Summary Field Report:
Saving Philippine Reefs

Coral Reef Surveys for Conservation In Tubbataha Reefs National Marine Park, Sulu Sea, Philippines April, 2004

A joint project of:

Coastal Conservation and Education Foundation, Inc.
and the
Coastal Resource Management Project

with the participation and support of the Expedition volunteers

Coastal Conservation and Education Foundation, Inc.

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PHILIPPINES

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With the participation and support of the

Expedition Volunteers

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Summary Field Report: “Saving Philippine Reefs”
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Produced by the Coastal Conservation and Education Foundation, Inc. and the Coastal Resource Management Project

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

The Coastal Resource Management Project (CRMP) operates in selected areas in the Philippines to assist local and national government to develop coastal resource management plans and to facilitate their implementation.

Cover photo by Denise Illing

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ABSTRACT

This project assessed the condition of the coral reefs in the Tubbataha National Marine Park at selected sites and updated information from surveys in 1984, 1989, 1992, 1996 and 2000. Information on the changes in corals, other substratum, fish fauna, invertebrates and causes of damage over time, patterns and trends exhibited and reef health is provided. Recommendations are made for improved conservation and management to the Tubbataha Protected Area Management Board and its partners for sustained management .

Live hard coral cover in Tubbataha is in fair condition. Surveys over time indicate that the rise in seawater temperature in 1998 during an El Niño event, contributed largely to changes in the Tubbataha coral reef substrate. Coral cover in all sites declined significantly from the year 1996 to 2000 and the response of each reef exhibited in the year 2004 varied: (1) no significant change in coral cover, (2) recovery in terms of increase in coral cover and (3) recovery in terms of increase in coral cover coupled with a phase shift in the living substrate composition.

It appears that the negative impact of bleaching on different reefs is variable and will have different effects on the different Tubbataha sites. Recovery from bleaching and changes in community structure of Tubbataha reefs will likely be driven by the resiliency of hard coral species present in the area, interactions between hard coral recruitment, soft coral competition, corallivory, local current patterns and the depth at which corals grow and future bleaching episodes.

Fish diversity and abundance in Tubbataha reefs is fairly high. Large marine life, not common in other Philippine reefs, was consistently sighted in all sites. It appears that fish abundance reflects the relative success of Tubbataha Park management rather than species diversity. Significantly higher fish densities were recorded in NR2 (Ranger Station), SR3 (Black Rock) and SR1 (Lighthouse). It is likely that the distance of the site from the Ranger station plays a vital role in maintaining good coral reef and marine life conditions in a site at Tubbataha. This may be a result of the different levels in patrol enforcement by Rangers due to site accessibility.

Identified problems that need to be addressed are: (1) the insufficient capacity of the naval personnel stationed at the Ranger station to patrol the marine park by boat and the need for better enforcement facilities; (2) better maintenance and mooring facilities to prevent damage from the increase in the number of dive boats visiting the area; (3) illegal fishing, although sporadic, is still likely to occur; (4) improvement of the dive-boat briefing system for all park visitors; (5) the need for a regulation on boat waste management; and, (6) the inclusion of Jessie Beazley and Bastera Reefs into the Park area.

The status of the coral reef and marine life of Tubbataha Reef National Marine Park has improved significantly over the years. Live coral cover in most sites in 2004 showed significant increases, thus recovery, after the El Niño bleaching episode in 1998. Most large marine life is more abundant than in years past. Since the primary mitigating measure for expected future bleaching events is improved reef management, continued emphasis on reef protection is a must.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This Earthwatch Expedition and its outcome are credited to the 13 volunteers (see Appendix 2) from the United States, United Kingdom, Australia and the Philippines who dedicated their time and funding to the research work. Equally important are the Coastal Conservation and Education Foundation staff, partners and volunteers (see Appendix 2) that prepared for the trip, worked long hours and have all done their part in the overall successful completion of the Expedition. They include: Anna Meneses, Co-Investigator; Sheryll Tesch, Data and research coordinator; Aileen Maypa, Researcher; Brian Stockwell, Researcher; and Vangie White, Overall support coordinator for the trip.

The Coastal Resource Management Project of Tetra Tech EM Inc. supported by the United States Agency for International Development, Philippines, has provided the overall context for the project to successfully proceed with support for the Principal Investigator.

The M/Y Tristar crew hosted the group with traditional Filipino hospitality and provided excellent service, accommodations, food and diving services and assistance.

The Tubbataha Reefs National Marine Park Management Group, under the supervision of Ms. Angelique Songco, and the Tubbataha Rangers gave invaluable support and assistance throughout the duration of the trip.

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

Alan T. White
Principal Investigator

LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
CB	Branching coral
CFD	Flat/encrusting coral
CFO	Foliose/cup coral
CM	Massive coral
CRMP	Coastal Resource Management Project
DC	White dead standing coral
DCA	Dead coral with algae
DENR	Department of Environment and Natural Resources
ENSO	El Niño Southern Oscillation
GBRMPA	Great Barrier Reef Marine Park Authority
GCRMN	Global Coral Reef Monitoring Network
JB	Jessie Beazley
JICA	Japan International Cooperation Agency
LC	Live coral
LHC	Live hard coral
M/Y	Marine Yacht
MPA	Marine Protected Area
N/A	Not applicable
NL	Non living
NR	North Reef
NRMC	Natural Resources Management Center
NS	Not significant
PAMB	Protected Area Management Board
PCSD	Palawan Council for Sustainable Development
R	Coral rubble
RK	Rock and block
SC	Soft coral
SD	Standard deviation
SE	Standard error
SI	Sand and silt
spp.	species
SPR	Saving Philippine Reefs
SR	South Reef
TRNMP	Tubbataha Reef National Marine Park
UNESCO	United Nations Educational, Scientific and
UVC	Underwater visual census
WWF	World Wide Fund

SAVING PHILIPPINE REEFS PROJECT
A coral reef survey expedition for conservation in the Tubbataha Reef National Marine Park Cagayancillo, Palawan

INTRODUCTION

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

One of these sites is the Tubbataha Reef in the southern Philippines. The Tubbataha Reef is comprised of two uninhabited coral atolls in the Sulu Sea, 150 kilometers southeast of Puerto Princesa City, Palawan. The coral reef biodiversity is outstanding, which makes this location important ecologically. It is also a popular dive site. It is a habitat to many species: 372 corals, 7 seagrasses, 79 algae, 6 cetaceans (White and Arquiza 1999), 510 fish and 7 shark species. The islets are nesting sites for sea birds and marine turtles. Despite being remote, the Tubbataha reefs deteriorated in the late 1980s because of destructive fishing by local and migrant fishermen from the South and Central Philippines, Taiwan and China (GCRMN 2002).

The SPR Project first surveyed Tubbataha in 1984. Findings from this study strongly recommended a more active effort for conservation of the area. Four years later, it was declared as a national marine park (Arquiza and White 1999).

Management History of Tubbataha Reefs Marine Park

Legal Establishment

National Marine Protected Area. In 1987, the provincial board of Palawan passed Resolution 244 requesting the declaration of Tubbataha as a marine sanctuary. It was then proclaimed as a national protected area upon the recommendation of the Secretary of the Environment and Natural Resources in August 11, 1988. The primary purpose for establishment is to protect and preserve the coral reef atoll with its abundant and diverse reef assemblage, including the marine turtles and water birds found roosting in the area. It is prohibited to collect, gather corals, wildlife or any marine life from the marine park or in any manner disturb or destroy the habitat and wildlife (PAWB/DENR 1992). Tubbataha was later declared under the National Integrated Protected Areas System Act in June 19, 1992 such that the use and enjoyment of this 33,000-hectare protected area must be consistent with the principles of biological diversity and sustainable development.

Declared as a World Heritage Site by UNESCO. The convention for World Heritage Sites provides for the protection of those cultural and natural properties deemed to be of outstanding universal value. This was adopted in 1972, with more than 150 State Parties, and is an important instrument of international cooperation for environmental protection. The Convention is founded on the premise that the world's great cultural and natural sites constitute a common heritage for all humankind, and their destruction would be an irreparable loss. The major criterion for inclusion on the list is 'outstanding universal value', with 4 natural criteria to assist in selection. A natural site must: (*1*) exemplify major stages of the earth's history; (*2*) represent ongoing ecological and biological processes; (*3*) be of exceptional natural beauty; or (*4*) contain the valued natural habitats, including those of endangered species (GCRMN 2002).

In December 1993, the World Conservation Union declared Tubbataha Reefs a World Heritage Site (White et al. 2000).

Management

Management of the Tubbataha Reef National Marine Park (TRNMP) was never easy. Past and present users of Tubbataha include small-scale and commercial fishers from Palawan and neighboring provinces as well as neighboring countries in southeast Asia. The park is isolated, has no human inhabitants, and covers quite a large area (White and Palaganas, 1991). This logistical condition makes operations for management and enforcement difficult and expensive to implement.

A timeline of management events leading up to the present is briefly described in the following (White et al. 2003):

1988 Park declared by Presidential Decree
1989 First draft of park management plan based on limited information
1990 Sporadic patrols started to stop illegal and destructive fishing
1991 Illegal seaweed farm removed from the Marine Park
1992 Several research expeditions collected baseline data on the coral reef
1993 Park management plan re-drafted; illegal activities increased
1994 World Heritage status declared
1995 Presidential Task Force set up to implement management and provide funds; Philippine Navy assigned to guard the Marine Park
1996 Coastal Resource Management Project (CRMP) refines management plan together with Japan International Cooperation Agency (JICA) support, Department of Environment and Natural Resources (DENR), Palawan Council for Sustainable Development (PCSD), World Wide Fund for Nature (WWF) and stakeholders in Palawan and Cagayancillo
1997 CRMP initiates study of legal basis for Protected Area Management Board (PAMB) to become functional together with DENR, PCSD, and WWF; JICA sponsors planning and supports educational tour for media together with CRMP
1998 PAMB formed based on DENR/CRMP recommendations; management plan endorsed in a workshop with all stakeholders with support from PCSD, DENR, WWF, CRMP; coral bleaching event kills more than 20% of living coral cover

1999 PAMB becomes operational with a park manager appointed and supported by WWF based on management plan designed by CRMP technical guidance

2000 Management plan fully endorsed by the PAMB for implementation and fee structure designed based on willingness-to-pay study of CRMP and WWF; revenue of between US$50,000 and 100,000 to be collected; CRMP and Sulu Fund jointly implement reef monitoring funded by volunteer divers

2001 Continued implementation of management plan to present

This EXPEDITION—2004

This coral reef survey is the 4th reef monitoring expedition in the Tubbataha Reef National Marine Park, Cagayancillo, Palawan (Figure 1). This 9-day expedition was conducted on April 3 to 11, 2004 and was participated by a team of 13 volunteers and 8 staff members. The volunteers hailed from the USA, UK, Australia and the Philippines. Most of them are seasoned Saving Philippine Reefs Expedition volunteers (10) who have joined in many of the foundation's previous expeditions. The dedicated volunteers and staff (Appendix 2) formed a very solid team and accomplished all the expeditions' objectives.

The expedition team's home for 9 days was the M/Y Tristar. With an efficient and friendly boat crew the M/Y Tristar proved to be a well-equipped and comfortable research vessel with the appropriate amenities and excellent service.

The team surveyed 7 sites in the north and south reef atolls including Jessie Beazley Reef located outside the park lying on the northwest side of the north atoll (Figure 2). The trip itinerary is shown in Appendix 1. The expedition was a success in complete and appropriate data collection and leisure. The diving and snorkeling gave participants an amazing experience of the Tubbataha Reefs and its diversity. The weather was perfect for diving and the coral reef was beautiful. Fish, sharks, sea turtles and rays were abundant, in contrast to many areas in the Philippines where they are rarely sighted. At the end of each survey day, presentations pertaining to marine life, marine coastal conservation and management and the CCE Foundation's initiatives were given as part of the training and to heighten awareness.

The survey team monitored the condition of the coral reef and other substratum, fish diversity, abundance, indicator species and human activities affecting the Tubbataha reefs. This report documents the changes in coral reef condition and reef fish abundance in Tubbataha over time. It also aims to report possible factors contributing to such changes and provides recommendations for improvement in Park management and conservation efforts.

Data Collected and Methods

The volunteers

Thirteen volunteers participated in the "Saving Philippine Reefs (SPR) Earthwatch Expedition" in Tubbataha reefs from April 2-10, 2004. They made financial contributions

which covered their travel, accommodation and subsistence costs. The volunteers came from different backgrounds including a graduate student, an M.Sc. in Ecology, a PhD in biology and consultant to higher education, entrepreneurs, business consultants and managers, a journalist and a computer science engineer. They were all experienced scuba divers and a majority have participated in previous Saving Philippine Reefs surveys.

Study site

Tubbataha reefs lies in the middle of the Sulu Sea and its reef structure consists of both fringing and atoll reefs (White et al. 2003). Continuous reef platforms, 200-250 m wide, completely enclose sandy and coral substrate lagoons that range from 1-24 meters in depth. At extreme low tide, portions of the atolls' shallow reef platforms are exposed (NRMC 1983). Data was gathered in seven protected sites and in a non-protected site which served as a control. This year's expedition study sites are as follows:

1. NR1 (North Reef): Amos Rock or Malayan Wreck
2. NR2 (North reef): Ranger Station
3. NR5 (North reef): Bird Islet
4. SR1 (South Reef): Lighthouse
5. SR3 (South Reef): Black Rock
6. SR4 (South Reef): Northwest corner of South Atoll
7. Jessie Beazley: A fishing ground, northeast of North and South Atolls

Methods

Substrate cover. Systematic snorkeling surveys were carried out in the shallow reef flat at 2-4 meter depth covering a distance of 1-1.5 km parallel to the reef crest. The substrate was evaluated within an estimated area of 1 m^2 quadrat at every 50 m stop (station). The following data was recorded:

1. Percent cover of living coral (hard and soft)
2. Percent cover of non-living substrate (e.g., rock, rubble, sand, dead coral)
3. Percent cover of 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 15 stations on one snorkel survey.

SCUBA surveys were carried out in the deep area (7-10 meters) parallel to the reef crest using a systematic point-intercept method. Transects were laid on sections of a reef flat, reef crest, slope or wall. Substrate was evaluated at 25 cm. intervals along a 50 meter transect. Data gathered during SCUBA surveys were the same type as those collected during snorkel surveys. Distance between transects was 5 to 10 meters.

Fish estimates. Fish abundance and diversity were estimated using an 8 replicate 50 x 10 meter underwater visual census (UVC) technique done by four fish visual census specialist (A. White, P. Christie, A. Maypa and B. Stockwell). Substrate transects were utilized during UVC. The abundance of large numbers of numerically dominant and visually obvious fish species were recorded using the Log4 abundance category developed by the Great Barrier Reef Marine Park Authority (GBRMPA in Russ and Alcala, 1989).

Data Analyses

Substrate cover. Substrate category was regrouped to total live hard coral, branching coral, soft coral, rubble, dead coral (white dead standing coral, dead coral with algae) and non-living substrate (rock and block, sand and silt) for comparison and presented graphically as live hard coral, soft coral, non-living substrate (rock and block, coral rubble, sand and silt, dead coral with algae, dead coral) and other (algae, seagrass, other animals). Each category was compared within site between years using a one factor Analysis of Variance (1-ANOVA). Similarly, each category was also compared between sites per year using 1-ANOVA. Surveys in the previous years with low replication ($n<3$) were excluded from statistical analyses. Thus, a T-test was used in sites with only two surveys (years) available. Live hard coral for each site was also compared with a control site (Bastera in 1996 and 2000, Jessie Beazley in 2004) between years. All percentage data was log transformed. Normality was tested using Kolmogorov's Test for normality and Levene's Test for homogeneity of variances.

Fish abundance and richness. Density of fish was presented and classified according to the 19 coral reef fish families 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). Densities within families between years within sites were compared using 1-ANOVA or T-test when appropriate, depending on the availability of well replicated surveys within years. Comparison in target fish density between each site and the control sites between years was also made. Count data was square root transformed. Normality was tested using Kolmogorov's Test for normality and Levene's Test for homogeneity of variances. Species richness was expressed as mean number of species per 500 m^2.

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.

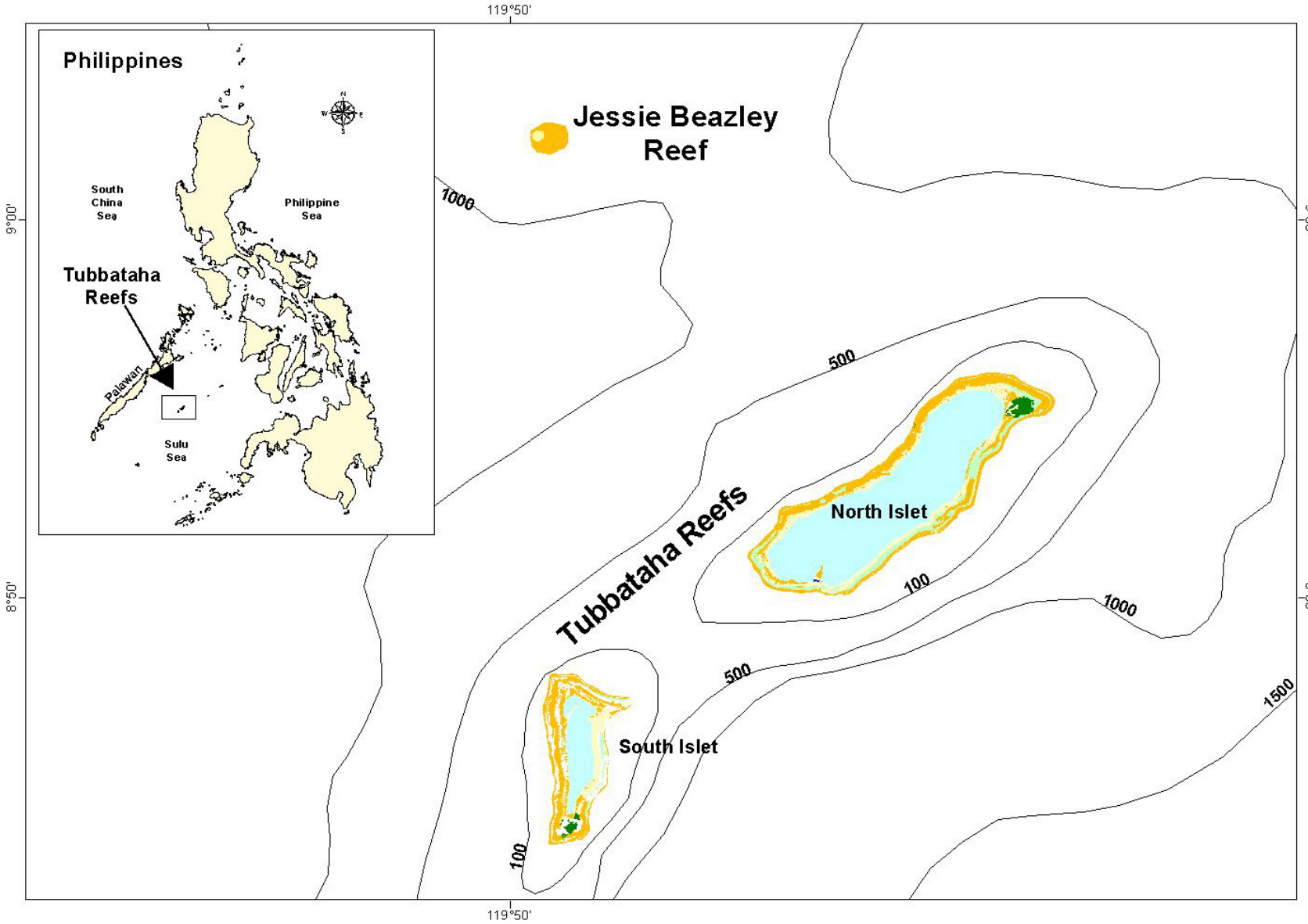


Figure 1. Location of Tubbataha Reefs in the Sulu Sea

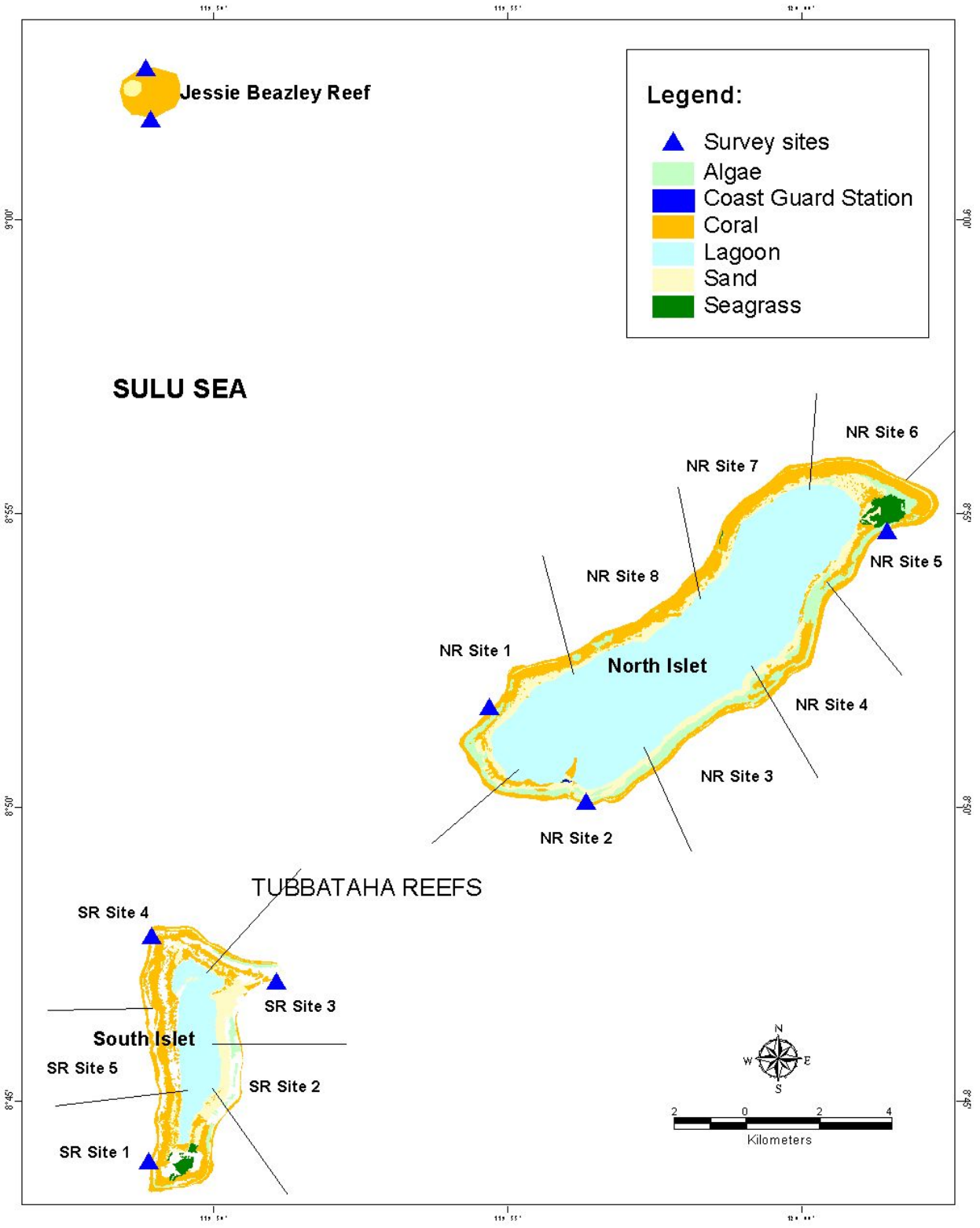


Figure 2. Study site locations on Tubbataha north and south atoll.

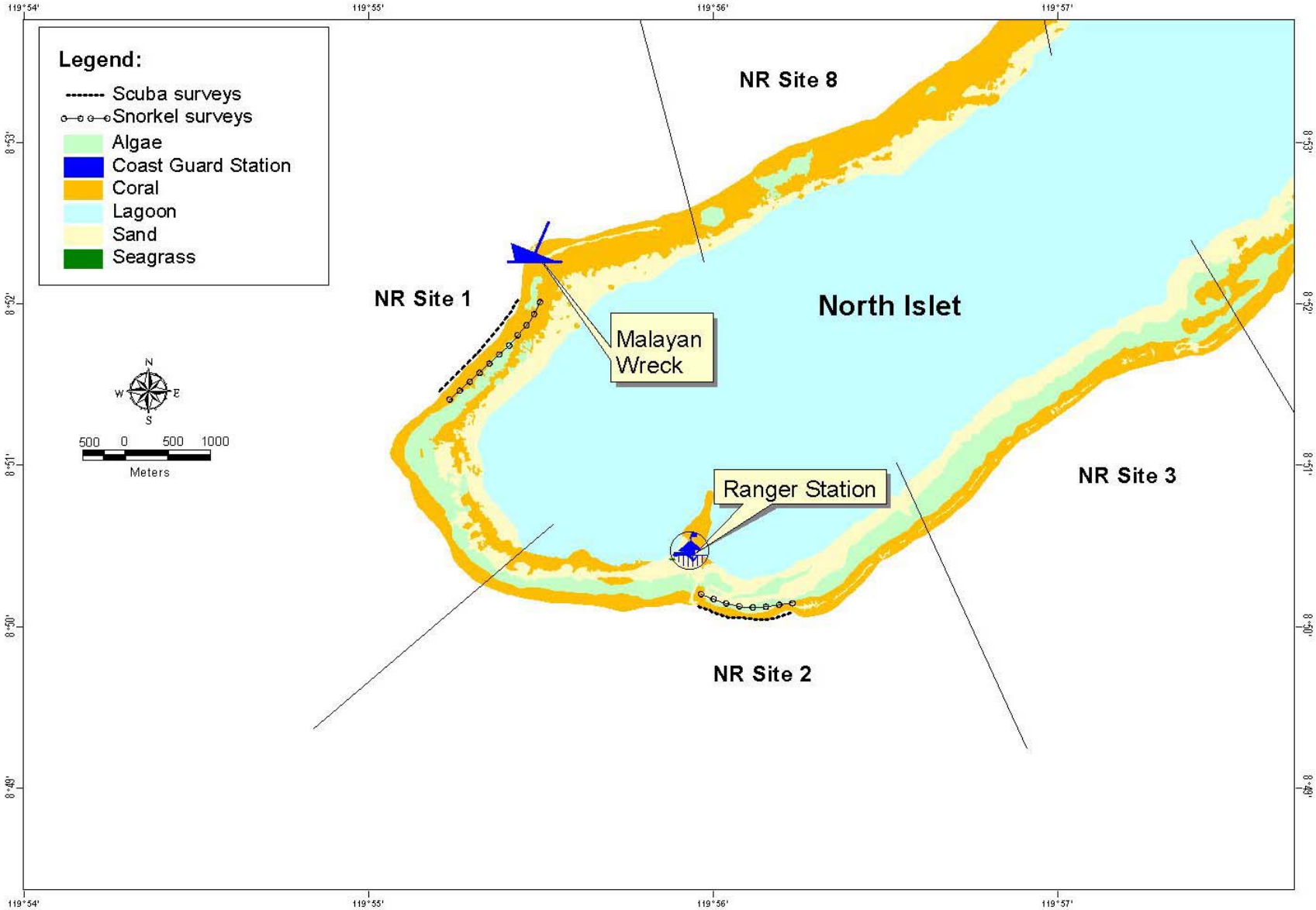


Figure 3. Study sites of North Reef 1 (Malayan Wreck or Amos Rock) and North Reef 2 (Ranger Station).

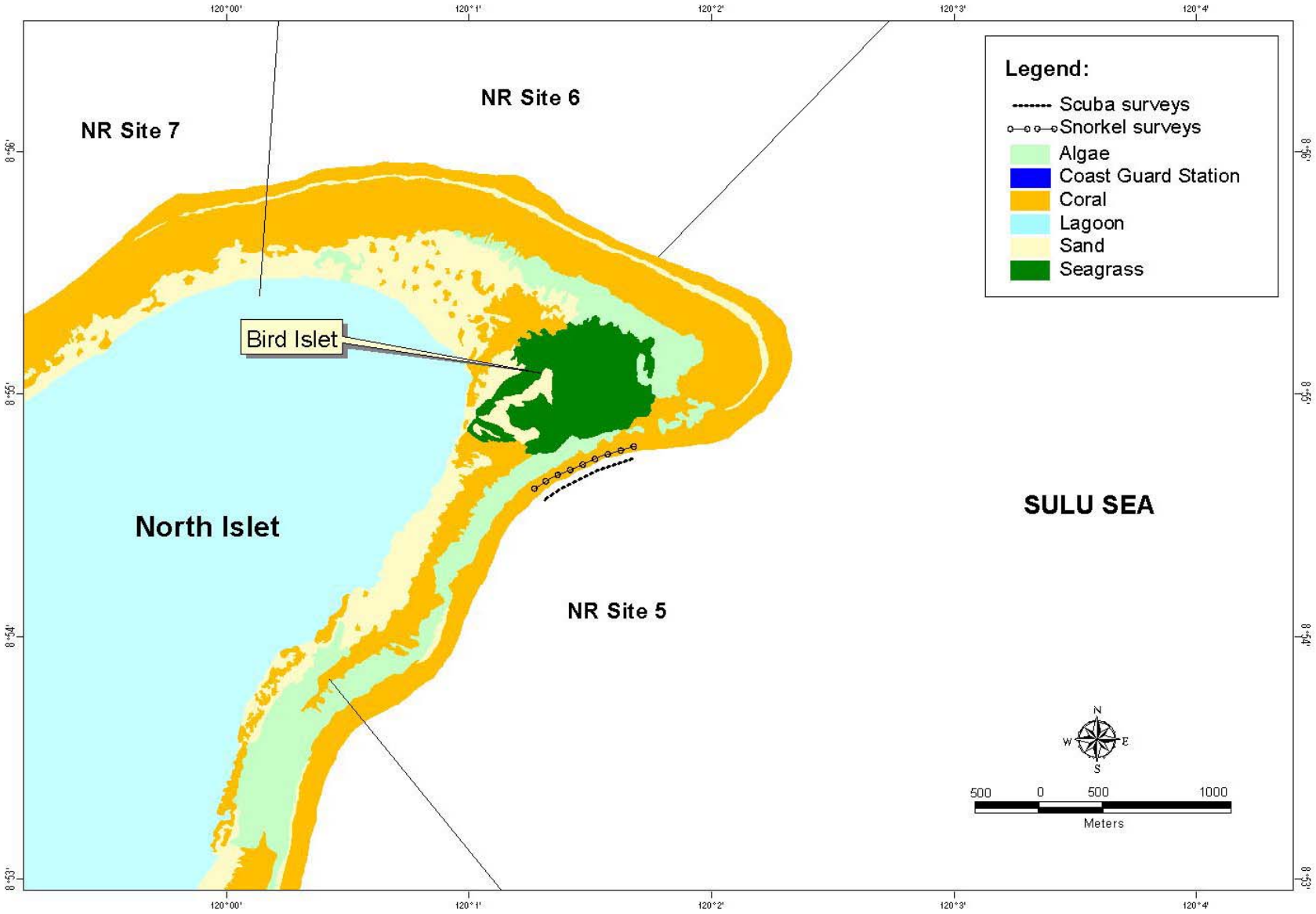


Figure 4. Study site at North Reef 5 (Bird Islet).

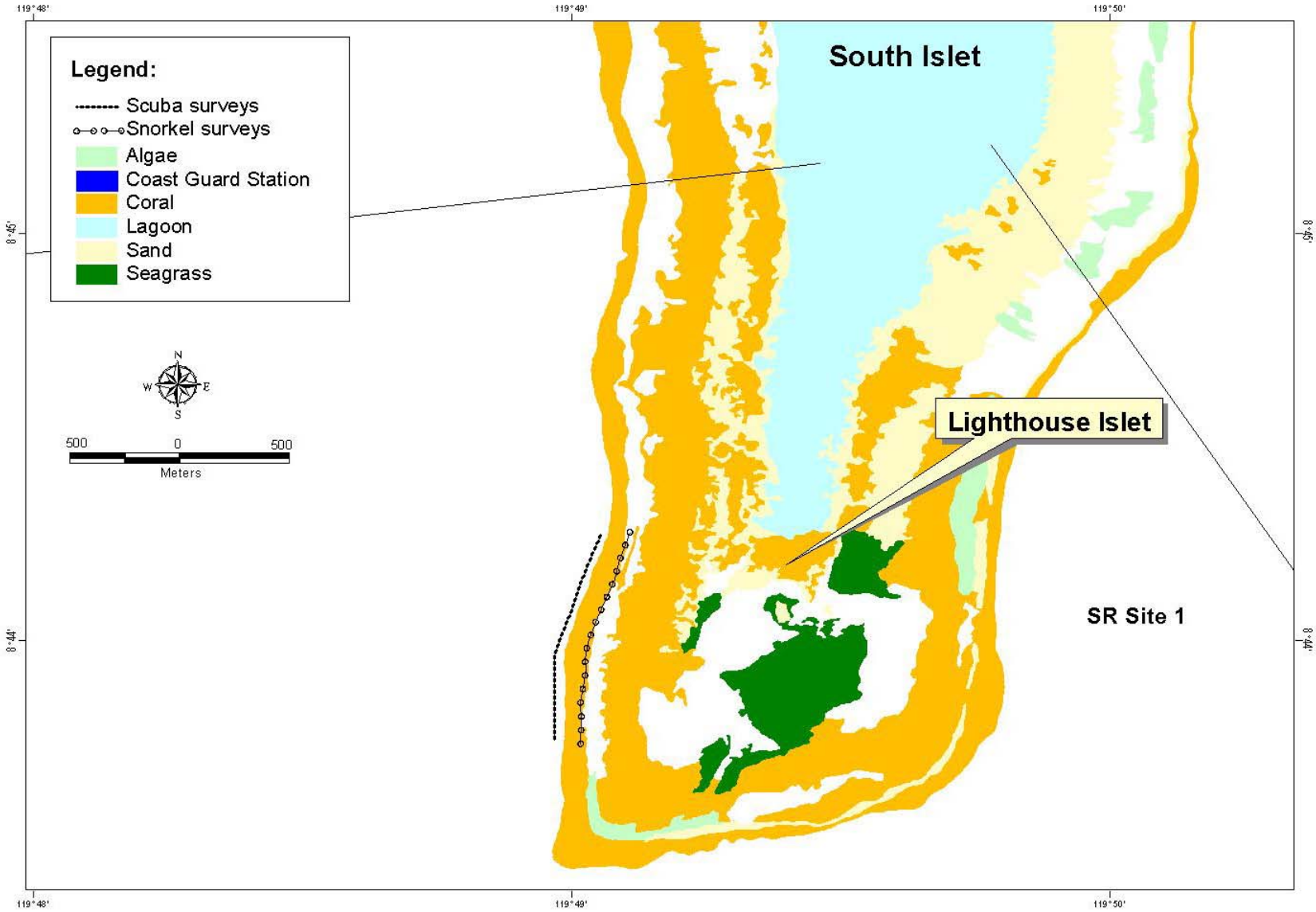


Figure 5. Study site at South Reef 1 (Lighthouse Islet).

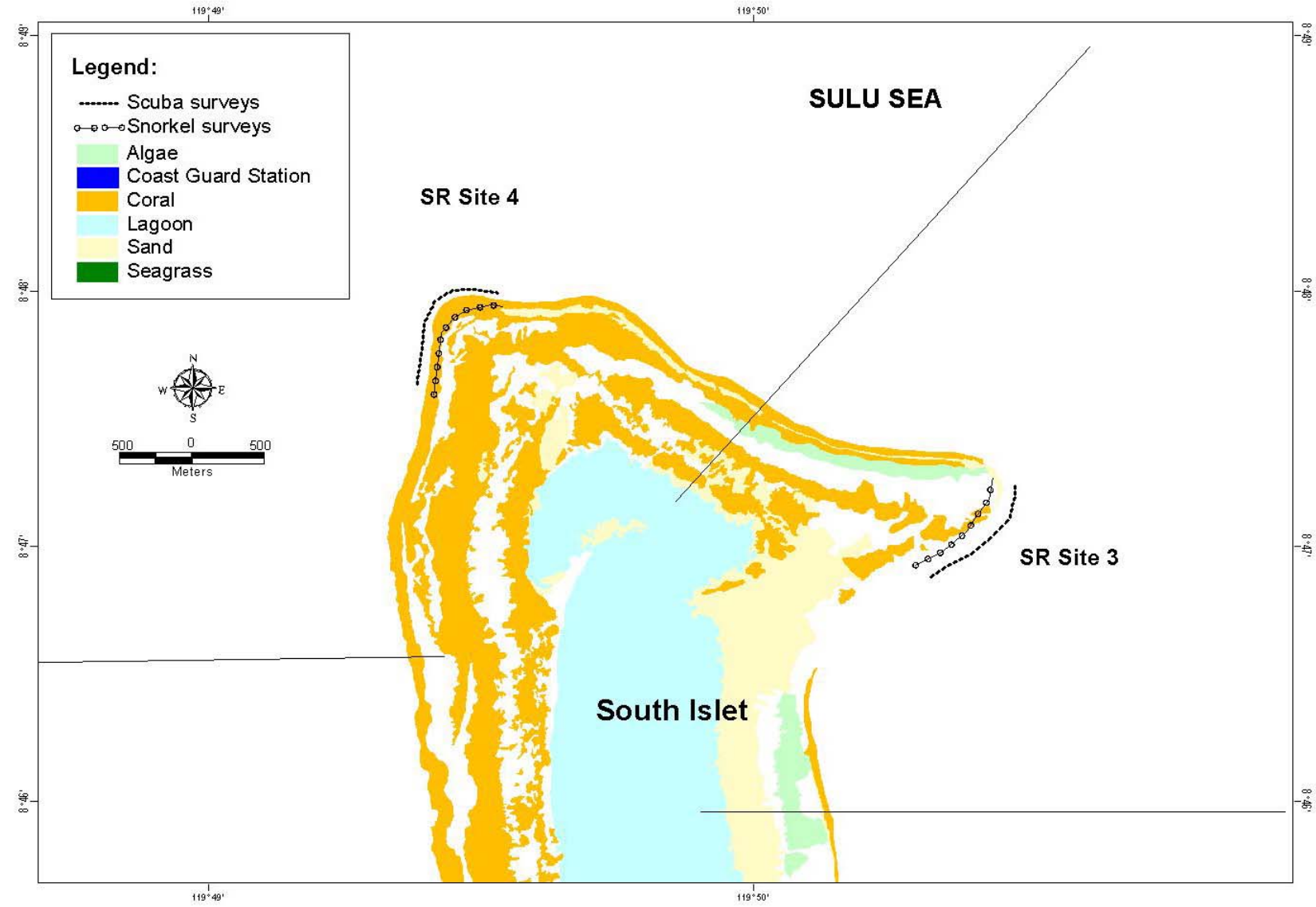


Figure 6. Study site at South Reef 3 (Black Rock) and South Reef 4 (NW Corner of south atoll).

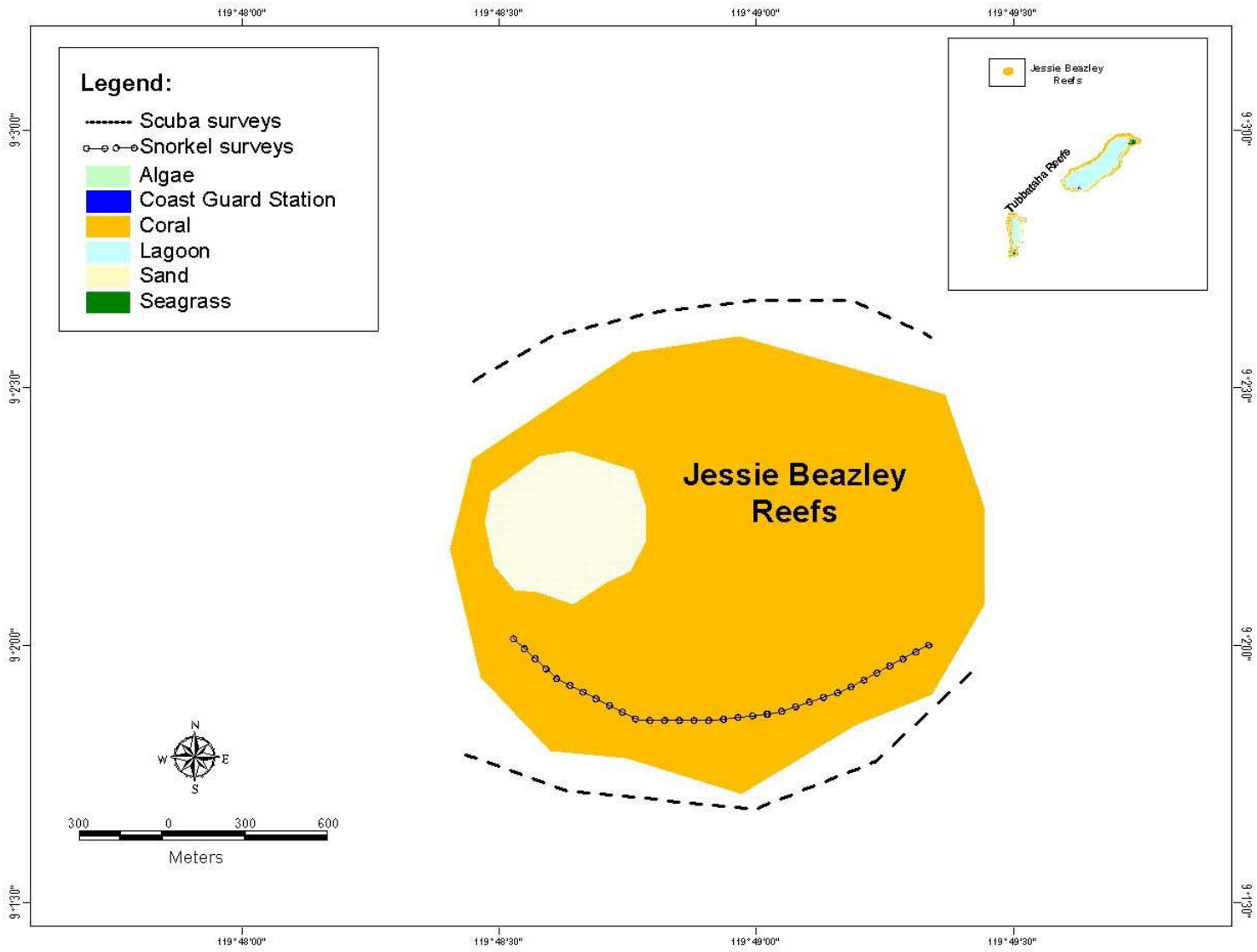


Figure 7. Study site at Jessie Beazley Reefs.

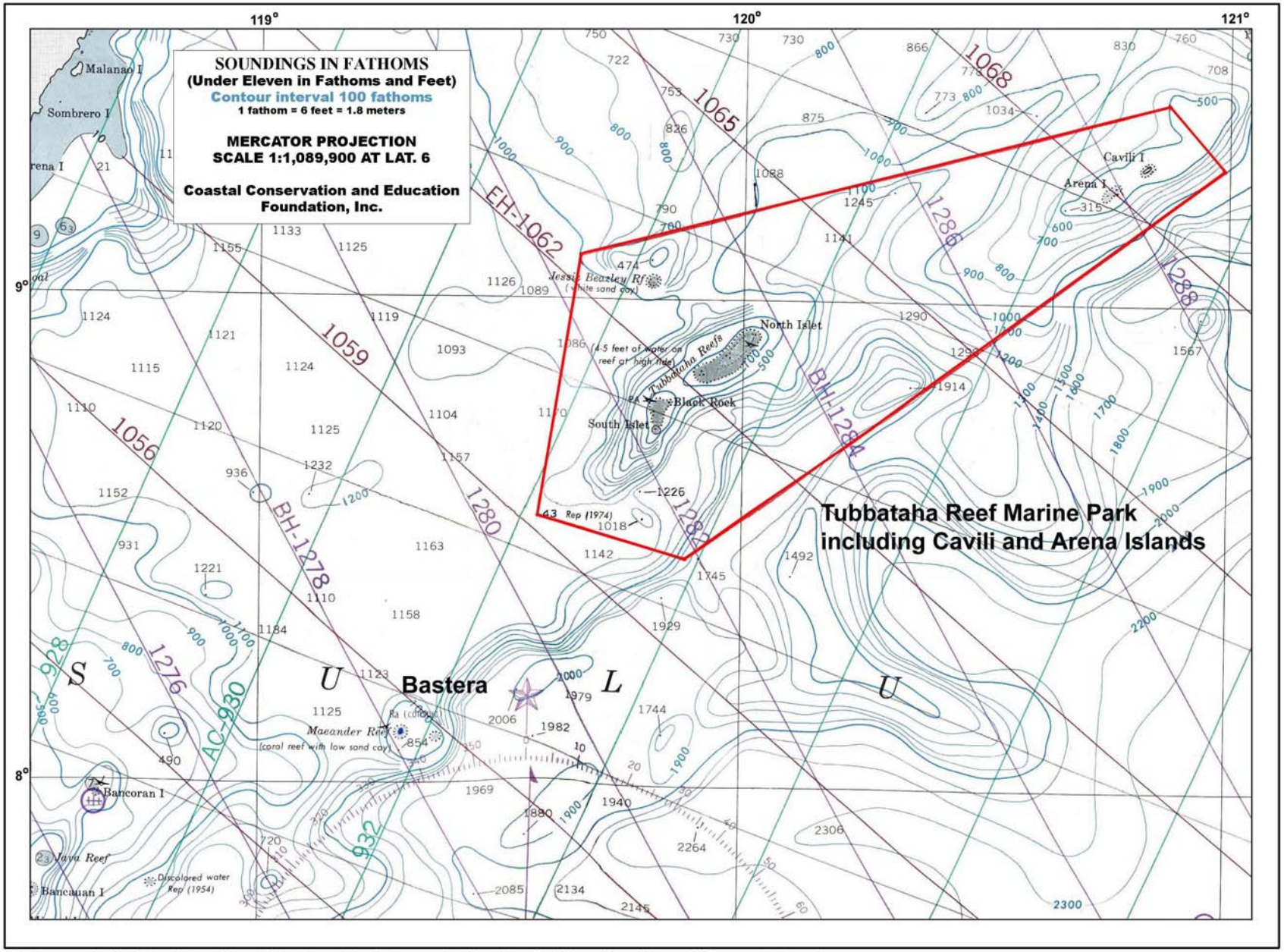


Figure 8. Tubbataha Reef Marine Park boundaries including Cavili and Arena Islands

North Reef 5 (NR5: Bird Islet)

Site overview

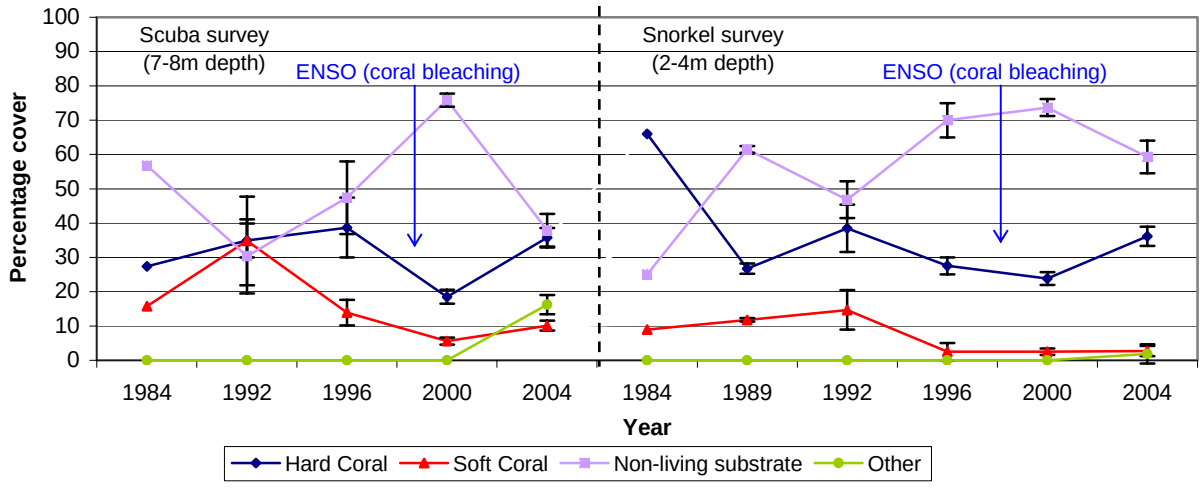
North Reef 5 is located near Bird Islet on the north atoll (Figure 4) and the whole islet is surrounded by seagrass extending to 300 -500 m (Arquiza and White 1999). Bird Islet serves as a nesting ground for about 1,000 Brown boobies and is possibly a nesting site for sea turtles. However, this islet has been covered with *Ipil-ipil (Lucaena)* trees since its introduction in 1989 by seaweed farm workers who used it as firewood, thus depriving the seabirds of their natural habitat which is an open space essential for nesting on the ground. It has been recommended that these trees be removed so that seabirds can return to their only protected habitat in the southern Philippines and possibly in the entire country (White et al. 2000).

Results

Substrate. Live hard coral in North Reef 5 was fair (shallow: 36.1 ± 2.7%, deep: 35.7 ± 9.23%) in the year 2004 (Figure 9, Table 1). This coral cover is significantly higher compared to other sites ($p \leq 0.001$, ANOVA; Appendix 4A) but equal to SR3 and the control site, Jessie Beazley. Branching corals comprised most of the total hard coral in the area, but flat/encrusting corals also contributed about 30% to the total cover in the deep area.

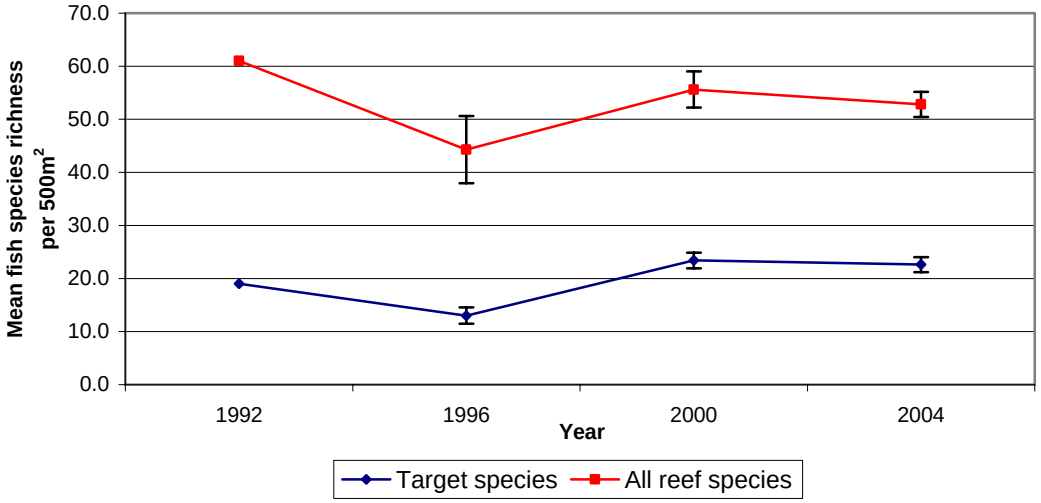
Highest coral cover in NR5 was in 1996 (38.7 ± 8.7 %, deep) which declined significantly in the year 2000 but increased significantly by 12.3% (shallow, $p = 0.185$, ANOVA), and 17.2 % (deep; $p = 0.004$, ANOVA) in 2004 (Fig. 9).

Figure 9. Changes in substrate composition (% mean ±SE) in NR-5 (North Reef) Bird Islet from 1984 to 2004.



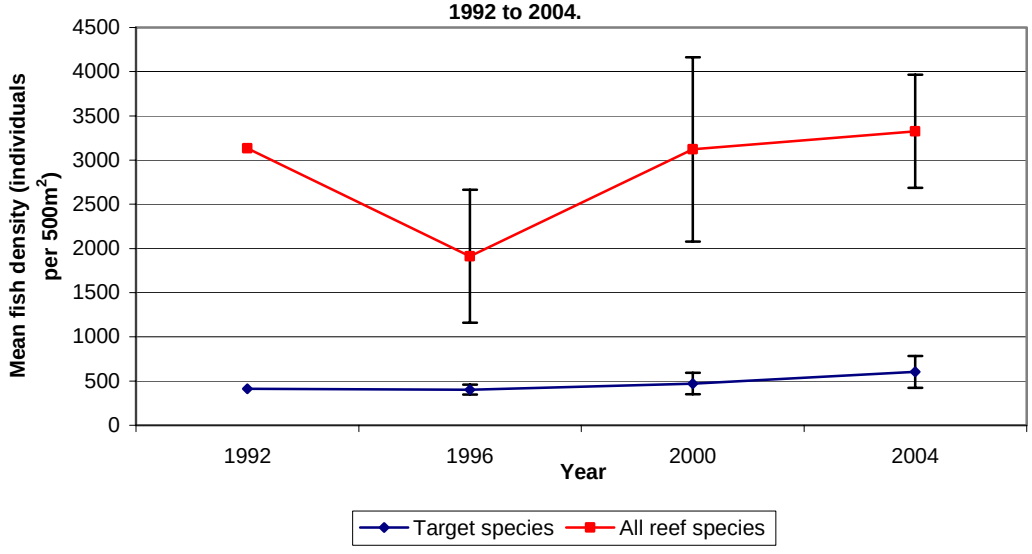
Fish diversity and abundance. A total of 221 fish species were listed in NR5 including three species of sharks (Appendix 3). Twenty nine butterflyfish species were recorded (Table 2). Mean richness for all reef species was 52.8 ± 2.4 fish/500m^2 and 22.6 ± 1.4 fish/500m^2 for target fish (Fig 10, Table 3). Change in species richness between years is shown in Table 4.

Figure 10. Mean (±SE) number of species/500m^2 at NR-5 (North Reef) Bird Islet from 1992 to 2004



Mean density for all reef species was 3325 ± 638.7 fish/500m^2 where Anthids (2015.0 ± 370 fish/500m^2) and Pomacentrids (542.4 ± 330.2 fish/500m^2) numerically dominated (Fig. 11, Table 3). Target fish density in NR5 was 602.2 ± 18.73 fish/500m^2. Among target species, Acanthurids (105.6 ± 45 fish/500m^2) and Caesionids (428.6 ± 127.8 fish/500m^2) dominated. Scarids (38.6 ± 31.3) had a fairly high density in this site compared to others. Comparison of densities within families between years (Table 5) indicated no significant change in abundance ($p > 0.05$, ANOVA).

Figure 11. Mean (±SE) density (fish/500m^2) at NR-5 (North Reef) Bird Islet from 1992 to 2004.



North Reef 1 (NR1: Amos Rock or Malayan Wreck)

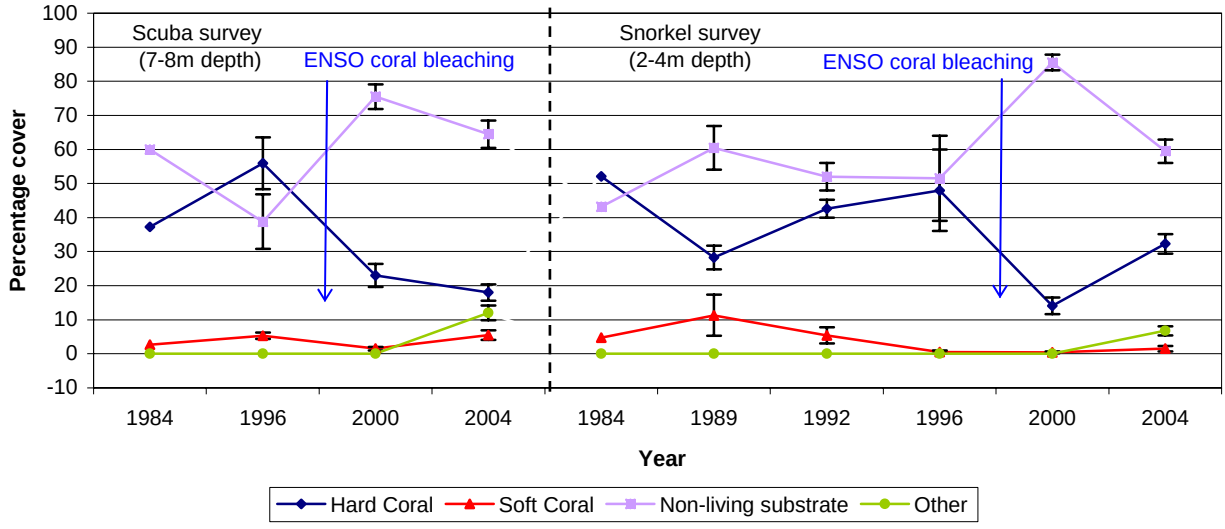
Site overview

Amos Rock is also known as the Southwest Rock, a distinct rock formation on the reef slope along the southwest tip of the north atoll (Figure 3). This site is popular to divers due to its rich coral cover in the past years as well as the Malayan wreck lodged on its slope. Sea turtles and manta rays have been consistently observed in NR1 during the previous years, however, mantas were not sighted in 1996 and 2004.

Results

Substrate. Live hard coral in North Reef 1 ranged from poor to fair in the year 2004. Coral cover was higher in the shallow (32 ± 3 % at 3-4 m) compared to the deeper area (18 ± 2% at 7-10 m; Fig.12, Table 6). Branching corals dominated over the rest of the coral growth forms present. NR1 was also characterized by high percentages of rock and block (shallow: 45 ± 3.7%, deep: 27.7 ± 3.5%) and coral rubble (deep: 19.3 ± 3.6%). This high occurrence of rock and block may be attributed to the 1998 coral bleaching, (included the non-living substrate category) badly affected the area (White et al. 2000). Live hard coral cover significantly declined by 33% ($p \leq 0.0001$, ANOVA) from 1996 to the year 2000 (Appendix 4A). In addition, no significant difference was detected between 2000 and 2004 (Bonferonni *post hoc*: 1996>2000=2004).

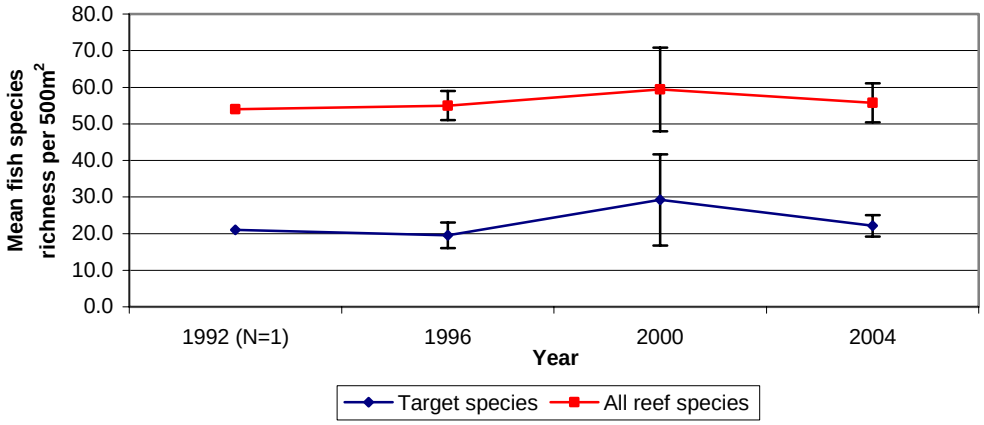
Figure 12. Changes in Substrate composition (%mean ±SE) in NR-1 (North Reef) Malayan Wreck from 1984 to 2004.



Comparison of the total live coral and branching coral covers between sites including the control sites (Bastera in 1996 and 2000 and Jessie Beazley in 2004) over time showed that NR1 had a significantly lower cover ($p \leq 0.001$, ANOVA).This suggests that coral recovery may take a longer time in this area compared to others. Further, gradual bleaching episodes may result in the continued decline of coral cover. Regular monitoring combined with strict protection, these can contribute to management and recovery of NR1 coral reef.

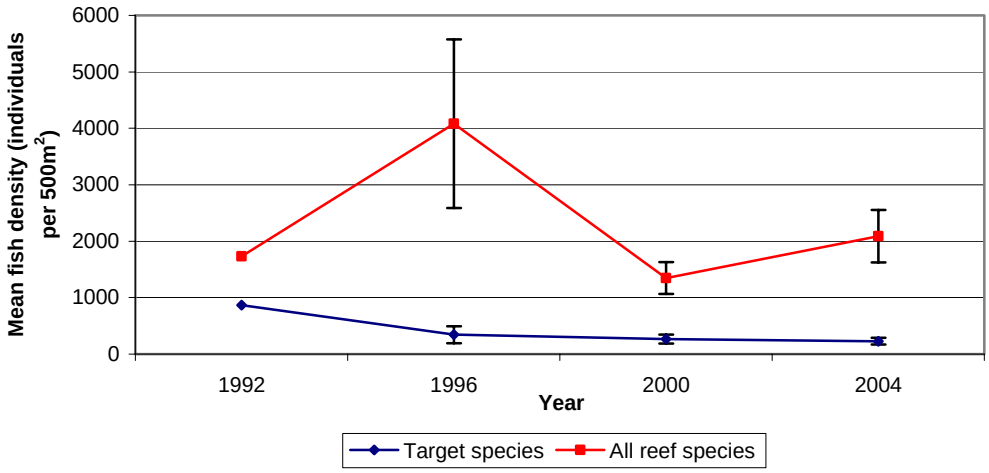
Fish diversity and abundance. A total of 202 fish species were listed in NR1 including a species of shark, *Triaenodon obesus* (Appendix 3), along with 27 butterflyfish species (Table 2). Mean richness for all reef species was 55.8 ± 5.3 fish/500m^2 and 22.1 ± 2.9 for target fish (Fig. 13, Table 7). Changes in species richness overtime are shown in Table 10.

Figure 13. Mean (±SE) number of species/500m^2 in NR-1 (North Reef) Malayan Wreck from 1992 to 2004



Pomacentrids (834.5 ± 260 fish/per 500m^2) and Anthids (402.6 ± 131 fish/500m^2) numerically dominated the fish fauna of NR1. The red tooth triggerfish, *Odonus niger* (563.2 ± 213.7 fish/500m^2), was also fairly abundant. Dominant target fish were Acanthurids and Caesionids wherein majority of these populations belong to the 11-20 cm size range, and up to 21-30 cm for the Caesionids. A couple of Humphead wrasses were also recorded. No significant changes were observed between densities of families over time within NR1 (T-test, Appendix 4B). However, target fish density in NR1 (228.5 ± 58.1 fish/500m^2) was significantly higher in 2004 compared to Jessie Beazley (185.4 ± 74.2 fish/500m^2; p = 0.0028, ANOVA; Table 9). In addition, it is important to note sightings of fish species not commonly seen in other sites in Tubbataha as well as the rest of the country like a school of *Bolbometopon muricatum* (Bumphead parrotfish), 40-50 cm in size was seen in NR1. Changes in fish density per family are shown in Table 9.

Figure 14. Mean (±SE) density (fish/500m^2) in NR-1 (North Reef) Malayan Wreck from 1992 to 2004.



North Reef 2 (NR2: Ranger Station)

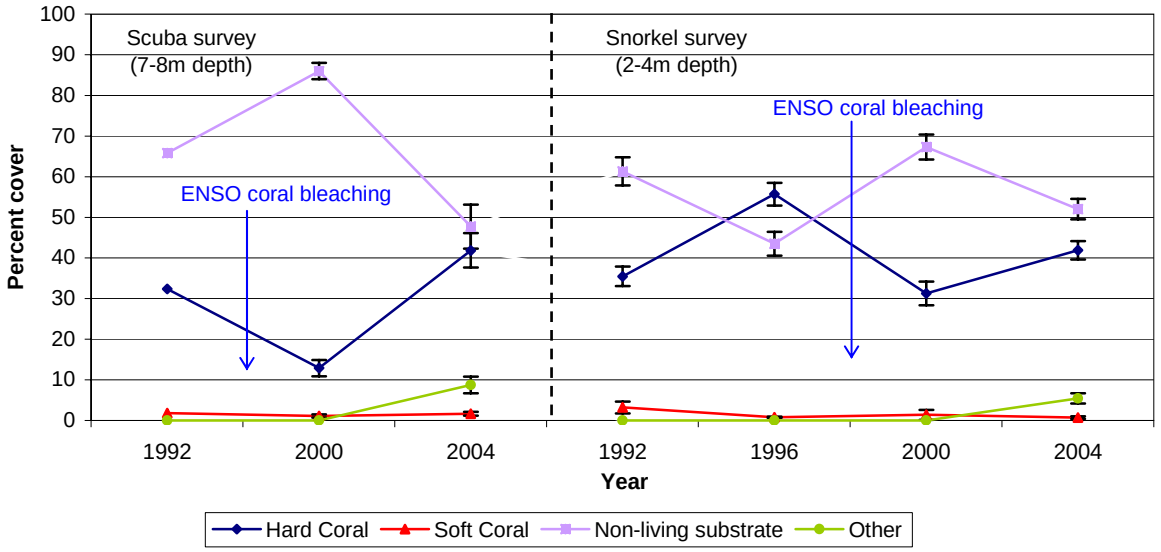
Site overview

North Reef 2 is located on the southeast sand cay on the north atoll (Figure 3). This site is a nesting ground for Green turtle and terns (Arquiza and White 1999).

Results

Substrate. Live hard coral in North Reef 2 was fair (shallow: 41.9 ± 5%, deep 41.9 ± 2%) in the year 2004 (Figure 15, Table 10). Branching corals comprised 26.9 ± 3.3% (shallow) to 30.4 ± 2% (deep) of which dominated over the rest of the coral growth forms. Coral cover in NR 2 appeared to exhibit a declining trend from 32.4% in 1992 to 12.9% in the year 2000. This value was by far the lowest cover recorded in all sites in 2000 (White et al. 2000), however, statistical tests are not possible due no low replication in these years. Low coral cover in 2000 accompanied with increased percentages of coral rubble and rock and block, again, indicate coral death in 1998 due to bleaching. In contrast, hard coral cover significantly increased by 29% in the deep and 10.6% in the shallow, from 2000 to 2004 ($p = \leq 0.0001$, T-test) along with a significant increase in branching corals and significant decreases in rubble ($p \leq 0.0001$, T-test), dead coral ($p \leq 0.0001$, T-test) and the rest of the non-living substrate ($p \leq 0.0001$, T-test; Appendix 4A). This suggests active coral growth and recovery in this site.

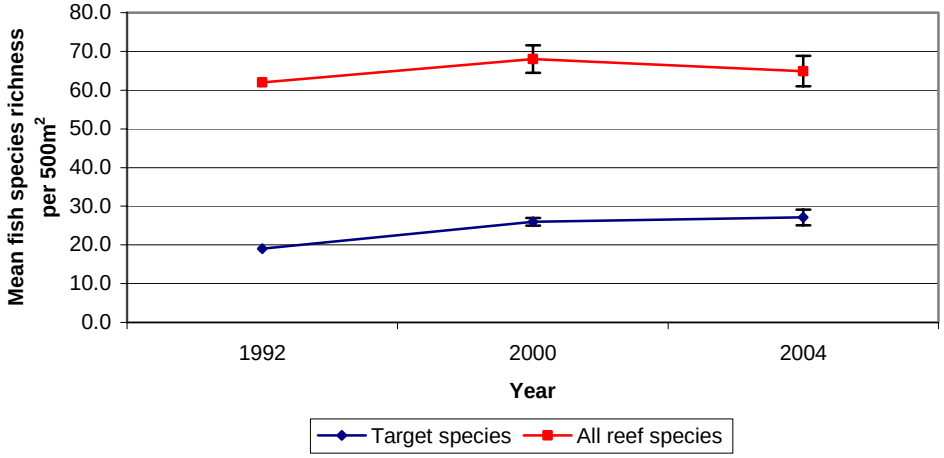
Figure 15. Changes in substrate composition (% mean ±SE) in NR-2 (North Reef) Ranger Station from 1992 to 2004.



Comparison between NR2 and the control sites (Bastera in 1996 and 2000, and Jessie Beazley in 2004 revealed that Bastera hard coral cover was significantly higher in the years 1996 and 2000 ($p \leq 0.0001$, 2-ANOVA), but no significant difference was detected between NR2 and Jessie Beazley in 2004 (Bonferroni post hoc).

Fish diversity and abundance. A total of185 fish species were listed in NR2 including a white tip shark and a black tip shark. (Appendix 3). Twenty six butterflyfish species were recorded (Table 2). Mean richness for all reef species was 64.9 ± 3.9 (Fig. 16) while diversity index for NR2 reef was 0.16. Changes in species richness between years are shown in Table 12.

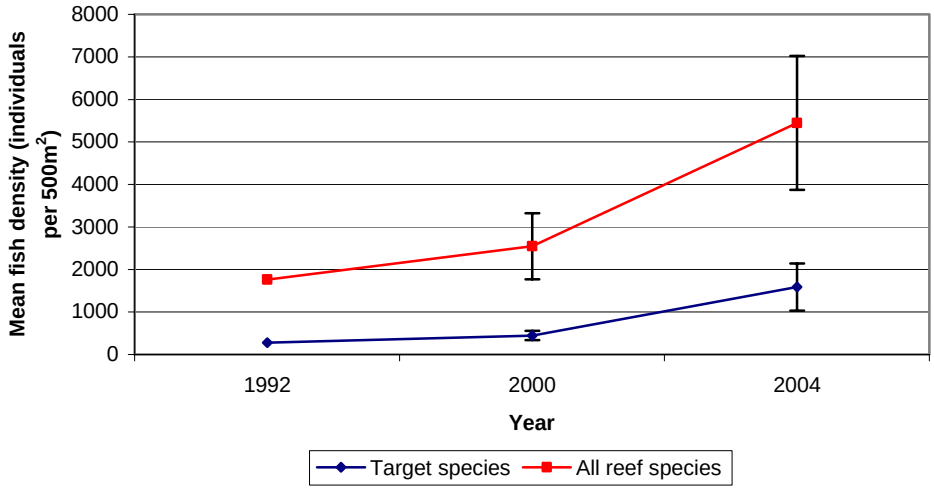
Figure 16. Mean (±SE) number of species/500m2 in NR-2 (North Reef) Ranger Station from 1992 to 2004



Target species mean density was 1587± 552.5 fish/500m^2 while 5446.6 ± 1573.7 fish/500m^2 for all species, by far one of the highest recorded along with SR1 and SR3 (Table 11). Target species density was significantly higher compared to the rest of the sites, including the control site ($p \leq 0.0001$, 1-ANOVA; Appendix 4B) in the year 2004. Caesionids (1396.5 ± 560.5) and Acanthurids (128.5 ± 29) numerically dominated NR2. Planktivorous species such as *Pterocaesio randalli* and *Acanthurus thompsoni* comprised most of the latter two families. The densities of large predatory fish such as Serranids (Epinephelinae), Carangids, Lutjanids and Lethrinids were also fairly high (Table 12).

Significant changes in density per family over time were only observed within Epinephelinae and Pomacanthidae (Table 13). Grouper density decreased significantly ($p = 0.014$, T-test) from 16.8 ± 2.2 fish/500m^2 in the year 2000 to 7.8 ± 2.7 fish/500m^2 in the year 2004. Similarly, angelfish density significantly decreased ($p = 0.013$, T-test) from 28.2 ± 5.8 fish/500m^2 to 7 ± 2.5 fish/500m^2.

Figure 17. Mean (±SE) density (fish/500m^2) in NR-2 (North Reef) Ranger Station from 1992 to 2004.



South Reef 3 (SR3: Black Rock)

Site overview

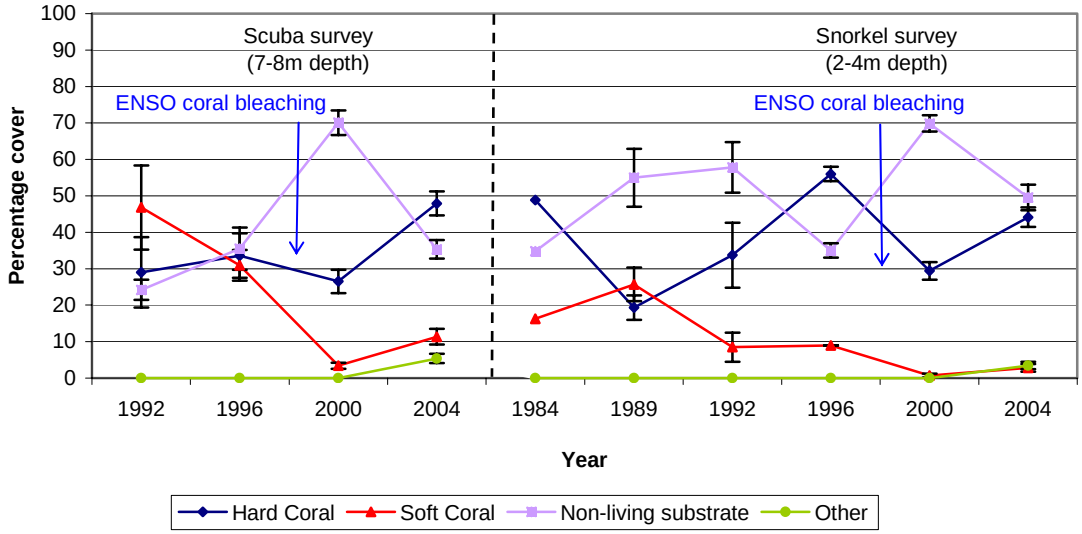
Black rock is located on the northeast corner of the south atoll (Figure 6). This site was severely damaged by anchoring and fishing in the late 80's until the early 90's. However, it has recovered over the years and has become a popular dive site because of the frequent sightings of large marine life in the area (Arquiza and White 1999).

Results

Substrate. Live hard coral in South Reef 3 was fair (shallow: 44.2 ± 2.7%, deep 47.9 ± 3.3%) in the year 2004 (Fig. 18, Table14). Branching corals which dominated over the rest of the coral growth forms in this site had a high cover. This comprised 27.5 ± 2.9% (shallow) to 39.1 ± 3.8% (deep) of the substrate comparable to SR1 and NR2. Among the non-living substrate, coral rubble had the highest cover (9.6 ± 1.64 , shallow and 16.7 ± 2.2, deep).

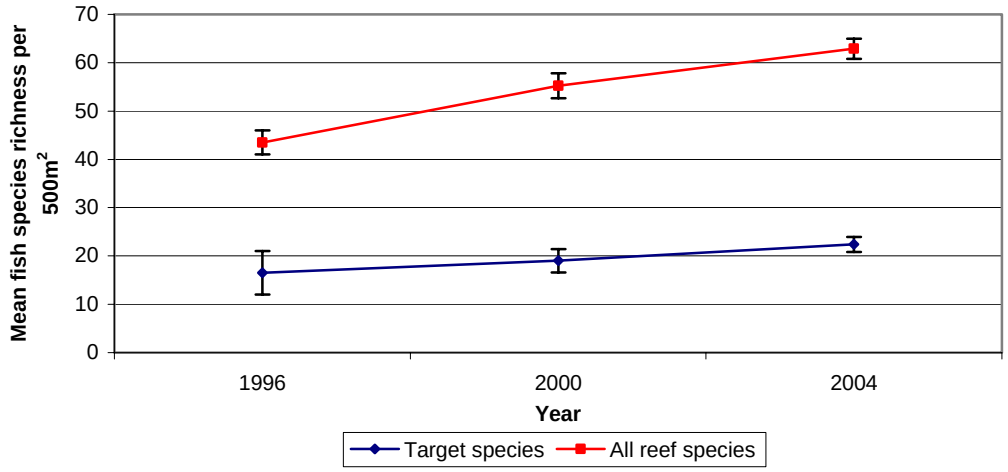
Like most of the sites surveyed, SR3 was also affected by the 1998 coral bleaching episode. However, unlike other sites, SR3 had a fairly high cover of soft coral in the previous years which severely bleached and 89% died from 1996 to 2000. Hard coral cover also decreased from 33.6 ± 6.1% in 1996 to 26.5 ± 3.2% in 2000 but was not significant. By 2004, a phase shift has occurred: live hard coral significantly increased ($p \leq 0.001$, ANOVA) by 81% replacing most of the soft coral and rubble which had decreased (Fig. 18).

Figure 18. Changes in substrate composition (% mean ±SE) in SR-3 (South Reef) Black Rock from 1984 to 2004.



Fish diversity and abundance. A total of 205 fish species were listed in SR3 including two species of sharks and rays (Appendix 3). Thirty one butterflyfish species were recorded (Table 2). Mean richness for all reef species was 43.5 ± 2.5 fish/500m^2 and 16.5 ± 4.5 fish/500m^2 for target fish (Fig. 32 and 33, Table 17). Changes in species richness between years are shown in Table 16.

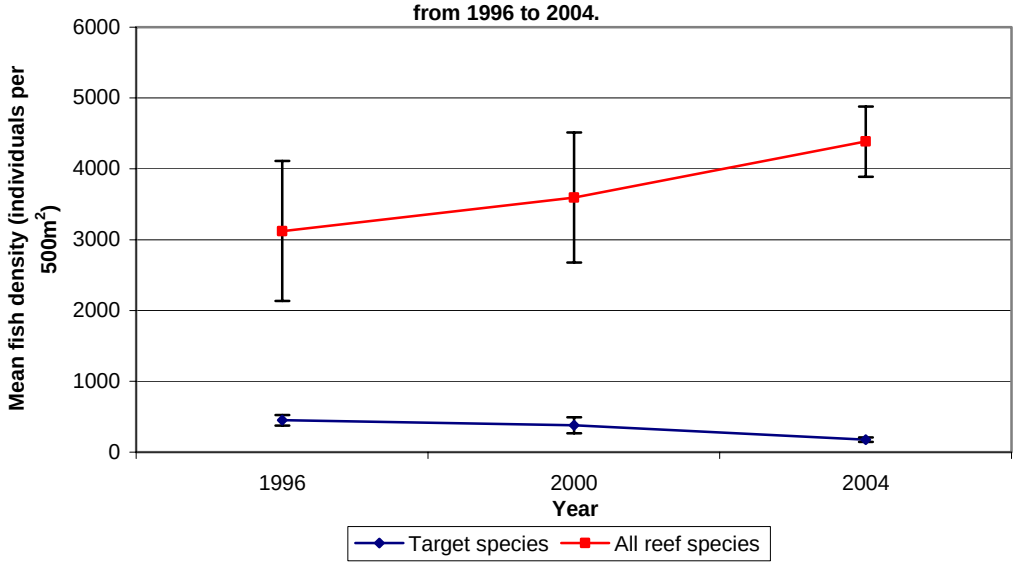
Figure 19. Mean (±SE) number of species/500m^2 in SR-3 (South Reef) Black Rock from 1996 to 2004.



Like NR2 and SR1, total mean density of reef fish is high (4384.5 ± 496.2 fish/500m^2) although diversity was lower compared to the rest of the sites. Pomacentrids (2309.9 ± 422.9 fish/500m^2) and Anthids (1733.5 ± 383.6 fish/500m^2) dominate SR3 numerically like most sites. Target fish density was 175.5 ± 31.2 fish/500m^2 dominated by Acanthurids (97.6 ± 37.9 fish/500m^2). Piscivore densities like Groupers, Emperors, Snappers and Jacks were also fairly high (Table 15). Grouper density was particularly high in this site compared to the rest (15.6 ± 3.9 fish/500m^2). Most of the species recorded were *Cephalopholis urodeta, C. argus* and *Aethaloperca rogaa.* The latter species is not commonly seen in other Philippine reefs.

Comparison of fish densities within families and site between years (Table 17) showed no significant differences. Similarly, comparison between SR3 target fish densities and the rest of the sites including the control site (Jessie Beazley, JB) in 2004 yielded the following relationship: NR2=NR5>SR4 >JB=SR1=SR3=NR1 (Bonferroni *post hoc*). Thus, no significant difference was seen between SR3 and the control site (Appendix 4B).

Figure 20. Mean (±SE) density (fish/500m^2) in SR-3 (South Reef) Black Rock from 1996 to 2004.



South Reef 4 (SR4: Northwest corner of the south atoll)

Site overview

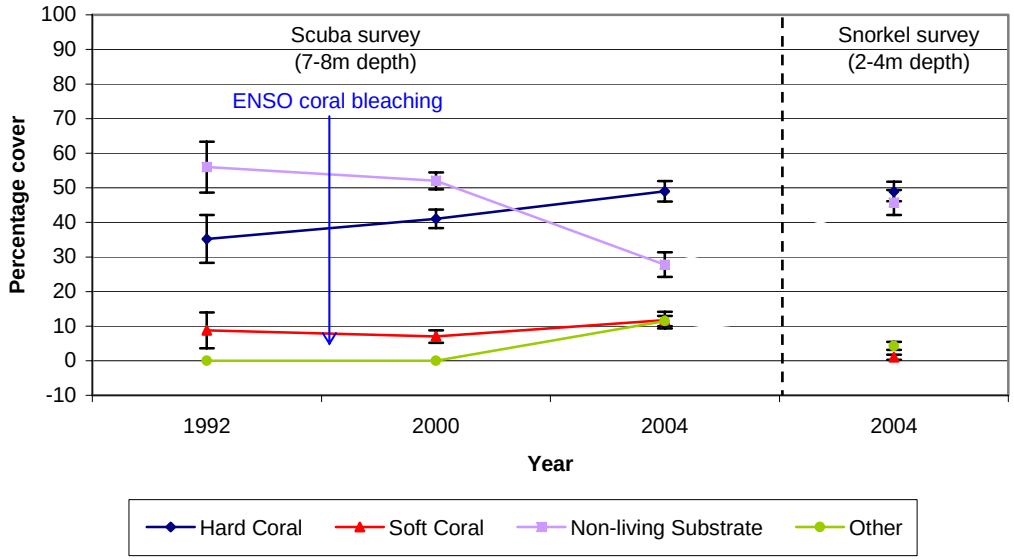
South Reef 4 has very clear waters and is exposed to strong currents, thus, not frequented by divers (Figure 6). A shallow reef flat and steep drop-off characterizes its topography. Hard coral cover and fish density recorded in the year 2000 were highest in this site compared to the rest.

Results

Substrate. Live hard coral in South Reef 4 was fair (shallow: 48.9 ± 2.8%, deep 49 ± 2.9%,) in the year 2004 (Figure 21, Table 18). Branching, encrusting and massive had similar covers in the shallow while branching corals comprised most of the coral cover in the deep area (27.2 ± 2.4%). Rock and block cover, included in the non-living substrate category, was fairly high in the shallow (36 ± 3.58%).

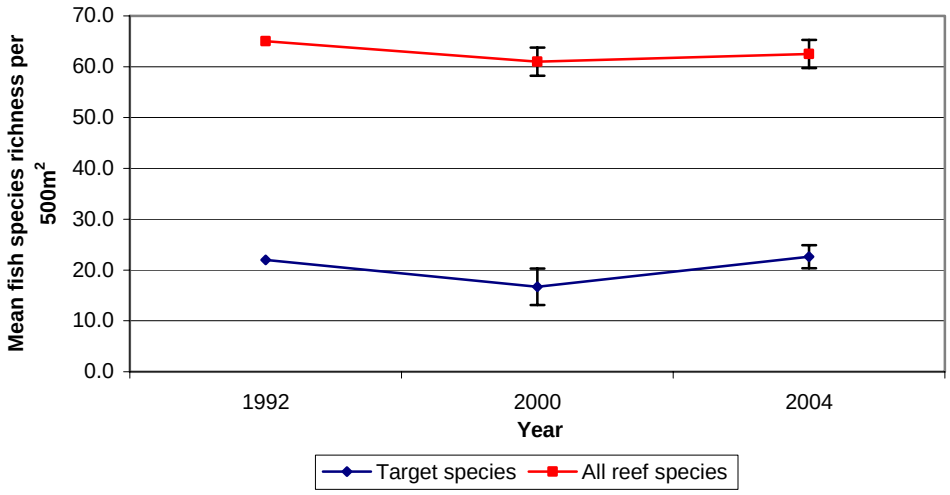
South Reef 4 reef appeared un-impacted by bleaching during the 2000 survey, however White et al. (2000) documented a 13% dead coral colonized by with algae which they attributed to coral bleaching. When tested, dead coral cover in the year 2000 was significantly higher compared to 1992 and 2004, indicating coral recovery. However, no significant differences were seen between live coral cover between years. Comparison in coral cover between SR4 and the control site (Jessie Beazley) between years revealed that the former is significantly higher ($p \leq 0.001$) than the 2000 coral cover, for both within site and control, but no significant difference was observed between SR4 and Jessie Beazley in 2004 (Table 4B).

Figure 21. Changes in substrate composition (% mean ±SE) in SR-4 (South Reef) North West Corner from 1992 to 2004.



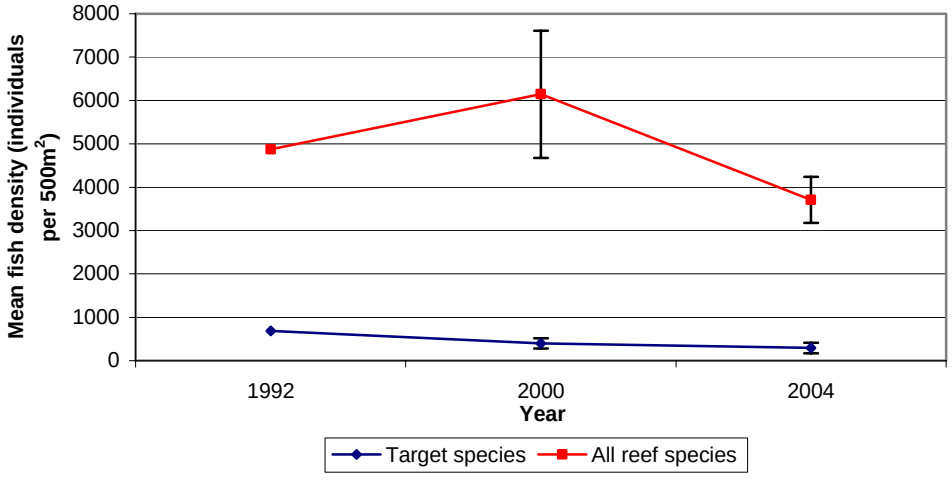
Fish diversity and abundance. A total of 190 fish species were listed in SR4 including three species of sharks (Appendix 3) and 30 butterflyfish species (Table 2). Mean richness for all reef species was 62.9 ± 2.8 fish/500m^2 and 22.6 ± 2.3 fish/500m^2 for target fish (Fig. 22, Table 20).

Figure 22. Mean (±SE) number of species/500m2 in SR-4 (South Reef) North West Corner from 1992 to 2004



Mean density of all reef species was 1508 ± fish/500m^2 which is lower compared to other sites. However, target fish mean density (292.6 ± 123.4) was interestingly high considering the low density of all reef species (Table 19, Fig. 23). Numerically dominant families were Anthiinae (1010.4 ± 205 fish/500m^2) and Balistidae (491.5 ± 255.8 fish/500m^2), the latter comprised mainly by the red tooth triggerfish, *Odonus niger.* Further, the target fish density was dominated by Acanthurids (106.3 ± 33.7 fish/500m^2), Scarids (24.9 ± 15.1 fish/500m^2) and Lutjanids (28.6 ± 16.5 fish/500m^2). Majority of the latter family was comprised of *Lutjanus bohar, L. monostigma* and *Aprion virescens,* all belonging to larger size classes (30 – 70 cm; Table 19). Fish densities per family did not change significantly from 2000 to 2004, except for Pomacentridae, whose density significantly declined (p 0.01, T-test) from 2508.6 ± 526 fish/500m^2 to 1010.4 ± 205 fish/500m^2. SR4 target fish density was significantly higher compared to the control site.

Figure 23. Mean (±SE) density (fish/500m^2) in SR-4 (South Reef) North West Corner from 1992 to 2004.



South Reef 1 (SR1: Lighthouse Islet)

Site overview

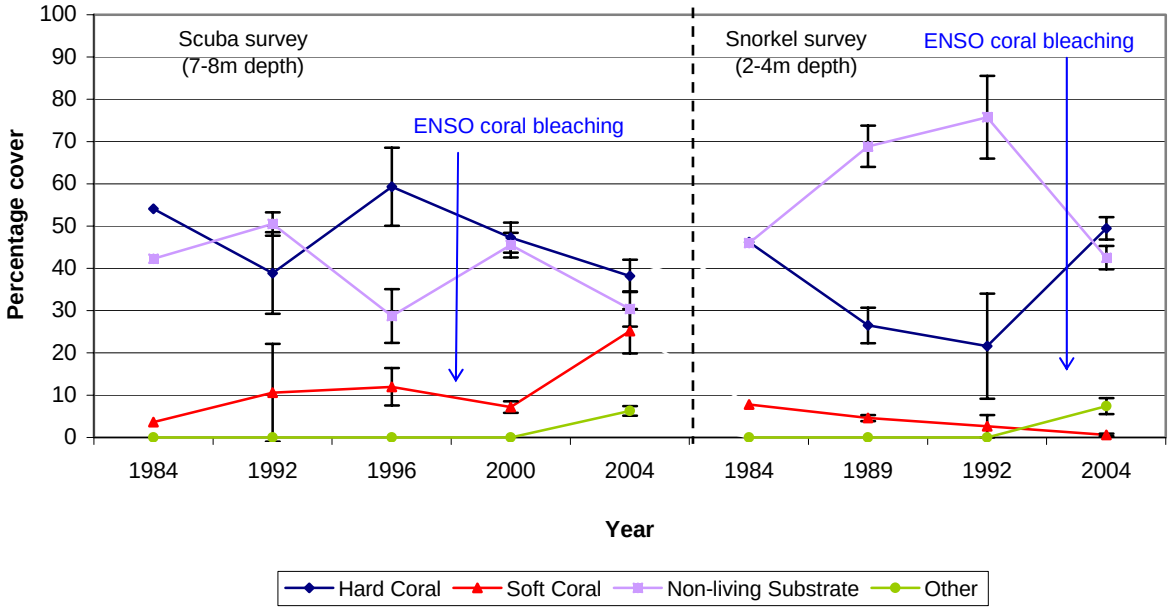
South Reef 1 is a frequented dive site due to the presence of the Lighthouse landmark (Figure 5).This site is known for its high cover of branching *Acropora* coral (White et al. 2000). White-tip sharks, schools of barracuda, tuna, jacks, surgeons, snappers and triggerfish families are commonly seen in this site (Arquiza and White 1999).

Results

Substrate. Live hard coral in South Reef 1 was fair (shallow: 49.5 ± 2.7%, deep 38.2 ± 4%) in the year 2004 (Figure 24, Table 22). Branching corals comprised 38.2 ± 3.8% (deep) to 49.5 ± 2.65% (shallow) of the substrate which dominated over the rest of the coral growth forms. SR1 is one of the few sites whose shallow reef and deep stands of corals (5-10 m) remained unbleached after the 1998 coral bleaching episode. No significant difference was seen in hard coral cover between the years1996, 2000 and 2004 ($p=0.3782$, ANOVA) in the deep area. Further, the coral cover in the shallow area had increased significantly ($p < 0.0001$, T-test) by 27.9% from 1992 to 2004 (Appendix 4B).

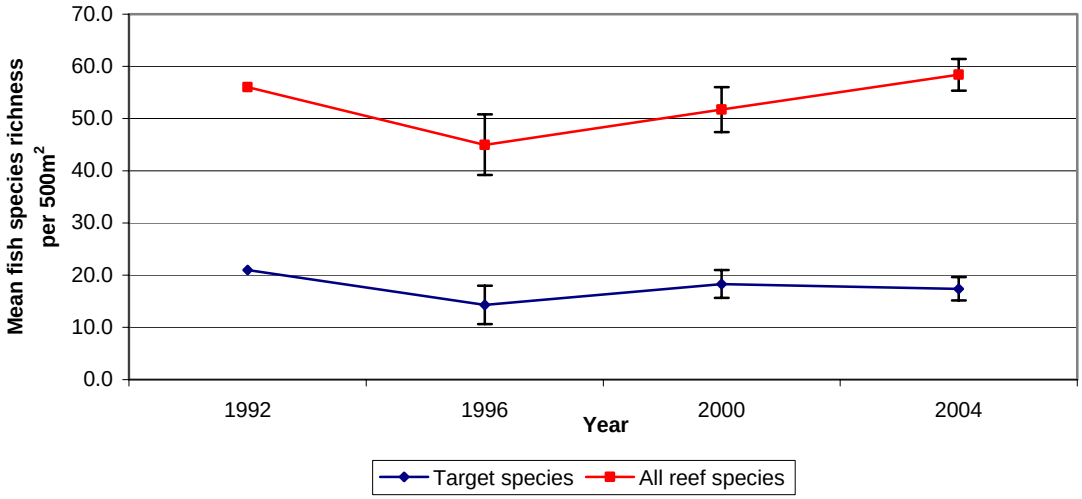
Comparison between SR1 and the control sites over time (Bastera in 1996 and 2000, and Jessie Beazley) showed that the SR1 2004 hard coral cover was significantly lower ($p \leq 0.0001$, ANOVA), compared to what was recorded in 2000. However, in 2004, no significant difference was seen between SR1 and the control site (Bonferroni post hoc).

Figure 24. Changes in substrate composition (% mean ±SE) in SR-1 (South Reef) Lighthouse Islet from 1984 to 2004.



Fish diversity and abundance. A total of 152 fish species were listed in SR1 including three species of sharks (Appendix 3) and 27 butterflyfish species (Table 2). Mean richness for all reef species was 58.4 ± 3 fish/500m^2 and 17.4 ± 2.2 fish/500m^2 (Fig 25, Table 23). Change in species richness between years is shown in Table 24.

Figure 25. Mean (±SE) number of species/500m^2 in SR-1 (South Reef) Lighthouse Islet from 1992 to 2004

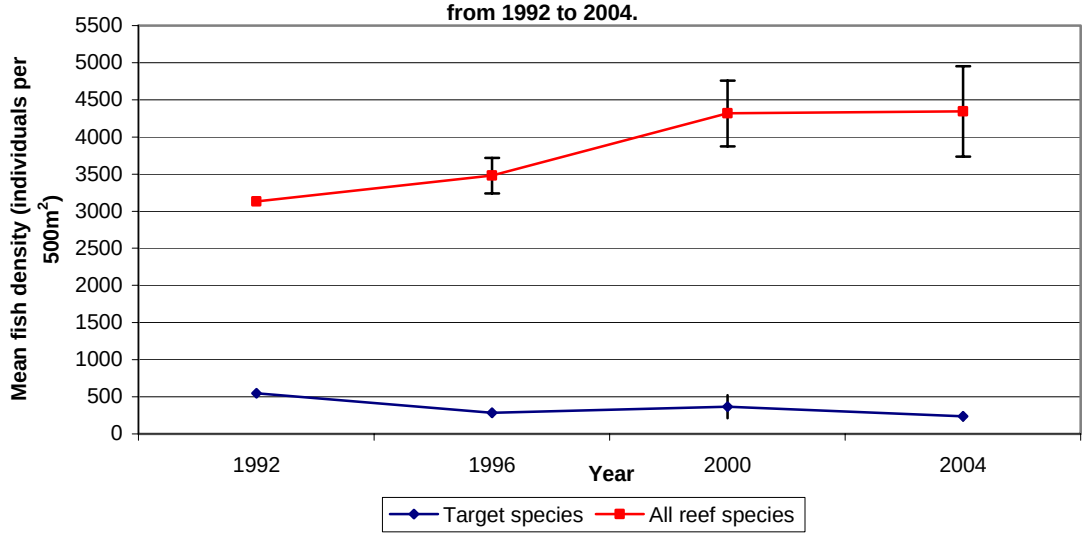


Like most of the sites surveyed, SR1, fish density was dominated by Pomacentrids (2042.5 ± fish/500m^2) and Anthids (1557.3 ± 566.3 fish/500m^2). *Chromis ternatensis* and *Pomacentrus auriventris* comprised most of the recorded damsels. Balistids were also abundant in SR1 (333.3 ± 140 fish/500m^2). Similar to NR1, the red tooth triggerfish, *Odonus niger* and *Melichthys* spp. were also abundant (Table 23).

Mean density of all reef species (4344.5 ± 754.3) and target species (235.5 ± 68.6) was high in SR1 although it had the lowest diversity compared to the rest of the sites (Fig. 26, Table 25). The observed low diversity in SR1 may be attributed to mono stands of coral which are more dominant in this site compared to the rest. Acanthurids, Caesionids and Lethrinids were among the numerically abundant target fish. The mean density of Groupers in this site was also higher among all sites but not significantly different ($p = 0.3170$, ANOVA). In addition, it is important to note that certain fish species not common in other areas and the rest of the country like a school of *Symphoricthys spirulus* (Lutjanidae) comprised of 52 individuals with a size range of 35-40 cm was seen in this area.

Comparison of mean target fish densities between sites in 2004 including the control site, Jessie Beazley, showed that SR1 density was significantly lower compared to NR2, NR5 and SR4 but equal to the control and the rest of the sites. However, when comparing target fish densities within site between years SR1 2004 was significantly higher compared to 1996 ($p = 0.001$, ANOVA), but no significant difference was seen between 2000 and 2004 (Bonferroni post hoc).

Figure 26. Mean (±SE) density (fish/500m^2) in SR-1 (South Reef) Lighthouse Islet from 1992 to 2004.



The Control Sites

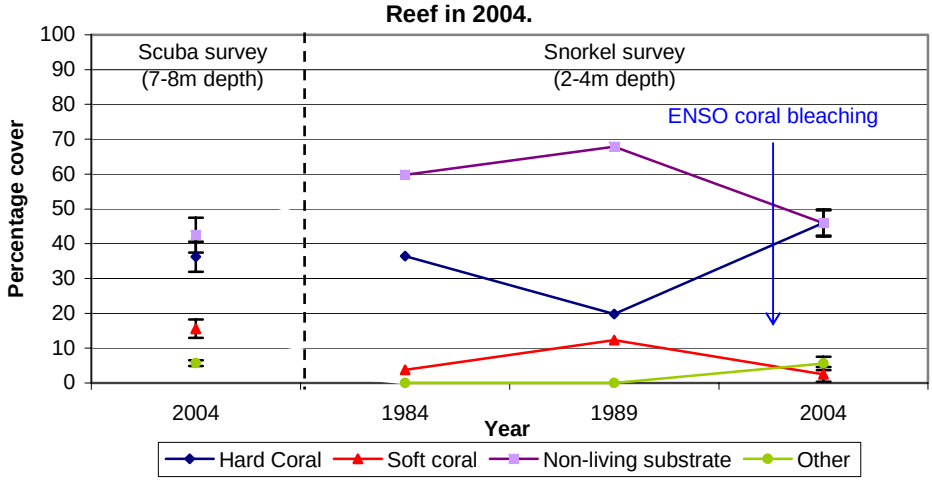
Jessie Beazley Reef

Site overview

Jessie Beazley Reef is located outside the Marine Park and is open for fishing (Figure 7). This site has a narrow sandy cay and shallow reef flat that extends to about 2 km in circumference (NMRC 1983, White 1984, White and Palaganas 1991).

Substrate. Live hard coral cover of Jessie Beazley in 2004 is fair (shallow: 46 ± 3.7%; deep: 36.3 ± 4.3%; Fig. 27, Table 26). Branching corals dominated over the rest of the growth forms, however encrusting corals were also evident in the deeper area. This site was surveyed in 1984 and 1989. Coral cover appeared lower in 2004 compared to previous years but statistical comparisons were not made due to low replication.

Figure 27. Substrate composition (% mean ±SE) in Jessie Beazley Reef in 2004.



Fish diversity and abundance. A total of 130 fish species were listed in Jessie Beazley. No sharks (except for a whale shark) or rays were sighted in the area (Appendix 3). Twenty seven butterflyfish species were recorded (Table 2). Mean richness for all reef species was 13.6 ± 0.8 fish/500m^2 and

target fish was (47.6 ± fish/500m^2 (Table 27). These values are lower compared to (Fig. 32, 33) most sites.

Mean density for all reef species (1751.1 ± 261.8 fish/500m^2) was lower than other sites (i.e., NR2, SR3, SR1). Target fish density was 185.4 ± 64.3 fish/500m^2 (Table 27), which is significantly lower than NR2, NR5, SR4 but higher than SR1, SR3 and NR1 ($p \leq 0.001$, ANOVA, Appendix 4B).

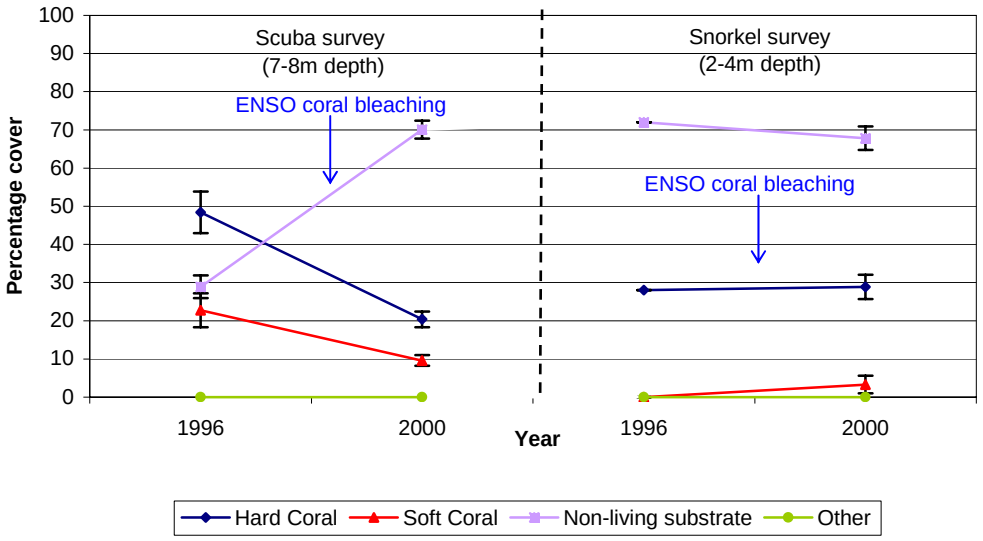
Bastera Reef

Site overview

Bastera Reef has a rich reef topography but is not included within the Tubbataha Park boundaries, thus unprotected (Figure 8). This site was not surveyed in the year 2004 but was assessed in the previous years (White et al, 2000).

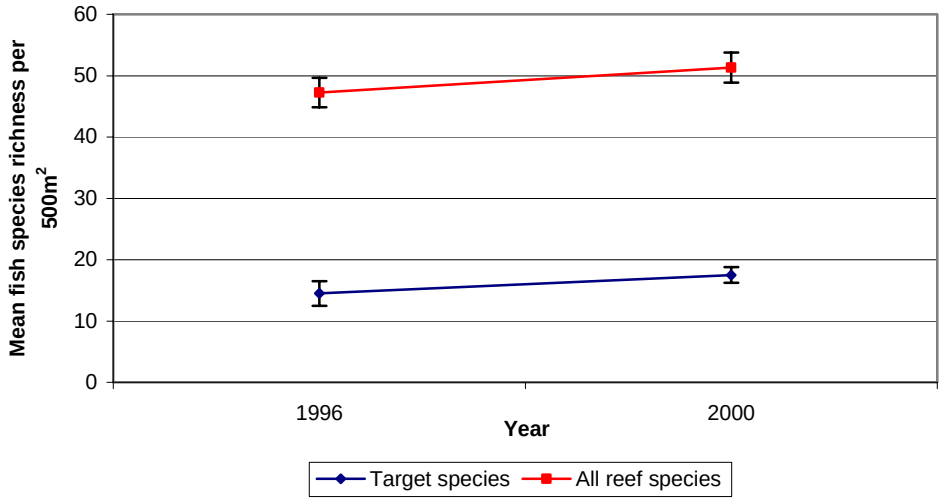
Substrate. Like other sites in Tubbataha, White et al (2000) had documented that Bastera reef was impacted by the 1998 coral bleaching. Live coral was significantly higher ($p \leq 0.001$, T-test) in 1996 (48.4 ± 5.5%) compared to 2000 (20.4 ± 2.1%) in the deeper area (Fig. 28, Table 28).

Figure 28. Changes in substrate composition (% mean ±SE) in Bastera Reef from 1984 to 2000.



Fish diversity and abundance. A total of 121 fish species were listed in Bastera Reef which included 27 butterflyfish species, a species of shark and a ray, in the year 2000 (White et al., 2000). Changes in species richness between years are shown in Table 29. Index of diversity cannot be computed due to the absence of specific data sets in the previous years.

Figure 29. Mean (±SE) number of species/500m^2 in Bastera from 1996 to 2000.



Mean density for all reef species (Fig. 30, Table 30) was significantly higher in the year 2000 (4408.3 ± 655.8 fish/500 m^2) compared to 1996 (2508.8 ± 492.4 fish/500 m^2; Fig 29). In contrast, no significant difference was observed in target fish densities between years (Fig 30, Appendix 4B).

Figure 30. Mean (±SE) density (fish/500m^2) in Bastera from 1996 to 2000.

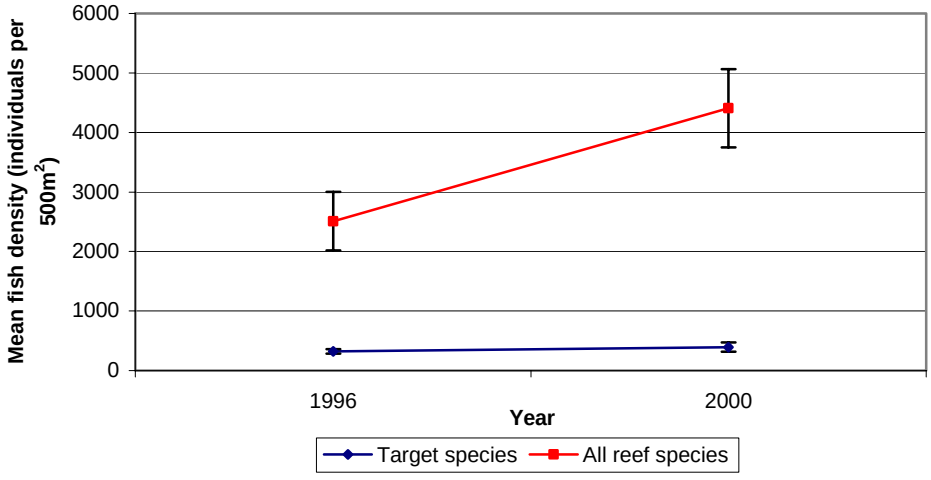


Table 1. Changes in substrate composition (%mean ±SE) in NR-5 (North Reef) Bird Islet from 1984 to 2004.

	SCUBA SURVEYS:									SNORKEL SURVEYS:									
	1984	1992	% Change 1984-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	1984	1989	% Change 1984-1989	1992	% Change 1989-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004
SUBSTRATE COVER	% cover	% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover		% cover	
Sand (s) and Silt (SI)	17.6	0.0	-100.0	18.2	+	17.1	-6.0	4.3	-74.7	8.0	6.3	-21.9	13.0	108.0	0.0	-100.0	5.5	+	13.4	144.1
Coral Rubble (R)	16.4	17.3	5.5	14.3	-17.3	22.6	58.0	10.7	-52.6	4.2	21.4	408.3	27.4	28.3	2.5	-90.9	9.2	268.0	18.1	96.7
Rock and Block (RK)	16.8	1.6	-90.5	12.7	693.8	27.0	112.6	17.3	-36.0	9.5	17.4	83.2	3.4	-80.5	57.0	1576.5	49.8	-12.6	23.2	-53.5
White Dead Standing Coral (DC)	6.0	11.4	90.0	2.2	-80.7	1.2	-45.5	0.2	-80.4	3.3	16.5	400.0	3.0	-81.8	10.5	250.0	0.2	-98.1	0.2	16.5
Dead Coral with Algae (DCA)	0.0	0.0	N/A	0.0	N/A	8.0	+	5.4	-33.1	0.0	0.0	N/A	0.0	N/A	0.0	N/A	9.0	+	4.4	-51.1
Subtotal Non-living Substrate	***56.8***	***30.3***	***-46.7***	***47.4***	***56.4***	***75.9***	***60.1***	***37.9***	***-50.1***	***25.0***	***61.5***	***146.0***	***46.8***	***-23.9***	***70.0***	***49.6***	***73.7***	***5.3***	***59.3***	***-19.5***
Branching (CB)	18.0	14.2	-21.1	25.1	76.8	9.7	-61.4	17.1	76.6	45.0	25.3	-43.9	25.0	-1.0	17.5	-30.0	0.0	-100.0	22.6	+
Massive (CM)	1.2	9.0	650.0	7.3	-18.9	3.8	-47.9	7.3	91.2	15.3	1.0	-93.5	8.0	700.0	5.0	-37.5	0.0	-100.0	11.0	+
Flat/Encrusting (CFD)	7.3	11.3	54.8	4.1	-63.7	4.0	-2.4	10.5	161.3	4.7	0.1	-97.9	4.2	4100.0	5.0	19.0	0.0	-100.0	2.2	+
Foliose Cup (CFO)	0.9	0.4	-55.6	2.2	450.0	1.0	-54.5	0.9	-11.8	1.0	0.4	-65.0	1.3	271.4	0.0	-100.0	0.0	N/A	0.3	+
Total Hard Coral	27.4	34.9	27.4	38.7	10.9	18.5	-52.2	35.7	93.1	66.0	26.7	-59.5	38.5	44.2	27.5	-28.6	23.8	-13.5	36.1	51.8
Total Soft Coral	15.8	34.8	120.3	13.9	-60.1	5.6	-59.7	10.1	80.8	9.0	11.8	31.1	14.7	24.6	2.5	-83.0	2.5	0.0	2.7	8.7
Subtotal Coral	***43.2***	***69.7***	***61.3***	***52.6***	***-24.5***	***24.1***	***-54.2***	***45.8***	***90.2***	***75.0***	***38.5***	***-48.7***	***53.2***	***38.2***	***30.0***	***-43.6***	***26.3***	***-12.3***	***38.8***	***47.7***
Sponges	~	~	N/A	~	N/A	~	N/A	5.9	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.3	N/A
Other animals	~	~	N/A	~	N/A	~	N/A	2.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.1	N/A
Algae																				
Turf algae	~	~	N/A	~	N/A	~	N/A	0.6	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.3	N/A
Fleshy algae	~	~	N/A	~	N/A	~	N/A	0.9	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.1	N/A
Coralline algae	~	~	N/A	~	N/A	~	N/A	6.7	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	1.1	N/A
Seagrass	~	~	N/A	~	N/A	~	N/A	0.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A
Subtotal Others	***0***	***0***	N/A	***0***	N/A	***0***	N/A	***16.2***	+	***0***	***0***	N/A	***0***	N/A	***0***	N/A	***0***	N/A	***1.9***	+
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters																				
Mean Slope (degrees)	~	~		~		14.7		57.5		~	~		~		~		3.5		1.9	
Mean Topography (m) *	1.8	2		2.2		1.9		1.9		2.1	1.4-2.8		.5-2		~		1.1		2.5	
Mean Depth/Range (m)	1-15	2-10		5-8		5.8		7.2		2-6	3.6		2-7		2-2.7		2.5		3.2	
Horizontal Visibility (m)	~	30		20		26		21.3		~	~		20-40		25		34.1		21.3	
No. of 50 m Transects	1	3		6		22		17		1	2		8		2		10		14	

~ no data available

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

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

(-) = decrease

(+) = increase

Table 2. Species list of butterflyfish in Tubbataha, Jessie Beasley and Bastera Reefs, Palawan from 1984 to 2004.

Butterfly species	Common name	SR-1				SR-3				SR-4		NR-1				NR-2			
		1992	1996	2000	2004	1992	1996	2000	2004	2000	2004	1992	1996	2000	2004	1992	1996	2000	2004
Chaetodon adiergastos	Philippine butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O		X	Z
Chaetodon auriga	Threadfin butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon baronessa	Eastern triangular butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon bennetti	Bluelashed butterflyfish		Y	X			Y	X	Z	X	Z		Y		Z	O	Y	X	Z
Chaetodon citrinellus	Speckled butterflyfish	O	Y	X	Z	O	Y		Z	X	Z	O	Y	X	Z	O	Y	X	
Chaetodon ephippium	Saddle butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon kleinii	Klein's butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon lineolatus	Lined butterflyfish		Y	X	Z	O	Y	X	Z	X	Z			X	Z	O	Y	X	Z
Chaetodon lunula	Raccoon butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon lunulatus	Pacific redfin butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon melannotus	Blackback butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon mertensii	Merten's butterflyfish																		
Chaetodon meyeri	Meyer's butterflyfish	O											Y	X					Z
Chaetodon ocellicaudus	Spottail butterflyfish		Y	X	Z		Y	X	Z	X	Z		Y	X	Z		Y	X	Z
Chaetodon octofasciatus	Eightband butterflyfish			X					Z										
Chaetodon ornatissimus	Ornate butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon oxycephalus	Spot-nape butterflyfish		Y	X	Z				Z	X	Z		Y	X	Z			X	
Chaetodon plebeius	Blueblotch butterflyfish																		
Chaetodon punctatofasciatus	Spotband butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon rafflesi	Latticed butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon reticulatus	Mailed butterflyfish													X					
Chaetodon selene	Yellowdotted butterflyfish								Z									X	
Chaetodon semeion	Dotted butterflyfish		Y				Y		Z		Z	O						X	Z
Chaetodon speculum	Mirror butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon trifascialis	Chevron butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z		Y	X	Z
Chaetodon ulietensis	Pacific doublesaddle butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon unimaculatus	Teardrop butterflyfish		Y	X	Z		Y	X	Z	X	Z		Y	X	Z	O			
Chaetodon vagabundus	Vagabond butterflyfish	O	Y	X	Z	O	Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Chaetodon xanthurus	Pearscale butterflyfish																	X	
Chelmon rostratus	Beaked coralfish																	X	
Forcipiger flavisimmus	Forcepsfish		Y	X	Z		Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Forcipiger longirostris	Longnose butterflyfish		Y	X	Z		Y	X	Z	X	Z	O		X	Z		Y	X	Z
Hemitaurichthys polylepis	Pyramid butterflyfish	O	Y	X	Z		Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Heniochus acuminatus	Pennant coralfish	O	Y	X	Z	O	Y	X	Z	X	Z			X			Y	X	
Heniochus chrysostomus	Threeband pennantfish	O	Y	X	Z		Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Heniochus diphreutes	Schooling bannerfish										Z								
Heniochus monoceros	Masked bannerfish													X					
Heniochus singularius	Singular bannerfish	O	Y	X	Z	O	Y	X	Z	X	Z	O		X	Z	O	Y	X	Z
Heniochus varius	Horned bannerfish		Y	X	Z		Y	X	Z	X	Z	O	Y	X	Z	O	Y	X	Z
Parachaetodon ocellatus	Sixspine butterflyfish																		
Coradion chrysozonus	Goldengirdled coralfish													X					
Coradion melanopus	Twospot coralfish																		
Total number of species/site		**21**	**29**	**29**	**27**	**19**	**28**	**26**	**31**	**28**	**30**	**23**	**25**	**31**	**27**	**23**	**25**	**31**	**26**

Total number of species observed in all sites surveyed in 1992: **29**
Total number of species observed in all sites surveyed in 1996: **30**
Total number of species observed in Tubbataha and Bastera in 2000: **38**
Total number of species observed in Tubbataha and Jessie Beazley in 2004: **32**

SR - South Reef
NR- North Reef
SL - South Lagoon

Table 2. Species list of butterflyfish in Tubbataha, Jessie Beasley and Bastera Reefs, Palawan from 1984 to 2004.

Butterfly species	Common name	NR-5				SL-2			Jessie Beazley	Bastera	
		1992	1996	2000	2004	1992	1996	2000	2004	1996	2000
Chaetodon adiergastos	Philippine butterflyfish	O	Y	X	Z	O			Z	Y	X
Chaetodon auriga	Threadfin butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon baronessa	Eastern triangular butterflyfish	O	Y	X	Z	O		X	Z	Y	X
Chaetodon bennetti	Bluelashed butterflyfish	O	Y	X	Z				Z	Y	X
Chaetodon citrinellus	Speckled butterflyfish	O	Y	X	Z		Y		Z	Y	X
Chaetodon ephippium	Saddle butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon kleinii	Klein's butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon lineolatus	Lined butterflyfish	O	Y	X	Z					Y	X
Chaetodon lunula	Raccoon butterflyfish	O	Y	X	Z	O			Z	Y	X
Chaetodon lunulatus	Pacific redfin butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon melannotus	Blackback butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon mertensii	Merten's butterflyfish			X							
Chaetodon meyeri	Meyer's butterflyfish								Z		
Chaetodon ocellicaudus	Spottail butterflyfish		Y	X	Z		Y	X	Z	Y	X
Chaetodon octofasciatus	Eightband butterflyfish				Z				Z		
Chaetodon ornatissimus	Ornate butterflyfish	O	Y	X	Z				Z	Y	X
Chaetodon oxycephalus	Spot-nape butterflyfish		Y	X	Z		Y	X		Y	X
Chaetodon plebeius	Blueblotch butterflyfish	O									
Chaetodon punctatofasciatus	Spotband butterflyfish	O	Y	X	Z				Z	Y	X
Chaetodon rafflesi	Latticed butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon reticulatus	Mailed butterflyfish										
Chaetodon selene	Yellowdotted butterflyfish										
Chaetodon semeion	Dotted butterflyfish	O	Y		Z					Y	
Chaetodon speculum	Mirror butterflyfish	O	Y	X	Z				Z	Y	X
Chaetodon trifascialis	Chevron butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon ulietensis	Pacific doublesaddle butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon unimaculatus	Teardrop butterflyfish		Y	X			Y			Y	X
Chaetodon vagabundus	Vagabond butterflyfish	O	Y	X	Z	O	Y	X	Z	Y	X
Chaetodon xanthurus	Pearscale butterflyfish										
Chelmon rostratus	Beaked coralfish										
Forcipiger flavisimmus	Forcepsfish	O	Y	X	Z				Z	Y	X
Forcipiger longirostris	Longnose butterflyfish	O		X	Z				Z	Y	
Hemitaurichthys polylepis	Pyramid butterflyfish			X	Z				Z	Y	X
Heniochus acuminatus	Pennant coralfish		Y	X					Z	Y	X
Heniochus chrysostomus	Threeband pennantfish	O	Y	X	Z	O	Y		Z	Y	X
Heniochus diphreutes	Schooling bannerfish								Z		
Heniochus monoceros	Masked bannerfish				Z						
Heniochus singularius	Singular bannerfish	O		X	Z				Z	Y	X
Heniochus varius	Horned bannerfish	O	Y	X	Z	O	Y			Y	X
Parachaetodon ocellatus	Sixspine butterflyfish										
Coradion chrysozonus	Goldengirdled coralfish										
Coradion melanopus	Twospot coralfish										
Total number of species/site		**25**	**26**	**29**	**29**	**14**	**15**	**12**	**27**	**29**	**27**

Total number of species observed in all sites surveyed in 1992: **29**
Total number of species observed in all sites surveyed in 1996: **30**
Total number of species observed in Tubbataha and Bastera in 2000: **38**
Total number of species observed in Tubbataha and Jessie Beazley in 2004: **32**

SR - South Reef
NR- North Reef
SL - South Lagoon

Table 3. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at NR-5 (North Reef) Bird Islet in 2004.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	6.4	0.5	4.4	28.6	43.8	28.8	105.6	45.0
Rabbitfish (Siganids)*	0.2	0.2	0.0	0.0	0.2	0.0	0.2	0.2
Groupers (Serranids)*	3.4	1.1	0.4	2.0	3.2	1.6	7.2	1.8
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	2.4	1.0	0.0	1.4	2.8	6.6	10.8	6.5
Sweetlips (Haemulids)*	0.8	0.4	0.0	0.2	0.0	1.2	1.4	0.7
Emperors (Lethrinids)*	0.8	0.2	0.0	0.0	0.6	1.0	1.6	0.9
Jacks (Carangids)*	1.4	0.2	0.0	0.2	0.6	7.8	8.6	1.3
Fusiliers (Caesionids)*	2.8	0.5	0.0	268.6	160.0	0.0	428.6	128.1
Spinecheeks (Nemipterids)*	0.2	0.2	0.0	0.2	0.0	0.0	0.2	0.2
Goatfish (Mullids)*	1.0	0.6	0.2	1.4	0.0	0.0	1.6	1.2
Parrotfish (Scarids)*	3.0	0.7	32.6	4.4	0.4	1.2	38.6	31.4
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.2	0.2	0.0	0.0	2.2	0.0	2.2	2.2
Triggerfish (Balistids)	1.2	0.2	15.0	0.8	0.4	0.0	16.2	11.6
Butterflyfish (Chaetodonids)	7.2	1.9	31.8	13.8	0.0	0.0	45.6	20.5
Angelfish (Pomacanthids)	1.8	0.6	2.2	10.4	0.4	0.0	13.0	10.1
Wrasses (Labrids)	5.2	1.3	83.2	0.4	0.2	0.0	83.8	33.3
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	9.8	1.2	542.4	0.0	0.0	0.0	542.4	330.8
Fairy Basslets (Anthids)	4.2	1.0	2015.0	0.0	0.0	0.0	2015.0	370.6
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	1.8	0.6	0.0	0.0	2.4	1.2
Total (target reef spp.):	**22.6**	**1.4**	**33.2**	**307.0**	**213.8**	**48.2**	**602.2**	**181.1**
Total (all reef spp.):	**52.8**	**2.4**	**2729.0**	**333.0**	**214.8**	**48.2**	**3325.0**	**639.8**

* Target species/families

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

Fairly high density

Table 4. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at NR-5 (North Reef) Bird Islet from 1992 to 2004.

Family	(N=1) 1992 Species	(N=3) 1996 Species	% Change 1992 1996	(N=8) 2000 Species	% Change 1996 2000	(N=5) 2004 Species	% Change 2000 2004
Surgeonfish (Acanthurids)*	12.0	5.7	-52.8	7.5	32.4	6.4	-14.7
Rabbitfish (Siganids)*	0.0	0.3	+	0.8	125.0	0.2	-73.3
Groupers (Serranids)*	1.0	1.3	33.3	3.8	181.3	3.4	-9.3
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A
Snapper (Lutjanids)*	2.0	1.3	-33.3	2.1	59.4	2.4	12.9
Sweetlips (Haemulids)*	0.0	0.7	+	0.9	31.3	0.8	-8.6
Emperors (Lethrinids)*	0.0	0.7	+	1.0	50.0	0.8	-20.0
Jacks (Carangids)*	1.0	0.3	-66.7	1.4	312.5	1.4	1.8
Fusiliers (Caesionids)*	2.0	0.3	-83.3	0.6	87.5	2.8	348.0
Spinecheeks (Nemipterids)*	0.0	0.7	+	0.5	-25.0	0.2	-60.0
Goatfish (Mullids)*	0.0	0.7	+	1.6	143.8	1.0	-38.5
Parrotfish (Scarids)*	1.0	1.0	0.0	2.6	162.5	3.0	14.3
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.6	+	0.2	-68.0
Triggerfish (Balistids)	2.0	1.7	-16.7	2.9	72.5	1.2	-58.3
Butterflyfish (Chaetodonids)	16.0	11.3	-29.2	11.4	0.4	7.2	-36.7
Angelfish (Pomacanthids)	1.0	1.3	33.3	1.6	21.9	1.8	10.8
Wrasses (Labrids)	6.0	6.3	5.6	6.0	-5.3	5.2	-13.3
Humphead wrasse	~	~	N/A	~	N/A	0.0	N/A
Damselfish (Pomacentrids)	14.0	8.7	-38.1	7.5	-13.5	9.8	30.7
Fairy Basslets (Anthids)	2.0	1.0	-50.0	1.9	87.5	4.2	124.0
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	1.0	0.0	0.8	-20.0
			N/A		N/A		N/A
Total (target reef spp.):	**19.0**	**13.0**	**-31.6**	**23.4**	**80.0**	**22.6**	**-3.4**
Total (all reef spp.):	**61.0**	**44.3**	**-27.4**	**55.6**	**25.5**	**52.8**	**-5.0**

* Target species/families

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

(-) = decrease

(+) = increase

Table 5. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at NR-5 (North Reef) Bird Islet from 1992 to 2004.

Family	(N=1) 1992 Density	(N=3) 1996 Density	% Change 1992-1996	(N=8) 2000 Density	% Change 1996-2000	(N=5) 2004 Density	% Change 2000-2004
Surgeonfish (Acanthurids)*	198.0	116.3	-41.2	150.1	29.0	105.6	-29.7
Rabbitfish (Siganids)*	0.0	3.0	+	1.4	-54.2	0.2	-85.5
Groupers (Serranids)*	5.0	8.0	60.0	13.8	71.9	7.2	-47.6
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A
Snapper (Lutjanids)*	5.0	16.0	220.0	22.9	43.0	10.8	-52.8
Sweetlips (Haemulids)*	0.0	6.0	+	24.3	304.2	1.4	-94.2
Emperors (Lethrinids)*	0.0	12.0	+	3.9	-67.7	1.6	-58.7
Jacks (Carangids)*	9.0	1.0	-88.9	17.8	1675.0	8.6	-51.5
Fusiliers (Caesionids)*	162.0	11.0	-93.2	115.8	952.3	428.6	270.3
Spinecheeks (Nemipterids)*	0.0	46.0	+	6.1	-86.7	0.2	-96.7
Goatfish (Mullids)*	0.0	54.0	+	23.6	-56.3	1.6	-93.2
Parrotfish (Scarids)*	33.0	129.0	290.9	61.1	-52.6	38.6	-36.9
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	29.8	+	2.2	-92.6
Triggerfish (Balistids)	3.0	7.0	133.3	17.0	142.9	16.2	-4.7
Butterflyfish (Chaetodonids)	62.0	37.7	-39.2	28.9	-23.3	45.6	57.9
Angelfish (Pomacanthids)	2.0	8.0	300.0	15.1	89.1	13.0	-14.0
Wrasses (Labrids)	198.0	113.0	-42.9	70.9	-37.3	83.8	18.2
Humphead wrasse	~	~	N/A	~	N/A	0.0	N/A
Damselfish (Pomacentrids)	1422.0	942.0	-33.8	1424.9	51.3	542.4	-61.9
Fairy Basslets (Anthids)	1026.0	385.0	-62.5	1083.9	181.5	2015.0	85.9
Moorish Idols (*Zanclus cornutus*)	9.0	17.0	88.9	10.9	-36.0	2.4	-77.9
Total (target reef spp.):	**412.0**	**402.3**	**-2.4**	**470.4**	**16.9**	**602.2**	**28.0**
Total (all reef spp.):	**3134.0**	**1912.0**	**-39.0**	**3121.9**	**63.3**	**3325.0**	**6.5**

* Target species/families

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

(-) = decrease

(+) = increase

Table 6. Changes in substrate composition (% mean ±SE) in NR-1 (North Reef) Malayan Wreck from 1984 to 2004.

	SCUBA SURVEYS:							SNORKEL SURVEYS:									
	1984	1996	% Change 1984-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	1984	1989	% Change 1984-1989	1992	% Change 1989-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004
SUBSTRATE COVER	% cover	% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover		% cover	
Sand (s) and Silt (SI)	7.6	10.3	35.5	7.9	-23.3	14.5	83.5	6.1	0.5	-91.8	5.4	980.0	3.5	-35.2	14.3	308.6	6.3	-56.1
Coral Rubble (R)	10.5	10.8	2.9	22.7	110.2	19.3	-15.2	7	31.8	353.9	12.9	-59.4	4.0	-69.0	19.3	382.5	2.9	-84.9
Rock and Block (RK)	36	14.4	-60.0	33.2	130.6	27.7	-16.7	23.6	18.8	-20.5	27	43.8	32.8	21.3	45.9	40.2	45.0	-2.0
White Dead Standing Coral (DC)	5.9	0	-100.0	0.6	+	0.1	-79.2	6.5	9.4	44.6	6.7	-28.7	11.3	67.9	0.4	-96.4	0.1	-75.5
Dead Coral with Algae (DCA)	0	3.3	+	11.1	236.4	2.9	-73.5	0	0.0	N/A	0	N/A	0	N/A	5.6	+	5.2	-7.4
Subtotal Non-living Substrate	***60***	***38.8***	-35.3	***75.5***	94.6	***64.5***	-14.6	***43.2***	***60.4***	39.9	***52***	-14.0	***51.5***	-1.0	***85.5***	66.0	***59.5***	-30.5
Branching (CB)	19.4	46.6	140.2	10.5	-77.5	7.0	-33.3	36.3	22.6	-37.7	27	19.5	42.3	56.5	~	N/A	19.5	N/A
Massive (CM)	6.4	2.3	-64.1	6.2	169.6	5.5	-10.8	7.3	2.7	-62.6	8.1	196.7	4.5	-44.4	~	N/A	8.0	N/A
Flat/Encrusting (CFD)	11	7	-36.4	5.8	-17.1	5.2	-9.9	8	2.3	-70.9	4.5	93.1	1.3	-72.2	~	N/A	3.8	N/A
Foliose Cup (CFO)	0.5	0	-100.0	0.5	+	0.3	-50.0	0.5	0.6	20.0	3	400.0	0	-100.0	~	N/A	0.9	N/A
Total Hard Coral	37.3	55.9	49.9	23	-58.9	18.0	-21.7	52.1	28.3	-45.8	42.6	50.7	48	12.7	14.1	-70.6	32.3	128.8
Total Soft Coral	2.7	5.3	96.3	1.5	-71.7	5.5	264.6	4.7	11.3	141.1	5.4	-52.3	0.5	-90.7	0.4	-20.0	1.5	276.8
Subtotal Coral	***40***	***61.2***	53.0	***24.5***	-60.0	***23.5***	-4.2	***56.8***	***39.6***	-30.3	***48***	21.2	***48.5***	1.0	***14.5***	-70.1	***33.8***	132.9
Sponges	~	~	N/A	~	N/A	1.7	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.6	N/A
Other animals	~	~	N/A	~	N/A	0.2	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A
Algae																		
Turf algae	~	~	N/A	~	N/A	6.6	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	2.9	N/A
Fleshy algae	~	~	N/A	~	N/A	0.8	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	2.0	N/A
Coralline algae	~	~	N/A	~	N/A	2.8	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	1.3	N/A
Seagrass	~	~	N/A	~	N/A	0.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A
Subtotal Others	~	~	N/A	~	N/A	***12.1***	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	***6.8***	N/A
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Paramenters																		
Mean Slope (degrees)	~			9.1		13.5		~	~		~		~		0.9		15.0	
Mean Topography (m) *	2.4	2.2		1.6		1.1		2.1	1.5-2		1.5-4		~		0.8		1.2	
Mean Depth/Range (m)	1.5-15	6-7		5.6		7.2		2-8	3-7		2-5		2-3		2.2		2.9	
Horizontal Visibility (m)	~	18		20.3		23.7		~	~		~		25		22.2		22.7	
No. of 50 m Transects	1	4		15		16.0		1	3		6		2		14		14.0	

~ no data available

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

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

(-) = decrease

(+) = increase

Table 7. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at NR-1 (North Reef) Malayan Wreck in 2004.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	9.3	1.0	40.8	57.1	19.9	10.5	128.3	30.8
Rabbitfish (Siganids)*	0.3	0.3	0.0	0.4	0.0	0.0	0.4	0.4
Groupers (Serranids)*	2.4	0.4	0.0	7.3	1.8	0.8	9.8	2.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.9	0.9	0.0	3.1	1.8	3.8	8.6	4.8
Sweetlips (Haemulids)*	0.3	0.3	0.0	0.0	0.0	0.5	0.5	0.5
Emperors (Lethrinids)*	1.0	0.3	0.0	2.5	4.9	0.4	7.8	4.1
Jacks (Carangids)*	0.8	0.4	0.0	0.0	16.1	8.0	24.1	16.7
Fusiliers (Caesionids)*	0.6	0.3	0.0	27.0	23.9	0.0	50.9	31.5
Spinecheeks (Nemipterids)*	0.6	0.2	0.1	2.3	0.0	0.0	2.4	1.1
Goatfish (Mullids)*	1.9	0.2	0.6	16.1	4.6	0.0	21.4	6.1
Parrotfish (Scarids)*	3.3	1.0	0.3	6.6	6.5	1.9	15.3	4.1
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	4.3	0.6	1.6	322.4	2.1	0.3	326.4	142.0
Butterflyfish (Chaetodonids)	9.8	1.7	41.3	3.1	0.0	0.0	44.4	12.4
Angelfish (Pomacanthids)	1.8	0.5	8.8	0.8	0.1	0.0	9.6	4.7
Wrasses (Labrids)	8.6	1.4	194.8	3.8	0.4	0.1	199.0	137.0
Humphead wrasse	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
Damselfish (Pomacentrids)	6.9	1.3	834.5	0.0	0.0	0.0	834.5	260.2
Fairy Basslets (Anthids)	1.5	0.3	402.6	0.0	0.0	0.0	402.6	130.8
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	2.3	0.8	0.0	0.0	3.0	1.3
Total (target reef spp.):	**22.1**	**2.9**	**1.0**	**122.4**	**79.4**	**25.8**	**228.5**	**58.1**
Total (all reef spp.):	**55.8**	**5.3**	**1527.5**	**453.1**	**82.0**	**26.3**	**2088.9**	**465.5**

* Target species/families

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

Fairly high density

Table 8. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at NR-1 (North Reef) Malayan Wreck from 1992 to 2004.

Family	(N=1) 1992 Species	(N=2) 1996 Species	% Change 1992 1996	(N=5) 2000 Species	% Change 1996 2000	(N=8) 2004 Species	% Change 1996 2000
Surgeonfish (Acanthurids)*	9.0	8.0	-11.1	5.6	-30.0	9.3	65.2
Rabbitfish (Siganids)*	0.0	1.0	+	0.6	-40.0	0.3	-58.3
Groupers (Serranids)*	2.0	3.0	50.0	2.6	-13.3	2.4	-8.7
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A
Snapper (Lutjanids)*	2.0	1.0	-50.0	2.2	120.0	1.9	-14.8
Sweetlips (Haemulids)*	1.0	0.5	-50.0	0.0	-100.0	0.3	+
Emperors (Lethrinids)*	0.0	0.5	+	0.8	60.0	1.0	25.0
Jacks (Carangids)*	1.0	1.0	0.0	0.8	-20.0	0.8	-6.3
Fusiliers (Caesionids)*	4.0	1.5	-62.5	0.4	-73.3	0.6	56.3
Spinecheeks (Nemipterids)*	0.0	1.0	+	12.6	1160.0	0.6	-95.0
Goatfish (Mullids)*	1.0	1.0	0.0	1.4	40.0	1.9	33.9
Parrotfish (Scarids)*	1.0	1.0	0.0	2.0	100.0	3.3	62.5
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.2	+	0.0	-100.0
Triggerfish (Balistids)	2.0	3.5	75.0	4.2	20.0	4.3	1.2
Butterflyfish (Chaetodonids)	11.0	11.0	0.0	9.6	-12.7	9.8	1.6
Angelfish (Pomacanthids)	2.0	3.0	50.0	2.6	-13.3	1.8	-32.7
Wrasses (Labrids)	5.0	4.0	-20.0	6.6	65.0	8.6	30.7
Humphead wrasse	~	~	N/A	~	N/A	0.1	N/A
Damselfish (Pomacentrids)	10.0	11.0	10.0	5.2	-52.7	6.9	32.2
Fairy Basslets (Anthids)	2.0	2.0	0.0	1.0	-50.0	1.5	50.0
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	1.0	0.0	0.8	-25.0
Total (target reef spp.):	**21.0**	**19.5**	**-7.1**	**29.2**	**49.7**	**22.1**	**-24.2**
Total (all reef spp.):	**54.0**	**55.0**	**1.9**	**59.4**	**8.0**	**55.8**	**-6.1**

* Target species/families

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

(-) = decrease

(+) = increase

Table 9. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at NR-1 (North Reef) Malayan Wreck from 1992 to 2004.

Family	(N=1) 1992 Density	(N=2) 1996 Density	% Change 1992 1996	(N=5) 2000 Density	% Change 1996 2000	(N=8) 2004 Density	% Change 1996 2000
Surgeonfish (Acanthurids)*	222.0	123.0	-44.6	104.0	-15.4	128.3	23.3
Rabbitfish (Siganids)*	0.0	3.0	+	1.0	-66.7	0.4	-62.5
Groupers (Serranids)*	6.0	16.0	166.7	13.8	-13.8	9.8	-29.3
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A
Snapper (Lutjanids)*	42.0	21.0	-50.0	15.0	-28.6	8.6	-42.5
Sweetlips (Haemulids)*	3.0	1.5	-50.0	0.0	-100.0	0.5	+
Emperors (Lethrinids)*	0.0	4.5	+	4.0	-11.1	7.8	93.8
Jacks (Carangids)*	9.0	6.0	-33.3	1.2	-80.0	24.1	1910.4
Fusiliers (Caesionids)*	324.0	97.5	-69.9	51.6	-47.1	50.9	-1.4
Spinecheeks (Nemipterids)*	0.0	18.0	+	13.8	-23.3	2.4	-82.8
Goatfish (Mullids)*	129.0	21.0	-83.7	14.8	-29.5	21.4	44.4
Parrotfish (Scarids)*	129.0	33.0	-74.4	45.8	38.8	15.3	-66.7
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.6	+	0.0	-100.0
Triggerfish (Balistids)	5.0	109.5	2090.0	69.0	-37.0	326.4	373.0
Butterflyfish (Chaetodonids)	44.0	75.0	70.5	65.0	-13.3	44.4	-31.7
Angelfish (Pomacanthids)	38.0	9.0	-76.3	34.2	280.0	9.6	-71.9
Wrasses (Labrids)	189.0	27.0	-85.7	48.8	80.7	199.0	307.8
Humphead wrasse	~	~	N/A	~	N/A	0.1	N/A
Damselfish (Pomacentrids)	420.0	3153.0	650.7	616.8	-80.4	834.5	35.3
Fairy Basslets (Anthids)	162.0	354.0	118.5	242.0	-31.6	402.6	66.4
Moorish Idols (*Zanclus cornutus*)	9.0	9.0	0.0	4.8	-46.7	3.0	-37.5
Total (target reef spp.):	**864.0**	**344.5**	**-60.1**	**265.6**	**-22.9**	**228.5**	**-14.0**
Total (all reef spp.):	**1731.0**	**4081.0**	**135.8**	**1346.2**	**-67.0**	**2088.9**	**55.2**

* Target species/families

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

(-) = decrease

(+) = increase

Table 10. Changes in substrate composition (% mean ±SE) in NR-2 (North Reef) Ranger Station from 1992 to 2004.

	SCUBA SURVEYS:					SNORKEL SURVEYS:						
SUBSTRATE COVER	1992 % cover	2000 % cover	% Change 1992-2000	2004 % cover	% Change 2000-2004	1992 % cover	1996 % cover	% Change 1992-1996	2000 % cover	% Change 1996-2000	2004 % cover	% Change 2000-2004
Sand (s) and Silt (SI)	20.2	8.1	-59.9	8.8	8.8	20.3	22.3	9.9	16.2	-27.4	6.4	-60.7
Coral Rubble (R)	0.5	33.3	6560.0	22.1	-33.7	24.9	7.1	-71.5	17.6	147.9	18.2	3.3
Rock and Block (RK)	38.8	11.1	-71.4	13.2	18.5	10	6.3	-37.0	23.1	266.7	18.7	-19.2
White Dead Standing Coral (DC)	6.3	0.9	-85.7	0.2	-82.6	6.1	7.8	27.9	0.3	-96.2	0.8	170.7
Dead Coral with Algae (DCA)	0	32.6	+	3.5	-89.2	0	0	N/A	10.1	+	8.0	-20.9
Subtotal Non-living Substrate	***65.8***	***86***	**30.7**	***47.7***	**-44.5**	***61.3***	***43.5***	**-29.0**	***67.3***	**54.7**	***52.0***	**-22.7**
Branching (CB)	25.5	8.9	-65.1	26.9	202.7	22.6	51	125.7	~	N/A	30.4	N/A
Massive (CM)	1.2	1.9	58.3	6.0	214.1	6.5	4.7	-27.7	~	N/A	7.5	N/A
Flat/Encrusting (CFD)	5.7	1.9	-66.7	7.8	311.2	4.4	0	-100.0	~	N/A	3.1	N/A
Foliose Cup (CFO)	0	0.2	+	1.2	478.1	2	0	-100.0	~	N/A	0.8	N/A
Total Hard Coral	32.4	12.9	-60.2	41.9	224.6	35.5	55.7	56.9	31.3	-43.8	41.9	33.8
Total Soft Coral	1.8	1.1	-38.9	1.7	50.6	3.2	0.8	-75.0	1.4	75.0	0.7	-51.2
Subtotal Coral	***34.2***	***14***	**-59.1**	***43.5***	**210.9**	***38.7***	***56.5***	**46.0**	***32.7***	**-42.1**	***42.6***	**30.2**
Sponges	~	~	N/A	3.6	N/A	~	~	N/A	~	N/A	0.5	N/A
Other animals	~	~	N/A	1.0	N/A	~	~	N/A	~	N/A	0.9	N/A
Algae				0.0							0.0	
Turf algae	~	~	N/A	0.4	N/A	~	~	N/A	~	N/A	0.9	N/A
Fleshy algae	~	~	N/A	0.5	N/A	~	~	N/A	~	N/A	1.1	N/A
Coralline algae	~	~	N/A	3.3	N/A	~	~	N/A	~	N/A	1.6	N/A
Seagrass	~	~	N/A	0.0	N/A	~	~	N/A	~	N/A	0.3	N/A
Subtotal Others	***0***	***0***	N/A	***8.8***	+	***0***	***0***	N/A	***0***	N/A	***5.4***	+
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**	
Environmental Parameters												
Mean Slope (degrees)	~	15.6		53.6		~	~		3.4		12.2	
Mean Topography (m) *	4	2.9		2.1		1-3	~		1.6		1.1	
Mean Depth/Range (m)	5	6.5		7.4		1-10	3		2.8		3.0	
Horizontal Visibility (m)	~	23.8		26.2		~	25		20.8		9.9	
No. of 50 m Transects	1	16		16		6	2		13		14	

~ no data available

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

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

(-) = decrease

(+) = increase

Table 11. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at NR-2 (North Reef) Ranger Station in 2004.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	8.1	0.9	45.6	70.5	7.9	4.5	128.5	29.0
Rabbitfish (Siganids)*	1.3	0.3	0.0	1.0	1.3	0.1	2.4	0.6
Groupers (Serranids)*	2.9	0.4	0.0	2.4	3.8	1.5	7.6	2.3
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	4.5	0.7	0.0	9.9	4.4	5.4	19.6	4.7
Sweetlips (Haemulids)*	0.9	0.1	0.0	0.1	0.9	0.8	1.8	0.5
Emperors (Lethrinids)*	1.4	0.3	0.0	19.9	2.9	1.5	24.3	15.4
Jacks (Carangids)*	1.3	0.3	0.0	0.0	4.6	4.6	9.3	4.1
Fusiliers (Caesionids)*	2.5	0.4	439.3	917.4	39.9	0.0	1396.5	560.5
Spinecheeks (Nemipterids)*	0.5	0.3	0.0	0.5	0.9	0.0	1.4	1.0
Goatfish (Mullids)*	1.1	0.1	0.1	7.1	0.5	0.0	7.8	3.8
Parrotfish (Scarids)*	2.6	0.7	0.0	27.4	1.5	0.6	29.5	15.0
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.1	0.1	0.0	0.0	4.1	0.0	4.1	4.1
Triggerfish (Balistids)	1.9	0.3	0.4	8.3	0.0	0.0	8.6	2.8
Butterflyfish (Chaetodonids)	11.4	1.2	33.4	0.0	2.1	0.0	35.5	4.8
Angelfish (Pomacanthids)	2.5	0.6	6.3	1.0	0.3	0.0	7.5	2.4
Wrasses (Labrids)	6.6	1.3	112.0	5.4	0.0	0.0	117.4	26.9
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	12.4	0.6	2578.0	0.0	0.0	0.0	2578.0	1215.7
Fairy Basslets (Anthids)	2.1	0.2	1057.9	3.9	0.0	0.0	1061.8	355.8
Moorish Idols (*Zanclus cornutus*)	0.9	0.1	4.9	0.4	0.0	0.0	5.3	1.5
Total (target reef spp.):	**27.1**	**2.0**	**439.4**	**1056.1**	**72.5**	**19.0**	**1587.0**	**552.5**
Total (all reef spp.):	**64.9**	**3.9**	**4277.8**	**1075.0**	**74.9**	**19.0**	**5446.6**	**1573.7**

* Target species/families

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

Fairly high density

Table 12. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at NR-2 (North Reef) Ranger Station from 1992 to 2004.

Family	(N=1)	(N=6)	% Change 1992-2000	(N=8)	% Change 2000-2004
	1992	2000		2004	
	Species			Species	
Surgeonfish (Acanthurids)*	8.0	6.8	-14.6	8.1	18.9
Rabbitfish (Siganids)*	1.0	1.5	50.0	1.3	-16.7
Groupers (Serranids)*	5.0	4.3	-13.3	2.9	-33.7
Barramundi cod	~	~	N/A	0.0	N/A
Snapper (Lutjanids)*	1.0	2.5	150.0	4.5	80.0
Sweetlips (Haemulids)*	0.0	0.7	+	0.9	31.3
Emperors (Lethrinids)*	1.0	0.7	-33.3	1.4	106.3
Jacks (Carangids)*	0.0	2.0	+	1.3	-37.5
Fusiliers (Caesionids)*	0.0	1.3	+	2.5	87.5
Spinecheeks (Nemipterids)*	1.0	0.7	-33.3	0.5	-25.0
Goatfish (Mullids)*	1.0	1.8	83.3	1.1	-38.6
Parrotfish (Scarids)*	1.0	3.5	250.0	2.6	-25.0
Bumphead parrotfish	~	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.2	+	0.1	-25.0
Triggerfish (Balistids)	2.0	2.7	33.3	1.9	-29.7
Butterflyfish (Chaetodonids)	14.0	10.2	-27.4	11.4	11.9
Angelfish (Pomacanthids)	2.0	3.5	75.0	2.5	-28.6
Wrasses (Labrids)	9.0	10.8	20.4	6.6	-38.8
Humphead wrasse	~	~	N/A	0.0	N/A
Damselfish (Pomacentrids)	13.0	12.7	-2.6	12.4	-2.3
Fairy Basslets (Anthids)	2.0	1.2	-41.7	2.1	82.1
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	0.9	-12.5
Total (target reef spp.):	**19.0**	**26.0**	**36.8**	**27.1**	**4.3**
Total (all reef spp.):	**62.0**	**68.0**	**9.7**	**64.9**	**-4.6**

* Target species/families

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

(-) = decrease

(+) = increase

Table 13. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at NR-2 (North Reef) Ranger Station from 1992 to 2004.

Family	(N=1) 1992 Density	(N=6) 2000 Density	% Change 1992-2000	(N=8) 2004 Density	% Change 2000-2004
Surgeonfish (Acanthurids)*	90.0	193.7	115.2	128.5	-33.6
Rabbitfish (Siganids)*	4.0	5.2	29.2	2.4	-54.0
Groupers (Serranids)*	8.0	16.8	110.4	7.6	-54.7
Barramundi cod	~	~	N/A	0.0	N/A
Snapper (Lutjanids)*	5.0	18.0	260.0	19.6	9.0
Sweetlips (Haemulids)*	0.0	3.8	+	1.8	-54.3
Emperors (Lethrinids)*	9.0	1.3	-85.2	24.3	1718.8
Jacks (Carangids)*	0.0	13.0	+	9.3	-28.8
Fusiliers (Caesionids)*	0.0	104.0	+	1396.5	1242.8
Spinecheeks (Nemipterids)*	3.0	2.5	-16.7	1.4	-45.0
Goatfish (Mullids)*	129.0	12.7	-90.2	7.8	-38.8
Parrotfish (Scarids)*	33.0	70.7	114.1	29.5	-58.3
Bumphead parrotfish	~	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	5.5	+	4.1	-25.0
Triggerfish (Balistids)	3.0	14.8	394.4	8.6	-41.9
Butterflyfish (Chaetodonids)	50.0	30.8	-38.3	35.5	15.1
Angelfish (Pomacanthids)	34.0	28.2	-17.2	7.5	-73.4
Wrasses (Labrids)	117.0	120.0	2.6	117.4	-2.2
Humphead wrasse	~	~	N/A	0.0	N/A
Damselfish (Pomacentrids)	1020.0	994.8	-2.5	2578.0	159.1
Fairy Basslets (Anthids)	258.0	905.3	250.9	1061.8	17.3
Moorish Idols (*Zanclus cornutus*)	3.0	4.0	33.3	5.3	31.3
Total (target reef spp.):	**281.0**	**447.2**	**59.1**	**1587.0**	**254.9**
Total (all reef spp.):	**1766.0**	**2545.2**	**44.1**	**5446.6**	**114.0**

* Target species/families

% change = [(Yr_2/Yr_1)-1] x 100

(-) = decrease

(+) = increase

Table 14. Changes in substrate composition (% mean ±SE) in SR-3 (South Reef) Black Rock from 1984 to 2004.

	SCUBA SURVEYS:							SNORKEL SURVEYS:									
SUBSTRATE COVER	1992 % cover	1996 % cover	% Change 1992-1996	2000 % cover	% Change 1996-2000	2004 % cover	% Change 2000-2004	1984 % cover	1989 % cover	% Change 1984-1989	1992 % cover	% Change 1989-1992	1996 % cover	% Change 1992-1996	2000 % cover	% Change 1996-2000	2004 % cover	% Change 2000-2004
Sand (s) and Silt (SI)	1.1	3.8	245.5	3.8	0.0	8.9	135.2	1.1	6.1	454.5	14.4	136.1	6.0	-58.3	4.1	-31.7	8.3	101.7
Coral Rubble (R)	17.6	22.5	27.8	40.5	80.0	16.7	-58.8	16.3	26.6	63.2	9.0	-66.2	6.5	-27.8	12.7	95.4	9.6	-24.7
Rock and Block (RK)	4.9	7.4	51.0	14.8	100.0	5.0	-66.3	12.2	18.3	50.0	32.3	76.5	4.5	-86.1	41.9	831.1	24.7	-41.0
White Dead Standing Coral (DC)	0.6	1.8	200.0	2.6	44.4	0.3	-90.4	5.2	4.0	-23.1	2.1	-47.5	18.0	757.1	2.0	-88.9	0.4	-78.7
Dead Coral with Algae (DCA)	0.0	0.0	N/A	8.4	+	4.4	-47.2	0.0	0.0	N/A	0.0	N/A	0.0	N/A	9.2	+	6.6	-28.6
Subtotal Dnon-living Substrate	***24.2***	***35.5***	***46.7***	***70.1***	***97.5***	***35.3***	***-49.6***	***34.8***	***55.0***	***58.0***	***57.8***	***5.1***	***35.0***	***-39.4***	***69.9***	***99.7***	***49.5***	***-29.1***
Branching (CB)	17.9	27.7	54.7	17.5	-36.8	39.1	123.2	32.7	15.7	-52.0	19.3	22.9	41.0	112.4	~	N/A	27.5	N/A
Massive (CM)	8.1	2.1	-74.1	3.4	61.9	2.8	-17.5	8.8	3.6	-59.1	8.6	138.9	9.0	4.7	~	N/A	8.9	N/A
Flat/Encrusting (CFD)	0.7	2.7	285.7	4.8	77.8	5.3	9.9	5.4	0.0	-100.0	5.1	+	4.5	-11.8	~	N/A	6.5	N/A
Foliose Cup (CFO)	2.4	1.1	-54.2	0.9	-18.2	0.8	-13.2	2.0	0.0	-100.0	0.7	+	1.5	114.3	~	N/A	1.2	N/A
Total Hard Coral	29.0	33.6	15.9	26.5	-21.1	47.9	80.8	48.9	19.3	-60.5	33.7	74.6	56.0	66.2	29.4	-47.5	44.2	50.2
Total Soft Coral	46.8	30.9	-34.0	3.4	-89.0	11.4	234.6	16.3	25.7	57.7	8.5	-66.9	9.0	5.9	0.7	-92.2	2.9	307.2
Subtotal Coral	***75.8***	***64.5***	***-14.9***	***29.9***	***-53.6***	***59.3***	***98.3***	***65.2***	***45.0***	***-31.0***	***42.2***	***-6.2***	***65.0***	***54.0***	***30.1***	***-53.7***	***47.0***	***56.2***
Sponges	~	~	N/A	~	N/A	1.8	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.6	N/A
Other animals	~	~	N/A	~	N/A	0.5	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.2	N/A
Algae																		
Turf algae	~	~	N/A	~	N/A	0.8	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	1.3	N/A
Fleshy algae	~	~	N/A	~	N/A	0.1	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.2	N/A
Coralline algae	~	~	N/A	~	N/A	2.2	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	1.2	N/A
Seagrass	~	~	N/A	~	N/A	0.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A
Subtotal Others	***0.0***	***0.0***	N/A	***0.0***	N/A	***5.4***	+	***0.0***	***0.0***	N/A	***0.0***	N/A	***0.0***	N/A	***0.0***	N/A	***3.5***	+
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters																		
Mean Slope (degrees)	~	~		16.9		32.3		~	~		~		~		5.8		11.4	
Mean Topography (m) *	1.9	2.5		2.9		1.5		1.9	~		1.5		~		1.3		0.7	
Mean Depth/Range (m)	8-15	8-9		6.8		7.3		3.5	~		2-7		1-2.7		2.6		2.7	
Horizontal Visibility (m)	~	25.0		27.9		28.8		~	~		~		~		23.9		28.7	
No. of 50 m Transects	4	4		16		16		1	2		3		2		12		15	

~ no data available

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

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

(-) = decrease

(+) = increase

Table 15. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at SR-3 (South Reef) Black Rock in 2004.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	6.1	0.6	24.4	57.6	11.0	4.6	97.6	37.9
Rabbitfish (Siganids)*	1.4	0.5	0.0	2.1	2.4	0.0	4.5	1.7
Groupers (Serranids)*	3.1	0.4	0.0	7.8	6.5	1.4	15.6	3.9
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	2.8	0.6	0.0	7.8	2.1	1.9	11.8	6.7
Sweetlips (Haemulids)*	0.6	0.3	0.0	0.0	1.5	2.0	3.5	2.0
Emperors (Lethrinids)*	1.5	0.4	0.0	1.4	15.8	3.1	20.3	14.8
Jacks (Carangids)*	1.4	0.2	0.0	1.4	1.4	4.5	7.3	1.0
Fusiliers (Caesionids)*	0.1	0.1	0.0	4.1	0.0	0.0	4.1	4.1
Spinecheeks (Nemipterids)*	0.3	0.2	0.0	0.4	0.4	0.0	0.8	0.5
Goatfish (Mullids)*	1.8	0.4	0.3	8.8	1.9	0.0	10.9	4.7
Parrotfish (Scarids)*	3.4	0.8	0.8	15.3	5.6	2.0	23.6	4.6
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)	2.5	0.5	0.8	5.6	2.1	0.1	8.6	1.6
Butterflyfish (Chaetodonids)	11.1	1.8	31.6	0.3	0.6	0.0	32.5	7.1
Angelfish (Pomacanthids)	2.8	0.5	7.6	1.4	0.4	0.0	9.4	2.6
Wrasses (Labrids)	8.6	1.5	78.8	6.3	0.1	0.4	85.5	40.7
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	12.5	1.2	2309.9	0.0	0.0	0.0	2309.9	422.9
Fairy Basslets (Anthids)	2.1	0.1	1521.0	212.5	0.0	0.0	1733.5	383.6
Moorish Idols (*Zanclus cornutus*)	0.9	0.1	3.4	0.8	1.1	0.0	5.3	1.3
Total (target reef spp.):	**22.4**	**1.6**	**1.0**	**106.5**	**48.5**	**19.5**	**175.5**	**31.2**
Total (all reef spp.):	**62.9**	**2.1**	**3978.4**	**333.3**	**52.9**	**20.0**	**4384.5**	**496.2**

* Target species/families

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

Fairly high density

Table 16. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at SR-3 (South Reef) Black Rock from 1996 to 2004.

Family	(N=2) 1996 Species	(N=5) 2000 Species	% Change 1996-2000	2004 (N=8) 2004 Species	% Change 2000-2004
Surgeonfish (Acanthurids)*	7.5	7.2	-4.0	6.1	-14.9
Rabbitfish (Siganids)*	1.5	1.2	-20.0	1.4	14.6
Groupers (Serranids)*	2.0	2.4	20.0	3.1	30.2
Barramundi cod	~	~	N/A	0.0	N/A
Snapper (Lutjanids)*	1.0	2.0	100.0	2.8	37.5
Sweetlips (Haemulids)*	0.5	0.6	20.0	0.6	4.2
Emperors (Lethrinids)*	0.0	0.6	+	1.5	150.0
Jacks (Carangids)*	0.0	1.0	+	1.4	37.5
Fusiliers (Caesionids)*	1.5	1.2	-20.0	0.1	-89.6
Spinecheeks (Nemipterids)*	0.5	0.2	-60.0	0.3	25.0
Goatfish (Mullids)*	1.0	1.2	20.0	1.8	45.8
Parrotfish (Scarids)*	1.0	0.8	-20.0	3.4	321.9
Bumphead parrotfish	~	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.6	+	0.0	-100.0
Triggerfish (Balistids)	2.5	4.2	68.0	2.5	-40.5
Butterflyfish (Chaetodonids)	8.0	12.0	50.0	11.1	-7.3
Angelfish (Pomacanthids)	1.5	2.6	73.3	2.8	5.8
Wrasses (Labrids)	4.5	5.4	20.0	8.6	59.7
Humphead wrasse	~	~	N/A	0.0	N/A
Damselfish (Pomacentrids)	7.5	9.0	20.0	12.5	38.9
Fairy Basslets (Anthids)	2.0	2.0	0.0	2.1	6.3
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	0.9	-12.5
Total (target reef spp.):	**16.5**	**19.0**	**15.2**	**22.4**	**17.8**
Total (all reef spp.):	**43.5**	**55.2**	**26.9**	**62.9**	**13.9**

* Target species/families

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

(-) = decrease

(+) = increase

Table 17. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at SR-3 (South Reef) Black Rock from 1996 to 2004.

Family	(N=2) 1996 Density	(N=5) 2000 Density	% Change 1996-2000	(N=8) 2004 Density	% Change 2000-2004
Surgeonfish (Acanthurids)*	84.5	156.6	85.3	97.6	-37.7
Rabbitfish (Siganids)*	7.5	3.0	-60.0	4.5	50.0
Groupers (Serranids)*	3.5	11.6	231.4	15.6	34.7
Barramundi cod	~	~	N/A	0.0	N/A
Snapper (Lutjanids)*	9.0	7.2	-20.0	11.8	63.2
Sweetlips (Haemulids)*	1.5	3.0	100.0	3.5	16.7
Emperors (Lethrinids)*	0.0	2.6	+	20.3	678.8
Jacks (Carangids)*	0.0	9.8	+	7.3	-26.0
Fusiliers (Caesionids)*	193.5	81.4	-57.9	4.1	-94.9
Spinecheeks (Nemipterids)*	16.5	0.2	-98.8	0.8	275.0
Goatfish (Mullids)*	66.0	28.2	-57.3	10.9	-61.4
Parrotfish (Scarids)*	69.0	58.2	-15.7	23.6	-59.4
Bumphead parrotfish	~	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	17.8	+	0.0	-100.0
Triggerfish (Balistids)	3.5	21.6	517.1	8.6	-60.1
Butterflyfish (Chaetodonids)	25.5	24.8	-2.7	32.5	31.0
Angelfish (Pomacanthids)	3.5	16.2	362.9	9.4	-42.1
Wrasses (Labrids)	67.5	154.2	128.4	85.5	-44.6
Humphead wrasse	~	~	N/A	0.0	N/A
Damselfish (Pomacentrids)	919.5	2096.8	128.0	2309.9	10.2
Fairy Basslets (Anthids)	1618.5	890.8	-45.0	1733.5	94.6
Moorish Idols (*Zanclus cornutus*)	33.0	9.4	-71.5	5.3	-44.1
Total (target reef spp.):	**451.0**	**379.6**	**-15.8**	**175.5**	**-53.8**
Total (all reef spp.):	**3122.0**	**3593.4**	**15.1**	**4384.5**	**22.0**

* Target species/families

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

(-) = decrease

(+) = increase

Table 18. Changes in substrate composition (% mean ±SE) in SR-4 (South Reef) North West Corner from 1992 to 2004.

	SCUBA SURVEYS:					SNORKEL SURVEY:
	1992	2000	% Change 1992-2000	2004	% Change 2000-2004	2004
SUBSTRATE COVER	% cover	% cover		% cover		% cover
Sand (s) and Silt (SI)	2.3	1.7	-26.1	4.0	137.0	3.9
Coral Rubble (R)	11.8	10.3	-12.7	8.9	-14.0	3.1
Rock and Block (RK)	41.6	26.5	-36.3	11.5	-56.5	36.0
White Dead Standing Coral (DC)	~	0.8	N/A	0.2	-74.3	0.0
Dead Coral with Algae (DCA)	0.3	12.7	4133.3	3.2	-74.8	2.7
Subtotal Non-living Substrate	***56.0***	***52.0***	***-7.1***	***27.8***	***-46.5***	***45.8***
Branching (CB)	19.2	20.0	4.2	27.2	36.0	17.0
Massive (CM)	7.7	9.6	24.7	10.3	6.9	13.4
Flat/Encrusting (CFD)	6.0	10.6	76.7	10.5	-0.9	15.8
Foliose Cup (CFO)	2.3	0.8	-65.2	1.0	25.0	2.8
Total Hard Coral	35.2	41.0	16.5	49.0	19.4	48.9
Total Soft Coral	8.8	7.0	-20.5	11.7	67.6	1.0
Subtotal Coral	***44.0***	***48.0***	***9.1***	***60.7***	***26.5***	***49.9***
Sponges	~	~	N/A	3.2	N/A	0.4
Other animals	~	~	N/A	1.1	N/A	0.1
Algae						
Turf algae	~	~	N/A	0.5	N/A	0.2
Fleshy algae	~	~	N/A	0.9	N/A	0.0
Coralline algae	~	~	N/A	5.9	N/A	3.6
Seagrass	~	~	N/A	0.0	N/A	0.0
Subtotal Others	***0.0***	***0.0***	N/A	***11.5***	+	***4.3***
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**
Environmental Parameters						
Mean Slope (degrees)	~	21.8		46.5		6.3
Mean Topography (m) *	2.0	1.6		1.4		1.3
Mean Depth/Range (m)	2-7	6.5		7.6		2.4
Horizontal Visibility (m)	~	27.8		28.5		28.7
No. of 50 m Transects	3	18		17		15

~ no data available

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

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

(-) = decrease

(+) = increase

Table 19. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at SR-4 (South Reef) North West Corner in 2004.

Family	Species		Size Class				Abundance	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	7.8	0.8	58.3	32.8	5.3	10.0	106.3	33.7
Rabbitfish (Siganids)*	1.0	0.2	0.3	1.8	0.1	0.0	2.1	0.5
Groupers (Serranids)*	3.4	0.4	0.3	8.3	4.6	1.9	15.0	3.5
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	3.1	0.9	1.0	17.9	5.0	4.8	28.6	16.5
Sweetlips (Haemulids)*	0.3	0.3	0.0	0.0	0.3	0.3	0.5	0.5
Emperors (Lethrinids)*	0.9	0.2	0.0	5.3	0.6	7.0	12.9	7.2
Jacks (Carangids)*	1.6	0.3	0.0	4.1	6.1	3.4	13.6	4.8
Fusiliers (Caesionids)*	0.4	0.3	0.0	1.3	4.3	0.0	5.5	4.3
Spinecheeks (Nemipterids)*	0.4	0.2	0.0	5.5	0.0	0.0	5.5	4.1
Goatfish (Mullids)*	1.1	0.1	0.1	8.0	0.3	0.0	8.4	3.8
Parrotfish (Scarids)*	2.1	0.5	0.0	21.4	3.3	0.3	24.9	15.1
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.6	0.6	0.0	0.0	127.5	0.1	127.6	127.6
Triggerfish (Balistids)	3.0	0.8	0.4	490.1	0.6	0.4	491.5	255.8
Butterflyfish (Chaetodonids)	12.5	1.5	36.0	12.5	0.1	0.0	48.6	10.7
Angelfish (Pomacanthids)	2.5	0.6	9.3	3.4	0.3	0.0	12.9	4.9
Wrasses (Labrids)	8.5	1.4	85.0	7.0	19.0	0.5	111.5	43.1
Humphead wrasse	0.4	0.2	0.0	0.0	0.1	0.5	0.6	0.4
Damselfish (Pomacentrids)	10.8	1.2	1010.4	0.0	0.0	0.0	1010.4	205.0
Fairy Basslets (Anthids)	1.5	0.3	1679.0	0.0	0.0	0.0	1679.0	437.1
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	3.5	0.0	0.1	0.0	3.6	1.3
Total (target reef spp.):	**22.6**	**2.3**	**1.6**	**106.1**	**157.3**	**27.6**	**292.6**	**123.4**
Total (all reef spp.):	**62.5**	**2.8**	**2883.4**	**619.1**	**177.5**	**29.0**	**3709.0**	**533.2**

* Target species/families

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

Fairly high density

Table 20. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at SR-4 (South Reef) North West Corner from 1992 to 2004.

Family	(N=1)	(N=6)	% Change 1992-2000	(N=8)	% Change 2000-2004
	1992	2000		2004	
	Species			Species	
Surgeonfish (Acanthurids)*	12.0	7.0	-41.7	7.8	10.7
Rabbitfish (Siganids)*	0.0	0.8	+	1.0	20.0
Groupers (Serranids)*	3.0	4.3	44.4	3.4	-22.1
Barramundi cod	~	~	N/A	0.0	N/A
Snapper (Lutjanids)*	3.0	1.2	-61.1	3.1	167.9
Sweetlips (Haemulids)*	1.0	0.2	-83.3	0.3	50.0
Emperors (Lethrinids)*	0.0	0.5	+	0.9	75.0
Jacks (Carangids)*	1.0	0.5	-50.0	1.6	225.0
Fusiliers (Caesionids)*	1.0	0.5	-50.0	0.4	-25.0
Spinecheeks (Nemipterids)*	0.0	1.0	+	0.4	-62.5
Goatfish (Mullids)*	0.0	1.7	+	1.1	-32.5
Parrotfish (Scarids)*	1.0	2.5	150.0	2.1	-15.0
Bumphead parrotfish	~	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	1	+
Triggerfish (Balistids)	5.0	5.0	0.0	3.0	-40.0
Butterflyfish (Chaetodonids)	17.0	13.8	-18.6	12.5	-9.6
Angelfish (Pomacanthids)	2.0	3.7	83.3	2.5	-31.8
Wrasses (Labrids)	5.0	8.3	66.7	8.5	2.0
Humphead wrasse	~	~	N/A	0.4	N/A
Damselfish (Pomacentrids)	10.0	7.8	-21.7	10.8	37.2
Fairy Basslets (Anthids)	3.0	1.2	-61.1	1.5	28.6
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	0.8	-25.0
Total (target reef spp.):	**22.0**	**16.7**	**-24.1**	**22.6**	**35.5**
Total (all reef spp.):	**65.0**	**61.0**	**-6.2**	**62.5**	**2.5**

* Target species/families

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

(-) = decrease

(+) = increase

Table 21. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at SR-4 (South Reef) North West from 1992 to 2004.

Family	(N=1)	(N=6)	% Change 1992-2000	(N=8)	% Change 2000-2004
	1992	2000		2004	
	Density			Density	
Surgeonfish (Acanthurids)*	324.0	215.2	-33.6	106.3	-50.6
Rabbitfish (Siganids)*	0.0	2.7	+	2.1	-20.3
Groupers (Serranids)*	17.0	21.5	26.5	15.0	-30.2
Barramundi cod	~	~	N/A	0.0	N/A
Snapper (Lutjanids)*	75.0	7.2	-90.4	28.6	299.4
Sweetlips (Haemulids)*	3.0	0.5	-83.3	0.5	0.0
Emperors (Lethrinids)*	0.0	27.2	+	12.9	-52.6
Jacks (Carangids)*	9.0	22.2	146.3	13.6	-38.5
Fusiliers (Caesionids)*	129.0	15.8	-87.7	5.5	-65.3
Spinecheeks (Nemipterids)*	0.0	24.3	+	5.5	-77.4
Goatfish (Mullids)*	0.0	20.0	+	8.4	-58.1
Parrotfish (Scarids)*	129.0	39.5	-69.4	24.9	-37.0
Bumphead parrotfish	~	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	128	+
Triggerfish (Balistids)	537.0	1422.5	164.9	491.5	-65.4
Butterflyfish (Chaetodonids)	86.0	62.8	-26.9	48.6	-22.6
Angelfish (Pomacanthids)	36.0	63.7	76.9	12.9	-79.8
Wrasses (Labrids)	213.0	123.8	-41.9	111.5	-10.0
Humphead wrasse	~	~	N/A	0.6	N/A
Damselfish (Pomacentrids)	978.0	2508.8	156.5	1010.4	-59.7
Fairy Basslets (Anthids)	2307.0	1558.8	-32.4	1679.0	7.7
Moorish Idols (*Zanclus cornutus*)	33.0	7.7	-76.8	3.6	-52.7
Total (target reef spp.):	**686.0**	**395.8**	**-42.3**	**292.6**	**-26.1**
Total (all reef spp.):	**4876.0**	**6144.2**	**26.0**	**3709.0**	**-39.6**

* Target species/families

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

(-) = decrease

(+) = increase

Table 22. Changes in substrate composition (% mean ±SE) in SR-1 (South Reef) Lighthouse Islet from 1984 to 2004.

	SCUBA SURVEYS:									SNORKEL SURVEYS:						
	1984	1992	% Change 1984-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	1984	1989	% Change 1984-1989	1992	% Change 1989-1992	2004	% Change 1992-2004
SUBSTRATE COVER	% cover	% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover	
Sand (s) and Silt (SI)	1.7	2.0	17.6	0.0	-100.0	2.9	+	1.3	-54.4	0.5	3.6	620.0	14.6	305.6	3.0	-79.5
Coral Rubble (R)	8.3	13.1	57.8	16.7	27.5	16.6	-0.6	18.4	10.7	3.5	20.6	488.6	20.5	-0.5	0.5	-97.7
Rock and Block (RK)	32.1	35.1	9.3	9.5	-72.9	3.4	-64.2	7.2	112.1	37.0	39.6	7.0	40.2	1.4	36.4	-9.3
White Dead Standing Coral (DC)	0.2	0.3	50.0	2.5	733.3	3.3	32.0	0.4	-86.6	5.0	5.1	2.0	0.5	-90.2	0.3	-37.9
Dead Coral with Algae (DCA)	0.0	0.0	N/A	0.0	N/A	19.3	+	3.0	-84.4	0.0	0.0	N/A	0.0	N/A	2.3	+
Subtotal Non-living Substrate	***42.3***	***50.5***	**19.4**	***28.7***	**-43.2**	***45.5***	**58.5**	***30.4***	**-33.2**	***46.0***	***68.9***	**49.8**	***75.8***	**9.9**	***42.5***	**-43.9**
Branching (CB)	33.6	29.5	-12.2	51.6	74.9	41.6	-19.4	25.9	-37.8	25.0	15.2	-39.2	15.1	-0.7	13.2	-12.3
Massive (CM)	10.1	6.5	-35.6	3.0	-53.8	1.9	-36.7	6.5	243.3	10.2	7.2	-29.4	3.8	-47.9	16.6	341.5
Flat/Encrusting (CFD)	10.3	1.5	-85.4	3.8	153.3	3.3	-13.2	5.3	61.5	9.2	3.2	-65.2	0.0	-100.0	17.4	+
Foliose Cup (CFO)	0.1	1.1	1000.0	0.9	-18.2	0.5	-44.4	0.5	-1.2	1.8	0.9	-50.0	2.8	205.6	2.3	-16.8
Total Hard Coral	54.1	38.9	-28.1	59.3	52.4	47.3	-20.2	38.2	-19.2	46.2	26.5	-42.6	21.6	-18.5	49.5	129.0
Total Soft Coral	3.6	10.6	194.4	12.0	13.2	7.2	-40.0	25.1	248.9	7.8	4.6	-41.0	2.7	-42.4	0.6	-77.8
Subtotal Coral	***57.7***	***49.5***	**-14.2**	***71.3***	**44.0**	***54.5***	**-23.6**	***63.3***	**16.2**	***54.0***	***31.1***	**-42.4**	***24.3***	**-22.0**	***50.0***	**106.4**
Sponges	~	~	N/A	~	N/A	~	N/A	1.7	N/A	~	~	N/A	~	N/A	0.8	N/A
Other animals	~	~	N/A	~	N/A	~	N/A	1.0	N/A	~	~	N/A	~	N/A	0.4	N/A
Algae																
Turf algae	~	~	N/A	~	N/A	~	N/A	0.8	N/A	~	~	N/A	~	N/A	1.1	N/A
Fleshy algae	~	~	N/A	~	N/A	~	N/A	0.3	N/A	~	~	N/A	~	N/A	1.2	N/A
Coralline algae	~	~	N/A	~	N/A	~	N/A	2.5	N/A	~	~	N/A	~	N/A	4.0	N/A
Seagrass	~	~	N/A	~	N/A	~	N/A	0.0	N/A	~	~	N/A	~	N/A	0.0	N/A
Subtotal Others	***0.0***	***0.0***	N/A	***0.0***	N/A	***0.0***	N/A	***6.3***	+	***0.0***	***0.0***	N/A	***0.0***	N/A	***7.4***	+
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**	
Environmental Parameters																
Mean Slope (degrees)	~	~		~		16.2		21.7		~	~		~		8.3	
Mean Topography (m) *	1.5	4.0		2.3		2.7		1.6		1.5	1.5		0.5		0.6	
Mean Depth/Range (m)	1.5-15	5-10		7-10		7.5		7.7		2-7	2-7		1.5		2.9	
Horizontal Visibility (m)	~	30.0		25.0		27.8		25.0		~	~		~		25.9	
No. of 50 m Transects	1	4		8		16		17		1	3		2		17	

~ no data available

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

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

(-) = decrease

(+) = increase

Table 23. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at SR-1 (South Reef) Lighthouse Islet in 2004.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.9	0.4	45.3	85.4	14.0	0.5	145.1	38.1
Rabbitfish (Siganids)*	0.3	0.2	0.0	0.6	0.0	0.0	0.6	0.4
Groupers (Serranids)*	2.6	0.3	0.6	6.5	4.5	1.8	13.4	2.3
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	1.6	0.6	0.0	0.0	2.4	4.3	6.6	2.7
Sweetlips (Haemulids)*	0.1	0.1	0.0	0.0	0.0	5.6	5.6	5.6
Emperors (Lethrinids)*	1.0	0.3	0.0	41.5	4.6	0.5	46.6	41.0
Jacks (Carangids)*	0.9	0.1	0.0	0.0	2.3	5.4	7.6	3.8
Fusiliers (Caesionids)*	0.6	0.4	0.0	29.6	0.0	0.0	29.6	24.0
Spinecheeks (Nemipterids)*	0.6	0.2	0.0	1.3	0.0	0.0	1.3	0.5
Goatfish (Mullids)*	1.5	0.3	0.0	9.9	0.4	0.0	10.3	5.0
Parrotfish (Scarids)*	2.3	0.8	4.1	8.0	1.1	0.8	14.0	4.9
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)	4.1	0.4	2.1	327.4	2.4	1.4	333.3	113.0
Butterflyfish (Chaetodonids)	12.0	1.0	42.3	0.9	2.3	0.0	45.4	7.6
Angelfish (Pomacanthids)	3.9	0.3	16.3	0.8	0.9	0.0	17.9	6.3
Wrasses (Labrids)	9.4	1.1	56.9	5.0	0.0	0.5	62.4	10.3
Humphead wrasse	0.1	0.1	0.0	0.0	0.1	0.1	0.3	0.3
Damselfish (Pomacentrids)	8.5	1.1	2042.5	0.0	0.0	0.0	2042.5	351.8
Fairy Basslets (Anthids)	2.1	0.4	1557.3	0.0	0.0	0.0	1557.3	456.9
Moorish Idols (*Zanclus cornutus*)	0.9	0.1	3.8	1.1	0.0	0.0	4.9	1.4
Total (target reef spp.):	**17.4**	**2.2**	**4.8**	**182.8**	**29.3**	**18.8**	**235.5**	**55.3**
Total (all reef spp.):	**58.4**	**3.0**	**3771.0**	**517.9**	**34.9**	**20.8**	**4344.5**	**608.6**

* Target species/families

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

Table 24. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at SR-1 (South Reef) Lighthouse Islet from 1992 to 2004.

Family	(N=1) 1992 Species	(N=4) 1996 Species	% Change 1992-1996	(N=6) 2000 Species	% Change 1996-2000	(N=8) 2004 Species	% Change 2000-2004
Surgeonfish (Acanthurids)*	8.0	5.0	-37.5	5.7	13.3	5.9	3.7
Rabbitfish (Siganids)*	2.0	1.0	-50.0	1.8	83.3	0.3	-86.4
Groupers (Serranids)*	4.0	2.3	-43.8	2.5	11.1	2.6	5.0
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A
Snapper (Lutjanids)*	2.0	0.8	-62.5	0.8	11.1	1.6	95.0
Sweetlips (Haemulids)*	1.0	0.0	-100.0	0.2	+	0.1	-25.0
Emperors (Lethrinids)*	0.0	0.3	+	1.0	300.0	1.0	0.0
Jacks (Carangids)*	1.0	0.5	-50.0	1.0	100.0	0.9	-12.5
Fusiliers (Caesionids)*	1.0	1.0	0.0	0.3	-66.7	0.6	87.5
Spinecheeks (Nemipterids)*	0.0	0.8	+	0.5	-33.3	0.6	25.0
Goatfish (Mullids)*	1.0	0.8	-25.0	0.5	-33.3	1.5	200.0
Parrotfish (Scarids)*	1.0	2.0	100.0	4.0	100.0	2.3	-43.8
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A
Triggerfish (Balistids)	4.0	1.8	-56.3	4.3	147.6	4.1	-4.8
Butterflyfish (Chaetodonids)	8.0	12.3	53.1	10.2	-17.0	12.0	18.0
Angelfish (Pomacanthids)	2.0	1.5	-25.0	2.8	88.9	3.9	36.8
Wrasses (Labrids)	5.0	4.8	-5.0	5.8	22.8	9.4	60.7
Humphead wrasse	~	~	N/A	~	N/A	0.1	N/A
Damselfish (Pomacentrids)	13.0	7.0	-46.2	7.3	4.8	8.5	15.9
Fairy Basslets (Anthids)	2.0	2.5	25.0	1.8	-26.7	2.1	15.9
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	1.0	0.0	0.9	-12.5
Total (target reef spp.):	**21.0**	**14.3**	**-31.9**	**18.3**	**28.0**	**17.4**	**-5.1**
Total (all reef spp.):	**56.0**	**45.0**	**-19.6**	**51.7**	**14.9**	**58.4**	**12.9**

* Target species/families

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

(-) = decrease

(+) = increase

Table 25. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at SR-1 (South Reef) Lighthouse Islet from 1992 to 2004.

Family	(N=1) 1992 Density	(N=4) 1996 Density	% Change 1992 1996	(N=6) 2000 Density	% Change 1996 2000	(N=8) 2004 Density	% Change 2000 2004
Surgeonfish (Acanthurids)*	232.0	82.0	-64.7	158.0	92.7	145.1	-8.1
Rabbitfish (Siganids)*	2.0	4.5	125.0	4.5	0.0	0.6	-86.1
Groupers (Serranids)*	13.0	8.3	-36.5	17.8	116.2	13.4	-25.0
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A
Snapper (Lutjanids)*	18.0	11.3	-37.5	1.8	-83.7	6.6	261.4
Sweetlips (Haemulids)*	9.0	0.0	-100.0	0.3	+	5.6	1587.5
Emperors (Lethrinids)*	0.0	0.8	+	11.5	1433.3	46.6	305.4
Jacks (Carangids)*	9.0	2.5	-72.2	3.7	46.7	7.6	108.0
Fusiliers (Caesionids)*	129.0	21.0	-83.7	5.2	-75.4	29.6	473.4
Spinecheeks (Nemipterids)*	0.0	42.8	+	0.8	-98.1	1.3	50.0
Goatfish (Mullids)*	9.0	66.8	641.7	22.2	-66.8	10.3	-53.8
Parrotfish (Scarids)*	129.0	43.5	-66.3	140.2	222.2	14.0	-90.0
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.0	N/A	0.0	N/A
Triggerfish (Balistids)	148.0	45.3	-69.4	129.8	186.9	333.3	156.7
Butterflyfish (Chaetodonids)	33.0	35.3	6.8	34.0	-3.5	45.4	33.5
Angelfish (Pomacanthids)	34.0	14.0	-58.8	26.8	91.7	17.9	-33.4
Wrasses (Labrids)	87.0	40.0	-54.0	179.0	347.5	62.4	-65.2
Humphead wrasse	~	~	N/A	~	N/A	0.3	N/A
Damselfish (Pomacentrids)	1221.0	2232.0	82.8	2805.2	25.7	2042.5	-27.2
Fairy Basslets (Anthids)	1026.0	802.5	-21.8	762.0	-5.0	1557.3	104.4
Moorish Idols (*Zanclus cornutus*)	33.0	27.0	-18.2	13.8	-48.8	4.9	-64.8
Total (target reef spp.):	**550.0**	**283.3**	**-48.5**	**366.0**	**29.2**	**235.5**	**-35.7**
Total (all reef spp.):	**3132.0**	**3479.3**	**11.1**	**4316.7**	**24.1**	**4344.5**	**0.6**

* Target species/families

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

(-) = decrease

(+) = increase

Table 26. Changes in substrate composition (% mean ±SE) in Jessie Beazley Reef from 1984 to 2004.

	SCUBA SURVEY		SNORKEL SURVEY					
	2004		1984		1989		2004	
	% cover	SE	% cover	SE	% cover	SE	% cover	SE
SUBSTRATE COVER								
Sand (s) and Silt (SI)	7.0	1.6	5.0	~	3.0	~	5.4	2.0
Coral Rubble (R)	16.0	3.1	11.9	~	10.6	~	3.6	1.1
Rock and Block (RK)	13.1	2.1	35.9	~	48.0	~	33.5	4.8
White Dead Standing Coral (DC)	2.0	1.8	7.0	~	6.3	~	0.1	0.1
Dead Coral with Algae (DCA)	4.3	0.7	0.0	~	0.0	~	3.4	1.1
Subtotal Non-living Substrate	***42.5***	***5.0***	***59.8***	~	***67.9***	~	***45.9***	***3.9***
Branching (CB)	18.4	3.3	14.6	~	4.3	~	14.1	1.5
Massive (CM)	5.9	1.0	10.5	~	9.3	~	6.9	1.4
Flat/Encrusting (CFD)	10.6	2.3	10.5	~	4.0	~	24.2	3.0
Foliose Cup (CFO)	1.3	0.7	0.8	~ ~	2.3	~ ~	0.8	0.5
Total Hard Coral	36.3	4.3	36.4	~	19.8	~	46.0	3.7
Total Soft Coral	15.6	2.6	3.8	~	12.3	~	2.5	2.1
Subtotal Coral	***51.8***	***4.8***	***40.2***	~	***32.1***	~	***48.4***	***4.1***
Sponges	1.4	0.3	~	~	~	~	0.5	0.3
Other animals	0.5	0.2	~	~	~	~	0.0	0.0
Algae								
Turf algae	0.2	0.1	~	~	~	~	1.3	0.6
Fleshy algae	0.3	0.1	~	~	~	~	1.7	1.3
Coralline algae	3.4	0.7	~	~	~	~	2.1	0.9
Seagrass	0.0	0.0	~	~	~	~	0.0	0.0
Subtotal Others	***5.7***	***0.8***		~		~	***5.6***	***1.9***
TOTAL	100.0		100.0		100.0		100.0	
Environmental Parameters								
Mean Slope (degrees)	17.3						7.0	
Mean Topography (m) *	0.7						1.5	
Mean Depth/Range (m)	6.9						2.7	
Horizontal Visibility (m)	29.7						26.7	
No. of 50 m Transects	16						13	

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

Table 27. Mean (±SE) fish species richness (species/500m2) and density (fish/500m2) per family at Jessie Beazley in 2004.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.9	0.5	45.4	117.6	69.0	0.0	172.9	74.1
Rabbitfish (Siganids)*	0.3	0.2	0.0	0.3	3.0	0.0	0.7	0.5
Groupers (Serranids)*	2.3	0.2	0.0	4.0	51.0	0.7	12.0	4.1
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.6	0.2	0.0	2.6	3.0	0.1	3.1	1.6
Sweetlips (Haemulids)*	0.1	0.1	0.0	0.4	0.0	0.0	0.4	0.4
Emperors (Lethrinids)*	1.3	0.2	0.0	3.4	5.0	0.4	4.6	1.3
Jacks (Carangids)*	0.1	0.1	0.0	0.0	1.0	0.0	0.1	0.1
Fusiliers (Caesionids)*	0.4	0.2	0.0	20.3	0.0	0.0	20.3	18.2
Spinecheeks (Nemipterids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goatfish (Mullids)*	1.4	0.4	0.0	11.0	13.0	0.0	12.9	6.7
Parrotfish (Scarids)*	1.1	0.3	0.0	2.6	7.0	0.1	3.7	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	0.1	0.1	0.1
Triggerfish (Balistids)	3.6	0.4	44.0	98.4	353.0	0.0	192.9	72.8
Butterflyfish (Chaetodonids)	7.6	0.8	23.9	10.6	3.0	0.0	34.9	11.7
Angelfish (Pomacanthids)	2.4	0.3	16.6	1.0	0.0	0.0	17.6	5.2
Wrasses (Labrids)	9.0	1.3	75.4	21.3	0.0	8.7	105.4	21.7
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	9.0	0.7	592.3	0.0	0.0	0.0	592.3	94.3
Fairy Basslets (Anthids)	1.7	0.3	564.9	0.0	0.0	0.0	564.9	314.2
Moorish Idols (*Zanclus cornutus*)	0.7	0.2	9.4	0.9	15.0	0.0	12.4	5.4
Total (target reef spp.):	**13.6**	**0.8**	**0.0**	**162.1**	**152.0**	**1.6**	**185.4**	**74.2**
Total (all reef spp.):	**47.6**	**2.3**	**1371.9**	**294.3**	**523.0**	**10.3**	**1751.1**	**261.8**

* Target species/families

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

Table 28. Changes in substrate composition (% mean ±SE) in Bastera Reef from 1984 to 2000.

	SCUBA SURVEYS:			SNORKEL SURVEYS:		
	1984	1996	% Change 1984-1996	1984	1989	% Change 1984-1989
SUBSTRATE COVER	% cover	% cover		% cover	% cover	
Sand (s) and Silt (SI)	2.8	15.9	474.1	13	5.4	-58.8
Coral Rubble (R)	7.5	23.9	218.6	37	6.4	-82.7
Rock and Block (RK)	15.9	19.4	21.9	22	53.8	144.3
White Dead Standing Coral (DC)	2.7	0.1	-96.7	0	0.0	N/A
Dead Coral with Algae (DCA)	0.0	10.7	+	0	2.3	+
Subtotal Non-living Substrate	***28.9***	***70.1***	***142.5***	***72***	***67.8***	***-5.8***
Branching (CB)	35.0	10.1	-71.2	20	~	N/A
Massive (CM)	4.2	4.0	-5.7	8	~	N/A
Flat/Encrusting (CFD)	7.4	5.1	-30.8	0	~	N/A
Foliose Cup (CFO)	1.7	1.1	-32.5	0	~	N/A
Total Hard Coral	48.4	20.4	-57.9	28	28.9	3.1
Total Soft Coral	22.7	9.6	-57.8	0	3.3	+
Subtotal Coral	***71.1***	***29.9***	***-57.9***	***28***	***32.2***	***14.9***
Sponges	~	~	N/A	~	~	N/A
Other animals	~	~	N/A	~	~	N/A
Algae						
Turf algae	~	~	N/A	~	~	N/A
Fleshy algae	~	~	N/A	~	~	N/A
Coralline algae	~	~	N/A	~	~	N/A
Seagrass	~	~	N/A	~	~	N/A
Subtotal Others	~	~	N/A	~	~	N/A
TOTAL	**100.0**	**100.0**		**100.0**	**100.0**	
Environmental Paramenters						
Mean Slope (degrees)	~	14		~	2.4	
Mean Topography (m) *	~	~		~	~	
Mean Depth/Range (m)	7-8 m	7-8 m		2-4 m	2-4 m	
Horizontal Visibility (m)	~	~		~	~	
No. of 50 m Transects	7	17		1	15	

~ no data available

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

Table 29. Mean (±SE) fish species richness (species/500m2) and percentage change between years at Bastera Reef from 1996 to 2000.

Family	(N=4)	(N=6)	% Change 1992-1996
	1996	2000	
	Species		
Surgeonfish (Acanthurids)*	5.8	6.5	13.0
Rabbitfish (Siganids)*	0.8	0.5	-33.3
Groupers (Serranids)*	2.0	3.3	66.7
Barramundi cod	~	~	N/A
Snapper (Lutjanids)*	1.8	1.0	-42.9
Sweetlips (Haemulids)*	0.3	0.0	-100.0
Emperors (Lethrinids)*	0.3	0.7	166.7
Jacks (Carangids)*	0.3	0.7	166.7
Fusiliers (Caesionids)*	1.3	0.5	-60.0
Spinecheeks (Nemipterids)*	0.0	0.5	+
Goatfish (Mullids)*	1.0	1.7	66.7
Parrotfish (Scarids)*	1.0	1.8	83.3
Bumphead parrotfish	~	~	N/A
Rudderfish (Kyphosids)*	0.3	0.3	33.3
Triggerfish (Balistids)	3.8	4.3	15.6
Butterflyfish (Chaetodonids)	12.8	9.0	-29.4
Angelfish (Pomacanthids)	2.0	2.2	8.3
Wrasses (Labrids)	4.5	7.7	70.4
Humphead wrasse	~	~	N/A
Damselfish (Pomacentrids)	6.3	8.3	33.3
Fairy Basslets (Anthids)	2.5	1.5	-40.0
Moorish Idols (*Zanclus cornutus*)	1.0	0.8	-16.7
Total (target reef spp.):	**14.5**	**17.5**	**20.7**
Total (all reef spp.):	**47.3**	**51.3**	**8.6**

* Target species/families

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

(-) = decrease

(+) = increase

Table 30. Mean (±SE) density (fish/500m2) and percentage change of fish families between years at Bastera from 1996 to 2000.

Family	(N=4)	(N=6)	% Change 1992-1996
	1996	2000	
	Density		
Surgeonfish (Acanthurids)*	198.0	271.2	37.0
Rabbitfish (Siganids)*	3.8	1.0	-73.3
Groupers (Serranids)*	9.0	24.2	168.5
Barramundi cod	~	~	N/A
Snapper (Lutjanids)*	21.8	4.5	-79.3
Sweetlips (Haemulids)*	0.3	0.0	-100.0
Emperors (Lethrinids)*	0.8	5.8	677.8
Jacks (Carangids)*	0.8	1.3	77.8
Fusiliers (Caesionids)*	59.3	32.2	-45.7
Spinecheeks (Nemipterids)*	0.0	6.2	+
Goatfish (Mullids)*	13.5	11.5	-14.8
Parrotfish (Scarids)*	7.5	33.2	342.2
Bumphead parrotfish	~	~	N/A
Rudderfish (Kyphosids)*	8.3	4.2	-49.5
Triggerfish (Balistids)	94.3	348.7	269.9
Butterflyfish (Chaetodonids)	49.5	61.2	23.6
Angelfish (Pomacanthids)	5.0	40.5	710.0
Wrasses (Labrids)	224.5	110.7	-50.7
Humphead wrasse	~	~	N/A
Damselfish (Pomacentrids)	1019.3	2411.8	136.6
Fairy Basslets (Anthids)	778.5	1026.0	31.8
Moorish Idols (*Zanclus cornutus*)	15.0	14.3	-4.4
Total (target reef spp.):	**322.8**	**395.0**	**22.4**
Total (all reef spp.):	**2508.8**	**4408.3**	**75.7**

* Target species/families

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

(-) = decrease

(+) = increase

Table 31. Human activities and other causes of stress affecting the coral reef on sites surveyed during a survey day, April 2004.

SITE NAME / SITE INFORMATION	Malayan Wreck NR 1	Ranger Station NR 2	Bird Islet NR 5	Lighthouse Reef SR 1	Black Rock SR 3	South Reef SR 4	Jessie Beazley
A. FISHING STRESSES AND THREATS TO THE AREA							
# of fishing boats w/in 500m	0	0	0	0	0	0	0
# of aquarium fishers w/in 500m	0	0	0	0	0	0	0
# of gleaners for food or curios w/in 500m	0	0	0	0	0	0	0
# of blasts heard during the dive	0	0	0	0	0	0	0
% of area used for mariculture w/in 1km	0	0	0	0	0	0	0
B. POPULATION STRESSES AND THREATS							
Distance to nearest population (km)	149	149	148	150	149	149	150
Approximate population (1000)							
# of factories/km of adjacent coast	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Distance to nearest river (km)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of farmed area of coastline	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of forested area of coastline	N/A	N/A	N/A	N/A	N/A	N/A	N/A
# of mines within sight	N/A	N/A	N/A	N/A	N/A	N/A	N/A
# of items of floating trash observed*	0	0	Few	0	0	0	Few
# of items of trash observed underwater*	0	Few	Few	0	0	0	Few
# of fish nets left as trash*	Few	0	Few	0	0	0	Few
C. TOURISM STRESSES							
# of boats anchoring w/in 500m	3	1	1	3	1	2	3
# of dive shops w/in 10km	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of coast build-up with structure	N/A	N/A	N/A	N/A	N/A	N/A	N/A
# of divers observed w/in 500m	≈ 20	0	7	≈ 30	≈ 10	≈ 20	≈ 30
D. OTHER STRESSES AND THREATS							
Year since last typoon (>100kph)	2002	2002	2002	2002	2002	2002	2002
# of large ships w/in sight	0	0	0	1	1	0	0
Year since last bleaching	1998	1998	1998	1998	1998	1998	1998
% of bleached coral area	0	10%	0	0	1%	0	0
% of diseased coral area	0	0	0	0	0	0	1%

~ - No data

*** -** 0 - Not observed

Few - <20 pieces

Some - >20 pieces

Many - > 100 pieces

Table 33. Changes in abundance of large marine life in Tubbataha, Bastera and Jessie Beazley Reefs, Palawan.

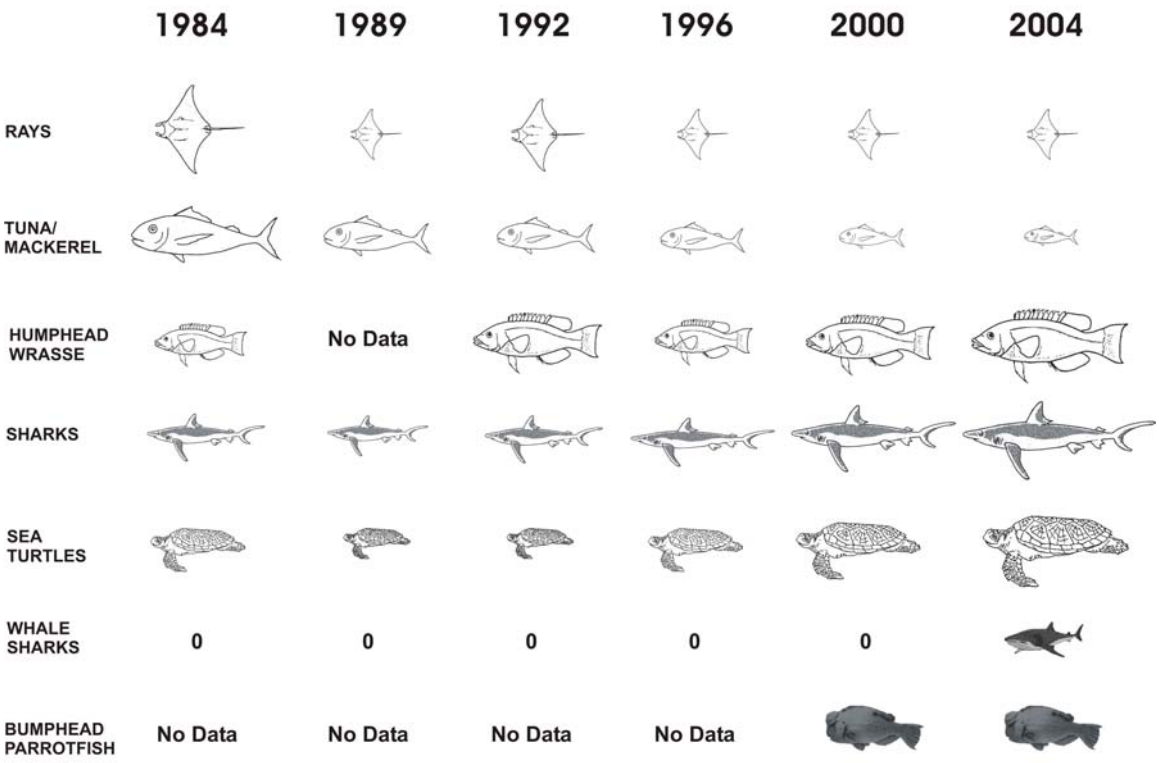
Marine Life / Year	1984	1989	1992	1996	2000	2004
MantaRays/Stingrays/Eagle Rays	30-50	~10	6 sites, ~20	2 sites, 2	5 sites, 10	1 site, 1
Tuna / Mackerel	large schools, abundant	many schools	schools	6 sites, few	2 sites, few	2 sites, schools
Humphead wrasses	Present	No Data	3 sites, ~30-40	1 site, ~5	5 sites, 20-30	abundant in all sites ~50
Sharks	most sites, abundant	5 sites, abundant	8 sites, abundant	6 sites, ~100	7 sites, ~100	7 sites, abundant ~ 200
Sea turtles	most sites, ~50, common	most sites	most sites	5 sites, ~36	7 sites, ~50	7 sites, common ~ 75
Whale sharks	0	0	0	0	0	Jessie Beazley, 1
Bumphead parrotfish	No Data	No Data	No Data	No Data	2 sites, few	Malayan Wreck, 1 school

SUMMARY OF RESULTS AND TRENDS

Large Marine Life

The changes of large marine life can be a gauge of reef health and/or fishing pressure of an area (Green et al. 2003). Tubbataha National Marine Park is known for its large marine life. Sharks, Humphead wrasses, Bumphead parrotfish, jacks, sea turtles, manta rays and other rays not found in most Philippine reefs are frequently seen in Tubbataha reefs. In the year 2004, a school of Bumphead parrotfish composed of 27 individuals was sighted in NR1, a whale shark in Jessie Beazley Reef and other sharks along with Humphead wrasses and turtles were seen in almost every dive. The numbers of sharks, sea turtles and humphead wrasses appear to be more compared to the surveys in 2000 and 1996 (Fig. 38). In contrast, the number of manta rays sighted appears to be declining sharply over the years which may be a reflection of fishing pressure in the Sulu Sea and other parts of the country. The large marine animals that stay mostly in the Park area are doing well, while the migratory species such as manta rays and tuna are declining.

Figure 39. Changes in abundance of large marine life since 1984 as listed in Table 33.



Invertebrates

The results of invertebrate surveys are presented in Table 32 as counts/100 m^2. Giant clams appeared to be the most abundant recorded invertebrate in Tubbataha reefs, however, not common in most Philippine reefs. Higher giant clam numbers were recorded in SR3, SR4 and JB in the year 2004 compared to 2000. Moreover, *Tridacna crocea* was abundant in the

shallows. Up to 150 giant clams were listed in SR1 during a single snorkeling survey covering 100 – 150 m.

Table 32. Number of invertebrates per 100m^2 from selected sites, Tubbataha Reefs.

Organism	NR-1		NR-2		NR-5		SR-1		SR-3		SR-4		Bastera	Jessie Beazley
	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004
Diadema urchin	1	1	1	2	1.5	1	0	2	0	0	1	0	3	0
Pencil urchin	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Crown of thorns seastar	8.7	0	0	0	1	0	0	0	0	0	3	4	0	4
Giant clam	4.3	4	2.8	23	2.8	7	3	6	1.6	25	2.8	17	1.6	17
Triton shell	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lobster	0	0	1	0	1	1	0	0	1	0	P	0	0	0
Sea cucumber	2.7	17	1.8	2	1.8	11	1	2	1.3	0	20.2	3	1.5	3
Banded coral shrimp	0	0	0	0	0	0	0	0	0	0	0	0	0	0

note: no available data for 1992 and 1996
legend: P = present in small numbers (1-10)

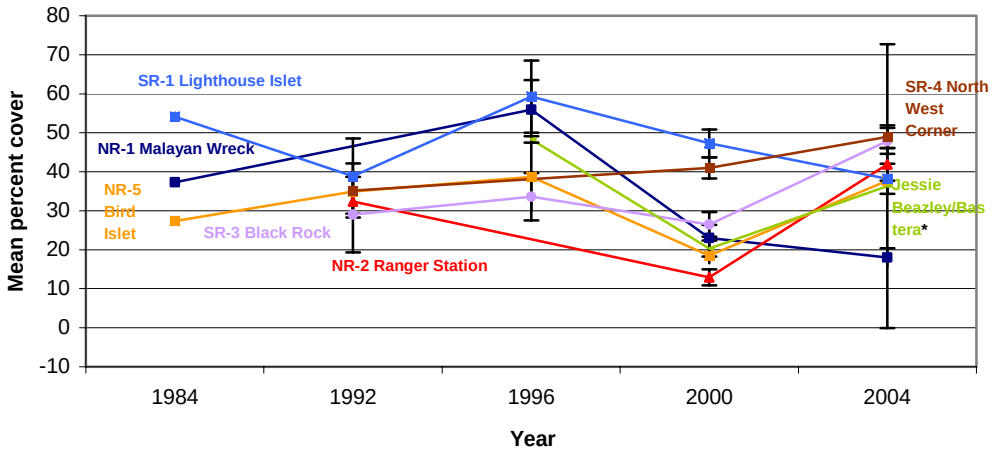
Coral Reef and other substrate

Live hard coral for all 2004 surveyed sites in Tubbataha reef is fair (Fig. 31). The highest recorded was in NR5 and SR3 but were not significantly different from Jessie Beazley (control site). In contrast, a significant lower cover was recorded from NR1.

Surveys over time indicated that the rise in seawater temperature in 1998 during an ENSO event, contributed largely to changes in the Tubbataha coral reef substrate. Coral cover in all sites declined significantly from the year 1996 to 2000 and the response of each reef exhibited in the year 2004 varied: (1) no significant change in coral cover, (2) recovery in terms of increase in coral cover and (3) recovery in terms of increase in coral cover coupled with a phase shift in the living substrate composition. The overall trend between 2000 and 2004 is positive.

SR4 coral reef cover was least impacted in terms of bleaching. Although there is an increase in its total coral cover, it is not significant. SR4 coral cover remains unchanged from 1996 to 2004. Factors that may have contributed to the high survival of corals at this site during sea water temperature rise include: (1) the depth at which the corals thrive, (2) species composition of the reef and (3) the exposure of the reef to strong currents that could have acted as a temporary buffer for temperature rise.

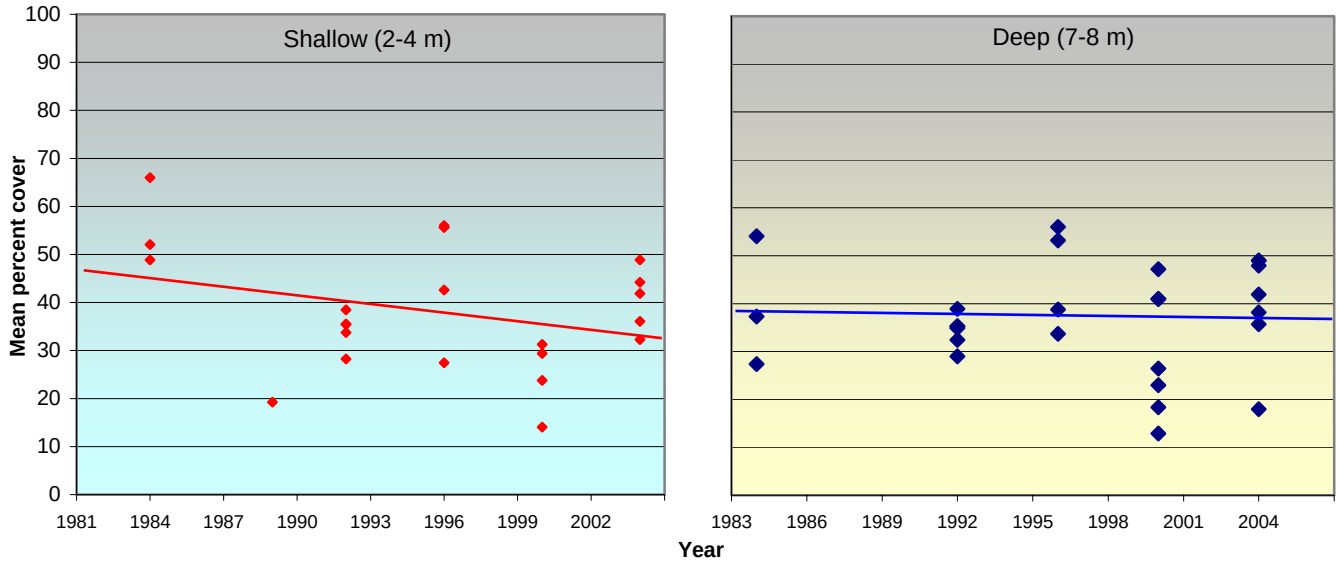
Figure 31. Changes in live hard coral (%mean ±SE) in sites at Tubbataha Reefs Marine Park from 1984 to 2004.



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park

Coral reef recovery was evident in most Tubbataha survey sites in the year 2004. NR1 was severely impacted by bleaching which resulted into the sharp decline of its coral cover from 1996 (good) to 2000 (fair). However, an increasing trend in coral cover was observed from 2000 to 2004 indicating recovery through coral growth in sites like NR2 (% change, deep = 224.6), NR5 (% change, deep = 93.1) and SR3 (% change, deep = 80.8). In contrast, no significant change in coral cover was yet observed in SR1 and NR1 from 2000 to 2004 (Appendix 5), indicating that it may take longer for SR1 and NR1 coral cover to recover compared to other sites. An average living coral trend is shown in Figure 32 that indicates an overall decrease in shallow areas and an almost even trend in deep areas.

Figure 32. Trend of average living coral cover for all sites monitored from 1984 to 2004.



Changes in community structure as a consequence of coral bleaching and death was seen in SR3 (Fig. 9). A decline in both soft coral and hard coral cover was observed in this site from 1996 to 2000. By 2004, a phase shift has occurred. Live hard coral cover increased significantly by 81% replacing most of the soft coral population in the area prior to the bleaching episode. A similar change in Apo Island, Central Philippines was documented by Raymundo and Maypa (2002, 2003). Soft coral cover steadily increased while the hard coral cover decreased in the area after ENSO from 1999 to 2001. However, by 2002 the hard coral cover had started to increase while soft coral cover started to decline.

It appears that the negative impact of bleaching on different reefs is variable (Douglas 2003). Gradual bleaching episodes will have different effects on the different Tubbataha sites. Recovery from bleaching and changes in community structure of Tubbataha reefs will likely be driven by the resiliency of hard coral species present in the area, interactions between hard coral recruitment, soft coral competition (specifically in SR3), corallivory, local current patterns and the depth at which corals grow and future bleaching episodes. “Thus the need for sustained management of the reef ecosysytems and protection from anthropogenic factors is greater than ever (Douglas 2003).” Protection combined with regular reef monitoring is thus, essential for a good and sustained management of Tubbataha reefs.

Fish diversity and abundance

Fish abundance reflects the relative success of Tubbataha Park management rather than species richness (Fig 33, 34). Fish density for all reef species (Fig. 35) was significantly higher in SR1 (Lighthouse), SR3 (Black Rock) and NR2 (Ranger Station) compared to Jessie Beazley and other sites (Appendix 4B). In addition, high densities of target fish were recorded in NR2 (Figure 36). Out of the seven sites surveyed in 2004, six are legally protected from fishing (Fig.8). Jessie Beazley reef is outside the Park. It also appears that the distance of the site from the Ranger station plays a role in maintaining good coral reef and marine life conditions in a site at Tubbataha. This may be a result of the relative levels in patrol enforcement by Rangers due to site accessibility.

Figure 33. Mean (±SE) species richness (species/500m^2) of all reef species at seven sites in Tubbataha Reefs Marine Park.

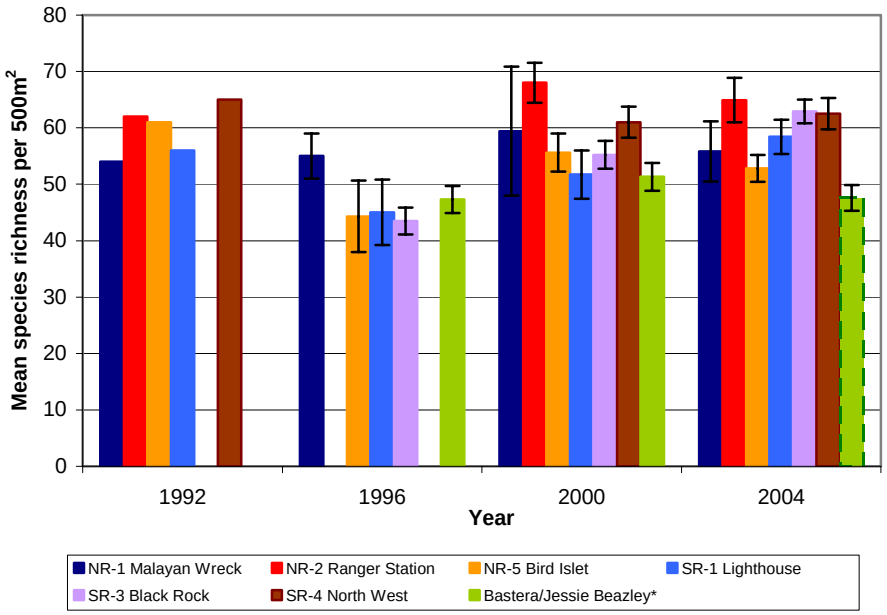
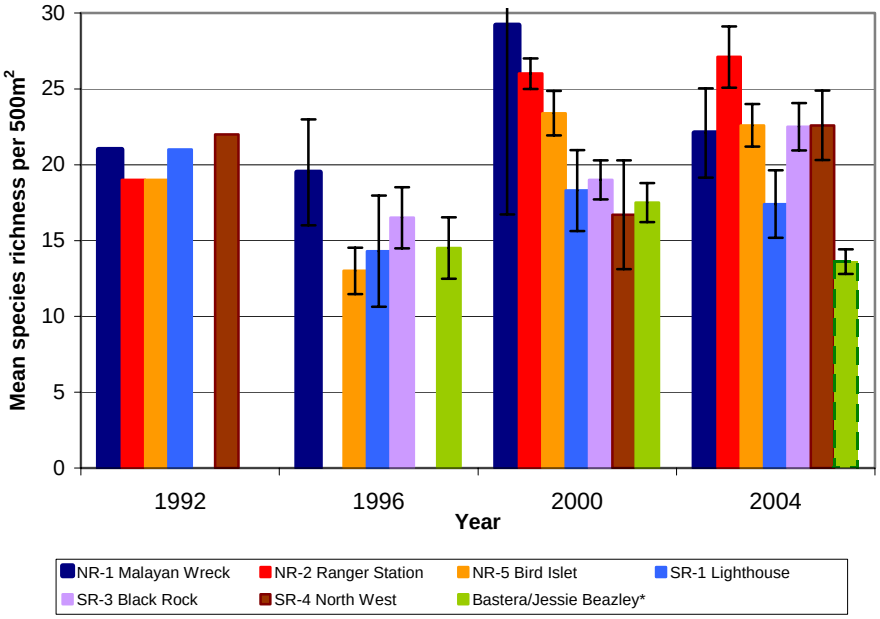


Figure 34. Mean (±SE) species richness (species/500 m^2) of target species at seven sites in Tubbataha Reefs Marine Park.



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park

Figure 35. Mean (±SE) density (fish/500m^2) of all reef species at seven sites in Tubbataha Reefs Marine Park.

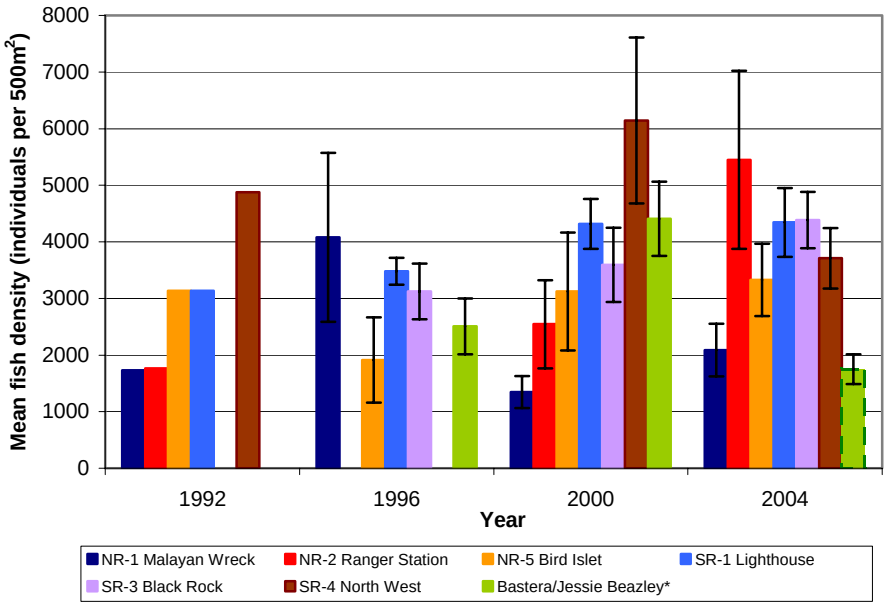
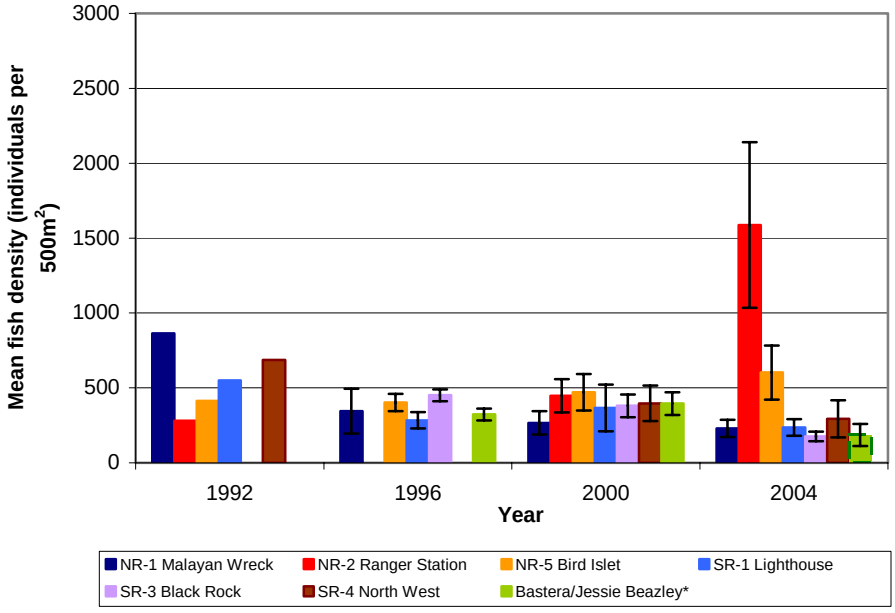


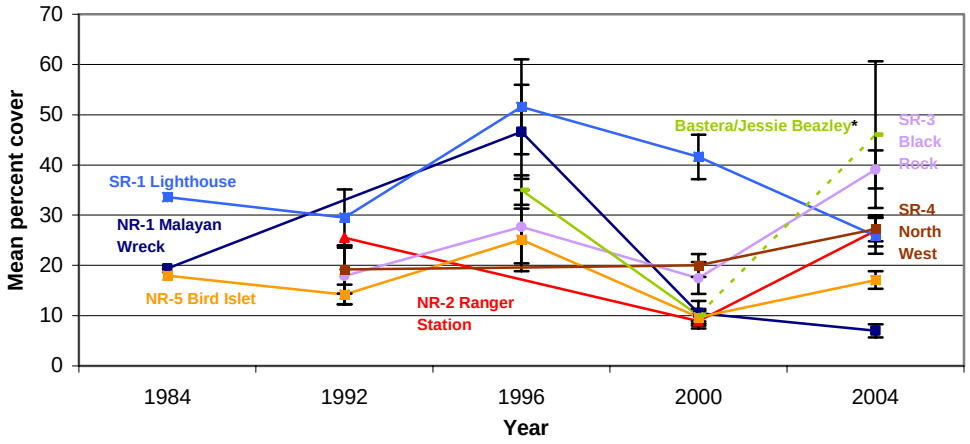
Figure 36. Mean (±SE) density (fish/500m^2) of target species at seven sites in Tubbataha Reefs Marine Park.



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park

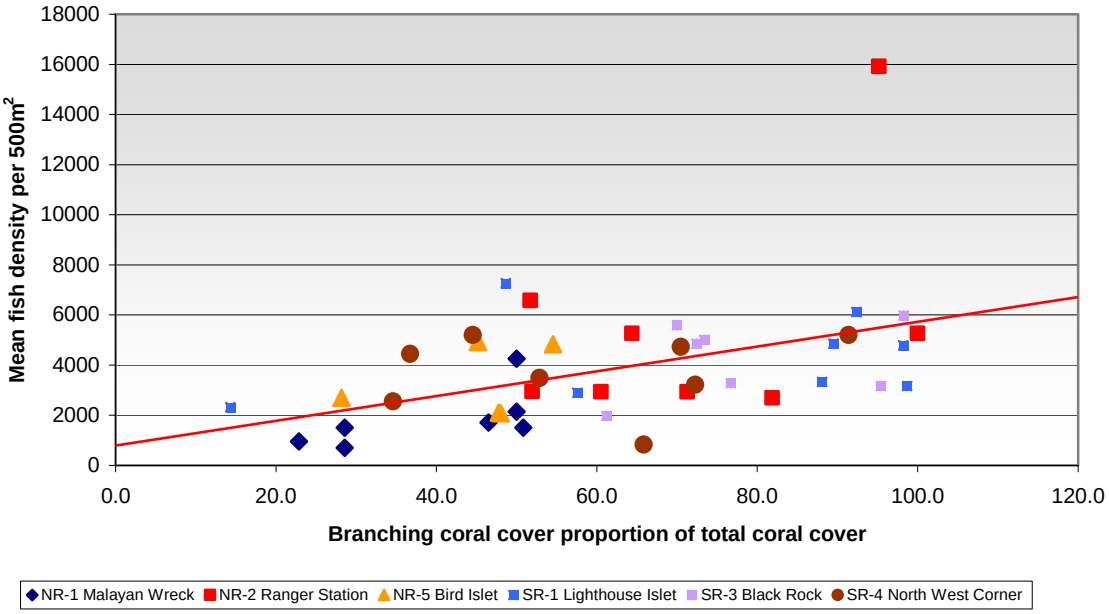
Alternatively, a significant positive correlation (r = 0.463, p = 0.001, Pearson Product Moment correlation) resulted between mean species density of all reef species and the proportion of branching coral relative to the total live hard coral cover of the area (Fig 37). NR2, SR1 and SR3 had higher proportions of branching corals (Fig. 38) and high mean species density for all reef species (Fig. 33) compared to the rest of the sites. However, this result should be interpreted with caution since Tubbataha reefs are far better reefs in terms of coral cover and fish fauna compared to other reefs in the country (White et al. 2000, Deocadez et al. 2003). Thus other factors aside from the proportion of branching corals in relation to the total hard coral cover of the area may contribute to the high fish density of a particular site. The high fish density in NR2, SR1 and SR3 is more likely a synergistic effect, a reflection of various factors interacting at the same time. Further, the high proportions of branching corals can also be partially attributed to protection from human induced damage in these sites, thus to management.

Figure 37. Changes in branching coral cover (%mean ±SE) for all sites of Tubbataha Reefs Marine Park from 1984 to 2004.



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park

Figure 38. Mean density of all reef species and the proportion of branching coral relative to total live hard coral cover in all sites of Tubbataha Reefs Marine Park, 2004.



A major difference in fish densities between Tubbataha and most reefs in the Philippines is in the quality of its fish fauna. Fish abundance in Tubbataha is not only derived from Pomacentrids and Anthids but including large predatory fish and other target fish belonging to large size classes as well. Large marine life is also common in every site indicating a healthy reef. Comparison with other reefs in the Philippines like Lingayen Gulf (northwestern Philippines), where its fish biomass is 14 times lower than Tubbataha (Deocadez et al. 2003), only supports our conclusion that Tubbataha has a healthy reef.

Human activities

A snapshot of human activities in Tubbataha Reefs over time is presented in Table 31. A shift in reef users can be observed. Tubbataha was a traditional fishing ground of Cagayancillo fishers, thus many fishers were still sighted in the area during the 1980's. By 1992, fishing activities sharply declined, until none was observed in1996. The decline and absence of fishing activities was replaced by an increasing number of tourist boats and divers in the area. Interviews with park rangers and manager (A. Songco) revealed that enforcement has been strict since the year 2000.

RECOMMENDATIONS FOR IMPROVED MANAGEMENT

Tubbataha Reef National Marine Park (TRNMP) has come a long way after sixteen (16) years of implementation. It is now managed and protected according to the 5-year Management Plan endorsed in 1999. Over the years, management efforts have considerably reduced illegal fishing activities and have helped the park revert back to its natural ecology. Large marine life is slowly returning as well as the resident and migratory birds of Tubbataha. For this same reason, Tubbataha continuously attracts local and foreign tourists, particularly diving enthusiasts.

The challenge now lies in sustaining efforts to enforce the law and manage the growing volume of tourism. It is important to continue and strengthen protection of Tubbataha through an integrated management approach that is consistent with the preservation of biodiversity as well as sustainable and equitable use of resources. The following are specific suggestions to enhance conservation of TRNMP:

1. **Additional boats must be provided for use in patrolling.** Active patrols are essential in preventing illegal fishermen and boats from entering the park. To date, only one boat is used for patrolling the entire 33,000-ha park. This needs upgrading to a fully functional boat and surveillance system that functions all year. This patrolling vigilance is especially important during the non-tourism season, from June through February when tourist boats do not enter the Tubbataha Park.

2. **The Park Navy personnel can take a more active role in park management.** Persons stationed in the Park at the ranger station are not fully utilized. Efforts are needed to program activities for the park staff stationed in the area to keep records on all visitors, watch for illegal fishers, record weather and wave conditions, check permits and make presentations to all park visitors about their work. Opportunities for stationed personnel to become more engaged in various activities are many.

3. **More and better anchor buoys are needed to moor visiting boats.** There is a need to improve the mooring facilities in the park. Better mooring facilities is essential and should be installed and maintained as the number of boats increases to Tubbataha. The current mooring buoys are not sufficient enough in number and size for the dive boats to anchor on. Some anchor buoys show signs of being dragged across the reef when the boat is too large and the mooring line is too short. This is a yearly job where the Navy personnel, WWF staff and the dive boat operators can contribute and work together with.

4. **Improved management of tourism to Tubbataha is essential.** Tourism in Tubbataha Reefs is increasing and will continue to do so. This will require more coordination among dive boats and between the PAMB and the dive operators. Although the current system of park user fee collection and yearly entry permits was quite smooth this 2004, improvements can still be made. The number of boats anchoring at popular dive sites will need to be coordinated so that boats are not forced to drop anchors when too many boats are visiting any given site. Diver education and awareness to marine conservation has improved nationwide, however, there is still a need to better educate some boat operators in Tubbataha.

Dive boat operators and dive masters also need to be better informed about park rules and procedures to minimize confusion.

5. **More diver and boat operator education is needed.** Each dive boat needs to allocate time for diver briefings on Tubbataha Park and rules. Every boat should have the appropriate materials in the form of a flip-chart, video and handouts that fully explain the park regulations and the do's and don'ts of the area. Information on the natural and human history should also be available. Each boat should have one trained person on board who can make this briefing to all visitors to the area.

6. **Raising awareness about waste disposal is needed.** As more boats moor in Tubbataha, more waste will be disposed there. Regulations are needed to guide how boats manage their waste, both solid and liquid. In addition, shipping companies should be encouraged to stop dumping in mid-water in the Sulu Sea in the vicinity of Tubbataha so that solid and liquid wastes do not drift onto the reefs.

7. **User fees need to be managed credibly and made transparent and allocated for park management as appropriate.** The sustainability of financial management for Tubbataha will depend on user fees and permit fees to cover management costs in the long term. Information explaining how user fees are collected, managed and ultimately utilized should be made available for anyone who wants to access it. This may also stimulate extra donations from some visitors.

8. **Monitoring and evaluation information needs to be shared among all stakeholders.** Sharing collected information has improved over the years, however, this is still not sufficient. Since 1984, data has been gathered in Tubbataha reefs and only a few institutions or organizations share their findings. Sharing of collected information is essential for the park management and policy formulation.

9. **Continued monitoring for sustained management.** Future ENSO bleaching episodes are expected to impact Tubbataha reefs as a consequence of elevated sea surface temperature. Information from regular monitoring on the condition of Tubbataha reefs will help managers plan and implement necessary actions. Coral reef loss from events like this can be minimized and recovered when coral reefs are fully protected from direct human damage.

Overall, the Park management is doing a fine job given their relative lack of resources for the large and demanding job of protecting Tubbataha Reefs!

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APPENDIX 1

ITINERARY OF EVENTS
Saving Philippine Reefs: Tubbataha Expedition
April 2- 11, 2004

DAY	DATE & SITE	TIME	ACTIVITIES
1	Saturday/ April 3 Puerto Princesa	10:00 12:30 PM 1:00 2:00 7:00	Rendezvous Puerto Princesa airport Proceed to Tristar boat pier Welcome briefing Lunch on boat Briefing on SPR project Practice snorkel and scuba dive, Puerto Princesa Bay (White beach crossing) Dinner Short presentation on corals/ discussion on Tubbataha
2	Sunday/ April 4 North Reef 5 NR-5 (Bird Islet)	7:00 AM 8:00 9:00 12:00 PM 2:00 5:00 7:00	Breakfast Briefing (field techniques to be used) Practice survey: 50 m transect of reef substrate and fish (snorkel and scuba) Lunch Practice survey: 50 m transect reef substrate and fish (scuba) Compile data and submit data forms Transition dive Dinner Slides show on Butterfly fish/ discussion (Brian)
3	Monday/ April 5 Jessie Beazley	7:00 12:00 5:00 7:00	Breakfast Conduct surveys (snorkel and scuba) Lunch Compile and submit completed data forms Dinner
4	Tuesday/ April 6 NR 1 Amos Rock (Malayan Wreck)	7:00 AM 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (snorkel and scuba) Compile and submit completed data forms Transition dive Dinner Presentation: CCE Foundation (Anna and Sheryll)
5	Wednesday/ April 7 SR 3 (Black Rock)	7:00 AM 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Transition dive Dinner

DAY	DATE & SITE	TIME	ACTIVITIES
8	Thursday/ April 8 SR-4 (Northwest Corner)	7:00 AM 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Dinner Presentation (Aileen and Brian)
6	Friday/ April 9 SR-1 (Lighthouse Reef and Del San Wreck)	7:00 AM 12:00 5:00 7:00	Transition dive Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Dinner
7	Saturday/ April 10 NR 2 (Ranger Station)	7:00 AM 12:00 PM 5:00 7:00	Breakfast Morning briefing Conduct surveys (snorkel and scuba) Lunch Complete surveys (scuba) Compile and submit completed data forms Visit ranger station Dinner Presentation (Patrick)
9	Sunday/ April 11 Puerto Princesa	 9:00 AM	Breakfast Debriefing Depart boat for airport Check in at the airport for those leaving Palawan

APPENDIX 2

EXPEDITION VOLUNTEERS
April 3-11, 2004

	Name / Address	Telephone / fax / email	Profession / Affiliations / Interests
1	**Jane Jones** 1096 Lunaanela St. Kailua Hawaii 96734	(808) 261-0507 (Home) Email: nojones2@worldnet.att.net	Volunteer Docent at Waikiki Aquarium and volunteers at the Mediation Center of the Pacific and ReefCheck. Interest in corals, coral reefs and ecology, experienced diver and snorkeler; 7th Earthwatch "Saving Philippine Reefs" Expedition.
3	**Thomas Mueller** 43 Bircholm Ln Little Deer Isle, ME 04650 U.S.A.	Day Phone: 917-592-7074 Evening Phone: 207-348-6134 Email: tj@tjmueller.com	Self employed educational consultant to Higher Education; PhD in Biology; small boat experience, especially sail; underwater photographer; SCUBA instructor; 6th "Saving Philippine Reefs" expedition
4	**Jonathan "Drew" Achabal** 372 Richlee Drive Campbell, CA 95008 U.S.A.	Day Phone: 408 480 4084 Email: dachabal@sbcglobal.net	Experienced scuba diver. Consultant for retail industry (Planalytics) defining business processes and implementing technology to support such processes. 2nd Saving Philippine Reefs Expedition.
5	**Thure Meyer** 411 Apodaca Hill Santa Fe, New Mexico 87501	Home phone: 505 983-1325 Cell phone: 646 207-5457 Email: ethinker@sprynet.com	Information Technology, State of New Mexico, advanced and rescue diver (NAUI)
6	**Geoff Illing** 34 Oakland Drive Warrandyte, VIC 3133 Australia	Day Phone: 03 9865 9140 Office Phone: +613 9865 9118 Home Phone: +613 9844 1583 Mobile: +61 419307047 Email: geoffi@netscape.net.au illing@bigpond.net.au	Director, UNICO Computer Systems. Post-graduate Part III Maths in Cambridge. Software designer with own company providing intelligent network software. Rescue diver and DAN First Aid. Interest in helping with reef preservation. 2nd Saving Philippine Reefs expedition.
7	**Denise Illing** 34 Oakland Drive Warrandyte, VIC 3133 Australia	Day Phone: 03 9865 9140 Office Phone: 04 1931 7653 Home Phone: 03 9844 1583 Email: geoffl@netscape.net.au illing@bigpond.net.au	Technical Librarian, UNICO Computer Systems. BA in Geography and Sociology. DAN First Aid and Oxygen Provider with CPR. Interested in marine life, reefs, and diving. Have a reef tank at home. 2nd Saving Philippine Reefs expedition.
8	**Mark Copley** 5 Normandy Cir Colorado Springs, CO 80906 USA	Tel: 719-578-8670 (H) 719-310-2073 (M) Email: mark_copley@yahoo.com mhc@quizdog.com	Owner of Quiz Dogs Productions; Engineer University of Colorado; MS Computer Science from Brown University. 2nd Saving Philippine Reefs expedition.
9	**Vittoria Annoscia-Thornley** Kemble Mill, Somerford Keynes Cirencester, Glos. GL7 GED U.K.	(012) (85) 861303 (Home) (012) (85) 860888 (Fax) Email: vittoria@annoscia-thornley.freeserve.co.uk	Oxford University graduate in Human Sciences; International manager for stock photography agency for 9 years; MSc in Ecology; advanced openwater scuba diver.

	Name / Address	Telephone / fax / email	Profession / Affiliations / Interests
10	**Heather D'Agnes** 1225 NE 61st Street Seattle, WA 98115 U.S.A.	206-517-4718 Email: hdagnes@u.washington.edu	Student, School of Marine Affairs and Evans School of Public Affairs, University of Washington; 2nd Saving Philippine Reefs expedition; advanced openwater scuba diver.
11	**Mary Julia Cichowski** 24 Fayette Street, Boston MA 02116 U.S.A.	(617) 451-6976 (Home) (617) 563-0881 (Work) Email: Julia.cichowski@fmr.com	V.P, Development, Fidelity Investments; Computer Science graduate; interest in underwater photography; 5th Saving Philippine Reefs Expedition; Divemaster.
12	**Matthew Montagu-Pollock** 2114 Paraiso Street Dasmarinas Village, Makati 1222 Metro Manila, Philippines	Email: pollock@mydestiny.net matthew@montagu-pollock.org.uk	Journalist, would be entrepreneur; openwater diver; 1st Saving Philippine Reefs expedition
13	**Aliaa Zayed Montagu-Pollock** 2114 Paraiso Street Dasmarinas Village, Makati 1222 Metro Manila, Philippines	Email: aliaa@mydestiny.net ; or aliaa@ montague-pollock.org.uk	Likes to read; snorkeler; 1st Saving Philippine Reefs expedition
14	**Gabriel Montagu-Pollock** 2114 Paraiso Street Dasmarinas Village, Makati 1222 Metro Manila, Philippines	Email: Gabriel1@mydestiny.net or Gabriel@montagu-pollock.org.uk	Student; likes to play football, rugby, and t-ball; 1st Saving Philippine Reefs expedition
15	**Sasha Montagu-Pollock** 2114 Paraiso Street Dasmarinas Village, Makati 1222 Metro Manila, Philippines	Email: sasha@mydestiny.net or sasha@montagu-pollock.org.uk	Student; likes to read, listen to music and swim; 1st Saving Philippine Reefs expedition

EXPEDITION STAFF
April 3-11, 2004

	Name / Address	Telephone / fax / email	Profession / Affiliations / Interests
1	**Alan T. White, Ph.D** Principal Investigator (PI)	(6332) 231-1521 (6332) 232-1821 up to 22 awhite@mozcom.com	Chief of Party Coastal Resource Management Project Tetra Tech EM Inc. and USAID 5th Floor, CIFC Towers North Reclamation Area, Cebu City 6000 Philippines President Coastal Conservation and Education Foundation, Inc (formerly "Sulu Fund")
2	**Patrick Christie** Co-principal Investigator (Co-PI)	patrickc@u.washington.edu	Professor University of Washington (reef conservation and function) 14312 SW 240th Vashon, WA 98070 USA
3	**Anna Blesilda Meneses** Co-principal Investigator (Co-PI)	(6332) 233-6909/47 (Work) (6332) 233-6891 (Fax) 0918-930-8526 abtmeneses@yahoo.com ccef@mozcom.com	Marine Protected Area Project Coordinator CCE Foundation Room 302, PDI Condominium Archbishop Reyes Avenue Banilad, 6000, Cebu City
4	**Evangeline White** Logistics and Support Coordinator	(6332) 233-6909/47 (Work) (6332) 233-6891 (Fax) (6332) 231-1521 (Home) sulufund@mozcom.com	Financial Manager / Board Secretary CCE Foundation Room 302, PDI Condominium Archbishop Reyes Avenue Banilad, 6000, Cebu City
5	**Sheryll Tesch** Data and Research Coordinator	(6332) 233-6909/47 (Work) (6332) 233-6891 (Fax) sheryll.tesch@lycos.com ccef@mozcom.com	CRM Data/IEC Coordinator CCE Foundation Room 302, PDI Condominium Archbishop Reyes Avenue Banilad, 6000, Cebu City
6	**Aileen Maypa** Researcher	(6332) 233-6909/47 (Work) (6332) 233-6891 (Fax) ccef@mozcom.com	Research Specialist CCE Foundation Room 302, PDI Condominium Archbishop Reyes Avenue Banilad, 6000, Cebu City
7	**Brian Stockwell** Researcher	(6335) 422-5698/(6335) 225 4608 0919-510-4553 brian_stockwell@hotmail.com	Fisheries Research Specialist Silliman University Marine Laboratory Dumaguete City, Negros Oriental
8	**Danny Ocampo**	danny0@surfshop.net.ph	Batangas Coordinator CCE Foundation Room 302, PDI Condominium Archbishop Reyes Avenue Banilad, 6000, Cebu City
9	**Ian White**	sulufund@mozcom.com	Student; soccer and baseball player; good swimmer; likes to play!

M/Y TRISTAR CREW

	Name	Duty	Affiliation
1	Fernando Morato	Divemaster	M/Y Tristar
2	Bo-Yoing Morato	Divemaster	M/Y Tristar
3	Michelle Tinsay	Divemaster	M/Y Tristar
4	Keith Lapous	Divemaster	M/Y Tristar
5	Captain Francisco Dimayacyac	Captain	M/Y Tristar
6	R. Castillo	Crew	M/Y Tristar
7	H. Luzano	Crew	M/Y Tristar
8	J. Atienza	Crew	M/Y Tristar
9	R. Maneja	Crew	M/Y Tristar
10	C. Pacheco	Crew	M/Y Tristar
11	M. Hapinat	Crew	M/Y Tristar
12	G. Nequias	Crew	M/Y Tristar
13	M. Azul	Crew	M/Y Tristar
14	A. Yape	Crew	M/Y Tristar
15	R. Febris	Crew	M/Y Tristar
16	G. Pendilla	Crew	M/Y Tristar
17	R. Hapinat	Crew	M/Y Tristar
18	M. de San Jose	Crew	M/Y Tristar

APPENDIX 3

FISH SPECIES LIST

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	CHONDRICHTHYES: Cartilaginous fishes															
	SHARKS															
I	**Carcharhinidae - Requiem sharks**															
	Carcharhinus melanopterus		1		1		1		1		1		1			1
	Carcharhinus amblyrhchos								1							1
II	**Ginglymostomatidae - Nurse sharks**															
	Nebrius ferrugineus							1								1
III	**Hemigaleidae - White-tip reef sharks**															
	Triaenodon obesus	1	1	1	1	1	1	1	1	1	1	1	1		1	1
IV	**Rhincodontidae - Whale sharks**															
	Rhincodon typus													1		
V	**Sphyrnidae - Hammerhead sharks**															
	Sphyrna mokarran												1			
VI	**Stegostomatidae - Zebra/Leopard Shark**															
	Stegostoma fasciatum									1						1
	RAYS															
VII	**Dasyatididae - Sting rays**															
	Dasyatis kuhli									1						1
	Himantura uarnak					1										
	Taeniura lymma		1			1										
	Taeniura meyeni		1				1									1
VIII	**Mobulidae - Manta/Devil rays**															
	Manta birostris									1						1
IX	**Myliobatidae - Eagle ray**															
	Aetobatus narinari										1	1				1
X	**Rhinobatidae - Guitarfishes**															
	Rhynchobatus djiddensis															1

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	OSTEICHTHYES: Bony fishes															
XI	**Acanthuridae - Surgeonfishes**															
	Acanthurus achilles															1
	Acanthurus dussummieri					1										1
	Acanthurus guttatus															1
	Acanthurus japonicus		1		1		1		1		1		1	1		
	Acanthurus lineatus	1	1	1		1		1	1		1	1	1	1	1	1
	Acanthurus lituratus															
	Acanthurus mata										1	1				1
	Acanthurus nigricans	1		1		1		1				1				1
	Acanthurus nigricauda	1	1	1		1		1		1	1	1			1	
	Acanthurus nigrofuscus															1
	Acanthurus olivaceus	1	1		1	1							1	1		1
	Acanthurus pyroferus		1	1	1	1	1				1	1	1			1
	Acanthurus thompsoni		1	1	1	1	1			1	1	1	1			1
	Acanthurus triostegus		1		1				1		1		1	1		1
	Acanthurus xanthopterus	1	1		1	1		1					1			1
	Ctenochaetus binotatus	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
	Ctenochaetus strigosus												1			
	Ctenochaetus tominiensis	1				1		1								1
	Naso annulatus								1		1					1
	Naso brachycentron								1							1
	Naso brevirostris	1		1	1	1	1	1	1	1		1	1		1	1
	Naso caeruleacauda													1		
	Naso hexacanthus	1	1		1	1	1	1	1		1	1	1			1
	Naso lituratus		1		1	1		1	1		1	1	1		1	1
	Naso lopezi	1														1
	Naso minor					1		1	1			1		1		
	Naso thynnoides										1	1		1	1	
	Naso tuberosus								1							1
	Naso unicornis	1	1	1		1		1			1		1			1
	Naso vlamingii		1		1	1	1	1	1	1	1	1	1	1		1

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Paracanthus hepatus	1	1											1		1
	Zebrasoma scopas	1	1	1	1	1	1	1	1		1	1	1	1		1
	Zebrasoma veliferum	1	1			1	1	1	1	1	1	1				1
XII	**Anomalopidae - Flashlight fish**															
	Anomalops katoptron															1
XIII	**Apogonidae - Cardinalfishes**															
	Cheilodipterus macrodon						1									
XIV	**Aulostomidae - Trumpetfishes**															
	Aulostomus chinensis							1							1	1
XV	**Balistidae - Triggerfishes**															
	Balistapus undulatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Balistoides conspicillum	1	1	1		1		1	1		1	1	1	1	1	1
	Balistoides viridescens	1	1	1	1	1		1	1		1		1	1		1
	Melichthys niger	1	1	1	1	1		1	1	1	1	1	1			1
	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
	Pseudobalistes flavimarginatus			1	1	1		1		1		1			1	1
	Rhinecanthus aculeatus				1	1										1
	Rhinecanthus rectangulus	1							1				1		1	1
	Rhinecanthus verrucosus												1			1
	Sufflamen bursa	1	1	1		1		1				1	1	1	1	1
	Sufflamen chrysopterus	1	1						1		1	1				1
XVI	**Belonidae - Needlefishes**															
	Tylosorus crocodilus								1	1		1	1			1
	Tylosorus gavialoides															
	Strongylura incisa	1				1						1				
XVII	**Blenniidae - Blennies**															
	Aspindotus taeniorus							1		1						
	Ecsenius dilemma					1				1						
	Ecsenius sp.															1
	Plagiotremus rhinorhynchus	1				1		1		1						
	Plagiotremus tapeinosoma															1
	Salarias fasciatus	1						1								

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
XVIII	**Bothidae - Flounders**															
	Bothus mancus															1
XIX	**Caesionidae - Fusiliers**															
	Caesio caerulaurea	1			1	1	1			1		1		1		1
	Caesio cuning															1
	Caesio erythrogaster															1
	Caesio lunaris	1		1	1	1	1	1			1			1		1
	Caesio teres				1		1				1					
	Pterocaesio lativittata															1
	Pterocaesio lunaris															1
	Pterocaesio marri															1
	Pterocaesio pisang			1						1	1					1
	Pterocaesio randalli		1	1	1	1	1			1	1		1			1
	Pterocaesio tesselata							1								
	Pterocaesio tile			1	1		1			1	1		1		1	1
	Pterocaesio trilineata			1												
XX	**Carangidae - Jacks**															
	Alectes indicus											1				1
	Carangoides bajad			1	1	1	1									1
	Carangoides ferdau		1	1	1	1			1		1		1			1
	Carangoides gymnostethus															1
	Carangoides orthogrammus				1	1		1								
	Caranx ignobilis			1		1			1		1	1	1			1
	Caranx lugubris			1		1		1		1						
	Caranx melampygus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Caranx sexfasciatus	1	1	1					1	1		1	1			1
	Elagatis bipinnulatus				1						1	1	1			1
	Gnathanodon speciosus											1				1
	Scomberoides lysan		1													
	Trachinotus blochii						1									
XXI	**Chaetodontidae - Butterflyfishes**															
	Chaetodon adiergastos	1	1	1	1	1	1	1	1	1	1	1			1	1
	Chaetodon auriga	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Tubbataha Reef National Marine Park
Fish Species List as of April 2004

	Family and species/site	NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
		2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2004	2000	1992/1996
	Chaetodon baronessa	1		1	1	1		1		1	1	1	1	1	1	1
	Chaetodon bennetti		1	1	1	1	1	1	1	1	1	1	1		1	1
	Chaetodon citrinellus	1	1	1	1	1		1	1			1	1	1	1	1
	Chaetodon ephippium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon kleinii	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon lineolatus	1	1	1	1	1		1	1	1	1	1	1		1	1
	Chaetodon lunula	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
	Chaetodon melannotus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon mertensii					1										1
	Chaetodon meyeri	1			1											1
	Chaetodon ocellicaudus	1		1	1	1		1	1	1	1	1	1		1	1
	Chaetodon octofasciatus							1								
	Chaetodon ornatissimus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon oxycephalus	1	1	1		1	1	1	1			1	1		1	1
	Chaetodon plebeius															1
	Chaetodon punctatofasciatus	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
	Chaetodon reticulatus	1														
	Chaetodon selene			1												
	Chaetodon semeion			1	1						1					1
	Chaetodon speculum	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	1
	Chaetodon ulietensis	1	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
	Chaetodon vagabundus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon xanthurus			1												
	Chelmon rostratus			1												
	Coradion chrysozonus	1														
	Coradion melanopus															
	Forcipiger flavissimus	1	1	1	1	1		1	1	1	1	1	1	1	1	1
	Forcipiger longirostris	1	1	1		1	1	1	1	1	1	1		1		1
	Hemitaurichthys polylepis	1	1	1	1	1	1	1	1	1		1	1	1	1	1

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	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	1
	Heniochus diphreutes												1	1		
	Heniochus monoceros	1					1									
	Heniochus singularis	1	1	1	1	1	1	1		1	1	1	1	1	1	1
	Heniochus varius	1	1	1	1	1	1	1		1	1	1	1		1	1
XXII	**Chanidae - Milkfish**															
	Chanos chanos										1					
XXIII	**Cirrhitidae - Hawkfishes**															
	Cirrhitichthys aprinus												1			
	Cirrhitichthys falco		1			1			1							1
	Cirrhitichthys oxycephalus		1										1	1		
	Cirrhitus pinnulatus		1													
	Oxycirrhites typus															1
	Paracirrhites arcatus	1	1	1		1	1	1	1	1		1	1		1	1
	Paracirrhites forsteri		1	1			1	1	1		1	1	1	1	1	1
	Paracirrhites hemistictus															1
XXIV	**Clupeidae - Herrings and Sardines**															
	Spratelloides delicatulus							1								
XXV	**Diodontidae - Porcupinefishes**															
	Chilomycterus reticulatus					1										
	Diodon hystrix							1	1	1						1
	Diodon liturosus			1						1				1		
XXVI	**Echeneididae - Shark suckers**															
	Echeneis naucrates									1						1
XXVII	**Ephippidae - Batfishes**															
	Platax boersii		1										1			
	Platax orbicularis	1		1		1										
	Platax pinnatus						1									
	Platax teira											1				1
XXVIII	**Fistulariidae - Cornetfishes**															
	Fistularia commersonii													1	1	1
XXIX	**Heterocongridae - Garden eels**															

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Heteroconger hassi			1	1					1	1					1
XXX	**Gobiidae - Gobies**															
	Amblyeleotris hectori						1									
	Amblygobius phalaena				1											
	Eviota pellucida								1							
	Valenciennea randalli	1				1										
	Valenciennea strigata															1
XXXI	**Haemulidae - Sweetlips**															
	Diagramma menalarcum										1					
	Plectorhinchus celebicus															
	Plectorhinchus chaetodonoides	1	1		1	1	1		1	1	1	1				1
	Plectorhinchus gaterinus															1
	Plectorhinchus lessoni						1				1					1
	Plectorhincus lineatus	1	1				1				1		1			
	Plectorhinchus obscurus															1
	Plectorhinchus orientalis					1				1						1
	Plectorhinchus picus						1				1					1
XXXII	**Holocentridae - Soldier and Squirrel fishes**															
	Myripristis adusta		1		1	1		1		1	1		1			1
	Myripristis berndti	1				1	1	1		1						1
	Myripristis kuntee															1
	Myripristis murdjan	1	1	1	1	1		1		1	1	1	1	1	1	1
	Myripristis violacea	1		1			1									1
	Neoniphon argenteus					1										
	Neoniphon opercularis															1
	Neoniphron sammara					1	1									1
	Sargocentron caudimaculatum	1	1	1		1	1	1					1	1		1
	Sargocentron diadema														1	
	Sargocentron ittodai	1														
	Sargocentron spiniferum	1	1	1	1	1	1	1		1	1	1	1	1		1
	Sargocentron violaceum														1	1
XXXIII	**Kyphosidae - Drummers**															
	Kyphosus cinerascens	1		1		1		1		1					1	1

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Kyphosus vaigiensis		1				1		1	1					1	
XXXIV	**Labridae - Wrasses**															
	Anampses geographicus															
	Anampses meleagrides			1									1	1		
	Anampses melanurus	1				1		1		1		1				
	Anampses twistii		1	1		1	1			1	1	1	1	1		
	Bodianus axillaris					1						1				1
	Bodianus diana		1			1	1		1	1		1	1	1		1
	Bodianus mesothorax				1	1	1						1			1
	Cheilinus chlorourus	1						1			1	1	1		1	1
	Cheilinus fasciatus	1	1		1	1	1				1		1			1
	Cheilinus trilobatus	1	1			1									1	1
	Cheilinus undulatus	1	1			1		1	1	1	1	1	1		1	1
	Cheilio inermis					1		1								
	Choerodon anchorago					1		1								
	Cirrhilabrus cyanopleura		1	1	1	1			1		1		1	1		
	Cirrhilabrus exquisitus		1							1						
	Coris aygula									1						
	Coris batuensis	1				1		1	1		1			1	1	
	Coris gaimard	1	1		1	1		1	1		1	1	1	1		1
	Coris variegata															1
	Diproctacanthus xanthurus	1		1		1										1
	Epibulus insidiator		1	1	1	1				1	1					
	Gomphosus varius	1	1	1	1	1	1	1	1		1	1	1	1	1	1
	Halichoeres biocellatus															1
	Halichoeres chrysus	1	1	1		1	1		1		1	1	1	1	1	
	Halichoeres hortulanus	1	1	1	1	1	1	1	1	1	1	1	1	1		1
	Halichoeres margaritaceus		1								1		1			1
	Halichoeres melanurus													1		1
	Halichores nebulosa		1						1				1			
	Halichoeres prosopeion						1				1					1
	Halichoeres scapularis	1		1		1			1		1	1			1	
	Halichoeres trimaculatus				1			1							1	

Tubbataha Reef National Marine Park
Fish Species List as of April 2004

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		2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2004	2000	1992/1996
	Halichoeres tripunctatus										1					
	Hemigymnus fasciatus	1		1	1	1		1			1		1	1		1
	Hemigymnus melapterus	1	1	1	1	1		1	1		1		1			1
	Hologymnosus annulatus		1				1							1		
	Hologymnosus doliatus		1						1	1	1	1				
	Labrichthys unilineatus			1	1	1	1	1			1	1		1		
	Labroides bicolor	1	1		1	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
	Labroides pectoralis			1	1	1	1			1	1	1				
	Leptojulis cyanopleura	1				1		1								
	Macropharyngodon meleagris	1		1	1	1							1	1		
	Macropharyngodon negrosensis	1	1	1					1	1						
	Macropharyngodon ornatus															
	Novaculichthys taeniorus	1	1	1	1	1		1			1	1	1	1	1	1
	Oxycheilinus bimaculatus															
	Oxycheilinus celebicus		1	1		1	1	1				1				
	Oxycheilinus diagrammus							1					1		1	1
	Oxycheilinus unifasciatus										1		1	1		
	Pseudocheilinus evanidus			1	1	1		1	1	1		1				1
	Pseudocheilinus hexataenia	1	1	1	1	1		1	1	1	1	1	1	1		1
	Pseudocheilinus octotaenia				1	1			1	1	1	1	1			1
	Pseudodax mollucanus		1		1	1	1	1	1		1	1				
	Stetojulis bandanensis		1		1			1			1		1	1		
	Stetojulis strigiventer	1		1						1					1	
	Stetojulis trilineata	1								1					1	
	Thalassoma amblycephalum		1	1	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
	Thalassoma janseni	1	1		1				1		1	1	1	1	1	
	Thalassoma lunare	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Thalassoma lutescens	1		1		1		1		1		1		1		1
	Thalassoma purpureum	1										1		1	1	1
	Thalassoma quinquevittatum	1	1						1	1	1		1			1
	Wetmorella albofasciata										1					

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Xyrichthys pavo					1										
XXXV	**Leiognathidae - Ponyfishes**															
	Leiognathus equulus															1
XXXVI	**Lethrinidae - Emperors**															
	Gnathodentex aurolineatus	1	1	1	1	1	1	1			1	1		1		1
	Lethrinus atkinsoni			1		1										
	Lethrinus erythracanthus				1				1		1					
	Lethrinus erythropterus							1			1					
	Lethrinus harak		1													1
	Lethrinus microdon												1			
	Lethrinus nebulosus			1								1			1	
	Lethrinus obsoletus					1										
	Lethrinus olivaceus	1	1		1	1	1	1	1				1			1
	Lethrinus ornatus										1					
	Lethrinus semicinctus			1		1		1							1	
	Lethrinus xanthochilus	1	1			1		1		1	1	1	1	1		
	Monotaxis grandoculus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
XXXVII	**Lutjanidae - snappers**															
	Aphareus furca			1	1	1	1	1		1	1	1	1		1	1
	Aprion virescens	1	1	1					1				1			1
	Lutjanus argentimaculatus					1	1									1
	Lutjanus biguttatus			1												
	Lutjanus bohar	1	1	1	1	1	1		1	1	1	1	1			1
	Lutjanus decussatus	1	1	1	1	1		1			1		1		1	1
	Lutjanus ehrenbergi															
	Lutjanus fulviflamma	1														
	Lutjanus fulvus		1	1	1	1				1	1				1	1
	Lutjanus gibbus	1	1		1	1		1	1	1	1		1	1		1
	Lutjanus kasmira		1		1	1										1
	Lutjanus monostigma		1	1			1	1			1	1	1		1	1
	Lutjanus rivulatus		1			1			1		1				1	1
	Lutjanus russelli					1										
	Lutjanus semicinctus	1				1										

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Macolor macularis		1	1	1	1		1	1	1	1	1	1	1		1
	Macolor niger	1	1	1	1		1				1	1				1
	Paracaesio sordidus														1	
	Symphorichthys spilurus		1								1	1	1			1
XXXVIII	**Malacanthidae - Sand tilefishes**															
	Haplolatilus starcki						1		1							
	Malacanthus brevirostris	1	1			1			1		1	1			1	1
	Malacanthus latovittatus	1	1		1	1				1	1				1	1
XXXIX	**Microdesmidae - Dartfishes**															
	Nemateleotris magnifica	1	1	1	1		1		1			1	1	1		1
	Ptereoletris evides	1	1				1		1				1	1		1
	Ptereoletris heteroptera	1		1												
	Ptereoletris zebra												1			
XL	**Monacanthidae - Leatherjackets**															
	Aluterus scriptus		1			1										1
	Amanses scopas							1		1				1	1	
	Cantherhines dumerilii										1		1			
	Cantherhines pardalis	1														
	Oxymonocanthus longirostris															1
	Paraluteres prionurus		1								1		1			1
	Pervagor janthinosoma											1				
XLI	**Mullidae - Goatfishes**															
	Mulloidichthys flavolineatus	1			1			1			1					
	Mulloidichthys vanicolensis	1									1			1	1	
	Parupeneus barbarinoides															1
	Parupeneus barberinus	1	1	1	1	1		1	1	1	1	1				1
	Parupeneus bifasciatus	1	1	1	1	1	1	1			1	1	1	1	1	1
	Parupeneus cyclostomus	1	1	1	1	1	1	1	1		1	1	1			1
	Parupeneus indicus	1				1		1	1							1
	Parupeneus multifasciatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Parupeneus pleurostigma			1		1					1					
	Upeneus tragula		1													
XLII	**Muraenidae - Moray eels**															

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Gymnothorax flavimarginatus															1
	Gymnothorax javanicus	1	1			1				1		1	1			1
	Gymnothorax melanospilus											1				
	Gymnothorax meleagris		1											1		1
XLIII	**Nemipteridae - Breams**															
	Pentapodus bifasciatus															
	Scolopsis bilineatus	1	1	1	1	1	1		1		1		1		1	1
	Scolopsis lineatus	1	1			1		1								1
	Scolopsis margaritifer			1	1											
	Scolopsis monogramma				1											
	Scolopsis trilineatus							1								
XLIV	**Ostraciidae - boxfishes**															
	Ostracion cubicus	1	1	1	1	1					1		1		1	1
	Ostracion meleagris		1						1			1			1	1
	Ostracion solorensis	1														1
XLV	**Pempheridae - Sweepers**															
	Pempheris oulensis					1										1
XLVI	**Pinguipedidae - sandperches**															
	Clathrata multipunctata		1													
	Clathrata tetracantha		1		1											
	Parapercis clathrata	1	1		1	1							1	1		1
	Parapercis cylindrica					1										1
	Parapercis hexopthalma														1	
	Parapercis millipunctata			1											1	1
XLVII	**Pomacanthidae - Angelfishes**															
	Apomelichthys trimaculatus						1		1	1			1			1
	Centropyge bicolor	1	1	1	1	1	1	1	1		1					1
	Centropyge bispinosus			1	1	1	1		1		1	1	1			1
	Centropyge flavicauda								1	1						
	Centropyge flavissimus								1							
	Centropyge heraldi									1						1
	Centropyge multifasciatus		1													1
	Centropyge tibicen		1			1	1	1	1		1	1	1	1		1

	Tubbataha Reef National Marine Park Fish Species List as of April 2004	NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Centropyge vroliki	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Genicanthus lamarcki															1
	Pomacanthus imperator		1		1	1	1		1		1	1	1			1
	Pomacanthus navarchus					1									1	1
	Pomacanthus sextriatus				1	1	1			1	1	1	1		1	
	Pomacanthus xanthometopon		1		1		1		1		1	1				
	Pygoplites diacanthus	1	1	1	1	1	1	1	1	1	1	1	1	1		1
XLVIII	**Pomacentridae - Damselfishes**															
	Abudefduf lorenzi															1
	Abudefduf septemfasciatus								1							
	Abudefduf sexfasciatus													1		1
	Abudefduf vaigiensis	1	1			1			1				1	1	1	1
	Amblyglyphidodon aureus	1	1	1	1	1	1		1		1		1			1
	Amblyglyphidodon curacao					1		1		1	1				1	1
	Amblyglyphidodon leucogaster				1	1	1				1					1
	Amphiprion chrysopterus															1
	Amphiprion clarkii				1	1					1	1	1			1
	Amphiprion frenatus						1				1	1				1
	Amphiprion melanopus															1
	Amphiprion ocellaris					1					1		1			1
	Amphiprion peridereion					1										1
	Amphiprion sandaricinos															1
	Chromis agilis				1		1									1
	Chromis amboinensis				1		1				1		1			1
	Chromis analis			1	1		1		1		1	1	1	1		
	Chromis atripectoralis															1
	Chromis atripes			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
	Chromis retrofasciata			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
	Chromis viridis			1	1			1	1		1					1

Tubbataha Reef National Marine Park
Fish Species List as of April 2004

	Family and species/site	NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
		2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2004	2000	1992/1996
	Chromis weberi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chromis xanthura		1	1	1	1	1	1	1		1	1	1	1	1	1
	Chrysiptera biocellata				1			1							1	
	Chrysiptera brownriggi				1											
	Chrysiptera cyanea	1		1	1	1							1		1	1
	Chrysiptera leucopoma														1	
	Chrysiptera parasema			1												
	Chrysiptera rex												1			
	Chrysiptera rollandi				1						1					
	Chrysiptera springeri															
	Chrysiptera talboti		1		1		1				1					1
	Dascyllus aruanus	1			1	1										1
	Dascyllus reticulatus	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
	Dischistodus chrysopoecilus				1			1								
	Dischistodus melanotus				1			1			1					
	Dischistodus perspicillatus		1		1			1								
	Neoglyphidodon melas		1			1		1		1	1				1	1
	Neoglyphidodon nigroris									1		1				1
	Neoglyphidodon thoracotaeniatus			1	1											
	Plectroglyphidodon dicki	1	1	1				1	1	1	1		1	1	1	1
	Plectroglyphidodon lachrymatus	1	1	1	1	1		1	1					1		1
	Plectroglyphidodon leucozonus		1		1			1						1		
	Pomacentrus adelus													1		
	Pomacentrus alexanderae										1					
	Pomacentrus alleni						1									
	Pomacentrus amboinensis				1						1			1		1
	Pomacentrus auriventris	1	1	1	1	1		1	1	1	1	1	1	1		
	Pomacentrus bankanensis		1						1		1		1			
	Pomacentrus brachialis		1	1	1		1						1			1
	Pomacentrus caeruleolineata						1									
	Pomacentrus caeruleus													1		
	Pomacentrus caudalis												1			

Tubbataha Reef National Marine Park
Fish Species List as of April 2004

	Family and species/site	NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
		2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2004	2000	1992/1996
	Pomacentrus coelestis						1		1				1			1
	Pomacentrus cyanea										1					
	Pomacentrus imperator						1									
	Pomacentrus lepidogenys		1		1	1	1			1	1		1	1	1	1
	Pomacentrus magaritifer		1		1								1			
	Pomacentrus moluccensis			1		1	1	1			1				1	1
	Pomacentrus nigromanus						1									
	Pomacentrus pavo				1											
	Pomacentrus philippinus	1														
	Pomacentrus tripunctatus							1					1			
	Pomacentrus vaiuli	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Pomacentrus xanthura		1		1						1		1			
	Stegastes lividus							1								
XLIX	**Priacanthidae - Bigeyes**															
	Priacanthus hamrur				1					1				1	1	1
L	**Pseudochromidae**															
	Pseudochromis marshallensis															1
LI	**Scaridae - Parrotfishes**															
	Bolbometopon muricatum	1	1					1								1
	Cetoscarus bicolor		1		1	1	1	1	1	1	1	1	1	1		1
	Chlororus bleekeri	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	Chlororus sordidus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Hipposcarus longiceps		1	1	1	1		1	1		1		1			1
	Scarus altipinnis															1
	Scarus bowersi		1	1	1			1								1
	Scarus chameleon															1
	Scarus dimidiatus	1	1	1	1	1		1	1	1	1				1	1
	Scarus festivus															1
	Scarus forsteni	1	1	1	1			1		1		1	1	1		
	Scarus frenatus	1														
	Scarus ghobban	1	1			1			1	1	1	1	1	1		1
	Scarus gibbus															1
	Scarus hypselopterus	1		1		1										

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Scarus javanicus															1
	Scarus microrhinos	1	1		1	1	1	1	1	1	1	1		1		1
	Scarus niger	1	1	1	1	1	1	1		1	1		1	1	1	
	Scarus oviceps		1	1	1	1		1			1	1	1		1	1
	Scarus prasiognathus		1		1			1		1						1
	Scarus psittacus															1
	Scarus pyrrhurus	1													1	
	Scarus rubroviolaceus					1							1		1	
	Scarus scaber															1
	Scarus schlegeli	1	1	1	1	1		1	1	1	1	1	1		1	1
	Scarus spinus		1					1	1		1				1	
	Scarus tricolor	1	1			1			1					1		1
LII	**Scombridae - tunas/ mackerels**															
	Gymnosorda unicolor						1			1			1			1
LIII	**Scorpaenidae - scorpionfishes**															
	Dendrochirus biocellatus	1	1			1										
	Pterois antennata		1											1		1
	Pterois volitans	1				1						1				1
	Scorpaenopsis diabolus															1
	Scorpaenopsis guamensis															1
	Scorpaenopsis oxycephala									1						1
LIV	**Serranidae - basslets/soapfish/groupers**															
	Anthiinae															
	Pseudoanthias dispar	1	1		1	1	1		1		1		1	1		1
	Pseudoanthias huchtii	1	1	1	1	1	1		1		1	1	1	1		1
	Pseudoanthias pleurotaenia		1		1						1					1
	Pseudoanthias randalli															1
	Pseudoanthias smithvanizi								1		1					1
	Pseudoanthias squamipinnis	1	1				1		1				1	1		1
	Pseudoanthias tuka	1	1		1	1	1	1			1	1	1	1		1
	Gramistinae															
	Grammistes sexlineatus									1						
	Pogonoperca punctata													1	1	

Tubbataha Reef National Marine Park Fish Species List as of April 2004		NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2000**	**2004**	**2004**	**2000**	**1992/1996**
	Aethaloperca rogaa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Epinephilinae															
	Anyperodon leucogrammicus									1	1					1
	Cephalopolis argus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Cephalopolis boenak	1												1		1
	Cephalopholis leopardus		1								1		1			
	Cephalopolis miniata	1	1				1					1	1	1		1
	Cephalopolis polleni									1						1
	Cephalopolis sonnerati											1				
	Cephalopolis urodotea	1	1	1	1	1	1	1	1		1	1	1	1		1
	Epinephelus caeruleopunctatus															1
	Ephinephelus fasciatus	1	1	1		1	1					1	1			1
	Ephinephelus fuscoguttatus										1					1
	Ephinephelus hexagonatus															1
	Ephinephelus merra			1	1				1				1		1	1
	Ephinephelus microdon															1
	Epinephelus polyphekadion										1					
	Epinephelus sexfasciatus				1	1					1		1	1		
	Epinephelus tauvina														1	1
	Gracila albomarginata			1		1	1									1
	Plectropomus areolatus			1												1
	Plectropomus laevis		1	1	1		1	1	1							1
	Plectropomus leopardus		1													1
	Plectropomus oligacanthus				1	1										
	Variola albimarginata		1													1
	Variola louti			1				1	1	1	1					1
LV	**Siganidae - Rabbitfishes**															
	Siganus argentus															1
	Siganus corallinus	1		1		1					1					1
	Siganus puellus					1		1		1	1	1	1			1
	Siganus punctatissimus			1	1			1			1		1			
	Siganus punctatus			1	1						1					
	Siganus tetrazonus				1								1			

Tubbataha Reef National Marine Park
Fish Species List as of April 2004

	Family and species/site	NR-1 (North Reef) Malayan Wreck		NR-2 (North Reef) Ranger Station		NR-5 (North Reef) Bird Islet		SR-1 (South Reef) Lighthouse Islet		SR-3 (South Reef) Black Rock		SR-4 (South Reef) North West Corner		Jessie Beazley Reef	Bastera Reef	ALL SITES (excluding Jessie Beazley)
		2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2000	2004	2004	2000	1992/1996
	Siganus unimaculatus				1											
	Siganus virgatus					1		1		1						
	Siganus vulpinus			1	1	1		1	1		1		1			1
LVI	**Soleidae - Soles**															
	Pardachirus pavoninus			1												
LVII	**Sphyraenidae - Barracudas**															
	Sphyraena barracuda		1									1				1
	Sphyraena forsteri															1
LVIII	**Synotodontidae -Lizardfishes**															
	Saurida gracilis	1				1				1						1
	Synodos variegatus															1
LIX	**Tetraodontidae - Puffers**															
	Arothron hispidus										1		1			1
	Arothron mappa		1				1						1			
	Arothon meleagris			1												1
	Arothron nigropunctatus	1	1	1	1	1	1	1	1	1	1		1	1	1	1
	Arothron stellatus	1				1				1			1			1
	Canthigaster bennetti															1
	Canthigaster compressa	1														1
	Canthigaster solandri					1										1
	Canthigaster valentini		1	1			1				1					1
LX	**Zanclidae - Moorish idol**															
	Zanclus cornutus	1	1	1	1	1	1	1	1	1	1	1	1	1		1
	TOTAL	182	202	171	185	221	144	170	152	141	205	156	190	130	119	330

333 species in 57 families in 1992 and 1996
327 species in 44 familes in 1999
329 species in 43 families in 2004
510 species in 60 families from 1992 to 2004

APPENDIX 4

LIST OF STATISTICAL TABLES IN APPENDIX 4

Table 4A-1. Results from one-factor Analysis of Variance and T-test within a substrate category between years per site (alpha = 0.05).
LHC=Live hard coral cover, CB=Coral branching, SC=soft coral, NL=Non-living (Rock and block, Sand and silt)
DC=Dead coral (dead coral with algae, white dead standing coral)

SCUBA surveys				Snorkel surveys			
NR5: Substrate	**1-ANOVA**		**Bonferroni post hoc**	**NR5: Substrate**	**1-ANOVA**		**Bonferroni post hoc**
	p	**F**			**p**	**F**	
LHC	0.0004	7.497	1992=1996=2004>2000	LHC	0.0185	4.5906	1992>2000=2004
CB	0.0002	5.8072	1996>2004>2000	CB*			
SC	NS			SC	0.0169	5.1663	1992>2000=2004
R	0.0009	6.5659	2000>2004=1996	R	0.0319	3.9067	2004>2000>1992
NL	≤ 0.0001	17.046	2000>1992>1996>2004	NL	≤ 0.0001	20.71	2004=2000>1992
DC	0.013	4.05	2000>1996	DC	NS		
NR1: Substrate	**1-ANOVA**		**Bonferroni post hoc**	**NR1: Substrate**	**1-ANOVA**		**Bonferroni *post hoc***
	p	**F**			**p**	**F**	
LHC	≤ 0.0001	20.7772	1996>2000=20004	LHC	≤ 0.0001	16.225	1989=1992=1996>2000=20004
CB	0.0003	10.566	1996>2000>2004	CB	NS		
SC	0.0203	4.4966	1996=2000>2004	SC	0.0004	8.0233	1989>2000=1996=2004
R	NS			R	≤ 0.0001	10.861	1989>1996>2000>2004
NL	0.047	3.3595	NS	NL	≤ 0.0001	10.86	2000>2004>1996>1989
DC	≤ 0.003	11.16	2000>1996=2004	DC	≤ 0.0001	39.668	2004>2000>1996>1989
NR2: Substrate	**T-test**			**NR2: Substrate**	**1-ANOVA/T-test**		**Bonferroni *post hoc***
	p	**Ranking**			**p**	**F**	
LHC	≤ 0.0001	2004>2000		LHC	0.0208	4.4169	2004>2000=1992
CB	≤ 0.0001	2004>2000		CB	≤ 0.0001		2004>1992 (T-test)
SC	NS			SC	NS		
R	0.016	2000>2004		R	NS		
NL	NS			NL	0.0067	5.9877	1992>2004>2000
DC	≤ 0.0001	2004>2000		DC	≤ 0.0001	89.116	1992=2000>2004

Table 4A-2. Results from one-factor Analysis of Variance and T-test within a substrate category between sites per year (alpha = 0.05).

LHC=Live hard coral cover, CB=Coral branching, SC=soft coral, NL=Non-living (Rock and block, Sand and silt), DC=Dead coral (dead coral with algae, white dead standing coral); JB=Jessie Beazley; NS=not significant

Scuba surveys	1992			1996			2000			2004		
Substrate	1-ANOVA		Bonferroni	1-ANOVA		Bonferroni	1-ANOVA		Bonferroni	1-ANOVA		Bonferroni
	p	F	post hoc	p	F	post hoc	p	F	post hoc	p	F	post hoc
LHC	NS			NS			NS			≤ 0.0001	8.3597	NR5=SR3=JB>NR1
CB	NS			NS			NS			≤ 0.0001	15.817	NR2=NR5>other sites
SC	NS			0.0056	4.7734	SR1=SR3=NR5>SR4	≤ 0.0001	6.449	SR1>NR; SR1>NR1>SR3 SR4>NR5; SR1>Bastera	≤ 0.0001	8.0873	other sites>NR2=NR1
R	NS			NS			≤ 0.0001	6.9305		≤ 0.0001	4.7949	SR1=SR3=NR1=NR5>SR4=JB
NL	0.023	5.678	SR4>SR1	NS			≤ 0.0001	9.8397		≤ 0.0001	9.0247	NR sites>SR sites
DC	NS			NS			≤ 0.0001	21.926		NS		

Table 4A-3. Results from one-factor Analysis of Variance and T-test within a substrate category between sites per year (alpha = 0.05).

LHC=Live hard coral cover, CB=Coral branching, SC=soft coral, NL=Non-living (Rock and block, Sand and silt), DC=Dead coral (dead coral with algae, white dead standing coral); JB=Jessie Beazley, NS=not significant.

SNORKEL Surveys	1989		1992			2000			2004		
Substrate	T-test		1-ANOVA		Bonferroni	1-ANOVA		Bonferroni	1-ANOVA		Bonferroni
	p		p	F	post hoc	p	F	post hoc	p	F	post hoc
LHC	NS		0.0023	5.9493	NR1=NR2=NR5>SR4	< 0.0001	9.8235	SR3=NR2=NR5> NR1	< 0.0001	5.1683	SR1>NR1; SR4>JB
CB	NS		NS			NS			< 0.0001	21.032	NR5=SR3>SR4=NR2 >SR1=JB>NR1
SC	0.0035	NR1>SR1	NS			NS			< 0.0001	7.155	JB> other sites
R	NS		NS			NS			< 0.0001	27.729	NR5> other sites
NL	NS		NS			NS			0.0269	2.5433	NR2=NR5=SR4>other sites
DC	NS		≤ 0.0001	13.925	NR2>NR1=NR5>SR4	≤ 0.0001	46.006	NR5>NR1=NR2>SR3	NS		

Table 4B-1. Results from one-factor Analysis of Variance and T-test within fish families between years (alpha = 0.05).

NS = not significant

Fish family	NR5		NR1	NR2		SR3		SR4		SR1			Bastera	
	1-ANOVA		T-test	T-test		T-test		T-test		1-ANOVA		Bonferroni	T-test	
	p	F	p	p	Ranking	p	Ranking	p	Ranking	p	F	*post hoc*	p	Ranking
Acanthuridae*	NS		NS	NS		NS		NS		NS			NS	
Siganidae*	NS		NS	NS		NS		NS		0.0016	10.233	2004>1996=2000	NS	
Serranidae, Epinephelinae*	NS		NS	0.014	2000>2004	NS		NS		NS			0.045	1996<2000
Lutjanidae*	NS		NS	NS		NS		NS		NS			NS	
Haemulidae*	NS		NS	NS		NS		NS		NS			NS	
Lethrinidae*	NS		NS	NS		NS		NS		NS			NS	
Carangidae*	NS		NS	NS		NS		NS		NS			NS	
Caesionidae*	0.02	NS	NS	NS		NS		NS		NS			NS	
Nemipteridae*	NS		NS	NS		NS		NS		0.0156	5.557	1996>2000=2000	NS	
Mullidae*	NS		NS	NS		NS		NS		NS			NS	
Scaridae*	NS		NS	NS		NS		NS		0.0382	4.0897	2004>2000	NS	
Kyphosidae*	NS		NS	NS		NS		NS		NS			NS	
Balistidae*	NS		NS	NS		NS		NS		NS			NS	
Chaetodontidae	NS		NS	NS		NS		NS		NS			NS	
Pomacanthidae	NS		NS	NS		NS		NS		NS			NS	
Labridae	NS		NS	NS		NS		NS		NS			NS	
Pomacentridae	NS		NS	0.013	2000<2004	0.025	2000>2004	0.01		NS			0.015	1996<2000
Serranidae, Anthiinae	NS		NS	NS		NS		NS		NS			NS	
Zanclidae	NS		NS	NS		NS		0.038	2000>2004	0.011	6.9895	1996=2000>2004	NS	
*Target species	NS		NS	NS		NS		NS		NS			NS	
All reef species	NS		NS	NS		NS		NS		NS			NS	

Table 4B-2. Results from one-factor Analysis of Variance and T-test within fish family between sites (alpha = 0.05).

NS = not significant

Fish family	1996		2000			2004		
	T-test		1-ANOVA		Bonferroni	1-ANOVA		Bonferroni
	p	Ranking	p	F	*post hoc*	p	F	*post hoc*
Acanthuridae*	NS		NS			NS		
Siganidae*	NS		NS					
Serranidae, Epinephelinae*	NS		NS					
Lutjanidae*	NS		NS					
Haemulidae*	NS		NS					
Lethrinidae*	NS		NS					
Carangidae*	NS		NS					
Caesionidae*	NS		NS			≤ 0.001	13.608	NR2=NR5>other sites
Nemipteridae*	NS		NS					
Mullidae*	NS		NS					
Scaridae*	NS		NS					
Kyphosidae*	NS		NS					
Balistidae*	NS		≤ 0.001	9.5109	SR4>other sites	0.0021	4.15	SR4>SR3=NR5
Chaetodontidae	NS		NS					
Pomacanthidae	NS		NS					
Labridae	NS		NS					
Pomacentridae	NS		0.006	6.281	SR1>NR1=NR2=NR5			
Serranidae, Anthiinae	0.0176		NS			0.021	NS	
Zanclidae	0.001		NS					
*Target species	NS		NS			≤ 0.001	6.742	NR2=NR5>SR4=other sites
All reef species	≤ 0.001	SR1>NR5	0.0093	4.3508	SR4>NR1			

APPENDIX 5

MANAGEMENT RATING SYSTEM[1]

. Date of survey: April 2004

Level I: Marine Protected Area *Initiated* : Passing (Year 1) (6 points required)

Criteria or activity satisfied	**0/1**
Site selected (Boundaries identified with map and technical description)	1
Site surveyed with baseline assessment complete (Completed the ff.: Resources Basic Inventory; Protected Area Suitability Assessment, and; Survey and Registration of Protected Area Occupants)	1
Education program started (At least 2 public education and notification activities for the directly affected communities)	1
NIPAS establishment approved by community and documented (Consulted affected stakeholders: fishers, resource users and social groups, both men and women. Documented either through resolutions or signature campaigns as well as documentation of public consultations and meetings)	1
Core group (not including DENR) has suggested or initiated NIPAS establishment (Passing of resolution or endorsement by the LGUs or NGOs for NIPAS establishment)	1
Initial protected area management plan endorsed by the Regional Development Council	0

Level II: Marine Protected Area *Established* : Fair (Year 1 or 2) (14 pts required)

Criteria or activity satisfied	**0/1**
Education program raising awareness about MPA benefits (At least 4 documented IEC activities regarding MPAs with participation of affected communities; with printed IEC materials e.g. leaflets, brochures, posters)	1
PAMB formally organized and recognized (Members with certificate of appointment)	1
Capacity development for PAMB members and PA staff (Completed at least 3 trainings, e.g. NIPAS orientation, PA management, Biodiversity monitoring system)	1
Management plan adopted by communities and LGUs (Passing of resolutions in support of the stipulations/ policies in management plan e.g. zoning, regulated fishing, user-fee)	1
MPA proclaimed (Presidential Proclamation passed by the Congress)	0
Anchor buoys, marker buoys and/or boundary marks installed (Buoys and boundary markers installed in strategic locations showing the MPA map, zonation, and coordinates	1
User-fee system formulated (PAMB Resolution passed on fee system)	1
Socio-economic conditions assessment of affected communities conducted (Baseline socio-economic data available)	1

Level III: Marine Protected Area *Enforced* : Good (Year 2) (26 pts required)

Criteria or activity satisfied	**0/1**
MPA rules and/or mgt plan posted on billboards at strategic locations	1
Education program increased awareness about MPA functions/benefits (At least 5 trainings for capacity building and community empowerment activities with representation from fishers, resource users and social groups, both men and women. Process should be documented.)	1
Biophysical monitoring measuring habitat condition and changes (Documented surveys at least once after the baseline assessment, using standard/ accepted method)	1
Regular patrolling and surveillance conducted (At least 3 staff/volunteers (either from DENR, PAMB, PNP, PCG, Fish Wardens) on rotation assigned to guard and patrol the area day and night)	1
Anchor and marker buoys maintained (Budget allocated for maintenance of buoys. Can be a part of or an item within the municipal CRM budget)	1
MPA outpost established	1

[1] This simple rating system is dynamic and is not a definitive statement on the status of any MPA rated. Rating level achieved is limited by number of years in existence of MPA Zero (0) means that the criterion is not fully satisfied; one (1) means that the criterion is satisfied for the MPA. This is part of the MPA Database System implemented by the MPA Project of the CCE Foundation.

(Administration building or PASU office established)	
PAMB and PA staff trained and empowered to manage the MPA (Trainings completed on: Paralegal and environmental laws; Law enforcement, and; Leadership and team-building)	1
PAMB active (Members meet quarterly; Assist in enforcement of the MPA; Participates in regular monitoring activities)	1
Budget from national gov't or from other sources allocated and is accessible for MPA mgmt (There is a legal document by the local government or an agreement with the private sector allocating budget for MPA mgmt.)	1
Fishing effectively stopped inside of strict protection zone or sanctuary (No fishing-related violations/ apprehensions reported in the strict protection zone for the past six (6) months)	1
Illegal and destructive fishing reduced outside of strict protection zone (Violations/apprehensions reported outside strict protection zone was reduced by 50% for the last 6 months)	1
Operational Integrated Protected Area Fund system (Fees collected and deposited in the PA sub-fund code)	0

Level IV: Marine Protected Area *Sustained* : Very Good (Year 3 or after) (32 points)

Criteria or activity satisfied	**0/1**
Biophysical monitoring and feedback of results implemented for 2 years or more (Documented surveys using standard/accepted method; Analysis of results and recommendations presented to PAMB and stakeholders)	1
Monitoring includes local participation (Locals trained to do reef assessments and they participate on regular monitoring)	1
Budget from government/IPAF/ from other sources allocated and was accessed for 2 or more consecutive years (There is a legal document made by the local government or an agreement with a funding source allocating budget for MPA management.)	1
PAMB and PA staff capacitated for financial management as needed (PAMB and PA staff is able to handle their money effectively; facilitates wise use and proper documentation)	1
Enforcement system fully operational (Enforcement group with clear mandate and workplan; There is a clear mechanism in place and consistency of enforcement within the past year)	1
Illegal and destructive activities stopped inside and within vicinity of MPA (No violations/apprehensions reported in the past year.)	1
Environment friendly livelihood initiated as part of MPA (Sells environment friendly souvenirs to tourists, crab fattening in mariculture zone, construction of visitors' facilities for the recreation and/or educational zone, etc.)	1

Level V: Marine Protected Area *Institutionalized* : Excellent (Year 4 or after) (40 pts)

Criteria or activity satisfied	**0/1**
MPA management plan incorporated in the LGU land-use and development plan (MPA incorporated within the long-term LGU area-wide development plan)	1
Monitoring and evaluation of impacts of MPA on biophysical & socio-economics conducted & feedback of results and recommendations completed (Results of biophysical assessments, attitude and perception surveys and socio-economic studies are presented to PAMB and other key stakeholders)	1
Information dissemination on MPA management maintained (Information through billboards, brochures, posters, news articles and radio programs)	1
Revenues from enterprise and/or fees sustained and accounted for (Collection of fees consistently enforced and recorded properly; financial report easily accessible.)	1
MPA management plan updated and adopted in a participatory process (Revisions made with the participation of all stakeholders: fishers, diver operators, partners, local government units, resource users and social groups, both men and women)	1
MPA used as a study-tour site, residents advocate for MPAs (Presence of an identified group that conducts guided tours and are capable of giving relevant information about the MPA.)	1
MPA endorsed for Congressional enactment (Draft PA Bill submitted to the House of Representatives and the Senate)	0

Total points accumulated: 36

- Total possible points: 40
- All points are cumulative
- Points from higher levels can be used to satisfy lower rating levels
- Required points for **Level I** : Passing = 6 points accumulated
  II : Fair = 14 points accumulated
  III : Good = 26 points accumulated
  IV : Very Good = 32 points accumulated
  V : Excellent = 40 points accumulated

APPENDIX 6

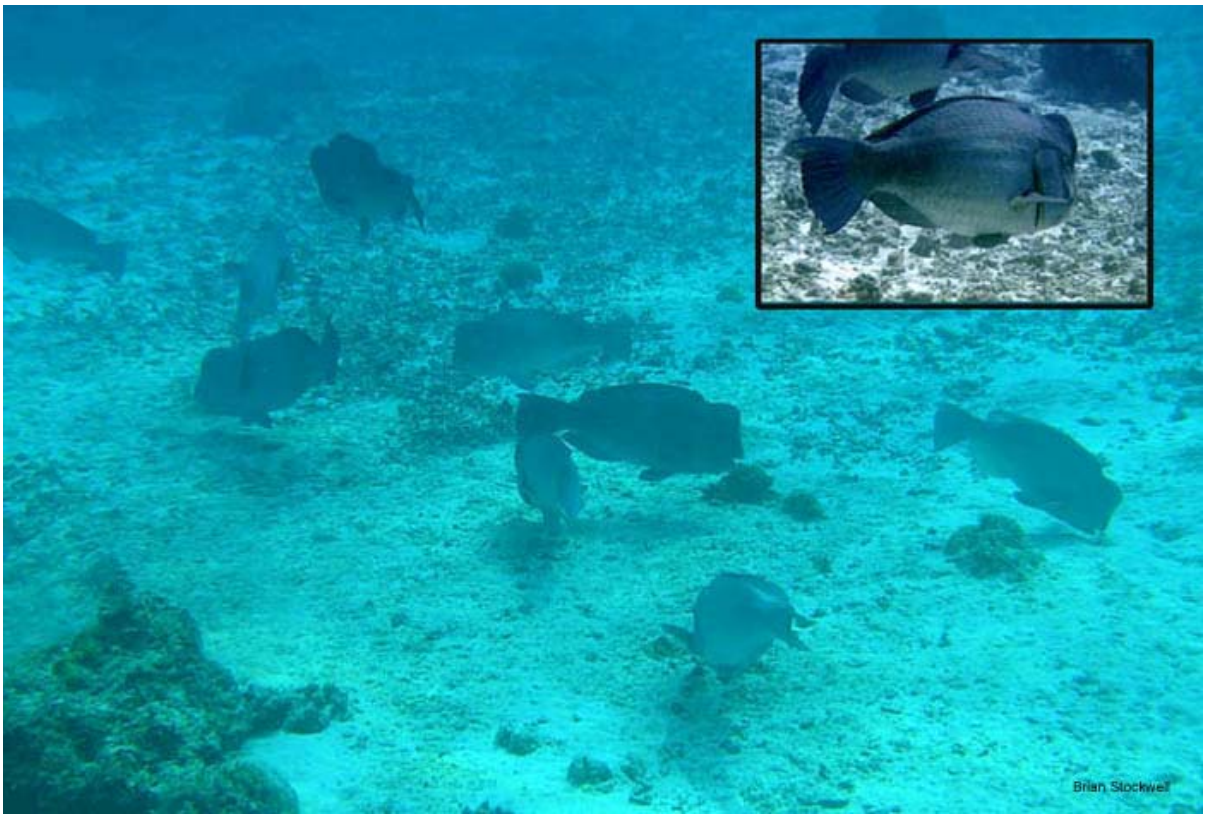
COORDINATES OF STUDY SITES

Reef sites	Survey coordinates
Malayan Wreck, NR 1	N 8° 53.003' E 119° 53.338' N 8° 53.268' E 119° 53.494' N 8° 53.175' E 119° 53.338' N 8° 53.108' E 119° 53.422' N 8° 53.201' E 119° 53.578'
Ranger Station, NR 2	N 8° 50.777' E 119° 35.241' N 8° 50.775' E 119° 55.067' N 8° 50.777' E 119° 55.147' N 8° 50'44.6' E 119° 54.978' N 8° 50.777' E 119° 55.241'
Bird Islet, NR 5	N 8° 55.521' E 120° 0.338' N 8° 55.522' E 120° 0.338' N 8° 55.594' E 120° 0.327' N 8° 55.521' E 120° 0.471' N 8° 55.528' E 120° 0.411'
Lighthouse Reef, SR 1	N8° 44.396' E 119° 48.711' N8° 44.530' E 119° 48.592' N8° 44.348' E 119° 48.089' N8° 44.353' E119° 48.752' N8° 44.330' E 119° 48.795' N8° 44.464' E 119° 48.676'
Black Rock, SR 3	N 8° 47.805' E 119° 50.078' N 8°47.878' E 119° 50.155' N 8°47.842' E 119° 50.352' N 8° 47.787' E 119° 15.227' N 8° 47.738' E 119° 50.162' N 8° 47.811' E 119° 50.239'
South Reef, SR 4	N 8° 48.350' E 119° 48.368' N 8°48. 518' E 119° 48.468' N 8° 48.604' E 119° 48.462' N 8° 48.531' E119° 48.308' N 8° 47.805' E 119° 50.078' N 8° 47.878' E 119° 50.155' N 8° 48.465' E 119° 48.392' N 8° 48.538' E 119° 48.546'
Jessie Beazley	N 9° 2.465' E 119° 49.048' N 9° 2.571' E 119° 48' 628' N 9° 2.944' E 119° 48. 541' N 9° 2.710' E 119° 48.935' N 9° 2.877' E 119° 48.625' N 9° 2.643' E 119° 49.019'

APPENDIX 7.

PHOTOS TAKEN DURING EXPEDITION IN APRIL, 2004.

Home for ten days, the M/Y Tristar provided excellent accommodations, service and diving.

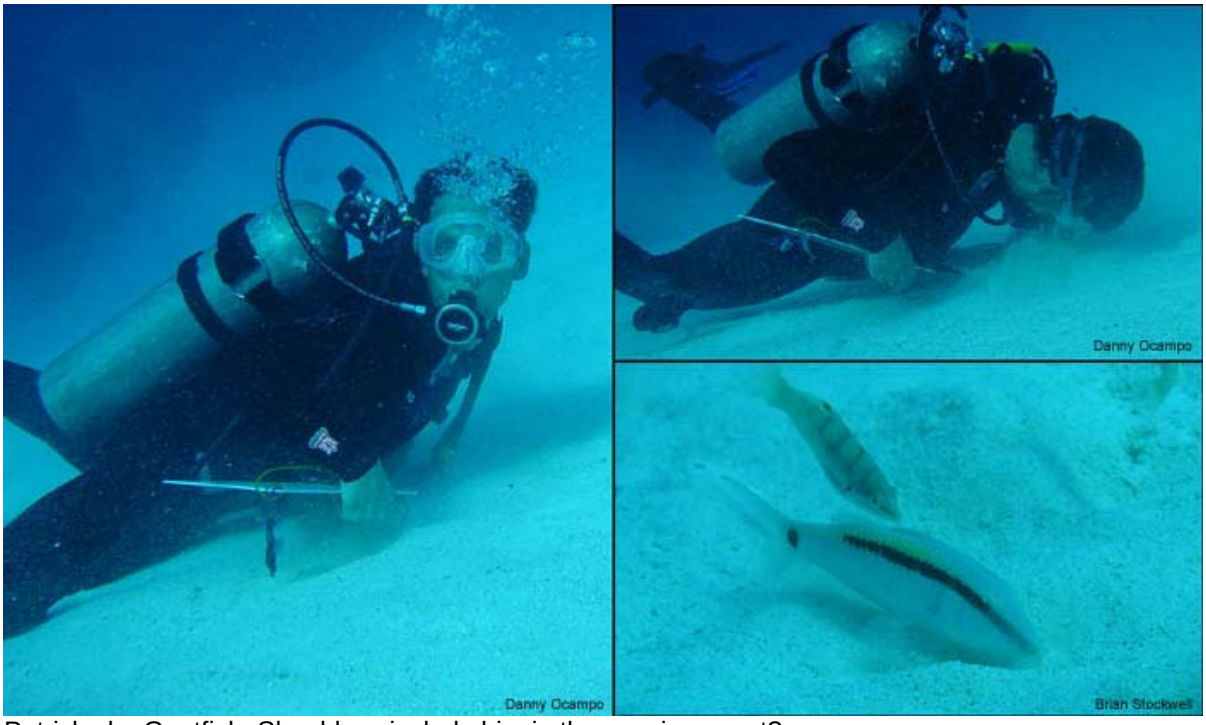


A school of Bumphead parrotfish at NR1.

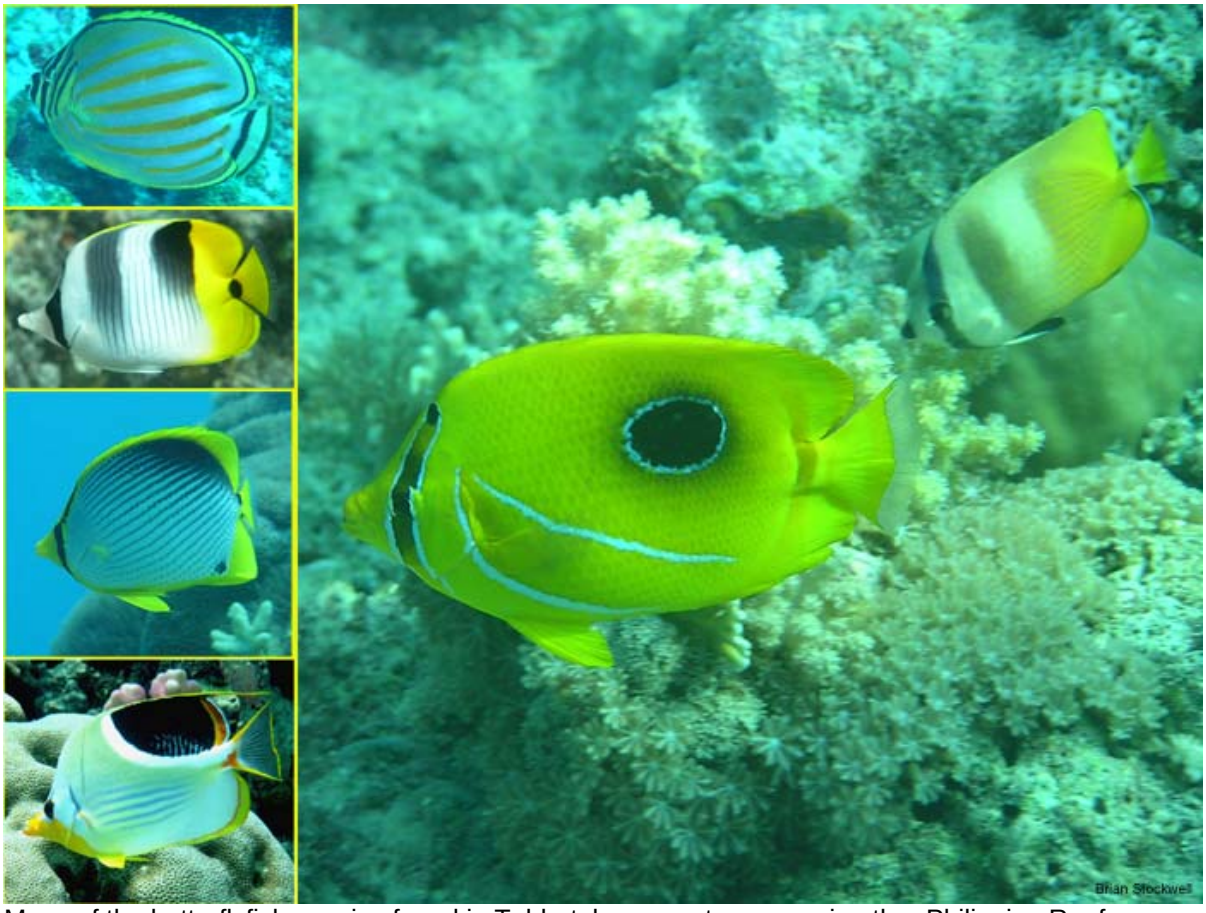
Ranger station (NR-2).

Turtles in search of food sometimes break coral branches in the process. This may solve the mystery holes in the stands of branching corals!

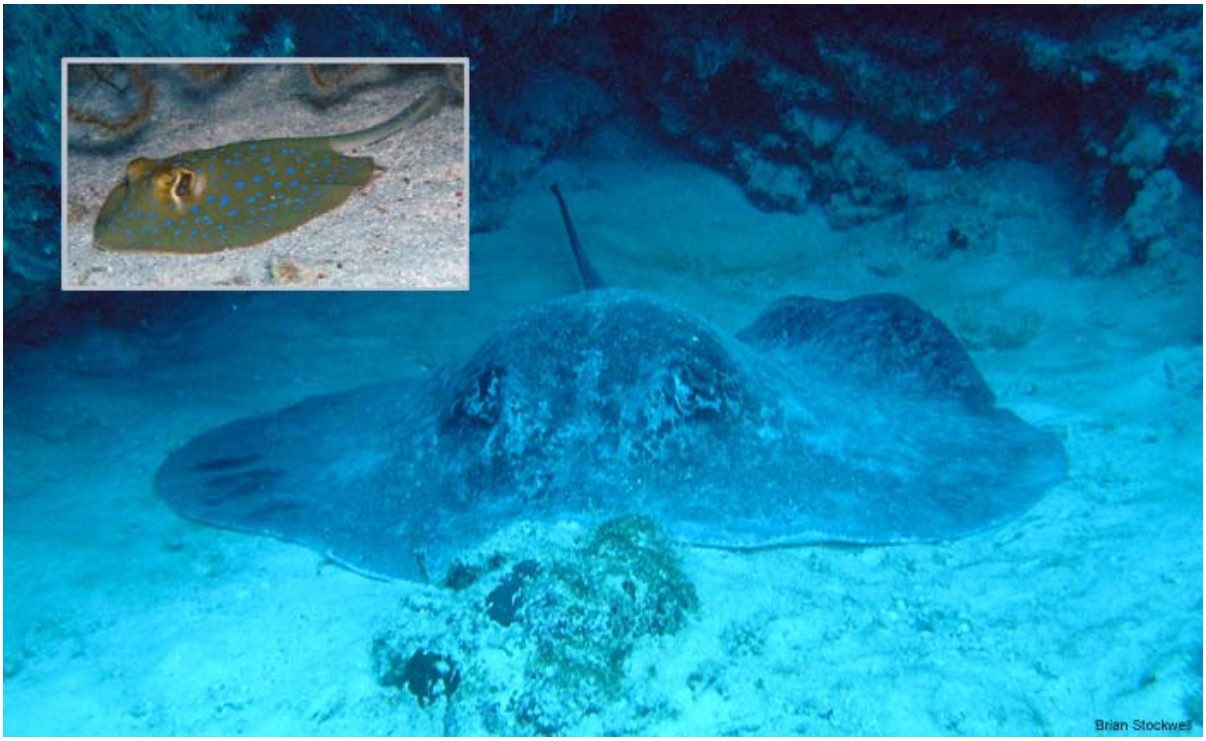
Alan giving a briefing before a survey dive.



Patrick aka Goatfish. Should we include him in the species count?



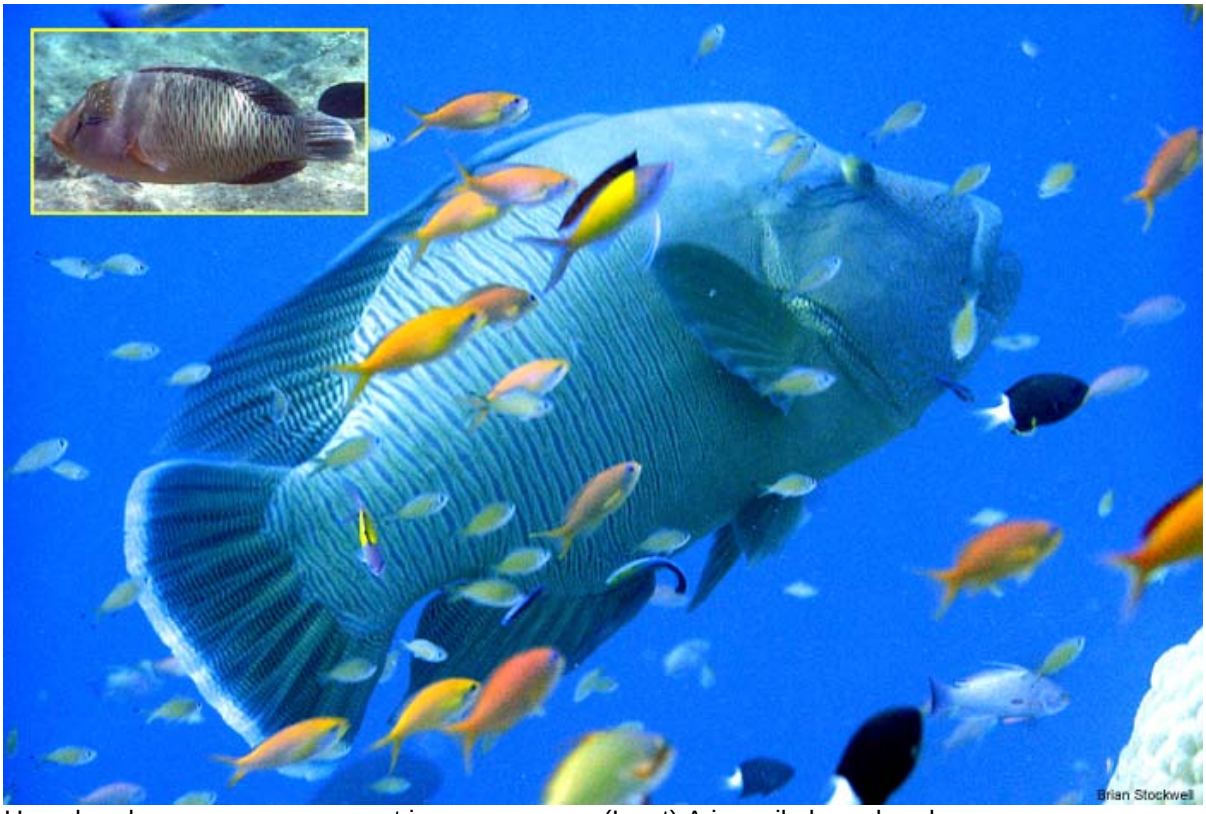
Many of the butterflyfish species found in Tubbataha are not common in other Philippine Reefs.



Despite a decline in manta ray sightings, other large rays were present.

(Left) The SPR team preparing to visit the Ranger Station; (Right) Visiting the rangers at their station. (Bottom) Drew and Heather resting after a snorkel survey.

Some Tubbataha scenes (top) Lighthouse Islet; (middle) Terns at Ranger Station sandbar; (bottom left) Malayan Wreck; (bottom right) Ranger Station.



Humphead wrasses were present in every survey. (Inset) A juvenile humphead wrasse.

White-tip and black-tip sharks were common in all sites.