.4	0.0	1.2	0.4
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.0	0.3	0.0	3.0	0.2	0.0	3.2	2.2
Sweetlips (Haemulids)*	0.2	0.2	0.0	0.0	0.2	0.0	0.2	0.2
Emperors (Lethrinids)*	0.4	0.2	0.0	2.0	0.0	0.0	2.0	1.8
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.6	0.4	25.8	200.2	0.0	0.0	226.0	195.4
Spinecheeks (Nemipterids)*	0.8	0.2	0.0	2.8	0.0	0.0	2.8	1.6
Goatfish (Mullids)*	0.2	0.2	1.8	0.0	0.0	0.0	1.8	1.8
Parrotfish (Scarids)*	2.0	0.7	1.2	6.0	6.2	1.0	14.4	7.1
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	1.8	0.4	0.0	3.8	0.0	0.0	3.8	1.5
Butterflyfish (Chaetodonids)	7.4	1.8	17.8	3.2	0.0	0.0	21.0	7.7
Angelfish (Pomacanthids)	2.2	0.4	6.6	0.2	0.0	0.0	6.8	2.5
Wrasses (Labrids)	7.6	1.3	88.0	0.6	0.0	0.0	88.6	47.4
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	14.6	1.2	4031.6	0.0	0.0	0.0	4031.6	798.7
Fairy Basslets (Anthids)	1.0	0.3	1673.8	0.0	0.0	0.0	1673.8	504.4
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	4.0	0.0	0.0	0.0	4.0	1.6
Total (target reef species)*	**9.2**	**1.8**	**29.6**	**219.2**	**7.2**	**1.4**	**257.4**	**196.1**
Total (all reef species)	**44.6**	**2.9**	**5859.8**	**227.0**	**7.2**	**1.4**	**6095.4**	**854.3**

* Target species/families

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

Table 11b. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family at Cathedral Rock in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	4.5	0.5	35.5	269.0	6.5	0.0	311.0	209.0
Rabbitfish (Siganids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groupers (Serranids)*	1.5	0.5	0.0	4.5	1.5	0.0	6.0	3.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.5	0.5	1.5	0.0	0.0	0.0	1.5	1.5
Jacks (Carangids)*	1.0	0.0	0.0	0.0	26.5	0.0	26.5	6.5
Fusiliers (Caesionids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinecheeks (Nemipterids)*	1.5	0.5	0.0	6.5	0.0	0.0	6.5	2.5
Goatfish (Mullids)*	0.5	0.5	10.0	0.0	0.0	0.0	10.0	10.0
Parrotfish (Scarids)*	1.0	0.0	0.0	17.5	0.0	0.0	17.5	15.5
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	1.0	1.0	0.0	7.5	0.0	0.0	7.5	7.5
Butterflyfish (Chaetodonids)	4.5	2.5	581.0	0.0	0.0	0.0	581.0	421.0
Angelfish (Pomacanthids)	3.5	0.5	45.0	0.0	0.0	0.0	45.0	39.0
Wrasses (Labrids)	6.5	1.5	34.5	3.0	0.0	0.0	37.5	8.5
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	6.0	0.0	1231.0	0.0	0.0	0.0	1231.0	31.0
Fairy Basslets (Anthids)	1.0	0.0	1600.0	0.0	0.0	0.0	1600.0	400.0
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	14.0	0.0	0.0	0.0	14.0	6.0
Total (target reef spp.)*	**10.5**	**1.5**	**11.5**	**297.5**	**34.5**	**0.0**	**343.5**	**200.5**
Total (all reef spp.)	**34.0**	**4.0**	**3552.5**	**308.0**	**34.5**	**0.0**	**3895.0**	**161.0**

* Target species/families

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

Table 12. Mean (±SE) fish species (species/500m^2) and percentage change between years inside Cathedral Reef Sanctuary and Cathedral Rock from 1991 to 2005.

FAMILY	Cathedral Reef Sanctuary			Cathedral Rock		
	(N=6)	(N=5)	% Change 2001 2005	(N=1)	(N=2)	% Change 2001-2005
	2001	2005		2001	2005	
	species			species		
Surgeonfish (Acanthurids)*	5.5	2.6	-52.7	5.0	4.5	-10.0
Rabbitfish (Siganids)*	1.0	0.4	-60.0	1.0	0.0	-100.0
Groupers (Serranids)*	1.7	1.0	-40.0	4.0	1.5	-62.5
Barramundi cod	0.0	0.0	N/A	0.0	0.0	N/A
Snapper (Lutjanids)*	0.3	1.0	200.0	1.0	0.0	-100.0
Sweetlips (Haemulids)*	0.2	0.2	20.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.8	0.4	-52.0	1.0	0.5	-50.0
Jacks (Carangids)*	0.5	0.0	-100.0	1.0	1.0	0.0
Fusiliers (Caesionids)*	0.3	0.6	80.0	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	1.3	0.8	-40.0	1.0	1.5	50.0
Goatfish (Mullids)*	1.3	0.2	-85.0	1.0	0.5	-50.0
Parrotfish (Scarids)*	2.2	2.0	-7.7	1.0	1.0	0.0
Bumphead parrotfish	0.0	0.0	N/A	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.2	0.0	-100.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.3	1.8	35.0	4.0	1.0	-75.0
Butterflyfish (Chaetodonids)	8.5	7.4	-12.9	11.0	4.5	-59.1
Angelfish (Pomacanthids)	3.0	2.2	-26.7	5.0	3.5	-30.0
Wrasses (Labrids)	9.2	7.6	-17.1	7.0	6.5	-7.1
Humphead wrasse	0.0	0.0	N/A	0.0	0.0	N/A
Damselfish (Pomacentrids)	15.7	14.6	-6.8	6.0	6.0	0.0
Fairy Basslets (Anthids)	1.5	1.0	-33.3	2.0	1.0	-50.0
Moorish Idols (Zanclids)	1.0	0.8	-20.0	1.0	1.0	0.0
Total (target reef species)*	**15.3**	**9.2**	-40.0	**16.0**	**10.5**	-34.4
Total (all reef species)	**55.5**	**44.6**	-19.6	**52.0**	**34.0**	-34.6

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 100

(-) = decrease

(+) = increase

Table 13. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years inside Cathedral Reef Sanctuary and at Cathedral Rock from 1991 to 2005.

FAMILY	Cathedral Reef Sanctuary (N=6) 2001 Density	Cathedral Reef Sanctuary (N=5) 2005 Density	% Change 2001-2005	Cathedral Rock (N=1) 2001 Density	Cathedral Rock (N=2) 2005 Density	% Change 2001-2005
Surgeonfish (Acanthurids)*	71.3	13.2	-81.5	1543.0	311.0	-79.8
Rabbitfish (Siganids)*	5.0	1.0	-80.0	9.0	0.0	-100.0
Groupers (Serranids)*	3.8	1.2	-68.7	36.0	6.0	-83.3
Barramundi cod	0.0	0.0	N/A	0.0	0.0	N/A
Snapper (Lutjanids)*	1.7	3.2	92.0	33.0	0.0	-100.0
Sweetlips (Haemulids)*	0.2	0.2	20.0	0.0	0.0	N/A
Emperors (Lethrinids)*	3.8	2.0	-47.8	33.0	1.5	-95.5
Jacks (Carangids)*	1.2	0.0	-100.0	9.0	26.5	194.4
Fusiliers (Caesionids)*	25.7	226.0	780.5	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	12.2	2.8	-77.0	33.0	6.5	-80.3
Goatfish (Mullids)*	8.5	1.8	-78.8	9.0	10.0	11.1
Parrotfish (Scarids)*	9.0	14.4	60.0	129.0	17.5	-86.4
Bumphead parrotfish	0.0	0.0	N/A	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.3	0.0	-100.0	0.0	0.0	N/A
Triggerfish (Balistids)	8.5	3.8	-55.3	78.0	7.5	-90.4
Butterflyfish (Chaetodonids)	31.2	21.0	-32.6	235.0	581.0	147.2
Angelfish (Pomacanthids)	20.3	6.8	-66.6	105.0	45.0	-57.1
Wrasses (Labrids)	87.2	88.6	1.6	159.0	37.5	-76.4
Humphead wrasse	0.0	0.0	N/A	0.0	0.0	N/A
Damselfish (Pomacentrids)	1958.7	4031.6	105.8	1737.0	1231.0	-29.1
Fairy Basslets (Anthids)	497.7	1673.8	236.3	547.0	1600.0	192.5
Moorish Idols (Zanclids)	7.7	4.0	-47.8	33.0	14.0	-57.6
Total (target reef species)*	**123.7**	**257.4**	108.1	**1510.0**	**343.5**	-77.3
Total (all reef species)*	**2753.8**	**6095.4**	121.3	**4728.0**	**3895.0**	-17.6

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 100

(-) = decrease

(+) = increase

Table 14. Changes in substrate composition (% mean ±SE) in Batalang Bato (Pulang-buli) Sanctuary from 1993 to 2005.

	SCUBA SURVEYS:						SNORKEL SURVEYS:					
	1993	1995	1997	2001	2005	% Change 2001-2005	1993	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
SUBSTRATE COVER												
Sand (s) & Silt (SI)	21.6	12.4	23.2	24.7	11.6	-53.2	13.0	8.0	17.8	7.0	5.9	-15.2
Coral Rubble (R)	11.2	14.7	9.2	15.4	10.4	-32.9	12.7	18.8	7.0	3.7	4.3	14.7
Rock & block (RCK)	3.8	0.1	5.1	6.7	9.2	36.7	8.1	7.9	7.5	11.3	10.4	-7.7
White Dead Standing Coral (DA)	1.2	0.1	1.6	0.1	0.0	-100.0	~	3.6	2.4	0.7	0.2	-70.4
Dead Coral with Algae (DCA)	~	~	~	1.4	0.2	-85.3	~	~	~	3.7	2.6	-29.3
Subtotal Non-living Substrate	***37.8***	***27.3***	***39.1***	***48.2***	***31.3***	-35.2	***33.8***	***38.3***	***34.7***	***26.4***	***23.5***	-11.2
Branching (CB)	13.7	0.3	1.3	2.3	2.1	-8.0	22.0	17.3	6.8	17.3	11.9	-31.5
Massive (CM)	3.0	7.8	2.5	7.9	4.0	-49.0	6.2	2.7	6.8	9.2	9.5	3.3
Flat/Encrusting (CE)	3.0	14.8	5.8	3.3	8.6	155.6	2.6	4.3	4.0	5.0	3.9	-22.6
Foliose/Cup (CF)	1.3	1.5	0.9	1.4	0.9	-37.7	2.2	2.6	3.3	2.8	3.2	13.2
Total Hard Coral	**21.0**	**24.4**	**10.4**	**14.9**	**15.6**	4.2	**33.0**	**26.9**	**20.8**	**34.3**	**28.4**	-17.2
Total Soft Coral	**41.2**	**48.3**	**50.4**	**34.6**	**40.9**	18.2	**33.2**	**35.0**	**44.5**	**35.1**	**43.8**	24.8
Subtotal Coral	***62.2***	***72.7***	***60.9***	***49.5***	***56.4***	14.0	***66.2***	***61.9***	***65.3***	***69.4***	***72.2***	4.0
Sponges (SP)	~	~	~	1.7	3.8	120.6	~	~	~	3.2	2.3	-27.9
Other animals (OT)	~	~	~	~	7.9	N/A	~	~	~	~	1.5	N/A
Algae												
Fleshy (MA)	~	~	~	0.3	0.1	-80.0	~	~	~	0.7	0.1	-83.9
Turf (TA)	~	~	~	0.3	0.3	-1.8	~	~	~	0.2	0.3	13.3
Coralline (CA)	~	~	~	0.1	0.4	620.0	~	~	~	0.1	0.1	2.7
Seagrass (SG)	~	~	~	~	0.0	N/A	~	~	~	~	0.0	N/A
Total others	**~**	**~**	**~**	**2.3**	**12.4**	429.3	**~**	**~**	**~**	**4.2**	**4.3**	3.6
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters												
Mean Slope (degrees)	**~**	~	16	14.0	12.5	-10.7	~	~	17	7.3	21.7	196.8
Mean Topography (m)*	**~**	~	1.0	1.3	0.8	-41.0	~	~	2.0	2.0	1.5	-25.0
Mean Depth/Range (m)	7-8	7-8	7-9	6.2	7.4	19.2	2-4	2-4	2-5	2.4	2.8	14.6
Horizontal Visibility (m)	12	16	17	20.3	14.8	-27.3	12	15	16	18.8	15.0	-20.2
No. of 50 m Transects	3	3	5	18	10		60	120[a]	110[a]	435[a]	16.0	

a = total number of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 15. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Batalang Bato (Pulang Buli) Sanctuary in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	2.7	0.3	13.3	16.5	133.5	0.0	163.3	131.0
Rabbitfish (Siganids)*	0.5	0.3	0.0	0.5	0.0	0.0	0.5	0.3
Groupers (Serranids)*	2.0	0.4	0.0	2.5	2.3	1.5	6.3	1.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.2	0.4	0.0	2.5	0.2	0.8	3.5	1.8
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.7	0.2	0.0	3.5	0.0	0.0	3.5	1.8
Jacks (Carangids)*	0.2	0.2	0.0	0.0	0.0	16.7	16.7	16.7
Fusiliers (Caesionids)*	0.5	0.3	0.0	41.7	16.7	0.0	58.3	37.5
Spinecheeks (Nemipterids)*	1.0	0.0	0.0	10.7	0.2	0.0	10.8	4.8
Goatfish (Mullids)*	0.8	0.2	7.0	0.7	0.0	0.0	7.7	5.2
Parrotfish (Scarids)*	2.3	0.4	0.0	8.5	1.2	0.2	9.8	4.7
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.7	0.2	0.2	1.5	0.0	0.0	1.7	0.8
Butterflyfish (Chaetodonids)	4.8	1.1	17.3	2.2	0.0	0.0	19.5	4.6
Angelfish (Pomacanthids)	1.2	0.5	3.8	0.0	0.0	0.0	3.8	1.8
Wrasses (Labrids)	8.5	1.0	55.5	2.7	0.0	0.0	58.2	27.9
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	12.5	1.2	4818.2	0.0	0.0	0.0	4818.2	2777.9
Fairy Basslets (Anthids)	2.0	0.4	4967.5	0.0	0.0	0.0	4967.5	1322.3
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	5.0	0.0	0.0	0.0	5.0	1.7
Total (target reef species)*	**11.8**	**1.0**	**7.0**	**87.0**	**154.0**	**19.2**	**267.2**	**163.5**
Total (all reef species)	**42.3**	**2.9**	**9887.8**	**93.3**	**154.0**	**19.2**	**10154.3**	**3959.0**

* Target species/families

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

Table 16. Mean (±SE) fish species (species/500m^2) and percentage change between years in Batalang Bato (Pulang Buli) Sanctuary from 1991 to 2005.

	(N=2)	(N=2)	(N=2)	(N=6)	(N=6)	% Change 2001-2005
	1993	1995	1997	2001	2005	
	species		species	species	species	
Surgeonfish (Acanthurids)*	2.5	2.0	4.5	3.5	2.7	-23.8
Rabbitfish (Siganids)*	1.5	0.0	0.5	1.0	0.5	-50.0
Groupers (Serranids)*	0.5	0.5	0.0	0.2	2.0	1100.0
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	1.0	0.5	0.5	1.2	133.3
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	0.0	0.0	0.2	0.7	300.0
Jacks (Carangids)*	0.0	0.0	0.5	0.2	0.2	0.0
Fusiliers (Caesionids)*	0.5	0.0	0.5	0.7	0.5	-25.0
Spinecheeks (Nemipterids)*	1.0	1.0	1.0	1.0	1.0	0.0
Goatfish (Mullids)*	0.5	0.5	0.5	1.7	0.8	-50.0
Parrotfish (Scarids)*	1.0	1.0	1.0	2.8	2.3	-17.6
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.2	0.0	-100.0
Triggerfish (Balistids)	0.0	0.0	0.5	1.7	0.7	-60.0
Butterflyfish (Chaetodonids)	3.5	4.5	3.5	4.0	4.8	20.8
Angelfish (Pomacanthids)	0.5	0.0	1.5	1.8	1.2	-36.4
Wrasses (Labrids)	4.5	4.5	6.0	9.5	8.5	-10.5
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	8.5	9.0	9.5	11.5	12.5	8.7
Fairy Basslets (Anthids)	2.0	2.0	2.0	1.7	2.0	20.0
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	0.8	-16.7
Total (target reef species)*	**5.0**	**4.0**	**4.5**	**11.8**	**11.8**	0.0
Total (all reef species)	**27.5**	**27.0**	**33.0**	**43.0**	**42.3**	-1.6

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 17. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years in Batalang Bato (Pulang Buli) Sanctuary from 1991 to 2005.

FAMILY	(N=2) 1993 density	(N=2) 1995	(N=2) 1997 density	(N=6) 2001 density	(N=6) 2005 density	% Change 2001-2005
Surgeonfish (Acanthurids)*	14.5	15.0	78.0	69.8	163.3	133.9
Rabbitfish (Siganids)*	6.0	0.0	0.5	1.3	0.5	-62.5
Groupers (Serranids)*	0.5	0.5	0.0	0.2	6.3	3700.0
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	1.0	0.5	1.8	3.5	90.9
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	0.0	0.0	0.2	3.5	2000.0
Jacks (Carangids)*	0.0	0.0	4.5	0.2	16.7	9900.0
Fusiliers (Caesionids)*	5.0	0.0	16.5	18.0	58.3	224.1
Spinecheeks (Nemipterids)*	6.0	6.0	6.0	5.2	10.8	109.7
Goatfish (Mullids)*	1.5	0.5	1.5	9.5	7.7	-19.3
Parrotfish (Scarids)*	6.0	9.0	9.0	16.3	9.8	-39.8
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	5.5	0.0	-100.0
Triggerfish (Balistids)	0.0	0.0	1.5	3.3	1.7	-50.0
Butterflyfish (Chaetodonids)	12.5	25.5	14.5	15.3	19.5	27.2
Angelfish (Pomacanthids)	0.5	0.0	10.5	23.7	3.8	-83.8
Wrasses (Labrids)	121.5	205.5	73.5	107.2	58.2	-45.7
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	373.5	865.5	2322.5	880.2	4818.2	447.4
Fairy Basslets (Anthids)	1794.0	4098.0	2370.0	1196.7	4967.5	315.1
Moorish Idols (Zanclids)	6.0	9.0	21.0	9.3	5.0	-46.4
Total (target reef species)*	**25.0**	**17.0**	**38.5**	**105.5**	**267.2**	153.2
Total (all reef species)	**2347.5**	**5235.5**	**4930.0**	**2363.7**	**10154.3**	329.6

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 18. Changes in substrate composition (% mean ±SE) in Layag-layag, Tingloy from 1993 to 2005.

	SCUBA SURVEYS:						SNORKEL SURVEYS:					
	1993	1995	1997	2001	2005	% Change 2001-2005	1993	1995	1997	2001	2005	% Change 2001-2005
	%cover	%cover	%cover	%cover	%cover		%cover	%cover	%cover	%cover	%cover	
SUBSTRATE COVER:												
Sand (S) & Silt (SI)	22.7	11.3	15.0	17.3	23.9	37.7	21.3	6.1	4.9	1.3	1.2	-4.1
Coral Rubble (R)	27.1	30.6	28.6	20.0	17.1	-14.6	6.0	7.5	8.0	8.0	15.8	96.4
Rock & block (RCK)	6.9	14.5	10.8	11.2	14.1	25.9	5.1	8.2	11.5	7.1	9.4	33.3
White Dead Standing Coral (DA)	1.0	1.1	6.3	0.3	0.1	-60.0	2.3	3.5	10.3	1.2	1.9	59.9
Dead Coral with Algae (DCA)	~	~	~	7.0	5.3	-25.3	~	~	~	9.4	24.1	156.4
Subtotal Non-living Substrate	***57.7***	***57.5***	***60.7***	***55.9***	***60.4***	8.2	***34.7***	***25.3***	***34.7***	***27.0***	***52.4***	94.4
Branching (CB)	13.3	13.1	9.6	14.2	4.8	-66.6	39.2	55.7	48.2	54.7	31.6	-42.2
Massive (CM)	13.3	5.9	8.5	13.9	8.6	-38.5	17.0	6.4	9.7	9.9	5.5	-44.2
Flat/Encrusting (CE)	5.5	6.9	8.1	6.4	5.4	-15.6	3.9	3.6	2.6	2.2	1.4	-36.0
Foliose/Cup (CF)	2.1	1.1	3.3	4.6	5.5	19.6	1.8	3.5	2.7	2.1	4.8	130.9
Total Hard Coral	**34.2**	**27.0**	**29.4**	**39.2**	**24.3**	-38.1	**61.9**	**69.2**	**63.0**	**68.9**	43.4	-37.0
Total Soft Coral	**8.1**	**15.6**	**9.9**	**3.8**	**12.8**	236.1	**3.4**	**5.5**	**2.3**	**2.2**	1.1	-51.4
Subtotal Coral	***42.3***	***42.6***	***39.3***	***43.0***	***37.1***	-13.8	***65.3***	***74.7***	***65.3***	***71.1***	***44.5***	-37.4
Sponges (SP)	~	~	~	0.9	0.8	-9.7	~	~	~	0.2	0.1	-53.6
Other animals (OT)	~	~	~	~	0.4	N/A	~	~	~	~	0.4	N/A
Algae												
Fleshy (MA)	~	~	~	0.0	0.7	2100.0	~	~	~	0.7	1.1	49.6
Turf (TA)	~	~	~	0.2	0.4	71.4	~	~	~	1.0	0.2	-83.7
Coralline (CA)	~	~	~	0.0	0.3	+	~	~	~	0.1	1.3	1636.4
Seagrass (SG)	~	~	~	~	0.0	N/A	~	~	~	~	0.0	N/A
Subtotal Others	**~**	**~**	**~**	***1.1***	***2.5***	119.2	**~**	**~**	**~**	***2.0***	***3.1***	57.2
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters												
Mean Slope (degrees)	**~**	**~**	8	5.7	7.5	31.6	~	~	11	5.1	10.0	96.1
Mean Topography (m)*	**~**	**~**	1.8	1.7	2	17.6	~	~	2	1.3	1.3	-3.8
Mean Depth/Range (m)	7-8	7-8	6-8	6.3	6.9	9.8	3-4	3-4	2-4	2.8	2.3	-16.2
Horizontal Visibility (m)	15	17	18	17.3	16.1	-6.7	15	22	22	17.4	15.1	-13.1
No. of 50 m Transects	3	3	12	16	8		70	120[a]	120[a]	195[a]	14.0	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 19. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family at Layag-layag in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.5	0.6	15.8	31.0	0.0	0.0	46.8	11.4
Rabbitfish (Siganids)*	0.3	0.3	0.0	0.0	0.3	0.0	0.3	0.3
Groupers (Serranids)*	0.8	0.3	0.3	0.5	0.0	0.0	0.8	0.3
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.3	0.3	0.0	0.3	0.0	0.0	0.3	0.3
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.8	0.3	0.8	1.3	0.0	0.0	2.0	0.9
Jacks (Carangids)*	0.3	0.3	0.0	0.3	0.0	0.0	0.3	0.3
Fusiliers (Caesionids)*	0.3	0.3	8.3	0.0	0.0	0.0	8.3	8.3
Spinecheeks (Nemipterids)*	0.8	0.3	2.3	1.0	0.0	0.0	3.3	2.0
Goatfish (Mullids)*	1.3	0.3	2.3	1.3	0.0	0.0	3.5	1.8
Parrotfish (Scarids)*	3.8	2.1	0.5	13.8	1.5	0.3	16.0	7.2
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	2.0	0.6	0.5	4.0	0.0	0.0	4.5	2.0
Butterflyfish (Chaetodonids)	7.3	1.5	25.5	0.0	0.0	0.0	25.5	5.1
Angelfish (Pomacanthids)	2.8	0.3	9.8	0.0	0.0	0.0	9.8	2.6
Wrasses (Labrids)	9.0	1.5	245.5	3.5	0.0	0.0	249.0	115.7
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	16.5	1.8	2001.3	0.0	0.0	0.0	2001.3	462.0
Fairy Basslets (Anthids)	1.5	0.3	1164.5	0.0	0.0	0.0	1164.5	979.0
Moorish Idols (*Zanclus cornutus*)	0.8	0.3	3.3	0.0	0.0	0.0	3.3	2.0
Total (target reef species)*	**11.8**	**2.7**	**14.3**	**49.3**	**1.8**	**0.3**	**65.5**	**12.0**
Total (all reef species)	**51.5**	**2.9**	**3480.3**	**56.8**	**1.8**	**0.3**	**3539.0**	**1269.4**

* Target species/families

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

Table 20. Mean (±SE) fish species (species/500m^2) and percentage change between years at Layag-layag from 1991 to 2005.

	(N=2)	(N=2)	(N=8)	(N=4)	(N=4)	% Change 2001-2005
	1993	1995	1997	2001	2005	
	species	species	species	species	species	
Surgeonfish (Acanthurids)*	3.5	3.0	3.6	3.8	3.5	-6.7
Rabbitfish (Siganids)*	1.0	2.5	1.4	0.0	0.3	+
Groupers (Serranids)*	0.5	0.5	0.3	0.3	0.8	200.0
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.5	0.0	0.1	0.0	0.3	+
Sweetlips (Haemulids)*	0.0	1.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.5	0.0	0.0	0.5	0.8	50.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.3	+
Fusiliers (Caesionids)*	0.5	0.0	0.5	0.0	0.3	+
Spinecheeks (Nemipterids)*	1.0	1.0	0.8	1.5	0.8	-50.0
Goatfish (Mullids)*	1.0	0.0	1.0	1.5	1.3	-16.7
Parrotfish (Scarids)*	0.5	1.0	1.0	2.3	3.8	66.7
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.5	0.5	1.1	2.5	2.0	-20.0
Butterflyfish (Chaetodonids)	4.5	8.0	3.3	7.3	7.3	0.0
Angelfish (Pomacanthids)	1.5	1.0	2.9	2.3	2.8	22.2
Wrasses (Labrids)	5.0	5.0	7.0	8.8	9.0	2.9
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	9.5	10.5	6.9	15.3	16.5	8.2
Fairy Basslets (Anthids)	2.0	2.0	1.9	1.3	1.5	20.0
Moorish Idols (Zanclids)	1.0	0.0	1.0	1.0	0.8	-25.0
Total (target reef species)*	**5.5**	**6.0**	**5.1**	**9.8**	**11.8**	20.5
Total (all reef species)	**34.0**	**36.0**	**32.8**	**48.0**	**51.5**	7.3

* Target species/families

%Change = {(Ave_{2001}/Ave_{1997})-1} x 100

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 21. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years at Layag-layag from 1991 to 2005.

FAMILY	(N=2) 1993	(N=2) 1995	(N=8) 1997	(N=4) 2001	(N=4) 2005	% Change 2001-2005
	Density		Density	Density	Density	
Surgeonfish (Acanthurids)*	39.5	4.8	109.3	40.3	46.8	16.1
Rabbitfish (Siganids)*	6.0	6.0	3.9	0.0	0.3	+
Groupers (Serranids)*	1.0	0.5	0.3	0.3	0.8	200.0
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.5	0.0	0.1	0.0	0.3	+
Sweetlips (Haemulids)*	0.0	9.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.5	0.0	0.0	0.5	2.0	300.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.3	+
Fusiliers (Caesionids)*	4.5	0.0	8.3	0.0	8.3	+
Spinecheeks (Nemipterids)*	9.0	9.0	2.8	6.0	3.3	-45.8
Goatfish (Mullids)*	9.0	0.0	11.3	7.0	3.5	-50.0
Parrotfish (Scarids)*	4.5	9.0	8.3	13.0	16.0	23.1
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	4.5	0.5	2.1	33.5	4.5	-86.6
Butterflyfish (Chaetodonids)	31.5	24.5	11.3	42.0	25.5	-39.3
Angelfish (Pomacanthids)	5.5	1.0	15.3	35.0	9.8	-72.1
Wrasses (Labrids)	226.5	425.0	422.9	244.3	249.0	1.9
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	802.5	686.0	643.6	1000.0	2001.3	100.1
Fairy Basslets (Anthids)	642.0	1026.0	950.9	148.0	1164.5	686.8
Moorish Idols (Zanclids)	9.0	0.0	6.0	8.5	3.3	-61.8
Total (target reef species)*	**36.0**	**33.5**	**35.0**	**54.3**	**65.5**	20.7
Total (all reef species)	**1797.0**	**2201.3**	**2196.4**	**1578.3**	**3539.0**	124.2

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 100

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 22. Changes in substrate composition (% mean ±SE) in Sombrero Island from 1993 to 2005.

	SCUBA SURVEYS:							SNORKEL SURVEYS:					
	1983	1993	1995	1997	2001	2005	% Change 2001-2005	1993	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
SUBSTRATE COVER													
Sand (S) & Silt (SI)	8.4	9.6	4.7	6.3	4.4	6.2	40.2	16.5	16.2	6.2	3.1	1.5	-53.6
Coral Rubble (R)	21.9	30.1	24.1	14.6	18.4	19.4	5.4	30.6	17.7	6.7	6.1	4.9	-18.3
Rock & Block (RCK)	3.5	11.3	0.8	5.9	9.2	7.9	-14.7	35.3	28.7	13.9	14.2	7.4	-48.0
White dead standing coral (DA)	8.4	7.8	1.7	5.8	0.3	0.3	-15.6	2.7	3.8	3.5	0.9	0.0	-100.0
Dead coral with algae (DCA)	~	~	~	~	11.5	6.0	-47.9	~	~	~	9.0	2.4	-73.0
Subtotal Non-living Substrate	***42.2***	***58.8***	***31.3***	***32.6***	***43.8***	***39.7***	-9.5	***85.1***	***66.4***	***30.4***	***33.2***	**16.2**	-51.2
Branching (CB)	~	19.5	50.3	39.8	14.6	12.7	-13.2	3.2	20.1	49.1	33.8	47.4	40.3
Massive (CM)	~	4.5	3.1	3.2	10.1	6.8	-32.5	2.7	1.7	4.3	7.9	4.3	-45.9
Flat/Encrusting (CE)	~	13.0	7.5	5.2	5.3	6.3	19.8	5.4	8.0	7.8	8.0	4.6	-42.0
Foliose/Cup (CF)	~	0.6	1.8	4.8	6.4	5.4	-14.9	0.8	2.0	2.6	6.6	12.4	88.4
Total Hard Coral	**45.9**	**37.6**	**62.7**	**53.0**	**36.4**	**31.3**	-14.1	**12.1**	**31.8**	**63.7**	**56.3**	**68.8**	22.2
Total Soft Coral	**11.7**	**3.6**	**8.9**	**14.4**	**16.1**	**22.1**	37.2	**2.8**	**2.0**	**5.9**	**6.7**	**12.7**	90.9
Subtotal Coral	***57.6***	***41.2***	***71.6***	***67.4***	***52.5***	***53.3***	1.6	***14.9***	***33.8***	***69.6***	***63.0***	**81.5**	29.4
Sponges (SP)	~	~	~	~	3.7	3.3	-12.2	~	~	~	1.5	0.8	-47.6
Other animals (OT)	~	~	~	~	~	0.5	N/A	~	~	~	~	0.0	N/A
Algae													
Fleshy (MA)	~	~	~	~	0.6	0.6	-5.7	~	~	~	1.8	0.8	-55.3
Turf (TA)	~	~	~	~	0.6	1.9	213.6	~	~	~	0.3	0.5	35.0
Coralline (CA)	~	~	~	~	0.6	0.7	2.9	~	~	~	0.3	0.3	15.6
Seagrass (SG)	~	~	~	~	~	0.0	N/A	~	~	~	~	0.0	N/A
Subtotal Others	~	~	~	~	***3.7***	***7.0***	89.8	~	~	~	***3.9***	**2.3**	-40.1
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters													
Mean Slope (degrees)	~	~	~	13	4.9	6.1	24.7	~	~	8	4.1	7.5	82.9
Mean Topography (m)*	~	~	~	2.9	2.0	1.0	-51.3	~	~	~	1.5	1.3	-12.5
Mean Depth/Range (m)	1-3	7-8	7-8	6-9	6.8	7.4	8.5	3-5	2-3	2-5	2.6	2.8	9.0
Horizontal Visibility (m)	~	16	17	22	22.9	14.9	-35.0	12	15	25	22.4	13.7	-39.0
No. of 50 m Transects	2	3	3	10	27	18.0		63[a]	60[a]	170[a]	450[a]	14.0	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 23. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Sombrero Island in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	2.7	0.3	29.0	6.5	0.0	0.0	35.5	10.8
Rabbitfish (Siganids)*	0.2	0.2	0.0	0.2	0.0	0.0	0.2	0.2
Groupers (Serranids)*	0.3	0.2	0.0	0.3	0.0	0.0	0.3	0.2
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.2	0.2	0.0	0.0	0.0	0.2	0.2	0.2
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.3	0.2	0.5	0.5	0.0	0.0	1.0	0.6
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.3	0.2	21.5	0.2	0.0	0.0	21.7	21.5
Spinecheeks (Nemipterids)*	0.8	0.2	8.0	1.0	0.0	0.0	9.0	5.3
Goatfish (Mullids)*	0.7	0.2	7.3	0.0	0.0	0.0	7.3	5.3
Parrotfish (Scarids)*	1.0	0.3	0.2	4.7	0.3	0.0	5.2	2.3
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	1.0	0.6	1.3	0.3	0.0	0.0	1.7	1.3
Butterflyfish (Chaetodonids)	4.8	0.6	29.0	0.0	0.0	0.0	29.0	8.8
Angelfish (Pomacanthids)	2.0	0.7	21.7	0.0	0.0	0.0	21.7	9.0
Wrasses (Labrids)	10.5	1.1	245.3	2.5	0.0	0.0	247.8	199.3
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	14.8	0.9	4436.5	0.0	0.0	0.0	4436.5	1961.7
Fairy Basslets (Anthids)	1.5	0.2	3493.7	0.0	0.0	0.0	3493.7	748.9
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	12.8	0.0	0.0	0.0	12.8	6.4
Total (target reef species)*	**6.5**	**0.8**	**37.5**	**13.3**	**0.3**	**0.2**	**51.3**	**26.2**
Total (all reef species)	**42.0**	**2.2**	**8306.8**	**16.2**	**0.3**	**0.2**	**8323.5**	**2078.5**

* Target species/families

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

Table 24. Mean (±SE) fish species (species/500m^2) and percentage change between years at Sombrero Island from 1993 to 2005.

FAMILY	(N=2) 1993	(N=2) 1995	(N=6) 1997	(N=8) 2001	(N=6) 2005	% Change 2001-2005
	species		species	species	species	
Surgeonfish (Acanthurids)*	4.5	3.5	3.7	4.3	2.7	-37.3
Rabbitfish (Siganids)*	0.5	1.0	1.2	0.8	0.2	-77.8
Groupers (Serranids)*	1.5	0.0	0.7	1.5	0.3	-77.8
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.0	0.5	0.4	0.2	-55.6
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.5	0.0	0.0	0.5	0.3	-33.3
Jacks (Carangids)*	0.0	0.0	0.0	0.3	0.0	-100.0
Fusiliers (Caesionids)*	0.5	0.0	1.2	0.3	0.3	33.3
Spinecheeks (Nemipterids)*	1.0	0.5	0.7	1.0	0.8	-16.7
Goatfish (Mullids)*	1.0	0.5	1.0	1.0	0.7	-33.3
Parrotfish (Scarids)*	1.0	0.5	1.0	2.9	1.0	-65.2
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.0	0.5	1.3	2.3	1.0	-55.6
Butterflyfish (Chaetodonids)	4.5	6.0	5.2	5.6	4.8	-14.1
Angelfish (Pomacanthids)	1.0	2.0	2.7	2.4	2.0	-15.8
Wrasses (Labrids)	5.5	5.5	7.5	13.3	10.5	-20.8
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	10.5	8.5	9.8	13.8	14.8	7.9
Fairy Basslets (Anthids)	2.0	2.0	2.0	2.1	1.5	-29.4
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	0.8	-16.7
Total (target reef species)*	**6.0**	**2.5**	**6.2**	**12.8**	**6.5**	-49.0
Total (all reef species)	**36.0**	**31.5**	**39.4**	**53.1**	**42.0**	-20.9

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 25. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years at Sombrero Island from 1993 to 2005.

FAMILY	(N=2) 1993 density	(N=2) 1995 density	(N=6) 1997 density	(N=8) 2001 density	(N=6) 2005 density	% Change 2001-2005
Surgeonfish (Acanthurids)*	172.5	63.5	88.3	90.0	35.5	-60.6
Rabbitfish (Siganids)*	1.0	1.0	3.5	1.1	0.2	-85.2
Groupers (Serranids)*	1.5	0.0	0.7	2.0	0.3	-83.3
Barramundi cod	~	~	~	0.1	0.0	-100.0
Snapper (Lutjanids)*	0.0	0.0	0.5	1.0	0.2	-83.3
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.5	0.0	0.0	1.1	1.0	-11.1
Jacks (Carangids)*	0.0	0.0	0.0	4.3	0.0	-100.0
Fusiliers (Caesionids)*	16.5	0.0	66.5	20.3	21.7	7.0
Spinecheeks (Nemipterids)*	6.0	4.5	0.7	3.4	9.0	166.7
Goatfish (Mullids)*	9.0	4.5	5.0	7.3	7.3	1.1
Parrotfish (Scarids)*	3.0	4.5	8.0	12.1	5.2	-57.4
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	6.0	1.5	3.8	11.3	1.7	-85.2
Butterflyfish (Chaetodonids)	29.0	27.0	19.8	44.3	29.0	-34.5
Angelfish (Pomacanthids)	18.0	7.0	18.3	22.6	21.7	-4.2
Wrasses (Labrids)	406.5	377.5	170.8	187.9	247.8	31.9
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	382.5	472.5	852.8	1897.6	4436.5	133.8
Fairy Basslets (Anthids)	2562.0	3330.0	2306.5	1566.1	3493.7	123.1
Moorish Idols (Zanclids)	9.0	9.0	7.3	12.6	12.8	1.7
Total (target reef species)*	**38.5**	**14.5**	**84.8**	**142.7**	**51.3**	-64.0
Total (all reef species)	**3624.0**	**4302.5**	**3552.6**	**3885.0**	**8323.5**	114.2

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 100

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 26. Changes in substrate composition (% mean ±SE) at White Sand Reef from 1993 to 2005.

	SCUBA SURVEYS:						SNORKEL SURVEYS:				
	1993	1995	1997	2001	2005	% Change 2001-2005	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	
SUBSTRATE COVER											
Sand (S) & silt (SI)	38.8	28.2	32.7	33.8	33.1	-1.9	26.3	15.1	16.7	7.2	-57.2
Coral rubble (R)	15.8	27.1	10.8	12.5	24.4	95.0	8.6	8.2	8.6	15.8	83.7
Rock & block (RCK)	7.9	4.6	5.8	7.3	2.6	-65.0	7.3	16.7	15.0	7.0	-53.7
White dead standing coral (DA)	0.3	0.2	7.6	0.0	0.0	N/A	2.1	6.5	1.2	2.2	79.2
Dead coral with algae (DCA)	~	~	~	7.6	2.9	-61.2	~	~	22.7	4.9	-78.6
Subtotal non-living substrate	**62.8**	**60.1**	**56.9**	**61.1**	**63.0**	3.1	**44.3**	**46.4**	**64.2**	**36.9**	-42.5
Branching (CB)	2.6	17.2	16.6	6.2	5.9	-4.0	29.1	27.4	11.7	21.8	86.3
Massive (CM)	9.8	6.2	6.4	10.1	8.3	-17.4	5.9	7.8	6.7	11.3	68.7
Flat/Encrusting (CE)	8.1	7.0	6.7	2.2	3.8	71.4	5.9	6.4	1.8	4.4	141.7
Foliose/Cup (CF)	1.1	0.3	1.5	0.6	2.3	311.1	0.3	1.6	1.4	10.5	650.0
Total Hard Coral	**21.6**	**30.7**	**30.8**	**19.0**	**20.3**	6.9	**41.2**	**43.1**	**21.6**	**48.0**	122.0
Total Soft Coral	**15.6**	**9.2**	**12.4**	**18.3**	**14.1**	-23.2	**14.5**	**10.5**	**6.8**	**8.5**	25.0
Subtotal Coral	**37.2**	**39.9**	**43.1**	**37.3**	**34.4**	-7.9	**55.7**	**53.6**	**28.4**	**56.5**	98.8
Sponges (SP)	~	~	~	0.4	0.6	66.7	~	~	1.9	2.3	21.1
Other animals (OT)	~	~	~	0.0	1.0	+	~	~	0.0	2.0	+
Algae											
Fleshy (MA)	~	~	~	0.4	0.7	57.1	~	~	3.4	0.0	-100.0
Turf (TA)	~	~	~	0.4	0.3	-42.9	~	~	1.3	2.4	80.8
Coralline (CA)	~	~	~	0.3	0.2	-40.0	~	~	0.8	0.0	-100.0
Seagrass (SG)	~	~	~	0.0	0.0	N/A	~	~	0.0	0.0	N/A
Subtotal Others	**~**	**~**	**~**	**1.6**	**2.8**	76.0	**~**	**~**	**7.4**	**6.7**	-10.6
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100**		**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters											
Mean Slope (degrees)	**~**	**~**	6	2.9	7.5	158.6	~	7	3.0	~	N/A
Mean Topography(m)*	**~**	**~**	0.9	1	1.5	50.0	~	1.0	1.2	~	N/A
Mean Depth/Range (m)	7-8	5-8	4-8	5.3	7.0	32.1	2-8	2-4	2.4	2.5	4.2
Horizontal Visibility (m)	16	15	18	12.9	13.4	4.1	14	19	12.8	10.0	-21.9
No. of 50 m Transects	3	3	7	8	8		100[a]	170[a]	360[a]	2	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 27. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family at White Sand Reef in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	2.0	0.7	6.4	15.0	0.0	0.0	21.4	5.8
Rabbitfish (Siganids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groupers (Serranids)*	0.2	0.2	0.0	0.2	0.0	0.0	0.2	0.2
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.4	0.2	0.0	0.4	0.0	0.0	0.4	0.2
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.2	0.2	0.0	1.8	0.0	0.0	1.8	1.8
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinecheeks (Nemipterids)*	1.8	0.2	0.0	8.6	0.2	0.0	8.8	1.4
Goatfish (Mullids)*	0.8	0.4	0.0	1.4	0.0	0.0	1.4	0.6
Parrotfish (Scarids)*	0.6	0.4	0.0	0.8	0.2	0.0	1.0	0.6
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.4	0.2	0.6	0.0	0.0	0.0	0.6	0.4
Butterflyfish (Chaetodonids)	4.4	0.9	14.2	0.0	0.0	0.0	14.2	3.2
Angelfish (Pomacanthids)	1.2	0.2	4.0	0.0	0.0	0.0	4.0	1.4
Wrasses (Labrids)	9.0	1.6	145.6	0.0	0.0	0.0	145.6	43.3
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	12.8	1.6	1056.6	0.0	0.0	0.0	1056.6	369.1
Fairy Basslets (Anthids)	1.6	0.2	341.6	0.0	0.0	0.0	341.6	55.1
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	3.0	0.0	0.0	0.0	3.0	1.6
Total (target reef species)*	**6.0**	**1.4**	**0.0**	**28.2**	**0.4**	**0.0**	**28.6**	**7.1**
Total (all reef species)	**36.2**	**3.4**	**1572.0**	**28.2**	**0.4**	**0.0**	**1600.6**	**452.0**

* Target species/families

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

Table 28. Mean (±SE) fish species (species/500m^2) and percentage change between years at White Sand Reef from 1995 to 2005.

FAMILY	(N=2) 1995 species	(N=4) 1997 species	(N=3) 2001 species	(N=5) 2005 species	% Change 2001-2005
Surgeonfish (Acanthurids)*	4.0	2.5	2.3	2.0	-14.3
Rabbitfish (Siganids)*	0.0	0.3	0.3	0.0	-100.0
Groupers (Serranids)*	0.0	1.3	0.7	0.2	-70.0
Barramundi cod	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	0.8	0.0	0.4	+
Sweetlips (Haemulids)*	1.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.0	0.5	0.7	0.2	-70.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	0.5	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	1.0	0.8	1.3	1.8	35.0
Goatfish (Mullids)*	1.0	1.0	1.0	0.8	-20.0
Parrotfish (Scarids)*	1.0	1.0	0.3	0.6	80.0
Bumphead parrotfish	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	2.0	1.3	1.0	0.4	-60.0
Butterflyfish (Chaetodonids)	5.0	10.5	6.7	4.4	-34.0
Angelfish (Pomacanthids)	1.0	1.5	1.7	1.2	-28.0
Wrasses (Labrids)	3.5	7.3	4.7	9.0	92.9
Humphead wrasse	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	14.0	14.5	17.7	12.8	-27.5
Fairy Basslets (Anthids)	1.5	1.8	2.0	1.6	-20.0
Moorish Idols (Zanclids)	1.0	1.0	0.3	0.8	140.0
Total (target reef species)*	**6.0**	**6.0**	**6.7**	**6.0**	-10.0
Total (all reef species)	**38.0**	**46.3**	**40.7**	**36.2**	-11.0

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1995 to 1997, surgeonfish not included as a target species

Table 29. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years at White Sand Reef from 1995 to 2005.

FAMILY	(N=2) 1995 density	(N=4) 1997 density	(N=3) 2001 density	(N=5) 2005 density	% Change 1995-1997
Surgeonfish (Acanthurids)*	44.0	27.0	37.3	21.4	-42.7
Rabbitfish (Siganids)*	0.0	0.3	0.7	0.0	-100.0
Groupers (Serranids)*	0.0	1.5	2.0	0.2	-90.0
Barramundi cod	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	0.8	0.0	0.4	+
Sweetlips (Haemulids)*	0.5	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	4.5	3.0	11.3	1.8	-84.1
Jacks (Carangids)*	0.0	0.0	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	9.0	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	9.0	2.3	5.3	8.8	65.0
Goatfish (Mullids)*	1.5	5.5	12.3	1.4	-88.6
Parrotfish (Scarids)*	6.0	21.0	3.0	1.0	-66.7
Bumphead parrotfish	~	~	0	0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	3.0	4.3	5.7	0.6	-89.4
Butterflyfish (Chaetodonids)	23.0	30.5	25.0	14.2	-43.2
Angelfish (Pomacanthids)	6.0	9.5	17.0	4.0	-76.5
Wrasses (Labrids)	408.0	83.0	219.0	145.6	-33.5
Humphead wrasse	~	~	0	0	N/A
Damselfish (Pomacentrids)	900.0	2680.0	1314.7	1056.6	-19.6
Fairy Basslets (Anthids)	193.5	706.3	467.0	341.6	-26.9
Moorish Idols (Zanclids)	2.0	15.0	3.0	3.0	0.0
Total (target reef species)*	**22.5**	**43.4**	**41.0**	**28.6**	-30.2
Total (all reef species)	**1602.0**	**3599.0**	**2123.3**	**1600.6**	-24.6

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1995 to 1997, surgeonfish not included as a target species

Table 30. Changes in substrate composition (% mean ±SE) at White House Reef from 1994 to 2005.

	SCUBA SURVEY:					
	1994	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover	
SUBSTRATE COVER						
Sand (S) & silt (SI)	41.5	35.4	28.0	40.1	33.2	-17.2
Coral rubble (R)	10.4	6.8	15.3	14.5	6.0	-58.6
Rock & block (RCK)	13.3	4.3	0.9	7.6	5.4	-28.6
White dead standing coral (DA)	12.0	6.0	9.3	0.0	0.0	N/A
Dead coral with algae (DCA)	~	~	~	11.0	3.3	-70.1
Subtotal non-living substrate	***77.1***	***52.5***	***53.5***	***73.2***	***47.9***	-34.5
Branching (CB)	10.0	27.5	14.4	3.6	13.8	282.9
Massive (CM)	4.5	2.5	6.5	3.8	7.2	89.8
Flat/Encrusting (CE)	1.8	5.6	7.8	2.1	2.0	-4.8
Foliose/Cup (CF)	2.0	1.9	1.2	2.8	1.6	-43.9
Total Hard Coral	**18.3**	**37.4**	**29.9**	**12.3**	**24.6**	99.8
Total Soft Coral	4.7	10.2	12.5	11.4	**25.9**	127.4
Subtotal Coral	***22.9***	***47.5***	***42.4***	***23.7***	***50.5***	113.1
Sponges (SP)	~	~	~	0.5	0.3	-42.9
Other animals (OT)	~	~	~	0.0	0.6	+
Algae						
Fleshy (MA)	~	~	~	2.1	0.1	-96.6
Turf (TA)	~	~	~	0.4	0.5	25.0
Coralline (CA)	~	~	~	0.1	0.1	-28.6
Seagrass (SG)	~	~	~	~	0.0	N/A
Subtotal Others	***~***	***~***	***~***	***3.1***	***1.6***	-49.3
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters						
Mean Slope (degrees)	~	~	6	~	5.0	N/A
Mean Topography(m)*	~	~	1.0	1.0	0.9	-10.0
Mean Depth/Range (m)	4	4	4	5.3	4.3	-18.1
Horizontal Visibility (m)	22.0	18.0	22.0	14.5	16.0	10.3
No. of 50 m Transects	2	2	4	4	7	

~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 31. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family at White House Reef in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	2.6	0.9	5.8	4.0	0.6	0.0	10.4	3.0
Rabbitfish (Siganids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groupers (Serranids)*	0.2	0.2	0.0	0.2	0.0	0.0	0.2	0.2
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.6	0.4	1.8	1.0	0.0	0.0	2.8	1.8
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinecheeks (Nemipterids)*	1.4	0.4	0.6	3.4	0.0	0.0	4.0	1.3
Goatfish (Mullids)*	0.8	0.4	1.8	1.0	0.0	0.0	2.8	1.7
Parrotfish (Scarids)*	1.0	0.5	2.2	0.8	0.6	0.0	3.6	2.0
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	0.2	0.2	0.2	0.0	0.0	0.0	0.2	0.2
Butterflyfish (Chaetodonids)	4.0	0.7	10.0	2.4	0.0	0.0	12.4	3.0
Angelfish (Pomacanthids)	1.0	0.3	4.8	1.2	0.0	0.0	6.0	1.6
Wrasses (Labrids)	9.0	1.9	88.8	0.0	0.0	0.0	88.8	24.2
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	13.6	1.2	742.6	0.0	0.0	0.0	742.6	114.1
Fairy Basslets (Anthids)	1.6	0.2	551.6	0.0	0.0	0.0	551.6	247.0
Moorish Idols (*Zanclus cornutus*)	0.6	0.2	1.4	0.0	0.0	0.0	1.4	0.5
Total (target reef species)*	**6.6**	**1.2**	**6.4**	**10.4**	**1.2**	**0.0**	**18.0**	**4.2**
Total (all reef species)	**36.6**	**3.4**	**1411.6**	**14.0**	**1.2**	**0.0**	**1426.8**	**316.6**

* Target species/families

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

Table 32. Mean (±SE) fish species (species/500m^2) and percentage change between years at White House Reef from 2001 to 2005.

FAMILY	(N=2) 2001 species	(N=5) 2005 species	% Change 2001-2005
Surgeonfish (Acanthurids)*	1.5	2.6	73.3
Rabbitfish (Siganids)*	0.5	0.0	-100.0
Groupers (Serranids)*	1.0	0.2	-80.0
Barramundi cod	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	0.0	-100.0
Sweetlips (Haemulids)*	0.0	0.0	N/A
Emperors (Lethrinids)*	0.5	0.6	20.0
Jacks (Carangids)*	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	1.5	1.4	-6.7
Goatfish (Mullids)*	2.0	0.8	-60.0
Parrotfish (Scarids)*	2.0	1.0	-50.0
Bumphead parrotfish	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A
Triggerfish (Balistids)	1.5	0.2	-86.7
Butterflyfish (Chaetodonids)	4.5	4.0	-11.1
Angelfish (Pomacanthids)	1.5	1.0	-33.3
Wrasses (Labrids)	5.5	9.0	63.6
Humphead wrasse	0.0	0.0	N/A
Damselfish (Pomacentrids)	16.0	13.6	-15.0
Fairy Basslets (Anthids)	2.0	1.6	-20.0
Moorish Idols (Zanclids)	0.5	0.6	20.0
Total (target reef species)*	**10.0**	**6.6**	-34.0
Total (all reef species)	**41.5**	**36.6**	-11.8

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

Table 33. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years at White House Reef from 2001 to 2005.

FAMILY	(N=2) 2001 density	(N=5) 2005 density	% Change 2001-2005
Surgeonfish (Acanthurids)*	10.5	10.4	-1.0
Rabbitfish (Siganids)*	1.0	0.0	-100.0
Groupers (Serranids)*	1.5	0.2	-86.7
Barramundi cod	0.0	0.0	N/A
Snapper (Lutjanids)*	1.5	0.0	-100.0
Sweetlips (Haemulids)*	0.0	0.0	N/A
Emperors (Lethrinids)*	16.5	2.8	-83.0
Jacks (Carangids)*	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	28.5	4.0	-86.0
Goatfish (Mullids)*	12.0	2.8	-76.7
Parrotfish (Scarids)*	3.5	3.6	2.9
Bumphead parrotfish	0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A
Triggerfish (Balistids)	3.5	0.2	-94.3
Butterflyfish (Chaetodonids)	16.5	12.4	-24.8
Angelfish (Pomacanthids)	24.0	6.0	-75.0
Wrasses (Labrids)	65.5	88.8	35.6
Humphead wrasse	0.0	0.0	N/A
Damselfish (Pomacentrids)	680.5	742.6	9.1
Fairy Basslets (Anthids)	321.0	551.6	71.8
Moorish Idols (Zanclids)	3.0	1.4	-53.3
Total (target reef species)*	**64.5**	**18.0**	-72.1
Total (all reef species)	**1189.0**	**1426.8**	20.0

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

Table 34. Changes in substrate composition (% mean ±SE) in Sepoc from 1993 to 2005.

	SCUBA SURVEYS:						SNORKEL SURVEYS:					
	1993	1995	1997	2001	2005	% Change 2001-2005	1993	1995	1997	2001	2005	% Change 2001-2005
	% cover	% cover	% cover	% cover	% cover		% cover	% cover	% cover	% cover	% cover	
SUBSTRATE COVER												
Sand (S) & Silt (SI)	15.5	5.2	4.8	5.0	2.5	-49.6	12.1	6.8	2.2	0.2	0.1	-37.3
Coral Rubble (R)	11.9	11.5	8.5	17.6	11.4	-35.1	11.0	8.8	1.4	2.8	1.5	-46.3
Rock & Block (RCK)	22.4	4.7	11.0	7.3	9.4	27.8	37.3	12.2	7.7	9.5	4.7	-50.5
White Dead Standing Coral (DA)	0.4	0.9	4.8	0.5	0.8	50.0	0.8	2.1	3.5	1.7	6.2	258.9
Dead Coral with Algae (DCA)	~	~	~	10.0	16.9	69.4	~	~	~	7.6	15.7	106.9
Subtotal Non-living Substrate	***50.2***	***22.3***	***29.1***	***40.4***	***41.0***	1.4	***61.2***	***29.9***	***14.8***	***21.7***	***28.2***	29.7
Branching (CB)	16.5	34.1	28.4	32.3	18.6	-42.5	23.4	46.5	60.4	63.0	47.9	-24.0
Massive (CM)	11.9	10.1	9.6	12.6	9.6	-24.0	4.8	7.1	8.2	3.3	1.8	-43.5
Flat/Encrusting (CE)	12.0	11.5	8.4	5.5	5.8	5.3	8.5	10.3	6.3	3.5	4.5	28.8
Foliose/Cup (CF)	2.7	1.9	2.9	1.6	2.9	80.8	0.9	5.1	6.3	5.3	8.5	58.7
Total Hard Coral	**43.1**	**57.6**	**49.2**	**52.0**	**36.8**	-29.1	**37.6**	**68.1**	**81.2**	**75.1**	62.7	-16.5
Total Soft Coral	**6.6**	**20.1**	**21.6**	**6.3**	**16.6**	164.2	**1.2**	**2.0**	**4.0**	**1.4**	**0.6**	-58.7
Subtotal Coral	***49.7***	***77.7***	***70.9***	***58.3***	***53.4***	-8.3	***38.8***	***70.1***	***85.2***	***76.5***	***63.3***	-17.3
Sponges (SP)	~	~	~	0.8	0.5	-37.5	~	~	~	0.0	0.1	+
Other animals (OT)	~	~	~	~	1.1	N/A	~	~	~	~	0.9	N/A
Algae												
Fleshy (MA)	~	~	~	0.4	0.9	134.4	~	~	~	0.9	3.9	328.3
Turf (TA)	~	~	~	0.1	1.3	900.0	~	~	~	0.9	0.9	6.2
Coralline (CA)	~	~	~	0.0	1.8	+	~	~	~	0.0	2.8	+
Seagrasses (SG)	~	~	~	~	0.0	N/A	~	~	~	~	0.0	N/A
Subtotal Others	**~**	**~**	**~**	***1.3***	***5.6***	319.8	**~**	**~**	**~**	***1.8***	***8.5***	376.4
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	
Environmental Parameters												
Mean Slope (degrees)	**~**	**~**	11	3.4	15.0	341.2	~	~	6	2	9.0	350.0
Mean Topography (m)*	**~**	**~**	1.5	1.1	2.3	112.1	~	~	1.0	1.3	1.2	-10.3
Mean Depth/Range (m)	8	6-8	6-8	6.6	7.0	6.1	3-4	2-4	3-5	3.0	2.6	-14.6
Horizontal Visibility (m)	20	18	21	18.3	19.4	5.9	20	18	25	17.1	20.0	17.0
No. of 50 m Transects	3	3	11	12	8.0		40[a]	60[a]	150[a]	150[a]	11.0	

a = total no. of stops made by snorkelers
~ no data available
* mean distance between lowest and highest point on the horizontal transect line

%change = [(Yr2/Yr1)-1] x 100
(-) = decrease
(+) = increase

Table 35. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Sepoc Point in 2005.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.0	0.4	18.0	21.0	0.2	0.0	39.2	7.9
Rabbitfish (Siganids)*	0.2	0.2	0.4	0.0	0.0	0.0	0.4	0.4
Groupers (Serranids)*	0.6	0.4	0.0	0.6	0.0	0.0	0.6	0.4
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.8	0.2	0.0	1.6	0.0	0.2	1.8	0.9
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.2	0.2	0.0	0.2	0.0	0.0	0.2	0.2
Fusiliers (Caesionids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinecheeks (Nemipterids)*	0.2	0.2	0.0	1.8	0.0	0.0	1.8	1.8
Goatfish (Mullids)*	0.4	0.2	0.0	0.4	0.0	0.0	0.4	0.2
Parrotfish (Scarids)*	2.6	0.7	0.0	11.0	0.8	0.0	11.8	3.0
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	1.4	0.4	4.4	2.6	0.0	0.0	7.0	4.1
Butterflyfish (Chaetodonids)	5.0	0.7	17.0	0.0	0.0	0.0	17.0	3.8
Angelfish (Pomacanthids)	3.2	0.7	13.6	0.2	0.0	0.0	13.8	6.9
Wrasses (Labrids)	8.4	1.4	33.6	0.0	0.0	0.0	33.6	8.9
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	14.0	0.6	2280.0	0.0	0.0	0.0	2280.0	503.8
Fairy Basslets (Anthids)	0.8	0.4	315.6	0.0	0.0	0.0	315.6	201.4
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	3.8	0.0	0.0	0.0	3.8	1.5
Total (target reef species)*	**8.0**	**1.1**	**0.4**	**36.6**	**1.0**	**0.2**	**38.2**	**7.7**
Total (all reef species)	**41.6**	**1.0**	**2686.4**	**39.4**	**1.0**	**0.2**	**2727.0**	**425.2**

* Target species/families

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

Table 36. Mean (±SE) fish species (species/500m^2) and percentage change between years in Sepoc Point from 1993 to 2005.

FAMILY	(N=1) 1993 species	(N=4) 1995 species	(N=8) 1997 species	(N=4) 2001 species	(N=5) 2005 species	% Change 2001-2005
Surgeonfish (Acanthurids)*	4.0	3.0	3.3	4.8	3.0	-36.8
Rabbitfish (Siganids)*	0.0	0.3	0.4	0.5	0.2	-60.0
Groupers (Serranids)*	0.0	0.3	0.4	1.3	0.6	-52.0
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.3	0.4	1.0	0.8	-20.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.0	0.0	0.0	0.0	0.0	N/A
Jacks (Carangids)*	0.0	0.0	0.0	0.3	0.2	-20.0
Fusiliers (Caesionids)*	0.0	0.0	0.5	0.3	0.0	-100.0
Spinecheeks (Nemipterids)*	1.0	0.5	0.4	0.8	0.2	-73.3
Goatfish (Mullids)*	1.0	1.0	1.0	1.0	0.4	-60.0
Parrotfish (Scarids)*	1.0	1.0	1.0	2.3	2.6	15.6
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.3	0.0	-100.0
Triggerfish (Balistids)	1.0	1.3	2.0	1.0	1.4	40.0
Butterflyfish (Chaetodonids)	8.0	6.5	6.8	6.0	5.0	-16.7
Angelfish (Pomacanthids)	1.0	2.0	3.1	3.5	3.2	-8.6
Wrasses (Labrids)	4.0	3.5	5.5	9.3	8.4	-9.2
Humphead wrasse	~	~	~	0	0	N/A
Damselfish (Pomacentrids)	8.0	8.8	12.4	14.8	14.0	-5.1
Fairy Basslets (Anthids)	2.0	2.0	1.9	1.0	0.8	-20.0
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	0.8	-20.0
Total (target reef species)*	**4.0**	**3.4**	**4.0**	**12.3**	**8.0**	-34.7
Total (all reef species)	**33.0**	**31.5**	**39.9**	**48.8**	**41.6**	-14.7

* Species sought by fishermen.

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 37. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years in Sepoc Point from 1993 to 2005.

FAMILY	(N=1) 1993 density	(N=4) 1995 density	(N=8) 1997 density	(N=4) 2001 density	(N=5) 2005 density	% Change 2001-2005
Surgeonfish (Acanthurids)*	78.0	58.0	80.5	73.0	39.2	-46.3
Rabbitfish (Siganids)*	0.0	0.3	5.6	1.0	0.4	-60.0
Groupers (Serranids)*	0.0	0.3	0.4	2.5	0.6	-76.0
Barramundi cod	~	~	~	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.3	0.4	4.0	1.8	-55.0
Sweetlips (Haemulids)*	0.0	0.0	4.1	0.0	0.0	N/A
Emperors (Lethrinids)*	9.0	0.0	0.0	0.0	0.0	N/A
Jacks (Carangids)*	0.0	0.0	0.0	0.8	0.2	-73.3
Fusiliers (Caesionids)*	0.0	0.0	24.4	2.3	0.0	-100.0
Spinecheeks (Nemipterids)*	9.0	3.0	1.4	5.0	1.8	-64.0
Goatfish (Mullids)*	9.0	5.0	7.4	21.0	0.4	-98.1
Parrotfish (Scarids)*	33.0	11.0	15.8	8.8	11.8	34.9
Bumphead parrotfish	~	~	~	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	2.3	0.0	-100.0
Triggerfish (Balistids)	9.0	1.8	13.8	4.0	7.0	75.0
Butterflyfish (Chaetodonids)	43.0	28.0	26.1	30.5	17.0	-44.3
Angelfish (Pomacanthids)	9.0	5.3	44.5	32.8	13.8	-57.9
Wrasses (Labrids)	174.0	199.0	79.9	96.3	33.6	-65.1
Humphead wrasse	~	~	~	0.0	0.0	N/A
Damselfish (Pomacentrids)	234.0	522.0	1794.8	2128.3	2280.0	7.1
Fairy Basslets (Anthids)	258.0	450.0	1346.4	139.5	315.6	126.2
Moorish Idols (Zanclids)	9.0	9.0	14.3	7.5	3.8	-49.3
Total (target reef species)*	**60.0**	**19.9**	**59.4**	**69.5**	**38.2**	-45.0
Total (all reef species)	**874.0**	**1293.0**	**3459.6**	**2559.3**	**2727.0**	6.6

* Target species/families

% change = $\{(Yr_2/Yr_1)-1\} \times 100$

(-) = decrease

(+) = increase

From 1993 to 1997, surgeonfish not included as a target species

Table 38. Human activities and other causes of stress affecting the coral reef on sites surveyed during a survey day, March, 2005.

SITE NAME / SITE INFORMATION	Arthur's Rock Sanctuary					Twin rocks Sanctuary					Cathedral Rock and Reef Sanctuary		
	1993	1995	1997	2001	2005	1993	1995	1997	2001	2005	1995	2001	2005
Type of reef	Gradual slope					Steep slope					Pinnacle rock and slope		
Site description	Sheltered					Sheltered					Sheltered		
SITE CLASSIFICATION													
Fish sanctuary	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Fishing village	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
Resort	yes	yes	yes	yes	yes	no	no	no	no	yes	yes	yes	yes
Beach with access	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no
A. FISHING STRESSES AND THREATS TO THE AREA													
# of fishing boats w/in 500m	0	2	1	2	0	0	0	0	0	3	0	0	2
# of aquarium fishers w/in 500m	0	0	0	0	0	0	0	0	0	0	0	0	0
# of gleaners for food or curios w/in 500m	1	0	0	2	3	0	0	1	0	0	0	0	0
# of blasts heard during the dive	~	~	~	~	0	~	~	~	~	0	~	~	0
% of area used for mariculture w/in 1km	~	~	~	~	0	~	~	~	~	0	~	~	0
B. POPULATION STRESSES AND THREATS													
Distance to nearest population (km)	2	2	3	3	3.5	0.5	0.5	0.5	0.5	0.5	1	1	1
Approximate population (x1000)	2	2	3	3	5	2	2	2	2	2.5	1	2	2000
# of factories/km of adjacent coast	~	~	~	~	~	~	~	~	~	~	~	~	~
Distance to nearest river (km)	1	1	1	1	1	0.5	0.5	0.5	0.5	0.5	1	1	1
% of farmed area of coastline	~	~	~	~	~	~	~	~	~	~	50%	50%	50%
% of forested area of coastline	50%	40%	30%	25%	25%	80%	80%	80%	80%	70%	50%	50%	30%
# of mines within sight	~	~	~	~	~	~	~	~	~	~	~	~	~
# of items of floating trash observed*	F*	F*	F*	F*	few**	F*	F*	F*	A*	many**	F*	F*	some
# of items of trash observed underwater*	F*	F*	F*	F*	few**	F*	F*	F*	A*	many**	F*	F*	some
# of fish nets left as trash*	~	~	~	~	~	~	~	~	~	0	~	~	0
C. TOURISM STRESSES													
# of boats anchoring w/in 500m	10	15	10-15	10-15	~	4	9	5	10	15	2	6	23
# of dive shops w/in 10km	20	20	30	30	>30	20	20	30	>30	>30	20	30	30
% of coast build-up with structure	50%	60%	75%	75%	25%	20	20	20	30	35	75	75	80
# of divers observed w/in 500m	20-30	40	20	20	20	20	45-50	30	30	>30	10	20	20
D. OTHER STRESSES AND THREATS													
# years since last typoon (>100kph)	5	7	9	12	16	5	7	9	12	15	7	12	15
# of large ships w/in sight	~	~	~	2	1	~	~	~	3	6	~	1	1
# years since last bleaching	~	~	~	3	6	~	~	~	3	6	~	3	6
% of bleached coral area	~	~	~	<5%	~	~	~	~	<10%	~	~	<3%	~
% of diseased coral area	<2%	<2%	<2%	<2%	~	~	~	~	<5%	~	~	<2%	~

~ - No data
* ~ - not observed (using old report guide)
F - Few
A - Abundant
** ~ - Not observed (using updated report guide)
Few - <20 pieces
Some - >20 pieces
Many - > 100 pieces

Table 38. Human activities and other causes of stress affecting the coral reef on sites surveyed during a survey day, March, 2005.

SITE INFORMATION \ SITE NAME	Pulang-Buli/Batalang Bato Marine Sanctuary					White House Reef	White Sand Reef				Layag-layag				
	1993	1995	1997	2001	2005	2005	1995	1997	2001	2005	1993	1995	1997	2001	2005
Type of reef	Slope					Flat	Flat				Fringe				
Site description	Exposed					Sheltered	Sheltered				Sheltered				
SITE CLASSIFICATION															
Fish sanctuary	no	no	no	no	yes	no	no	no	no	no	no	no	no	no	no
Fishing village	yes	yes	yes	yes	yes	no	no	no	no	no	no	no	no	no	no
Resort	no	no	no	no	no	yes	yes	yes	yes	yes	no	no	no	no	no
Beach with access	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
A. FISHING STRESSES AND THREATS TO THE AREA															
# of fishing boats w/in 500m	0	1	5	3	1	0	0	0	1	1	1	2	1	3	3
# of aquarium fishers w/in 500m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
# of gleaners for food or curios w/in 500m	0	1	1	1	0	2	1	1	1	1	0	1	1	0	2
# of blasts heard during the dive	~	~	~	~	0	0	~	~	~	0	~	~	~	~	0
% of area used for mariculture w/in 1km	~	~	~	~	0	~	~	~	~	0	~	~	~	~	~
B. POPULATION STRESSES AND THREATS															
Distance to nearest population (km)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	~	~	~	2	2
Approximate population (x1000)	~	~	~	2	3	3	2	3	3	3.5	~	~	~	2	3
# of factories/km of adjacent coast	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Distance to nearest river (km)	~	~	~	~	~	0.5	0.5	0.5	0.5	0.5	~	~	~	~	~
% of farmed area of coastline	~	~	~	~	20%	5%	~	~	~	~	~	~	~	~	5%
% of forested area of coastline	~	~	~	50%	50%	60%	70%	70%	70%	60%	~	~	~	80%	80%
# of mines within sight	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
# of items of floating trash observed*	F*	F*	F*	A*	0	few	F*	F*	A*	few	F*	F*	F*	A*	some
# of items of trash observed underwater*	F*	F*	F*	A*	few	few	F*	F*	A*	few	F*	F*	F*	A*	few
# of fish nets left as trash*	~	~	~	~	0	0	~	~	~	~	~	~	~	~	
C. TOURISM STRESSES															
# of boats anchoring w/in 500m	2	1	10	2	3	10	2	3	4	5	2	2	4	6	4
# of dive shops w/in 10km	~	~	~	30	30	30	20	30	30	30	~	~	~	15	>15
% of coast build-up with structure	~	~	~	10	20	40	10	15	20	40	~	~	~	20	20
# of divers observed w/in 500m	10	7	29	11	20	20	6	12	5	20	10	10	16	20	20
D. OTHER STRESSES AND THREATS															
# years since last typoon (>100kph)	5	7	9	12	15	15	7	9	12	15	5	7	9	12	15
# of large ships w/in sight	~	~	~	2	0	0	~	~	1	1	~	~	~	1	1
# years since last bleaching	~	~	~	3	6	6	~	~	3	6	~	~	~	3	6
% of bleached coral area	~	~	~	<5%	~	~	~	~	>20%	~	~	~	~	10%	~
% of diseased coral area	~	~	~	<10%	~	~	~	~	>70%	~	~	~	~	~	~

~ - No data
* ~ - not observed (using old report guide)
F - Few
A - Abundant
** ~ - Not observed (using updated report guide)
Few - <20 pieces
Some - >20 pieces
Many - > 100 pieces

Table 38. Human activities and other causes of stress affecting the coral reef on sites surveyed during a survey day, March, 2005.

SITE NAME / SITE INFORMATION	Sombrero Island					Sepoc Point				
	1993	1995	1997	2001	2005	1993	1995	1997	2001	2005
Type of reef	Slope					Flat				
Site description	Exposed					Exposed				
SITE CLASSIFICATION										
Fish sanctuary	no	no	no	no	no	no	no	no	no	no
Fishing village	no	no	no	no	no	no	no	no	no	no
Resort	no	no	no	no	no	no	no	no	no	yes
Beach with access	yes	yes	yes	no	no	yes	yes	yes	yes	yes
A. FISHING STRESSES AND THREATS TO THE AREA										
# of fishing boats w/in 500m	3	3	9	8	1	0	2	3	5	3
# of aquarium fishers w/in 500m	0	0	0	0	0	0	0	0	0	0
# of gleaners for food or curios w/in 500m	0	1	1	2	2	1	1	0	0	2
# of blasts heard during the dive	~	~	~	~	0	~	~	~	~	0
% of area used for mariculture w/in 1km	~	~	~	~	0	~	~	~	~	0
B. POPULATION STRESSES AND THREATS										
Distance to nearest population (km)	3	3	3	3	3	~	~	~	3	3
Approximate population (x1000)	~	~	~	2	3	~	~	~	2	3
# of factories/km of adjacent coast	~	~	~	~	~	~	~	~	~	~
Distance to nearest river (km)	~	~	~	~	~	~	~	~	~	~
% of farmed area of coastline	~	~	~	~	~	~	~	~	~	10%
% of forested area of coastline	~	~	~	~	50%	~	~	~	90%	85%
# of mines within sight	~	~	~	~	~	~	~	~	~	~
# of items of floating trash observed*	F*	F*	F*	A*	few	F*	F*	F*	A*	some
# of items of trash observed underwater*	F*	F*	F*	A*	few	F*	F*	F*	F*	some
# of fish nets left as trash*	~	~	~	~	1	~	~	~	~	2
C. TOURISM STRESSES										
# of boats anchoring w/in 500m	2	3	30	5	3	3	2	5	10	6
# of dive shops w/in 10km	~	~	~	30	30	~	~	~	30	30
% of coast build-up with structure	~	~	~	5	5	~	~	~	10	15
# of divers observed w/in 500m	10	8	50	10	30	16	10	30	>50	>40
D. OTHER STRESSES AND THREATS										
# years since last typoon (>100kph)	5	7	9	12	15	5	7	9	12	15
# of large ships w/in sight	~	~	~	2	1	~	~	~	3	6
# years since last bleaching	~	~	~	3	6	~	~	~	3	6
% of bleached coral area	~	~	~	>10%	~	~	~	~	<10%	15%
% of diseased coral area	~	~	~	>5%	~	~	~	~	<5%	10%

~ - No data
* ~ - not observed (using old report guide)
F - Few
A - Abundant
** ~ - Not observed (using updated report guide)
Few - <20 pieces
Some - >20 pieces
Many - > 100 pieces

Table 38. Human activities and other causes of stress affecting the coral reef on sites surveyed during a survey day, March, 2005.

SITE NAME / SITE INFORMATION	Dive and Trek Sanctuary	Cemetery Beach			Selo Point		Caban Cove
	2001	1993	1995	1997	1993	1995	1997
Type of reef	Fringe/Slope	Slope			Slope		Flat
Site description	Sheltered	Sheltered			Sheltered		Exposed
SITE CLASSIFICATION							
Fish sanctuary	yes	no	no	no	no	no	no
Fishing village	no	no	no	no	yes	yes	yes
Resort	yes	no	no	no	no	no	no
Beach with access	no	yes	yes	yes	yes	yes	yes
A. FISHING STRESSES AND THREATS TO THE AREA							
# of fishing boats w/in 500m	1	1	2	0	3	0	5
# of aquarium fishers w/in 500m	1	0	0	0	0	0	0
# of gleaners for food or curios w/in 500m	0	1	1	0	1	0	0
# of blasts heard during the dive	~	~	~	~	~	~	~
% of area used for mariculture w/in 1km	~	~	~	~	~	~	~
B. POPULATION STRESSES AND THREATS							
Distance to nearest population (km)	1	~	~	3	~	0.5	5
Approximate population (x1000)	1	~	~	~	~	~	~
# of factories/km of adjacent coast	~	~	~	~	~	~	~
Distance to nearest river (km)	~	~	~	~	~	~	~
% of farmed area of coastline	~	~	~	~	~	~	
% of forested area of coastline	80%	~	~	~	~	~	~
# of mines within sight	~	~	~	~	~	~	~
# of items of floating trash observed*	F*	F*	F*	F*	F*	F*	A*
# of items of trash observed underwater*	F*	F*	F*	F*	F*	F*	A*
# of fish nets left as trash*	~	~	~	~	~	~	~
C. TOURISM STRESSES							
# of boats anchoring w/in 500m	4	3	2	5-10	10	1	14
# of dive shops w/in 10km	7	~	~	20	~	30	30
% of coast build-up with structure	25	~	~	~	~	30	~
# of divers observed w/in 500m	0	10	8	10	30-40	8	22
D. OTHER STRESSES AND THREATS							
# years since last typoon (>100kph)	12	5	7	9	~	~	~
# of large ships w/in sight	2	~	~	~	~	~	~
# years since last bleaching	3	~	~	~	~	~	~
% of bleached coral area	<10%	~	~	~	~	~	~
% of diseased coral area	<5%	~	~	~	~	~	~

~ - No data
* ~ - not observed (using old report guide)
F - Few
A - Abundant
** ~ - Not observed (using updated report guide)
Few - <20 pieces
Some - >20 pieces
Many - > 100 pieces

Table 39. Mean number of invertebrates per 100m^2 from selected sites, Mabini and Tingloy, Batangas.

Invertebrates	Arthur's Rock Sanctuary		Twin Rocks Sanctuary		Cathedral Reef Sanctuary and Rock		Batalang Bato Sanctuary		Layag-layag Reef		Sombrero Island		White Sand Reef		Sepoc Point		White House Reef	
	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005
Diadema urchin	2.1	0.1	2.6	2.1	2.8	1.0	5.7	3.3	23.9	15.0	11.0	8.9	4.3	0.1	7.6	8.5	7.8	1.4
Pencil urchin	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.3	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.0
Crown-of-thorns seastar	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.5	0.0	0.0
Giant clam	0.7	0.8	0.5	1.3	1.7	0.4	0.0	0.0	0.3	0.3	0.0	0.1	0.4	0.0	0.0	0.1	0.3	0.1
Triton shell	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lobster	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Sea cucumber	0.0	0.1	0.3	0.2	1.2	0.1	1.1	2.3	1.2	0.3	0.1	0.1	1.3	0.8	0.3	0.0	1.3	0.6
Banded coral shrimp	0.1	0.1	0.2	0.1	0.0	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0

Table 40. Causes of coral damage observed in survey sites at Mabini and Tingloy, Batangas.

Cause of coral damage	Arthur's Rock Sanctuary		Twin Rocks Sanctuary		Cathedral Reef Sanctuary and Rock		Batalang Bato Sanctuary		Layag-layag Reef		Sombrero Island		White Sand Reef		Sepoc Point		White House Reef	
	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005
Sediment	m	m	E	M	M		m		m	m	m	m	M	m	M		m	m
Seaweed overgrowth	m	m	m			m					m	m				m	m	
Blasting patterns					m		m				E		m		m			
Coral-eating snails	m		m			m					m	m	m		m			
Crown of thorns seastar			m		m	m			m	m	m		m		m	m		
Plastics	m		M	m	m	m	M		m	m	M		m					
Other trash		m	M	m	m	m	M		m	m	M	m	m					
Bleaching	m		E		M		m		m		E		m		M	m	m	
Black band disease	m								m						m			
White band disease			m		m		m				m		m		m			
Other coral disease			m				m		M		M							
Anchor damage	M		E		E	m	M		E	m	E	M	M		E	m	m	
Other breakage	M	m	E	m	m	m	m		E	m	E	M	m		M			m

0 - not observed

m - (minor) observed 1 to 3 times

M - (moderate) observed 4 to 6 times

E - (extensive) - observed 7 times or more

Table 42. Mean biomass (mean ± SE) of selected target families at Mabini and Tingloy sites in Batangas in March 2005.

SITE	Arthur's Rock Sanctuary*	White Sand Reef	Layag-Layag	White House Reef	Sombrero I.	Pulang Buli Sanctuary*
Family	**g/500 m^2; n = 4**	**g/500 m^2; n = 4**	**g/500 m^2; n =3**	**g/500 m^2; n = 4**	**g/500 m^2; n = 4**	**g/500 m^2; n = 4**
Acanthuridae	787.28 ± 415.67	617.82 ± 313.42	2513.6 ± 1128.06	302.58 ± 201.93	1514.48 ± 1241.17	86124.62 ± 42429.95
Balistidae	10.38 ± 6.0	10.38 ± 10.38	87.10 ± 62.21	5.19 ± 5.19	31.154 ± 6.0	15.58 ± 4.97
Caesionidae	726.47 ± 726.47	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	7.26 ± 7.26	3447.96 ± 1364.47
Carangidae	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Haemulidae	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Labridae**	29.71 ± 13.10	18.74 ± 2.0	8.47 ± 8.50	13.55 ± 13.55	44.3 ± 37.71	76.88 ± 20.28
Lethrinidae	0.2 ± 0.2	0.0 ± 0.0	116.71 ± 95.88	133.95 ± 133.95	0.0 ± 0.0	57.77 ± 17.82
Lutjanidae	383.33 ± 339.78	0.25 ± 0.25	0.0 ± 0.0	0.0 ± 0.0	317.01 ± 317.01	1938.30 ± 497.60
Nemipteridae	246.31 ± 98.11	386.12 ± 81.57	36.38 ± 22.15	142.00 ± 105.33	64.13 ± 24.54	436.34 ± 121.41
Mullidae	26.83 ± 11.82	49.59 ± 29.33	78.08 ± 18.63	8.32 ± 8.32	14.81 ± 8.68	39.21 ± 6.88
Scaridae	1018.10 ± 692.43	157.42 ± 124.01	2455.64 ± 90.67	570.16 ± 537.62	247.68 ± 111.52	1096.74 ± 64.69
Siganidae	380.36 ± 380.36	0.0 ± 0.0	179.36 ± 179.57	0.0 ± 0.0	8.07 ± 8.07	140.35 ± 59.07
Serranidae	0.0 ± 0.0	11.14 ± 11.14	14.93 ± 7.47	0.0 ± 0.0	64.61 ± 55.22	491.29 ± 0.0
TOTAL BIOMASS	**3608.98 ± 2506.3**	**1251.5 ± 405.8**	**5490.3 ± 1123.4**	**1567.7 ± 807.5**	**2313.5 ± 1293.8**	**93865.1 ± 83963.7**

* Marine protected areas

** only larger labrids were included (e.g., *Bodianus* spp., *Cheilinus* spp. and *Hemigymnus* spp.)

SITE	Cathedral Reef Sanctuary*	Cathedral Rock	Twin Rocks Sanctuary*	Sepoc Pt.
Family	**g/500 m^2; n = 5**	**g/200m^2, n = 1**	**g/500 m^2; n = 5**	**g/500 m^2; n = 4**
Acanthuridae	604.85 ± 330.24	72749.29	8360.90 ± 4995.35	777.23 ± 241.35
Balistidae	90.94 ± 60.13	0.0	49.82 ± 18.80	72.94 ± 60.56
Caesionidae	9811.28 ± 9811.28	0.0	2779.01 ± 1919.36	0.0 ± 0.0
Carangidae	0.0 ± 0.0	12309.52	48.83 ± 48.84	39.45 ± 39.45
Haemulidae	0.0 ± 0.0	0.0	291.75 ± 189.40	0.0 ± 0.0
Labridae**	104.37 ± 77.76	33.48	112.27 ± 57.45	155.41 ± 92.57
Lethrinidae	43.61 ± 36.41	0.0	292.79 ± 169.94	0.0 ± 0.0
Lutjanidae	202.61 ± 95.59	479.23	4823.87 ± 2767.78	424.64 ± 200.96
Nemipteridae	32.96 ± 13.63	255.23	427.30 ± 157.98	0.0 ± 0.0
Mullidae	119.07 ± 119.07	0.0	319.26 ± 212.64	32.0 ± 15.90
Scaridae	4532.30 ± 3891.57	410.14	10512.10 ± 7822.50	1256.18 ± 455.17
Siganidae	501.44 ± 501.46	0.0	2163.60 ± 674.66	0.0 ± 0.0
Serranidae	103.81 ± 63.63	0.0	669.43 ± 315.80	5.60 ± 5.60
TOTAL BIOMASS	**16147 ± 9695.4**	**86236.89**	**30851 ± 11726.9**	**2763.5 ± 210.9**

* Marine protected areas

** only larger labrids were included (e.g., *Bodianus* spp., *Cheilinus* spp. and *Hemigymnus* spp.)

Table 43. Within site diifferences in familial biomass in g/500m^2 of selected target fish in Mabini and Tingloy areas in Batanagas in March 2005.

Nem=Nemipteridae, Acan=Acanthuridae, Scr=Scaridae, Lab = Labriae, Lut=Lutjanidae, Cae=Caesionidae, Sig=Siganidae, Ser=Serranidae

Site	Test	F/x^2	p	*Post hoc* (Bonferroni/Tukey-Kramer HSD)
Arthur's Rock Sanctuary	1-ANOVA		NS	
Canedral Reef	Kruskal Wallis		NS	
White Sand Reef	Kruskal Wallis	18.108	0.02	Nem>Acan>Scr>Lab*> all other families
Layag-layag	1-ANOVA	9.8299	0.001	Acan>Scar>all other families
White House Reef	Kruskal Wallis		NS	
Sombrero I.	Kruskal Wallis		NS	
Pulang Buli	1-ANOVA	2.2967	0.0447	NS
Twin Rocks Sanctuary	1-ANOVA	10.079	$\leq$ 0.0001	Scr>Acan>Lut>Cae=Sig>Ser>all other families
Sepoc Pt.	1-ANOVA	4.885	0.0029	Scr=Acan=Lut>all other families

* only larger labrids were included (e.g., *Bodianus* spp., *Cheilinus* spp. and *Hemigymnus* spp.)

Table 44. Between sites differences in familial biomass , total biomass and MPA vs. non-MPA biomass in g/500m^2 of selected target fish in Mabini and Tingloy sites in Batanagas in March 2005.

TW = Twin Rocks Sanctuary, PB = Pulang Buli Sanctuary, SP = Sepoc Pt., AR = Arthur's Rock Sanctuary, CR = Cathedral Reef Sanctuary, Som = Sombrero I., WH = White House Reef, WS = White Sand Reef, MPA =marine protected area NS = not significant

Family/factor	Test	F/x^2	p	*Post hoc* ranking (Bonferroni/Tukey-Kramer HSD)
Acanthuridae	1-ANOVA		NS	
Balistidae	1-ANOVA		NS	
Caesionidae	Kruskal-Wallis		NS	
Carangidae	Kruskal-Wallis		NS	
Haemulidae	Kruskal-Wallis		NS	
Labridae**	1-ANOVA		NS	
Lethrinidae	Kruskal-Wallis		NS	
Lutjanidae	1-ANOVA	4.926	0.0007	TW >PB>SP>AR> all other sites
Nemipteridae	1-ANOVA	4.4638	0.0014	TW=PB>all other sites>SP
Mullidae	1-ANOVA		NS	
Scaridae	1-ANOVA		NS	
Siganidae	Kruskal-Wallis		NS	
Serranidae	Kruskal-Wallis	25.619	0.001	PB>TW>CR>SOM>WH>SP=WS>AR
Total biomass	1-ANOVA	3.548	0.0062	TW > WSR
MPA vs. non-MPA	T-test		$\leq$ 0.001	MPA > non-MPA

** only larger labrids were included (e.g., *Bodianus* spp., *Cheilinus* spp. and *Hemigymnus* spp.)

Table 45. Between sites differences in percent live hard coral cover in Mabini and Tingloy sites in Batangas in March 2005.

CR=Cathedral Reef Sanctuary, ART=Arthur's Rock Sanctuary, SOM=Sombrero I., TW=Twin Rocks Sanctuary
SEP=Sepoc I., LAY=Layag-layag, PB=Pulang Buli, WH=White House Reef, WSR=White Sand Reef

Depth	Test	F	p	*Post hoc* ranking
2-4 m	1-ANOVA	21.117	≤ 0.0001	CR=ART=SOM=TW=SEP>LAY=PB=WH=WSR
7-8 m	1-ANOVA	19.929	≤ 0.0001	CR>ART=SOM=SEP=LAY=TW=WSR=WH>PB

Table 46. Differences in percent live hard coral cover within sites and between years 2001 and 2005 in Mabini and Tingloy areas in March 2005.

Shallow (2-4 m)

SITE	Test	p	*Post hoc* ranking
Shallow (2-4 m)			
Arthur's Rock Sanctuary	Mann - Witney U	≤ 0.0001	2005 > 2001
Cathedral Reef	Mann - Witney U	≤ 0.0001	2005>2001
White Sand Reef	Mann - Witney U	≤ 0.0001	data not sufficient
Layag-layag	Mann - Witney U	≤ 0.0001	2005 < 2001
White House Reef	Mann - Witney U	≤ 0.0001	data not sufficient
Sombrero I.	Mann - Witney U	≤ 0.0001	2005 > 2001
Pulang Buli	Mann - Witney U	≤ 0.0001	2005 < 2001
Twin Rocks Sanctuary	Mann - Witney U	≤ 0.0001	2005 > 2001
Sepoc Pt.	Mann - Witney U	≤ 0.0001	2005 < 2001
Deep (7-8 m)			
Arthur's Rock Sanctuary	Mann - Witney U	≤ 0.0001	2005 < 2001
Cathedral Reef	Mann - Witney U	≤ 0.0001	2005 > 2001
White Sand Reef	Mann - Witney U	≤ 0.0001	2005 > 2001
Layag-layag	Mann - Witney U	≤ 0.0001	2005 < 2001
White House Reef	Mann - Witney U	≤ 0.0001	2005 < 2001
Sombrero I.	Mann - Witney U	≤ 0.0001	2005 < 2001
Pulang Buli	Mann - Witney U	≤ 0.0001	2005 > 2001
Twin Rocks Sanctuary	Mann - Witney U	≤ 0.0001	2005 < 2001
Sepoc Pt.	Mann - Witney U	≤ 0.0001	2005 < 2001

SUMMARY OF FINDINGS AND TRENDS

Coral reef substrate and invertebrates

Live hard coral (LHC) cover in Mabini and Tingloy areas range from poor (15.6 ± 2.8: Pulang Buli MPA, 7-8 m) to excellent (75.3 ± 4.8: Cathedral reef, 7-8 m). Figures 33 & 34 summarizes the LHC changes over time. Surveys indicate that the overall physical condition of surveyed reefs appears improved in the shallow areas (3-4 m). An increasing trend is shown in Fig. 35. In addition, LHC cover in all shallow sites is higher compared to the deeper zone, except in Cathedral Reef. This variation in cover at different depths can be attributed in part to differences in light availability between zones. However, it was also observed that in majority of our sites, visibility was fairly low (< 10 – 15 m) and siltation was evident in some sites in deeper areas.

Figure 33. Changes in live hard coral (%mean ±SE) in sites at Mabini and Tingloy, Batangas from 1983 to 2005 (7-8m depth).

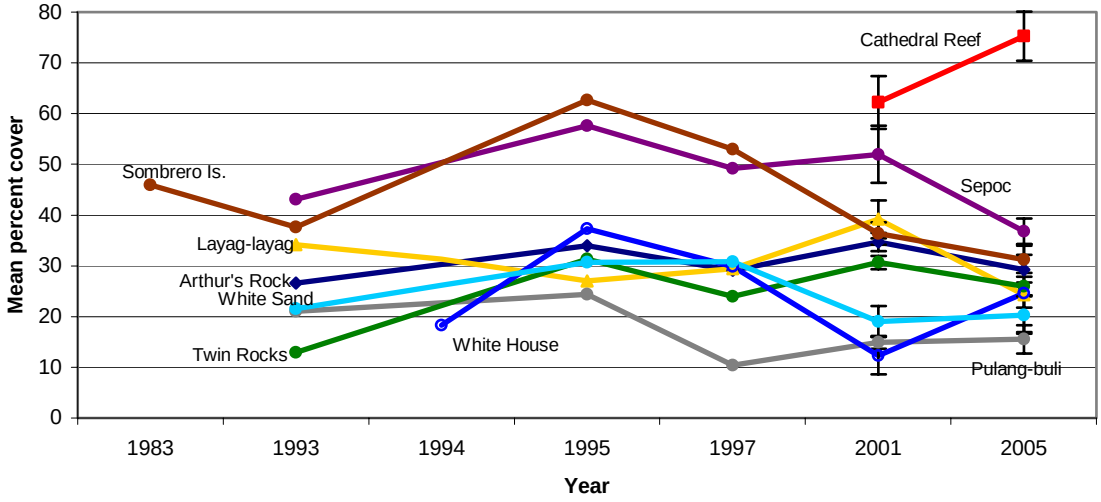
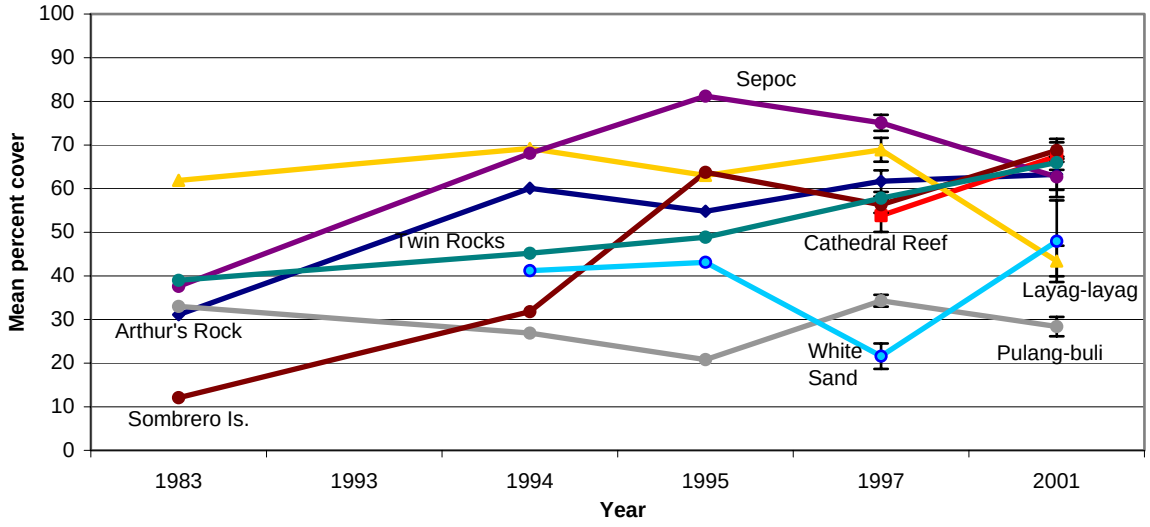


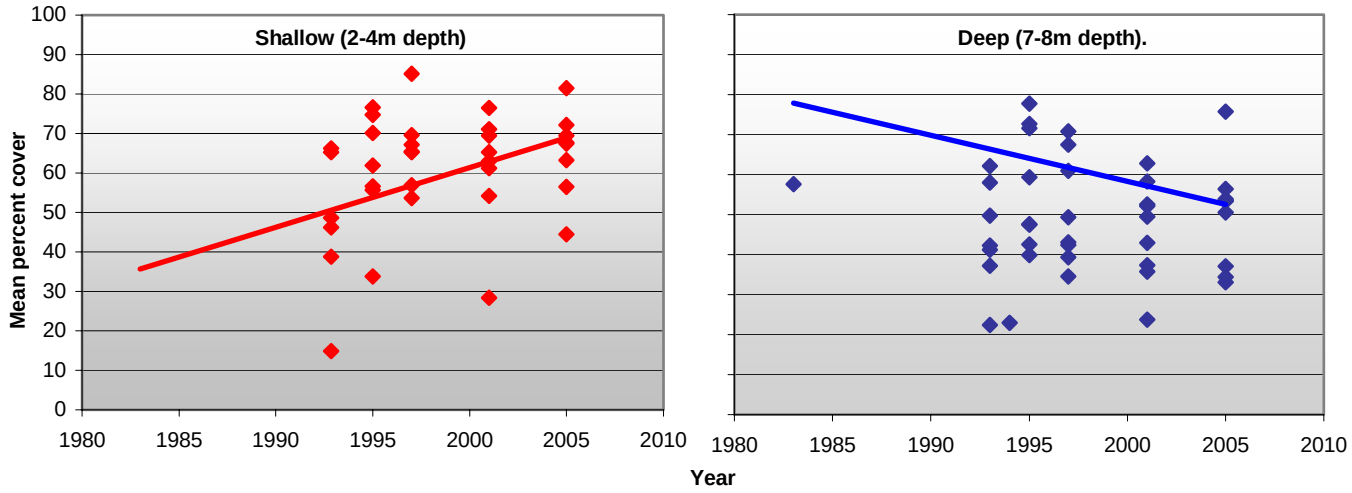
Figure 34. Changes in live hard coral (%mean SE) in sites at Mabini and Tingloy, Batangas from 1993 to 2005 (2-4m depth).



In contrast, a decreasing trend is seen at deeper areas (7-8 m; Fig 35). Most significant decreases ($p \leq 0.001$, Table 46) in LHC cover were observed in non-MPA sites. Surveys overtime indicated that human impact largely contributed to changes in LHC cover rather than natural perturbations unlike Tubbataha Reef (see Maypa *et al.* 2004). In sites, like Sepoc Point Reef, Sombrero Island and Layag-layag, anchor damage was apparent. During our most recent survey, it was observed that dive boats drop their anchors on corals and create further damage by dragging the same anchors. Rubble areas result.

No significant numbers of invertebrates were observed in any of the sites, except for Sepoc Point reef that showed a fairly high number of Crown-of-Thorns seastars in the shallow reef. This outbreak caused some destruction to the shallow reef that was composed mainly of *Acropora* corals.

Figure 35. Trend of average living coral cover for all sites monitored from 1983 to 2005.



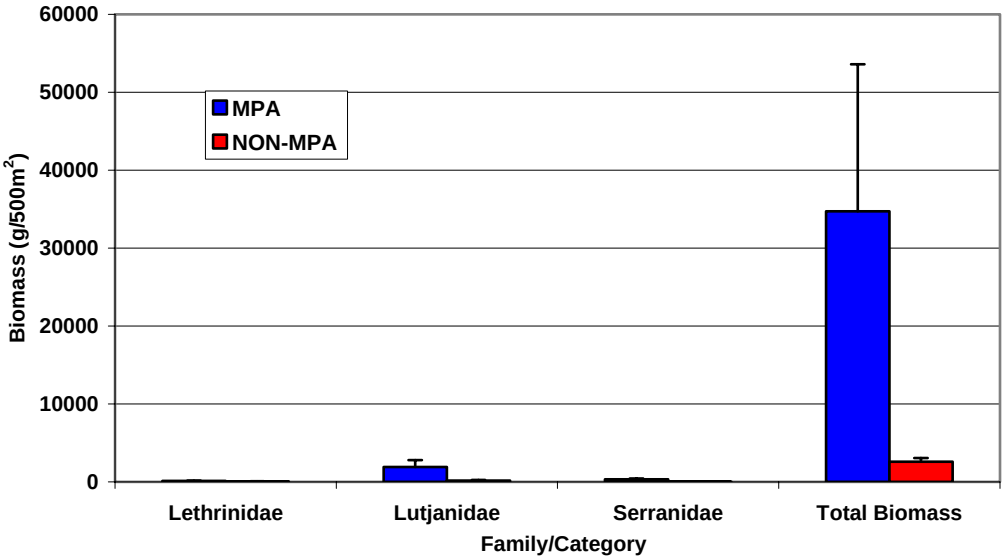
Mabini -Tingloy (Anilao) is a popular dive destination for foreign and local tourists (White *et al.* 2001, Solandt *et al.* 2003) but urgently needs enhancement and streamlining in management efforts and priorities. In the 1970s -1980s, the National Environment Protection Council made efforts to establish MPAs in Sombrero Island, Sepoc and Layag-layag, however were unsuccessful. In 1990-1991, Haribon Foundation together with the local communities successfully established Cathedral Rock, Arthur's Reef and Twin Rocks fish sanctuaries under the municipality of Mabini through a community-based approach (White *et al.* 2001, White and Vogt 2000, Solandt *et al.* 2003). In the mid 1990's, the Coastal Conservation and Education Foundation (formerly Sulu Fund), thru Earthwatch and the Saving Philippine Reefs Project, began a series of surveys until the present. In 1997, WWF-Philippines (Kabang-Kalikasan ng Pilipinas) also promoted this area as a key site within the Sulu-Sulawesi Marine Eco-Region Program (White and Vogt 2000). In addition, WWF worked with another Philippine-based NGO, the Philippine Reef and Rainforest Conservation Foundation Inc., and Coral Cay Conservation to conduct a baseline assessment for coral reefs for mapping purposes (Solandt *et al.* 2003). Community-based coastal resource management has, therefore, thrived in this area. However, sustained efforts are necessary to prevent the already observed declines in coral reef health.

Fish diversity, abundance, biomass and large marine life

Fish diversity, abundance of target species and biomass are higher in MPAs compared to non-MPAs (biomass, $p \leq 0.001$, Table 44, Fig. 37). Significantly higher biomass ($p = < 0.5$) of

piscivorous target fish families (Serranidae, Lutjanidae, Lethrinidae) were observed at Batalang Bato (Pulang Buli) and Twin Rocks sanctuaries. This reflects the good management and enforcement of these sanctuaries. Especially in Batalang Bato where soft coral comprises up to 44% of its substrate, still, Serranid biomass is significantly highest (491 g/500 m^2; p =`0.001, x^2 = 25.619) in this site compared to the rest. Arthur's Rock and Cathedral Rock sanctuaries had fewer target species and lower biomass. In addition, abundance and diversity of butterflyfish and angelfish appeared lower compared to previous years. These patterns indicate the possibility of poaching and/or high fishing pressure of both target and aquarium fish in adjacent fishing grounds. However, in terms of the fish list created of the study sites, overall, there was an increase species identified and listed in the area from 327 species in 2001 to a total of 368 species in 2005, with noticeable increases in most sites (Appendix 3).

Figure 36. Comparison of biomass of selected target fish families between MPAs and non-MPAs in Mabini-Tingloy areas, Batangas, during a March 2005 survey.*



*Total biomass included the following: Acanthuridae, Balistidae, Caesionidae, Carangidae, Haemulidae, Labridae (larger species only), Lethrinidae, Lutjanidae, Nemipteridae, Mullidae, Scaridae and Serranidae.

In non-MPA sites, although LHC cover may be fair to good, there is an alarming lack of target species, lack of larger sizes of fish and indicator species such as butterflyfish. This indicates high fishing pressure in the area, a condition that was also observed in previous years (White *et al.* 2001). There is also a lack of large marine life in the survey of 2005 where only one sea turtle and one shark were spotted. Yet in 2001, five different kinds of large (or uncommonly sighted) marine life were observed in various sites (Table 41). Although a few marine sanctuaries have been put in place, it may not be enough to balance the on going exploitation and degradation activities. This may result into the failure of these few marine sanctuaries in the expectation of biomass spillover (export of adult biomass) and recruitment spillover (export of propagules) (see Maypa *et al.*, 2002, Gell and Roberts 2003, Russ *et al.* 2003, 2004). Enhancement of management and enforcement efforts are urgently needed in this area for improvement of fish standing stocks.

Figure 37. Mean (±SE) species richness (species/500m^2) of all reef species at all surveyed sites in Mabini and Tingloy, Batangas.

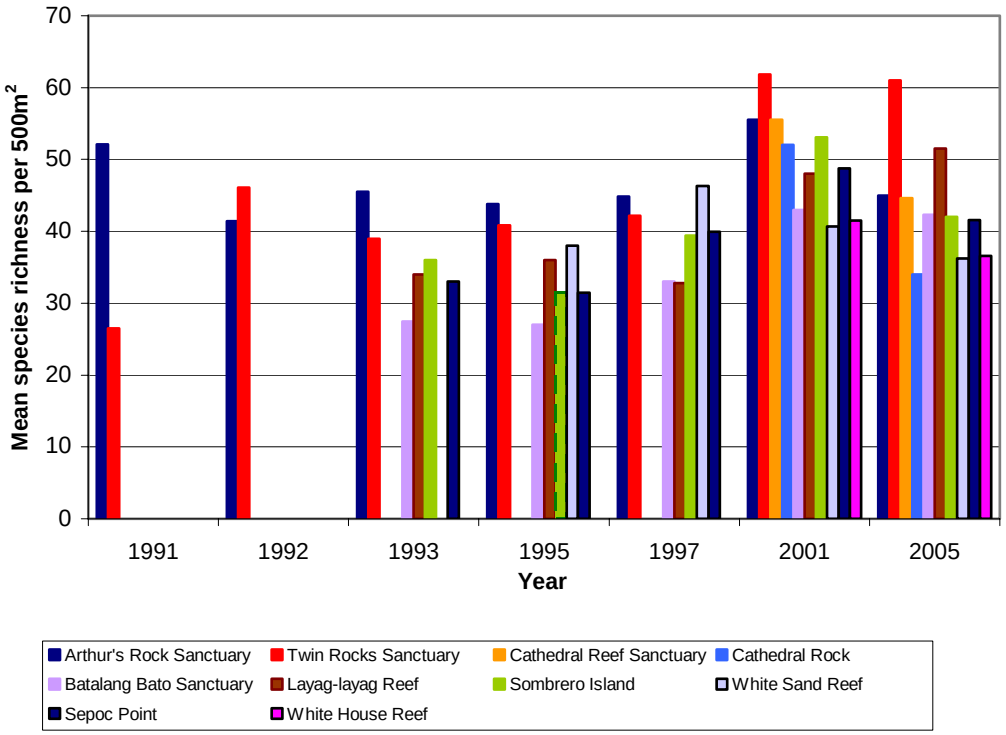


Figure 38. Mean (±SE) species richness (species/500 m^2) of target species at all surveyed sites in Mabini and Tingloy, Batangas.

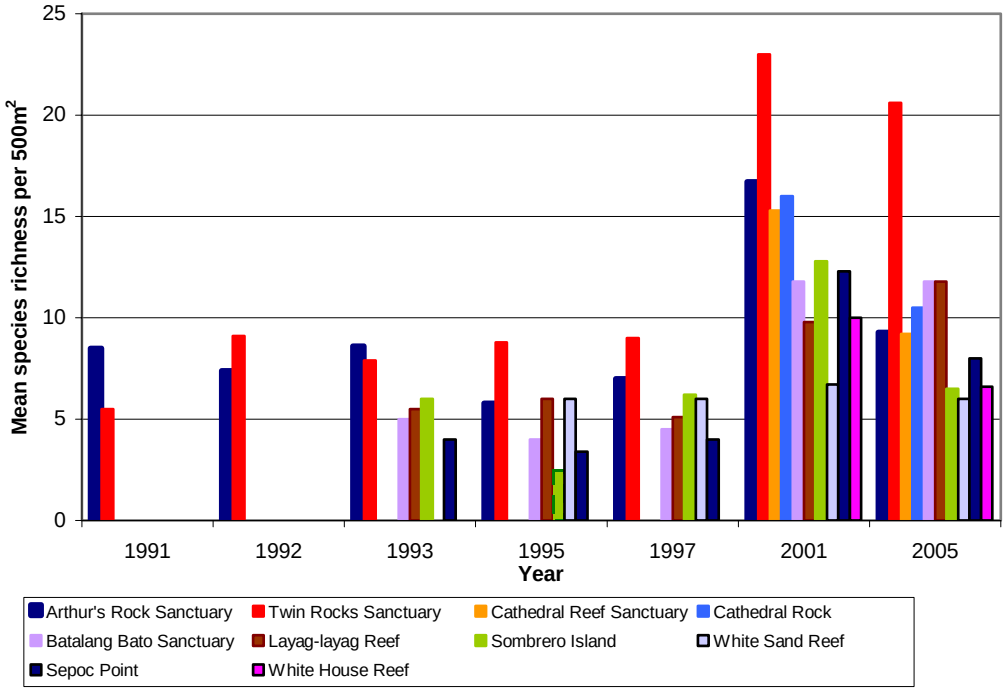


Figure 39. Mean (±SE) density (individuals/500m^2) of all reef species at all surveyed sites in Mabini and Tingloy, Batangas.

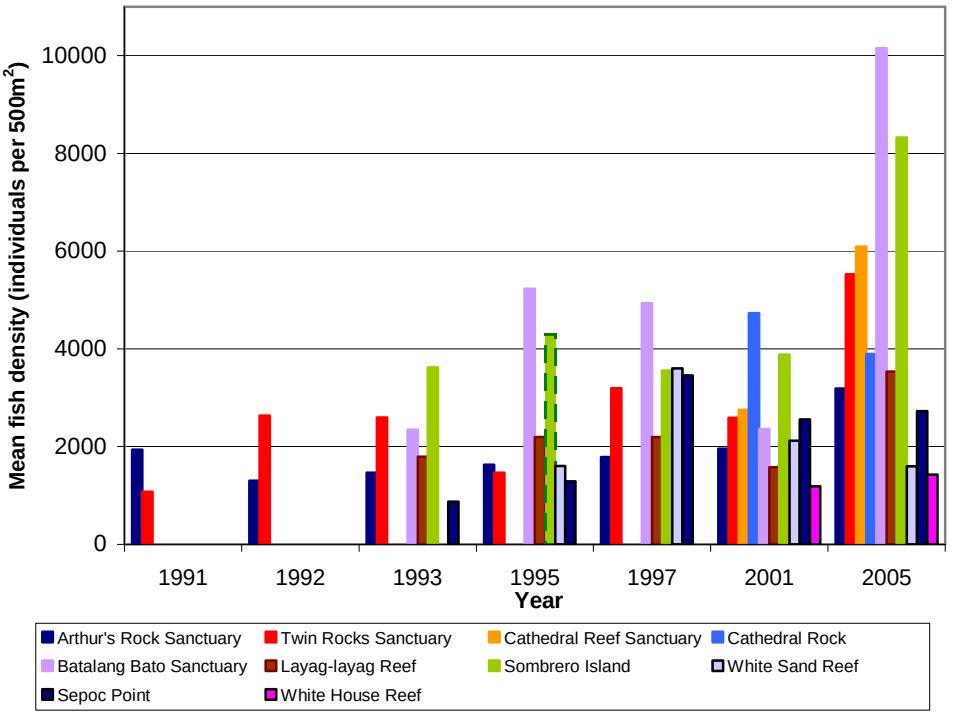


Figure 40. Mean (±SE) density (individuals/500m^2) of target species at all surveyed sites in Mabini and Tingloy, Batangas.

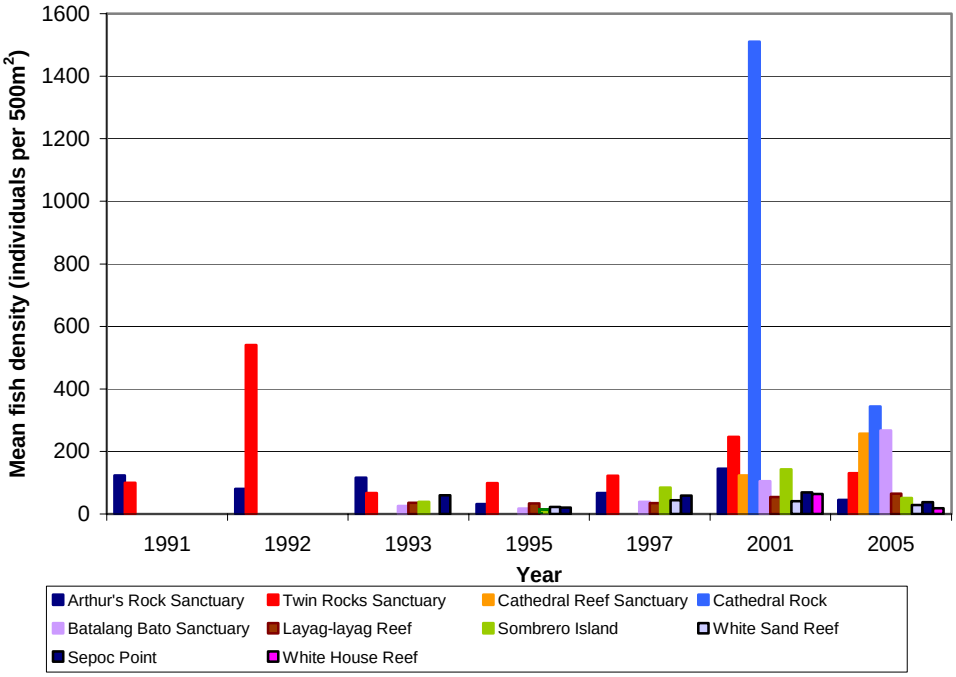


Table 41. Changes in abundance of large marine life in Mabini and Tingloy, Batangas.

Large Marine Life	Arthur's Rock Sanctuary		Twin Rocks Sanctuary		Cathedral Reef Sanctuary and Rock		Batalang Bato Sanctuary		Layag-layag Reef		Sombrero Island		White Sand Reef		Sepoc Point		White House Reef	
	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005	2001	2005
Jacks	~	~	**A**	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Sea turtles	**P**	~	~	~	~	~	~	**P**	~	~	~	~	~	~	**P**	~	~	~
Sharks	**P**	~	~	~	~	~	~	~	~	~	~	~	~	**P**	~	~	~	~
Blue spotted rays	~	~	~	~	~	~	**P**	~	~	~	~	~	~	~	~	~	~	~
Octopi	~	~	**P**	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~

~ - not present
P - present
A - abundant

Human activities

Human activity in terms of tourism and construction has greatly increased in Mabini and Tingloy areas. As the closest dive site to Metro Manila, the area attracts many visitors and tourists diving on weekends and holidays. In each site, an increasing pattern in the number of boats, divers and new resorts were observed. Boat traffic between dive sites also increased (Table 38). This increased in tourist activities indicates higher stress in coral reefs, especially in non-MPA areas where no guidelines are stipulated pertaining to site use and care. In MPAs, however, increased site utilization may exceed the carrying capacity of these protected reefs. It is important then to manage the tourism activities in each dive site and determine the carrying capacities of these areas. Other factors such as foreshore development and increased coastal population (as indicated by the increased number of resorts and houses along the coastline) have affected the coastal habitats, causing erosion and trash accumulation.

RECOMMENDATIONS FOR IMPROVED MANAGEMENT

The Mabini-Tingloy Management area needs to have an integrated approach to management whereby, Mabini and Tingloy municipalities are equal partners and cooperators. An integrated plan is needed with the following recommendations:

1. **Enhance management efforts of Cathedral Rock and Arthur's Rock sanctuaries.** These sanctuaries have depauperate target fish species compared to Twin Rocks and Batalang Bato. Indicator fish species diversity and abundance are low. These conditions may improve from a more strict enforcement and management of fishing in adjacent fishing grounds. Destructive fishing and spear fishing using compressed air, especially in Sombrero Island and vicinity need to be completely stopped.

2. **Education and information campaigns on CRM and the proper use of marine sanctuaries are needed for dive resorts, dive guide and tourist divers.** It has been observed that many tourist divers still wear gloves when diving within MPAs, thus are able to touch and grab on anything in the substrate while diving. Many were observed to have mediocre skills in buoyancy causing the breakage of corals along their path. Boatmen are also not sensitive to the damage they make by dropping anchors on corals.

3. **More anchor buoys are urgently needed in Layag-layag, Sombrero Island and Sepoc Point Reef.** Coral damage can be minimized by putting in place more anchor buoys in popular dive sites where there is none or few. This should go hand in hand with education and information campaigns.

4. **More sanctuaries are needed to provide benefits to heavily fished areas.** This should be coupled with an initiative to manage fishing in the area (i.e., discrimination from bad and *good* fishing gear or zoning) for more effective results.

5. **An integrated, long-term management plan is recommended for the Mabini and Tingloy area.** This plan can serve as the focus of discussion of all stakeholders and be a topic for various workshops and educational programs.

REFERENCES

Gell, F., C.M. Roberts 2002. The Fishery Effects of Marine Reserves and Fishery Closures. WWF-US, 1250 24th Street, NW, Washington, D.C. 20037, USA.

Hilomen, V., C.L. Lañola, Jr., and A. L. Dantis. in review. Status of Philippine reef fish communities.

Maypa, A.P., G.R. Russ, A.C. Alcala and H.P. Calumpong 2002. Long term trends in yield and catch rates of coral reef fisheries at Apo Island, Central Philippines. Marine and Freshwater Research Journal 53: 207-213.

Maypa, A.P., A.T. White, S. Tesch, A.B. Meneses and E. White. 2004. Long-term changes in coral reef benthic composition of Tubbataha Reefs: Response to bleaching in 1998 and protection. Silliman Journal 45 (2): 59-75.

Russ, G.R., A.C. Alcala and A.P. Maypa, H.P. Calumpong and A.T. White**.** 2004. Marine Reserve benefits local fisheries. Ecological Applications 14(2): 597-606.

Russ, G.R., A.C. Alcala and A.P. Maypa. 2003. Spillover from Marine Reserves: The case of *Naso vlamingii* at Apo Island, Philippines. Marine Ecology Progress Series 254: 15-20.

Solandt, J., J. Comley, S.P. Harding, R. Trono and P.S. Raines. Effectiveness of fish sanctuaries in the Mabini marine reserve, Philippines, after a decade of protection. Silliman Journal 44 (2): 35-60.

White, A.T., P. Christie, J. Apurado, A. Meneses, E. White and S. Tesch. 2001. Summary field report: Coral reef monitoring in Mabini and Tingloy, Batangas, Philippines, April 6-25, 2001. Coastal resources management Project and the Sulu fund for Marine conservation Foundation, Inc. Cebu City, 95 p.

White, A.T. and H. P. Vogt. 2002. Philippine coral reefs under threat: Lessons learned after 25 years of community based reef conservation. Marine pollution Bulletin 40(60): 537-550.