Summary Field Report
"Saving Philippine Reefs"

Coral Reef Monitoring Expedition to
Mabini and Tingloy,
Batangas, Philippines
March 20 – 28, 2011

A Project of:

The Coastal Conservation and Education Foundation, Inc.
(Formerly Sulu Fund for Marine Conservation, Inc.)

With the participation and support of the

Expedition Volunteer Researchers

Summary Field Report
"Saving Philippine Reefs"

Coral Reef Monitoring Expedition to
Mabini and Tingloy,
Batangas, Philippines
March 20 – 28, 2011

A Project of:

The Coastal Conservation and Education Foundation, Inc.
(Formerly Sulu Fund for Marine Conservation, Inc.)

With the participation and support of the

Expedition Volunteer Researchers

Principal investigators and primary researchers:

Alan T. White, Ph.D.
Senior Scientist, The Nature Conservancy
Honolulu, Hawaii USA

Dean R. Apistar
Coastal Conservation and Education Foundation, Inc.
Cebu, Philippines

Agnes Corine Z. Sabonsolin
Sheryll C. Tesch
Jimmy A. Paguio
Wenifel P. Porpetcho
Danilo P. Delizo Jr.
Raphael T. Martinez
Evangeline E. White
Coastal Conservation and Education Foundation, Inc.
Cebu, Philippines

Ethan Y. Lucas, M.M.A.
Knauss Fellow, National Oceanographic and Atmospheric Agency (NOAA)

Thomas J. Mueller, Ph.D.
Expedition Volunteer

Summary Field Report: “Saving Philippine Reefs”
Coral Reef Monitoring Expedition to Mabini and Tingloy, Batangas, Philippines, March 20–28, 2011.

Produced by the Coastal Conservation and Education Foundation, Inc.

Cebu City, Philippines

Citation:
White, A.T., D. Apistar, A.C. Sabonsolin, S. Tesch, J. Paguio, W. Porpetcho, D. Delizo Jr., R. Martinez, E. White, E.Y. Lucas and T.J. Mueller. 2011. Summary Field Report: Coral Reef Monitoring Expedition to Mabini and Tingloy, Batangas, Philippines, March 20–28, 2011. The Coastal Conservation and Education Foundation, Inc., Cebu City, 103 p.

CCEF Document Number: ____This publication may be reproduced or quoted in other publications as long as proper reference is made to the source.

This report was made possible through the support provided by the Expedition Research Volunteers listed in the appendix and organized through the Coastal Conservation and Education Foundation, Inc. The opinions expressed here are those of the authors and do not necessarily reflect the views of the CCE Foundation or the Expedition Volunteers.

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

Cover photo by Laurent Boillon

All communications to:

The Coastal Conservation and Education Foundation, Inc.
3rd Floor, PDI Condominium, Archbishop Reyes Avenue, Banilad,
Cebu City, Philippines

Phones: 6332-233-6909, 6332-233-6947 or 6332-416-2040
Fax: 6332-233-6891
Email: ccef@mozcom.com or alan_white@tnc.org

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES ii

ABSTRACT vii

ACKNOWLEDGEMENTS viii

LIST OF ACRONYMS AND ABBREVIATIONS Ix

INTRODUCTION

Management History of Study Sites in Mabini and Tingloy, Batangas 1

This Expedition - 2011 3

Data Collected and Methodology 3

OVERVIEWS AND RESULTS OF SITES SURVEYED

Arthur's Rock Sanctuary 11

Twin Rocks Sanctuary 12

Cathedral Reef Sanctuary 14

Batalang Bato Sanctuary (Pulang Buli Sanctuary) 15

Layag-Layag Reef 17

Sombrero Island 18

White Sand Reef (Dive Solana/El Pinoy Reef) 19

White House Reef 20

Sepoc Point Reef 22

SUMMARY OF RESULTS AND TRENDS

Coral Reef Substrate and Invertebrates 66

Fish Diversity, Abundance and Biomass 66

RECOMMENDATIONS FOR IMPROVED MANAGEMENT 69

REFERENCES 70

APPENDICES

1. Expedition itinerary 72

2. Expedition staff and volunteers 74

3. Fish species list 78

4. MPA Rating 92

5. Expedition photos 98

LIST OF FIGURES

Figure No.	Title	Page
1	Expedition research area in Mabini and Tingloy, Batangas in relation to Manila.	6
2	Expedition area, study sites and other important dive sites in Mabini and Tingloy, Batangas	7
3	Study sites within the Mabini Marine Reserve, Mabini, Batangas	8
4	Study sites and other dive sites at north ends of Maricaban and Caban Islands, Tingloy, Batangas.	9
5	Study site in Barangay Sto. Tomas, Tingloy, Batangas.	10
6	Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2011 (7-8m depth).	11
7	Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2011 (3-4 m depth).	11
8	Mean (±SE) density (fish/500m2) at Arthur's Rock Sanctuary from 1991 to 2011 (6-8m depth).	12
9	Mean (±SE) Species (species/500m2) at Arthur's Rock Sanctuary from 1991 to 2011 (6-8m depth).	12
10	Changes in substrate composition (% mean ±SE) in Twin Rocks Sanctuary from 1993 to 2011 (7-8m depth).	13
11	Changes in substrate composition (% mean ±SE) in Twin Rocks Sanctuary from 1993 to 2011 2-3m depth).	13
12	Mean (±SE) density (fish/500m2) at Twin Rocks Sanctuary from 1991 to 2011 (6-8m depth).	13
13	Mean (±SE) Species (species/500m2) at Twin Rocks Sanctuary from 1991 to 2011 (6-8m depth).	13
14	Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2011 (2-3m depth).	14
15	Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2011 (7-8m depth).	14
16	Mean (±SE) density (fish/500m2) at Cathedral Reef Sanctuary from 2001 to 2011 (6-8m depth).	14
17	Mean (±SE) Species (species/500m2) at Cathedral Reef Sanctuary from 2001 to 2011 (6-8m depth).	15
18	Changes in substrate composition (% mean ±SE) in Batalang Bato Sanctuary from 1993 to 2011 (7-8m depth).	15

Figure No.	Title	Page
19	Changes in substrate composition (% mean ±SE) in Batalang Bato Sanctuary from 1993 to 2011 (2-3m depth).	15
20	Mean (±SE) density (fish/500m2) at Batalang Bato Sanctuary from 1993 to 2011 (6-8m depth).	16
21	Mean (±SE) Species (species/500m2) at Batalang Bato Sanctuary from 1993 to 2011 (6-8m depth).	16
22	Changes in substrate composition (% mean ±SE) in Layag-Layag from 1993 to 2011 (7-8m depth).	17
23	Changes in substrate composition (% mean ±SE) in Layag-Layag from 1993 to 2011 (2-3m depth).	17
24	Mean (±SE) density (fish/500m2) at Layag-Layag from 1993 to 2011 (6-8m depth).	17
25	Mean (±SE) Species (species/500m2) at Layag-Layag from 1993 to 2011 (6-8m depth).	18
26	Changes in substrate composition (% mean ±SE) in Sombrero Island from 1983 to 2011 (7-8m depth).	18
27	Changes in substrate composition (% mean ±SE) in Sombrero Island from 1983 to 2011 (2-3m depth).	18
28	Mean (±SE) density (fish/500m2) at Sombrero Island from 1993 to 2011 (6-8m depth).	19
29	Mean (±SE) Species (species/500m2) at Sombrero Island from 1993 to 2011 (6-8m depth).	19
30	Changes in substrate composition (% mean ±SE) in White Sand Reef from 1993 to 2011 (7-8m depth).	20
31	Changes in substrate composition (% mean ±SE) in White Sand Reef from 1993 to 2011 (2-3m depth).	20
32	Mean (±SE) density (fish/500m2) at White Sand Reef from 1995 to 2011 (6-8m depth).	20
33	Mean (±SE) Species (species/500m2) at White Sand Reef from 1993 to 2011 (6-8m depth).	20
34	Changes in substrate composition (% mean ±SE) in White House Reef from 1993 to 2011 (7-8m depth).	21
35	Changes in substrate composition (% mean ±SE) in White House Reef from 1993 to 2011 (2-3m depth).	21
36	Mean (±SE) density (fish/500m2) at White House Reef from 2001 to 2011 (6-8m depth).	21
37	Mean (±SE) Species (species/500m2) at White House Reef from 2001 to 2011 (6-8m depth).	22
38	Changes in substrate composition (% mean ±SE) in Sepoc Point Reef from 1993 to 2011 (7-8m depth).	22

Figure No.	Title	Page
39	Changes in substrate composition (% mean ±SE) in Sepoc Point Reef from 1993 to 2011 (2-3m depth).	22
40	Mean (±SE) density (fish/500m2) at Sepoc Point Reef from 1993 to 2011 (6-8m depth).	23
41	Mean (±SE) Species (species/500m2) at Sepoc Point Reef from 1993 to 2011 (6-8m depth).	23
42	Changes in live hard coral (mean ±SE) in sites at Mabini and Tingloy, Batangas. From 1983 to 2011 (7-8m depth)	67
43	Mean (±SE) density (density/500m2) of all reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011(7-8m depth).	67
44	Mean (±SE) density (density/500m2) of all target fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)	68
45	Mean (±SE) species (species/500m2) of all reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)	68
46	Mean (±SE) species (species/500m2) of all reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)	69
47	Mean (±SE) biomass (kg/500m2) of target reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)	69

LIST OF TABLES

Table No.	Title	Page
1	Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2011.	24
2	Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2011.	25
3	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family in Arthur's Rock Sanctuary in 2011.	29
4	Mean (±SE) fish species (species/500m2) and percentage change between years in Arthur's Rock Sanctuary from 1991 to 2011.	30
5	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years in Arthur's Rock Sanctuary from 1991 to 2011.	31
6	Changes in substrate composition (% mean ±SE) in Twin Rocks Sanctuary from 1993 to 2011.	32
7	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family in Twin Rocks Sanctuary in 2011.	33

Table No.	Title	Page
8	Mean (±SE) fish species (species/500m2) and percentage change between years in Twin Rocks Sanctuary from 1991 to 2011.	34
9	Mean (±SE) fish species (species/500m2) and percentage change between years in Twin Rocks Sanctuary from 1991 to 2011.	35
10	Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2011.	36
11	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family in Cathedral Reef Sanctuary in 2011.	37
12	Mean (±SE) fish species (species/500m2) and percentage change between years inside the Cathedral Reef Sanctuary from 1991 to 2011.	38
13	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years inside the Cathedral Reef Sanctuary from 1991 to 2011.	39
14	Changes in substrate composition (% mean ±SE) in Batalang Bato (Pulang-buli) Sanctuary from 1993 to 2011.	40
15	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family in Batalang Bato (Pulang Buli) Sanctuary in 2011.	41
16	Mean (±SE) fish species (species/500m2) and percentage change between years in Batalang Bato (Pulang Buli) Sanctuary from 1991 to 2011.	42
17	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years in Batalang Bato (Pulang Buli) Sanctuary from 1991 to 2011.	43
18	Changes in substrate composition (% mean ±SE) in Layag-Layag, Tingloy from 1993 to 2011.	44
19	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family at Layag-Layag in 2011.	45
20	Mean (±SE) fish species (species/500m2) and percentage change between years at Layag-Layag from 1991 to 2011.	46
21	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years at Layag-Layag from 1991 to 2011.	47
22	Changes in substrate composition (% mean ±SE) in Sombrero Island from 1993 to 2011.	48
23	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family in Sombrero Island in 2011.	49
24	Mean (±SE) fish species (species/500m2) and percentage change between years at Sombrero Island from 1993 to 2011.	50
25	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years at Sombrero Island from 1993 to 2011.	51

Table No.	Title	Page
26	Changes in substrate composition (% mean ±SE) at White Sand Reef from 1993 to 2011.	52
27	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family at White Sand Reef in 2011.	53
28	Mean (±SE) fish species (species/500m2) and percentage change between years at White Sand Reef from 1995 to 2011.	54
29	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years at White Sand Reef from 1995 to 2011.	55
30	Changes in substrate composition (% mean ±SE) at White House Reef from 1994 to 2011.	56
31	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family at White House Reef in 2011.	57
32	Mean (±SE) fish species (species/500m2) and percentage change between years at White House Reef from 2001 to 2011.	58
33	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years at White House Reef from 2001 to 2011.	59
34	Changes in substrate composition (% mean ±SE) in Sepoc Point from 1993 to 2011.	60
35	Mean (±SE) fish species richness (species/500m2) and density (individuals/ 500m2) per family in Sepoc Point in 2011.	61
36	Mean (±SE) fish species (species/500m2) and percentage change between years in Sepoc Point from 1993 to 2011.	62
37	Mean (±SE) density (individuals/500m2) and percentage change of fish families between years in Sepoc Point from 1993 to 2011.	63
38	Table 38. Differences in percent live hard coral cover within sites and between years 2001 and 2011 in Mabini and Tingloy areas in March 2011.	64
39	Between sites difference in target fish density found at 7-8m depth in Mabini and Tingloy areas in 2011.	64
40	Between sites difference in target fish diversity found at 7-8m depth in Mabini and Tingloy areas in 2011.	64
41	Between sites difference in all reef fish density found at 7-8m depth in Mabini and Tingloy areas in 2011.	65
42	Between sites difference in all reef fish diversity found at 7-8m depth in Mabini and Tingloy areas in 2011.	65

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 in March 2011. Information on the changes in coral cover, other substratum, fish fauna, and 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) in all sites surveyed ranged from poor to good in 2011(14.6% to 62%). No significant change in LHC cover were observed in most of the sites except for Sombrero Is. and Sepoc Point Reef. LHC increased in Sombrero Is. from 2005 to 2011 from 31.3% to 38.8% while the opposite pattern was observed in Sepoc Point Reef which can primarily be attributed to impact of storm waves. Nevertheless, the status quo in LHC cover in the majority of the sites and especially inside MPA boundaries indicates positive management in the area.

Reef fish density for all species in most sites is in moderate condition. Only Sombrero Is. recorded high density in 2011 for all species (2668/500m^2). Four out of nine sites surveyed revealed a decrease in all reef fish density over the years. The same decreasing pattern was seen for all reef species diversity wherein only Arthur's rock, Cathedral reef and White sand reef showed no change in 2011 in reef species richness. On the other hand, target fish density and species diversity especially inside marine reserves showed an increasing trend over the years. Fish biomass in most of the sites also showed an increasing trend from 2005 to 2011.

Recommendations for improved management include: (1) need to enhance management efforts of Cathedral Rock and Arthur's Rock, (2) Sombrero Is. should be protected as a no-fishing marine sanctuary, (3) Continued education and information campaigns on coastal resource management and proper use of marine sanctuaries for dive resorts, dive guides and tourists, (4) Anchor buoys are urgently needed in Layag-Layag, Sombrero Is. and Sepoc Point reefs, (5) More no-take sanctuaries are needed to provide benefits for heavily fished areas, and (6) Efforts to renew coordination between Tingloy and Mabini municipalities are needed to improve the efficiency of enforcement in the larger Mabini-Tingloy area.

ACKNOWLEDGEMENTS

This Saving Philippine Reefs Expedition and its outcome are credited to the 15 volunteers (see Appendix 2) from the United States, Australia and the Philippines who dedicated their time and funding to the research work. Equally important are the Coastal Conservation and Education Foundation staff, partners and volunteers (see Appendix 2) that prepared for the trip, worked long hours and have contributed substantially in the overall successful completion of the Expedition. They include: Dean R. Apistar, Co-principal investigator; Jimmy Paguio and Sheryll Tesch, Trip coordinators; Danilo P. Delizo and Wenifel Propetcho, Fish visual census; Raphael T. Martinez, Maps and Data management, Ethan Y. Lucas, Dive master, Pablita L. Toyong, Logistic assistant and Vangie White, Overall Saving Philippine Reefs project coordinator.

Dive Solana Resort, in San Teodoro, Mabini, Batangas and its resort manager, Ma. Antonette Abaya, and the resort staff are commended for being committed to marine conservation and sustainable development in the Mabini area. They are equally thanked for providing excellent service, accommodations, food and diving facilities and assistance with true Filipino hospitality.

The final production of this report has been efficiently accomplished by Agnes Sabonsolin, Dean Apistar and Sheryll Tesch of 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	Batalong Bato Management Council
CA	coralline algae
CB	branching coral
CCEF	Coastal Conservation and Education Foundation, Inc.
CE	flat/encrusting coral
CM	massive coral
CRM	coastal resource management
CRMP	Coastal Resource Management Project
DA	Department of Agriculture
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	meter
MA	macroalgae/fleshy algae
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 States 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 regularly conducting coral reef monitoring assessments within 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 and attracted many visitors, some of whom 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 timeline show 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 one reserve restricting certain fishing and recreational activities
1991	First baseline data collected on sanctuary sites and shoreline of Mabini
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 coastal resource management (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-Tingloy
2005	Fifth Saving Philippine Reefs Expedition conducted in March
2005	MOA 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
2006	Review of existing ordinances pertaining to coastal management
2007	CCE Foundation continues to work with Batalang Bato community to support MPA
2007-8	Bantay dagat patrols supported by Tingloy and Mabini commence
2011	Sixth Saving Philippine Reefs Expedition conducted in March

The development of a stronger consensus for coastal management in Mabini and Tingloy is progressing. The Municipality of Tingloy has become active in implementing laws to ban illegal fishing and the use of compressor for fishing. In particular, Barangay Sto. Tomas is very active in implementing and enforcing the marine sanctuary Batalang Bato Marine Sanctuary. 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 signed a memorandum of agreement (MOA) for the unified collection between the two municipalities. While, the two municipalities, through the CRM Board, have increased interest in coastal resource management, there is still a need for improved coordination and transparency between the 2 municipalities in sharing of user fees and programming proceeds for marine conservation projects.

THIS EXPEDITION – 2011

This coral reef monitoring project in Mabini and Tingloy was comprised of 15 volunteer researchers and 9 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 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 data from the area in 1983, 1991, 1992, 1993, 1995, 1997, 2001 and 2005.

The volunteer team resided at Dive Solana Resort in San Teodoro, Mabini. The location was convenient for daily trips to the survey sites coupled with the good service provided by the resort staff. The weather and sea conditions were fine while temperatures (air and water) were a bit cooler than normal for March in Batangas with the average sea-surface temperature being about 25 degrees C (77 degrees F).

Data Collected and Methodology

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. This historically well known dive site is only three hours from Manila. It is frequented primarily by Filipino (from Manila) and other Asian divers and tourists. The offshore area away from the diving sites is an important fishing ground for artisanal and tuna fishery. 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 Reef (non-MPA)
8. Layag-Layag (non-MPA)
9. Batalang Bato Sanctuary / Pulang Buli Sanctuary (MPA)

Data collection

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

1. Percent cover of living coral (hard and soft)
2. Percent cover of non-living substrate (e.g., rock, rubble, sand, dead coral)

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

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

Scuba surveys were carried out in the deep area (6-8 m) parallel to the reef crest using a systematic point-intercept method. Transects were laid on sections of a reef flat, reef crest or slope. Substrate was evaluated at 25 cm intervals along a 50 m transect. Data gathered during scuba surveys were the same type as those collected during snorkel surveys. The distance between transects was approximately 5 m.

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

Data Analyses

Coral and fish abundance. Substrate was categorized into total live hard coral (branching, massive, encrusting and foliose), soft coral, rubble, non-living substrate (white dead standing coral, dead coral, rock and block, sand and silt) and others (sponges, algae, and seagrass) for comparison and presented graphically. Each category was compared within site between years using a one factor analysis of variance (1-ANOVA), Kruskal-Wallis or T-test whichever is appropriate. Sites with surveys that has low replications (n>2) were excluded from statistical analyses. Similarly, each category was also compared between sites per year and per site using 1-ANOVA, Kruskal-Wallis or T-test whichever is appropriate. Only those years with available raw data were included in the analysis. Data plotted in graphs for years 1983 to 2005 are from White et al (2005, unpublished). Data included in the statistical analyses were tested for normality (when necessary) using probability plots, log or square root transformation was made whenever appropriate and Tukey's Test was used as post hoc. All statistical analyses used the software Minitab 14®. In describing coral condition, the following terms may have the corresponding values:

Gomez et al. (1994) categories:

Live Coral Cover (%mean ±SE)			
Poor	Fair	Good	Excellent
0% – 24.9%	25% – 49.9%	50% - 74.5%	75 – 100

Density of fish was presented and classified according to the 19 coral reef fish families/ subfamily which include target fish families (Serranidae: Epinephelinae and Anthiinae, Lutjanidae Haemulidae, Lethrinidae, Carangidae, Caesionidae, Nemipteridae, Mullidae, Balistidae, Chaetodontidae, Pomacanthidae, Labridae, Scaridae, Acanthuridae, Siganidae, Kyphosidae, Pomacentridae and Zanclidae), used as indicators in Coral Reef Monitoring for

Management (Uychiaoco *et al*. 2001). Target fish families were also classified according to trophic groups: Piscivores, Planktivores, Invertebrate Feeders, Herbivores, Omnivores; and Coral Indicators for comparison. When applicable, species richness was expressed as mean number of species per 500m². Target fish densities were compared between years where raw data is available, using 1-ANOVA and Tukey's Test was used for post hoc. All data were tested for variance equality and normality using Minitab 14®. A log or square root transformation was made whenever appropriate. Classification of target fish densities followed that of Hilomen et al. (2000), where values were computed from a 1000m^2 area. Thus, our values were extrapolated from the 500m^2 sampling area to 1000m^2 to be able to use the aforementioned fish density categories.

Hilomen et al. (2000) categories:

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

Fish biomass. Fish biomass was computed using the formula: $\mathbf{a} \cdot \mathbf{L}^{\mathbf{b}}$ (Fishbase 2004), using the length-weight constants (www.fishbase.org). Biomass of target fish species were computed on the species level and summed up per family, based on selected target fish/commercially important food fish: Epinephilinae (Serranidae), Lethrinidae, Lutjanudae, Acanthuridae, Caesionidae, Carangidae, Haemulidae, Nemipteridae, Mullidae, Scaridae, Siganidae, Labridae (larger species, i.e., *Cheorodon* spp., *Cheilinus* spp.), including a non-reef family, Scombridae. Comparisons between families within sites used 1-ANOVA or Kruskal-Wallis whichever is appropriate. For this report, biomass computations were based on species-specific lengths (n=3-5).

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. In years past in each site surveyed, interviews with local residents, divers, resort owners, or local fishers were conducted about their general perception of the area, marine protected area management, fishing practices, and laws pertaining to the dive site or protected area. In 2011, only a few interviews were done.

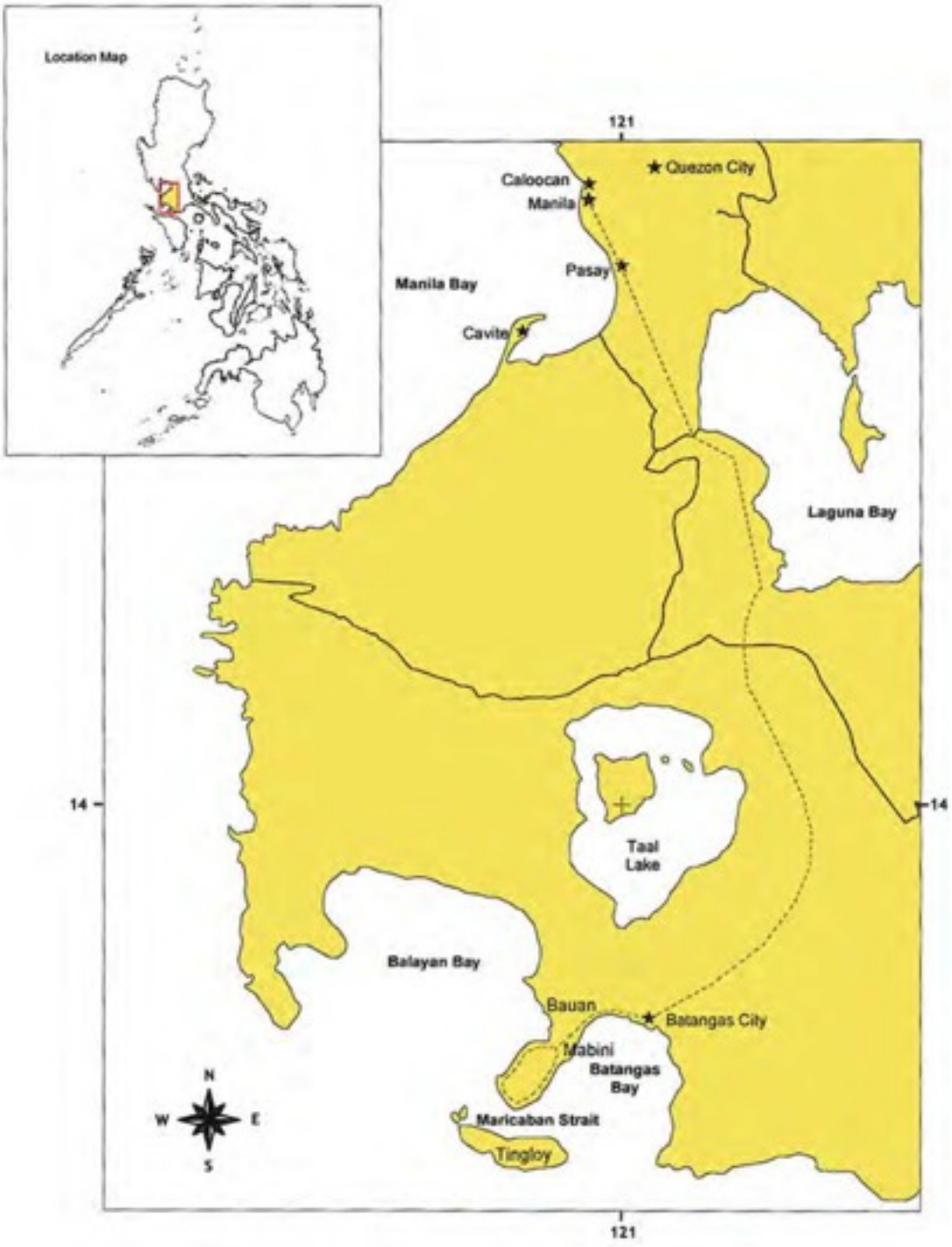


Figure 1. Expedition research area in Mabini and Tingloy, Batangas in relation to Manila.

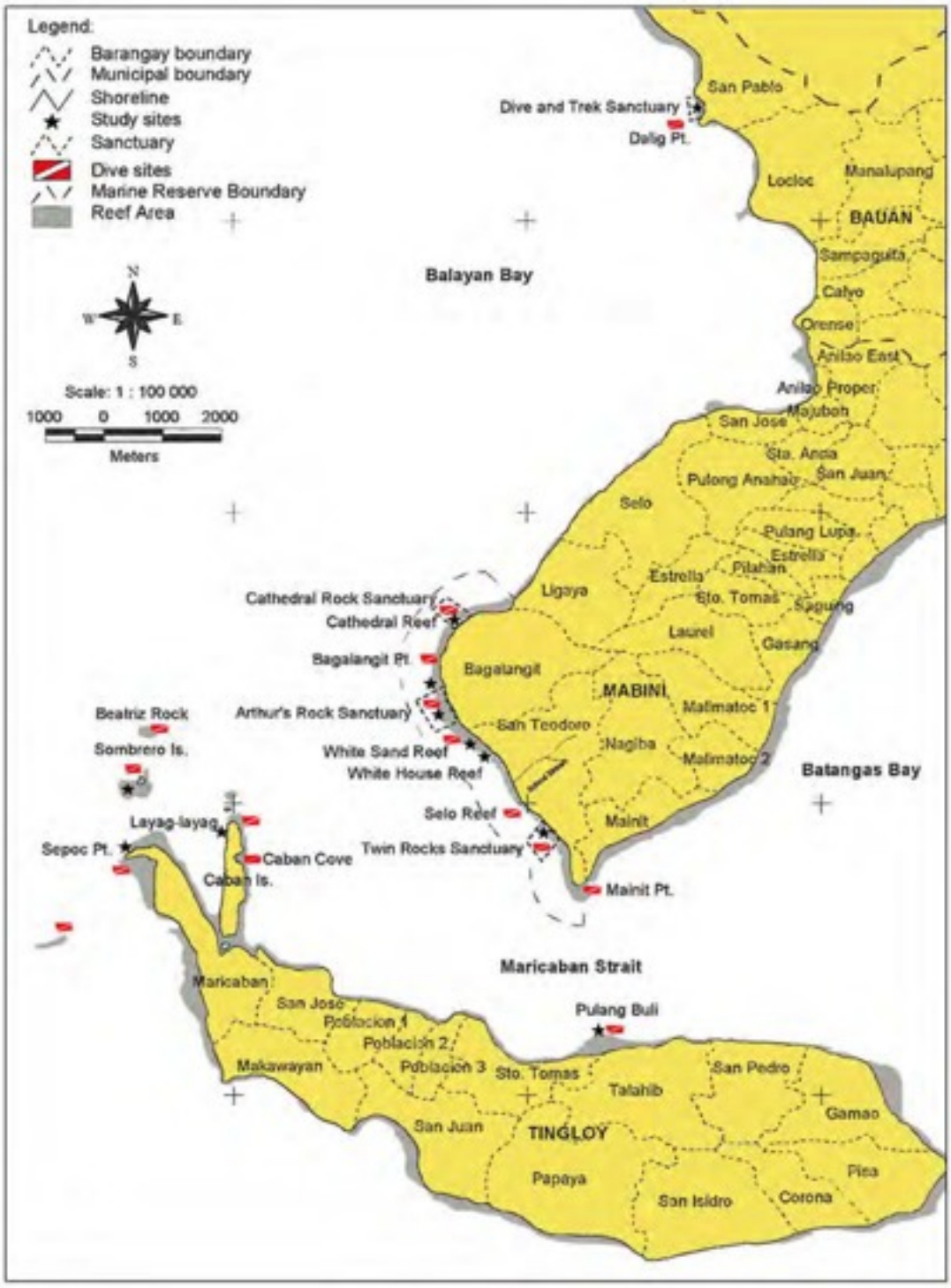


Figure 2. Expedition area, study sites and other important dive sites in Mabini and Tingloy, Batangas

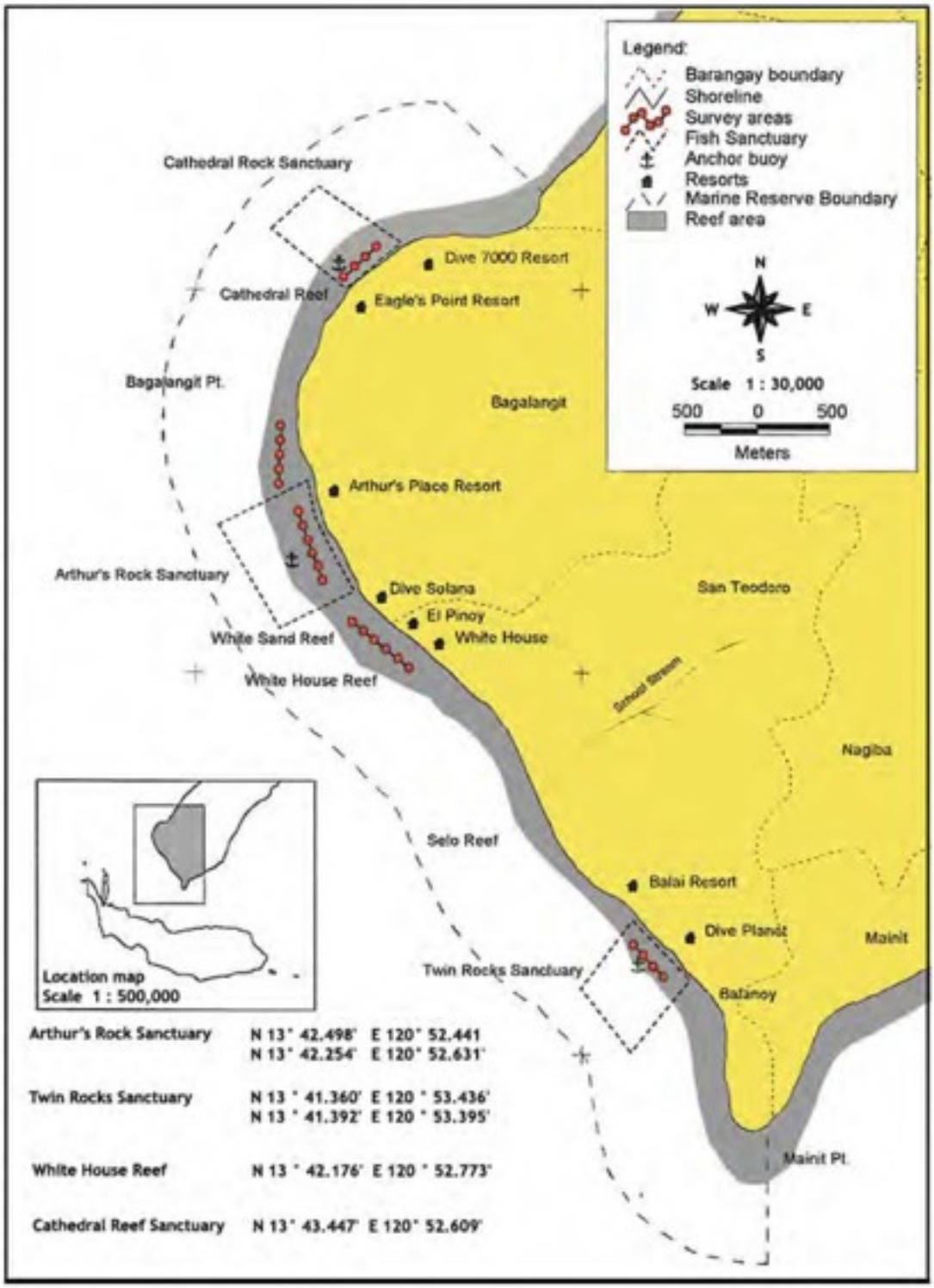


Figure 3. Study sites within the Mabini Marine Reserve, Mabini, Batangas

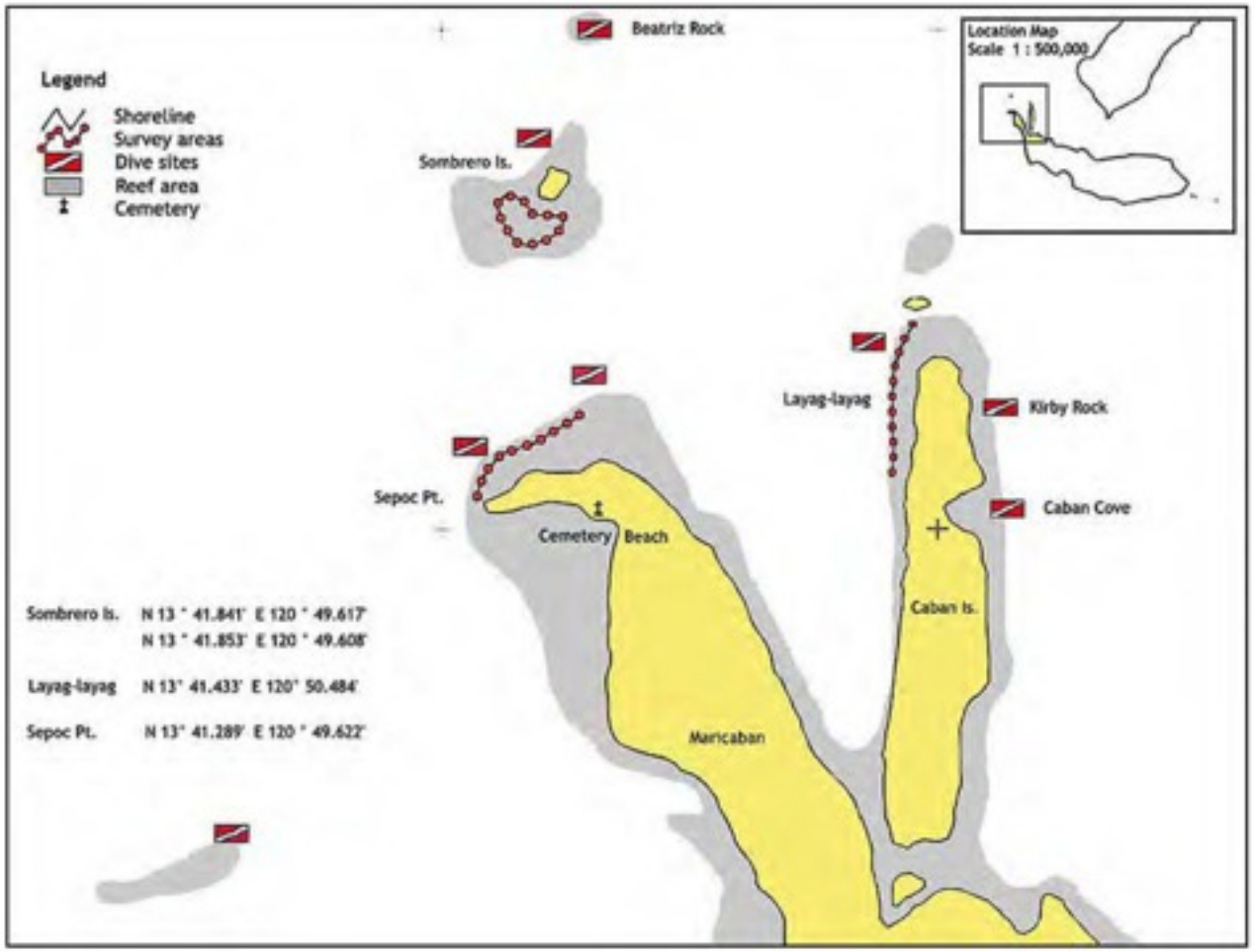


Figure 4. Study sites and other dive sites at north ends of Maricaban and Caban Islands, Tingloy,, Batangas.

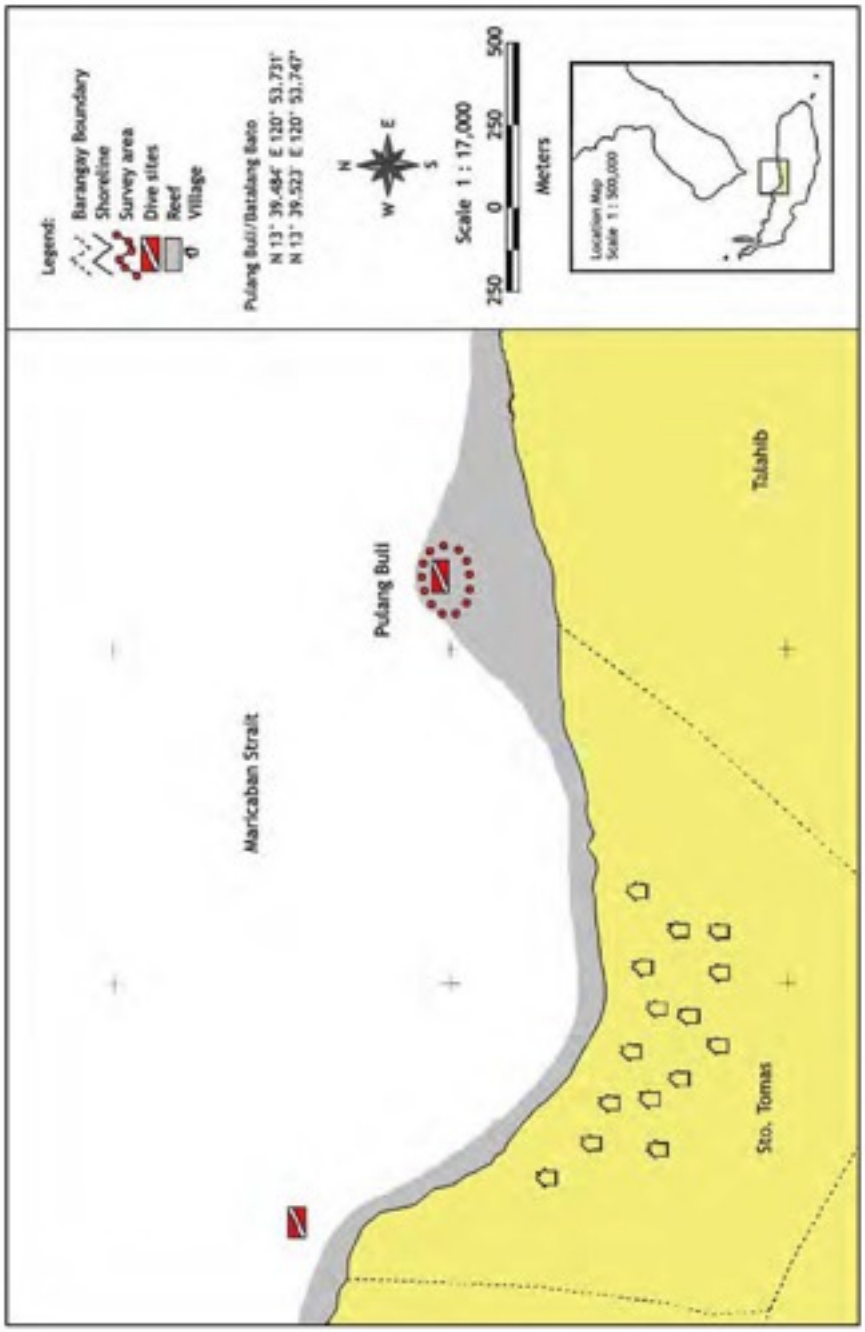


Figure 5. Study site in Barangay Sto. Tomas, Tingloy, Batangas.

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. It is a well protected site and very popular among divers for its variety of marine life and topography. It is managed by a committee in the barangay.

Table 1 and Figure 6 show that live hard coral (LHC) of Arthur's Rock sanctuary has declined since 1995 in the 7-8 m depth. However, statistical comparisons indicate no significant decrease in the shallow and deep zones from 2001 (61.7 ± 2.6 and 34.6 ± 1.8% respectively) to 2011 (59.0 ± 5.3 and 22.2 ± 4.2% respectively, Fig. 6, 7). The lower hard cover in the deeper area may be attributed to lower visibility at this depth, competition with soft coral growth and the natural composition of the reef. Arthur's Rock Sanctuary is among those sites in the area with a stable and healthy coral cover (Table 1) with new growth in shallow areas.

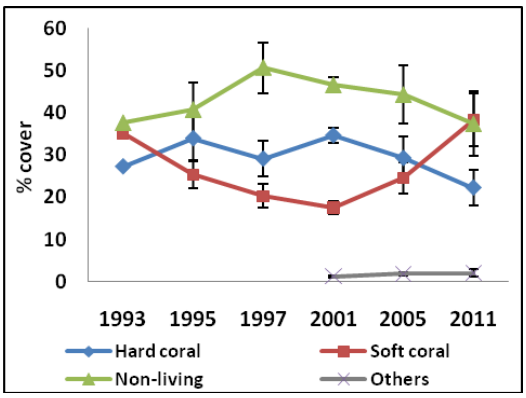


Figure 6. Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2011 (7-8m depth).

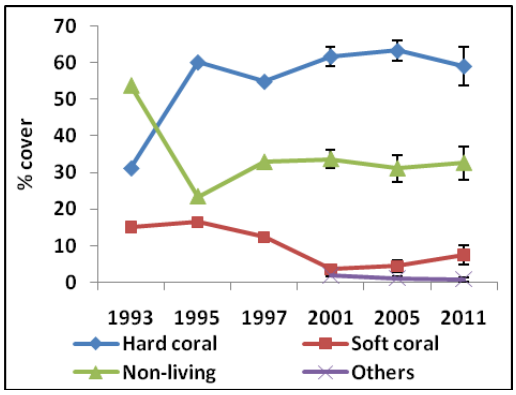


Figure 7. Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2011 (3-4 m depth).

Target reef fish density and diversity appears to increase from 2005 (34.7 ± 26.8 fish /500 m^2 and 9.6 ± 1.4 species/500 m^2 respectively) to 2011 (78.2 ± 30.1 fish /500 m^2 and 11.4 ± 1.6 species /500 m^2 respectively). However, statistical test from 2005 to 2011 (where raw data is available) showed that target fish density and diversity decreased significantly (P=0.003 and 0.007 respectively). Nevertheless, all reef fish density and diversity at Arthur's rock in 2011 is in good condition based on the index category of Hilomen (2000). All reef fish density and diversity was at 2098.8 ± 528.8 fish /500 m^2 and 44.0 ± 3.01species /500 m^2 respectively (Fig 8, 9).

Fish biomass of all reef fishes was recorded at 75.6 ±12.4 kg /500 m^2 wherein 22.9 ± 15.4 kg / 500 m^2 of it are target fish biomass. Target fish biomass in 2011 appeared higher compared to the previous data (2005: 3.6 ± 2.5 kg /500 m^2). However, due to the absence of raw data from 2005, no statistical tests were performed.

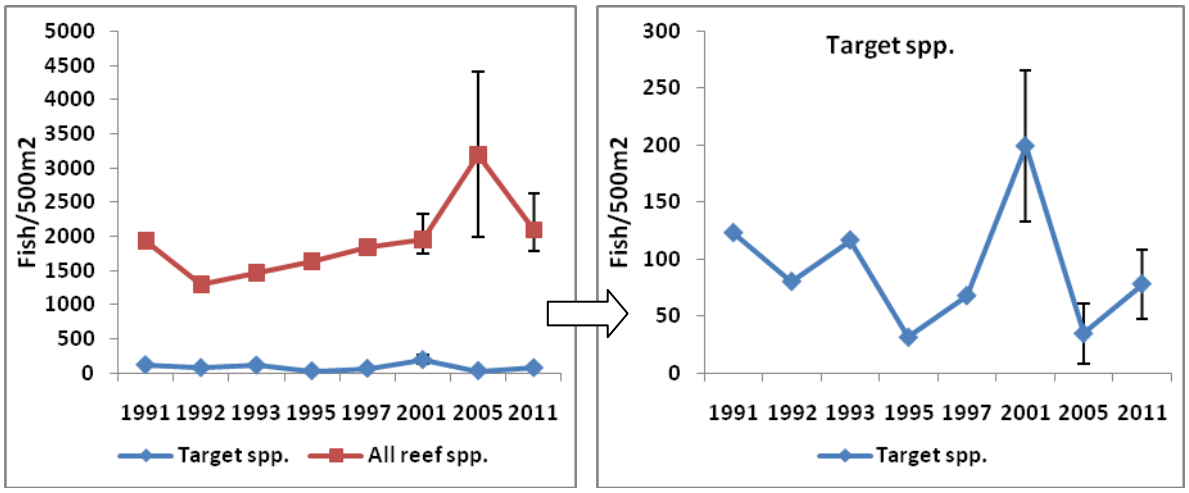


Figure 8. Mean (±SE) density (fish/500m^2) at Arthur's Rocks Sanctuary from 1991 to 2011 (6-8m depth).

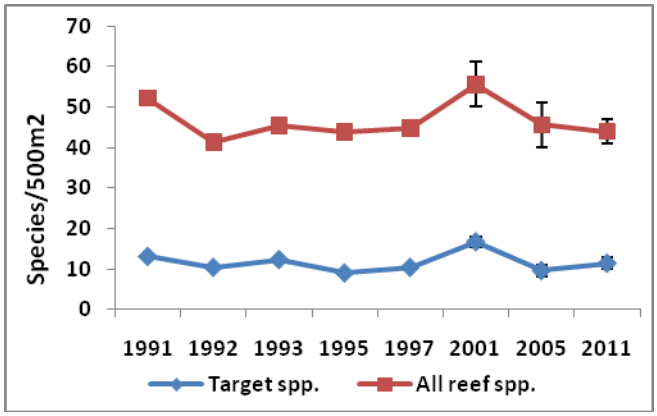


Figure 9. Mean (±SE) species (species/500m^2) at Arthur's Rock Sanctuary from 1991 to 2011 (6-8m depth).

Consistent coral cover over the years and target fish abundance indicate some degree of sanctuary protection. 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 20 years (1991 – 2011; Table 3) may indicate fishing pressure from adjacent areas and a possibility of poaching. This MPA has a level 3 in the MPA rating system. It now has visually obvious boundary signs and sufficient anchor buoys for dive boats. Yet, Arthur's Rock would benefit from enhancing the protection and enforcement efforts by the barangay management body.

Twin Rocks Sanctuary

Twin Rocks sanctuary was established in 1991 together with Arthur's Rock and Cathedral Reef. This sanctuary is well protected and appears to be benefiting from closure to fishing and no anchoring. The Balanoy community manages the area.

Live hard coral cover in the deep appears to be increasing consistently after 1993, indicating that this MPA has benefited from protection. Since 1995, LHC has been stable with a slightly increasing trend. However, hard coral cover in the shallow decreased significantly (1-ANOVA: P=0.00) from 57.8 ± 1.8% (2001) to 44.1 ± 3.9% (2011). This decrease may be attributed to coral damage caused by divers and snorkelers during shore entry dives.

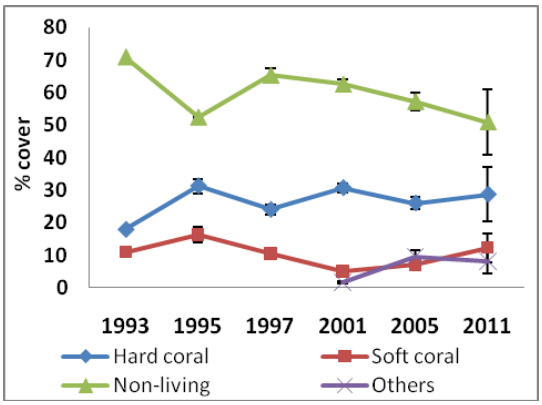


Figure 10. Changes in substrate composition (% mean ±SE) in Twin Rocks Sanctuary from 1993 to 2011 (7-8m depth).

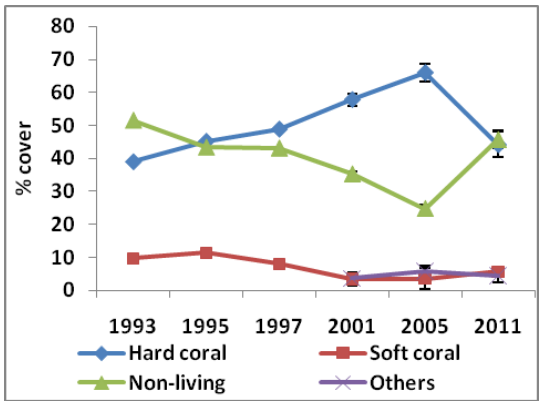


Figure 11. Changes in substrate composition (% mean ±SE) in Twin Rocks Sanctuary from 1993 to 2011 2-3m depth).

Similar to Arthur's Rock, all reef fish density and diversity in Twin Rocks is high in 2011 (2154.2 ±310.9 fish/500m^2 and 43.2 ±2.3 species/500m^2 respectively, Fig. 12, 13). However, statistical analysis revealed a significant decrease in all reef fish density and diversity from 2005 to 2011. Nevertheless, comparing from its baseline data, fish density and diversity appear to increase over time. Total fish biomass in 2011 was recorded at 419.2 ±339.7 kg/500m^2 wherein 363.5 ±336.6 kg/500m^2 of this are target fish biomass. The high number of target fish biomass is due to the school of jacks (*Caranx sexfaciatus*) recorded during the survey.

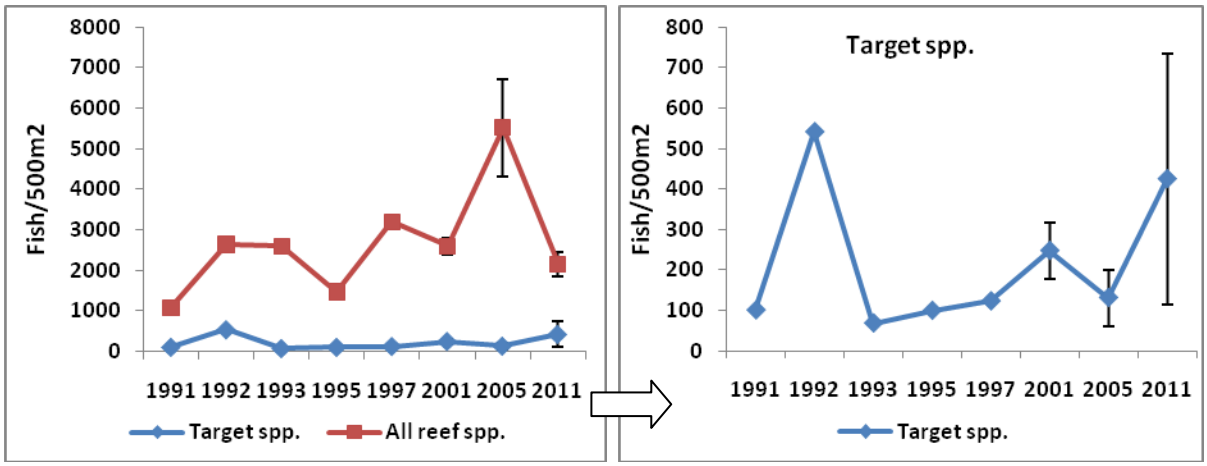


Figure 12. Mean (±SE) density (fish/500m^2) at Twin Rocks Sanctuary from 1991 to 2011 (6-8m depth).

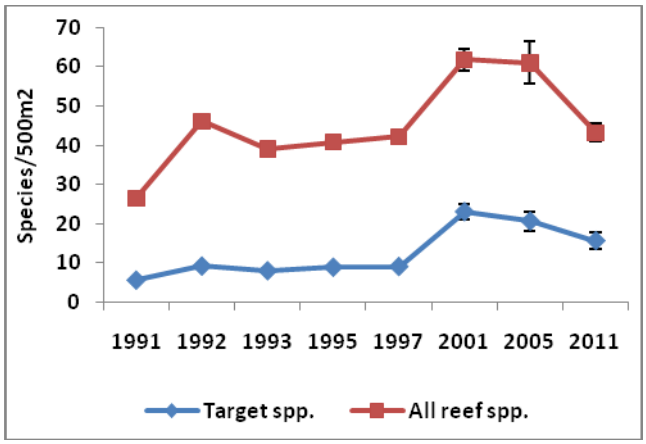


Figure 13. Mean (±SE) species (species/500m^2) at Twin Rocks Sanctuary from 1991 to 2011 (6-8m depth).

Stable and slightly increasing coral cover and increasing fish biomass in the Twin Rocks Sanctuary indicates that protection is in place. Visually obvious signs are posted and anchor buoys are adequate to prevent dropping of anchors on the reef. The MPA rating is level 4 for Twin Rocks, higher than any other MPA in Mabini.

Cathedral Reef Sanctuary

Cathedral Reef Sanctuary was established in 1991 together with Twin Rocks and Arthur's Rock Sanctuaries (Figure 8). Cathedral Rock and Reef Sanctuary was first surveyed in 2001 by the SPR team. Fish on the Rock/Cross are abundant, especially the butterflyfish, *Chaetodon kleinii* (581 individuals/200m^2; n =1, 2005). The fish are tame in the area and fish feeding was evident.

Cathedral reef, a fringing reef of Cathedral Rock has good coral cover (62 ± 12%) at 7-8 m and an excellent LHC at 2-4 m (74.7 ± 3.0%) Comparisons in live coral cover between 2005 and 2011 show coral cover is lower in deep areas but higher in shallow areas (Table 10, Fig. 14, 15).

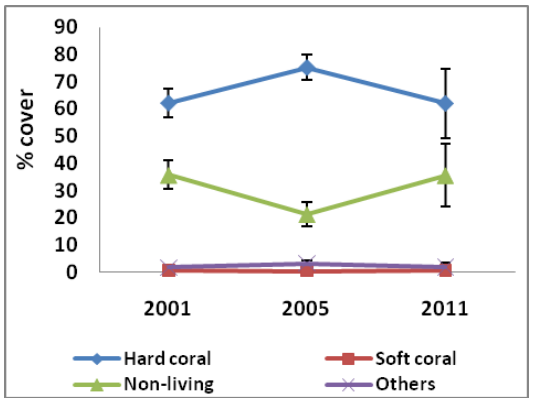


Figure 14. Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2011 (7-8m depth).

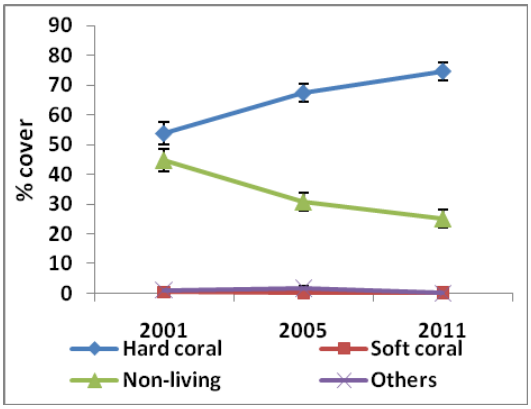


Figure 15. Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2011 (2-4m depth).

All reef fish density and diversity in Cathedral reef was moderate in 2011 and recorded at 906.3 ±60.1 fish/500m^2 and 36.0 ±3.2 species/500m^2 respectively wherein it was lower compared to 2005. Statistical analysis also revealed a significant decrease in all reef fish density (1-ANOVA: P=0.004) from 2005 (6095 ±854.3 fish/500m^2) to 2011. All reef fish biomass was recorded at 39.0 ±10.0 kg/500m^2 wherein 17.5 ±8.7 kg/500m^2 of it are target fish biomass.

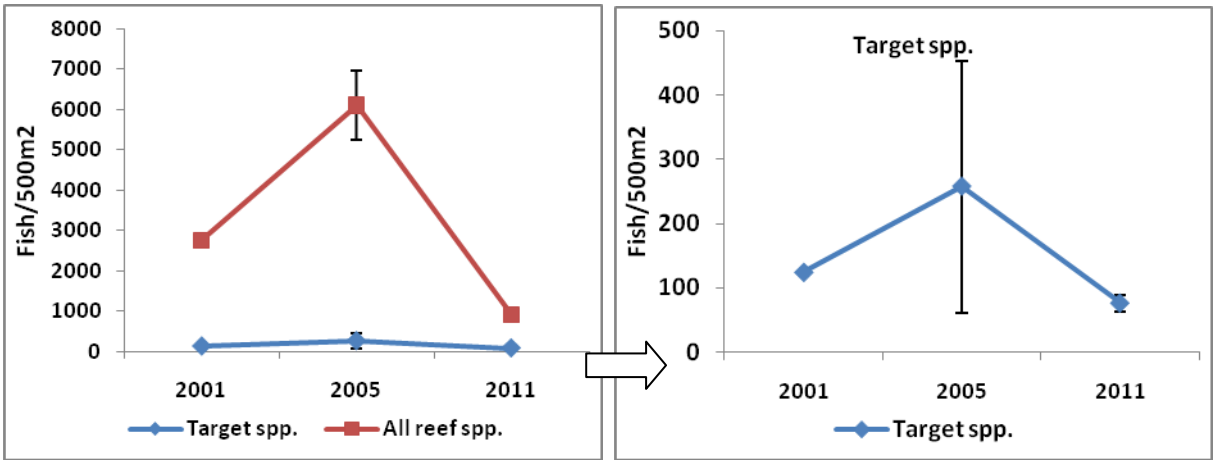


Figure 16. Mean (±SE) density (fish/500m^2) at Cathedral Reef Sanctuary from 2001 to 2011 (6-8m depth).

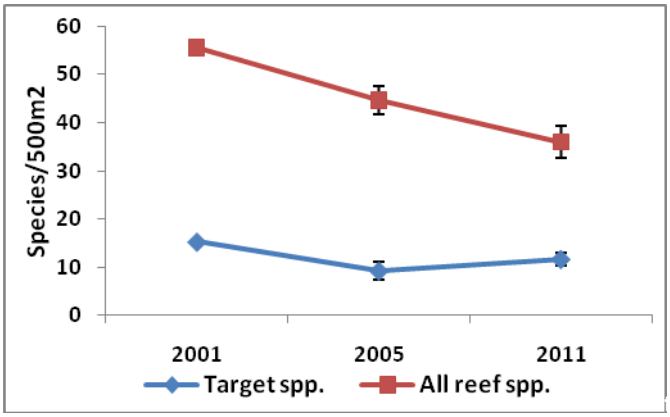


Figure17. Mean (±SE) species (species/500m^2) at Cathedral Reef Sanctuary from 2001 to 2011 (6-8m depth).

Cathedral Reef is protected by virtue of it being a popular dive site due to the attraction of Cathedral Rock. The shallow reef has a high coral cover that appears quite stable over time but lacks target species of fish.This sanctuary has benefited from several anchor buoys, thus maintaining good reef condition despite the frequency of dive boats in the area. The MPA rating level is only 2 because of an apparent lack of vigilance to prevent fishing within the boundaries and because there are no boundary markers or signs in place.

Batalang Bato Sanctuary (Pulang Buli Sanctuary)

Batalang Bato Sanctuary, formerly known as Pulang Buli, is a shoal located offshore from Maricaban Island in the Municipality of Tingloy. This sanctuary was established in 2002 and is managed by the Batalang Bato Management Council (BBMC).

The reef is dominated by soft coral which comprises 19.1% at 7-8 m depth and 36.6 ± 3.3% in the 2-3m depth. Total live hard coral is low (16.7 ± 9% at 7-8 m) to fair (29.6 ± 3.5% at 2-3 m). Total live hard coral cover appears naturally low on this reef. The shallow area showed a phase shift from hard coral to soft coral cover in 2005 but in 2011, soft coral cover was replaced by non-living substrate as reflected in Figure 19.

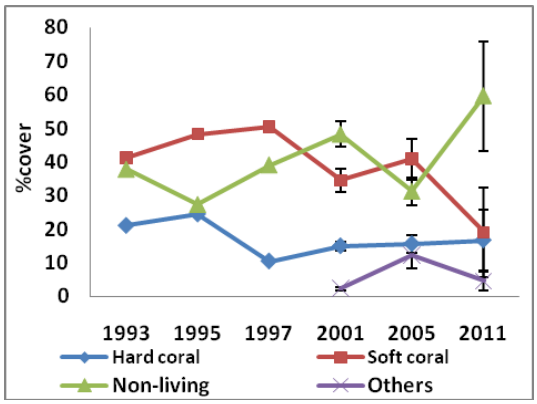


Figure 18. Changes in substrate composition (% mean ±SE) in Batalang Bato Sanctuary from 1993 to 2011 (7-8m depth).

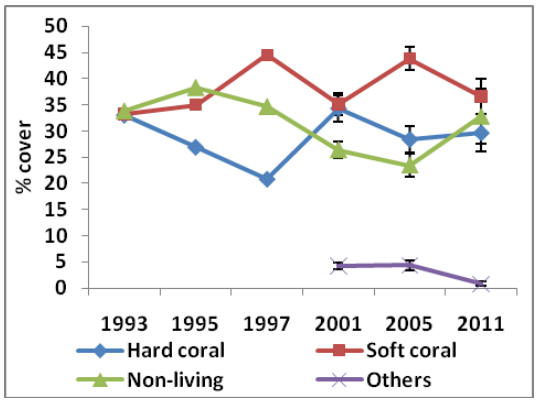


Figure 19. Changes in substrate composition (% mean ±SE) in Batalang Bato Sanctuary from 1993 to 2011 (2-3m depth).

All reef fish density and diversity in Batalang Bato appears to decrease from 2005 (10,145.3 ± 3959 fish/500m^2 and 42.3 ±2.9 species/500m^2 respectively) to 2011 (1136±384.7 fish/500m^2 and 26 ± 5.6 species/500m^2 respectively, Fig 20) (Kruskal-Wallis: P=0.003 and P=0.046, respectively). Target fish density and diversity appears to steadily increase from 2001 (105.5 ±41 fish/500m^2 and 11.8 ± 1.4 species/500m^2 respectively) to 2011 (181.4 ± 43.1 fish/500m^2 and 22.4 ± 7.8 species/500m^2 respectively). Total biomass was recorded at 71.0 ± 22.7 kg/ 500m^2 wherein 33.6 ± 12.1 kg/500m^2 of it are considered target fish density. This unusual pattern of high target fish biomass despite low live coral cover may be attributed to strict protection/enforcement and good MPA management.

Batalang Bato has an MPA rating of 3. It was noted that the *Bantay Dagat* (MPA wardens) in the area were not hesitant to approach and question dive boats anchored within the area and the community takes pride in its protection of the site. No diving is allowed inside the sanctuary area except for monitoring.

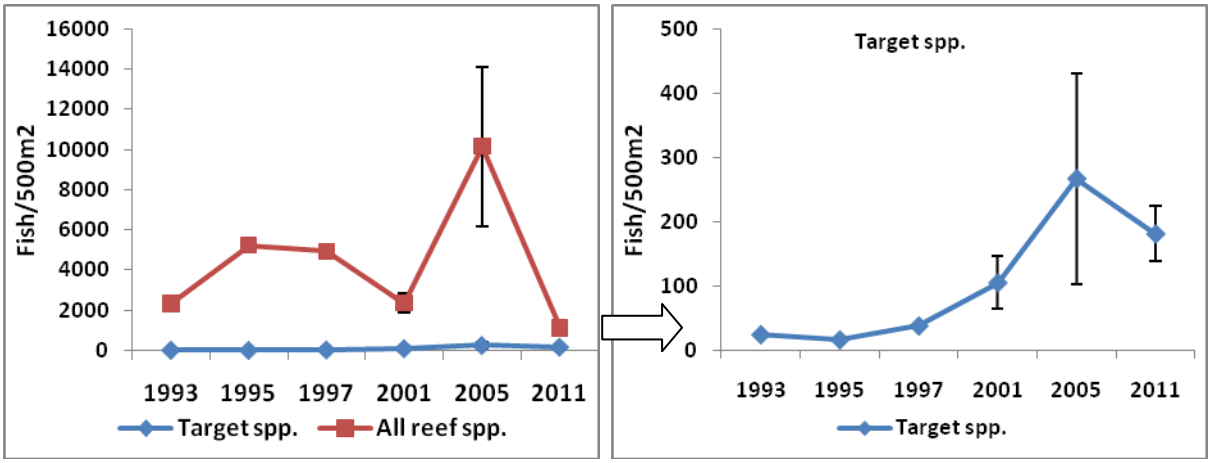


Figure 20. Mean (±SE) density (fish/500m^2) at Batalang Bato Sanctuary from 1993 to 2011 (6-8m depth).

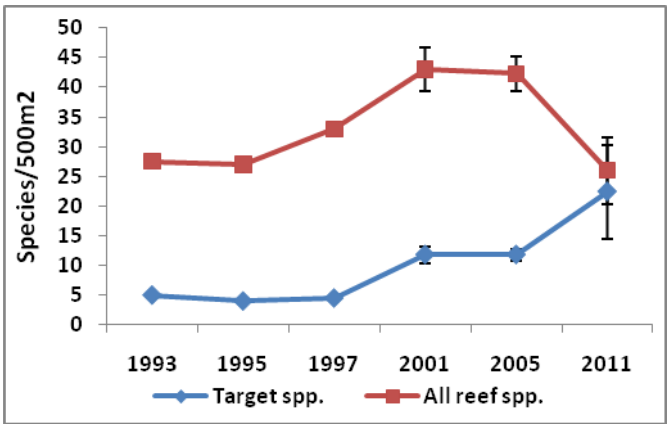


Figure 21. Mean (±SE) species (species/500m^2) at Batalang Bato Sanctuary from 1993 to 2011 (6-8m depth).

Layag-Layag Reef

Layag-Layag Reef is a popular destination for scuba divers and snorkelers (White et al. 2001). In 1982, it was recommended to be part of a marine park that included Sombrero Island although this was never acted on by the national government.

Coral cover is fair (33.6 ± 8.6%) in the deep and in the shallow (55.9 ±4.2%; Table 18, Fig 22). LHC cover increased since 2005. Significant decrease in live hard coral cover from 68.9 ± 2.5% (2001) to 43.4 ± 3.7% (2005) has recovered slightly in 2011, with LHC cover of 55.9 ±4.2%. The reef continues to be damaged by dropping of anchors.

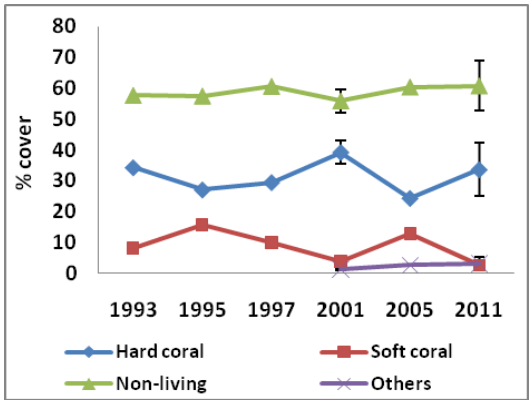


Figure 22. Changes in substrate composition (% mean ±SE) in Layag-Layag from 1993 to 2011 (7-8m depth).

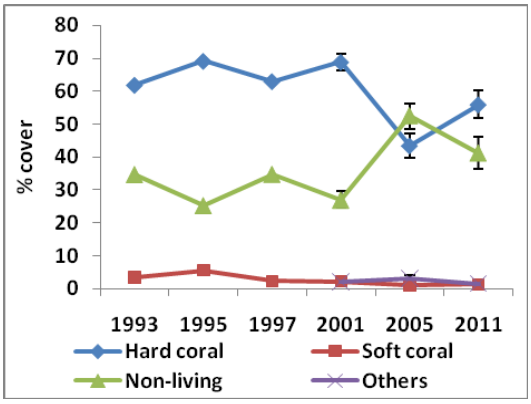


Figure 23. Changes in substrate composition (% mean ±SE) in Layag-Layag from 1993 to 2011 (2-3m depth).

All reef fish density and diversity in Layag-Layag were observed to decrease in 2011 recorded at 1521.4 ± 336.1 fish/500m^2 and 32.0 ± 3.7 species/500m^2, respectively. Moreover, statistical analysis revealed that the decrease in all fish diversity from 2005 to 2011 was significant (1-ANOVA: P=0.005). This may be a consequence of the continued fishing and collecting of aquarium fish by fishers nearby Tingloy village (White *et al.* 2001).

Physical damage from anchors are observed in Layag-Layag Reef. The placement of mooring buoys would greatly improve the condition of the reef, especially in the deeper areas. Layag-Layag encompasses the northern tip of Caban Island and Kirby Rock on the East. Both are exposed to currents and may play a role in larvae distribution in the area and are thus good sites for a no-fishing sanctuary.

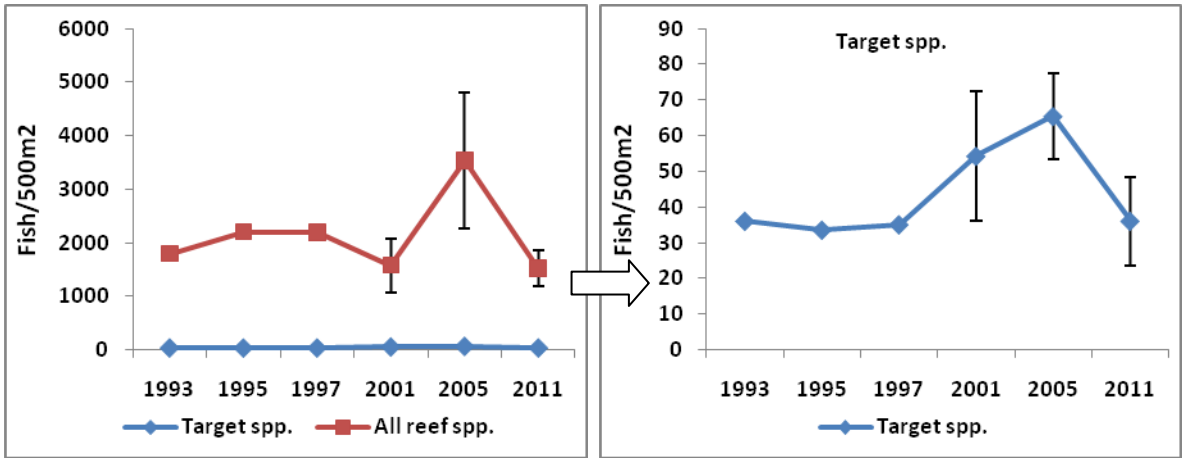


Figure 24. Mean (±SE) density (fish/500m^2) at Layag-Layag from 1993 to 2011 (6-8m depth).

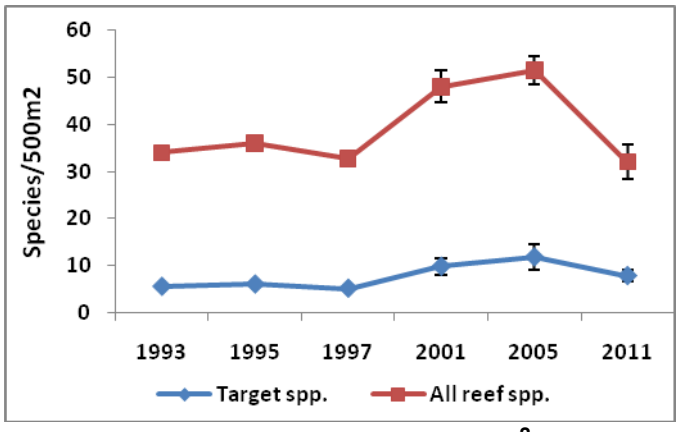


Figure 25. Mean (±SE) species (species/500m^2) at Layag-Layag from 1993 to 2011 (6-8m depth).

Sombrero Island

Sombrero Island has been a popular dive site since the 1970s in Batangas and benefits from an exposed and diverse coral reef. It was recommended as a national marine park in 1982 because of its extensive reef, ecological importance and relatively high water visibility.

Figure 26 and 27 shows the changes in substrate composition of Sombrero Island in the deep and shallow areas from 1983 to 2011. LHC in the 7-8 m depth in 2005 was 31.3% and increased to 38.9% in 2011. Further, the increase in soft coral cover observed from 1993 to 2005 (16.1 ± 2.6%) has subsided in 2011 to 8.3%. Live hard coral cover was poor in the shallow (2-4 m) in 1993. This was attributed to severe storm damage in 1988 (White *et al.* 2001). In the following years, shallow coral cover has been consistently increasing and by 2011, LHC was 74.0 ± 1.2% at 2-3 m depth.

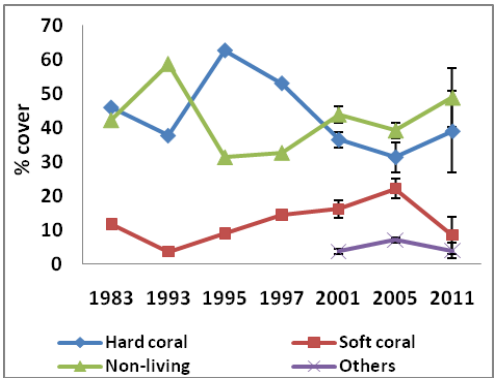


Figure 26. Changes in substrate composition (% mean ±SE) in Sombrero Island from 1983 to 2011 (7-8m depth).

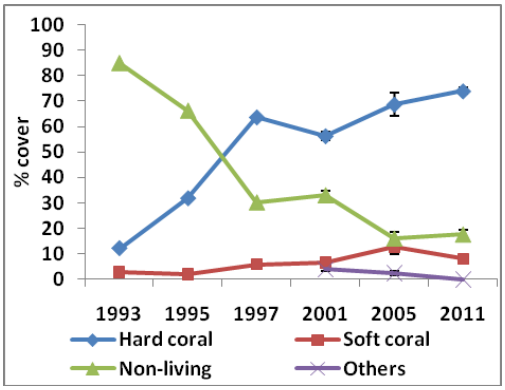


Figure 27. Changes in substrate composition (% mean ±SE) in Sombrero Island from 1983 to 2011 (2-3m depth).

Similar with the previous sites, a descending pattern in reef fish density and diversity were also observed in Sombrero Island. All reef fish density and diversity decreased significantly from 2005 (8323 ± 2078 fish/500m^2 and 42 ± 2.2 species/500m^2 respectively) to 2011 (3369 ± 1585 fish/500m^2 and 35 ± 3 species/500m^2 respectively). The observed decreasing pattern may be attributed to the continued fishing pressure in the area.

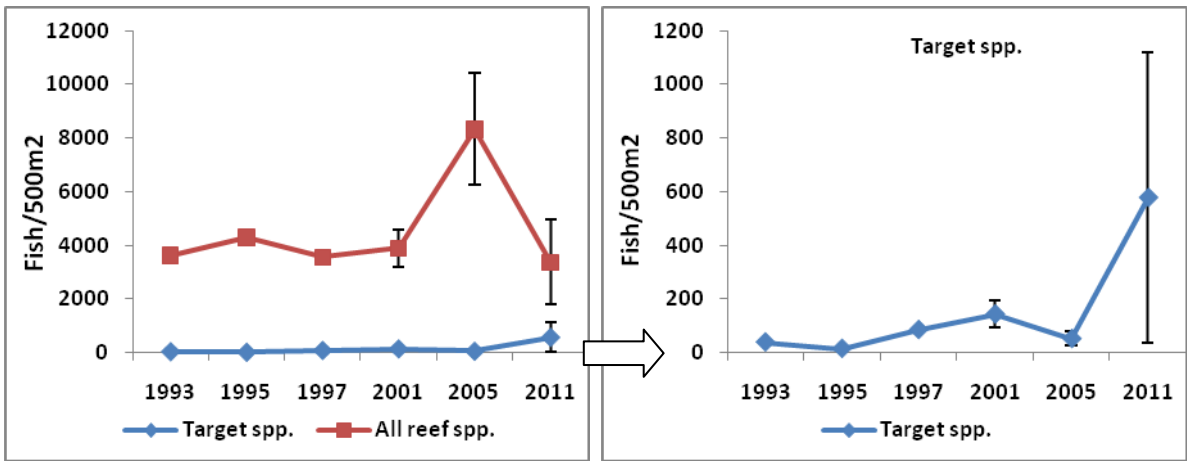


Figure 28. Mean (±SE) density (fish/500m^2) at Sombrero Island from 1993 to 2011 (6-8m depth).

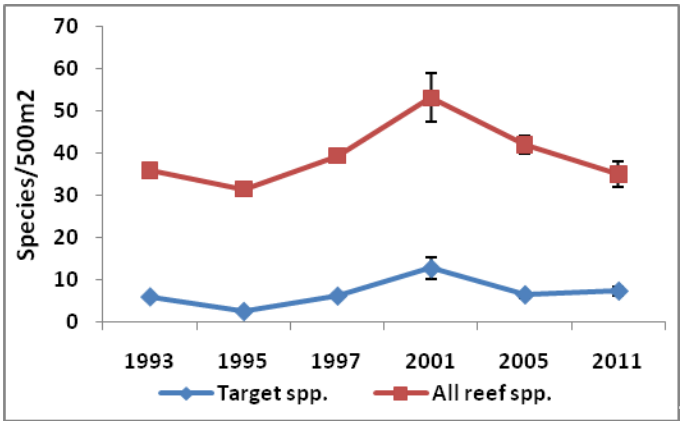


Figure 29. Mean (±SE) species (species/500m^2) at Sombrero Island from 1993 to 2011 (6-8m depth).

The island is frequented by divers and snorkelers and fishing pressure is present. These factors may contribute to the decline in coral cover and the relatively low number of target fish. This area will benefit more if anchor buoys are in place.

White Sand Reef (Dive Solana/El Pinoy Reef)

White Sand Reef is adjacent to the south end of Arthur's Rock fronting Dive Solana and El Pinoy resorts and also adjacent to the White House Reef. It is a popular snorkel and dive area being in front of 2 resorts. The shallow reef has much life to observe.

Hard coral cover in the deeper area was 19 ± 3.1% in 2005 and 21.6 +_10.3 in 2011. The shallow reef has slightly lower LHC at 45.9 ±6.0% compared to 48 ± 9.5% in 2005. The dominant substrates are sand (< 30%) at 7-8 m and live hard corals at 2-4 m. The shallow reef in particular has been affected in the past by bleaching (1998), crown-of-thorns epidemics and anchors. By 2011, non-living substrate has decreased and replaced by soft and hard corals.

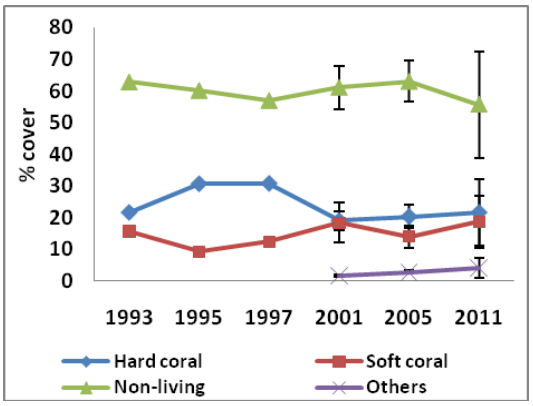


Figure 30. Changes in substrate composition (% mean ±SE) in White Sand Reef from 1993 to 2011 (7-8m depth).

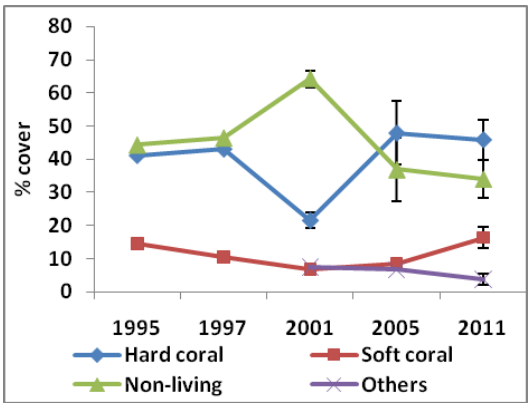


Figure 31. Changes in substrate composition (% mean ±SE) in White Sand Reef from 1993 to 2011 (2-3m depth).

Compared to all sites surveyed during the expedition, White sand reef was the only site that recorded a significant increase (1-ANOVA: P=0.04) in target fish density. Target reef fish density increased from 28.6 ± 7.1 fish/500m^2 in 2005 to 138.2 ± 33.4 fish/500m^2 in 2011, which may also be the reason for the exponential increase in target fish biomass from 1.3 ± 0.4 kg/500m^2 (2005) to 33.3 ± 12.3 kg/500m^2(2011). Moreover, all reef fish density is high (1882 ± 810.1 fish/ 500m^2) while all reef fish diversity is moderate having 31.6 ± 4.4 species/500m^2. Average biomass for all reef fish was recorded at 56.1 ± 2.3 kg/500m^2 wherein 33.3 ± 12.3 kg/500m^2 of it are target fish. Based on the previous data, target fish biomass increased exponentially from 2005 to 2011. The increase may be attributed to the improved management of the area.

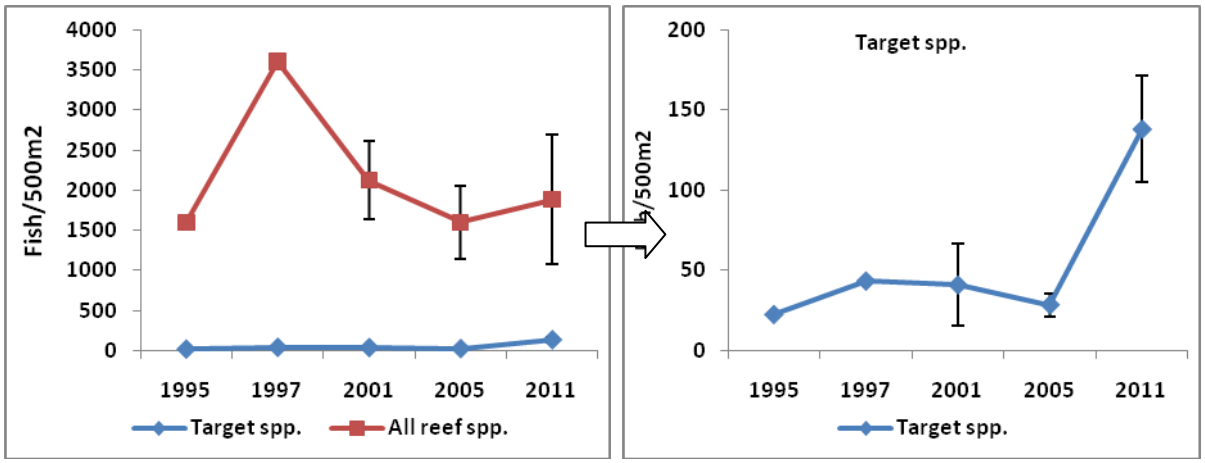


Figure 32. Mean (±SE) density (fish/500m^2) at White Sand Reef from 1995 to 2011 (6-8m depth).

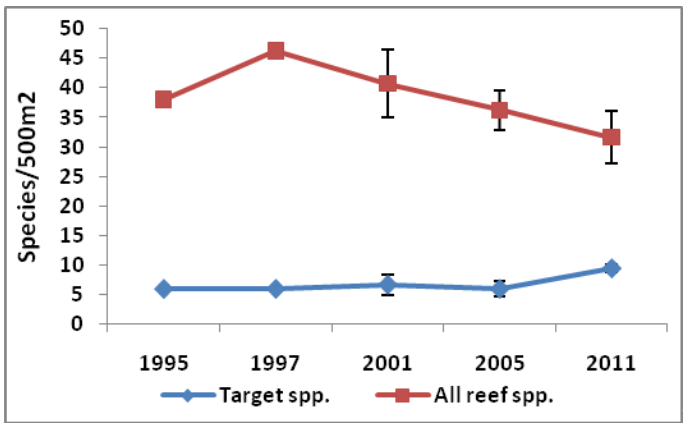


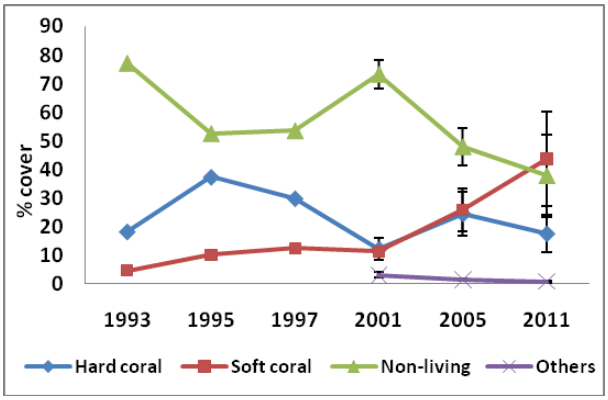
Figure 33. Mean (±SE) species (species/500m^2) at White Sand Reef **from 1993 to 2011 (6-8m depth).**

Sombrero Island is heavily used for recreation. Nevertheless, the shallow reef is generally improving with much new growth of branching corals. All resorts fronting the beach appear concerned with protection of the area which may explain the increased biomass of target fishes.

White House Reef

This site is adjacent to the White Sand Reef fronting the "White-house." It is a shallow reef with sand in the deeper portions so surveys were done on a shallower depth (5-7m) than on the other reefs. The snorkel survey was done at 2-3m depth.

Coral cover was low in the 6-8m depth at 17.6 ± 6.7% which is lower than the 24.6 ± 7.6% recorded in 2005. The snorkel survey measured an LHC of 48.6 ± 8.6%. In some of the shallow areas, much new growth of branching corals were observed. In the past, the area has been plagued by crown-of-thorns. There is also freshwater run-off that may have affected coral growth in this area through sedimentation. Anchor damage is evident but some beach front home owners have placed anchor buoys for their own boats.



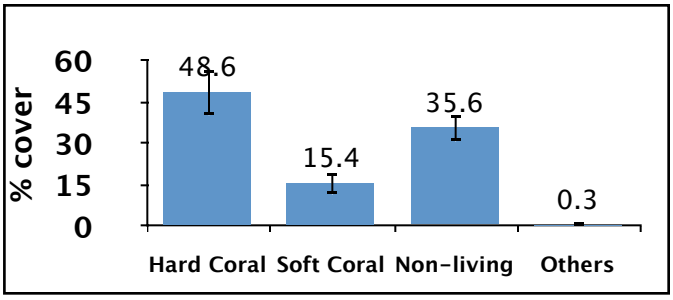


Figure 35. Substrate composition (% mean ±SE) in White House Reef in 2011 (2-3m depth).

Figure 34. Changes in substrate composition (% mean ±SE) in White House Reef from 1993 to 2011 (7-8m depth).

All reef and target fish density and diversity appear to decrease over the years. Statistical analysis also revealed a significant decrease (T-test: P=0.33) in all reef fish diversity from 2005 (36.6 ± 3.4 species/500m^2) to 2011 (20.0 ± 4.5 species/500m^2). Nevertheless, target fish biomass appeared to increase from 1.6 ± 0.8 kg/500m^2 in 2005 to 10.0 ± 9.0 kg/500m^2 in 2011. All reef fish density is moderate in 2011.

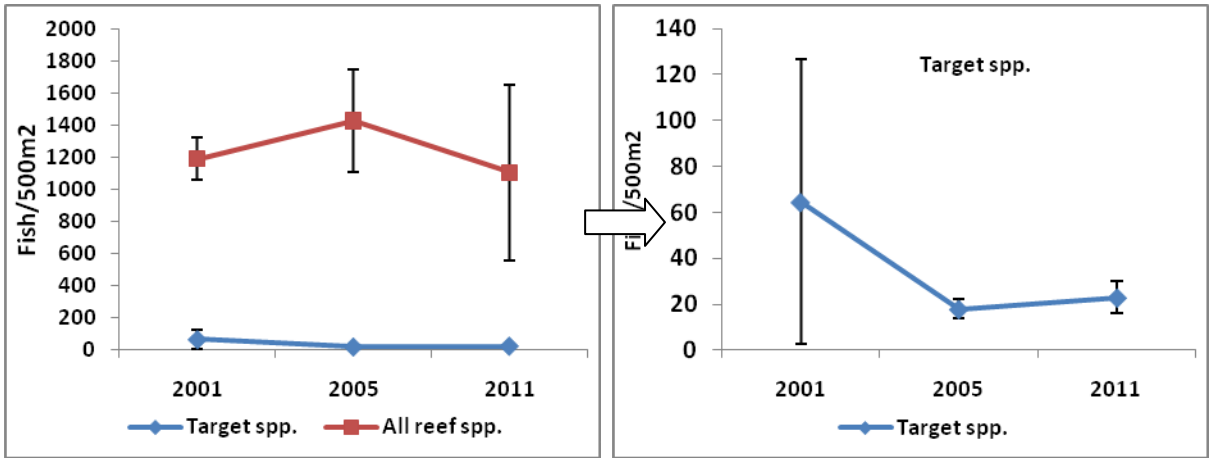


Figure 36. Mean (±SE) density (fish/500m^2) at White House Reef from 2001 to 2011 (6-8m depth).

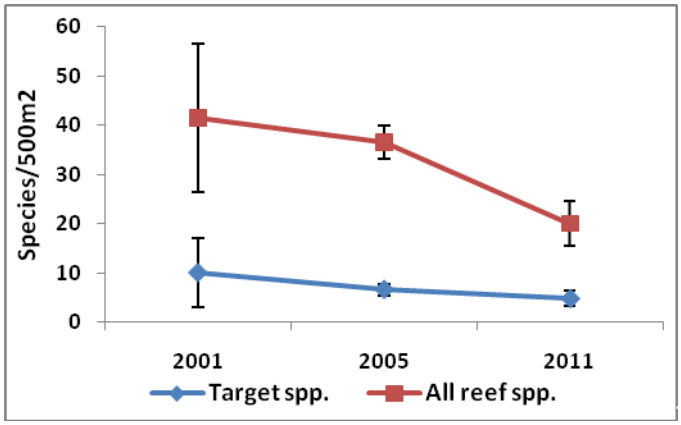


Figure 37. Mean (±SE) species (species/500m^2) at White House Reef from 2001 to 2011 (6-8m depth).

Sepoc Point Reef

Sepoc Point Reef has been a popular dive site since the 1970s in Batangas and benefits from being an exposed and diverse reef. It was recommended to be part of a national marine park in 1982 together with Sombrero Island because it is part of the same reef complex. This was not acted upon and now the reef may have suffered from the lack of protection.

LHC at the 7-8m depth has declined substantially from 36.8 ± 2.5% to 14.6 ± 4.7% (Table 34, Fig 38). Shallow live hard coral cover in Sepoc Point has declined significantly ($p < 0.001$) from 62.7 ± 4.8% in 2005 to 4.7 ±1.9% in 2011. However, statistical analysis revealed a significant increase (Kruskal-Wallis: P:0.00) in coral cover from 2001 (6.3±5.7%) to 2011 (14.6±4.7%). Nevertheless, the cause of decline from 2005 (36.8±2.5%) is reported to have been a major storm in 2008, given its exposure to open seas. Observations also indicate that the reef has been affected by crown of thorns outbreaks (2005) and anchor damage in the deeper areas.

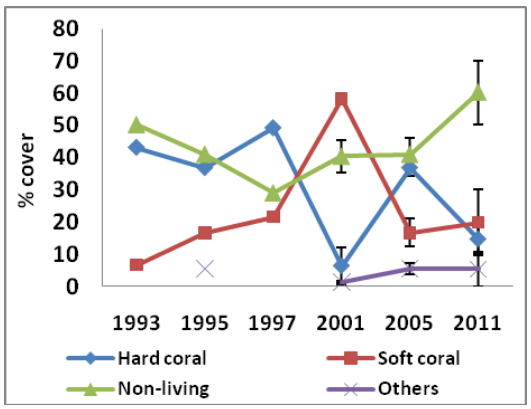


Figure 38. Changes in substrate composition (% mean ±SE) in Sepoc Point from 1993 to 2011 (7-8m depth).

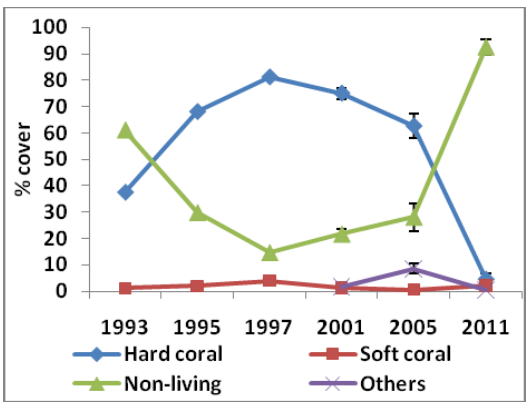


Figure 39. Changes in substrate composition (% mean ±SE) in Sepoc Point from 1993 to 2011 (2-3m depth).

Fish density and diversity in Sepoc point shows a decreasing trend over the years. All reef fish diversity decreased from 41.6 ± 1.0 species/500m^2 (2005) to 32.0 ± 6.7 species/500m^2 in 2011 (Kruskall-Wallis: P=0.01). This may be a reflection of heavy fishing pressure and poor coral cover. The proximity of this site to the village of Tingloy makes it an accessible fishing ground. Both butterfly fish diversity and abundance appeared to be lower compared to 2005 and 2001 (Table 2). Among the numerically abundant fish are the Anthids and Pomacentrids.

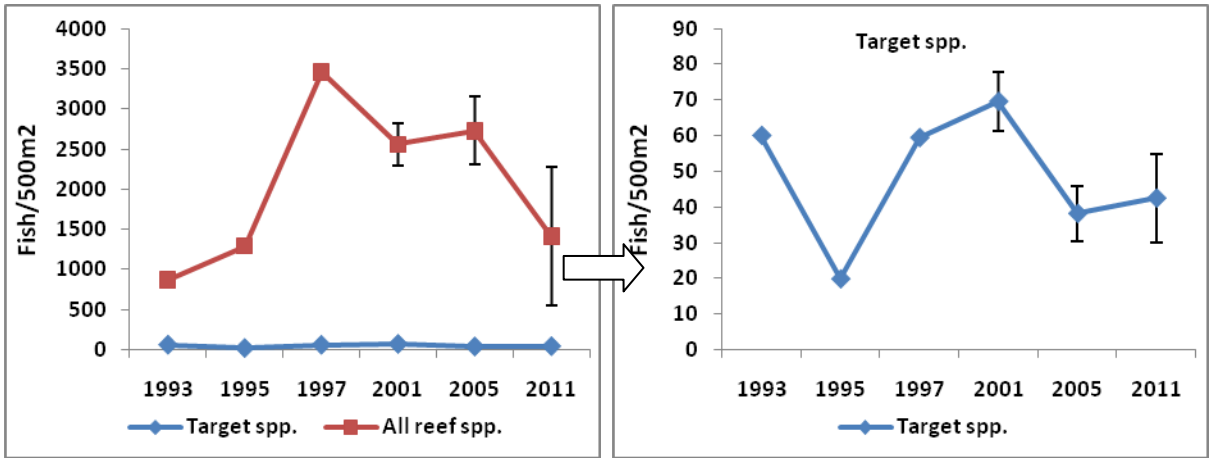


Figure 40. Mean (±SE) density (fish/500m^2) at Sepoc Point Reef from 1993 to 2011 (6-8m depth).

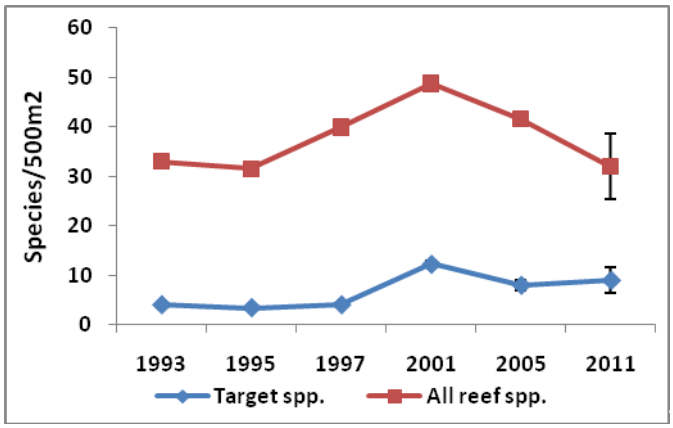


Figure 41. Mean (±SE) species (species/500m^2) at Sepoc Point Reef from 1993 to 2011 (6-8m depth).

Sepoc Point was a healthy reef as measured by LHC in 2005. At present, coral cover has declined and is in need of improved management to prevent more degradation. The area is used heavily for recreation and fishing and anchor buoys are urgently needed in the area.

Table 1. Changes in substrate composition (% mean ±SE) in Arthur's Rock Sanctuary from 1993 to 2011.

	SCUBA SURVEYS:											SNORKEL SURVEYS:										
	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011
	% cover	% cove		% cove		% cove		% cove				% cove	% cove		% cove		% cove		% cove		% cove	
SUBSTRATE COVER																						
Sand (S) & silt (SI)	13.6	6.6	-51.5	18.8	184.7	12.3	-34.3	20.3	64.1	16.3	-19.6	25.4	6.5	-74.4	9.3	42.4	3.2	-65.3	4.4	35.4	8.8	102.6
Coral rubble (R)	18.3	31.9	74.3	23.0	-27.8	16.4	-28.9	16.6	1.6	8.6	-48.5	11.7	9.0	-23.1	9.3	3.4	5.2	-44.5	6.4	24.4	7.1	10.7
Rock & block (RCK)	7.4	1.9	-74.3	5.0	164.1	8.2	62.5	4.1	-50.2	7.2	77.8	14.6	7.6	-47.9	9.7	27.6	16.0	64.9	15.2	-5.2	12.9	-14.8
White dead standing coral (DA)	2.7	0.3	-88.9	3.8	1154.	0.2	-95.2	0.4	141.6	0.7	52.4	2.0	0.3	-85.0	4.6	1422.	1.0	-77.3	1.3	28.7	1.6	16.7
Dead coral with algae (DCA)	~	~	N/A	~	N/A	9.5	N/A	2.9	-69.6	4.7	62.3	~	~	N/A	0.0	N/A	8.2	+	3.8	-53.8	2.1	-43.5
Subtotal non-living substrate	***42.0***	***40.7***	-3.1	***50.6***	24.3	***46.5***	-8.1	***44.3***	-4.9	***37.4***	-15.5	***53.7***	***23.4***	-56.4	***32.8***	40.3	***33.6***	2.4	**31.1**	-7.6	**32.6**	4.8
Branching (CB)	5.5	11.5	109.1	7.1	-38.7	5.6	-20.0	4.3	-24.7	7.2	68.6	12.2	39.9	227.0	27.1	-32.1	34.4	27.1	23.0	-33.2	19.3	-15.8
Massive (CM)	10.1	15.4	52.5	11.1	-27.9	16.6	49.5	13.5	-18.7	8.1	-39.9	10.8	11.9	10.2	15.1	27.0	13.2	-12.7	16.6	25.5	13.7	-17.3
Flat/Encrusting (CE)	7.5	5.4	-28.0	4.8	-11.3	4.3	-11.0	8.1	90.6	4.8	-40.5	5.9	5.3	-10.2	9.0	70.5	5.7	-36.9	8.1	41.2	5.2	-35.6
Foliose/Cup (CF)	3.5	1.7	-51.4	6.2	264.6	8.1	31.4	3.4	-58.6	2.1	-37.4	2.2	3.0	36.4	3.6	19.8	8.4	133.7	15.7	86.7	20.8	32.7
Total Hard Coral	**26.6**	**34.0**	27.8	**29.1**	-14.4	**34.6**	19.1	**29.3**	-15.6	22.2	-24.0	**31.1**	**60.1**	93.2	**54.8**	-8.8	**61.7**	12.6	**63.3**	2.5	**59.0**	-6.7
Total Soft Coral	**31.4**	**25.3**	-19.4	**20.3**	-19.9	**17.5**	-13.6	**24.6**	40.7	38.3	55.4	**15.1**	**16.5**	9.3	**12.3**	-25.2	**3.6**	-70.8	**4.5**	23.5	**7.5**	68.6
Subtotal Coral	***58.0***	***59.3***	2.2	***49.4***	-16.8	***52.2***	5.7	***53.9***	3.3	***60.5***	12.3	***46.2***	***76.6***	65.8	***67.2***	-12.3	***65.3***	-2.8	**67.7**	3.7	**66.6**	-1.7
Sponges (SP)	~	~	N/A	~	N/A	1.4	N/A	0.5	-64.3	0.7	-33.3	~	~	N/A	~	N/A	1.0	N/A	0.1	-85.8	0.5	266.0
Other animals (OT)	~	~	N/A	~	N/A	~	N/A	0.8	N/A	0.3	-100.(	~	~	N/A	~	N/A	~	N/A	0.3	N/A	0.1	-73.1
Algae																						
Fleshy (MA)	~	~	N/A	~	N/A	0.6	N/A	0.1	-77.4	0.7	477.8	~	~	N/A	~	N/A	0.6	N/A	0.2	-63.9	0.2	-1.2
Turf (TA)	~	~	N/A	~	N/A	0.3	N/A	0.3	15.6	~	N/A	~	~	N/A	~	N/A	0.3	N/A	0.3	-25.5	0.1	-70.4
Coralline (CA)	~	~	N/A	~	N/A	0.1	N/A	0.1	15.6	~	N/A	~	~	N/A	~	N/A	0.0	N/A	0.3	+	0.0	-100.(
Seagrass (SG)	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.3	+	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	***2.3***	N/A	***1.9***	-19.6	***2.1***	12.6	**~**	**~**	N/A	**~**	N/A	***2.0***	N/A	**1.2**	-38.8	**0.9**	-25.9
TOTAL	**100.0**	**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)	**~**	**~**	N/A	12	N/A	5.5	-54.9	5.0	-9.1		-100.(	~	~	N/A	9	N/A	3	-66.3	5.2	73.3		-100.(
Mean Topography (m)*	**~**	**~**	N/A	1.5	N/A	1.6	6.7	0.8	-47.9		-100.(	~	~	N/A	1.5	N/A	1.8	20.0	2.0	11.1		-100.(
Mean Depth/Range (m)	7-8	6-9	0.0	6-8	-6.7	6.3	-10	7.3	15.1		-100.(	3-4	2-4	-14.3	3-4	16.7	3.5	0.0	2.6	-25.4		-100.(
Horizontal Visibility (m)	15	15	0.0	15	1.3	15.5	2.0	13.6	-12.1		-100.(	12	14	16.7	15	9.3	17.9	17.0	13.9	-22.3		-100.(
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 2011.

Butterflyfish species	Common name	ARTHUR'S ROCK SANCTUARY								TWIN ROCKS SANCTUARY							
		1991	1992	1993	1995	1997	2001	2005	2011	1991	1992	1993	1995	1997	2001	2005	2011
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	H	S	O	W	X	Y	Z	A	H
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	H	S	O	W	X	Y	Z	A	H
Chaetodon lineolatus	Lined butterflyfish						Z								Z	A	
Chaetodon lunula	Raccoon butterflyfish	S	O	W	X	Y	Z	A	H	S	O		X	Y	Z	A	H
Chaetodon lunulatus	Pacific redfin butterflyfish	S	O	W	X	Y	Z	A	H	S		W	X	Y	Z	A	H
Chaetodon melannotus	Blackback butterflyfish	S	O	W	X	Y	Z	A	H		O	W		Y	Z	A	H
Chaetodon mertensii	Merten's butterflyfish	S	O	W			Z				O						
Chaetodon ocellicaudus	Spottail butterflyfish				X	Y	Z	A	H				X		Z	A	H
Chaetodon octofasciatus	Eightband butterflyfish	S	O	W	X	Y	Z	A	H		O	W	X	Y	Z	A	H
Chaetodon ornatissimus	Ornate butterflyfish					Y	Z	A	H								
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	H		O	W		Y	Z	A	H
Chaetodon rafflesi	Latticed butterflyfish	S	O	W	X	Y	Z	A	H			W			Z	A	H
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	H						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	H								
Chaetodon vagabundus	Vagabond butterflyfish	S	O	W	X	Y	Z	A	H	S		W	X	Y	Z	A	
Chaetodon xanthurus	Pearscale butterflyfish			W	X	Y	Z	A				W	X	Y	Z	A	
Forcipiger flavissimus	Forcepsfish	S	O	W	X	Y	Z	A	H		O	W	X	Y	Z	A	H
Forcipiger longirostris	Longnose butterflyfish						Z									A	
Hemitaurichthys polylepis	Pyramid butterflyfish	S															H
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	H						Z	A	
Heniochus varius	Horned bannerfish	S	O	W	X	Y	Z	A	H	S	O	W	X	Y	Z	A	H
Coradion chrysozonus	Goldengirdled coralfish						Z										
Total number or species/site		**23**	**22**	**21**	**23**	**22**	**29**	**22**	**16**	**8**	**13**	**14**	**12**	**16**	**22**	**22**	**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
Total number of species observed in all sites surveyed in 2011: 25

Table 2. Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2011.

Butterflyfish species	Common name	CATHEDRAL ROCK					CATHEDRAL REEF SANCTUARY			BATALANG BATO/PULANG-BULI REEF							WHITE HOUSE	
		199	199	199	2001	2005	2001	2005	2011	199	199	199	199	2001	2005	2011	2005	2011
Chaetodon adiergastos	Philippine butterflyfish				Z		Z	A	H			X	Y	Z	A	H		
Chaetodon auriga	Threadfin butterflyfish	S			Z			A	H			X			A			
Chaetodon baronessa	Eastern triangular butterflyfish	S	W	X	Z		Z	A	H	S	W	X	Y	Z	A	H	A	H
Chaetodon citrinellus	Speckled butterflyfish												Y		A			
Chaetodon ephippium	Saddle butterflyfish																	
Chaetodon kleinii	Klein's butterflyfish	S	W	X	Z	A	Z	A	H	S	W	X	Y	Z	A	H	A	
Chaetodon lineolatus	Lined butterflyfish							A	H						A			
Chaetodon lunula	Raccoon butterflyfish		W		Z		Z	A	H	S			Y	Z	A		A	
Chaetodon lunulatus	Pacific redfin butterflyfish	S		X	Z		Z	A	H		W	X			A	H	A	H
Chaetodon melannotus	Blackback butterflyfish	S								S	W	X	Y				A	
Chaetodon mertensii	Merten's butterflyfish	S			Z					S						H		
Chaetodon ocellicaudus	Spottail butterflyfish				Z			A	H				Y		A		A	
Chaetodon octofasciatus	Eightband butterflyfish										W		Y				A	H
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	H			X		Z	A	H		
Chaetodon rafflesi	Latticed butterflyfish				Z		Z	A	H				Y	Z	A		A	
Chaetodon selene	Yellowdotted butterflyfish		W	X	Z	A	Z	A						Z	A			
Chaetodon speculum	Mirror butterflyfish							A	H			X	Y	Z	A		A	
Chaetodon trifascialis	Chevron butterflyfish	S					Z	A			W	X		Z	A		A	
Chaetodon unimaculatus	Teardrop butterflyfish						Z	A	H			X	Y	Z	A	H		
Chaetodon vagabundus	Vagabond butterflyfish		W	X	Z		Z	A	H	S	W	X	Y	Z	A	H	A	
Chaetodon xanthurus	Pearscale butterflyfish		W	X	Z		Z	A										
Forcipiger flavissimus	Forcepsfish	S	W	X	Z	A	Z	A	H	S				Z	A	H		
Forcipiger longirostris	Longnose butterflyfish				Z	A	Z	A							A			
Hemitaurichthys polylepis	Pyramid butterflyfish	S	W	X	Z	A		A								H		
Heniochus acuminatus	Pennant coralfish	S			Z			A						Z		H		
Heniochus chrysostomus	Threeband penantfish						Z		H	S	W			Z	A	H	A	
Heniochus singularius	Singular bannerfish						Z								A			
Heniochus varius	Horned bannerfish	S	W		Z		Z	A	H					Z	A	H		H
Coradion chrysozonus	Goldengirdled coralfish							A										
Total number or species/site		**12**	**10**	**9**	**19**	**5**	**18**	**22**	**16**	**8**	**8**	**11**	**12**	**15**	**21**	**13**	**12**	**4**

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
Total number of species observed in all sites surveyed in 2011: 25

Table 2. Species list of butterflyfish in Mabini and Tingloy, Batangas from 1991 to 2011.

Butterflyfish species	Common name	WHITE SAND REEF							LAYAG-LAYAG REEF						
		1991	1993	1995	1997	2001	2005	2011	1991	1993	1995	1997	2001	2005	2011
Chaetodon adiergastos	Philippine butterflyfish							H	S					A	H
Chaetodon auriga	Threadfin butterflyfish	S		X	Y					W	X	Y		A	H
Chaetodon baronessa	Eastern triangular butterflyfish	S	W	X	Y	Z	A	H	S	W	X	Y	Z	A	H
Chaetodon citrinellus	Speckled butterflyfish			X	Y				S	W				A	
Chaetodon ephippium	Saddle butterflyfish														
Chaetodon kleinii	Klein's butterflyfish	S	W	X	Y	Z	A	H	S	W	X	Y	Z	A	H
Chaetodon lineolatus	Lined butterflyfish				Y										
Chaetodon lunula	Raccoon butterflyfish				Y						X	Y			
Chaetodon lunulatus	Pacific redfin butterflyfish		W	X	Y	Z	A	H	S	W	X	Y	Z	A	H
Chaetodon melannotus	Blackback butterflyfish	S			Y	Z	A	H	S	W	X			A	H
Chaetodon mertensii	Merten's butterflyfish								S						H
Chaetodon ocellicaudus	Spottail butterflyfish				Y	Z		H		W	X		Z	A	
Chaetodon octofasciatus	Eightband butterflyfish	S	W	X	Y	Z	A			W		Y			
Chaetodon ornatissimus	Ornate butterflyfish		W					H							
Chaetodon oxycephalus	Spot-nape butterflyfish							H							
Chaetodon plebeius	Blueblotch butterflyfish										X				
Chaetodon punctatofasciatus	Spotband butterflyfish		W	X	Y	Z	A	H	S	W	X	Y	Z	A	H
Chaetodon rafflesi	Latticed butterflyfish	S		X	Y		A		S					A	H
Chaetodon selene	Yellowdotted butterflyfish		W			Z				W	X		Z	A	
Chaetodon speculum	Mirror butterflyfish				Y	Z				W	X		Z	A	H
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		H		W	X	Y	Z	A	
Chaetodon xanthurus	Pearscale butterflyfish		W	X	Y			H		W	X	Y		A	
Forcipiger flavissimus	Forcepsfish		W	X	Y	Z	A	H	S		X		Z	A	H
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			H							
Heniochus varius	Horned bannerfish	S	W	X	Y	Z		H	S	W	X	Y	Z	A	H
Coradion chrysozonus	Goldengirdled coralfish												1		
Total number or species/site		**8**	**11**	**14**	**20**	**14**	**10**	**14**	**14**	**16**	**16**	**13**	**13**	**18**	**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
Total number of species observed in all sites surveyed in 2011: 25

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

Butterflyfish species	Common name	SOMBRERO ISLAND							SEPOC POINT											
		199	199	199	199	2001	2005	2011	19	199	199	2001	2005	2007	2001	199	1997	199	199	20
Chaetodon adiergastos	Philippine butterflyfish				Y	Z	A	H	W	X		Z			Z					
Chaetodon auriga	Threadfin butterflyfish						A				Y	Z		Z	Z	Y		W	X	
Chaetodon baronessa	Eastern triangular butterflyfish	S	W	X	Y	Z	A	H	W	X	Y	Z	A	Z	Z	Y	Y	W	X	H
Chaetodon citrinellus	Speckled butterflyfish					Z	A		W	X	Y					Y				
Chaetodon ephippium	Saddle butterflyfish																			
Chaetodon kleinii	Klein's butterflyfish	S	W	X	Y	Z	A	H	W	X	Y	Z	A	Z	Z	Y	Y	W	X	H
Chaetodon lineolatus	Lined butterflyfish			X							Y		A		Z					
Chaetodon lunula	Raccoon butterflyfish						A				Y	Z			Z				X	
Chaetodon lunulatus	Pacific redfin butterflyfish		W	X	Y	Z	A	H	W	X	Y	Z	A	Z	Z	Y	Y	W	X	H
Chaetodon melannotus	Blackback butterflyfish					Z	A	H	W	X	Y	Z	A			Y		W		
Chaetodon mertensii	Merten's butterflyfish	S				Z							A							
Chaetodon ocellicaudus	Spottail butterflyfish			X	Y		A	H		X	Y		A			Y				H
Chaetodon octofasciatus	Eightband butterflyfish				Y				W		Y				Z	Y	Y	W	X	
Chaetodon ornatissimus	Ornate butterflyfish						A						A		Z					
Chaetodon oxycephalus	Spot-nape butterflyfish														Z					
Chaetodon plebeius	Blueblotch butterflyfish				Y	Z	A		W		Y									
Chaetodon punctatofasciatus	Spotband butterflyfish	S	W	X	Y	Z	A	H	W	X	Y	Z	A	Z	Z	Y	Y	W	X	H
Chaetodon rafflesi	Latticed butterflyfish					Z	A	H			Y	Z	A		Z		Y			
Chaetodon selene	Yellowdotted butterflyfish		W		Y	Z		H	W	X		Z	A	Z			Y	W		
Chaetodon speculum	Mirror butterflyfish			X	Y		A	H			Y	Z								
Chaetodon trifascialis	Chevron butterflyfish		W	X	Y	Z	A		W	X	Y	Z	A	Z	Z	Y		W		
Chaetodon unimaculatus	Teardrop butterflyfish				Y	Z	A				Y	Z	A	Z			Y			H
Chaetodon vagabundus	Vagabond butterflyfish					Z	A		W	X	Y	Z	A	Z	Z		Y		X	
Chaetodon xanthurus	Pearscale butterflyfish						A			X	Y		A		Z	Y	Y			
Forcipiger flavissimus	Forcepsfish						A	H	W	X	Y	Z	A	Z	Z		Y	W	X	H
Forcipiger longirostris	Longnose butterflyfish						A								Z					
Hemitaurichthys polylepis	Pyramid butterflyfish				Y		A	H												
Heniochus acuminatus	Pennant coralfish					Z				X			A	Z	Z					
Heniochus chrysostomus	Threeband penantfish	S				Z	A	H	W	X	Y	Z	A		Z	Y		W		
Heniochus singularius	Singular bannerfish														Z					
Heniochus varius	Horned bannerfish	S		X	Y	Z	A	H	W	X	Y	Z	A	Z	Z	Y	Y	W	X	
Coradion chrysozonus	Goldengirdled coralfish													Z						
Total number or species/site		**6**	**6**	**9**	**14**	**17**	**23**	**14**	**1(**	**16**	**21**	**17**	**19**	**13**	**21**	**13**	**12**	**12**	**10**	**7**

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
Total number of species observed in all sites surveyed in 2011: 25

Table 3. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Arthu

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.0	5.0	0.4	29.4	7.2	0.6	37.6	9.4
Rabbitfish (Siganids)*	0.2	0.2	0.0	0.0	0.2	0.0	0.2	0.2
Groupers (Serranids)*	0.6	0.6	0.0	0.6	0.0	0.2	0.8	0.5
Barramundi cod; senorita	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.8	0.8	0.0	0.4	0.4	0.4	1.2	0.7
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.4	0.4	0.0	0.0	0.2	0.2	0.4	0.2
Jacks (Carangids)*	0.4	0.4	0.0	0.4	0.0	0.4	0.8	0.7
Fusiliers (Caesionids)*	0.2	0.2	0.0	0.0	0.0	6.0	6.0	5.5
Spinecheeks (Nemipterids)*	0.8	0.8	0.0	1.4	0.0	0.0	1.4	0.4
Goatfish (Mullids)*	1.8	1.8	0.0	2.8	1.4	0.0	4.2	1.4
Parrotfish (Scarids)*	3.8	3.8	0.4	14.8	2.2	0.6	18.0	7.5
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)	2.2	2.2	0.0	184.8	1.8	0.2	186.8	108.6
Butterflyfish (Chaetodonids)	10.0	10.0	9.6	23.6	1.2	0.0	34.4	6.8
Angelfish (Pomacanthids)	2.2	2.2	3.0	5.8	0.0	0.0	8.8	2.7
Wrasses (Labrids)	7.6	7.6	109.2	10.2	1.8	0.2	121.4	52.8
Humphead wrasse; ameng	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	11.8	11.8	1534.8	104.6	0.0	0.0	1639.4	444.8
Fairy Basslets (Anthids)	0.2	0.2	0.0	24.0	0.0	0.0	24.0	21.9
Moorish Idols (Zanclids)	1.0	1.0	0.8	2.8	0.0	0.0	3.6	0.5
Total (target reef species)*	**14.0**	**14.0**	**0.4**	**49.8**	**11.6**	**8.4**	**70.2**	**19.4**
Total (all reef species)	**49.0**	**49.0**	**1658.2**	**405.6**	**16.4**	**8.8**	**2089.0**	**485.6**

* Target species/families

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

Table 4. Mean (±SE) fish species (species/500m2) and percentage change between years in Arthur's Rock Sanctuary from 1991

FAMILY	(N=4) 1991 species	(N=3) 1992 species	% Change 1991-1992	(N=3) 1993 species	% Change 1992-1993	(N=5) 1995 species	% Change 1993-1995	(N=5) 1997 species	% Change 1995-1997	(N=6) 2001 species	(N=4) 2005 species	(N=5) 2011 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	4.5	3.0	-33.3	3.7	23.3	3.2	-13.5	3.4	6.3	5.8	3.0	5.0	66.7
Rabbitfish (Siganids)*	0.5	0.0	-100.0	0.0	N/A	0.4	+	0.2	-50.0	0.5	0.3	0.2	-20.0
Groupers (Serranids)*	2.3	2.0	-13.0	2.3	15.0	1.2	-47.8	2.2	83.3	1.5	0.3	0.6	140.0
Barramundi cod	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.8	0.7	-12.5	0.7	0.0	1.0	42.9	0.6	-40.0	1.7	0.8	0.8	6.7
Sweetlips (Haemulids)*	0.3	0.0	-100.0	0.3	+	0.0	-100.0	0.0	N/A	0.5	0.0	0.0	N/A
Emperors (Lethrinids)*	0.3	0.7	133.3	0.7	0.0	0.0	-100.0	0.4	+	0.5	0.3	0.4	60.0
Jacks (Carangids)*	0.3	0.3	0.0	0.3	0.0	0.0	-100.0	0.2	+	0.5	0.0	0.4	+
Fusiliers (Caesionids)*	1.0	1.3	30.0	1.3	0.0	0.2	-84.6	0.2	0.0	1.0	0.3	0.2	-20.0
Spinecheeks (Nemipterids)*	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.2	20.0	1.5	1.8	0.8	-54.3
Goatfish (Mullids)*	1.0	0.7	-30.0	1.0	42.9	1.0	0.0	1.0	0.0	1.5	1.0	1.8	80.0
Parrotfish (Scarids)*	1.0	0.7	-30.0	1.0	42.9	1.0	0.0	1.0	0.0	1.7	1.8	3.8	117.1
Bumphead parrotfish	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	2.0	1.3	-35.0	1.3	0.0	1.0	-23.1	1.0	0.0	1.5	0.8	2.2	193.3
Butterflyfish (Chaetodonids)	11.0	9.0	-18.2	10.0	11.1	8.2	-18.0	9.0	9.8	10.5	5.8	10.0	73.9
Angelfish (Pomacanthids)	3.8	1.7	-55.3	2.3	35.3	2.0	-13.0	2.2	10.0	3.2	2.0	2.2	10.0
Wrasses (Labrids)	7.0	3.3	-52.9	5.0	51.5	6.8	36.0	6.0	-11.8	6.0	7.8	7.6	-1.9
Humphead wrasse	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	12.5	12.7	1.6	12.3	-3.1	13.8	12.2	13.4	-2.9	15.2	17.8	11.8	-33.5
Fairy Basslets (Anthids)	1.8	2.0	11.1	1.3	-35.0	2.0	53.8	1.8	-10.0	1.5	1.5	0.2	-86.7
Moorish Idols (Zanclids)	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.3	1.0	300.0
													N/A
Total (target reef species)*	**8.5**	**7.4**	-12.9	**8.6**	16.2	**5.8**	-32.6	**7.0**	20.7	**16.7**	**9.3**	**14.0**	51.4
Total (all reef species)	**52.1**	**41.4**	-20.5	**45.5**	9.9	**43.8**	-3.7	**44.8**	2.3	**55.5**	**45.0**	**49.0**	8.9
													N/A

* 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 2011.

FAMILY	(N=4) 1991 Density	(N=3) 1992 Density	% Change 1991-1992	(N=3) 1993 Density	% Change 1992-1993	(N=5) 1995 Density	% Change 1993-1995	(N=5) 1997 Density	% Change 1995-1997	(N=6) 2001 Density	(N=4) 2005 Density	(N=5) 2011 Density	% Change 2001-2011
Surgeonfish (Acanthurids)*	132.0	67.0	-49.2	58.3	-13.0	55.0	-5.7	49.8	-9.5	116.5	14.5	37.6	159.3
Rabbitfish (Siganids)*	1.0	0.0	-100.0	0.0	N/A	1.2	+	6.6	450.0	0.8	0.5	0.2	-60.0
Groupers (Serranids)*	3.0	3.7	23.3	6.0	62.2	1.4	-76.7	3.4	142.9	2.5	0.3	0.8	220.0
Barramundi cod	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	3.3	230.0	1.0	-69.7	1.4	40.0	7.4	428.6	4.7	0.8	1.2	60.0
Sweetlips (Haemulids)*	0.0	0.0	N/A	0.3	+	0.0	-100.0	0.0	N/A	0.8	0.0	0.0	N/A
Emperors (Lethrinids)*	2.0	6.0	200.0	1.3	-78.3	0.0	-100.0	0.6	+	2.0	0.3	0.4	60.0
Jacks (Carangids)*	2.0	0.3	-85.0	11.0	3566.7	0.0	-100.0	0.2	+	5.8	0.0	0.8	+
Fusiliers (Caesionids)*	27.0	34.0	25.9	68.0	100.0	1.8	-97.4	25.8	1333.3	37.0	25.0	6.0	-76.0
Spinecheeks (Nemipterids)*	15.0	15.0	0.0	5.0	-66.7	3.8	-24.0	2.4	-36.8	7.5	4.0	1.4	-65.0
Goatfish (Mullids)*	21.0	4.0	-81.0	7.0	75.0	3.2	-54.3	7.8	143.8	10.7	1.0	4.2	320.0
Parrotfish (Scarids)*	51.0	14.0	-72.5	17.0	21.4	18.6	9.4	12.6	-32.3	10.7	2.8	18.0	554.5
Bumphead parrotfish	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	15.0	5.3	-64.7	7.3	37.7	8.8	20.5	15.0	70.5	7.8	0.8	186.8	24806.7
Butterflyfish (Chaetodonids)	51.0	32.7	-35.9	35.7	9.2	27.0	-24.4	29.4	8.9	42.8	17.5	34.4	96.6
Angelfish (Pomacanthids)	75.0	27.0	-64.0	31.6	17.0	8.6	-72.8	15.0	74.4	17.3	3.5	8.8	151.4
Wrasses (Labrids)	97.0	28.7	-70.4	129.0	349.5	161.4	25.1	160.4	-0.6	218.8	204.5	121.4	-40.6
Humphead wrasse	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	887.0	837.3	-5.6	811.3	-3.1	750.0	-7.6	1091.2	45.5	1123.7	1462.5	1639.4	12.1
Fairy Basslets (Anthids)	538.0	218.0	-59.5	268.0	22.9	573.0	113.8	347.6	-39.3	340.7	1450.0	24.0	-98.3
Moorish Idols (Zanclids)	21.0	7.0	-66.7	9.0	28.6	16.0	77.8	11.4	-28.8	7.8	0.5	3.6	620.0
Total (target reef species)*	**123.0**	**80.3**	-34.7	**116.6**	45.2	**31.4**	-73.1	**66.8**	112.7	**145.0**	**44.8**	**70.2**	56.9
Total (all reef species)	**1939.0**	**1303.3**	-32.8	**1466.8**	12.5	**1631.2**	11.2	**1786.6**	9.5	**1958.0**	**3188.3**	**2089.0**	-34.5

* 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 2011.

	SCUBA SURVEYS:											SNORKEL SURVEYS:										
	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-200	2011	% Change 2005-2011
	% cover	% cover		% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover		% cover	
SUBSTRATE COVER																						
Sand (S) & Silt (SI)	54.3	12.8	-76.4	27.6	115.4	34.2	24.1	26.3	-23.0	32.5	23.2	32.1	21.5	-33.0	22.0	2.1	9.8	-55.4	5.5	-44.3	17.4	219.4
Coral Rubble (R)	11.4	28.3	148.2	21.5	-24.2	14.0	-35.0	20.1	43.9	8.0	-60.4	3.5	5.8	65.7	2.4	-58.3	2.9	20.7	4.2	42.6	7.2	72.7
Rock & Block (RCK)	11.8	10.2	-13.6	14.2	39.4	6.8	-52.2	6.0	-11.2	0.8	-86.9	15.9	14.5	-8.8	16.3	12.5	13.8	-15.7	7.4	-45.9	13.1	76.6
White Dead Standing Coral (DA)	2.1	1.1	-47.6	2.2	100.0	0.1	-96.6	0.2	207.7	5.4	2247.	0.1	1.6	1500.	2.4	50.0	1.1	-53.2	1.0	-12.3	1.8	83.6
Dead Coral with Algae (DCA)	~	~	N/A	~	N/A	7.6	N/A	4.6	-39.6	5.4	18.3	~	~	N/A	~	N/A	7.7	N/A	6.7	-13.1	6.1	-7.6
Subtotal Non-living Substrate	***79.6***	***52.4***	-34.2	***65.4***	24.9	***62.6***	-4.3	***57.3***	-8.6	***52.0***	-9.1	***51.6***	***43.4***	-15.9	***43.1***	-0.7	***35.3***	-18.2	***24.7***	-29.9	***45.7***	85.1
Branching (CB)	2.8	7.4	164.3	4.4	-40.8	9.4	114.6	7.5	-19.8	6.4	-15.4	17.6	21.7	23.3	22.4	3.1	31.9	42.7	41.2	29.0	26.9	-34.6
Massive (CM)	4.2	8.7	107.1	10.5	20.6	15.3	45.6	7.8	-48.9	14.6	87.3	18.3	17.6	-3.8	19.3	9.9	20.6	6.5	15.7	-23.8	15.7	0.1
Flat/Encrusting (CE)	5.0	12.5	150.0	7.6	-39.1	3.9	-48.4	7.8	97.9	6.2	-20.1	1.0	3.6	260.0	4.9	36.5	3.5	-29.0	2.8	-21.2	0.6	-79.2
Foliose/Cup (CF)	0.9	2.7	200.0	1.5	-43.0	2.1	34.7	2.9	39.0	1.5	-49.4	2.1	2.3	9.5	2.2	-2.5	1.8	-18.7	6.4	249.2	1.0	-85.1
Total Hard Coral	**12.9**	**31.3**	142.6	**24.0**	-23.3	**30.7**	27.7	**26.0**	-15.2	**28.7**	10.3	**39.0**	**45.2**	15.9	**48.9**	8.1	**57.8**	18.3	**66.0**	14.1	**44.1**	-33.1
Total Soft Coral	**9.5**	**16.3**	71.6	**10.5**	-35.3	**5.1**	-51.9	**7.1**	39.4	**12.3**	74.3	**9.7**	**11.4**	17.5	**8.0**	-29.5	**3.3**	-58.4	**3.6**	6.2	**5.7**	59.6
Subtotal Coral	***22.4***	***47.6***	112.5	***34.6***	-27.4	***35.8***	3.4	***33.1***	-7.5	***41.0***	24.0	***48.7***	***56.6***	16.2	***56.9***	0.5	***61.2***	7.5	***69.5***	13.7	***49.8***	-28.4
Sponges (SP)	~	~	N/A	~	N/A	0.7	N/A	1.9	174.7	2.6	36.5	~	~	N/A	~	N/A	0.7	N/A	2.2	211.2	2.5	13.7
Other animals (OT)	~	~	N/A	~	N/A	~	N/A	4.7	N/A	2.8	-40.5	~	~	N/A	~	N/A	~	N/A	0.8	N/A	0.4	-54.8
Algae																						
Fleshy (MA)	~	~	N/A	~	N/A	0.6	N/A	0.5	-9.1	1.8	266.7	~	~	N/A	~	N/A	1.7	N/A	1.7	-4.2	1.6	-2.7
Turf (TA)	~	~	N/A	~	N/A	0.2	N/A	1.8	686.3	~	N/A	~	~	N/A	~	N/A	0.8	N/A	0.4	-44.4	~	N/A
Coralline (CA)	~	~	N/A	~	N/A	0.1	N/A	0.8	515.4	~	N/A	~	~	N/A	~	N/A	0.4	N/A	0.7	82.8	~	N/A
Seagrass (SG)	~	~	N/A	~	N/A	0.7	N/A	0.0	-100.0	~	N/A	~	~	N/A	~	N/A	~	N/A	0.0	N/A	~	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	***2.3***	N/A	***9.7***	315.2	***7.3***	-24.9	**~**	**~**	N/A	**~**	N/A	***3.6***	N/A	***5.8***	61.0	***4.5***	-22.5
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.3**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters																						
Mean Slope (degrees)	**~**	**~**	N/A	14	N/A	17.0	25.0	34.2	101.0		-100.0	~	~	N/A	15	N/A	6.0	-58.9	18.3	205.6		-100.0
Mean Topography (m)*	**~**	**~**	N/A	1.8	N/A	1.4	-22.2	1.4	-1.8		-100.0	~	~	N/A	1.0	N/A	1.3	30.0	1.4	5.8		-100.0
Mean Depth/Range (m)	7-8	7-8		6-9	0.0	6.2	-17.3	6.6	6.7		-100.0	3-4	2-4	-14.3	2-4	0.0	2.6	-13.3	3.0	13.8		-100.0
Horizontal Visibility (m)	16	15	-6.3	13	-15.3	13.5	6.3	15.2	12.8		-100.0	14	13	-7.1	10	-25.4	13.7	41.2	11.0	-19.7		-100.0
No. of 50 m Transects	4	3	-25.0	10	233.3	20	100.0	13.0	-35.0		-100.0	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/500m2) and density (individuals/500m2) per family in Twin Rocks Sanctuary in 2011

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.4	1.0	0.0	28.6	3.6	13.4	45.6	17.1
Rabbitfish (Siganids)*	1.6	0.4	0.0	2.4	1.2	0.8	4.4	1.1
Groupers (Serranids)*	3.2	0.7	0.0	2.4	1.2	0.4	4.0	0.8
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	2.6	0.5	0.0	9.4	2.8	0.0	12.2	6.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.6	0.2	0.0	2.0	2.8	0.0	4.8	2.3
Jacks (Carangids)*	0.4	0.2	0.0	0.0	0.0	302.0	302.0	273.4
Fusiliers (Caesionids)*	1.4	0.4	0.0	18.0	24.4	0.0	42.4	13.6
Spinecheeks (Nemipterids)*	1.0	0.3	0.0	4.0	0.0	0.0	4.0	1.3
Goatfish (Mullids)*	1.8	0.2	0.0	6.4	1.8	0.0	8.2	1.7
Parrotfish (Scarids)*	1.4	0.5	0.0	2.0	1.6	0.4	4.0	1.9
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)	2.8	0.5	0.0	233.4	0.8	0.0	234.2	64.5
Butterflyfish (Chaetodonids)	6.0	0.6	1.6	22.2	0.0	0.0	23.8	5.8
Angelfish (Pomacanthids)	2.2	0.3	5.2	7.8	0.0	0.0	13.0	3.4
Wrasses (Labrids)	7.2	1.3	120.6	16.4	1.0	0.0	138.0	90.5
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	10.2	1.4	946.2	264.4	0.0	0.0	1210.6	104.9
Fairy Basslets (Anthids)	1.0	0.0	90.0	0.0	0.0	0.0	90.0	49.4
Moorish Idols (*Zanclus cornutus*)	0.6	0.2	0.0	1.8	0.0	0.0	1.8	0.8
Total (target reef species)*	**19.4**	**2.2**	**0.0**	**75.2**	**39.4**	**317.0**	**431.6**	**287.8**
Total (all reef species)	**49.4**	**3.2**	**1163.6**	**621.2**	**41.2**	**317.0**	**2143.0**	**278.8**

* 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 2011

FAMILY	(N=2) 1991 species	(N=3) 1992 species	% Change 1991-1992	(N=3) 1993 species	% Change 1992-1993	(N=5) 1995 species	% Change 1993-1995	(N=6) 1997 species	% Change 1995-1997	(N=10) 2001 species	(N=5) 2005 species	(N=5) 2011 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	2.0	5.3	165.0	2.7	-49.1	3.6	33.3	3.0	-16.7	5.3	4.6	5.4	17.4
Rabbitfish (Siganids)*	0.0	0.0	N/A	1.0	+	0.8	-20.0	0.5	-37.5	2.5	2.0	1.6	-20.0
Groupers (Serranids)*	2.0	1.3	-35.0	1.3	0.0	1.4	7.7	1.5	7.1	2.6	2.6	3.2	23.1
Barramundi cod	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	1.7	+	1.7	0.0	2.0	17.6	1.3	-33.5	3.3	2.6	2.6	0.0
Sweetlips (Haemulids)*	0.0	0.7	+	0.3	-57.1	0.0	-100.0	0.0	N/A	0.0	1.2	0.0	-100.0
Emperors (Lethrinids)*	0.5	1.0	100.0	1.0	0.0	0.8	-20.0	0.8	3.7	1.4	0.6	0.6	0.0
Jacks (Carangids)*	0.0	0.0	N/A	0.3	+	0.0	-100.0	0.3	+	0.7	0.2	0.4	100.0
Fusiliers (Caesionids)*	1.5	2.0	33.3	0.0	-100.0	0.8	+	0.8	3.7	1.4	0.6	1.4	133.3
Spinecheeks (Nemipterids)*	0.5	0.7	40.0	1.0	42.9	1.0	0.0	1.3	33.0	2.1	2.0	1.0	-50.0
Goatfish (Mullids)*	0.5	1.0	100.0	0.3	-70.0	1.0	233.3	1.0	0.0	2.0	1.0	1.8	80.0
Parrotfish (Scarids)*	0.5	0.7	40.0	1.0	42.9	1.0	0.0	1.3	33.0	1.6	3.2	1.4	-56.3
Bumphead parrotfish	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A	0.1	0.0	0.0	N/A
Triggerfish (Balistids)	0.5	1.7	240.0	1.7	0.0	1.6	-5.9	2.0	25.0	1.8	1.2	2.8	133.3
Butterflyfish (Chaetodonids)	3.5	7.3	108.6	5.7	-21.9	7.2	26.3	6.7	-7.4	8.1	5.6	6.0	7.1
Angelfish (Pomacanthids)	1.5	3.0	100.0	2.0	-33.3	2.6	30.0	3.0	15.4	2.6	2.6	2.2	-15.4
Wrasses (Labrids)	2.0	4.0	100.0	4.0	0.0	4.0	0.0	4.7	16.8	7.1	10.2	7.2	-29.4
Humphead wrasse	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	8.5	13.0	52.9	12.0	-7.7	10.0	-16.7	11.0	10.0	16.0	18.2	10.2	-44.0
Fairy Basslets (Anthids)	2.0	1.7	-15.0	2.0	17.6	2.0	0.0	1.8	-8.5	2.2	1.6	1.0	-37.5
Moorish Idols (Zanclids)	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	1.0	0.6	-40.0
													N/A
Total (target reef species)*	**5.5**	**9.1**	65.5	**7.9**	-13.2	**8.8**	11.4	**9.0**	2.0	**23.0**	**20.6**	**19.4**	-5.8
Total (all reef species)	**26.5**	**46.1**	74.0	**39.0**	-15.4	**40.8**	4.6	**42.2**	3.3	**61.8**	**61.0**	**49.4**	-19.0

* 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/500m²) and percentage change of fish families between years in Twin Rocks Sanctuary from to 2011

FAMILY	(N=2) 1991 density	(N=3) 1992 density	% Change 1991-1992	(N=3) 1993 density	% Change 1992-1993	(N=5) 1995 density	% Change 1993-1995	(N=6) 1997 density	% Change 1995-1997	(N=10) 2001 density	(N=5) 2011 density	% Change 2001-2011
Surgeonfish (Acanthurids)*	26.0	60.0	130.8	42.7	-28.8	29.2	-31.6	42.3	45.0	57.5	45.6	27.2
Rabbitfish (Siganids)*	0.0	0.0	N/A	2.3	+	1.4	-39.1	1.8	30.7	16.7	4.4	-99.5
Groupers (Serranids)*	3.0	1.7	-43.3	1.7	0.0	2.2	29.4	2.3	5.9	7.8	4.0	-98.3
Barramundi cod	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	
Snapper (Lutjanids)*	0.0	3.3	+	2.7	-18.2	24.8	818.5	29.0	16.9	35.1	12.2	-42.0
Sweetlips (Haemulids)*	0.0	1.3	+	0.7	-46.2	0.0	-100.0	0.0	N/A	0.0	0.0	
Emperors (Lethrinids)*	4.5	5.0	11.1	25.0	400.0	5.8	-76.8	3.8	-34.0	9.9	4.8	-97.0
Jacks (Carangids)*	0.0	0.0	N/A	0.3	+	0.0	-100.0	0.7	+	2.6	302.0	4.8
Fusiliers (Caesionids)*	85.0	514.0	504.7	0.0	-100.0	15.2	+	55.5	265.1	107.2	42.4	-54.5
Spinecheeks (Nemipterids)*	1.5	4.0	166.7	9.0	125.0	18.6	106.8	13.0	-30.1	16.1	4.0	-83.2
Goatfish (Mullids)*	4.5	9.0	100.0	11.0	22.2	17.0	54.5	7.0	-58.8	17.8	8.2	-94.7
Parrotfish (Scarids)*	1.5	2.0	33.3	15.0	650.0	13.8	-8.0	9.0	-34.8	10.1	4.0	-67.3
Bumphead parrotfish	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0	
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	N/A	0.1	0.0	
Triggerfish (Balistids)	5.0	11.0	120.0	9.0	-18.2	5.4	-40.0	6.3	17.2	7.8	234.2	908.5
Butterflyfish (Chaetodonids)	18.0	29.0	61.1	24.7	-14.8	34.0	37.7	23.8	-29.9	26.5	23.8	112.4
Angelfish (Pomacanthids)	7.0	29.7	324.3	19.3	-35.0	15.4	-20.2	18.0	16.9	23.8	13.0	-59.7
Wrasses (Labrids)	8.0	298.0	3625.0	226.3	-24.1	85.2	-62.4	120.3	41.2	168.2	138.0	246.9
Humphead wrasse	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	0.0	
Damselfish (Pomacentrids)	504.0	1185.0	135.1	1173.0	-1.0	739.6	-36.9	1271.2	71.9	1456.5	1210.6	8203.5
Fairy Basslets (Anthids)	390.0	471.0	20.8	1026.0	117.8	450.0	-56.1	1581.0	251.3	619.8	90.0	-248.0
Moorish Idols (Zanclids)	17.0	15.0	-11.8	7.0	-53.3	9.0	28.6	9.0	0.0	7.6	1.8	-111.6
												N/A
Total (target reef species)*	**100.0**	**540.3**	440.3	**67.7**	-87.5	**98.8**	46.0	**122.2**	23.6	**247.0**	**431.6**	322.3
Total (all reef species)	**1075.0**	**2639.0**	145.5	**2595.7**	-1.6	**1466.6**	-43.5	**3194.2**	117.8	**2591.1**	**2143.0**	-11450.7

* 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 10. Changes in substrate composition (% mean ±SE) in Cathedral Reef Sanctuary from 2001 to 2011.

	SCUBA SURVEYS:					SNORKEL SURVEYS:				
	2001	2005	% Change	2011	% Change	2001	2005	% Change	2011	% Change
	% cover	% cover	2001-2005	% cover	2001-2005	% cover	% cover	2001-2005	% cover	2001-2011
SUBSTRATE COVER										
Sand (S) & silt (SI)	10.1	5.2	-48.6	5.2	-110.7	3.4	4.1	20.9	1.9	-90.9
Coral rubble (R)	4.3	1.2	-72.4	7.2	-110.0	1.7	1.0	-43.9	8.7	-119.9
Rock & block (RCK)	12.3	5.8	-52.7	5.3	-110.1	32.6	19.8	-39.4	6.6	-116.8
White dead standing coral (DA)	0.2	0.8	275.0	0.7	-99.7	1.3	0.7	-46.2	2.1	-104.6
Dead coral with algae (DCA)	8.7	8.2	-5.9	17.1	-390.5	5.7	5.3	-7.2	5.8	-180.9
Subtotal non-living substrate	**35.6**	**21.1**	-40.7	**35.6**	-187.6	**44.7**	**30.8**	-31.1	**25.2**	-181.1
Branching (CB)	40.2	59.7	48.5	45.7	-5.7	29.9		-100.0	63.1	-163.1
Massive (CM)	11.8	7.1	-39.6	6.6	-116.7	16.1	9.5	-41.2	6.6	-116.1
Flat/Encrusting (CE)	4.6	5.7	23.6	6.1	-74.2	6.0	4.5	-24.7	4.3	-117.5
Foliose/Cup (CF)	5.6	2.8	-49.8	3.6	-107.1	1.8	2.5	40.9	0.7	-98.4
Total Hard Coral	**62.2**	**75.3**	21.1	**62.0**	194.1	**53.8**	**67.5**	25.4	**74.7**	194.4
Total Soft Coral	**0.6**	**0.4**	-37.5	**0.6**	-101.6	**0.4**	**0.0**	-100.0	**0.1**	-100.1
Subtotal Coral	**62.8**	**75.7**	20.5	**62.6**	205.1	**54.2**	**67.5**	24.5	**74.8**	205.9
Sponges (SP)	0.6	0.4	-27.1	1.2	-104.3	0.3	0.7	121.2	0.0	-100.0
Other animals (OT)	0.0	0.1	+	0.4		0.0	0.1	+	0.0	
Algae										
Fleshy (MA)	0.4	0.9	134.4	0.1	-99.9	0.5	0.3	-45.5	0.0	-100.0
Turf (TA)	0.2	1.1	431.3	~	N/A	0.1	0.2	81.8	0.0	-100.0
Coralline (CA)	0.4	0.7	71.9	~	N/A	0.2	0.5	172.7	0.0	-100.0
Seagrass (SG)	0.0	0.0	N/A	0.1		0.0	0.0	N/A	0.0	
Subtotal Others	**1.6**	**3.2**	99.2	**1.8**	-98.2	**1.1**	**1.7**	57.9	**0.0**	-100.0
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**	**100.0**		**100.0**	
Environmental Parameters										
Mean Slope (degrees)	24.0	28.8	19.8		-100.0	6.4	15.0	134.4		-100.0
Mean Topography (m)*	1.8	1.1	-38.9		-100.0	1.6	1.4	-15.2		-100.0
Mean Depth/Range (m)	6.4	6.5	1.6		-100.0	2.5	2.6	2.0		-100.0
Horizontal Visibility (m)	14.2	17.5	23.2		-100.0	14.0	14.6	4.3		-100.0
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 11. Mean (±SE) fish species richness (species/500m^2) and density (individuals/500m^2) per family in Cathedral Reef Sanctuary in 2011.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	4.3	0.8	0.0	31.7	23.7	0.0	55.3	9.8
Rabbitfish (Siganids)*	0.7	0.5	0.0	1.7	0.0	0.0	1.7	1.2
Groupers (Serranids)*	0.3	0.2	0.0	0.0	0.3	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)*	1.3	0.2	0.0	1.7	0.3	1.0	3.0	1.4
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)*	0.3	0.2	0.0	0.0	0.0	1.3	1.3	0.9
Fusiliers (Caesionids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinecheeks (Nemipterids)*	1.0	0.4	0.0	4.7	0.0	0.0	4.7	2.1
Goatfish (Mullids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parrotfish (Scarids)*	2.0	0.4	0.0	1.3	1.7	0.0	3.0	0.4
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)	1.7	0.6	0.0	1.0	1.0	0.3	2.3	0.8
Butterflyfish (Chaetodonids)	6.7	2.2	1.7	25.0	0.0	0.0	26.7	10.7
Angelfish (Pomacanthids)	2.0	0.4	3.7	5.7	0.0	0.0	9.3	1.5
Wrasses (Labrids)	7.0	0.8	168.0	14.0	2.7	1.0	185.7	74.4
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	8.0	1.2	418.7	96.3	0.0	0.0	515.0	78.0
Fairy Basslets (Anthids)	0.7	0.2	91.0	0.0	0.0	0.0	91.0	53.1
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	0.0	1.7	0.0	0.0	1.7	0.2
Total (target reef species)*	**10.0**	**0.8**	**0.0**	**41.0**	**26.0**	**2.3**	**69.3**	**8.7**
Total (all reef species)	**37.0**	**1.2**	**683.0**	**184.7**	**29.7**	**3.7**	**901.0**	**44.6**

* 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 the Cathedral Reef Sanctuary from 1991 to 2011.

FAMILY	Cathedral Reef Sanctuary			
	(N=6)	(N=5)	(N=3)	% Change 2001-2011
	2001	2005	2011	
	species	species	species	
Surgeonfish (Acanthurids)*	5.5	2.6	4.3	66.7
Rabbitfish (Siganids)*	1.0	0.4	0.7	66.7
Groupers (Serranids)*	1.7	1.0	0.3	-66.7
Barramundi cod	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.3	1.0	1.3	33.3
Sweetlips (Haemulids)*	0.2	0.2	0	-100.0
Emperors (Lethrinids)*	0.8	0.4	0.0	-100.0
Jacks (Carangids)*	0.5	0.0	0.3	+
Fusiliers (Caesionids)*	0.3	0.6	0.0	-100.0
Spinecheeks (Nemipterids)*	1.3	0.8	1.0	25.0
Goatfish (Mullids)*	1.3	0.2	0.0	-100.0
Parrotfish (Scarids)*	2.2	2.0	2.0	0.0
Bumphead parrotfish	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.2	0.0	0.0	N/A
Triggerfish (Balistids)	1.3	1.8	1.7	-7.4
Butterflyfish (Chaetodonids)	8.5	7.4	6.7	-9.9
Angelfish (Pomacanthids)	3.0	2.2	2.0	-9.1
Wrasses (Labrids)	9.2	7.6	7.0	-7.9
Humphead wrasse	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	15.7	14.6	8.0	-45.2
Fairy Basslets (Anthids)	1.5	1.0	0.7	-33.3
Moorish Idols (Zanclids)	1.0	0.8	1.0	25.0
Total (target reef species)*	**15.3**	**9.2**	**10.0**	8.7
Total (all reef species)	**55.5**	**44.6**	**37.0**	-17.0

* Target species/families

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

(-) = decrease

Table 13. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years inside the Cathedral Reef Sanctuary from 1991 to 2011.

FAMILY	Cathedral Reef Sanctuary (N=6) 2001 Density	(N=5) 2005 Density	(N=3) 2011 Density	% Change 2001-2011
Surgeonfish (Acanthurids)*	71.3	13.2	55.3	-81.5
Rabbitfish (Siganids)*	5.0	1.0	1.7	-80.0
Groupers (Serranids)*	3.8	1.2	0.3	-68.7
Barramundi cod	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	1.7	3.2	3.0	92.0
Sweetlips (Haemulids)*	0.2	0.2	0.0	20.0
Emperors (Lethrinids)*	3.8	2.0	0.0	-47.8
Jacks (Carangids)*	1.2	0.0	1.3	-100.0
Fusiliers (Caesionids)*	25.7	226.0	0.0	780.5
Spinecheeks (Nemipterids)*	12.2	2.8	4.7	-77.0
Goatfish (Mullids)*	8.5	1.8	0.0	-78.8
Parrotfish (Scarids)*	9.0	14.4	3.0	60.0
Bumphead parrotfish	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.3	0.0	0.0	-100.0
Triggerfish (Balistids)	8.5	3.8	2.3	-55.3
Butterflyfish (Chaetodonids)	31.2	21.0	26.7	-32.6
Angelfish (Pomacanthids)	20.3	6.8	9.3	-66.6
Wrasses (Labrids)	87.2	88.6	185.7	1.6
Humphead wrasse	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	1958.7	4031.6	515.0	105.8
Fairy Basslets (Anthids)	497.7	1673.8	91.0	236.3
Moorish Idols (Zanclids)	7.7	4.0	1.7	-47.8
Total (target reef species)*	**123.7**	**257.4**	**69.3**	108.1
Total (all reef species)*	**2753.8**	**6095.4**	**901.0**	121.3

* 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	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011
	% cover	% cover		% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover		% cover	
SUBSTRATE COVER																						
Sand (s) & Silt (SI)	21.6	12.4	-42.6	23.2	87.1	24.7	6.5	11.6	-53.2	17.6	52.2	13.0	8.0	-38.5	17.8	122.8	7.0	-60.7	5.9	-15.2	6.1	3.4
Coral Rubble (R)	11.2	14.7	31.3	9.2	-37.3	15.4	67.2	10.4	-32.9	26.9	160.1	12.7	18.8	48.0	7.0	-62.9	3.7	-46.5	4.3	14.7	11.8	175.5
Rock & block (RCK)	3.8	0.1	-97.4	5.1	5040.	6.7	30.2	9.2	36.7	10.5	14.8	8.1	7.9	-2.5	7.5	-5.6	11.3	51.6	10.4	-7.7	12.7	22.2
White Dead Standing Coral (DA)	1.2	0.1	-91.7	1.6	1460.	0.1	-96.4	0.0	-100.(	0.2	+	~	3.6	N/A	2.4	-33.3	0.7	-71.9	0.2	-70.4	0.5	159.3
Dead Coral with Algae (DCA)	~	~	N/A	~	N/A	1.4	N/A	0.2	-85.3	4.5	2150.	~	~	N/A	~	N/A	3.7	N/A	2.6	-29.3	1.6	-38.9
Subtotal Non-living Substrate	***37.8***	***27.3***	-27.8	***39.1***	43.3	***48.2***	23.3	***31.3***	-35.2	***59.7***	90.9	***33.8***	***38.3***	13.3	***34.7***	-9.5	***26.4***	-23.8	***23.5***	-11.2	***32.8***	39.8
Branching (CB)	13.7	0.3	-97.8	1.3	333.3	2.3	75.6	2.1	-8.0	4.8	126.2	22.0	17.3	-21.4	6.8	-60.9	17.3	155.8	11.9	-31.5	19.4	64.0
Massive (CM)	3.0	7.8	160.0	2.5	-67.4	7.9	209.1	4.0	-49.0	5.3	33.3	6.2	2.7	-56.5	6.8	150.5	9.2	36.0	9.5	3.3	7.5	-21.2
Flat/Encrusting (CE)	3.0	14.8	393.3	5.8	-60.7	3.3	-42.5	8.6	155.6	5.8	-32.7	2.6	4.3	65.4	4.0	-7.0	5.0	25.0	3.9	-22.6	1.0	-74.2
Foliose/Cup (CF)	1.3	1.5	15.4	0.9	-41.3	1.4	64.1	0.9	-37.7	0.8	-7.4	2.2	2.6	18.2	3.3	25.2	2.8	-14.0	3.2	13.2	1.7	-46.2
Total Hard Coral	**21.0**	**24.4**	16.2	**10.4**	-57.2	**14.9**	42.9	**15.6**	4.2	**16.7**	7.2	**33.0**	**26.9**	-18.5	**20.8**	-22.6	**34.3**	64.7	**28.4**	-17.2	**29.6**	4.4
Total Soft Coral	**41.2**	**48.3**	17.2	**50.4**	4.4	**34.6**	-31.5	**40.9**	18.2	**19.1**	-53.3	**33.2**	**35.0**	5.4	**44.5**	27.2	**35.1**	-21.1	**43.8**	24.8	**36.6**	-16.5
Subtotal Coral	***62.2***	***72.7***	16.9	***60.9***	-16.3	***49.5***	-18.7	***56.4***	14.0	***35.8***	-36.6	***66.2***	***61.9***	-6.5	***65.3***	5.6	***69.4***	6.2	***72.2***	4.0	***66.2***	-8.3
Sponges (SP)	~	~	N/A	~	N/A	1.7	N/A	3.8	120.6	2.7	-28.9	~	~	N/A	~	N/A	3.2	N/A	2.3	-27.9	0.7	-67.9
Other animals (OT)	~	~	N/A	~	N/A	~	N/A	7.9	N/A	1.5	-80.9	~	~	N/A	~	N/A	~	N/A	1.5	N/A	0.0	-97.6
Algae																						
Fleshy (MA)	~	~	N/A	~	N/A	0.3	N/A	0.1	-80.0	0.4	733.3	~	~	N/A	~	N/A	0.7	N/A	0.1	-83.9	0.0	-100.(
Turf (TA)	~	~	N/A	~	N/A	0.3	N/A	0.3	-1.8	~	N/A	~	~	N/A	~	N/A	0.2	N/A	0.3	13.3	0.0	-100.(
Coralline (CA)	~	~	N/A	~	N/A	0.1	N/A	0.4	620.0	~	N/A	~	~	N/A	~	N/A	0.1	N/A	0.1	2.7	0.0	-100.(
Seagrass (SG)	~	~	N/A	~	N/A	~	N/A	0.0	N/A	~	N/A	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Total others	**~**	**~**	N/A	**~**	N/A	**2.3**	N/A	**12.4**	429.3	**4.6**	-62.9	**~**	**~**	N/A	**~**	N/A	**4.2**	N/A	**4.3**	3.6	**0.8**	-82.1
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**99.8**	
Environmental Parameters																						
Mean Slope (degrees)	**~**	~	N/A	16	N/A	14.0	-11.4	12.5	-10.7		-100.(	~	~	N/A	17	N/A	7.3	-56.3	21.7	196.8		-100.(
Mean Topography (m)*	**~**	~	N/A	1.0	N/A	1.3	30.0	0.8	-41.0		-100.(	~	~	N/A	2.0	N/A	2.0	0.0	1.5	-25.0		-100.(
Mean Depth/Range (m)	7-8	7-8		7-9	6.7	6.2	-22.5	7.4	19.2		-100.(	2-4	2-4		2-5	-16.7	2.4	-4	2.8	14.6		-100.(
Horizontal Visibility (m)	12	16	33.3	17	6.3	20.3	19.4	14.8	-27.3		-100.(	12	15	25.0	16	6.7	18.8	17.5	15.0	-20.2		-100.(
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/500m²) and density (individuals/500m²) per family in Batalang Bato (Pulang Buli) Sanctuary in 2011.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.2	0.9	3.2	73.8	4.4	1.2	82.6	17.6
Rabbitfish (Siganids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groupers (Serranids)*	1.6	0.5	0.0	0.6	0.4	0.8	1.8	0.7
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.0	0.4	0.0	0.2	0.4	0.6	1.2	0.4
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)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	2.2	0.3	0.0	70.2	10.2	0.0	80.4	25.1
Spinecheeks (Nemipterids)*	1.4	0.2	0.0	5.8	1.8	0.0	7.6	1.8
Goatfish (Mullids)*	2.6	0.8	0.0	5.0	2.4	0.0	7.4	2.4
Parrotfish (Scarids)*	1.4	0.2	0.0	2.2	1.0	0.4	3.6	0.7
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)	2.2	0.7	0.0	115.8	28.6	0.0	144.4	85.8
Butterflyfish (Chaetodonids)	7.2	1.8	3.6	29.6	0.0	0.0	33.2	10.3
Angelfish (Pomacanthids)	2.8	1.2	55.0	7.0	0.4	0.0	62.4	53.1
Wrasses (Labrids)	5.0	1.4	4.6	6.2	1.2	0.2	12.2	4.6
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	6.6	1.8	393.6	118.0	0.0	0.0	511.6	146.1
Fairy Basslets (Anthids)	0.8	0.3	178.6	0.0	0.0	0.0	178.6	142.2
Moorish Idols (*Zanclus cornutus*)	1.0	0.3	0.0	7.4	0.0	0.0	7.4	2.4
Total (target reef species)*	**15.4**	**2.4**	**0.0**	**157.8**	**20.6**	**3.0**	**181.4**	**39.2**
Total (all reef species)	**41.0**	**4.0**	**638.6**	**441.8**	**50.8**	**3.2**	**1134.4**	**350.9**

* 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 2011.

	(N=2) 1993 species	(N=2) 1995 species	% Change 1993-1995	(N=2) 1997 species	% Change 1995-1997	(N=6) 2001 species	% Change 1997-2001	(N=6) 2005 species	(N=5) 2011 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	2.5	2.0	-20.0	4.5	125.0	3.5	-22.2	2.7	5.2	95.0
Rabbitfish (Siganids)*	1.5	0.0	-100.0	0.5	+	1.0	100.0	0.5	0.0	-100.0
Groupers (Serranids)*	0.5	0.5	0.0	0.0	-100.0	0.2	+	2.0	1.6	-20.0
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	1.0	+	0.5	-50.0	0.5	0.0	1.2	1.0	-14.3
Sweetlips (Haemulids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	0.0	N/A	0.0	N/A	0.2	+	0.7	0.0	-100.0
Jacks (Carangids)*	0.0	0.0	N/A	0.5	+	0.2	-66.7	0.2	0.0	-100.0
Fusiliers (Caesionids)*	0.5	0.0	-100.0	0.5	+	0.7	33.3	0.5	2.2	340.0
Spinecheeks (Nemipterids)*	1.0	1.0	0.0	1.0	0.0	1.0	0.0	1.0	1.4	40.0
Goatfish (Mullids)*	0.5	0.5	0.0	0.5	0.0	1.7	233.3	0.8	2.6	212.0
Parrotfish (Scarids)*	1.0	1.0	0.0	1.0	0.0	2.8	183.3	2.3	1.4	-40.0
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.2	+	0.0	0.0	N/A
Triggerfish (Balistids)	0.0	0.0	N/A	0.5	+	1.7	233.3	0.7	2.2	230.0
Butterflyfish (Chaetodonids)	3.5	4.5	28.6	3.5	-22.2	4.0	14.3	4.8	7.2	49.0
Angelfish (Pomacanthids)	0.5	0.0	-100.0	1.5	+	1.8	22.2	1.2	2.8	140.0
Wrasses (Labrids)	4.5	4.5	0.0	6.0	33.3	9.5	58.3	8.5	5.0	-41.2
Humphead wrasse	~	~	N/A	~	N/A	0.0	N/A	0.0	0.0	N/A
Damselfish (Pomacentrids)	8.5	9.0	5.9	9.5	5.6	11.5	21.1	12.5	6.6	-47.2
Fairy Basslets (Anthids)	2.0	2.0	0.0	2.0	0.0	1.7	-16.7	2.0	0.8	-60.0
Moorish Idols (Zanclids)	1.0	1.0	0.0	1.0	0.0	1.0	0.0	0.8	1.0	20.0
Total (target reef species)*	**5.0**	**4.0**	-20.0	**4.5**	12.5	**11.8**	163.0	**11.8**	**15.4**	30.1
Total (all reef species)	**27.5**	**27.0**	-1.8	**33.0**	22.2	**43.0**	30.3	**42.3**	**41.0**	-3.1

* 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 2011.

FAMILY	(N=2) 1993 species	(N=2) 1995 species	% Change 1993-1995	(N=2) 1997 density	% Change 1995-1997	(N=6) 2001 density	% Change 1997-2001	(N=6) 2005 density	(N=5) 2011 density	% Change 2001-2011
Surgeonfish (Acanthurids)*	14.5	15.0	3.4	78.0	420.0	69.8	-10.5	163.3	82.6	-49.4
Rabbitfish (Siganids)*	6.0	0.0	-100.0	0.5	+	1.3	166.7	0.5	0.0	-100.0
Groupers (Serranids)*	0.5	0.5	0.0	0.0	-100.0	0.2	+	6.3	1.8	-71.6
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	1.0	+	0.5	-50.0	1.8	266.7	3.5	1.2	-65.7
Sweetlips (Haemulids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A	0.0	0.0	N/A
Emperors (Lethrinids)*	0.0	0.0	N/A	0.0	N/A	0.2	+	3.5	0.0	-100.0
Jacks (Carangids)*	0.0	0.0	N/A	4.5	+	0.2	-96.3	16.7	0.0	-100.0
Fusiliers (Caesionids)*	5.0	0.0	-100.0	16.5	+	18.0	9.1	58.3	80.4	37.8
Spinecheeks (Nemipterids)*	6.0	6.0	0.0	6.0	0.0	5.2	-13.9	10.8	7.6	-29.8
Goatfish (Mullids)*	1.5	0.5	-66.7	1.5	200.0	9.5	533.3	7.7	7.4	-3.5
Parrotfish (Scarids)*	6.0	9.0	50.0	9.0	0.0	16.3	81.5	9.8	3.6	-63.4
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	5.5	+	0.0	0.0	N/A
Triggerfish (Balistids)	0.0	0.0	N/A	1.5	+	3.3	122.2	1.7	144.4	8564.0
Butterflyfish (Chaetodonids)	12.5	25.5	104.0	14.5	-43.1	15.3	5.7	19.5	33.2	70.3
Angelfish (Pomacanthids)	0.5	0.0	-100.0	10.5	+	23.7	125.4	3.8	62.4	1527.8
Wrasses (Labrids)	121.5	205.5	69.1	73.5	-64.2	107.2	45.8	58.2	12.2	-79.0
Humphead wrasse	~	~	N/A	~	N/A	0.0	N/A	0.0	0.0	N/A
Damselfish (Pomacentrids)	373.5	865.5	131.7	2322.5	168.3	880.2	-62.1	4818.2	511.6	-89.4
Fairy Basslets (Anthids)	1794.0	4098.0	128.4	2370.0	-42.2	1196.7	-49.5	4967.5	178.6	-96.4
Moorish Idols (Zanclids)	6.0	9.0	50.0	21.0	133.3	9.3	-55.6	5.0	7.4	48.0
Total (target reef species)*	**25.0**	**17.0**	-32.0	**38.5**	126.5	**105.5**	174.0	**267.2**	**181.4**	-32.1
Total (all reef species)	**2347.5**	**5235.5**	123.0	**4930.0**	-5.8	**2363.7**	-52.1	**10154.3**	**1134.4**	-88.8

* 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 18. Changes in substrate composition (% mean ±SE) in Layag-layag, Tingloy from 1993 to 2011.

	SCUBA SURVEYS:											SNORKEL SURVEYS:										
	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011
	%cover	%cover		%cover		%cover		%cover		%cover		%cover	%cover		%cover		%cover		%cover		%cover	
SUBSTRATE COVER:																						
Sand (S) & Silt (SI)	22.7	11.3	-50.2	15.0	33.0	17.3	15.4	23.9	37.7	23.3	-2.3	21.3	6.1	-71.4	4.9	-19.3	1.3	-74.2	1.2	-4.1	4.8	296.1
Coral Rubble (R)	27.1	30.6	12.9	28.6	-6.5	20.0	-30.2	17.1	-14.6	13.6	-20.2	6.0	7.5	25.0	8.0	6.3	8.0	0.8	15.8	96.4	8.2	-47.8
Rock & block (RCK)	6.9	14.5	110.1	10.8	-25.8	11.2	4.3	14.1	25.9	8.4	-40.2	5.1	8.2	60.8	11.5	40.1	7.1	-38.6	9.4	33.3	22.2	136.1
White Dead Standing Coral (DA)	1.0	1.1	10.0	6.3	473.5	0.3	-95.0	0.1	-60.0	2.4	1855.6	2.3	3.5	52.2	10.3	195.2	1.2	-88.3	1.9	59.9	2.4	25.8
Dead Coral with Algae (DCA)	~	~	N/A	~	N/A	7.0	N/A	5.3	-25.3	13.0	147.6	~	~	N/A	~	N/A	9.4	N/A	24.1	156.4	3.5	-85.5
Subtotal Non-living Substrate	***57.7***	***57.5***	-0.3	***60.7***	5.6	***55.9***	-8.0	***60.4***	8.2	***60.8***	0.7	***34.7***	***25.3***	-27.1	***34.7***	37.3	***27.0***	-22.4	***52.4***	94.4	***41.2***	-21.4
Branching (CB)	13.3	13.1	-1.5	9.6	-27.0	14.2	48.6	4.8	-66.6	14.2	198.2	39.2	55.7	42.1	48.2	-13.5	54.7	13.6	31.6	-42.2	45.2	42.9
Massive (CM)	13.3	5.9	-55.6	8.5	43.8	13.9	64.0	8.6	-38.5	8.6	0.6	17.0	6.4	-62.4	9.7	50.8	9.9	2.6	5.5	-44.2	4.3	-22.6
Flat/Encrusting (CE)	5.5	6.9	25.5	8.1	16.9	6.4	-20.1	5.4	-15.6	5.6	2.2	3.9	3.6	-7.7	2.6	-28.9	2.2	-14.0	1.4	-36.0	1.5	7.7
Foliose/Cup (CF)	2.1	1.1	-47.6	3.3	201.5	4.6	38.7	5.5	19.6	5.2	-5.1	1.8	3.5	94.4	2.7	-24.0	2.1	-21.0	4.8	130.9	4.9	1.9
Total Hard Coral	**34.2**	**27.0**	-21.1	**29.4**	8.9	**39.2**	33.3	**24.3**	-38.1	**33.6**	38.4	**61.9**	**69.2**	11.8	**63.0**	-8.9	**68.9**	9.3	43.4	-37.0	**55.9**	28.9
Total Soft Coral	**8.1**	**15.6**	92.6	**9.9**	-36.5	**3.8**	-61.5	**12.8**	236.1	**2.5**	-80.5	**3.4**	**5.5**	61.8	**2.3**	-59.1	**2.2**	-2.0	1.1	-51.4	1.3	21.6
Subtotal Coral	***42.3***	***42.6***	0.7	***39.3***	-7.8	***43.0***	9.4	***37.1***	-13.8	***36.1***	-2.7	***65.3***	***74.7***	14.4	***65.3***	-12.6	***71.1***	8.9	***44.5***	-37.4	***57.2***	28.7
Sponges (SP)	~	~	N/A	~	N/A	0.9	N/A	0.8	-9.7	1.1	36.8	~	~	N/A	~	N/A	0.2	N/A	0.1	-53.6	0.3	226.3
Other animals (OT)	~	~	N/A	~	N/A	~	N/A	0.4	N/A	0.9	137.0	~	~	N/A	~	N/A	~	N/A	0.4	N/A	0.2	-54.5
Algae																						
Fleshy (MA)	~	~	N/A	~	N/A	0.0	N/A	0.7	2100.0	0.6	-19.2	~	~	N/A	~	N/A	0.7	N/A	1.1	49.6	0.5	-50.9
Turf (TA)	~	~	N/A	~	N/A	0.2	N/A	0.4	71.4	~	N/A	~	~	N/A	~	N/A	1.0	N/A	0.2	-83.7	0.5	204.4
Coralline (CA)	~	~	N/A	~	N/A	0.0	N/A	0.3	+	~	N/A	~	~	N/A	~	N/A	0.1	N/A	1.3	1636.4	0.0	-100.0
Seagrass (SG)	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.6	+	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	***1.1***	N/A	***2.5***	119.2	***3.1***	24.4	**~**	**~**	N/A	**~**	N/A	***2.0***	N/A	***3.1***	57.2	***1.5***	-51.1
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**99.9**	
Environmental Parameters																						
Mean Slope (degrees)	**~**	**~**	N/A	8	N/A	5.7	-28.8	7.5	31.6		-100.0	~	~	N/A	11	N/A	5.1	-53.6	10.0			-100.0
Mean Topography (m)*	**~**	**~**	N/A	1.8	N/A	1.7	-5.6	2	17.6		-100.0	~	~	N/A	2	N/A	1.3	-35.0	1.3			-100.0
Mean Depth/Range (m)	7-8	7-8		6-8	-6.7	6.3	-10	6.9	9.8		-100.0	3-4	3-4		2-4	-14.3	2.8	-6.7	2.3			-100.0
Horizontal Visibility (m)	15	17	13.3	18	5.9	17.3	-3.9	16.1	-6.7		-100.0	15	22	45.3	22	0.0	17.4	-20.2	15.1			-100.0
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 2011.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.6	0.7	0.0	20.8	1.8	0.0	22.6	8.9
Rabbitfish (Siganids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groupers (Serranids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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	0.2	0.0	0.0	0.2	0.2
Sweetlips (Haemulids)*	0.2	0.2	0.0	0.2	0.0	0.0	0.2	0.2
Emperors (Lethrinids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spinecheeks (Nemipterids)*	0.6	0.2	0.0	1.4	0.0	0.0	1.4	0.7
Goatfish (Mullids)*	0.4	0.2	0.0	0.2	0.8	0.0	1.0	0.7
Parrotfish (Scarids)*	2.6	0.6	0.0	6.2	1.6	0.2	8.0	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)	3.0	0.3	0.6	611.4	0.8	0.0	612.8	265.7
Butterflyfish (Chaetodonids)	5.6	0.6	0.2	24.8	0.0	0.0	25.0	2.1
Angelfish (Pomacanthids)	2.2	0.9	159.2	4.6	0.0	0.0	163.8	139.1
Wrasses (Labrids)	5.0	0.9	74.4	4.6	1.2	1.0	81.2	41.8
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	8.4	2.3	534.2	39.8	0.0	0.0	574.0	181.8
Fairy Basslets (Anthids)	0.6	0.2	27.0	0.0	0.0	0.0	27.0	14.8
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	0.0	2.6	0.0	0.0	2.6	0.7
Total (target reef species)*	**7.6**	**0.9**	**0.0**	**29.0**	**4.2**	**0.2**	**33.4**	**11.0**
Total (all reef species)	**33.4**	**3.4**	**795.6**	**716.8**	**6.2**	**1.2**	**1519.8**	**308.0**

* 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 2011.

	(N=2) 1993 species	(N=2) 1995 species	(N=8) 1997 species	(N=4) 2001 species	(N=4) 2005 species	(N=5) 2011 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	3.5	3.0	3.6	3.8	3.5	3.6	2.9
Rabbitfish (Siganids)*	1.0	2.5	1.4	0.0	0.3	0.0	-100.0
Groupers (Serranids)*	0.5	0.5	0.3	0.3	0.8	0.0	-100.0
Barramundi cod	~	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.5	0.0	0.1	0.0	0.3	0.2	-20.0
Sweetlips (Haemulids)*	0.0	1.0	0.0	0.0	0.0	0.2	+
Emperors (Lethrinids)*	0.5	0.0	0.0	0.5	0.8	0.0	-100.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.3	0.0	-100.0
Fusiliers (Caesionids)*	0.5	0.0	0.5	0.0	0.3	0.0	-100.0
Spinecheeks (Nemipterids)*	1.0	1.0	0.8	1.5	0.8	0.6	-20.0
Goatfish (Mullids)*	1.0	0.0	1.0	1.5	1.3	0.4	-68.0
Parrotfish (Scarids)*	0.5	1.0	1.0	2.3	3.8	2.6	-30.7
Bumphead parrotfish	~	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.5	0.5	1.1	2.5	2.0	3.0	50.0
Butterflyfish (Chaetodonids)	4.5	8.0	3.3	7.3	7.3	5.6	-22.8
Angelfish (Pomacanthids)	1.5	1.0	2.9	2.3	2.8	2.2	-20.0
Wrasses (Labrids)	5.0	5.0	7.0	8.8	9.0	5.0	-44.4
Humphead wrasse	~	~	~	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	9.5	10.5	6.9	15.3	16.5	8.4	-49.1
Fairy Basslets (Anthids)	2.0	2.0	1.9	1.3	1.5	0.6	-60.0
Moorish Idols (Zanclids)	1.0	0.0	1.0	1.0	0.8	1.0	33.3
Total (target reef species)*	**5.5**	**6.0**	**5.1**	**9.8**	**11.8**	**7.6**	-35.3
Total (all reef species)	**34.0**	**36.0**	**32.8**	**48.0**	**51.5**	**33.4**	-35.1

* 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 2011.

FAMILY	(N=2) 1993 Density	(N=2) 1995 Density	(N=8) 1997 Density	(N=4) 2001 Density	(N=4) 2005 Density	(N=5) 2011 Density	% Change 2001-2011
Surgeonfish (Acanthurids)*	39.5	4.8	109.3	40.3	46.8	22.6	-51.7
Rabbitfish (Siganids)*	6.0	6.0	3.9	0.0	0.3	0.0	-100.0
Groupers (Serranids)*	1.0	0.5	0.3	0.3	0.8	0.0	-100.0
Barramundi cod	~	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.5	0.0	0.1	0.0	0.3	0.2	-20.0
Sweetlips (Haemulids)*	0.0	9.0	0.0	0.0	0.0	0.2	+
Emperors (Lethrinids)*	1.5	0.0	0.0	0.5	2.0	0.0	-100.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.3	0.0	-100.0
Fusiliers (Caesionids)*	4.5	0.0	8.3	0.0	8.3	0.0	-100.0
Spinecheeks (Nemipterids)*	9.0	9.0	2.8	6.0	3.3	1.4	-56.9
Goatfish (Mullids)*	9.0	0.0	11.3	7.0	3.5	1.0	-71.4
Parrotfish (Scarids)*	4.5	9.0	8.3	13.0	16.0	8.0	-50.0
Bumphead parrotfish	~	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	4.5	0.5	2.1	33.5	4.5	612.8	13517.8
Butterflyfish (Chaetodonids)	31.5	24.5	11.3	42.0	25.5	25.0	-2.0
Angelfish (Pomacanthids)	5.5	1.0	15.3	35.0	9.8	163.8	1580.0
Wrasses (Labrids)	226.5	425.0	422.9	244.3	249.0	81.2	-67.4
Humphead wrasse	~	~	~	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	802.5	686.0	643.6	1000.0	2001.3	574.0	-71.3
Fairy Basslets (Anthids)	642.0	1026.0	950.9	148.0	1164.5	27.0	-97.7
Moorish Idols (Zanclids)	9.0	0.0	6.0	8.5	3.3	2.6	-20.0
Total (target reef species)*	**36.0**	**33.5**	**35.0**	**54.3**	**65.5**	**33.4**	-49.0
Total (all reef species)	**1797.0**	**2201.3**	**2196.4**	**1578.3**	**3539.0**	**1519.8**	-57.1

* 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 2011.

	SCUBA SURVEYS:													SNORKEL SURVEYS:									
	1983	1993	% Change 1983-1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2001-2011
	% cove	% cove		% cove		% cove		% cove		% cove		% cove		% cove	% cove		% cove		% cove		% cove		% cove	
SUBSTRATE COVER																								
Sand (S) & Silt (SI)	8.4	9.6	14.3	4.7	-51.0	6.3	33.6	4.4	-29.6	6.2	40.2	14.5	134.1	16.5	16.2	-1.8	6.2	-61.4	3.1	-49.7	1.5	-53.6	3.7	156.2
Coral Rubble (R)	21.9	30.1	37.4	24.1	-19.9	14.6	-39.4	18.4	25.8	19.4	5.4	14.7	-24.0	30.6	17.7	-42.2	6.7	-61.9	6.1	-10.2	4.9	-18.3	5.9	18.7
Rock & Block (RCK)	3.5	11.3	222.9	0.8	-92.9	5.9	640.0	9.2	56.2	7.9	-14.7	5.4	-31.0	35.3	28.7	-18.7	13.9	-51.6	14.2	2.0	7.4	-48.0	4.9	-33.9
White dead standing coral (DA)	8.4	7.8	-7.1	1.7	-78.2	5.8	242.4	0.3	-94.9	0.3	-15.6	2.2	766.7	2.7	3.8	40.7	3.5	-7.4	0.9	-75.7	0.0	-100.	0.4	+
Dead coral with algae (DCA)	~	~	N/A	~	N/A	~	N/A	11.5	N/A	6.0	-47.9	12.0	100.0	~	~	N/A	~	N/A	9.0	N/A	2.4	-73.0	2.9	21.1
Subtotal Non-living Substrate	***42.2***	***58.8***	39.3	***31.3***	-46.8	***32.6***	4.2	***43.8***	34.4	***39.7***	-9.5	***48.8***	23.0	***85.1***	***66.4***	-22.0	***30.4***	-54.2	***33.2***	9.2	**16.2**	-51.2	**17.8**	10.0
Branching (CB)	~	19.5	N/A	50.3	157.9	39.8	-20.8	14.6	-63.3	12.7	-13.2	13.4	5.9	3.2	20.1	528.1	49.1	144.0	33.8	-31.1	47.4	40.3	44.1	-6.9
Massive (CM)	~	4.5	N/A	3.1	-31.1	3.2	1.6	10.1	221.3	6.8	-32.5	10.3	51.2	2.7	1.7	-37.0	4.3	153.3	7.9	83.5	4.3	-45.9	2.6	-39.1
Flat/Encrusting (CE)	~	13.0	N/A	7.5	-42.3	5.2	-30.8	5.3	1.4	6.3	19.8	10.5	66.5	5.4	8.0	48.1	7.8	-2.9	8.0	3.0	4.6	-42.0	3.9	-15.3
Foliose/Cup (CF)	~	0.6	N/A	1.8	200.0	4.8	167.8	6.4	32.0	5.4	-14.9	4.6	-14.9	0.8	2.0	150.0	2.6	30.3	6.6	153.3	12.4	88.4	23.3	87.6
Total Hard Coral	**45.9**	**37.6**	-18.1	**62.7**	66.8	**53.0**	-15.5	**36.4**	-31.4	**31.3**	-14.1	**38.9**	24.4	**12.1**	**31.8**	162.8	**63.7**	100.4	**56.3**	-11.7	**68.8**	22.2	**74.0**	7.6
Total Soft Coral	**11.7**	**3.6**	-69.2	**8.9**	147.2	**14.4**	62.2	**16.1**	11.5	**22.1**	37.2	**8.4**	-62.0	**2.8**	**2.0**	-28.6	**5.9**	193.2	**6.7**	13.4	**12.7**	90.9	**8.1**	-36.0
Subtotal Coral	***57.6***	***41.2***	-28.5	***71.6***	73.8	***67.4***	-5.8	***52.5***	-22.2	***53.3***	1.6	***47.3***	-11.4	***14.9***	***33.8***	126.8	***69.6***	105.9	***63.0***	-9.6	**81.5**	29.4	**82.1**	0.8
Sponges (SP)	~	~	N/A	~	N/A	~	N/A	3.7	N/A	3.3	-12.2	2.9	-11.1	~	~	N/A	~	N/A	1.5	N/A	0.8	-47.6	0.1	-91.5
Other animals (OT)	~	~	N/A	~	N/A	~	N/A	~	N/A	0.5	N/A	0.3	-47.4	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Algae																								
Fleshy (MA)	~	~	N/A	~	N/A	~	N/A	0.6	N/A	0.6	-5.7	0.7	18.2	~	~	N/A	~	N/A	1.8	N/A	0.8	-55.3	0.0	-100.
Turf (TA)	~	~	N/A	~	N/A	~	N/A	0.6	N/A	1.9	213.6	~	N/A	~	~	N/A	~	N/A	0.3	N/A	0.5	35.0	0.0	-100.
Coralline (CA)	~	~	N/A	~	N/A	~	N/A	0.6	N/A	0.7	2.9	~	N/A	~	~	N/A	~	N/A	0.3	N/A	0.3	15.6	0.0	-100.
Seagrass (SG)	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A	~	N/A	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	**~**	N/A	***3.7***	N/A	***7.0***	89.8	***3.9***	-44.2	**~**	**~**	N/A	**~**	N/A	***3.9***	N/A	**2.3**	-40.1	**0.1**	-97.1
TOTAL	**100.0**	**100.0**		**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		-100.	~	~		8		4.1		7.5	82.9		-100.
Mean Topography (m)*	**~**	**~**		**~**		2.9		2.0		1.0	-51.3		-100.	~	~		**~**		1.5		1.3	-12.5		-100.
Mean Depth/Range (m)	1-3	7-8		7-8		6-9		6.8		7.4	8.5		-100.	3-5	2-3		2-5		2.6		2.8	9.0		-100.
Horizontal Visibility (m)	~	16		17		22		22.9		14.9	-35.0		-100.	12	15		25		22.4		13.7	-39.0		-100.
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 2011.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.4	0.2	0.0	63.8	0.8	0.0	64.6	38.3
Rabbitfish (Siganids)*	0.2	0.2	0.0	0.0	0.2	0.0	0.2	0.2
Groupers (Serranids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
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)*	0.4	0.2	0.0	0.8	0.0	0.0	0.8	0.4
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fusiliers (Caesionids)*	0.4	0.4	0.0	500.0	0.0	0.0	500.0	456.4
Spinecheeks (Nemipterids)*	0.4	0.2	0.0	1.0	0.0	0.0	1.0	0.7
Goatfish (Mullids)*	1.2	0.3	0.0	1.2	1.6	0.0	2.8	0.9
Parrotfish (Scarids)*	1.6	0.5	0.0	4.0	0.2	0.6	4.8	1.6
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)	3.0	0.5	6.0	62.8	1.6	0.0	70.4	31.6
Butterflyfish (Chaetodonids)	7.2	1.0	1.6	24.0	0.0	0.0	25.6	0.9
Angelfish (Pomacanthids)	2.4	0.8	52.8	3.8	0.0	0.0	56.6	39.6
Wrasses (Labrids)	5.4	0.8	5.2	10.2	0.6	0.0	16.0	4.2
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	8.4	2.0	1198.8	37.0	0.0	0.0	1235.8	590.9
Fairy Basslets (Anthids)	1.8	0.2	672.8	12.0	0.0	0.0	684.8	312.6
Moorish Idols (*Zanclus cornutus*)	0.8	0.3	0.0	5.2	0.0	0.0	5.2	3.3
Total (target reef species)*	**7.6**	**0.6**	**0.0**	**570.8**	**2.8**	**0.6**	**574.2**	**494.1**
Total (all reef species)	**36.6**	**2.7**	**1937.2**	**725.8**	**5.0**	**0.6**	**2668.6**	**1395.8**

* 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 2011

FAMILY	(N=2) 1993 species	(N=2) 1995 species	(N=6) 1997 species	(N=8) 2001 species	(N=6) 2005 species	(N=5) 2001 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	4.5	3.5	3.7	4.3	2.7	3.4	27.5
Rabbitfish (Siganids)*	0.5	1.0	1.2	0.8	0.2	0.2	20.0
Groupers (Serranids)*	1.5	0.0	0.7	1.5	0.3	0.0	-100.0
Barramundi cod	~	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.0	0.5	0.4	0.2	0.0	-100.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.5	0.0	0.0	0.5	0.3	0.4	20.0
Jacks (Carangids)*	0.0	0.0	0.0	0.3	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.5	0.0	1.2	0.3	0.3	0.4	20.0
Spinecheeks (Nemipterids)*	1.0	0.5	0.7	1.0	0.8	0.4	-52.0
Goatfish (Mullids)*	1.0	0.5	1.0	1.0	0.7	1.2	80.0
Parrotfish (Scarids)*	1.0	0.5	1.0	2.9	1.0	1.6	60.0
Bumphead parrotfish	~	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.0	0.5	1.3	2.3	1.0	3.0	200.0
Butterflyfish (Chaetodonids)	4.5	6.0	5.2	5.6	4.8	7.2	49.0
Angelfish (Pomacanthids)	1.0	2.0	2.7	2.4	2.0	2.4	20.0
Wrasses (Labrids)	5.5	5.5	7.5	13.3	10.5	5.4	-48.6
Humphead wrasse	~	~	~	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	10.5	8.5	9.8	13.8	14.8	8.4	-43.4
Fairy Basslets (Anthids)	2.0	2.0	2.0	2.1	1.5	1.8	20.0
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	0.8	0.8	-4.0
							N/A
Total (target reef species)*	**6.0**	**2.5**	**6.2**	**12.8**	**6.5**	**7.6**	16.9
Total (all reef species)	**36.0**	**31.5**	**39.4**	**53.1**	**42.0**	**36.6**	-12.9

* 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 25. Mean (±SE) density (individuals/500m^2) and percentage change of fish families between years at Sombrero Island from 1993 to 2011.

FAMILY	(N=2) 1993 density	(N=2) 1995 density	(N=6) 1997 density	(N=8) 2001 density	(N=6) 2005 density	(N=5) 2001 density	% Change 2001-2011
Surgeonfish (Acanthurids)*	172.5	63.5	88.3	90.0	35.5	64.6	82.0
Rabbitfish (Siganids)*	1.0	1.0	3.5	1.1	0.2	0.2	20.0
Groupers (Serranids)*	1.5	0.0	0.7	2.0	0.3	0.0	-100.0
Barramundi cod	~	~	~	0.1	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.0	0.5	1.0	0.2	0.0	-100.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.5	0.0	0.0	1.1	1.0	0.8	-20.0
Jacks (Carangids)*	0.0	0.0	0.0	4.3	0.0	0.0	N/A
Fusiliers (Caesionids)*	16.5	0.0	66.5	20.3	21.7	500.0	2207.7
Spinecheeks (Nemipterids)*	6.0	4.5	0.7	3.4	9.0	1.0	-88.9
Goatfish (Mullids)*	9.0	4.5	5.0	7.3	7.3	2.8	-61.8
Parrotfish (Scarids)*	3.0	4.5	8.0	12.1	5.2	4.8	-7.1
Bumphead parrotfish	~	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	6.0	1.5	3.8	11.3	1.7	70.4	4124.0
Butterflyfish (Chaetodonids)	29.0	27.0	19.8	44.3	29.0	25.6	-11.7
Angelfish (Pomacanthids)	18.0	7.0	18.3	22.6	21.7	56.6	161.2
Wrasses (Labrids)	406.5	377.5	170.8	187.9	247.8	16.0	-93.5
Humphead wrasse	~	~	~	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	382.5	472.5	852.8	1897.6	4436.5	1235.8	-72.1
Fairy Basslets (Anthids)	2562.0	3330.0	2306.5	1566.1	3493.7	684.8	-80.4
Moorish Idols (Zanclids)	9.0	9.0	7.3	12.6	12.8	5.2	-59.5
							N/A
Total (target reef species)*	**38.5**	**14.5**	**84.8**	**142.7**	**51.3**	**574.2**	1018.6
Total (all reef species)	**3624.0**	**4302.5**	**3552.6**	**3885.0**	**8323.5**	**2668.6**	-67.9

* 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 2011.

	SCUBA SURVEYS:											SNORKEL SURVEYS:								
	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1995	1997	% Change 1993-1995	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011
	% cover	% cover		% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover	
SUBSTRATE COVER																				
Sand (S) & silt (SI)	38.8	28.2	-27.3	32.7	15.9	33.8	3.3	33.1	-1.9	39.4	18.9	26.3	15.1	-42.7	16.7	10.8	7.2	-57.2	9.7	36.1
Coral rubble (R)	15.8	27.1	71.5	10.8	-60.1	12.5	15.7	24.4	95.0	11.4	-53.3	8.6	8.2	-5.2	8.6	5.5	15.8	83.7	7.7	-51.1
Rock & block (RCK)	7.9	4.6	-41.8	5.8	26.7	7.3	25.5	2.6	-65.0	3.7	43.1	7.3	16.7	129.2	15.0	-10.3	7.0	-53.7	11.0	57.8
White dead standing coral (DA)	0.3	0.2	-33.3	7.6	3678.6	0.0	-100.0	0.0	N/A	0.3	+	2.1	6.5	207.4	1.2	-81.4	2.2	79.2	2.3	8.5
Dead coral with algae (DCA)	~	~	N/A	~	N/A	7.6	N/A	2.9	-61.2	1.0	-66.0	~	~	N/A	22.7	N/A	4.9	-78.6	3.3	-32.0
Subtotal non-living substrate	**62.8**	**60.1**	-4.3	**56.9**	-5.4	**61.1**	7.5	**63.0**	3.1	**55.7**	-11.6	**44.3**	**46.4**	4.8	**64.2**	38.3	**36.9**	-42.5	**34.1**	-7.7
Branching (CB)	2.6	17.2	561.5	16.6	-3.3	6.2	-62.8	5.9	-4.0	7.7	30.1	29.1	27.4	-5.9	11.7	-57.3	21.8	86.3	29.3	34.6
Massive (CM)	9.8	6.2	-36.7	6.4	3.5	10.1	56.9	8.3	-17.4	10.2	22.3	5.9	7.8	32.1	6.7	-14.0	11.3	68.7	5.5	-51.3
Flat/Encrusting (CE)	8.1	7.0	-13.6	6.7	-4.7	2.2	-67.2	3.8	71.4	2.6	-31.9	5.9	6.4	7.6	1.8	-71.7	4.4	141.7	4.4	0.4
Foliose/Cup (CF)	1.1	0.3	-72.7	1.5	393.3	0.6	-62.0	2.3	311.1	1.2	-49.5	0.3	1.6	437.5	1.4	-13.2	10.5	650.0	6.7	-35.9
Total Hard Coral	**21.6**	**30.7**	42.1	**30.8**	0.2	**19.0**	-38.3	**20.3**	6.9	**21.6**	6.4	**41.2**	**43.1**	4.7	**21.6**	-49.9	**48.0**	122.0	**45.9**	-4.2
Total Soft Coral	**15.6**	**9.2**	-41.0	**12.4**	34.3	**18.3**	48.2	**14.1**	-23.2	**18.7**	32.7	**14.5**	**10.5**	-27.9	**6.8**	-35.0	**8.5**	25.0	**16.3**	91.4
Subtotal Coral	**37.2**	**39.9**	7.3	**43.1**	8.1	**37.3**	-13.5	**34.4**	-7.9	**40.3**	17.2	**55.7**	**53.6**	-3.8	**28.4**	-47.0	**56.5**	98.8	**62.2**	10.2
Sponges (SP)	~	~	N/A	~	N/A	0.4	N/A	0.6	66.7	1.3	113.3	~	~	N/A	1.9	N/A	2.3	21.1	1.0	-56.5
Other animals (OT)	~	~	N/A	~	N/A	0.0	N/A	1.0	+	1.4	38.9	~	~	N/A	0.0	N/A	2.0	+	1.0	-50.0
Algae																				
Fleshy (MA)	~	~	N/A	~	N/A	0.4	N/A	0.7	57.1	0.5	-27.3	~	~	N/A	3.4	N/A	0.0	-100.0	2.1	+
Turf (TA)	~	~	N/A	~	N/A	0.4	N/A	0.3	-42.9	~	N/A	~	~	N/A	1.3	N/A	2.4	80.8	0.6	-74.5
Coralline (CA)	~	~	N/A	~	N/A	0.3	N/A	0.2	-40.0	~	N/A	~	~	N/A	0.8	N/A	0.0	-100.0	0.0	N/A
Seagrass (SG)	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A	0.8	+	~	~	N/A	0.0	N/A	0.0	N/A	0.0	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	**1.6**	N/A	**2.8**	76.0	**4.0**	45.5	**~**	**~**	N/A	**7.4**	N/A	**6.7**	-10.6	**4.7**	-29.8
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100**		**100**		**100.0**	**100.0**		**100.0**		**100.0**		**100.9**	
Environmental Parameters																				
Mean Slope (degrees)	**~**	**~**		6		2.9		7.5	158.6		-100.0	~	7		3.0		~	N/A		N/A
Mean Topography (m)*	**~**	**~**		0.9		1		1.5	50.0		-100.0	~	1.0		1.2		~	N/A		N/A
Mean Depth/Range (m)	7-8	5-8		4-8		5.3		7.0	32.1		-100.0	2-8	2-4		2.4		2.5	4.2		-100.0
Horizontal Visibility (m)	16	15		18		12.9		13.4	4.1		-100.0	14	19		12.8		10.0	-21.9		-100.0
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 2011.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.8	0.8	2.0	44.2	6.2	0.0	52.4	12.4
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	0.0	0.0	0.4	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	0.0	0.0	0.2	0.2	0.2
Jacks (Carangids)*	0.2	0.2	0.0	0.0	0.0	0.8	0.8	0.7
Fusiliers (Caesionids)*	0.4	0.2	0.0	22.0	4.0	0.0	26.0	19.5
Spinecheeks (Nemipterids)*	1.0	0.3	0.0	2.0	0.4	0.0	2.4	0.7
Goatfish (Mullids)*	1.8	0.4	0.0	0.8	2.2	0.8	3.8	1.0
Parrotfish (Scarids)*	1.6	0.5	0.0	4.8	4.4	0.2	9.4	4.5
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)	2.4	0.7	0.0	97.0	2.0	0.0	99.0	69.6
Butterflyfish (Chaetodonids)	6.0	1.9	3.0	19.6	1.6	0.0	24.2	6.1
Angelfish (Pomacanthids)	1.8	0.5	4.0	4.6	0.0	0.0	8.6	2.7
Wrasses (Labrids)	5.0	1.2	274.8	8.4	2.0	0.0	285.2	150.4
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	7.8	1.7	719.4	61.2	0.0	0.0	780.6	312.3
Fairy Basslets (Anthids)	0.8	0.3	545.8	0.0	0.0	0.0	545.8	340.6
Moorish Idols (*Zanclus cornutus*)	1.2	0.3	0.0	2.8	0.0	0.0	2.8	0.8
Total (target reef species)*	**9.6**	**0.6**	**0.0**	**74.0**	**17.2**	**2.4**	**93.6**	**28.9**
Total (all reef species)	**34.6**	**5.2**	**1549.0**	**267.6**	**22.8**	**2.4**	**1841.8**	**750.6**

* 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 2011

FAMILY	(N=2) 1995	(N=4) 1997	(N=3) 2001	(N=5) 2005	(N=5) 2011	% Change 2001-2011
	species		species	species	species	
Surgeonfish (Acanthurids)*	4.0	2.5	2.3	2.0	3.8	90.0
Rabbitfish (Siganids)*	0.0	0.3	0.3	0.0	0.0	N/A
Groupers (Serranids)*	0.0	1.3	0.7	0.2	0.2	0.0
Barramundi cod	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	0.8	0.0	0.4	0.4	0.0
Sweetlips (Haemulids)*	1.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.0	0.5	0.7	0.2	0.2	0.0
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.2	+
Fusiliers (Caesionids)*	0.0	0.5	0.0	0.0	0.4	+
Spinecheeks (Nemipterids)*	1.0	0.8	1.3	1.8	1.0	-44.4
Goatfish (Mullids)*	1.0	1.0	1.0	0.8	1.8	125.0
Parrotfish (Scarids)*	1.0	1.0	0.3	0.6	1.6	166.7
Bumphead parrotfish	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	2.0	1.3	1.0	0.4	2.4	500.0
Butterflyfish (Chaetodonids)	5.0	10.5	6.7	4.4	6.0	36.4
Angelfish (Pomacanthids)	1.0	1.5	1.7	1.2	1.8	50.0
Wrasses (Labrids)	3.5	7.3	4.7	9.0	5.0	-44.4
Humphead wrasse	~	~	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	14.0	14.5	17.7	12.8	7.8	-39.1
Fairy Basslets (Anthids)	1.5	1.8	2.0	1.6	0.8	-50.0
Moorish Idols (Zanclids)	1.0	1.0	0.3	0.8	1.2	50.0
						N/A
Total (target reef species)*	**6.0**	**6.0**	**6.7**	**6.0**	**9.6**	60.0
Total (all reef species)	**38.0**	**46.3**	**40.7**	**36.2**	**34.6**	-4.4

* 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 2011.

FAMILY	(N=2) 1995 density	(N=4) 1997 density	(N=3) 2001 density	(N=5) 2005 density	(N=5) 2011 density	% Change 2001-2011
Surgeonfish (Acanthurids)*	44.0	27.0	37.3	21.4	52.4	144.9
Rabbitfish (Siganids)*	0.0	0.3	0.7	0.0	0.0	N/A
Groupers (Serranids)*	0.0	1.5	2.0	0.2	0.2	0.0
Barramundi cod	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	0.8	0.0	0.4	0.4	0.0
Sweetlips (Haemulids)*	0.5	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	4.5	3.0	11.3	1.8	0.2	-88.9
Jacks (Carangids)*	0.0	0.0	0.0	0.0	0.8	+
Fusiliers (Caesionids)*	0.0	9.0	0.0	0.0	26.0	+
Spinecheeks (Nemipterids)*	9.0	2.3	5.3	8.8	2.4	-72.7
Goatfish (Mullids)*	1.5	5.5	12.3	1.4	3.8	171.4
Parrotfish (Scarids)*	6.0	21.0	3.0	1.0	9.4	840.0
Bumphead parrotfish	~	~	0	0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	3.0	4.3	5.7	0.6	99.0	16400.0
Butterflyfish (Chaetodonids)	23.0	30.5	25.0	14.2	24.2	70.4
Angelfish (Pomacanthids)	6.0	9.5	17.0	4.0	8.6	115.0
Wrasses (Labrids)	408.0	83.0	219.0	145.6	285.2	95.9
Humphead wrasse	~	~	0	0	0.0	N/A
Damselfish (Pomacentrids)	900.0	2680.0	1314.7	1056.6	780.6	-26.1
Fairy Basslets (Anthids)	193.5	706.3	467.0	341.6	545.8	59.8
Moorish Idols (Zanclids)	2.0	15.0	3.0	3.0	2.8	-6.7
						N/A
Total (target reef species)*	**22.5**	**43.4**	**41.0**	**28.6**	**93.6**	227.3
Total (all reef species)	**1602.0**	**3599.0**	**2123.3**	**1600.6**	**1841.8**	15.1

* Target species/families

% change = {(Yr_2/Yr_1)-1} x 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 2011.

	SCUBA SURVEY:										
	1994	1995	% Change 1994-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011
	% cover	% cover		% cover		% cover		% cover		% cover	
SUBSTRATE COVER											
Sand (S) & silt (SI)	41.5	35.4	-14.6	28.0	-20.9	40.1	43.2	33.2	-17.2	29.4	-11.6
Coral rubble (R)	10.4	6.8	-34.3	15.3	125.0	14.5	-5.2	6.0	-58.6	7.4	24.0
Rock & block (RCK)	13.3	4.3	-67.7	0.9	-79.1	7.6	744.4	5.4	-28.6	0.9	-83.9
White dead standing coral (DA)	12.0	6.0	-50.0	9.3	54.2	0.0	-100.0	0.0	N/A	0.7	+
Dead coral with algae (DCA)	~	~	N/A	~	N/A	11.0	N/A	3.3	-70.1	6.5	97.8
Subtotal non-living substrate	***77.1***	***52.5***	-31.9	***53.5***	1.8	***73.2***	37.0	***47.9***	-34.5	***44.9***	-6.4
Branching (CB)	10.0	27.5	176.4	14.4	-47.8	3.6	-74.9	13.8	282.9	8.2	-40.6
Massive (CM)	4.5	2.5	-45.6	6.5	165.3	3.8	-41.5	7.2	89.8	4.9	-31.6
Flat/Encrusting (CE)	1.8	5.6	208.3	7.8	40.5	2.1	-73.1	2.0	-4.8	1.5	-25.0
Foliose/Cup (CF)	2.0	1.9	-7.5	1.2	-35.1	2.8	133.3	1.6	-43.9	0.9	-44.3
Total Hard Coral	**18.3**	**37.4**	104.7	**29.9**	-20.1	**12.3**	-58.8	**24.6**	99.8	**15.5**	-36.9
Total Soft Coral	4.7	10.2	118.3	12.5	23.2	11.4	-8.8	**25.9**	127.4	**38.9**	49.9
Subtotal Coral	***22.9***	***47.5***	107.4	***42.4***	-10.8	***23.7***	-44.0	***50.5***	113.1	***54.4***	7.7
Sponges (SP)	~	~	N/A	~	N/A	0.5	N/A	0.3	-42.9	0.7	140.6
Other animals (OT)	~	~	N/A	~	N/A	0.0	N/A	0.6	+	0.0	-100.0
Algae											
Fleshy (MA)	~	~	N/A	~	N/A	2.1	N/A	0.1	-96.6	0.1	-12.5
Turf (TA)	~	~	N/A	~	N/A	0.4	N/A	0.5	25.0	0.0	-100.0
Coralline (CA)	~	~	N/A	~	N/A	0.1	N/A	0.1	-28.6	0.0	-100.0
Seagrass (SG)	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	***3.1***	N/A	***1.6***	-49.3	***0.8***	-52.3
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters											
Mean Slope (degrees)	~	~		6		~		5.0	N/A		-100.0
Mean Topography (m)*	~	~		1.0		1.0		0.9	-10.0		-100.0
Mean Depth/Range (m)	4	4		4		5.3		4.3	-18.1		-100.0
Horizontal Visibility (m)	22.0	18.0		22.0		14.5		16.0	10.3		-100.0
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 2011.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	2.5	0.7	0.0	14.8	0.0	0.0	14.8	5.3
Rabbitfish (Siganids)*	0.3	0.2	0.0	0.0	0.3	0.0	0.3	0.2
Groupers (Serranids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.0	0.5	0.0	0.3	0.5	0.0	0.8	0.4
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)*	0.0	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)*	0.5	0.4	0.0	0.3	0.0	0.0	0.3	0.2
Goatfish (Mullids)*	0.8	0.4	0.0	2.5	0.0	0.0	2.5	1.2
Parrotfish (Scarids)*	0.5	0.4	0.0	3.3	0.0	0.0	3.3	2.7
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)	0.5	0.4	0.0	3.3	0.0	0.0	3.3	2.7
Butterflyfish (Chaetodonids)	1.8	0.5	0.5	3.3	0.0	0.0	3.8	1.1
Angelfish (Pomacanthids)	1.5	0.4	1.5	5.0	0.0	0.0	6.5	2.8
Wrasses (Labrids)	3.5	0.8	25.8	12.0	0.3	0.0	38.0	20.9
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	7.0	1.4	469.3	15.5	0.0	0.0	484.8	220.4
Fairy Basslets (Anthids)	1.0	0.0	277.5	3.8	0.0	0.0	281.3	172.2
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	0.0	1.0	0.0	0.0	1.0	0.3
Total (target reef species)*	**5.5**	**1.0**	**0.0**	**21.0**	**0.8**	**0.0**	**21.8**	**5.5**
Total (all reef species)	**21.5**	**3.4**	**774.5**	**64.8**	**1.0**	**0.0**	**840.3**	**317.2**

* 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 2011.

FAMILY	(N=2) 2001 species	(N=5) 2005 species	(N=4) 2011 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	1.5	2.6	2.5	73.3
Rabbitfish (Siganids)*	0.5	0.0	0.3	-100.0
Groupers (Serranids)*	1.0	0.2	0.0	-80.0
Barramundi cod	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	1.0	0.0	1.0	-100.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	0.5	0.6	0.0	20.0
Jacks (Carangids)*	0.0	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	1.5	1.4	0.5	-6.7
Goatfish (Mullids)*	2.0	0.8	0.8	-60.0
Parrotfish (Scarids)*	2.0	1.0	0.5	-50.0
Bumphead parrotfish	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	1.5	0.2	0.5	-86.7
Butterflyfish (Chaetodonids)	4.5	4.0	1.8	-11.1
Angelfish (Pomacanthids)	1.5	1.0	1.5	-33.3
Wrasses (Labrids)	5.5	9.0	3.5	63.6
Humphead wrasse	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	16.0	13.6	7.0	-15.0
Fairy Basslets (Anthids)	2.0	1.6	1.0	-20.0
Moorish Idols (Zanclids)	0.5	0.6	0.8	20.0
Total (target reef species)*	**10.0**	**6.6**	**5.5**	-34.0
Total (all reef species)	**41.5**	**36.6**	**21.5**	-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 2011.

FAMILY	(N=2) 2001 density	(N=5) 2005 density	(N=4) 2011 density	% Change 2001-2011
Surgeonfish (Acanthurids)*	10.5	10.4	14.8	-1.0
Rabbitfish (Siganids)*	1.0	0.0	0.3	-100.0
Groupers (Serranids)*	1.5	0.2	0.0	-86.7
Barramundi cod	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	1.5	0.0	0.8	-100.0
Sweetlips (Haemulids)*	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	16.5	2.8	0.0	-83.0
Jacks (Carangids)*	0.0	0.0	0.0	N/A
Fusiliers (Caesionids)*	0.0	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	28.5	4.0	0.3	-86.0
Goatfish (Mullids)*	12.0	2.8	2.5	-76.7
Parrotfish (Scarids)*	3.5	3.6	3.3	2.9
Bumphead parrotfish	0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	N/A
Triggerfish (Balistids)	3.5	0.2	3.3	-94.3
Butterflyfish (Chaetodonids)	16.5	12.4	3.8	-24.8
Angelfish (Pomacanthids)	24.0	6.0	6.5	-75.0
Wrasses (Labrids)	65.5	88.8	38.0	35.6
Humphead wrasse	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	680.5	742.6	484.8	9.1
Fairy Basslets (Anthids)	321.0	551.6	281.3	71.8
Moorish Idols (Zanclids)	3.0	1.4	1.0	-53.3
Total (target reef species)*	**64.5**	**18.0**	**21.8**	-72.1
Total (all reef species)	**1189.0**	**1426.8**	**840.3**	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 Point from 1993 to 2011.

	SCUBA SURVEYS:											SNORKEL SURVEYS:										
	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011	1993	1995	% Change 1993-1995	1997	% Change 1995-1997	2001	% Change 1997-2001	2005	% Change 2001-2005	2011	% Change 2005-2011
	% cover	% cover		% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover		% cover	
SUBSTRATE COVER																						
Sand (S) & Silt (SI)	15.5	5.2	-66.5	4.8	-7.7	5.0	3.3	2.5	-49.6	11.3	351.1	12.1	6.8	-43.8	2.2	-67.5	0.2	-90.8	0.1	-37.3	7.7	5950.0
Coral Rubble (R)	11.9	11.5	-3.4	8.5	-26.3	17.6	108.0	11.4	-35.1	20.6	79.7	11.0	8.8	-20.0	1.4	-84.4	2.8	101.8	1.5	-46.3	41.1	2658.5
Rock & Block (RCK)	22.4	4.7	-79.0	11.0	134.8	7.3	-33.6	9.4	27.8	12.3	31.0	37.3	12.2	-67.3	7.7	-36.7	9.5	22.4	4.7	-50.5	20.1	330.0
White Dead Standing Coral (DA)	0.4	0.9	125.0	4.8	436.4	0.5	-89.6	0.8	50.0	1.9	151.9	0.8	2.1	162.5	3.5	66.0	1.7	-50.1	6.2	258.9	0.3	-95.7
Dead Coral with Algae (DCA)	~	~	N/A	~	N/A	10.0	N/A	16.9	69.4	14.2	-16.0	~	~	N/A	~	N/A	7.6	N/A	15.7	106.9	23.3	49.0
Subtotal Non-living Substrate	***50.2***	***22.3***	-55.6	***29.1***	30.7	***40.4***	38.7	***41.0***	1.4	***60.2***	46.9	***61.2***	***29.9***	-51.1	***14.8***	-50.5	***21.7***	47.0	***28.2***	29.7	***92.6***	228.1
Branching (CB)	16.5	34.1	106.7	28.4	-16.8	32.3	13.9	18.6	-42.5	4.7	-74.9	23.4	46.5	98.7	60.4	30.0	63.0	4.2	47.9	-24.0	1.5	-96.8
Massive (CM)	11.9	10.1	-15.1	9.6	-5.3	12.6	31.5	9.6	-24.0	3.8	-59.9	4.8	7.1	47.9	8.2	14.8	3.3	-60.1	1.8	-43.5	1.7	-5.6
Flat/Encrusting (CE)	12.0	11.5	-4.2	8.4	-27.0	5.5	-34.9	5.8	5.3	4.0	-30.4	8.5	10.3	21.2	6.3	-38.5	3.5	-44.8	4.5	28.8	0.5	-88.2
Foliose/Cup (CF)	2.7	1.9	-29.6	2.9	55.0	1.6	-44.8	2.9	80.8	2.1	-28.1	0.9	5.1	466.7	6.3	23.0	5.3	-15.0	8.5	58.7	0.9	-89.0
Total Hard Coral	**43.1**	**57.6**	33.6	**49.2**	-14.5	**52.0**	5.5	**36.8**	-29.1	**14.6**	-60.3	**37.6**	**68.1**	81.1	**81.2**	19.2	**75.1**	-7.5	62.7	-16.5	4.7	-92.4
Total Soft Coral	**6.6**	**20.1**	204.5	**21.6**	7.6	**6.3**	-70.9	**16.6**	164.2	**19.8**	19.3	**1.2**	**2.0**	66.7	**4.0**	100.0	**1.4**	-65.4	**0.6**	-58.7	**2.2**	278.3
Subtotal Coral	***49.7***	***77.7***	56.3	***70.9***	-8.8	***58.3***	-17.8	***53.4***	-8.3	***34.4***	-35.5	***38.8***	***70.1***	80.7	***85.2***	21.5	***76.5***	-10.2	***63.3***	-17.3	***6.9***	-89.1
Sponges (SP)	~	~	N/A	~	N/A	0.8	N/A	0.5	-37.5	3.4	588.9	~	~	N/A	~	N/A	0.0	N/A	0.1	+	0.3	511.1
Other animals (OT)	~	~	N/A	~	N/A	~	N/A	1.1	N/A	0.3	-70.4	~	~	N/A	~	N/A	~	N/A	0.9	N/A	0.1	-84.4
Algae																						
Fleshy (MA)	~	~	N/A	~	N/A	0.4	N/A	0.9	134.4	1.4	48.1	~	~	N/A	~	N/A	0.9	N/A	3.9	328.3	0.0	-100.0
Turf (TA)	~	~	N/A	~	N/A	0.1	N/A	1.3	900.0	~	N/A	~	~	N/A	~	N/A	0.9	N/A	0.9	6.2	0.0	-100.0
Coralline (CA)	~	~	N/A	~	N/A	0.0	N/A	1.8	+	~	N/A	~	~	N/A	~	N/A	0.0	N/A	2.8	+	0.0	-100.0
Seagrasses (SG)	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.2	+	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	**~**	**~**	N/A	**~**	N/A	***1.3***	N/A	***5.6***	319.8	***5.3***	-4.1	**~**	**~**	N/A	**~**	N/A	***1.8***	N/A	***8.5***	376.4	***0.5***	-94.5
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**99.9**	
Environmental Parameters																						
Mean Slope (degrees)	**~**	**~**		11		3.4		15.0	341.2		-100.0	~	~		6		2		9.0	350.0		-100.0
Mean Topography (m)*	**~**	**~**		1.5		1.1		2.3	112.1		-100.0	~	~		1.0		1.3		1.2	-10.3		-100.0
Mean Depth/Range (m)	8	6-8		6-8		6.6		7.0	6.1		-100.0	3-4	2-4		3-5		3.0		2.6	-14.6		-100.0
Horizontal Visibility (m)	20	18		21		18.3		19.4	5.9		-100.0	20	18		25		17.1		20.0	17.0		-100.0
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 2011

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	3.8	3.3	0.0	26.5	1.5	0.0	28.0	7.9
Rabbitfish (Siganids)*	0.5	0.6	0.0	1.0	0.0	0.0	1.0	0.6
Groupers (Serranids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.5	1.0	0.0	0.0	0.0	0.5	0.5	0.4
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)*	0.0	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)*	1.0	0.8	0.0	1.8	0.0	0.0	1.8	0.7
Goatfish (Mullids)*	1.3	0.5	0.0	0.5	1.0	0.0	1.5	0.2
Parrotfish (Scarids)*	2.5	1.7	0.0	3.3	1.8	2.3	7.3	1.4
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)	2.5	1.7	0.0	76.5	1.0	0.0	77.5	40.9
Butterflyfish (Chaetodonids)	4.5	3.1	0.0	17.0	0.0	0.0	17.0	5.3
Angelfish (Pomacanthids)	1.5	1.3	11.5	0.5	0.0	0.0	12.0	7.1
Wrasses (Labrids)	5.3	2.9	156.3	7.0	0.5	0.0	163.8	72.8
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	9.3	3.4	776.3	30.3	0.0	0.0	806.5	403.5
Fairy Basslets (Anthids)	1.0	0.0	288.3	0.0	0.0	0.0	288.3	193.8
Moorish Idols (*Zanclus cornutus*)	1.3	0.5	0.3	3.5	0.0	0.0	3.8	0.9
	0.0							
Total (target reef species)*	9.5	**5.8**	**0.0**	**33.0**	**4.3**	**2.8**	**40.0**	**9.2**
Total (all reef species)	34.8	**15.7**	**1232.5**	**167.8**	**5.8**	**2.8**	**1408.8**	**706.1**

* 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 2011.

FAMILY	(N=1) 1993 species	(N=4) 1995 species	(N=8) 1997 species	(N=4) 2001 species	(N=5) 2005 species	(N=4) 2011 species	% Change 2001-2011
Surgeonfish (Acanthurids)*	4.0	3.0	3.3	4.8	3.0	3.8	25.0
Rabbitfish (Siganids)*	0.0	0.3	0.4	0.5	0.2	0.5	150.0
Groupers (Serranids)*	0.0	0.3	0.4	1.3	0.6	0.0	-100.0
Barramundi cod	~	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.3	0.4	1.0	0.8	0.5	-37.5
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	1.0	0.0	0.0	0.0	0.0	0.0	N/A
Jacks (Carangids)*	0.0	0.0	0.0	0.3	0.2	0.0	-100.0
Fusiliers (Caesionids)*	0.0	0.0	0.5	0.3	0.0	0.0	N/A
Spinecheeks (Nemipterids)*	1.0	0.5	0.4	0.8	0.2	1.0	400.0
Goatfish (Mullids)*	1.0	1.0	1.0	1.0	0.4	1.3	212.5
Parrotfish (Scarids)*	1.0	1.0	1.0	2.3	2.6	2.5	-3.8
Bumphead parrotfish	~	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.3	0.0	0.0	N/A
Triggerfish (Balistids)	1.0	1.3	2.0	1.0	1.4	2.5	78.6
Butterflyfish (Chaetodonids)	8.0	6.5	6.8	6.0	5.0	4.5	-10.0
Angelfish (Pomacanthids)	1.0	2.0	3.1	3.5	3.2	1.5	-53.1
Wrasses (Labrids)	4.0	3.5	5.5	9.3	8.4	5.3	-37.5
Humphead wrasse	~	~	~	0	0	0.0	N/A
Damselfish (Pomacentrids)	8.0	8.8	12.4	14.8	14.0	9.3	-33.9
Fairy Basslets (Anthids)	2.0	2.0	1.9	1.0	0.8	1.0	25.0
Moorish Idols (Zanclids)	1.0	1.0	1.0	1.0	0.8	1.3	56.3
							N/A
Total (target reef species)*	**4.0**	**3.4**	**4.0**	**12.3**	**8.0**	**9.5**	18.8
Total (all reef species)	**33.0**	**31.5**	**39.9**	**48.8**	**41.6**	**34.8**	-16.5

* Species sought by fishermen.

% change = {(Yr_2/Yr_1)-1} x 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 2011

FAMILY	(N=1) 1993 density	(N=4) 1995 density	(N=8) 1997 density	(N=4) 2001 density	(N=5) 2005 density	(N=4) 2011 Density	% Change 2001-2011
Surgeonfish (Acanthurids)*	78.0	58.0	80.5	73.0	39.2	28.0	-46.3
Rabbitfish (Siganids)*	0.0	0.3	5.6	1.0	0.4	1.0	-60.0
Groupers (Serranids)*	0.0	0.3	0.4	2.5	0.6	0.0	-76.0
Barramundi cod	~	~	~	0.0	0.0	0.0	N/A
Snapper (Lutjanids)*	0.0	0.3	0.4	4.0	1.8	0.5	-55.0
Sweetlips (Haemulids)*	0.0	0.0	4.1	0.0	0.0	0.0	N/A
Emperors (Lethrinids)*	9.0	0.0	0.0	0.0	0.0	0.0	N/A
Jacks (Carangids)*	0.0	0.0	0.0	0.8	0.2	0.0	-73.3
Fusiliers (Caesionids)*	0.0	0.0	24.4	2.3	0.0	0.0	-100.0
Spinecheeks (Nemipterids)*	9.0	3.0	1.4	5.0	1.8	1.8	-64.0
Goatfish (Mullids)*	9.0	5.0	7.4	21.0	0.4	1.5	-98.1
Parrotfish (Scarids)*	33.0	11.0	15.8	8.8	11.8	7.3	34.9
Bumphead parrotfish	~	~	~	0.0	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	0.0	2.3	0.0	0.0	-100.0
Triggerfish (Balistids)	9.0	1.8	13.8	4.0	7.0	77.5	75.0
Butterflyfish (Chaetodonids)	43.0	28.0	26.1	30.5	17.0	17.0	-44.3
Angelfish (Pomacanthids)	9.0	5.3	44.5	32.8	13.8	12.0	-57.9
Wrasses (Labrids)	174.0	199.0	79.9	96.3	33.6	163.8	-65.1
Humphead wrasse	~	~	~	0.0	0.0	0.0	N/A
Damselfish (Pomacentrids)	234.0	522.0	1794.8	2128.3	2280.0	806.5	7.1
Fairy Basslets (Anthids)	258.0	450.0	1346.4	139.5	315.6	288.3	126.2
Moorish Idols (Zanclids)	9.0	9.0	14.3	7.5	3.8	3.8	-49.3
Total (target reef species)*	**60.0**	**19.9**	**59.4**	**69.5**	**38.2**	**40.0**	-45.0
Total (all reef species)	**874.0**	**1293.0**	**3459.6**	**2559.3**	**2727.0**	**1408.8**	6.6

* 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 38. Differences in percent live hard coral cover within sites and between years 2001 and 2011 in Mabini and Tingloy areas in March 2011.

SITE	Test	p	year tested	*Post hoc* ranking	notes
Deep (7-8 m) Substrate					
Arthur's Rock Sanctuary	1-ANOVA	0.069	1995-2011	1995=1997=2005=2011,2005>2011	NS
Cathedral Reef	KRUSKAL-WALLIS	0.138	2001-2011		NS
White Sand Reef	1-ANOVA	0.95	2001-2011	2001=2005=2011	NS
Layag-Layag	1-ANOVA	0.27	2001-2011	2001=2005=2011	NS
White House Reef	1-ANOVA	0.489	2001-2011	2001=2005=2011	NS
Sombrero Island	1-ANOVA	0	2001-2011	2001=2011, 2005> 2001,2005	Significant increase
Batalang Bato	1-ANOVA	0.972	2001-2011	2001=2005=2011	NS
Twin Rocks Sanctuary	1-ANOVA	0.29	1995-2011	1995=1997=2001=2005=2011	NS
Sepoc Pt. Reef	KRUSKAL-WALLIS	0	2001-2011		Significant increase

Table 39. Between sites difference in target fish density found at 7-8m depth in Mabini and Tingloy areas in 2011.

SITE	Test	p	year tested	*Post hoc* ranking	notes
Deep (7-8 m) Target Density					
Arthur's Rock Sanctuary	1-ANOVA	0.003	2001-2005-2011	2001=2011, 2001>2005, 2005=2011	Significant decrease
Cathedral Reef	T-test	0.48	2005-2011		NS
White Sand Reef	1-ANOVA	0.04	2001-2005-2011	2001=2005<2011	Significant increase
Layag-Layag	1-ANOVA	0.356	2001-2005-2011	2001=2005=2011	NS
White House Reef	t-test	0.562	2005-2011	NA	NS
Sombrero Island	1-ANOVA	0.211	2001-2005-2011	2001=2005=2011	NS
Batalang Bato	1-ANOVA	0.49	2001-2005-2017	2001=2005=2011	NS
Twin Rocks Sanctuary	1-ANOVA	0.326	2001-2005-2018	2001=2005=2011	NS
Sepoc Pt. Reef	1-ANOVA	0.08	2001-2005-2019	2001=2005=2012	NS

Table 40. Between sites difference in target fish diversity found at 7-8m depth in Mabini and Tingloy areas in 2011.

SITE	Test	p	year tested	*Post hoc* ranking	notes
Deep (7-8 m) Target diversity					
Arthur's Rock Sanctuary	1-ANOVA	0.007	2001-2005-2011	2001>2005=2011	Significant decrease
Cathedral Reef	T-test	0.32	2005-2011		NS
White Sand Reef	1-ANOVA	0.143	2001-2005-2011	2001=2005<2011	NS
Layag-Layag	1-ANOVA	0.37	2001-2005-2011	2001=2005=2012	NS
White House Reef	t-test	0.384	2005-2011	NA	NS
Sombrero Island	1-ANOVA	0	2001-2005-2011	2001>2005=2011	Significant decrease
Batalang Bato	Kruskal-wallis	0.819	2001-2005-2011		NS
Twin Rocks Sanctuary	1-ANOVA	0.088	2001-2005-2011	2001=2005=2011	NS
Sepoc Pt. Reef	1-ANOVA	0.213	2001-2005-2012	2001=2005=2012	NS

Table 41. Between sites difference in all reef fish density found at 7-8m depth in Mabini and Tingloy areas in 2011.

SITE	Test	p	year tested	*Post hoc* ranking	notes
Deep (7-8 m) all density					
Arthur's Rock Sanctuary	1-ANOVA	0.438	2001-2005-2011	2001=2005=2011	NS
Cathedral Reef	t-test	0.004	2005-2011		Significant decrease
White Sand Reef	1-ANOVA	0.868	2001-2005-2011	2001=2005=2011	NS
Layag-Layag	1-ANOVA	0.142	2001-2005-2011	2001=2005=2011	NS
White House Reef	t-test	0.637	2005-2011		NS
Sombrero Island	1-ANOVA	0.001	2001-2005-2011	2001>2005=2011	Significant decrease
Batalang Bato	Kruskal-wallis	0.003	2001-2005-2011	NA	Significant decrease
Twin Rocks Sanctuary	1-ANOVA	0.002	2001-2005-2011	2001=2011<2005	Significant decrease
Sepoc Pt. Reef	1-ANOVA	0.249	2001-2005-2011	2001=2005=2011	NS

Table 42. Between sites difference in all reef fish diversity found at 7-8m depth in Mabini and Tingloy areas in 2011.

SITE	Test	p	year tested	*Post hoc* ranking	notes
Deep (7-8 m) all reef diversity					
Arthur's Rock Sanctuary	1-ANOVA	0.205	2001-2005-2011	2001=2005=2011	NS
Cathedral Reef	t-test	0.11	2005-2011		NS
White Sand Reef	1-ANOVA	0.415	2001-2005-2011	2001=2005=2011	NS
Layag-Layag	1-ANOVA	0.005	2001-2005-2011	2001=2005>2011	Significant decrease
White House Reef	t-test	0.033	2005-2011		Significant decrease
Sombrero Island	1-ANOVA	0	2001-2005-2011	2001>2005=2011	Significant decrease
Batalang Bato	Kruskal-wallis	0.046	2001-2005-2011	NA	marginally Significant decrease
Twin Rocks Sanctuary	1-ANOVA	0.016		2001=2011<2005	Significant decrease
Sepoc Pt. Reef	Kruskal-wallis	0.01	2001-2005-2011	NA	Significant decrease

SUMMARY OF RESULTS AND TRENDS

Coral reef and other substrates. LHC cover in all sites surveyed ranged from poor (14.6% in Sepoc Point Reef) to good (62.0% in Cathedral reef) in 2011 (Fig. 42). No significant changes in LHC cover were observed over the years except for Sombrero Island and Sepoc Point Reef. LHC in Sombrero Island increased significantly from 2001 to 2011. However, the opposite occurred in Sepoc Point Reef wherein LHC decreased significantly both in the shallow and deep areas in 2011. This may be due to unregulated dropping of anchors and the area's exposure to strong waves, where a storm in 2008 has apparently affected LHC. Nevertheless, the status quo of LHC in other sites that were surveyed may indicate a certain level of improvement of the coral condition in Mabini and Tingloy.

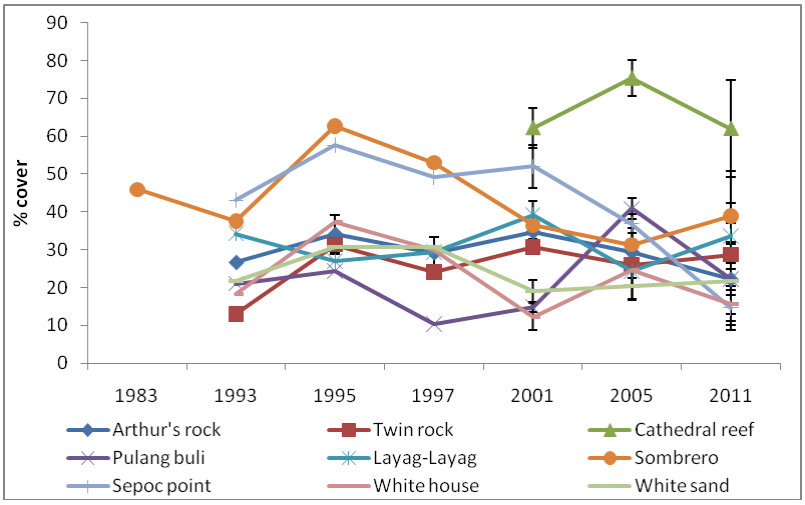


Figure 42. Changes in live hard coral (mean ±SE) in sites at Mabini and Tingloy, Batangas. From 1983 to 2011 (7-8m depth)

Fish diversity and abundance. All reef fish density in all sites except for Sombrero Is. are in moderate condition in 2011. All reef fish density ranged from 1104 ± 548 fish/500 m^2 in White house reef to 3369 ± 1585 fish/500 m^2 in Sombrero Island. However, four out of the nine sites surveyed showed a significant decrease in all reef fish density from 2001 to 2011. Only Arthur's Rock, White Sand Reef, Layag-Layag, Cathedral Reef, White House Reef and Sepoc Point Reef are in status quo for 2011 (Fig 43).

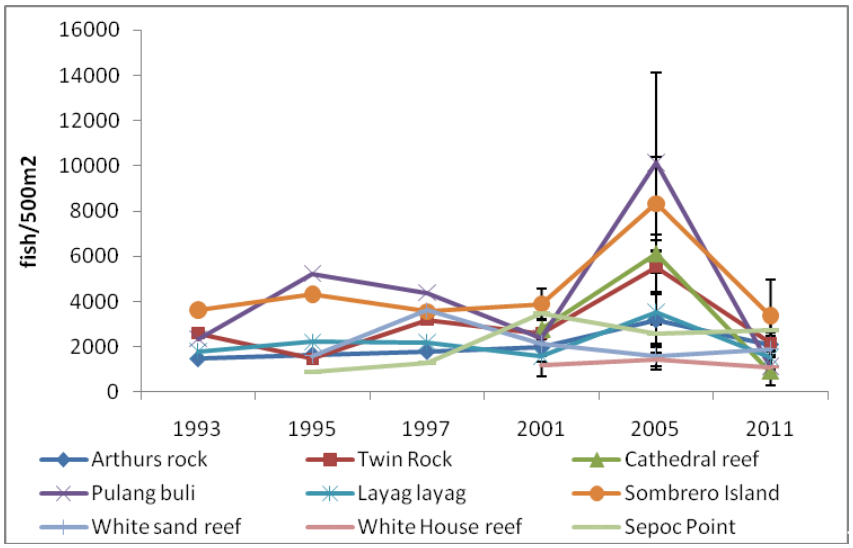


Figure 43. Mean (±SE) density (density/500m^2) of all reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011(7-8m depth).

The same decreasing trend is also observed for species diversity in all sites. Only Arthur's Rock, Cathedral Reef and White Sand Reef showed no change in 2011. The rest of the sites illustrated a decreasing trend in species diversity from 2001 to 2011 (Fig 44). The opposite is seen for target reef fishes. Target reef fish density and diversity in all sites, especially inside the marine reserves revealed an increasing trend over the years (Fig 45, 46).

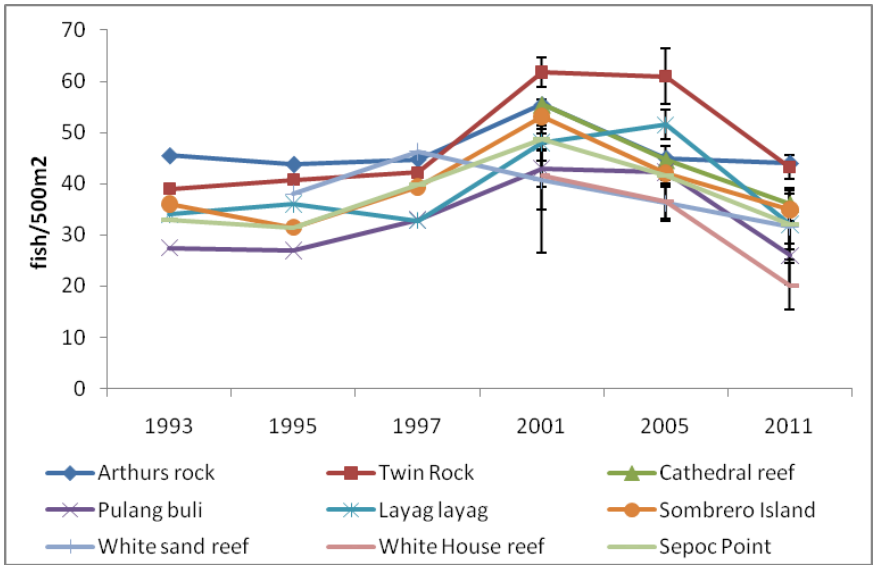


Figure 44. Mean (±SE) species (species/500m^2) of all reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)

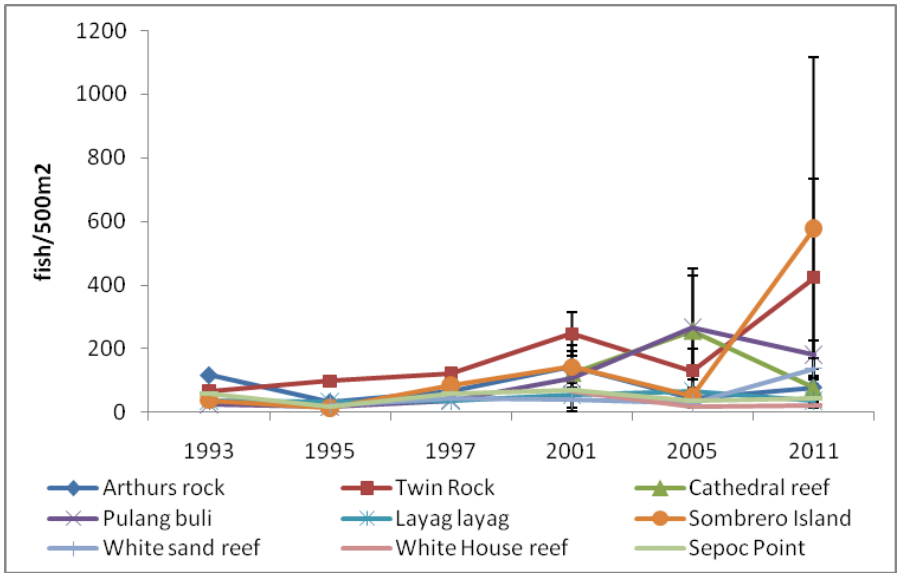


Figure 45. Mean (±SE) density (density/500m^2) of all target fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)

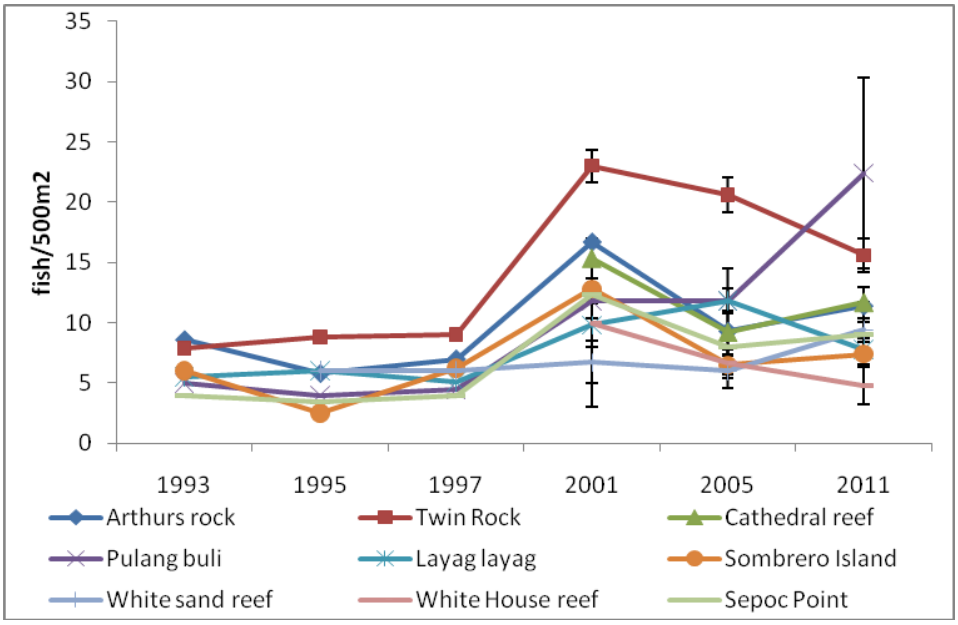


Figure 46. Mean (±SE) species (species/500m^2) of target fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)

Twin Rocks recorded highest in fish biomass, followed by Sombrero Is. and Batalang Bato (Fig. 47). Target fish biomass in 2011 suggests an increase from previous years. The absence of raw data in the previous year limits our ability to conclude whether this increase is significant or not.

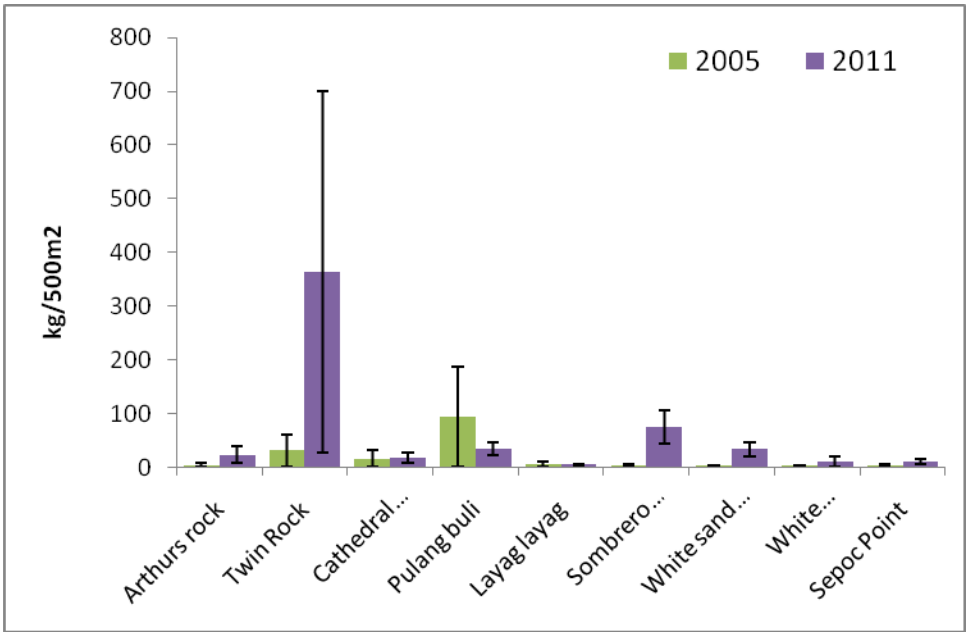


Figure 47. Mean (±SE) biomass (kg/500m^2) of target reef fishes at Mabini and Tingloy, Batangas from 1991 to 2011 (7-8m depth)

The overall results suggest that coral and fish condition in selected sites of Mabini and Tingloy are improving over the years. However, the decline in all reef fish density and diversity may be an effect of the aquarium fish trade in the area. Further protection of these resources could provide more benefit for the local stakeholders.

RECOMMENDATIONS FOR IMPROVED MANAGEMENT

The Mabini-Tingloy management needs 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 fewer target fish species and abundance compared to Twin Rocks and Batalang Bato. Indicator fish species diversity and abundance are low. Community and local government vigilance is needed to improve the status of these sanctuaries. Marker signs are needed on the shoreline of Cathedral Sanctuary boundaries.

2. **Sombrero Island should be protected by Municipal ordinance as a no-fishing marine sanctuary.** Fishing on Sombrero Island has depleted the fish biomass to a low level. Anchor buoys need to be installed and maintained to prevent damage to the fragile reef. Further, we encourage the Tingloy municipality to follow up on the 1982 proposal of the Marine Parks Task Force to include Sombrero Island as part of the Anilao Marine Park complex (White *et al.* 2001).

3. **Continued campaigns on coastal resource management and the proper use of marine sanctuaries are needed for dive resorts, dive guide and tourist divers.** A campaign using basic information about marine sanctuary protection among dive resorts and dive boat operators will improve basic stewardship by all users in the area. Divers still wear gloves when diving within MPAs and thus are able to touch and grab anything in the substrate while diving. Some boatmen are still not sensitive to the damage anchors can make on the corals.

4. **Anchor buoys are urgently needed in Layag-Layag, Sombrero Island and Sepoc Point Reef.** Coral damage can be minimized by installing anchor buoys in popular dive sites where there are none or only a few.

5. **More sanctuaries are needed to provide benefits for 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. The highest priority sites are Sombrero Island and several new sites on the Mabini coast.

6. **Renewed coordination between Tingloy and Mabini municipalities is needed to improve the efficiency of enforcement and to decide expenditures of the user (visitor) fees being collected by Mabini.** Expenditures may be allocated for enforcement operations, signs and anchor buoys, etc.

REFERENCES

Allen, G. and R. Swainston. 1992. Reef Fishes of New Guinea. Christensen Research Institute, Papua New Guinea. 132p.

Allen, G. and R. Steene. 1994. Indo-Pacific Coral Reef Field Guide. Tropical Reef Research, SIngapore. 378p.

Allen, G. and R. Steene. 1996. Marine Life of Southeast Asia and the Pacific. Periplus Editions (HK) Ltd., Singapore. 96p.

Allen, G. 1997. Marine Fishes of Tropical Australia and South-East Asia. Western Australia Museum. 292p.

Allen, G. and R. Steene. 1998. A Guide to Angelfishes and Butterflyfishes. Vanguard Press, Perth WA. 249p.

Kuite, R.H. and H. Debelius. 1997. Southeast Asia Tropical Fish Guide. IKAN, Frankfurt, Germany. 321 p.

Lieske, E. and R. Myers. 1994. Coral Reef Fishes, Indo-Pacific and Caribbean. HarperCollins Publishers. Italy. 400p.

Myers, R.I. 1999. Micronesian Reef Fishes. Coral Graphics. USA. 216p.

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, 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.

Uychiayco and White, A. 2000. Coral Reef Monitoring Book. Coastal Resource Management Project, Cebu City, Philippines.

White, A.T., 2001. Philippine Coral Reefs: A Natural History Guide. Bookmark Inc. and Sulu Fund for Marine Conservation Foundation, Inc., Manila, 276p.

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 Resource Management Project and the Sulu fund for Marine conservation Foundation, Inc. Cebu City, 95 p.

White, A.T., A. Maypa, S. Tesch, B. Stockwell, A. Meneses, E. White and T.J. Mueller. 2005. Summary Field Report: Coral Reef Monitoring Expedition to Mabini and Tingloy, Batangas, Philippines, March 19–27, 2005. The Coastal Conservation and Education Foundation, Inc. and the Fisheries Improved for Sustainable Harvest (FISH) Project, Cebu City, 117 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.

APPENDIX 1. Expedition itinerary

Saving Philippine Reefs 2011 Itinerary
March 20-28, 2011
Dive Solana Resort, Mabini, Batangas

Day	Date/Site	Time	Activity
1	Sunday, March 20	3:00 pm 7:00	Arrival of SPR Volunteers in Manila Travel to Batangas by bus (3-4 hours) Welcome briefing and dinner
2	Monday, March 21 Dive Solana Beach and Reef White Sand Reef (El Pinoy)	7:00 am 8:00 10:00 12:00 pm 1:00 7:00	Breakfast Briefing on survey methods and diving Snorkel practice, kick calibration and checkout dive Lunch at Dive Solana Resort Scuba survey: 50m transect, substrate and fish Compile data and submit data Dinner Presentation
3	Tuesday, March 22 Arthur's Rock White House Reef	7:00 am 8:00 8:30 12:00 pm 1:00 7:00	Breakfast Briefing at resort Conduct surveys (snorkel and scuba) Lunch at Dive Solana Conduct surveys (snorkel and scuba) Compile data and submit data forms Dinner Presentation
4	Wednesday, March 23 Layag-layag Reef	7:00 am 8:00 8:30 12:00 pm 1:00 7:00	Breakfast Morning briefing/Prepare gear Depart for survey site by boat Conduct surveys (snorkel and scuba) Lunch on beach Complete survey (scuba) Compile and check data Dinner Presentation
5	Thursday, March 24 Sombrero Island and Sepoc Point	7:00 am 8:00 8:30 12:00 pm 1:00 7:00	Breakfast Morning briefing/Prepare gear Depart for survey site by boat Conduct surveys (snorkel and scuba) Lunch on Sombrero beach Complete survey (scuba) Compile and check data Dinner Night dive (Arthur's Rock or Solana Reef)

Day	Date/Site	Time	Activity
6	Friday, March 25 Pulang Buli/Batalang Bato	7:00 am 8:00 8:30 12:00 am 1:00 7:00	Breakfast Morning briefing/Prepare gear Depart for survey site by boat Conduct surveys (snorkel and scuba) Lunch at Tingloy beach with community Conduct surveys (snorkel and scuba) Compile and check data Dinner Presentation
7	Saturday, March 26 Cathedral Reef and Cathedral Rock	7:00 am 8:00 8:30 12:00 pm 1:00 7:00	Breakfast Morning briefing/Prepare gear Depart for survey site Conduct surveys (snorkel and scuba) Lunch on the beach Fun dive on Cathedral (scuba) Compile and check data Dinner Review photos taken on trip
8	Sunday, March 27 Twin Rocks	7:00 am 8:00 8:30 12:00 pm 1:00 7:00	Breakfast Morning briefing/Prepare gear Depart for survey site Conduct surveys (snorkel and scuba) Lunch on Twin Rocks beach Complete survey (scuba) Compile and check data Dinner Presentation
9	Monday, March 28	7:00 am 8:00 12:00 pm 3:00	Breakfast Debriefing, packing, etc. Depart for Manila Arrival at airport

APPENDIX 2. Expedition staff and volunteers

Saving Philippine Reefs Volunteers
March 20 - 28, 2011
Batangas, Philippines

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
1	**Denise Illing** 34 Oakland Drive Warrandyte 3113 Australia	Home: +61 3 9844 1583 Mobile: +61 419307653 denise@unico.com.au	Wildlife artist(mainly watercolour) and photographer. Member Unico Conservation Foundation. Interested in environment, conservation, all kinds of wildlife.9th Saving Philippine Reefs Expedition.
2	**Geoff Illing** 34 Oakland Drive Warrandyte, VIC 3113 Australia	Phone: 03 9865 9140 Office Phone: +613 9865 9118 Home Phone: +613 9844 1583 Mobile: +61 419307047 geoff@unico.com.au	Originally a mathematician, but now director/owner of software development company. Amateur musician, playing clarinet, bass clarinet, sax and bassoon in concert bands, orchestra and small ensembles. 9th Saving Philippine Reefs Expedition.
3	**Thomas J. Mueller** 29905 Rainbow Crest Drive Agoura Hills, CA 91301 U.S.A.	Mobile Phone: 917-592-7074 (preferred) Home Phone: 818-865-2133 tj@tjmueller.com	Self employed educational consultant to Higher Education; PhD in Biology; small boat experience, especially sail; underwater photographer; SCUBA instructor; CCE Foundation, Institutional Development Advisor – Board Member.
4	**Alexander Douglas Robb** 4 Nevada Retreat, Bulleen, Victoria 3105 Australia	Tel 61-3-92438460 Wk 61-3-9850- 5497 Hm sandy.robb@griffithhack.com.au	Civil Engineer BSC (Hons) Edinburgh MSC Melbourne – History & Philosophy of Science; Interest - History & Philosophy of Science. 5th Saving Philippine Reefs Expedition.
5	**John Rowland** 24 Logan Street, Canterbury VIC 3126 Australia	Tel: +61 3 9830 5695 (home); Cell: +61 417 360 025 (mobile) John.Rowland@unico.com.au	Engineer Software Engineering; Certified SSI Advanced Open water Advanced Nitrox; Advanced Decompression: Deep; Night. 3rd Saving Philippine Reefs Expedition.
6	**Laurent Boillon** 27, Hardwicke Street, Balwyn VIC 3103 Australia	Tel: +61 3 98173664 (home); Cell: +61 412305038 (mobile) Laurent.Boillon@laurent.com.au	Pastry Chef; Certified SSI Advanced Open water; Advanced Nitrox; Advanced Decompression: Deep; Night. 3rd Saving Philippine Reefs Expedition.
7	**Steve Ludemann** 35498 Road K.1 Mancos, Colorado 81328 U.S.A.	Home: 970-564-9940 Cell: 970-560-3901 steveludemann@gmail.com	Retired (Aerospace Engineering) PADI Master Scuba Diver. 3rd Saving Philippine Reefs Expedition.

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
8	**Heather D'Agnes** 3542 10th Street NW Washington DC 20010 U.S.A.	Mobile: 206 769 3121 Email: hdagnes@gmail.com	Technical Advisor, USAID. International Development, Population, Health, Environment. 5th Saving Philippine Reefs Expedition.
9	**Heather Ludemann** 35498 Road K.1 Mancos, Colorado 81328 U.S.A.	Email: hludemann@yahoo.com	Associate Program Officer in the David and Lucile Packard Conservation and Science Program. 2nd Saving Philippine Reefs Expedition.
10	**Katie D'Agnes** Thomas or Leona D'Agnes 284 Ilikaa Place, Kailua, HI, 96734	Tel: 808-254-1282 kdagnes@gmail.com	Starting Masters degree in Business in July 2011; Snorkeler. 2nd Saving Philippine Reefs Expedition.
11	**Diane Amuro** 1571 Piikoi St #804 Honolulu, HI 96822 USA	Tel: 536-6426 diane.amuro@gmail.com	Lab technician at HMC East; Interested in native ecosystems.
12	**Lisa Dilworth** 364 Seaside Ave. #1101 Honolulu HI 96815	Mobile: +937 564 8040 littletux2@aol.com	Student-Marine Biology major (HPU)/ Volunteer at Aquarium.
13	**Eric Ludemann** 4915 Twin Lakes Rd #18 Boulder, CO 80301 USA	Cell: 303-903-7516 ericlude@yahoo.com	Engineering software designer. Advanced Openwater diver.

Saving Philippine Reefs Staff
March 20 – March 28, 2011
Batangas, Philippines

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
1	**Dr. Alan T. White** Principal Investigator 322 Aoloa St. #412 Kailua, HI 96734 U.S.A.	Phone: 808-262-1091 alan_white@tnc.org	Senior Scientist and Coral Triangle Program Manager, The Asia-Pacific Program, The Nature Conservancy President Coastal Conservation and Education Foundation, Inc.
2	**Evangeline White** SPR Project Manager 322 Aoloa St. #412 Kailua HI 96734 USA	Phone: (808) 2621091 vangiewhite@hawaiiantel.net	SPR Expedition Project Manager Waikiki Aquarium Volunteer Program Coordinator Honolulu HI 96815
3	**Sheryll Tesch** Data and Logistics Coordinator 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 sheryll.tesch@gmail.com	Administrative Officer/ IEC Coordinator/ Rare Conservation Fellow CCE Foundation, Inc.
4	**Ethan Lucas** Divemaster 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: 206-883-7033 ethanylucas@yahoo.com	Junior Specialist – National Center for Ecological Analysis and Synthesis (NCEAS)
5	**Dean Apistar** Assistant Divemaster/ 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 deaniro@yahoo.com	Marine Biologist - Team Leader of the Research Monitoring Team CCE Foundation, Inc
6	**Jimmy Paguio** Logistics Assistant 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 japaguio@gmail.com	Provincial Area Coordinator – Danajon Reef Project CCE Foundation, Inc.

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
7	**Rafael Martinez** GIS Specialist 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 232-1821 to 22 Fax: (6332) 232-1825 raffy.martinez@gmail.com	MARXAN/Database Programmer and GIS Specialist – Danajon Reef Project CCE Foundation, Inc.
8	**Danilo Delizo** Fish Visual Census Specialist 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 danilodelizojr@gmail.com	Marine Biologist – Research and Monitoring Team CCE Foundation, Inc.
9	**Wenifel Porpetcho** Fish Visual Census Specialist 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone (6332) 232-1821 232-1822 Fax: (6332) 232-1825 nipnip29@gmail.com	Marine Biologist – Research and Monitoring Team CCE Foundation, Inc.
10	**Pablita Huerbana** Logistics Assistant 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 btoyong@yahoo.com	Administrative Assistant CCE Foundation, Inc.
11	**Ian White** Volunteer 322 Aoloa St. #412 Kailua HI 96734 USA	Home Tel. (808) 2621091 IanWhite1@hawaiiantel.net	Student. Hawaii State Swimmer. PADI Openwater.

FISH SPECIES LIST

APPENDIX 3. Fish species list

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
	2001	2005	2011	2001	2005	2011	2001	2005	2011	2001	2005	2011	2001	2005	2011	2001	2005	2011	2001	2005	2011	2005	2011	2005	2011
Acanthuridae - surgeonfishes																									
Acanthurus auranticavus									1												1				
Acanthurus achilles																									
Acanthurus blochii					1																	1			
Acanthurus dussummieri						1																			
Acanthurus grammoptilus									1																
Acanthurus guttatus																									
Acanthurus japonicus		1												1	1		1	1						1	1
Acanthurus lineatus										1			1	1		1									
Acanthurus mata	1			1	1		1		1																
Acanthurus nigricans	1									1		1													
Acanthurus nigricauda	1			1												1									1
Acanthurus olivaceus	1																								
Acanthurus pyroferus	1	1	1	1	1				1	1		1		1	1		1	1			1		1	1	
Acanthurus thompsoni																	1								
Acanthurus triostegus																1									
Acanthurus xanthopterus				1		1																			
Ctenochaetus binotatus	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ctenochaetus striatus	1		1	1		1	1		1	1	1	1	1		1			1	1	1	1	1	1		1
Ctenochaetus tominiensis																1				1				1	
Naso annulatus						1																			
Naso brachycentron				1			1																		
Naso brevirostris	1																								1
Naso hexacanthus				1		1	1	1									1	1							
Naso lituratus	1		1	1	1	1				1	1	1	1	1	1	1		1				1		1	1
Naso lopezi	1			1																					
Naso minor				1			1	1	1			1		1	1			1			1			1	1
Naso thynnoides								1																	
Naso unicornis			1	1	1	1	1					1												1	1
Naso vlamingi	1	1		1	1	1	1	1	1		1		1	1		1	1			1		1		1	
Paracanthus hepatus	1																								
Zebrasoma scopas		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Zebrasoma veliferum																									
Apogonidae - cardinalfishes																									
Apogon aureus				1	1		1	1						1			1					1			
Apogon chrysopomus				1																					
Apogon compressus											1									1		1			
Apogon cyanosoma																				1					

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Apogon novemfasciatus		1																							
Apogon properupta				1																					
Apogon sealei																								1	
Archamia biguttta				1																					
Cheilodipterus macrodon		1		1	1																				
Cheilodipterus quinquilineatus				1	1						1			1						1		1		1	
Aulostomidae - trumpetfishes																									
Aulostomus chinensis	1	1	1	1	1			1		1	1		1	1	1	1	1			1	1			1	1
Balistidae - triggerfishes																									
Abalistes stellatus																									
Balistapus undulatus	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
Balistoides conspicillum							1										1								
Balistoides viridescens	1			1				1						1										1	1
Melichthys niger																									
Melichthys vidua	1	1					1		1			1		1	1	1	1	1			1			1	1
Odonus niger			1	1		1			1	1	1	1		1	1	1	1	1		1	1		1		
Pseudobalistes flavimarginatus																									
Rhinecanthus verrucosus																									
Sufflamen bursa				1	1			1		1	1	1		1				1		1				1	1
Sufflamen chrysopterus		1		1		1	1		1	1	1					1	1	1	1	1					
Belonidae - needlefishes																									
Tylosorus crocodilus				1						1															
Blenniidae - blennies																									
Aspindotus taeniorus				1																					
Cirrepectes castaneus				1																					
Ecsenius namiyei				1																					
Meiacanthus atrodorsalis		1		1	1					1	1						1			1		1		1	
Meiacanthus grammistes				1			1																		
Petroscirtes breviceps	1	1																							
Plagiotremus laudandus																									
Plagiotremus rhinorhynchus		1		1												1	1			1					
Salarias fasciatus																1									
Caesionidae - fusiliers																									
Caesio caerulaurea	1	1	1	1	1	1	1	1	1					1						1	1			1	1
Caesio cuning		1		1			1				1											1			
Caesio lunaris																									
Caesio teres				1																					
Pterocaesio digramma									1																
Pterocaesio pisang	1	1		1	1	1		1	1					1			1	1		1	1	1		1	
Pterocaesio randalli						1																			

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Pterocaesio tesselata	1				1		1	1	1					1											
Pterocaesio tile									1									1							
Callionymidae																									
Synchiropus bartelsi														1											
Carangidae - jacks																									
Carangoides bajad			1																						
Carangoides ferdau								1					1			1									
Carangoides plagiotaenia																									
Caranx lugubris				1																					
Caranx melampygus	1			1	1	1													1		1				1
Caranx sexfasciatus				1		1																			
Caranx sp.														1											
Elagatis bipinnulatus								1																	
Selaroides leptolepis				1																					
Carcharhinidae - Black-tip/grey re	1																								
Carcharhinus melanopterus																									
Centriscidae - shrimpfishes																									
Aeoliscus strigatus	1			1												1									
Chaetodontidae - butterflyfishes																									
Chaetodon adiergastos	1				1		1		1			1	1			1	1	1			1			1	1
Chaetodon auriga	1			1				1				1	1				1							1	1
Chaetodon baronessa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chaetodon bennetti																									
Chaetodon citrinellus	1	1						1			1					1	1								
Chaetodon ephippium																									
Chaetodon kleinii	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
Chaetodon lineolatus	1			1	1																				1
Chaetodon lunula	1	1	1	1	1	1	1	1					1				1					1		1	1
Chaetodon lunulatus	1	1	1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1
Chaetodon melannotus	1	1	1	1	1	1					1	1	1	1		1	1	1	1	1	1	1			
Chaetodon mertensii									1			1		1											
Chaetodon ocellicaudus	1	1	1	1	1	1		1		1	1			1	1		1	1	1		1	1		1	1
Chaetodon octofasciatus	1	1	1	1	1	1													1	1		1	1		
Chaetodon ornatissimus	1		1														1				1				
Chaetodon oxycephalus	1			1																	1				
Chaetodon plebeius	1															1									
Chaetodon punctatofasciatus	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1	1	1	1			1	1
Chaetodon rafflesi	1	1	1	1		1	1	1			1	1	1	1		1	1	1		1		1		1	1
Chaetodon selene	1			1	1		1	1			1		1	1		1		1	1					1	
Chaetodon speculum	1	1	1	1	1		1	1			1	1	1				1	1	1			1			1
Chaetodon trifascialis	1	1		1	1		1			1			1	1		1	1		1	1		1			
Chaetodon unimaculatus	1		1				1	1	1				1	1	1	1	1		1					1	1
Chaetodon vagabundus	1	1	1	1	1		1	1	1	1	1		1	1					1		1	1			1

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Chaetodon xanthurus	1	1		1	1						1			1			1				1				
Coradion chrysozonus										1														1	
Forcipiger flavissimus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1
Forcipiger longirostris	1				1															1				1	
Hemitaurichthys polylepis						1			1								1	1						1	
Heniochus acuminatus	1			1	1		1		1					1		1								1	
Heniochus chrysostomus	1			1			1	1	1	1	1		1	1		1	1	1				1			1
Heniochus singularis				1																	1				
Heniochus varius	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1		1	1	1
Chanidae																									
Chanos chanos				1																					
Cirrhitidae - hawkfishes																									
Cirrhitichthys aprinus								1									1			1					
Cirrhitichthys falco		1						1			1		1	1	1	1	1	1		1		1		1	1
Cirrhitichthys oxycephalus											1			1						1					
Neocirrihites armatus																									
Oxycirrhites typus																									
Paracirrhites arcatus														1		1									
Congridae																									
Heteroconger hassi				1																					
Dasyatidae Sting rays																									
Dasyatis kuhli																									
Echeneidae - Shark suckers																									
Echeneis naucrates							1																		
Engraulidae - anchovies																									
Thryssa baelama	1			1									1												
Ephippidae - batfishes																									
Platax orbicularis					1																				
Platax pinnatus					1																				
Platax teira				1		1																			
Fistulariidae - cornetfishes																									
Fistularia commersoni				1	1			1		1	1			1				1						1	1
Gobiidae - gobies																									
Amblyeleotris guttata		1												1											
Amblyeleotris hectori	1									1															
Amblyeleotris steinitzi																				1					
Amblyeleotris wheeleri		1																							
Amblygobius phalaena																									
Amblyeleotris yanoi																								1	
Asterropteryx ensiferus								1																	
Ecsenius bicolor																	1								
Ecsenius dilemma																				1					
Eviota bifasciata																									

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Istigobius rigilius																				1					
Valenciennea puellaris				1																					
Valenciennea randalli				1																					
Valenciennea strigata								1								1									
Grammistinae																									
Diploprion befasciatum					1									1											
Haemulidae - sweetlips																									
Diagramma pictum	1																								
Plectorhinchus chaetodonoides	1				1			1				1						1							
Plectorhinchus flavomaculatus					1			1																	
Plectorhinchus lessoni					1																				
Plectorhinchus lineatus				1																					
Plectorhinchus orientalis	1																								
Plectorhinchus pictus					1																				
Plectorhinchus polytaenia					1			1																	
Plectorhinchus vittatus					1																				
Holocentridae																									
Myripristis amaena											1			1			1	1							
Myripristis kuntee		1			1						1			1	1										
Myripristis murdjan	1				1	1					1			1										1	1
Sargocentron caudimaculatum														1											
Sargocentron cornutum		1																							
Sargocentron spiniferum																									
Kyphosidae - drummers																									
Kyphosus cinerascens													1												
Kyphosus vaigiensis				1												1									
Labridae - wrasses																									
Anampses meleagrides					1		1	1		1			1	1		1	1								
Anampses melanurus		1			1			1													1				
Anampses twistii		1					1			1				1		1						1			
Bodianus axillaris				1			1																		
Bodianus bilunulatus									1																
Bodianus diana		1			1	1		1	1							1	1			1				1	
Bodianus mesothorax	1	1	1	1	1	1	1		1	1	1	1		1	1	1	1	1		1	1	1	1	1	1
Cheilinus chlorourus	1			1			1		1	1			1	1		1		1	1	1	1		1		1
Cheilinus diagrammus																				1					
Cheilinus fasciatus	1		1	1	1	1		1	1	1		1		1	1	1		1			1			1	1
Cheilinus trilobatus					1	1	1	1			1					1									
Cheilinus undulatus																									
Cheilinus unifasciatus					1						1						1					1			
Cheilio inermis		1		1			1						1	1					1	1	1				
Choerodon anchorago	1																1		1						

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Choerodon fasciatus			1															1			1				
Cirrhilabrus cyanopleura	1	1	1	1	1	1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1
Cirrhilabrus filamentousus		1												1											
Cirrhilabrus lubbocki							1	1																	
Cirrhilabrus randalli							1																		
Cirrhilabrus scottorum																									
Cirrhilabrus temminckii														1											
Coris batuensis				1	1		1	1	1		1		1	1		1		1	1	1	1	1		1	
Coris gaimard	1		1				1	1	1	1	1	1	1	1	1	1	1	1						1	
Coris pictoides																				1		1			
Diproctacanthus xanthurus	1	1		1	1					1	1		1									1			
Epibulus insidiator		1	1	1	1		1		1	1	1	1	1	1		1	1	1				1		1	1
Gomphosus varius	1	1	1		1		1			1	1	1	1	1	1	1	1	1	1	1		1	1	1	1
Halichoeres biocellatus	1										1			1		1	1								
Halichoeres chrysus		1		1	1		1	1	1	1				1		1	1							1	
Halichoeres hartzfeldi																									
Halichoeres hortulanus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1
Halichoeres marginatus							1				1					1									
Halichoeres melanurus		1		1	1		1	1		1												1	1	1	
Halichores nebulosa								1																	
Halichoeres prodostigma								1			1	1		1			1					1			
Halichoeres prosopeion		1		1	1		1	1			1			1			1			1		1		1	
Halichoeres richmondi					1			1						1								1			
Halichoeres scapularis		1		1				1		1	1					1			1	1					
Halichoeres solorensis		1			1			1			1			1			1					1		1	
Halichoeres vroliki					1						1						1			1					
Hemigymnus fasciatus			1	1	1	1	1	1			1	1	1	1	1	1	1	1	1		1	1		1	1
Hemigymnus melapterus	1	1	1	1	1	1	1	1		1	1	1		1		1	1	1		1	1	1		1	1
Hologymnosus annulatus								1																	
Hologymnosus doliatus		1			1		1	1	1	1	1			1		1	1		1	1		1			
Labrichthys unilineatus	1	1	1	1	1		1	1		1	1	1	1	1		1	1	1						1	1
Labroides bicolor	1	1			1					1	1		1	1		1									1
Labroides dimidiatus	1	1	1	1	1		1	1		1	1		1	1		1	1	1	1	1		1	1	1	
Labropsis manabei														1										1	
Labropsis xanthonata																1									
Macropharyngodon meleagris		1					1	1		1						1	1	1			1				
Macropharyngodon negrosensis	1							1						1			1								
Novaculichthys taeniorus			1					1	1			1		1	1	1	1			1	1				
Oxycheilinus celebicus								1			1	1			1		1	1							
Oxycheilinus diagrammus	1	1	1	1			1		1	1			1		1	1	1	1	1	1	1			1	1
Oxycheilinus orientalis		1						1						1			1			1				1	

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Oxycheilinus unifasciatus		1													1			1							
Paracheilinus carpenteri								1																	
Pseudocheilinus evanidus							1			1	1		1			1									
Pseudocheilinus hexataenia		1		1	1						1					1	1					1		1	
Pseudocheilinus octotaenia																									
Pseudodax mollucanus					1						1			1			1								
Pseudojuloides cerasinus								1						1											
Pteragogus amboinensis				1			1									1									
Pteragogus enneacanthus		1												1			1								
Pteragogus flagellifera														1											
Pterogogus cryptus											1		1							1					
Stetojulis bandanensis					1			1			1		1			1	1					1		1	
Stetojulis strigiventer																	1			1					
Stetojulis trilineata	1			1			1																1		
Thalassoma amblycephalum	1	1			1		1	1		1	1					1	1			1				1	
Thalassoma hardwicke	1	1	1		1		1	1		1	1	1	1	1	1	1	1	1				1		1	
Thalassoma janseni							1									1	1								
Thalassoma lunare	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Thalassoma lutescens			1																						1
Thalassoma quinquevittatum								1									1								
Thalassoma trilobatum																									
Lethrinidae - emperors																									
Gnathodentex aurolineatus		1									1					1						1		1	
Gymnocranius griseus	1			1			1																		
Lethrinus harak		1	1	1	1	1		1		1			1			1		1	1		1			1	
Lethrinus lentjan			1																						
Lethrinus obsoletus																						1			
Lethrinus olivaceus				1																					
Lethrinus ornatus		1			1	1																		1	
Monotaxis grandoculus				1	1		1	1		1	1								1						
Lutjanidae - snappers																									
Aprion virescens					1																				
Lutjanus argentimaculatus		1																							
Lutjanus biguttatus						1																			
Lutjanus bohar				1										1		1									
Lutjanus decussatus	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1		1	1	1	1	1	1	1
Lutjanus ehrenbergi			1										1						1						
Lutjanus fulviflamma					1			1																1	
Lutjanus fulvus				1	1	1		1															1		
Lutjanus kasmira				1																					
Lutjanus lutjanus				1	1	1	1							1									1		
Lutjanus monostigma				1			1							1											
Lutjanus sebae																									

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Macolor macularis		1		1	1	1			1															1	1
Macolor niger														1			1				1				
Microdesmidae - dartfishes																									
Nemateleotris magnifica							1	1						1			1							1	
Ptereoletris evides					1						1						1								
Monacanthidae - leatherjackets																									
Aluterus monoceros																					1				
Aluterus scriptus		1		1		1								1											
Amanses scopas		1	1		1		1	1		1	1			1	1	1	1	1		1				1	1
Cantherhines pardalis																									
Oxymonocanthus longirostris	1												1												
Paraluteres prionurus		1					1				1			1		1	1						1	1	
Pervagor janthinosoma	1	1			1						1														
Pervagor melanocephalus		1					1			1	1					1	1			1					
Pseudomonacanthus macrurus	1									1															
Mugilidae - mullets																									
Mugil cephalus																									
Mullidae - goatfishes																									
Mulloidichthys flavolineatus	1		1	1	1					1									1		1	1		1	
Mulloidichthys vanicolensis	1																		1						
Parupeneus barbarinoides		1	1		1									1							1	1			
Parupeneus barberinus	1	1	1				1	1	1	1	1			1	1				1	1	1			1	
Parupeneus bifasciatus	1		1	1		1												1							
Parupeneus cyclostomus		1					1			1				1											
Parupeneus indicus			1	1																					
Parupeneus multifasciatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Parupeneus pleurostigma										1															
Upeneus mollucensis																									
Upeneus tragula				1															1	1	1				
Muraenidae - moray eels																									
Echidna nebulosa											1		1	1		1	1								
Echidna polyzona													1												
Enchelynassa canina		1																							
Gymnothorax meleagris	1						1																		
Gymnothorax undulatus																									
Heteroconger hassi																				1					
Rhinomuraena quaesita	1			1	1																				
Sideria thrysoidea				1										1		1									
Nemipteridae - breams																									
Pentapodus caninus							1			1				1									1		
Pentapodus emeryii																				1			1		
Scolopsis affinis				1																				1	
Scolopsis bilineatus	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1	1

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Scolopsis ciliatus	1	1		1	1	1		1											1	1		1	1	1	1
Scolopsis lineatus	1	1		1	1			1		1	1											1			1
Scolopsis margaritifer	1			1																					
Scolopsis monogramma				1			1																		
Scolopsis xenochrous														1							1				
Opistognathidae - jawfishes																									
Opistognathus sp.				1																		1			
Ostraciidae - boxfishes																									
Ostracion cubicus	1						1											1							
Ostracion meleagris		1							1		1		1	1			1							1	
Ostracion solorensis											1						1							1	
Tetrasomus sp.	1																								
Pempheridae - Sweepers																									
Pempheris oualensis				1						1															
Pempheris vanicolensis					1	1											1							1	
Pholidichthyidae - convict blenny																									
Pholidichthys leucotaenia				1																					
Pinguipedidae - sandperches																									
Parapercis clathrata		1			1			1						1		1	1					1		1	
Parapercis cylindrica	1						1									1									
Parapercis hexopthalma																									
Parapercis millepunctata		1						1			1						1		1						
Parapercis tetracantha																									
Parapercis xanthozona														1											
Plotosidae - catfishes																									
Plotosus lineatus	1													1						1					
Pomacanthidae - angelfishes								1																	
Apomelichthys trimaculatus		1						1						1										1	
Centropyge bicolor			1	1	1			1		1			1	1		1	1	1	1		1			1	
Centropyge bispinosus	1	1	1	1			1	1		1			1	1										1	1
Centropyge heraldi																									
Centropyge nox			1		1			1	1		1													1	1
Centropyge shepardi																									
Centropyge tibicen	1		1	1	1		1	1	1		1		1	1	1	1	1	1		1	1	1	1	1	1
Centropyge vroliki	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Chaetodontoplus mesoleucus	1							1			1	1												1	
Genicanthus lamarcki		1		1	1	1	1		1	1	1		1	1		1	1			1	1	1			
Genicanthus melanospilos		1									1			1			1								
Pomacanthus imperator																									
Pomacanthus semicirculatus		1		1	1		1						1											1	
Pygoplites diacanthus	1	1	1	1								1	1	1			1							1	1
Pomacentridae - damselfishes																									
Abudefduf lorenzi											1														

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Abudefduf notatus																	1								
Abudefduf septemfasciatus																1									
Abudefduf sexfasciatus		1	1			1					1						1		1				1		
Abudefduf sordidus																	1								
Abudefduf vaigiensis	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1			1		1	
Acanthochromis polyacanthus	1	1		1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1
Amblyglyphidodon aureus	1	1		1	1		1	1	1	1	1			1			1			1		1		1	
Amblyglyphidodon curacao	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	
Amblyglyphidodon leucogaster	1	1	1	1	1	1	1	1	1	1	1	1		1	1		1		1	1	1	1	1	1	1
Amblyglyphidodon ternetensis																									
Amphiprion clarkii	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1
Amphiprion frenatus	1	1	1	1	1	1			1	1	1	1		1	1		1	1		1	1	1		1	
Amphiprion melanopus																									
Amphiprion ocellaris					1						1											1		1	1
Amphiprion perideraion	1		1	1	1		1			1	1				1		1							1	1
Amphiprion sandaricinos		1			1			1			1						1			1		1			
Chromis agilis																									
Chromis amboinensis	1	1	1		1	1				1		1		1	1						1			1	1
Chromis analis	1					1	1	1	1		1	1			1					1				1	
Chromis atripectoralis					1			1			1			1			1							1	
Chromis atripes	1	1		1				1			1			1						1		1		1	
Chromis caudalis			1																						
Chromis delta																								1	
Chromis margaritifer	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1				1		1	
Chromis opercularis						1			1						1			1							
Chromis ovatiformes		1									1													1	
Chromis retrofasciata	1	1	1	1	1	1	1				1	1	1	1			1	1	1	1	1	1		1	1
Chromis scotochiloptera	1	1		1	1			1			1						1			1				1	
Chromis ternatensis	1	1	1	1	1		1	1			1	1	1	1		1	1	1	1	1		1		1	1
Chromis viridis	1		1	1	1	1	1	1	1	1	1		1	1		1	1	1	1				1	1	
Chromis weberi	1	1	1	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1
Chromis xanthura																							1		
Chrysiptera brownriggi																1	1								
Chrysiptera cyanea									1			1				1							1		
Chrysiptera parasema									1																
Chrysiptera rex				1	1						1														
Chrysiptera rollandi	1	1		1	1		1			1	1								1	1		1		1	
Chrysiptera talboti		1			1			1			1			1			1			1		1		1	
Chrysiptera traceyi				1																					
Dascyllus aruanus		1						1		1	1						1			1					
Dascyllus melanurus				1															1						

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Dascyllus reticulatus	1		1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dascyllus trimaculatus	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1	1
Dischistodus chrysopoecilus		1									1						1			1					
Hemiglyphidodon plagiometopon			1																						
Neoglyphidodon carlsoni																									
Neoglyphidodon melas	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1		1	
Neoglyphidodon nigroris	1	1		1			1				1		1	1	1		1					1		1	1
Plectroglyphidodon dicki	1						1	1					1	1		1	1	1						1	
Plectroglyphidodon lacrymatus	1	1	1		1		1			1	1	1	1	1	1	1	1	1	1		1	1		1	1
Plectroglyphidodon leucozona	1						1																		
Pomacentrus alexanderae	1	1	1	1	1	1				1							1								
Pomacentrus amboinensis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1
Pomacentrus auriventris	1	1		1	1		1	1		1	1			1		1	1		1	1		1			
Pomacentrus bankanensis					1									1			1			1		1		1	
Pomacentrus brachialis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pomacentrus coelestis		1			1		1	1					1			1	1	1		1		1			
Pomacentrus lepidogenys	1	1			1			1			1		1	1		1	1			1		1		1	
Pomacentrus molluccensis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1
Pomacentrus nagasakiensis																									
Pomacentrus nigromanus																									
Pomacentrus nigromarginatus		1		1	1					1	1													1	
Pomacentrus philippinus	1	1		1	1					1	1	1	1	1	1	1	1	1		1		1		1	
Pomacentrus stigma	1	1	1	1	1	1	1	1	1	1	1	1			1		1	1		1	1	1		1	1
Pomacentrus vaiuli	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1		1	1		1		1	
Priacanthidae - bigeyes																									
Priacanthus hamrur				1									1		1										
Pseudochromidae																									
Pseudochromis fuscus											1														
Scaridae - parrotfishes																									
Cetoscarus bicolor		1														1		1						1	
Chlorurus atrilunula											1														
Chlorurus bleekeri	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1			1			1	1
Chlorurus sordidus	1									1		1	1	1	1				1		1				
Hipposcarus longiceps				1																					
Scarus bowersi			1								1			1	1					1					
Scarus chameleon								1																	
Scarus dimidiatus	1	1	1				1	1			1			1		1					1		1	1	1
Scarus flavipectoralis			1																						
Scarus forsteni		1		1			1			1	1		1	1		1	1		1					1	
Scarus frenatus																1		1							1
Scarus ghobban				1	1																				
Scarus gibbus																									
Scarus niger	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1					1	1	1	1

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Scarus oviceps											1	1										1		1	
Scarus prasiognathus																								1	
Scarus psittacus					1	1																			
Scarus pyrrhurus																1			1						
Scarus quoyii		1			1																	1		1	
Scarus rivulatus		1		1	1			1				1			1	1			1						
Scarus schlegeli		1		1			1				1		1												
Scarus spinus		1					1	1								1								1	
Scarus tricolor		1	1		1			1	1		1			1	1		1	1							1
Scarus sp.		1			1			1			1									1					
Scombridae - tunas/ mackerels																									
Gymnosorda unicolor				1						1															
Rastrilliger kanagurta			1	1																	1				1
Scorpaenidae - scorpionfishes																									
Dendrochirus zebra				1						1															
Pterois antennata	1	1			1			1						1		1	1		1					1	1
Pterois volitans	1				1			1						1			1							1	
Scorpaenopsis diabolus										1															
Scorpaenopsis oxycephala		1																							
Serranidae - groupers/ basslets																									
Aethaloperca rogaa					1																			1	
Anyperodon leucogrammicus																									
Cephalopolis argus				1	1	1							1			1			1					1	1
Cephalopolis boenak			1		1	1			1												1				
Cephalopolis cyanostigma	1	1		1	1	1		1			1		1			1			1	1				1	
Cephalopolis leopardus									1																
Cephalopolis microprion		1			1	1			1		1			1										1	
Cephalopolis miniata			1	1	1	1	1	1	1								1								
Cephalopolis sexmaculata						1		1																	
Cephalopolis urodota				1		1		1						1		1	1		1						
Diploprion bifasciatum				1																					
Epinephelus caeruleopunctatus	1			1																					
Ephinephelus fasciatus					1				1					1		1									
Ephinephelus fuscoguttatus																									
Ephinephelus hexagonatus																	1								
Ephinephelus merra																									
Epinephelus maculatus																			1						
Epinephelus ongus					1																				
Epinephelus sexfasciatus																									
Luzonichthys waitei		1		1				1																1	
Plectropomus sp.																									
Pseudoanthias huchtii	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Pseudoanthias lori					1			1																1	
Pseudoanthias pleurotaenia																			1						
Pseudoanthias squamipinnis	1	1		1	1	1	1	1			1					1	1	1	1	1		1		1	
Pseudoanthias tuka				1														1			1				
Variola albimarginata					1																				
Variola louti				1				1					1												
Siganidae - rabbitfishes																									
Siganus argentus					1			1									1								
Siganus canaliculatus															1										
Siganus corallinus	1			1			1																		
Siganus fuscescens				1																					
Siganus guttatus			1	1	1		1	1															1		
Siganus javus					1																				
Siganus puellus					1		1	1		1															
Siganus punctatissimus																									
Siganus spinus	1			1			1									1									1
Siganus unimaculatus					1																			1	
Siganus virgatus	1	1			1	1		1		1								1	1						
Siganus vulpinus	1										1		1											1	
Sphyraenidae - barracudas																									
Sphyraena barracuda																									
Sphyraena flavicauda					1	1						1												1	
Sphyraena obtusuta				1																					
Syngnathidae - pipefishes																									
Corythoicthys intestinales											1														
Doryramphus dactylophorus																									
Siokunichthys nigrolineatus		1																							
Synotodontidae - lizardfishes																									
Saurida gracilis	1				1			1		1						1									
Synodos variegatus								1	1		1						1			1		1		1	
Tetraodontidae - puffers																									
Arothron hispidus																			1					1	
Arothon meleagris																			1						
Arothron nigropunctatus	1		1				1			1	1			1		1	1	1			1			1	1
Canthigaster compressa	1																						1		
Canthigaster papua									1																
Canthigaster solandri																									
Canthigaster valentini				1			1	1	1	1	1					1	1	1						1	1
Trichonothidae - sand divers																									
Trichonotus setigerus																									
Tripterygiidae - triplefins																									

SITES	Arthur's Rock Sanctuary			Twin Rocks Sanctuary			Batalang Bato (Pulang Buli) Marine Sanctuary			Layag-Layag			Sepoc Point Reef			Sombrero Island			White Sand Reef			White House Reef		Cathedral Reef Sanctuary	
Enneapterygius minutus				1																					
Helogramma striata					1												1			1					
Zanclidae - moorish idol																									
Zanclus cornutus	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1
Shellfish																									
Sepia sp.		1									1						1			1			1		
TOTAL	153	155	98	192	176	93	133	150	87	111	150	75	95	155	72	133	157	94	82	107	81	105	42	156	89

APPENDIX 4. MPA Rating

Arthur's Rock Fish Sanctuary MPA rating 2007

Year of rating: 2007
Rating items

Level I (MPA is initiated) - Passing:
a) MPA concept accepted
b) Site surveyed with baseline assessment complete
c) Site selected
d) Education program raising awareness about MPA benefits
e) Management body membership tentatively determined
f) Preliminary management plan drafted

Level II (MPA is established) - Fair:
a) Acceptance approved by community and documented
b) Ordinance approved by municipal council
c) Management body formally organized and recognized
d) Management plan adopted by community and LGU or PAMB
e) Management activities started
f) Biophysical monitoring includes local participation
g) IEC activities conducted to raise understanding on MPA rules and regulations
h) Anchor buoys, marker buoys and/or boundary markers installed
i) Sanctuary rules and/or mgt plan posted at strategic locations

Level III (MPA is enforced) - Good:
a) Education program sustained public awareness and compliance
b) Biophysical monitoring measuring habitat condition and changes
d) Marker and/or anchor buoys maintained
e) Management body active
f) Budget from local gov't or from other sources allocated and is accessible for MPA mgmt
h) Illegal and destructive fishing reduced outside of MPA

Level IV (MPA is sustained) - Very good:
a) MPA management plan updated and adopted in a participatory process
b) Biophysical monitoring and feedback of results implemented for 2 years or more.
c) Budget from government or from other sources allocated and was accessed for 2 or more consecutive years
g) Environment friendly enterprise and/or fees initiated as part of MPA

Level V (MPA is institutionalized) - Excellent:
a) Information on MPA management plan, rules and monitoring maintained

b) Ordinance passed by the Provincial Council giving MPA stronger political support

e) Evaluation of impacts on ecology and socio-economy conducted and feedback of results completed

f) Revenues from enterprise and/or user fees sustained and accounted for

i) Expansion strategies considered or initiated

Priorities for improved management

Lack of supplemental and alternative livelihood

Need for management capacity development

Weak law enforcement

MPA rating results

Total points: 30

Rating acquired: Level 4: Very good. MPA is sustained

Cathedral Rock Fish Sanctuary MPA rating 2007

Year of rating: 2007

Rating items

Level I (MPA is initiated) - Passing:

a) MPA concept accepted

b) Site surveyed with baseline assessment complete

c) Site selected

d) Education program raising awareness about MPA benefits

e) Management body membership tentatively determined

f) Preliminary management plan drafted

Level II (MPA is established) - Fair:

a) Acceptance approved by community and documented

b) Ordinance approved by municipal council

c) Management body formally organized and recognized

d) Management plan adopted by community and LGU or PAMB

e) Management activities started

f) Biophysical monitoring includes local participation

g) IEC activities conducted to raise understanding on MPA rules and regulations

h) Anchor buoys, marker buoys and/or boundary markers installed

i) Sanctuary rules and/or mgt plan posted at strategic locations

Level III (MPA is enforced) - Good:

a) Education program sustained public awareness and compliance

b) Biophysical monitoring measuring habitat condition and changes

d) Marker and/or anchor buoys maintained

e) Management body active

f) Budget from local gov't or from other sources allocated and is accessible for MPA mgmt

h) Illegal and destructive fishing reduced outside of MPA

Level IV (MPA is sustained) - Very good:

a) MPA management plan updated and adopted in a participatory process

b) Biophysical monitoring and feedback of results implemented for 2 years or more

c) Budget from government or from other sources allocated and was accessed for 2 or more consecutive years

g) Environment friendly enterprise and/or fees initiated as part of MPA

Level V (MPA is institutionalized) - Excellent:

a) Information on MPA management plan, rules and monitoring maintained

b) Ordinance passed by the Provincial Council giving MPA stronger political support

e) Evaluation of impacts on ecology and socio-economy conducted and feedback of results completed

f) Revenues from enterprise and/or user fees sustained and accounted for

Priorities for improved management

Lack of community awareness and support
Need for management capacity development
Weak law enforcement

MPA rating results

Total points: 29
Rating acquired: Level 3: Good. MPA is enforced

Twin Rocks Fish Sanctuary MPA rating 2007

Year of rating: 2007
Rating items

Level I (MPA is initiated) - Passing:
a) MPA concept accepted
b) Site surveyed with baseline assessment complete
c) Site selected
d) Education program raising awareness about MPA benefits
e) Management body membership tentatively determined
f) Preliminary management plan drafted

Level II (MPA is established) - Fair:
a) Acceptance approved by community and documented
b) Ordinance approved by municipal council
c) Management body formally organized and recognized
d) Management plan adopted by community and LGU or PAMB
e) Management activities started
f) Biophysical monotoring includes local participation
g) IEC activities conducted to raise understanding on MPA rules and regulations
h) Anchor buoys, marker buoys and/or boundary markers installed
i) Sanctuary rules and/or mgt plan posted at strategic locations

Level III (MPA is enforced) - Good:
a) Education program sustained public awareness and compliance
b) Biophysical monitoring measuring habitat condition and changes
d) Marker and/or anchor buoys maintained
e) Management body active
f) Budget from local gov't or from other sources allocated and is accessible for MPA mgmt
h) Illegal and destructive fishing reduced outside of MPA

Level IV (MPA is sustained) - Very good:
a) MPA management plan updated and adopted in a participatory process
b) Biophysical monitoring and feedback of results implemented for 2 years or more
c) Budget from government or from other sources allocated and was accessed for 2 or more consecutive years
g) Environment friendly enterprise and/or fees initiated as part of MPA

Level V (MPA is institutionalized) - Excellent:
a) Information on MPA management plan, rules and monitoring maintained
b) Ordinance passed by the Provincial Council giving MPA stronger political support
e) Evaluation of impacts on ecology and socio-economy conducted and feedback of results completed

f) Revenues from enterprise and/or user fees sustained and accounted for

h) MPA used as a study tour site, residents advocate for MPAs

i) Expansion strategies considered or initiated

Priorities for improved management

Lack of supplemental and alternative livelihood

Need for management capacity development

Weak law enforcement

MPA rating results

Total points: 31

Rating acquired: Level 4: Very good. MPA is sustained

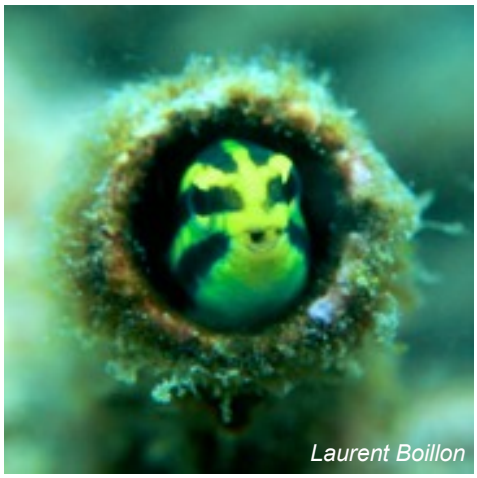
APPENDIX 5. Expedition Photos

A large school of bigeye trevally (*Caranx sexfaciatus*) inside the Twin Rocks Fish Sanctuary are an indication of a well-protected MPA.

Beautiful macrophotography subjects such as this blue ribbon eel (*Rhinomuraena quaesita*) were found inside various MPAs such as Arthur's Rock Fish Sanctuary.

This flamboyant cuttlefish (*Metasepia pfefferi*) was a surprise to see inside the Twin Rocks Fish Sanctuary on the last dive of the trip.

Shorthead fangblenny (*Petroscirtes breviceps*) can be found sheltering in abandoned worm tubes on the coastal reefs of Batangas.



Batfish (*Platax boersii*) were found to be overly friendly in the Twin Rocks Fish Sanctuary, possibly a result of fish-feeding.

High coral cover (75%) was observed at the Cathedral Rock Fish Sanctuary, one of the oldest MPAs in Batangas. This site was dominated by beautiful branching corals.

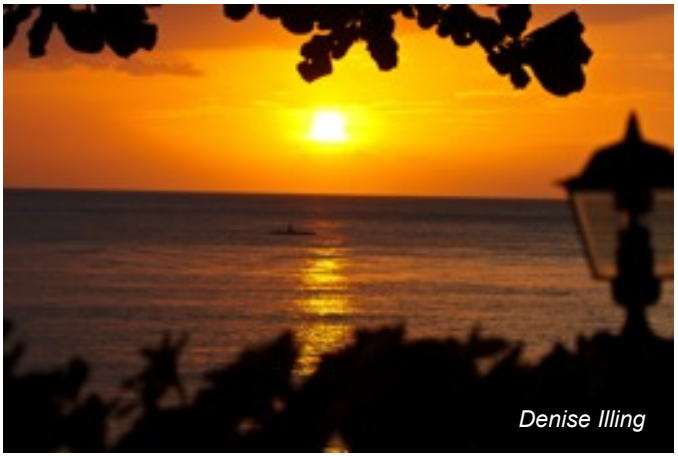
Sun corals (*Tubastrea faulkneri*) were observed at many of the sites. They are corals which lack symbiotic photosynthetic zooxanthellae and therefore rely upon catching plankton for their food source.

SPR Volunteers on the way to have lunch on Cemetery Beach in the Municipality of Tingloy, Batangas.

Ardeadoris egretta is another species of nudibranchs observed in the Arthur's Rock Fish Sanctuary.

A large school of fish including sleek unicorn fish (*Naso hexacanthus*), surgeonfish (*Acanthurus* sp.) and rabbitfish (*Siganus guttatus*) were seen in large numbers inside the Twin Rocks Fish Sanctuary, Mabini, Batangas.

CCEF staff Nip-Nip Porpecho, Mary Jane Trangia, Rose-Liza Eisma-Osorio (*from left to right*) and a boatman greet the Volunteers after a snorkel survey at the Batalang-Bato Fish Sanctuary in Tingloy, Batangas.

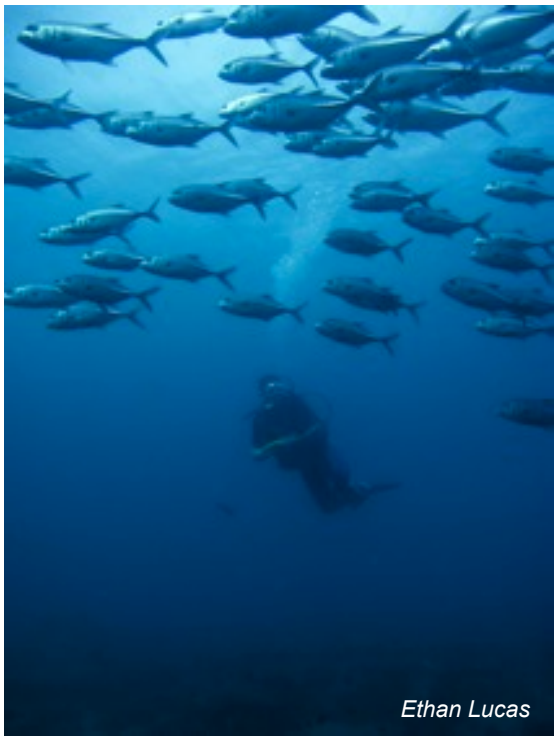


A local fisherman is captured against the backdrop of a picture perfect sunset as viewed from the Dive Solana waterfront.

A boatman disembarks to enjoy a well-deserved lunch after safely landing the diveboat at Cemetery Beach, Tingloy, Batangas.

SPR 2011 Volunteer Sandy Robb (*standing top left*) hanging out with SPR Staff Ian White, Nip-Nip Porpecho (*standing; left to right*), Ian White, Raffy Martinez, Ethan Lucas, Dean Apistar and Danilo Delizo (*seated bottom; left to right*) at the “White House”.

Ian White is captured enjoying the view amongst a large school of bigeye trevally (*Caranx sexfaciatus*) inside the Twin Rocks Fish Sanctuary, Mabini, Batangas.



The Saving Philippine Reefs staff and volunteers for the SPR-Batangas Expedition 2011.