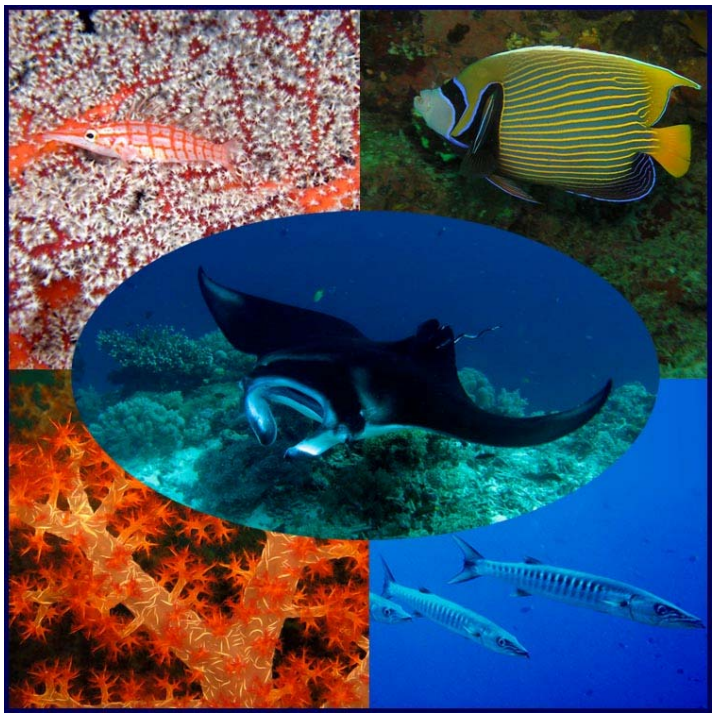
Summary Field Report

Saving Philippine Reefs



Coral Reef Monitoring Expedition to Tubbataha Natural Park, Sulu Sea, Philippines March 26 – April 1, 2008

A project of:

The Coastal Conservation and Education Foundation, Inc,

The Fisheries Improved for Sustainable Harvest Project

and the

Expedition Volunteers

Summary Field Report:
"Saving Philippine Reefs"
Coral Reef Monitoring Expedition to
Tubbataha Natural Park, Sulu Sea, Philippines
March 26 – April 1, 2008

A project of:

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

With the participation and support of the

Expedition Researchers

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

Cebu City, Philippines

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Coastal Conservation and Education Foundation, Inc (CCE Foundation) is a non-profit organization concerned with coral reef and coastal conservation in the Philippines.

Cover photo by Pamel Huxley (fish in soft coral), Vangie White (angelfish), Paul Stretton (manta ray), Roxie Diaz (soft coral), Aileen Maypa (barracuda).

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ABSTRACT

Tubbataha Reefs Natural Park (TRNP; formerly Tubbataha National Marine Park) includes two uninhabited coral reef atolls that contain more than 10,000 hectares of reef within its boundaries in the Sulu Sea. This biodiverse reef system is a World Heritage Site of global ecological importance. Tubbataha is known for its large marine life not found in most areas in the Philippines and is an outstanding and popular dive site.

This project assessed the condition of the coral reefs in TRNP (at selected sites and updated information from surveys in 1984, 1989, 1992, 1996, 2000 and 2004. In 2008, live hard coral (LHC) for all seven sites is fair to good (27.1 ± 2.9% to 62.4 ± 3.7%). Comparison between sites in the shallows gave a highly variable result. In the deeper zone, NR2 had the highest percent LHC, and NR2, the lowest. Slight increases in LHC were observed from 2004 to 2008. A total of 285 fish species in 43 families were listed in 2008. Butterflyfish counted were slightly lower at 30 species than in past years.

It appears that the El Niño Southern Oscillation (ENSO) has been and is a major factor in shaping the trajectory of Tubbataha reefs and is most likely compounded by management effects. Trends in percent LHC and fish densities vary from site to site. In all sites, significant LHC recovery is absent in both deep and shallow areas except the shallow zone of SR3. Increases in target fish density were found in two sites. For target fish biomass between sites in 2008, all sites had significantly higher values (median: 89.6 ± 51.8 to 325.7 ± 162.8 kg/500m^2) compared to Jessie Beazley (median: 19.1 ± 3.3 kg/500m^2) and SR3 (median: 45.7 ± 122.9 kg/500m^2). We may attribute the former's low biomass to short time of protection while the latter to high variation between replicate samples. The maintenance of strict enforcement in Tubbataha Reef Natural Park is seen as essential to maintain and build resilience and recovery from earlier ENSO impacts.

Information on other substratum, invertebrates, causes of coral damage over time, patterns, and trends in reef health per site were also collected. Recommendations on how to improve the management status of Tubbataha Reefs include: meeting the logistical needs for the rangers; increasing information dissemination to stakeholders; continued monitoring and research; and more education for all visitors, divers and boat operators on the natural history of the area as well as on dive and boating regulations. Finally, the Tubbataha Protected Area Management Board and its partners are congratulated for a job well done in protecting and managing the Tubbataha Reefs.

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ACKNOWLEDGEMENTS

This coral reef monitoring expedition and its outcome are credited to the 14 international researchers (see Appendix 2) from the United States, United Kingdom, Australia and the Philippines who dedicated their time and funding to the Expedition. Equally important are the Coastal Conservation and Education Foundation staff, partners and volunteers (See Appendix 2) that prepared for the trip, worked long hours and have all done their part in the overall successful completion of the Expedition. They include: Aileen Maypa, Co-Principal Investigator; Sheryll Tesch, Logistics and Research Coordinator; Roxie Diaz, Researcher and Assistant Divemaster; Ethan Lucas, Divemaster; Rafael Martinez, GIS Specialist; Agnes Sabonsolin, Data and Logistics Assistant; and Vangie White, Overall Project Manager and support coordinator for the trip.

The M/V Oceanic crew hosted the group with traditional Filipino hospitality and provided excellent service, accommodations, food and diving services and assistance. We would like to thank the dive masters, Pam Huxley and Paul Stretton, for their excellent assistance, and especially to the boat captain, for making it a safe and smooth trip.

The Tubbataha Reefs Natural 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.

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

Alan T. White
Principal Investigator

LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
CB	Branching coral
CFD	Flat/encrusting coral
CFO	Foliose/cup coral
CM	Massive coral
DC	White dead standing coral
DCA	Dead coral with algae
ENSO	El Niño Southern Oscillation
FVC	Fish visual census
JB	Jessie Beazley
LC	Live coral
LHC	Live hard coral
M/V	Marine vessel
MPA	Marine protected area
NL	Non living
NR	North Reef
NS	Not significant
PAMB	Protected Area Management Board
PCSD	Palawan Council for Sustainable Development
R	Coral rubble
RCK	Rock and block
SC	Soft coral
SD	Standard deviation
SE	Standard error
SI	Sand and silt
Spp.	Species
SPR	Saving Philippine Reefs
SR	South Reef
TRNP	Tubbataha Reefs Natural Park
UVC	Underwater visual census

SAVING PHILIPPINE REEFS
A coral reef monitoring expedition to
Tubbataha Reefs Natural Park
Sulu Sea, Philippines

INTRODUCTION

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

One SPR site 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 to conserve the area. Four years later in 1988, it was declared a national marine park (Arquiza and White 1999). In 1994, Tubbataha Reefs was declared a World Heritage Site by UNESCO. In 2008, legislation expanded the park boundaries to include the Jessie Beazley Reef and amended its name to: "Tubbataha Reefs Natural Park". The full legal and management history of Tubbataha is explained by Arquiza and White (1999) and WWF (2006).

Management of Tubbataha Reefs Natural Park

Management of the Tubbataha Reefs Natural Park (TRNP) has always been challenging. 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 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, WWF, 2006):

Early 1980s	Cagayanon fishers start to fish at Tubbataha; Tubbataha discovered as a dive site; start of research studies
Mid-1980s	Cagayanons convert to motorized fishing boats; introduction of dynamite and cyanide by Visayan fishers
1988	Tubbataha National Marine Park declared by Presidential Decree 306.

1989	First draft of park management plan based on limited information.
1990	Sporadic patrols started to stop illegal and destructive fishing. MOA between DENR and Tubbataha Foundation.
1992	Several research expeditions collected baseline data on the coral reef.
1993	Park management plan re-drafted; illegal activities increased. UNESCO World Heritage status declared.
1994	Presidential Task Force set up to implement management and provide funds; Philippine Navy assigned to guard the Marine Park.
1995	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. Memorandum Circular 128 creates the multi-sectoral Presidential Task Force, chaired by DENR Secretary.
1996	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. Issuance of Memorandum Circular 150 amending MC 128 and turning over the chairmanship of the Task Force to the Secretary of National Defense with DENR and PCSD representatives as co-chairpersons.
1997	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.
1998	PAMB becomes operational with a park manager appointed and supported by WWF based on management plan designed by CRMP technical guidance. Tubbataha Protected Area Management Board (TPAMB) created, chaired by the Provincial Governor, who also chairs the PCSD; park management plan prepared and approved by TPAMB.
1999	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. Tubbataha inscribed in List of Wetlands of International Importance, also known as Ramsar List; park management plan approved by PCSD; stakeholders agree to adhere to the no-fishing policy.
2000	Continued implementation of management plan to present.
2001	Tubbataha Management Office (TMO) established.
2002	Management plan revised – entry permits, collection of conservation fees, ecosystem research.
2004	Management plan revised – incorporation of park management effectiveness monitoring and evaluation program. Amendments to the delineation of the marine park, including Jessie Beazley reef as part of the protected area.
2007	Jessie Beazley officially included as part of the Tubbataha National Marine Park.

This EXPEDITION—2008

This coral reef survey is the 5th reef monitoring expedition to Tubbataha Reefs (Figure 1). This 9-day expedition was conducted on April 3 to 11, 2008 and was participated in 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 who have joined in one or more of the 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 nine days was the M/V Oceanic. With an efficient and friendly boat crew the M/V Oceanic 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, now located inside (after the park amendment in 2008) 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 through complete data collection and some 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 education program.

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

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 atoll's shallow reef platforms are exposed (NMRC 1983). Data was gathered in seven sites, six were located in reefs that had long-term protection while Jessie Beazly was only recently protected (personal communication, A. Songco, park manager).

Data collection

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

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

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

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

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

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

Data Analyses

Coral and fish abundance. The classification for live hard corals (LHC) followed that of Gomez et al 1994. Comparisons between years for both LHC percent cover and fish densities used one-way Analysis of Variance (1-ANOVA), Kruskal-Wallis multiple comparison test or t-test whenever appropriate. Data not meeting the assumptions of variance equality and normality (when necessary) were log or square root transformed. Levene's Test was used to check for variance equality. Statistical software used included Minitab 14 and SPSS 16.

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

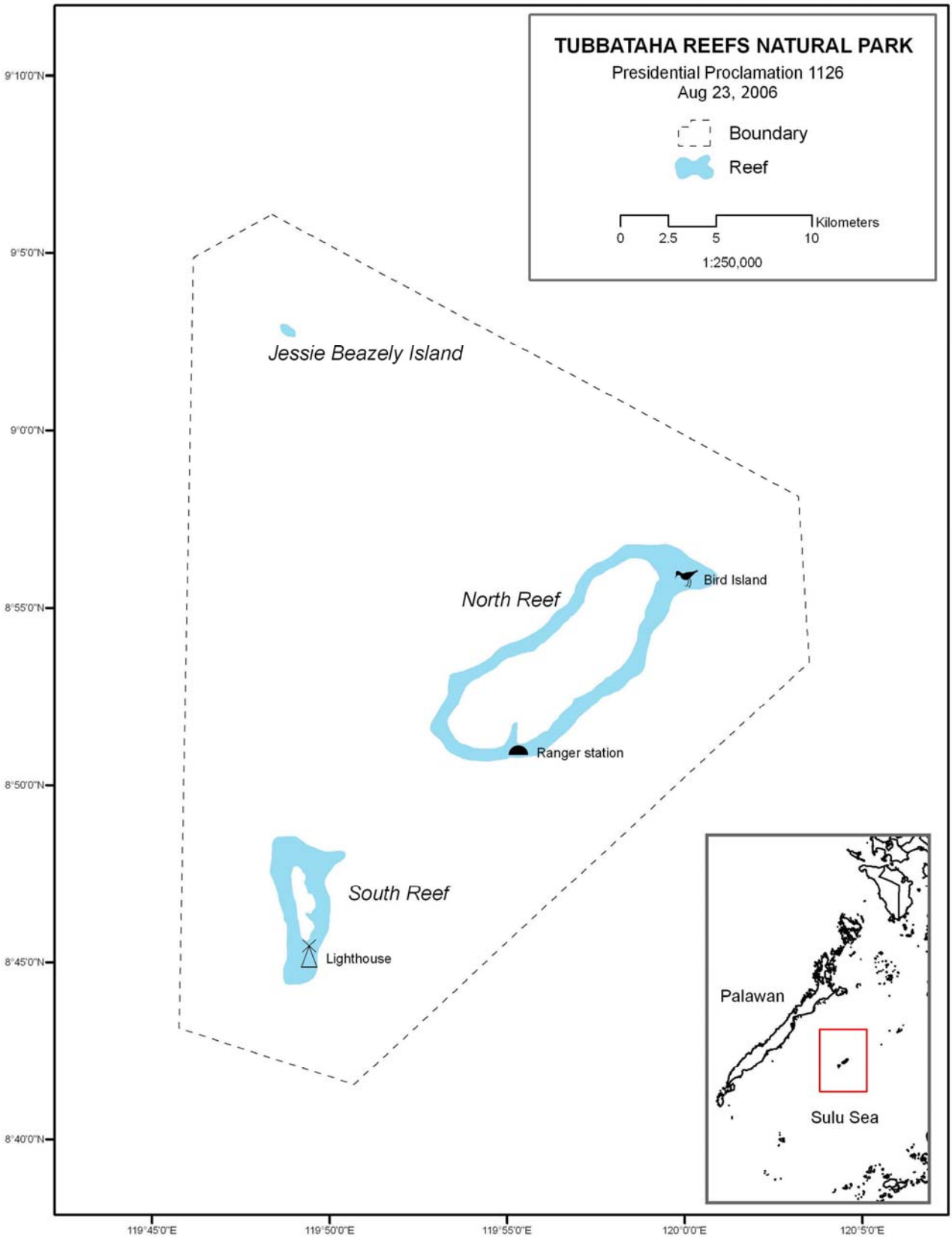


Figure 1. Location of Tubbataha Reefs in Sulu Sea and delineation of the marine park.

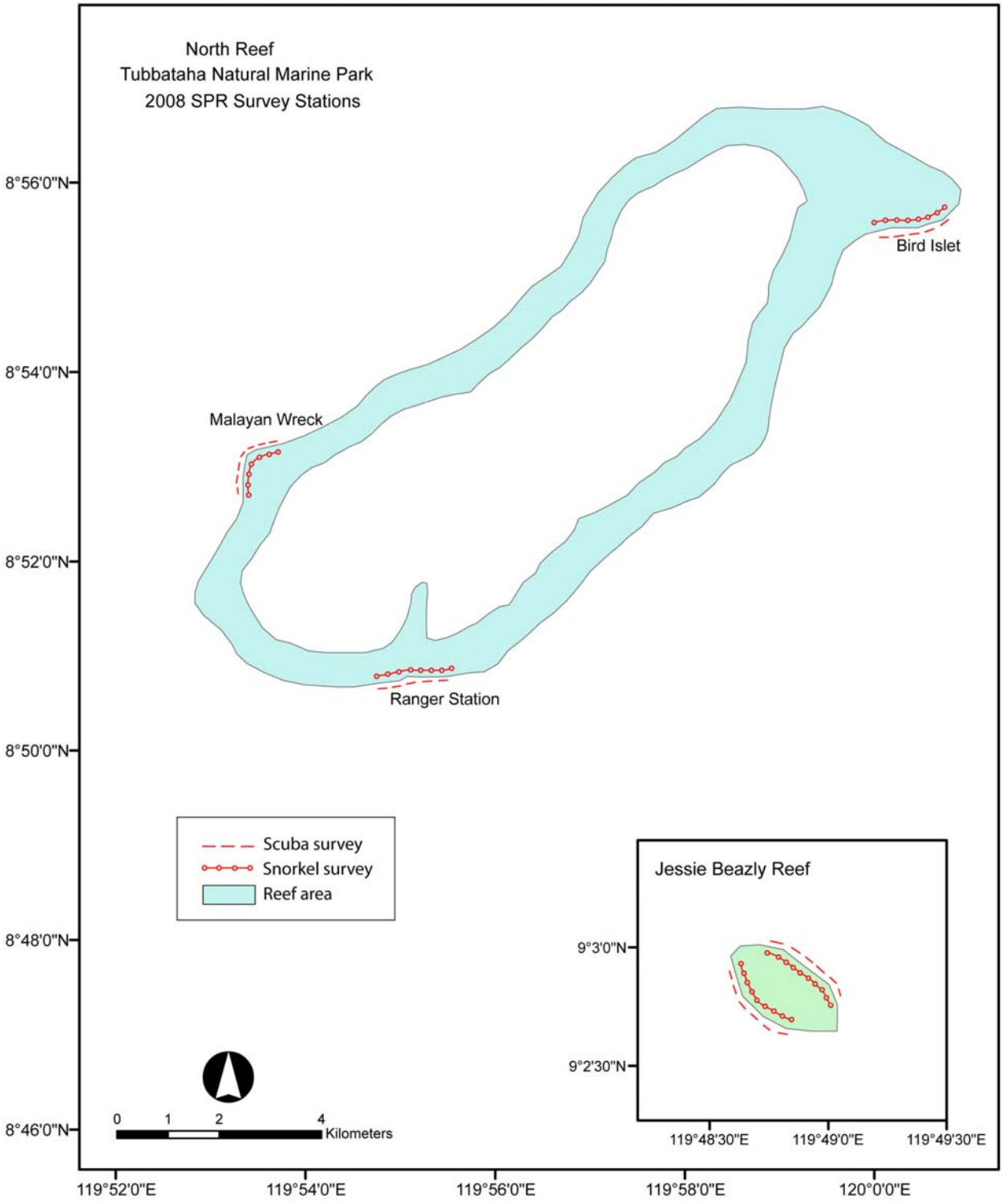


Figure 2. North Reef Survey sites.

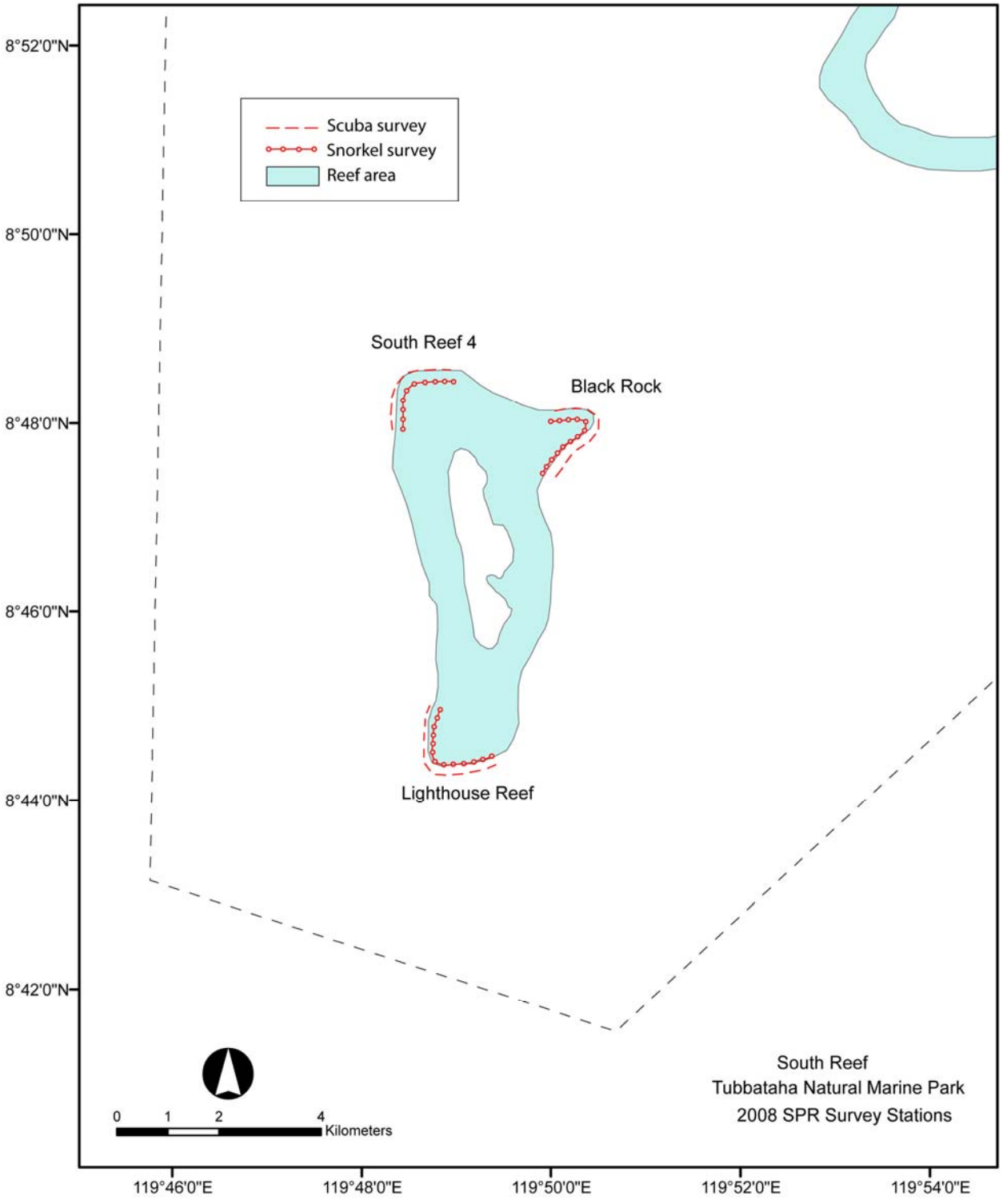


Figure 3. South Reef Survey Sites.

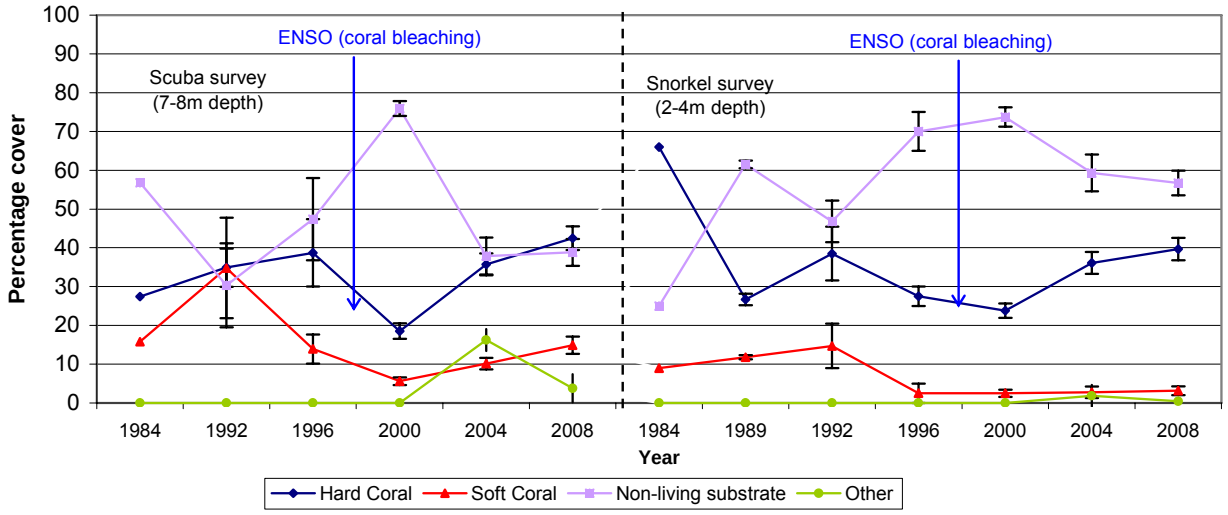
North Reef 5 (NR5: Bird Islet)

Site overview. North Reef 5 borders along the northern most tip of the north atoll close to the Bird Islet (Figure 2). This Islet serves as a nesting ground for about 1,000 brown boobies and is possibly a nesting site for sea turtles. However, Bird 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 the birds can return to their only protected habitat in the southern Philippines and possibly in the entire country (White et. al. 2000). In recent years most of these trees have been removed by the park rangers. Bird islet is also fringed by seagrasses extending to 300 to 500 meters.

Results

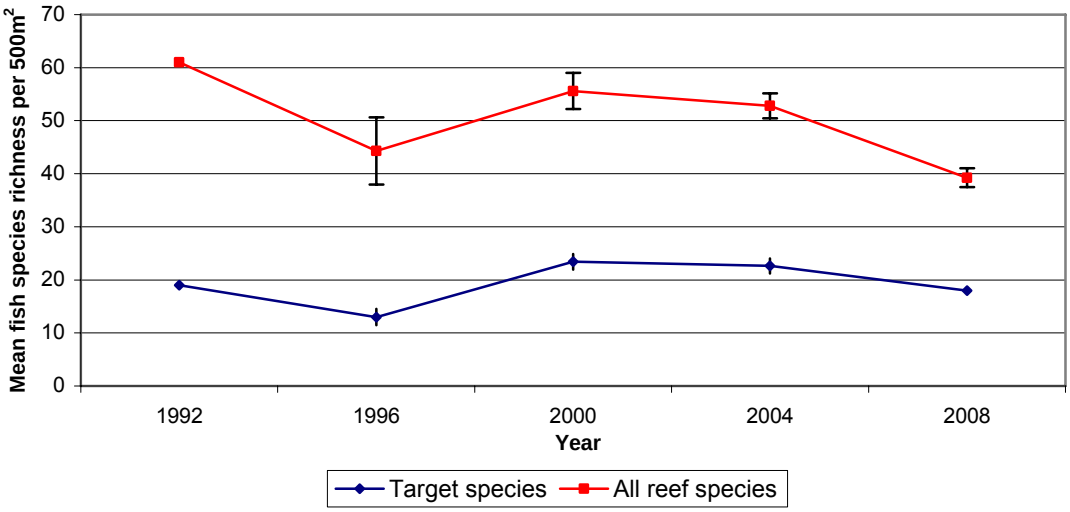
Substrate. Live hard coral (LHC) in North Reef 5 was fair (shallow: 39.6 ± 2.9%, deep 42.5 ± 3.0%) in the year 2008 (Figure 4, Table 1). Numerically, it appears that there is an increase in LHC for this site from the previous survey in 2004 for both deep (35.7 ± 9.2%) and shallow (36.1 ± 2.7%), yet this is not a statistically significant increase (Table 31). The lowest LHC cover was recorded in the year 2000 (deep: 24.1 ± 1.9%).This significantly low cover (p = 0.000, F = 8.62, DF = 5) had been attributed to coral death from the 1998 coral bleaching (Maypa et al. 2004). Recovery has been noticeable in the significant increases observed in the following years (see Table 31 for statistics results in LHC comparisons between years).

Figure 4. Changes in substrate composition (% mean ±SE) in NR-5 (North Reef) Bird Islet from 1984 to 2008.



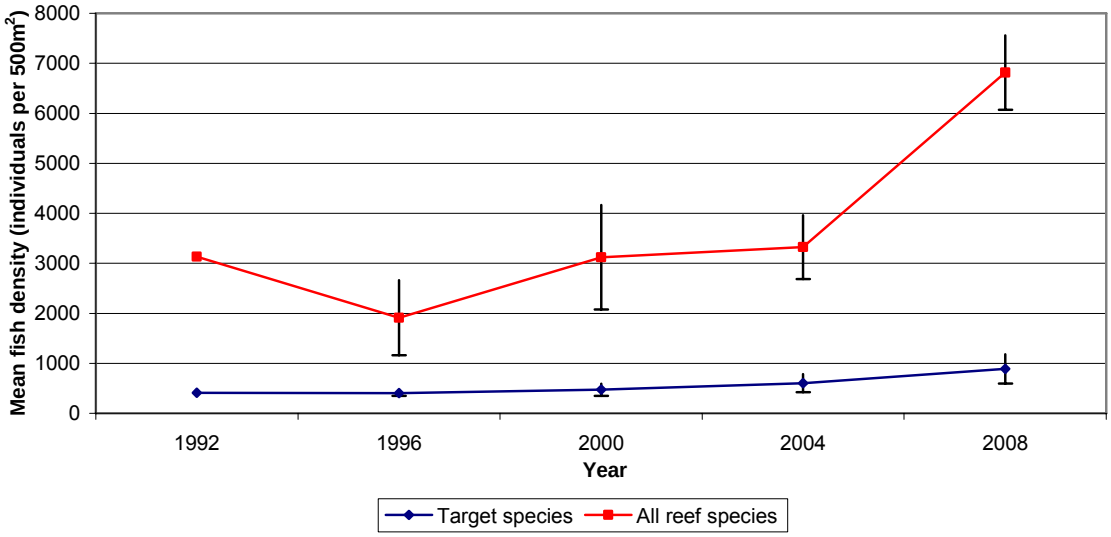
Fish diversity, abundance and biomass. A total of 159 fish species were listed in NR5 including two species of sharks (Appendix 3 fish list). Mean species richness for butterflyfish was 13.0 ± 0.7 fish/500m^2 (Table 3); for all reef species, 39.3 ± 8.1 fish/500m^2 and for target fish, 18.0 ± 1.8 fish/500m^2 (Figure 5). Change in species richness between years is shown in Table 4.

Figure 5. Mean (±SE) number of species/500m^2 at NR-5 (North Reef) Bird Islet from 1992 to 2008.



In the year 2008, NR5 recorded the highest target fish density (887.0 ± 293.5 fish/500m^2) among all sites (Table 5). This is dominated by Fusiliers at 597.0 ± 167.9 fish/500m^2; *Caesio caerulaurea, C. tile, C. lunare, Pterocaesio tile, P. randalli)*, Emperors *(Gnathodentex aurolineatus, Monotaxis grandoculis, Lethrinus olivaceus)* and Surgeonfishes *(Acanthurus* spp., *Naso* spp., and *Ctenochaetus* spp.).

Figure 6. Mean (±SE) density (fish/500m^2) at NR-5 (North Reef) Bird Islet from 1992 to 2008.



Similarly, the biomass of Fusiliers (median: 38.89 kg/500m^2) is significantly higher (p = 0.000, H = 44.44 , p = 16) compared to the rest of the families in NR5 (Figure 7). This is followed by Snappers (*Lutjanus* spp., *Macolor macularis, Aprion virescens, Aphareus furca*) and Jacks (*Caranx sexfasciatus, C. ignobilis, Carangoides plagiotaenia* (Table 32). The higher biomass of Snappers and Jacks compared to the more abundant Emperors and Surgeonfishes indicate that the former two families are composed of larger size classes compared to the latter (Table 3). Total target fish biomass in NR5 is 108.4 ± 18.8 kg/500m^2.

No significant difference was observed in total target fish densities between survey years in NR5 (Table 33). Fish families that dominated numerically in the years 2004 and 2008 appeared similar. For target fish, Fusiliers and Surgeonfishes made up most of the fish density. For non-target fish, Pomacentrids and Anthids dominated (Table 5).

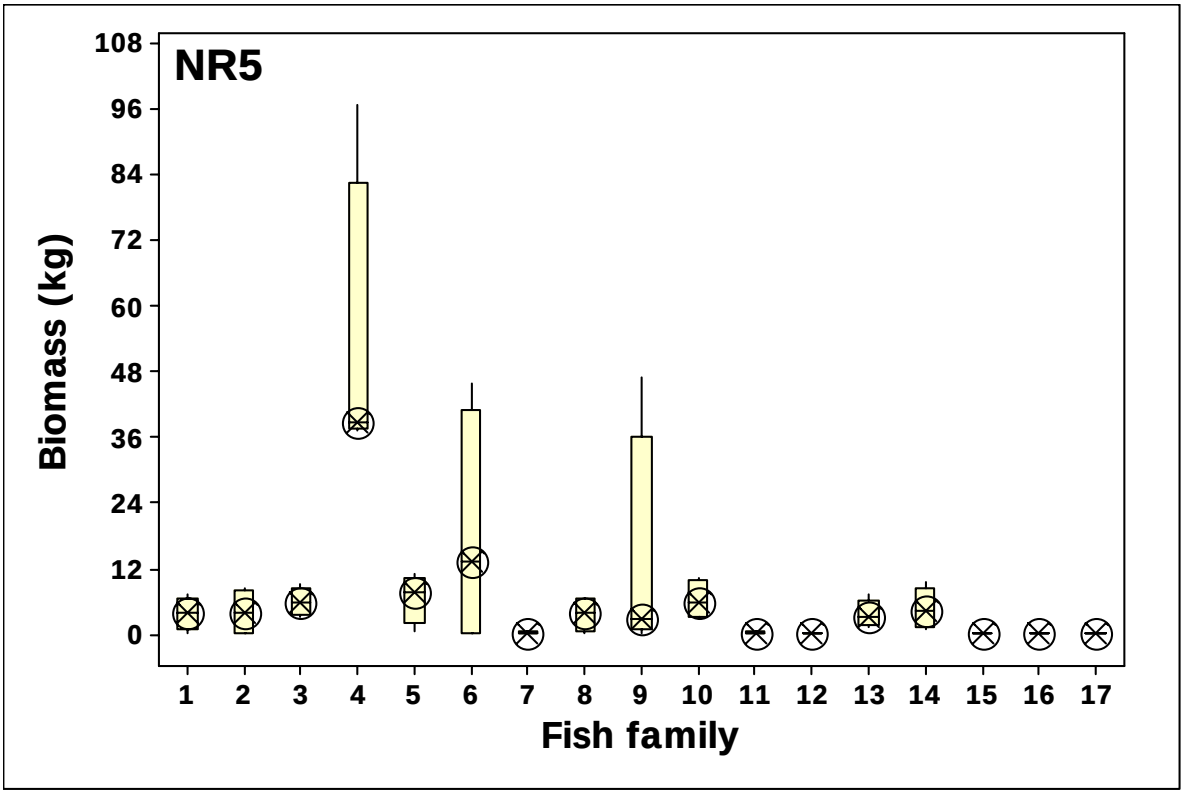


Figure 7. Boxplot of fish biomass (kg) in NR5 showing high median values for Caesionids (4), Canrangidae (5) and Lutjanids (10) families compared to other families within site. Circles represent median points. For statistical test results please refer to Table 32.

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

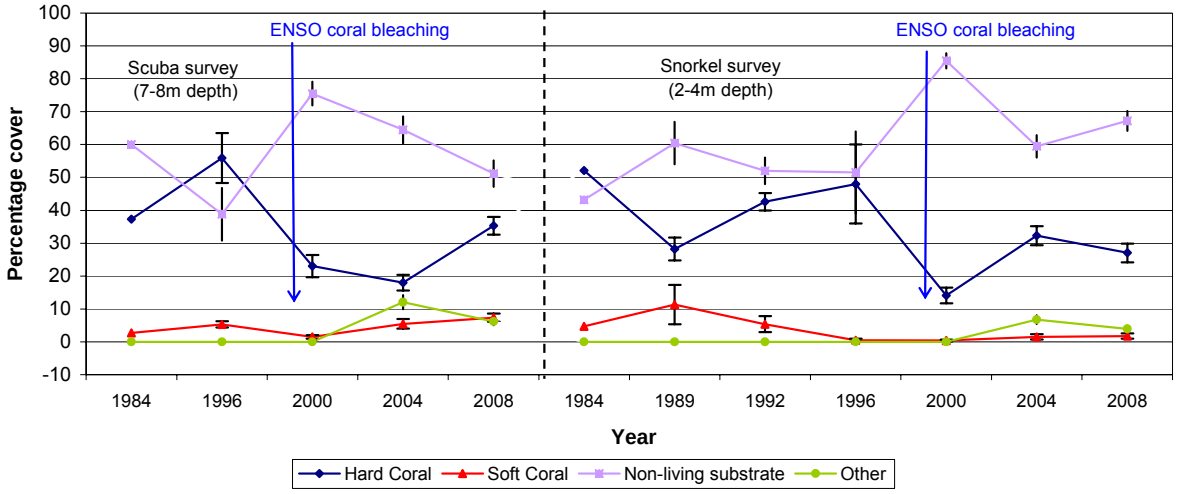
Site overview. Amos Rock is also known as the Southwest Rock, a distinct rock formation on the reef slope along the southwest tip of the north atoll (Figure 2). This site is popular to divers due to its rich coral cover in the past years as well as the Malayan wreck lodged on its slope. Sea turtles and manta rays have been consistently observed in NR1 during the previous years, however, mantas were not sighted in 1996, 2004 (White et al. 2004) and 2008. This year mantas were observed only at NR5.

Results

Substrate. Like NR5, live hard coral in North Reef 1 is also fair (shallow: 27.1± 2.9 %, deep 35.3 ± 2.69%) in the year 2008 (Figure 8, Table 6). Branching corals have continued to dominate the rest of the coral growth forms over the years. Yet, NR1 is also characterized by high proportions of rock and block which is attributed to the 1998 coral bleaching (White et al. 2004). In 2004, NR1 was the only site among the seven surveyed that showed no signs of LHC recovery from the 1998 coral

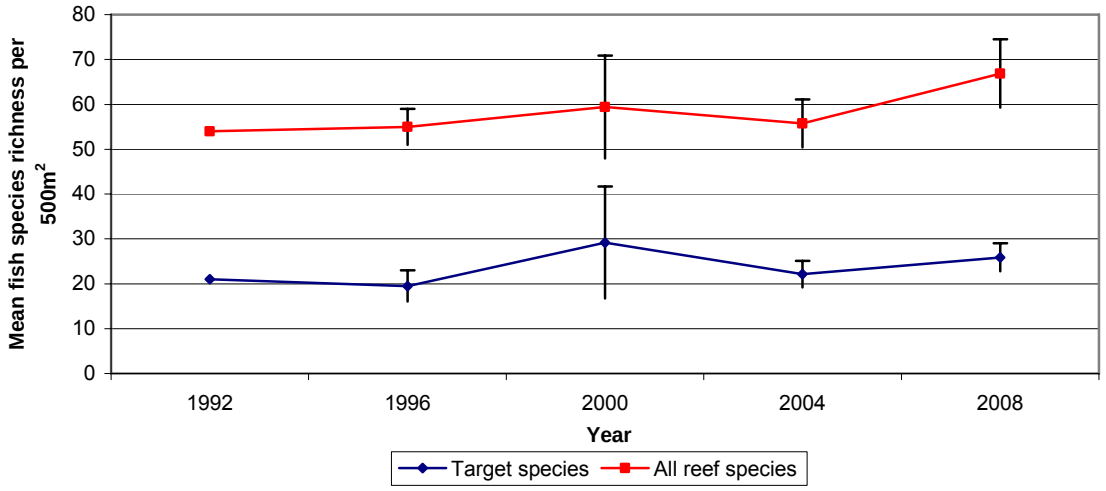
bleaching (Maypa et al. 2004). In 2008, a declining pattern is shown for rock and block coupled with increases in LHC ($p = 0.000$, $F = 10.41$, $DF = 4$) and soft corals in the deep but not in the shallow (Table 6). Live hard coral recovery from the 1998 bleaching in the shallow may take longer in this site compared to others. It is important to note the geographic recovery of reefs from coral bleaching. NR5 and NR2 situated at the eastern side of the northern atoll both showed immediate recovery through increases in LHC in 2004 while NR1, situated on the western side showed slow recovery in the deep but not in the shallow based on this year's survey. Current patterns and propagule supply may play a role in these observed patterns (Maypa et. al. 2004).

Figure 8. Changes in substrate composition (%mean ±SE) in NR-1 (North Reef) Malayan Wreck from 1984 to 2008.



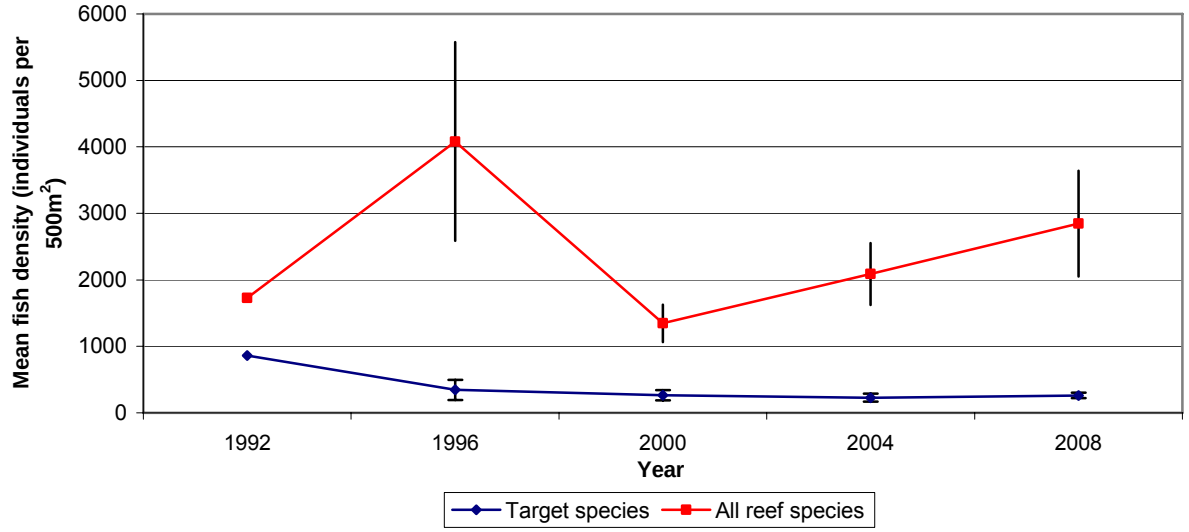
Fish diversity, abundance and biomass. A total of 183 fish species were listed in NR1 including 21 species of butterfly fish (Appendix 3 fish list). Mean richness for all reef species was 66.9 ± 7.5 fish/500m^2 and 25.9 ± 3.1 for target fish (Figure 9, Table 7). Changes in species richness overtime are shown in Table 8.

Figure 9. Mean (±SE) number of species/500m^2 in NR-1 (North Reef) Malayan Wreck from 1992 to 2008.



Numerically abundant families in NR1 include Pomacentrids (mean: 1013.6 ± 4193 fish/per 500m^2 and Anthids (mean: 983.3 ± 346.9 fish/500m^2). Dominant target fish were Balistids (mean: 420.8 ± fish/158.7 500m^2), where the species *Odonus niger* made up the bulk of the count; Acanthurids and Caesionids where majority of the schools recorded 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.

Figure 10. Mean (±SE) density (fish/500m^2) in NR-1 (North Reef) Malayan Wreck from 1992 to 2008.



Fish biomass was significantly highest (p = 0.000, H = 47.44, DF = 15; Table 32) for Lethrinids (median: 16.9 kg/500m^2) followed by Balistids (median: 9.9 kg/500m^2) and Nemipterids (6.8 kg/500m^2 ; Figure 11 Biomass graph for NR1). A fairly high biomass of herbivorous surgeonfishes (median: 5.8 kg/500m^2) was also noted (e.g. *Ctenochaetus* spp.). Total biomass of target species in NR1 is 113 ± 16.5 kg/500m^2.

In NR1, similar fish patterns are suggested by our results for the years 2004 and 2008 (Table 9 and Figure 10). The dominant species characteristic of this site in 2004, were noted in similar densities and richness in this current survey. The scarid, *Bolbometopon muricatum* (Bumphead parrotfish) was again sighted in NR1. Although less in number from the year 2004 (40-50 cm), the sizes were larger (60 cm). No significant difference was found in target fish densities between years (Table 33).

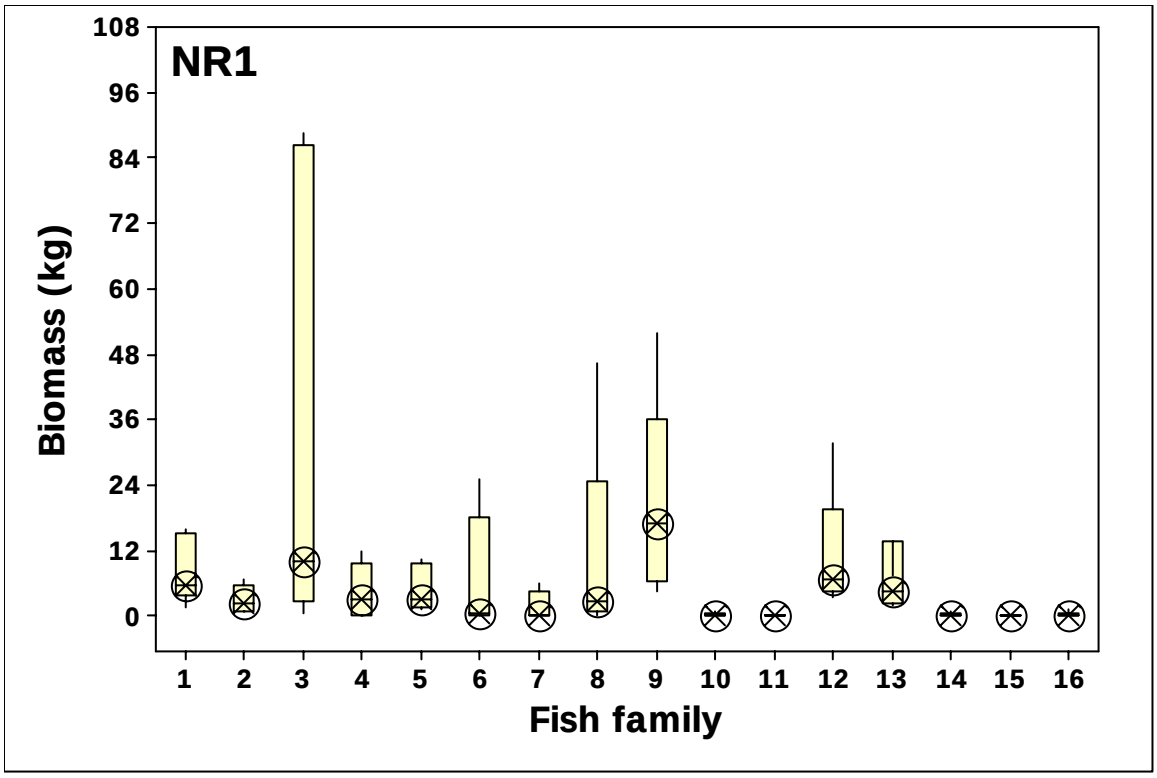


Figure 11. Boxplot of fish biomass (kg) in NR1 showing high median values for Lethrinidae (9), Balistidae (3), Nemipteridae (12) and the planktivorous Acanthurids (1) compared to other families within site. Circles represent the points. For statistical test results please refer to Table 32.

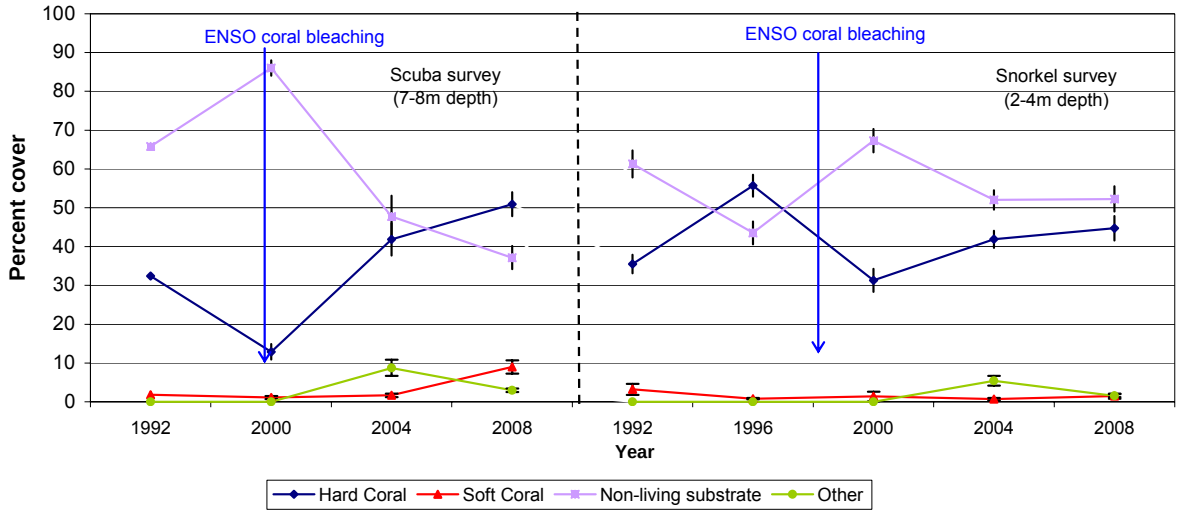
North Reef 2 (NR2: Ranger Station)

Site overview. North Reef 2 is located on the southeast sand cay on the north atoll where the Ranger Station is situated (Figure 2). This site is a nesting ground for Green turtles and terns (Arquiza and White 1999). Rangers stationed in this site come from Puerto Princesa take turns to patrol Tubbataha reefs (personal communication, Tubbataha rangers). Schools of barracudas were sighted in this current survey.

Results

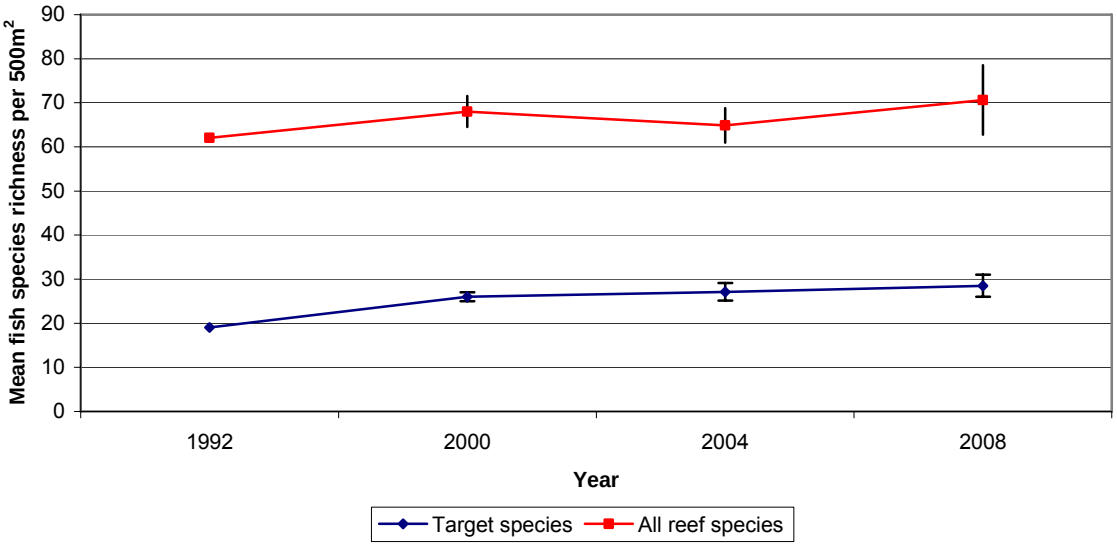
Substrate. Live coral cover in North Reef 2 was fair in the shallow (44.7 ± 3.2 %) and good in the deeper area (50.9 ± 3.1 %; Figure 12, Table 10). No significant changes in LHC were observed between 2008 and previous survey in 2004 (Table 31) despite observations of Crown-of-thorns starfish infestation. Like NR5, suggested LHC recovery for NR2 from the 1998 coral bleaching was seen through a significant increase from 2000 to 2004 (Maypa et al. 2004) and no further improvement was seen currently. Branching corals continue to dominate the benthos of this site.

Figure 12. Changes in substrate composition (%mean ±SE) in NR-2 (North Reef) Ranger Station from 1992 to 2008.



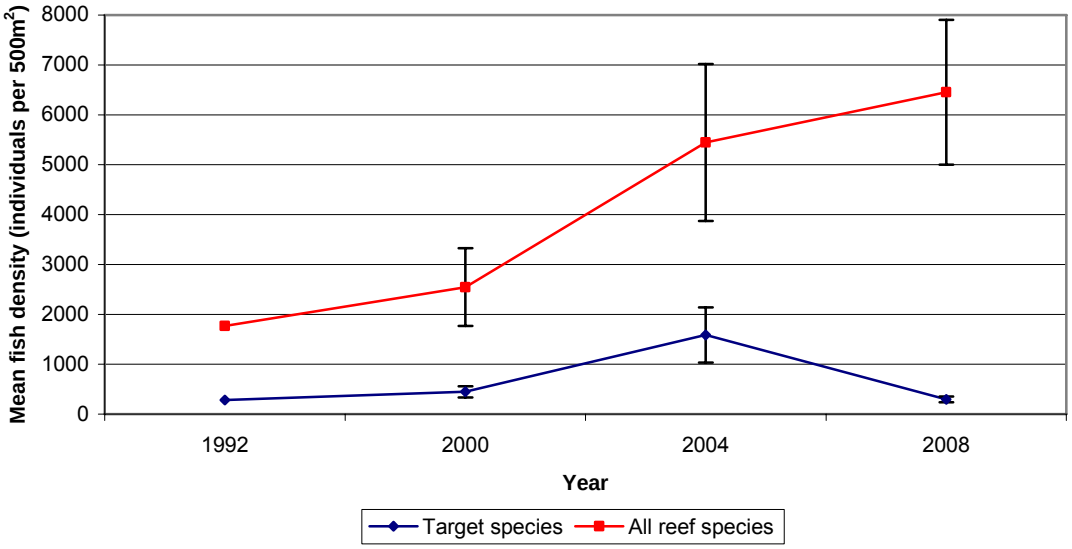
Fish diversity, abundance and biomass. A total of 192 fish species were listed in NR2 including white tip and black tip sharks (Appendix 3 fish list). 25 butterflyfish species were recorded (Table 2). Mean richness for all reef species was 70.6 ± 7.9 (Table 11, Figure 13). Changes in species richness between years are shown in Table 12.

Figure 13. Mean (±SE) number of species/500m^2 in NR-2 (North Reef) Ranger Station from 1992 to 2008.



Target species mean density was 294.8 ± 58.9 fish/500m^2 while 6452.0 ± 1451.1 fish/500m^2 for all species, by far the highest in mean species density for total reef species (Table 11). Target fish density in 2004 was significantly higher ($p = 0.003$, $F = 8.44$, $DF = 3$) compared to earlier years (Table 33). Fusiliers and surgeonfishes numerically dominate this site (Table 11).

Figure 14. Mean (±SE) density (fish/500m^2) in NR-2 (North Reef) Ranger Station from 1992 to 2008.



Alternatively, Balistids significantly (p = 0.015, H = 30.75, DF = 16) showed the highest biomass (median: 5.7 kg/500m^2) followed by planktivorous Acanthurids and Lutjanids (Figure 15 biomass graph). *Odonus niger* dominated numerically among other triggerfish species. Total fish biomass in NR2 is 91.7 ± 23.3 kg/500 m^2).

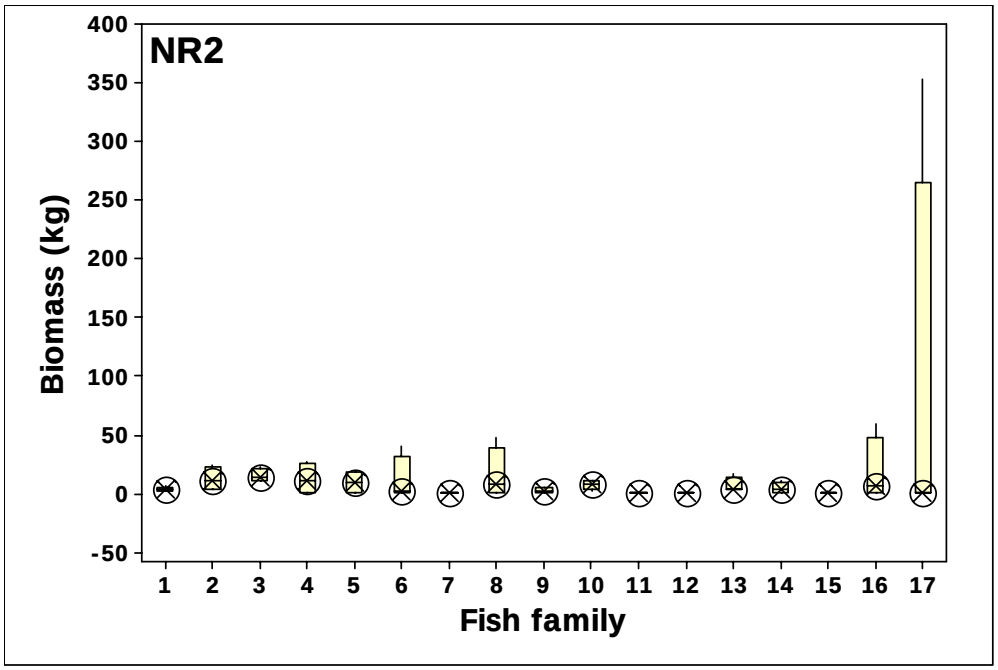


Figure 15. Boxplot of fish biomass (kg) in NR2 showing high median values for Balistidae (3), planktivorous Acanthuridae (2) and Lujanidae (10) compared to other families within site. Circles represent median points. For statistical tests result please refer to Table 32.

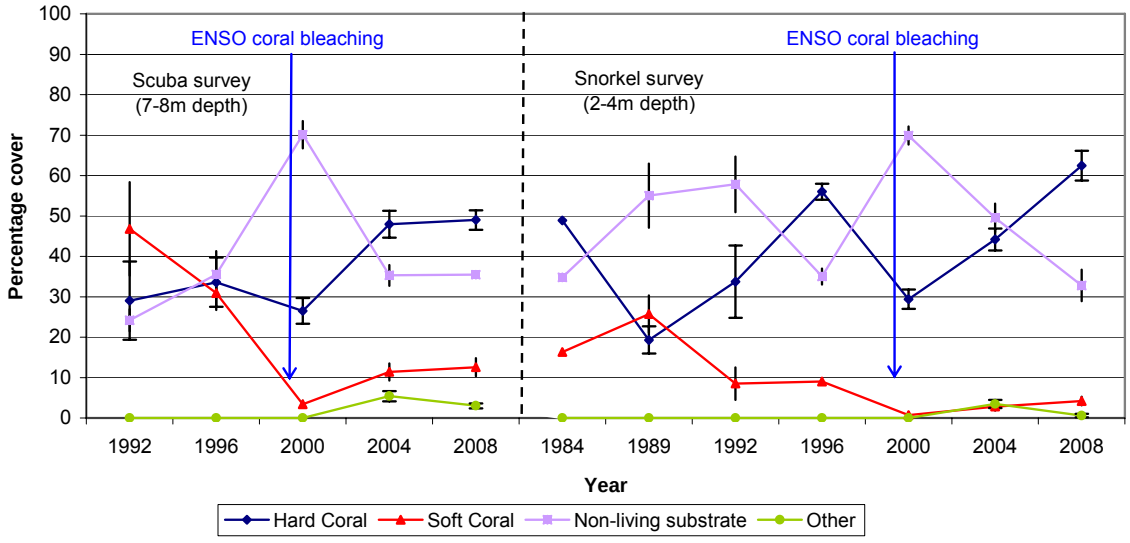
South Reef 3 (SR3: Black Rock)

Site overview. Black rock is located on the northeast corner of the south atoll (Figure 3). This site was severely damaged by anchoring and fishing in the late 1980's until the early 1990'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. In this year's survey, numerous sharks and turtles were sighted.

Results

Substrate. Live hard coral in South Reef 3 was good in the shallow (62.4 ± 3.7 %), showing a significant increase ($p = 0.00$, $F = 16.89$, $DF = 3$) from the previous year, 2004 (fair LHC at 44.2 ± 2.7%). In the deeper zone, however, increase in 2008 reflected in the graph is not statistically significant from 2004. Live hard coral in the deep remains fair (49.0 ± 2.4 %; (Figure 16, Table 14; Table 31). Like most of the sites surveyed, SR3 was also affected by the 1998 coral bleaching episode. However, unlike other sites, SR3 has had a fairly high soft coral cover in the previous years, which were severely bleached. 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 occurred: live hard coral significantly increased ($p < 0.001$, ANOVA) by 81% replacing most of the soft coral and rubble which had decreased (Figure 16; White et al. 2004). To date, LHC, dominated by branching corals, continues to increase significantly in the shallows and is maintained at 7-8m depth while soft coral cover declines at both depths. This is the only site that showed a significant increase in LHC from 2004 in the shallow.

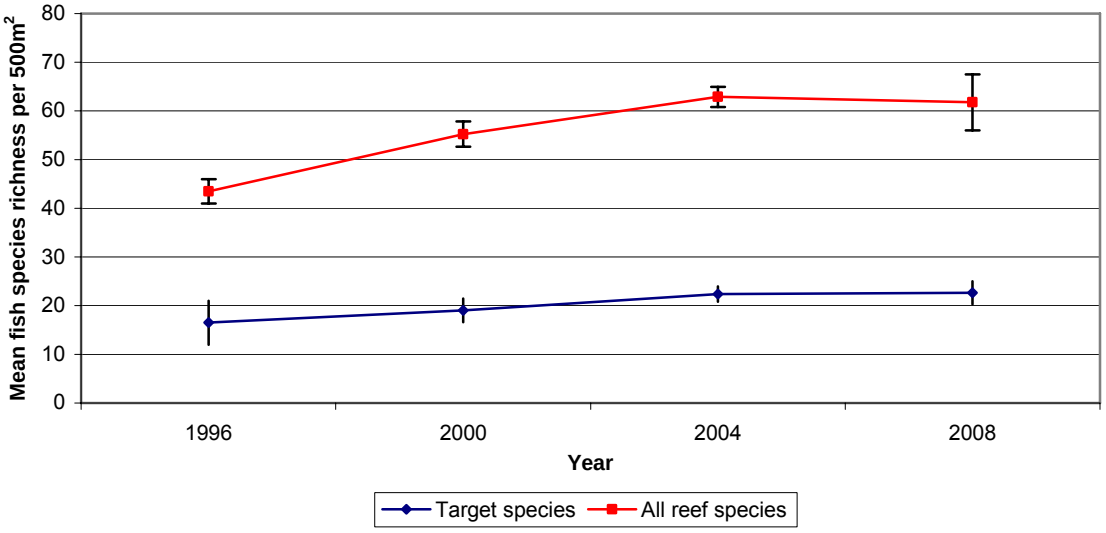
Figure 16. Changes in substrate composition (%mean ±SE) in SR-3 (South Reef) Black Rock from 1984 to 2008.



Fish diversity, abundance and biomass. A total of 178 reef fish species were listed in SR3 (Appendix 3 fish list). Mean target fish species is 22.6 ± 2.4 fish/500m^2 while mean total reef species is 61.8 ± 5.7 fish/500m^2. Among target fishes, Surgeonfishes, Fusiliers and Triggerfishes are most abundant. In terms of fish biomass, Snappers (median: 10.9 kg/500m^2), Balistids (median: 5.8 kg/500m^2) and Wrasses (median: 5.7 kg/500m^2) significantly ($p = 0.0009$, $H = 32.38$, $DF = 16$) made up the most of the mass (Figure 19). This indicates that the snapper species recorded in this

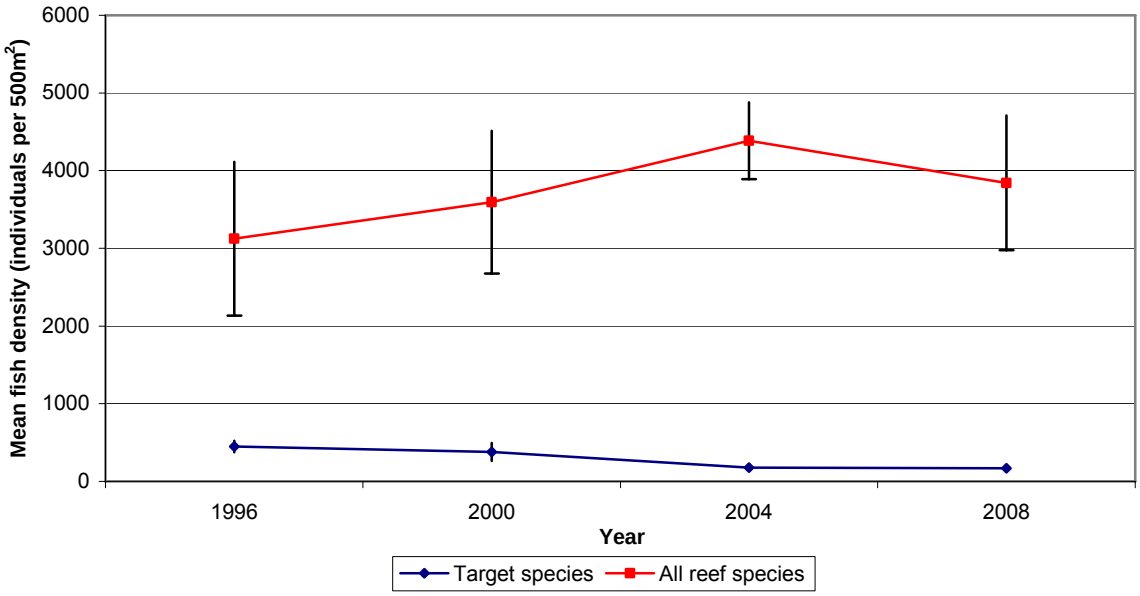
site are larger than the Triggerfishes which dominated numerically (Table 15). Total biomass for target species in SR3 is 45.7 ± 22.9 kg/500m^2.

Figure 17. Mean (±SE) number of species/500m^2 in SR-3 (South Reef) Black Rock from 1996 to 2008.



Comparison between years showed that fish density in 1996 was significantly high (p = 0.004, F = 8.01, DF = 3; Table 33). It appears that the density patterns of the Acanthurids has been maintained in SR3. *Ctenochaetus* spp., *Naso thynoides* and *Naso unicornis* comprise most of the Acanthurid density recorded.

Figure 18. Mean (±SE) density (fish/500m^2) in SR-3 (South Reef) Black Rock from 1996 to 2008.



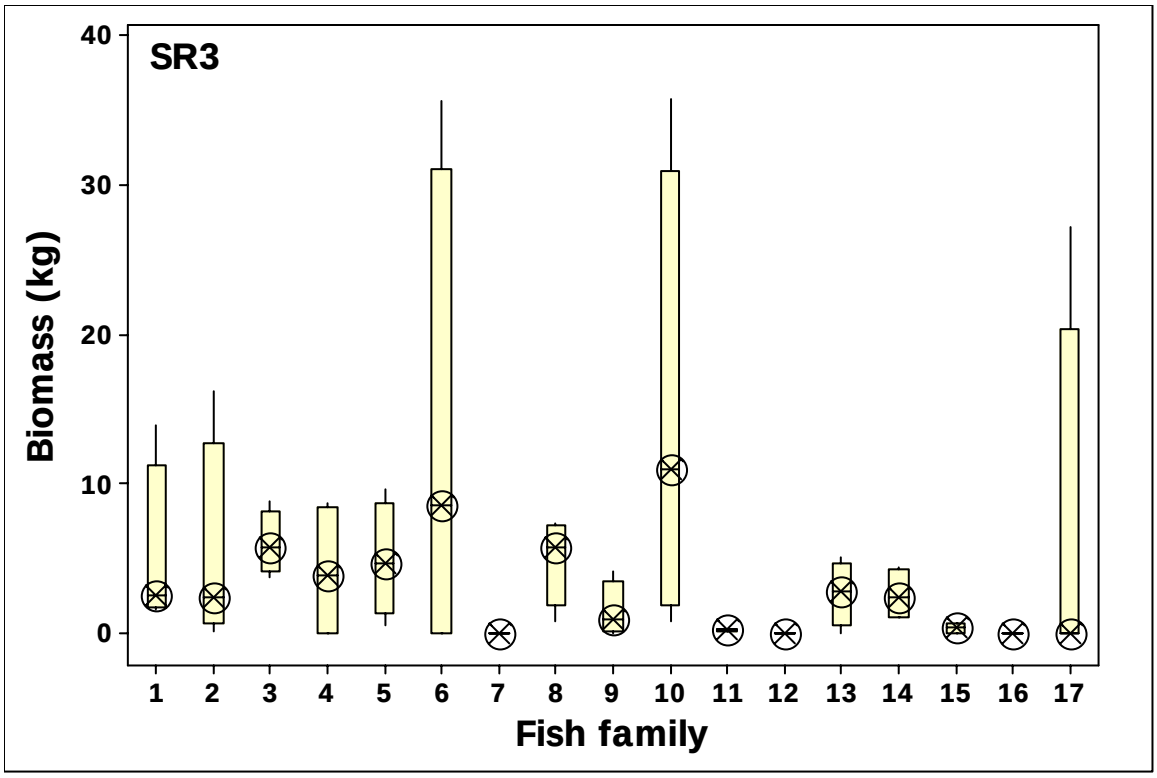


Figure 19. Boxplot of fish biomass (kg) in SR3 showing high median values for Lutjanidae (10), Balistidae (3), Labridae (8) compared to other families within site. Circles represent median points. For statistical test results please refer to Table 32.

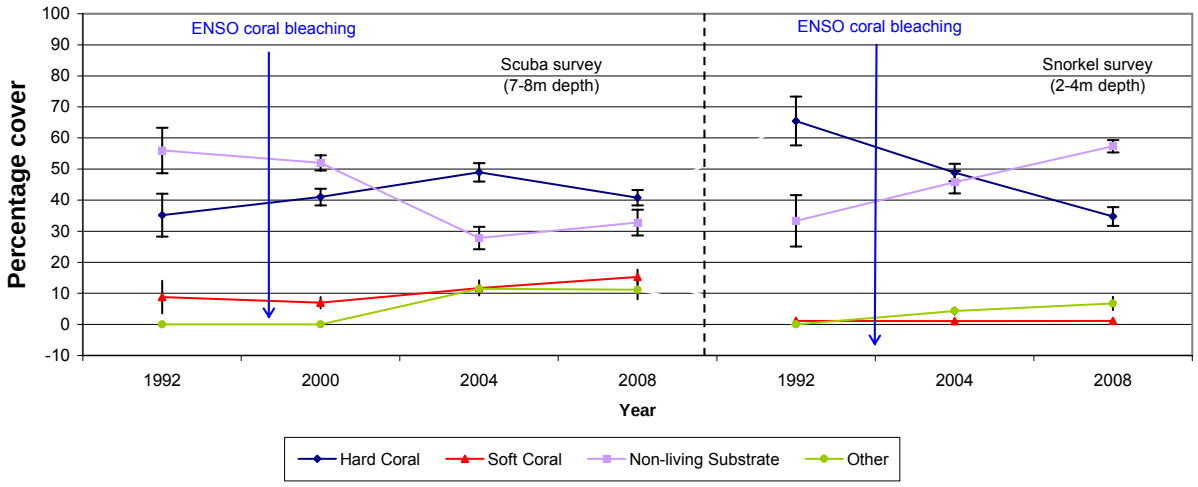
South Reef 4 (SR4: Northwest corner of the south atoll)

Site overview. South Reef 4 has very clear waters and is exposed to strong currents, thus, not frequented by divers (Figure 3). 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. In 2004 and 2008 surveys, the highest number of shark sightings were in SR4.

Results

Substrate. Live hard coral in South Reef 4 is fair (shallow: 34.8 ± 3 %, deep 40.8 ± 2.5 %,) in 2008 (Figure 20, Table 18). Massive corals dominate in the shallow while branching corals comprise most of the coral cover in the deep area (18.1 ± 1.9 %, in the year 2008 and 27.2 ± 2.4%, in 2004). Rock and block cover (non-living substrate category) was fairly high in the shallow (45.7 ± 2.9 %). This substrate composition suggests strong wave action in the shallow portion of SR4 for most times of the year, preventing more fragile growth forms to abound, such as foliose and branching corals, yet were recorded with higher covers further north of SR4 in the year 2004.

Figure 20. Changes in substrate composition (%mean ±SE) in SR-4 (South Reef) North West Corner from 1992 to 2008.



South Reef 4 LHC is the only site surveyed in 2000 that did not appear affected by the 1998 El Niño Southern Oscillation (ENSO) bleaching episode. It has been suggested that this unchanged condition can be attributed to: (1) the depth at which corals thrive, (2) species composition of the reef, and (3) the exposure of the reef to strong local currents (Maypa et al. 2004). In the 2008 survey, we observed strong converging currents in the area along with a distinct difference in sea surface temperatures between the colder water carried by currents flooding into the coral reef zone and the warmer water in the intertidal zone. It is likely that this site will not be significantly impacted by future bleaching episodes.

Fish diversity, abundance and biomass. A total of 169 reef fish species were listed in SR4 (Appendix 3 fish list). Mean target fish species is 239.7 ± 77.8 fish/500m^2 while mean total reef species is 3,129 ± 318.9 fish/500m^2. Balistids, Fusiliers and Surgeonfishes are among the most abundant families in SR4 (Table 19). Target fish density was significantly highest in 2008 ($p = 0.000$, $F = 24.24$, $DF = 2$) compared to the rest of the years.

Figure 21. Mean (±SE) number of species/500m^2 in SR-4 (South Reef) North West Corner from 1992 to 2008.

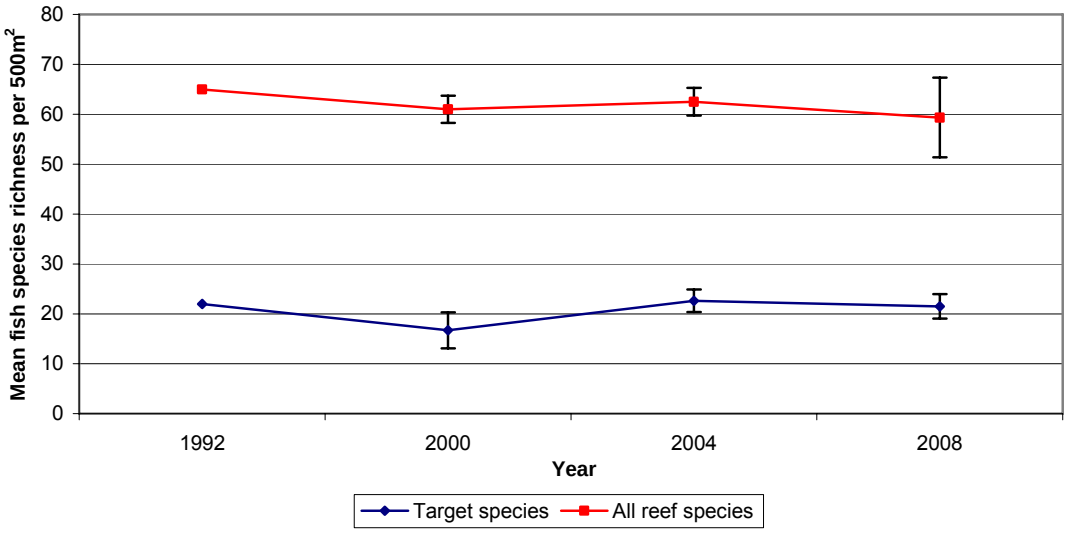
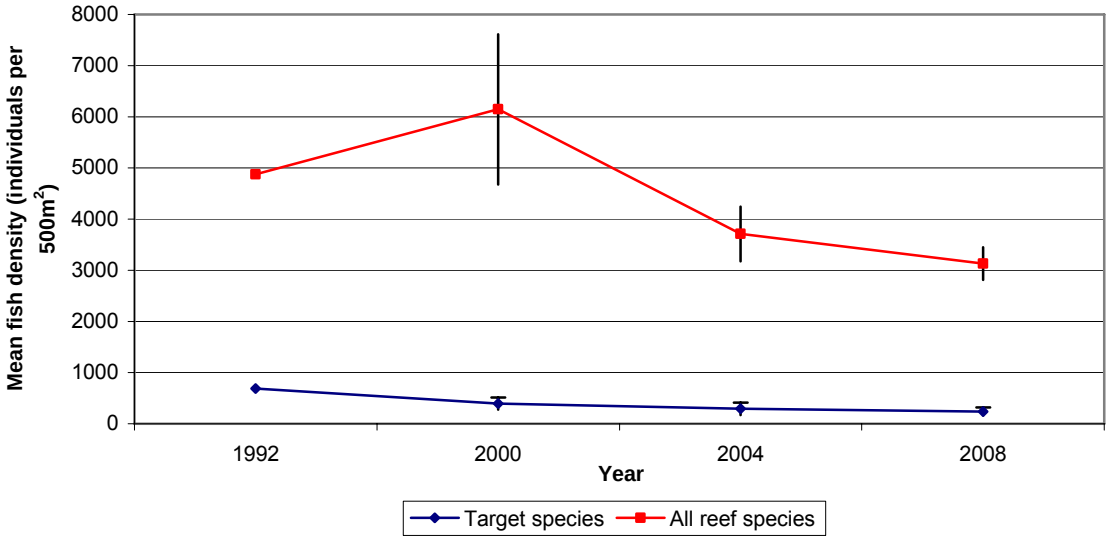


Figure 22. Mean (±SE) density (fish/500m^2) in SR-4 (South Reef) North West Corner from 1992 to 2008.



Target fish biomass in SR4 is (mean: 89.6 ± 51.8 kg/500m^2) second highest to SR1 (325.7 ± 162.8 kg/500m^2), although statistically not different. SR4 is the only site where groupers, a piscivore, dominate the bulk of the biomass (median: 7.99 kg/500m^2; p = 0.0006, H = 33.83, DF = 16). The rest of the families with high biomass in SR4 are Balistidae, planktivorous Acanthurids and Haemulidae (Figure 23).

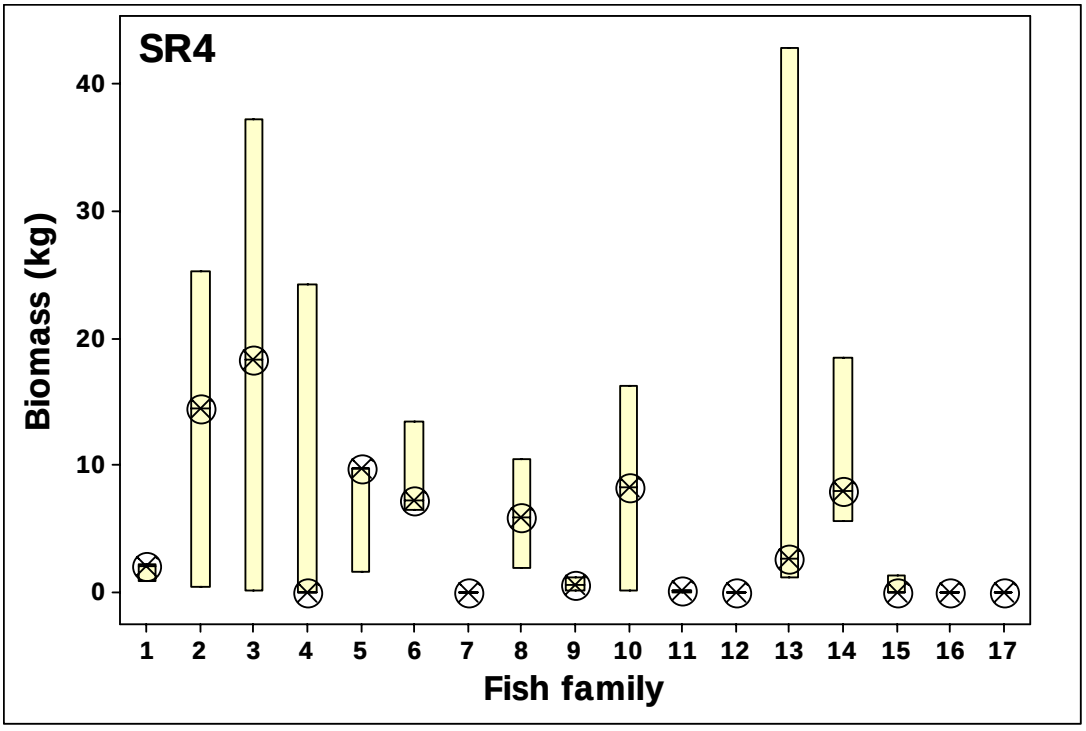


Figure 23. Boxplot of fish biomass (kg) in SR$ showing high median values for Epinephelinae (14), Balistidae (3), planktivorous Acanthuridae (2) and Haemulidae (6) compared to other families within site. Circles represent median points. For statistical test results please refer to Table 32.

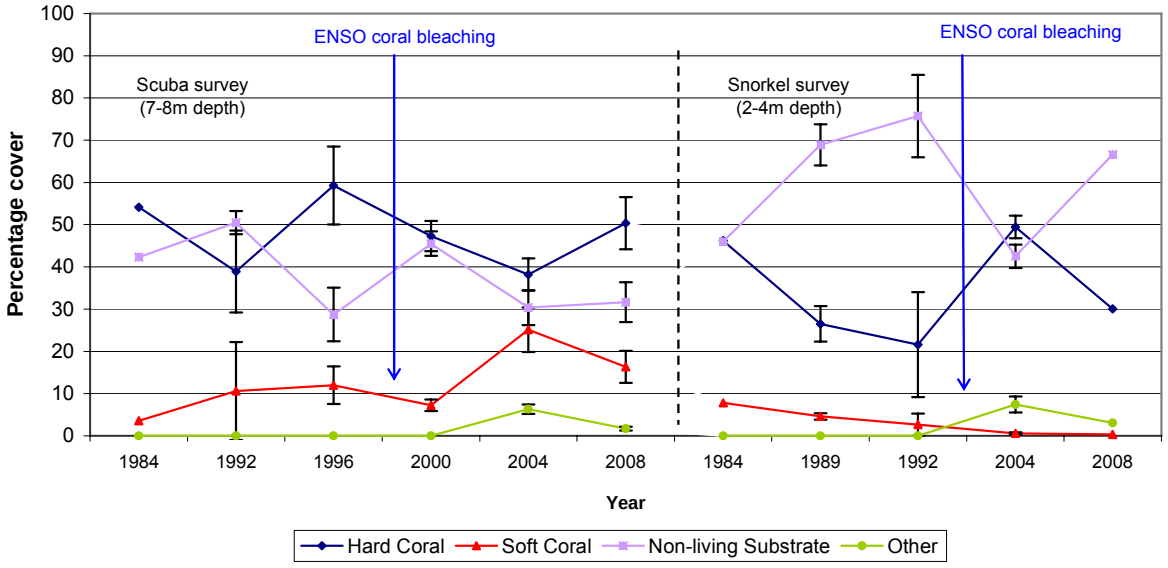
South Reef 1 (SR1: Lighthouse Islet)

Site overview. South Reef 1 is a frequented dive site due to the presence of the Lighthouse landmark (Figure 3). This site is known for its high cover of branching *Acropora* coral (White et al. 2000, 2004). Sharks, schools of barracuda, tuna, jacks, surgeons, snappers and triggerfish families are commonly seen in this site (Arquiza and White 1999), yet barracudas were not sighted in SR1 in 2008.

Results

Substrate. Live hard coral in South Reef 1 is good in the deeper zone (50.3 ± 6.2 %) while fair in the shallow (30.0 ± 4.2 %). The deep LHC value is an improvement from 2004 where LHC was only rated fair (Figure 24, Table 22; see Gomez et. al. 1994 for LHC categories). However, this observed increase is not significant from 2004 (Table 31). Branching corals dominated among other coral growth forms in both deep and shallow zones, a pattern seen consistently over time. SR1, along with SR3, underwent a phase shift in hard coral dominance to a soft coral substrate as a result of the 1998 ENSO and the pulses of coral bleaching thereafter (Maypa et al. 2004). The non-significant result between this current survey and the previous year, which is 2004, suggest no to little LHC recovery in this site.

Figure 24. Changes in substrate composition (%mean ±SE) in SR-1 (South Reef) Lighthouse Islet from 1984 to 2008.



Fish diversity, abundance and biomass. A total of 165 reef fish species were listed in SR1 (Appendix 3 fish list). Mean target fish species is 372.9 ± 137.4 fish/500m^2 while mean total reef species is 4758.1 ± 1518.2 fish/500m^2 (Figure 25,Table 23). Target fish density was made up mostly of Fusiliers and Surgeonfishes while Pomacentrids and Anthids for non-targets. No significant differences were seen in fish density between years.

Figure 25. Mean (±SE) number of species/500m^2 in SR-1 (South Reef) Lighthouse Islet from 1992 to 2008.

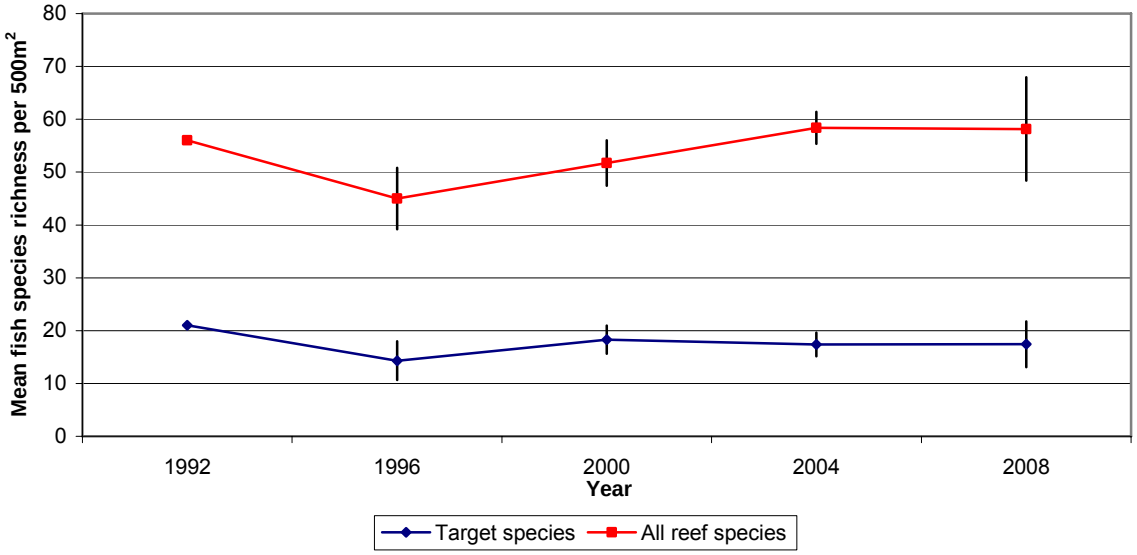
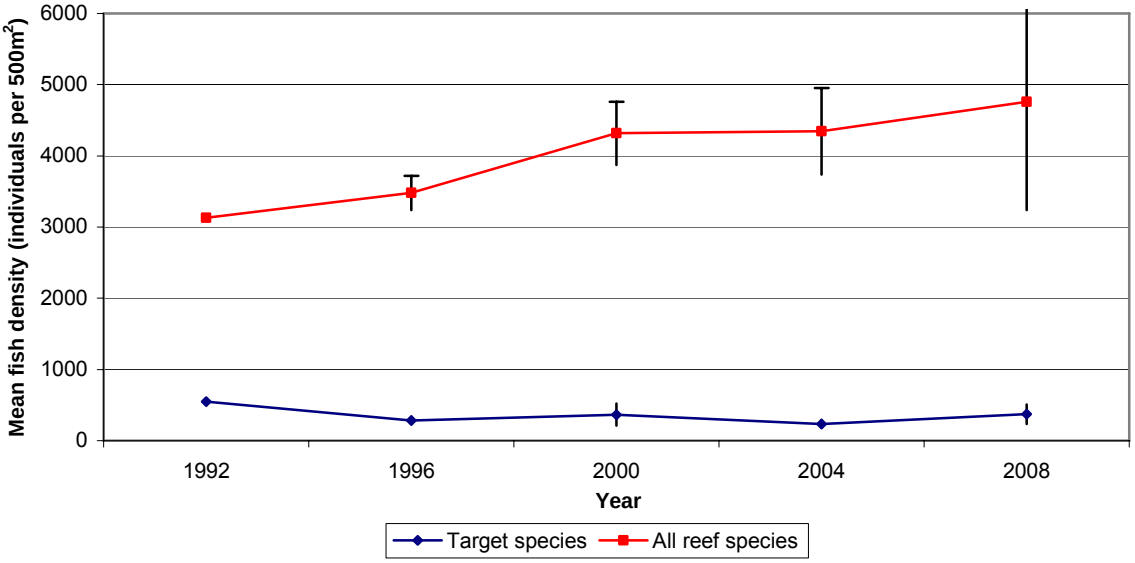


Figure 26. Mean (±SE) density (fish/500m^2) in SR-1 (South Reef) Lighthouse Islet from 1992 to 2008.



Total mean biomass for target fish in SR1 is 325.7 ± 162.8 kg/500m^2. The top three families having significantly high biomass are Lutjanidae (median: 9.8 kg/500m^2), Balistidae (median: 5.7 kg/500m^2) and Labridae (median: 4.2 kg/500m^2) (Figure 27). SR3 biomass appears high yet, statistically, it is one of the lowest due to the high variation of the replicate values. This is due to the presence of a numerically dominant species in one area and not in others within SR3 (e.g., Fusiliers), suggesting a patchy distribution of the species within the site.

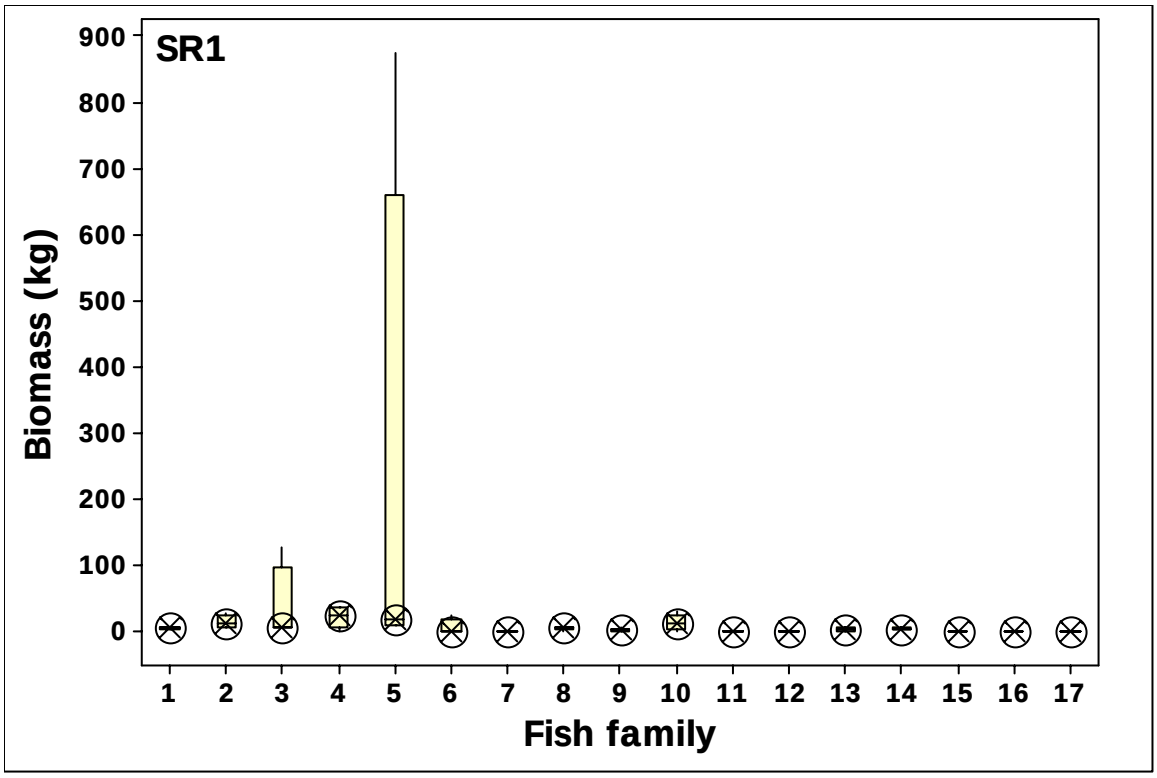


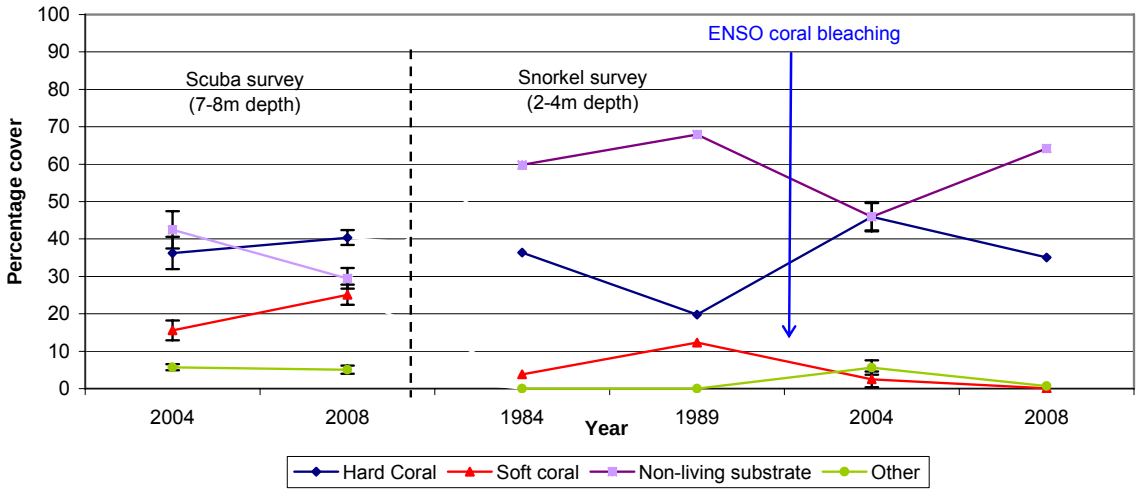
Figure 27. Boxplot of fish biomass (kg) in SR1 showing high median values for Carangidae (5), Acanthuridae-planktivores (2) and Balistidae (3) compared to other families within site. Circles represent median points. For statistical test results please refer to Table 32.

Jessie Beazley Reef

Site overview. In the previous years until 2007, Jessie Beazley Reef (JB) has been located outside the Marine Park and was open for fishing (Figure 2). In the year 2007 it was included as one of the Reefs of Tubbataha benefiting from the no-take protection (personal communication, A. Songco, TRMP Manager). This site has a narrow sandy cay and shallow reef flat that extends to about two kilometers in circumference (NMRC 1983, White 1984, White and Palaganas 1991).

Substrate. Live hard coral cover of JB in 2008 is fair (shallow: 35 ± 4.1 %; deep: 40.4 ± 2 %; Figure 28, Table 26). Branching corals dominate the rest of the growth forms, both in the shallow and deep areas. In addition, soft coral cover in the deep is significantly higher ($p = 0.018$, T-value = -2.08, DF = 25) in the year 2008 (25.1 ± 2.7 %) compared to 2004 (15.6 ± 2.6 %). 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 28. Changes in substrate composition (%mean ±SE) in Jessie Beazley Reef from 2004 to 2008.



Fish diversity, abundance and biomass. A total of 153 reef fish species were listed in Jessie Beazley (Appendix 3 fish list). Mean target fish species is 150.8 ± 44.7 fish/500m^2 while mean total reef species is 1579.8 ± 416.7 fish/500m^2. Target fish density was made up mostly of Triggerfishes and Wrasses. Pomacentrids and Anthids numerically dominated this site among non-target species. Balistids, Fusiliers and Surgeonfishes are among the most abundant families in SR4 (Table 27). Target fish density was significantly highest in 2008 (p = 0.000, F = 24.24, DF = 2) compared to the rest of the years. This indicates the effect of protection on fish density.

Figure 29. Mean (±SE) number of species/500m^2 in Jessie Beazley Reef from 2004 to 2008.

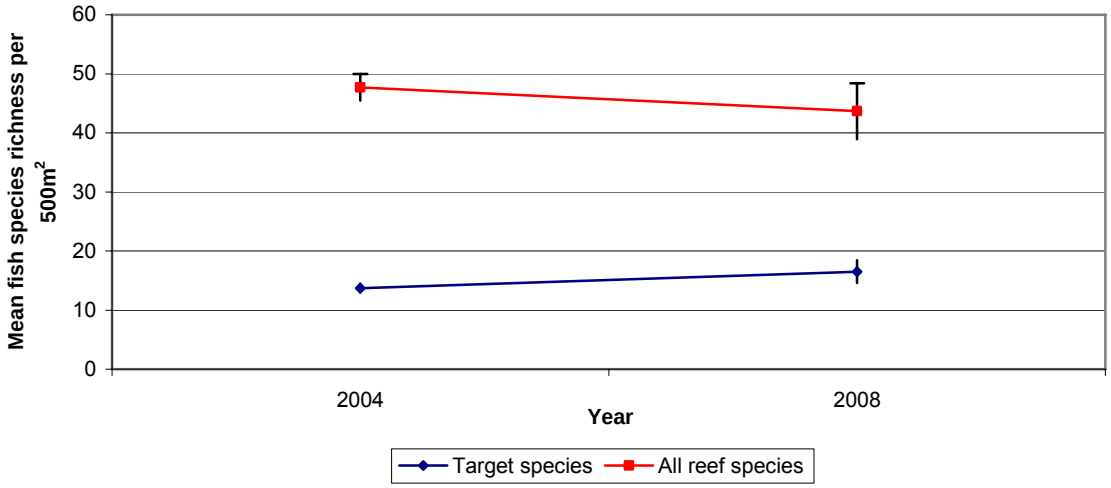
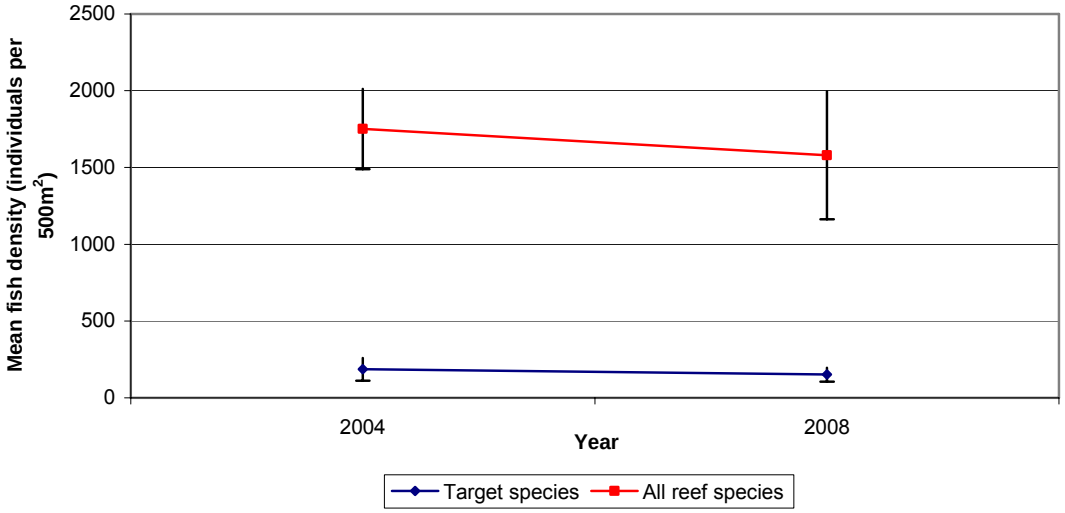


Figure 30. Mean (±SE) density (fish/500m^2) in Jessie Beazley from 2004 to 2008.



Total biomass in Jessie Beazley is 19.1 ± 3.3 kg/m^2 (mean), one of the sites having a significantly low biomass (p = 0.00, F =6.21, DF = 6), along with SR3 (mean: 45.7 ± 22.9 kg/500m^2 (Table 32). Families with significantly high biomass (p = 0.007, H = 32.98, DF =1 6) Jessie Beazley were Caesionidae (median: 3.5kg/500m^2), Carangidae (2.1 kg/500m^2) and Lutjanidae (median: 0.5 kg/500m^2). Density and biomass values in this site are generally lower and eight out of the 17 target fish families were not recorded, compared to other sites which have been protected longer. However, the dominance of piscivore target fish biomass, like jacks and snappers, suggest a potential for stocks and faster recovery if strict enforcement, such as the no-take policy, is sustained.

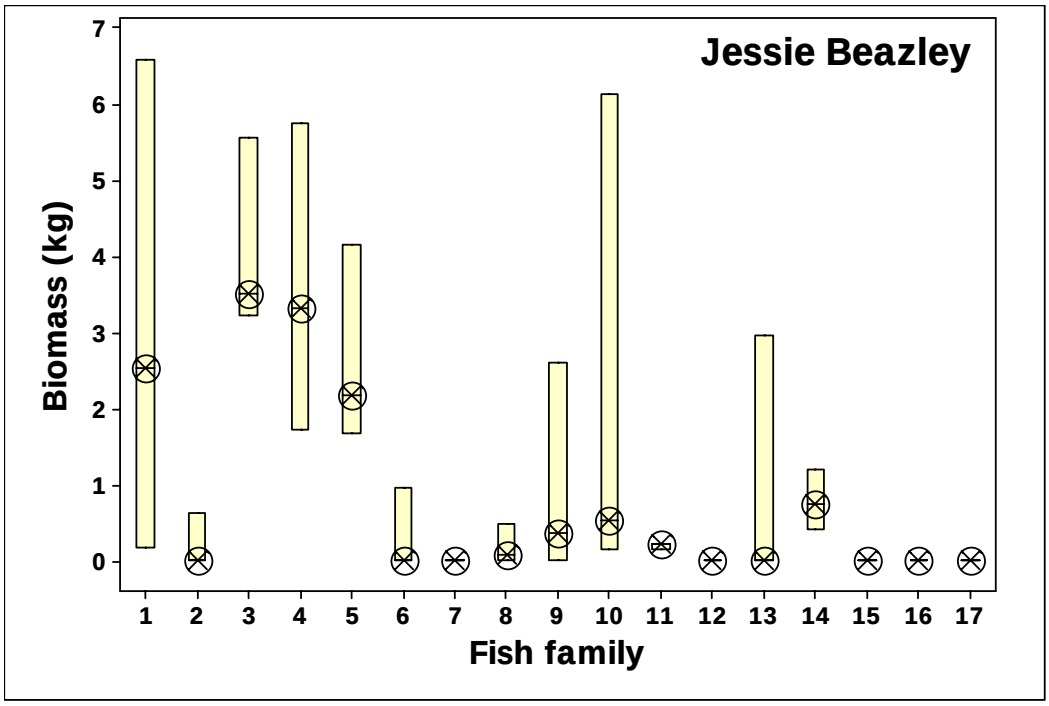


Figure 31. Boxplot of fish biomass (kg) in Jessie Beazley showing high median values for Caesionidae (4), Carangidae (5) and Lutjanidae (10) compared to other families within site. Circles represent median points. For statistical test results please refer to Table 32.

Table 1. Changes in substrate composition (%mean ±SE) in NR-5 (North Reef) Bird Islet from 1984 to 2008

	SCUBA SURVEYS:											SNORKEL SURVEYS:											
SUBSTRATE COVER	1984 % cover	1992 % cover	% Change 1984-1992	1996 % cover	% Change 1992-1996	2000 % cover	% Change 1996-2000	2004 % cover	% Change 2000-2004	2008 % cover	% Change 2004-2008	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	2008 % cover	% Change 2004-2008
Sand (s) and Silt (SI)	17.6	0.0	-100.0	18.2	+	17.1	-6.0	4.3	-74.7	14.0	223.2	8.0	6.3	-21.9	13.0	108.0	0.0	-100.0	5.5	+	13.4	144.1	17.4	29.9
Coral Rubble (R)	16.4	17.3	5.5	14.3	-17.3	22.6	58.0	10.7	-52.6	9.9	-8.0	4.2	21.4	408.3	27.4	28.3	2.5	-90.9	9.2	268.0	18.1	96.7	16.6	-8.5
Rock and Block (RK)	16.8	1.6	-90.5	12.7	693.8	27.0	112.6	17.3	-36.0	9.9	-42.6	9.5	17.4	83.2	3.4	-80.5	57.0	1576.5	49.8	-12.6	23.2	-53.5	16.0	-30.7
White Dead Standing Coral (DC)	6.0	11.4	90.0	2.2	-80.7	1.2	-45.5	0.2	-80.4	0.4	56.6	3.3	16.5	400.0	3.0	-81.8	10.5	250.0	0.2	-98.1	0.2	16.5	1.4	514.1
Dead Coral with Algae (DCA)	0.0	0.0	N/A	0.0	N/A	8.0	+	5.4	-33.1	4.7	-12.0	0.0	0.0	N/A	0.0	N/A	0.0	N/A	9.0	+	4.4	-51.1	5.2	19.0
Subtotal Non-living Substrate	***56.8***	***30.3***	***-46.7***	***47.4***	***56.4***	***75.9***	***60.1***	***37.9***	***-50.1***	***38.8***	2.5	***25.0***	***61.5***	***146.0***	***46.8***	***-23.9***	***70.0***	***49.6***	***73.7***	***5.3***	***59.3***	***-19.5***	***56.7***	-4.4
Branching (CB)	18.0	14.2	-21.1	25.1	76.8	9.7	-61.4	17.1	76.6	28.7	67.5	45.0	25.3	-43.9	25.0	-1.0	17.5	-30.0	0.0	-100.0	22.6	+	27.0	19.0
Massive (CM)	1.2	9.0	650.0	7.3	-18.9	3.8	-47.9	7.3	91.2	7.3	0.0	15.3	1.0	-93.5	8.0	700.0	5.0	-37.5	0.0	-100.0	11.0	+	10.1	-8.4
Flat/Encrusting (CFD)	7.3	11.3	54.8	4.1	-63.7	4.0	-2.4	10.5	161.3	6.0	-42.9	4.7	0.1	-97.9	4.2	4100.0	5.0	19.0	0.0	-100.0	2.2	+	1.9	-13.2
Foliose Cup (CFO)	0.9	0.4	-55.6	2.2	450.0	1.0	-54.5	0.9	-11.8	0.6	-37.4	1.0	0.4	-65.0	1.3	271.4	0.0	-100.0	0.0	N/A	0.3	+	0.7	143.2
Total Hard Coral	27.4	34.9	27.4	38.7	10.9	18.5	-52.2	35.7	93.1	42.5	18.9	66.0	26.7	-59.5	38.5	44.2	27.5	-28.6	23.8	-13.5	36.1	51.8	39.6	9.7
Total Soft Coral	15.8	34.8	120.3	13.9	-60.1	5.6	-59.7	10.1	80.8	14.9	47.1	9.0	11.8	31.1	14.7	24.6	2.5	-83.0	2.5	0.0	2.7	8.7	3.2	16.8
Subtotal Coral	***43.2***	***69.7***	***61.3***	***52.6***	***-24.5***	***24.1***	***-54.2***	***45.8***	***90.2***	***57.4***	25.1	***75.0***	***38.5***	***-48.7***	***53.2***	***38.2***	***30.0***	***-43.6***	***26.3***	***-12.3***	***38.8***	***47.7***	***42.8***	10.2
Sponges	~	~	N/A	~	N/A	~	N/A	5.9	N/A	1.6	-73.4	~	~	N/A	~	N/A	~	N/A	~	N/A	0.3	N/A	0.3	5.3
Other animals	~	~	N/A	~	N/A	~	N/A	2.0	N/A	0.7	-64.5	~	~	N/A	~	N/A	~	N/A	~	N/A	0.1	N/A	0.0	-76.2
Algae																								
Turf algae	~	~	N/A	~	N/A	~	N/A	0.6	N/A	0.6	-14.6	~	~	N/A	~	N/A	~	N/A	~	N/A	0.3	N/A	0.0	-93.6
Fleshy algae	~	~	N/A	~	N/A	~	N/A	0.9	N/A	0.2	-82.7	~	~	N/A	~	N/A	~	N/A	~	N/A	0.1	N/A	0.0	-100.0
Coralline algae	~	~	N/A	~	N/A	~	N/A	6.7	N/A	0.8	-88.3	~	~	N/A	~	N/A	~	N/A	~	N/A	1.1	N/A	0.1	-87.9
Seagrass	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	***0***	***0***	N/A	***0***	N/A	***0***	N/A	***16.2***	+	***3.8***	-76.7	***0***	***0***	N/A	***0***	N/A	***0***	N/A	***0***	N/A	***1.9***	+	***0.5***	-74.6
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters																								
Mean Slope (degrees)	~	~		~		14.7		57.5		45.5		~	~		~		~		3.5		1.9		5.0	
Mean Topography (m) *	1.8	2		2.2		1.9		1.9		2.0		2.1	1.4-2.8		.5-2		~		1.1		2.5		1.3	
Mean Depth/Range (m)	1-15	2-10		5-8		5.8		7.2		7.6		2-6	3.6		2-7		2-2.7		2.5		3.2		3.4	
Horizontal Visibility (m)	~	30		20		26		21.3		31.2		~	~		20-40		25		34.1		21.3		33.0	
No. of 50 m Transects	1	3		6		22		17		19		1	2		8		2		10		14		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 2. Species list of butterflyfish in tubbataha Reefs, Palawan from 1984 to 2008.

Butterfly species	Common name	SR-1					SR-3					SR-4			NR-1				
		1992	1996	2000	2004	2008	1992	1996	2000	2004	2008	2000	2004	2008	1992	1996	2000	2004	2008
Chaetodon adiergastos	Philippine butterflyfish	O	Y	X	Z	A	O	Y	X	Z		X	Z	A	O	Y	X	Z	
Chaetodon auriga	Threadfin butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon baronessa	Eastern triangular butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon bennetti	Bluelashed butterflyfish		Y	X		A		Y	X	Z	A	X	Z	A		Y		Z	A
Chaetodon citrinellus	Speckled butterflyfish	O	Y	X	Z		O	Y		Z		X	Z		O	Y	X	Z	
Chaetodon ephippium	Saddle butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon kleinii	Klein's butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon lineolatus	Lined butterflyfish		Y	X	Z	A	O	Y	X	Z	A	X	Z	A			X	Z	
Chaetodon lunula	Raccoon butterflyfish	O	Y	X	Z	A	O	Y	X	Z		X	Z	A	O	Y	X	Z	
Chaetodon lunulatus	Pacific redfin butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon melannotus	Blackback butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon mertensii	Merten's butterflyfish																		
Chaetodon meyeri	Meyer's butterflyfish	O														Y	X		
Chaetodon ocellicaudus	Spottail butterflyfish		Y	X	Z	A		Y	X	Z	A	X	Z	A		Y	X	Z	A
Chaetodon octofasciatus	Eightband butterflyfish			X						Z									
Chaetodon ornatissimus	Ornate butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon oxycephalus	Spot-nape butterflyfish		Y	X	Z	A				Z	A	X	Z			Y	X	Z	
Chaetodon plebeius	Blueblotch butterflyfish																		
Chaetodon punctatofasciatus	Spotband butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon rafflesi	Latticed butterflyfish	O	Y	X	Z		O	Y	X	Z		X	Z	A	O	Y	X	Z	A
Chaetodon reticulatus	Mailed butterflyfish																X		
Chaetodon selene	Yellowdotted butterflyfish									Z									
Chaetodon semeion	Dotted butterflyfish		Y					Y		Z			Z		O				
Chaetodon speculum	Mirror butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon trifascialis	Chevron butterflyfish	O	Y	X	Z		O	Y	X	Z		X	Z	A	O	Y	X	Z	A
Chaetodon ulietensis	Pacific doublesaddle butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon unimaculatus	Teardrop butterflyfish		Y	X	Z			Y	X	Z		X	Z			Y	X	Z	
Chaetodon vagabundus	Vagabond butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Chaetodon xanthurus	Pearscale butterflyfish																		
Chelmon rostratus	Beaked coralfish																		
Forcipiger flavissimmus	Forcepsfish		Y	X	Z			Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Forcipiger longirostris	Longnose butterflyfish		Y	X	Z			Y	X	Z		X	Z	A	O		X	Z	A
Hemitaurichthys polylepis	Pyramid butterflyfish	O	Y	X	Z	A		Y	X	Z		X	Z	A	O	Y	X	Z	A
Heniochus acuminatus	Pennant coralfish	O	Y	X	Z		O	Y	X	Z		X	Z				X		
Heniochus chrysostomus	Threeband pennantfish	O	Y	X	Z	A		Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Heniochus diphreutes	Schooling bannerfish												Z	A					
Heniochus monoceros	Masked bannerfish																X		
Heniochus singularius	Singular bannerfish	O	Y	X	Z	A	O	Y	X	Z	A	X	Z	A	O		X	Z	A
Heniochus varius	Horned bannerfish		Y	X	Z	A		Y	X	Z	A	X	Z	A	O	Y	X	Z	A
Coradion chrysozonus	Goldengirdled coralfish																X		
Total number of species/site		**21**	**29**	**29**	**27**	**21**	**19**	**28**	**26**	**31**	**19**	**28**	**30**	**25**	**23**	**25**	**31**	**27**	**21**

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**
Total number of species observed in Tubbataha and Jessie Beazley in 2008: **30**

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

Table 2. Species list of butterflyfish in tubbataha Reefs, Palawan from 1984 to 2008.

Butterfly species	Common name	NR-2					NR-5					Jessie Beazley	
		1992	1996	2000	2004	2008	1992	1996	2000	2004	2008	2004	2008
Chaetodon adiergastos	Philippine butterflyfish	O		X	Z	A	O	Y	X	Z		Z	A
Chaetodon auriga	Threadfin butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	
Chaetodon baronessa	Eastern triangular butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon bennetti	Bluelashed butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon citrinellus	Speckled butterflyfish	O	Y	X			O	Y	X	Z		Z	A
Chaetodon ephippium	Saddle butterflyfish	O	Y	X	Z	A	O	Y	X	Z		Z	
Chaetodon kleinii	Klein's butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon lineolatus	Lined butterflyfish	O	Y	X	Z	A	O	Y	X	Z			
Chaetodon lunula	Raccoon butterflyfish	O	Y	X	Z		O	Y	X	Z		Z	A
Chaetodon lunulatus	Pacific redfin butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon melannotus	Blackback butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon mertensii	Merten's butterflyfish								X				
Chaetodon meyeri	Meyer's butterflyfish				Z	A						Z	
Chaetodon ocellicaudus	Spottail butterflyfish		Y	X	Z	A		Y	X	Z	A	Z	A
Chaetodon octofasciatus	Eightband butterflyfish									Z		Z	
Chaetodon ornatissimus	Ornate butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon oxycephalus	Spot-nape butterflyfish			X		A		Y	X	Z	A		
Chaetodon plebeius	Blueblotch butterflyfish						O						
Chaetodon punctatofasciatus	Spotband butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon rafflesi	Latticed butterflyfish	O	Y	X	Z	A	O	Y	X	Z		Z	
Chaetodon reticulatus	Mailed butterflyfish										A		
Chaetodon selene	Yellowdotted butterflyfish			X									
Chaetodon semeion	Dotted butterflyfish			X	Z		O	Y		Z			
Chaetodon speculum	Mirror butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon trifascialis	Chevron butterflyfish		Y	X	Z	A	O	Y	X	Z	A	Z	
Chaetodon ulietensis	Pacific doublesaddle butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Chaetodon unimaculatus	Teardrop butterflyfish	O						Y	X				
Chaetodon vagabundus	Vagabond butterflyfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	
Chaetodon xanthurus	Pearscale butterflyfish			X									
Chelmon rostratus	Beaked coralfish			X									
Forcipiger flavissimmus	Forcepsfish	O	Y	X	Z	A	O	Y	X	Z	A	Z	A
Forcipiger longirostris	Longnose butterflyfish		Y	X	Z	A	O		X	Z	A	Z	
Hemitaurichthys polylepis	Pyramid butterflyfish	O	Y	X	Z	A			X	Z	A	Z	A
Heniochus acuminatus	Pennant coralfish		Y	X				Y	X		A	Z	A
Heniochus chrysostomus	Threeband pennantfish	O	Y	X	Z	A	O	Y	X	Z		Z	A
Heniochus diphreutes	Schooling bannerfish											Z	
Heniochus monoceros	Masked bannerfish									Z			
Heniochus singularius	Singular bannerfish	O	Y	X	Z	A	O		X	Z	A	Z	A
Heniochus varius	Horned bannerfish	O	Y	X	Z	A	O	Y	X	Z			A
Coradion chrysozonus	Goldengirdled coralfish												
Total number of species/site		**23**	**25**	**31**	**26**	**25**	**25**	**26**	**29**	**29**	**20**	**27**	**19**

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**
Total number of species observed in Tubbataha and Jessie Beazley in 2008: **30**

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 2008.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	8.8	1.4	9.5	44.3	17.3	0.0	71.0	20.0
Rabbitfish (Siganids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Groupers (Serranids)*	4.0	0.4	2.5	17.5	4.5	1.3	25.8	6.3
Barramundi cod	0.3	0.3	0.0	1.3	2.3	0.0	3.5	3.5
Snapper (Lutjanids)*	5.0	0.8	0.0	1.3	4.0	1.8	7.0	3.2
Sweetlips (Haemulids)*	1.3	0.5	0.0	0.8	3.5	9.5	13.8	6.8
Emperors (Lethrinids)*	1.8	0.5	0.0	153.3	0.3	0.8	154.3	149.3
Jacks (Carangids)*	2.0	0.4	0.0	0.0	1.3	4.0	5.3	1.8
Fusiliers (Caesionids)*	4.3	0.8	2.5	594.5	0.0	0.0	597.0	167.9
Spinecheeks (Nemipterids)*	0.3	0.3	0.0	0.3	0.0	0.0	0.3	0.3
Goatfish (Mullids)*	2.5	0.3	0.5	5.8	0.0	0.0	6.3	2.0
Parrotfish (Scarids)*	3.8	0.6	4.3	4.3	2.0	1.3	11.8	3.0
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.5	0.3	0.0	0.8	0.0	0.0	0.8	0.5
Triggerfish (Balistids)	5.3	0.5	0.8	24.0	2.0	0.3	27.0	4.0
Butterflyfish (Chaetodonids)	13.0	0.7	64.0	8.3	1.3	0.0	73.5	27.2
Angelfish (Pomacanthids)	2.3	0.3	2.8	2.5	0.8	0.5	6.5	2.2
Wrasses (Labrids)	10.5	1.9	17.3	21.0	0.0	1.5	39.8	5.0
Humphead wrasse	0.3	0.3	0.0	0.0	0.0	0.3	0.3	0.3
Damselfish (Pomacentrids)	10.8	0.5	3171.3	0.0	0.0	0.0	3171.3	388.9
Fairy Basslets (Anthids)	2.8	0.3	2600.0	0.0	0.0	0.0	2600.0	355.9
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	0.5	1.3	0.5	0.0	2.3	0.3
Total (target reef spp.):	**18.0**	**0.0**	**9.8**	**823.8**	**35.0**	**18.5**	**887.0**	**293.5**
Total (all reef spp.):	**39.3**	**1.8**	**5875.8**	**880.8**	**39.5**	**21.0**	**6817.0**	**743.4**

* Target species/families

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

⬭ Fairly high density for target families

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 2008.

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	(N=4) 2008 Species	% Change 2004 2008
Surgeonfish (Acanthurids)*	12.0	5.7	-52.8	7.5	32.4	6.4	-14.7	8.8	36.7
Rabbitfish (Siganids)*	0.0	0.3	+	0.8	125.0	0.2	-73.3	0.0	-100.0
Groupers (Serranids)*	1.0	1.3	33.3	3.8	181.3	3.4	-9.3	4.0	17.6
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.3	+
Snapper (Lutjanids)*	2.0	1.3	-33.3	2.1	59.4	2.4	12.9	5.0	108.3
Sweetlips (Haemulids)*	0.0	0.7	+	0.9	31.3	0.8	-8.6	1.3	56.3
Emperors (Lethrinids)*	0.0	0.7	+	1.0	50.0	0.8	-20.0	1.8	118.8
Jacks (Carangids)*	1.0	0.3	-66.7	1.4	312.5	1.4	1.8	2.0	42.9
Fusiliers (Caesionids)*	2.0	0.3	-83.3	0.6	87.5	2.8	348.0	4.3	51.8
Spinecheeks (Nemipterids)*	0.0	0.7	+	0.5	-25.0	0.2	-60.0	0.3	25.0
Goatfish (Mullids)*	0.0	0.7	+	1.6	143.8	1.0	-38.5	2.5	150.0
Parrotfish (Scarids)*	1.0	1.0	0.0	2.6	162.5	3.0	14.3	3.8	25.0
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.6	+	0.2	-68.0	0.5	150.0
Triggerfish (Balistids)	2.0	1.7	-16.7	2.9	72.5	1.2	-58.3	5.3	337.5
Butterflyfish (Chaetodonids)	16.0	11.3	-29.2	11.4	0.4	7.2	-36.7	13.0	80.6
Angelfish (Pomacanthids)	1.0	1.3	33.3	1.6	21.9	1.8	10.8	2.3	25.0
Wrasses (Labrids)	6.0	6.3	5.6	6.0	-5.3	5.2	-13.3	10.5	101.9
Humphead wrasse	~	~	N/A	~	N/A	0.0	N/A	0.3	+
Damselfish (Pomacentrids)	14.0	8.7	-38.1	7.5	-13.5	9.8	30.7	10.8	9.7
Fairy Basslets (Anthids)	2.0	1.0	-50.0	1.9	87.5	4.2	124.0	2.8	-34.5
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	1.0	0.0	0.8	-20.0	1.0	25.0
Total (target reef spp.):	**19.0**	**13.0**	**-31.6**	**23.4**	**80.0**	**22.6**	**-3.4**	**18.0**	-20.4
Total (all reef spp.):	**61.0**	**44.3**	**-27.4**	**55.6**	**25.5**	**52.8**	**-5.0**	**39.3**	-25.7

* 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 2008.

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	(N=4) 2008 Density	% Change 2004-2008
Surgeonfish (Acanthurids)*	198.0	116.3	-41.2	150.1	29.0	105.6	-29.7	71.0	-32.8
Rabbitfish (Siganids)*	0.0	3.0	+	1.4	-54.2	0.2	-85.5	0.0	-100.0
Groupers (Serranids)*	5.0	8.0	60.0	13.8	71.9	7.2	-47.6	25.8	257.6
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	3.5	+
Snapper (Lutjanids)*	5.0	16.0	220.0	22.9	43.0	10.8	-52.8	7.0	-35.2
Sweetlips (Haemulids)*	0.0	6.0	+	24.3	304.2	1.4	-94.2	13.8	882.1
Emperors (Lethrinids)*	0.0	12.0	+	3.9	-67.7	1.6	-58.7	154.3	9540.6
Jacks (Carangids)*	9.0	1.0	-88.9	17.8	1675.0	8.6	-51.5	5.3	-39.0
Fusiliers (Caesionids)*	162.0	11.0	-93.2	115.8	952.3	428.6	270.3	597.0	39.3
Spinecheeks (Nemipterids)*	0.0	46.0	+	6.1	-86.7	0.2	-96.7	0.3	25.0
Goatfish (Mullids)*	0.0	54.0	+	23.6	-56.3	1.6	-93.2	6.3	290.6
Parrotfish (Scarids)*	33.0	129.0	290.9	61.1	-52.6	38.6	-36.9	11.8	-69.6
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	29.8	+	2.2	-92.6	0.8	-65.9
Triggerfish (Balistids)	3.0	7.0	133.3	17.0	142.9	16.2	-4.7	27.0	66.7
Butterflyfish (Chaetodonids)	62.0	37.7	-39.2	28.9	-23.3	45.6	57.9	73.5	61.2
Angelfish (Pomacanthids)	2.0	8.0	300.0	15.1	89.1	13.0	-14.0	6.5	-50.0
Wrasses (Labrids)	198.0	113.0	-42.9	70.9	-37.3	83.8	18.2	39.8	-52.6
Humphead wrasse	~	~	N/A	~	N/A	0.0	N/A	0.3	+
Damselfish (Pomacentrids)	1422.0	942.0	-33.8	1424.9	51.3	542.4	-61.9	3171.3	484.7
Fairy Basslets (Anthids)	1026.0	385.0	-62.5	1083.9	181.5	2015.0	85.9	2600.0	29.0
Moorish Idols (*Zanclus cornutus*)	9.0	17.0	88.9	10.9	-36.0	2.4	-77.9	2.3	-6.3
									N/A
Total (target reef spp.):	**412.0**	**402.3**	**-2.4**	**470.4**	**16.9**	**602.2**	**28.0**	**887.0**	47.3
Total (all reef spp.):	**3134.0**	**1912.0**	**-39.0**	**3121.9**	**63.3**	**3325.0**	**6.5**	**6817.0**	105.0

* 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 2008.

	SCUBA SURVEYS:									SNORKEL SURVEYS:												
	1984	1996	% Change 1984-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	2008	% Change 2004-2008	1984	1989	% Change 1984-1989	1992	% Change 1989-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	2008	% Change 2004-2008
SUBSTRATE COVER	% cover	% 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	11.3	-22.0	6.1	0.5	-91.8	5.4	980.0	3.5	-35.2	14.3	308.6	6.3	-56.1	11.4	81.1
Coral Rubble (R)	10.5	10.8	2.9	22.7	110.2	19.3	-15.2	9.6	-50.1	7	31.8	353.9	12.9	-59.4	4.0	-69.0	19.3	382.5	2.9	-84.9	3.5	20.7
Rock and Block (RK)	36	14.4	-60.0	33.2	130.6	27.7	-16.7	21.3	-23.0	23.6	18.8	-20.5	27	43.8	32.8	21.3	45.9	40.2	45.0	-2.0	45.6	1.4
White Dead Standing Coral (DC)	5.9	0	-100.0	0.6	+	0.1	-79.2	0.6	405.3	6.5	9.4	44.6	6.7	-28.7	11.3	67.9	0.4	-96.4	0.1	-75.5	0.5	422.3
Dead Coral with Algae (DCA)	0	3.3	+	11.1	236.4	2.9	-73.5	8.3	184.0	0	0.0	N/A	0	N/A	0	N/A	5.6	+	5.2	-7.4	6.2	19.4
Subtotal Non-living Substrate	***60***	***38.8***	-35.3	***75.5***	94.6	***64.5***	-14.6	***51.2***	-20.6	***43.2***	***60.4***	39.9	***52***	-14.0	***51.5***	-1.0	***85.5***	66.0	***59.5***	-30.5	***67.2***	13.0
Branching (CB)	19.4	46.6	140.2	10.5	-77.5	7.0	-33.3	17.9	156.0	36.3	22.6	-37.7	27	19.5	42.3	56.5	~	N/A	19.5	N/A	12.8	-34.6
Massive (CM)	6.4	2.3	-64.1	6.2	169.6	5.5	-10.8	8.0	44.6	7.3	2.7	-62.6	8.1	196.7	4.5	-44.4	~	N/A	8.0	N/A	10.5	31.8
Flat/Encrusting (CFD)	11	7	-36.4	5.8	-17.1	5.2	-9.9	8.8	68.2	8	2.3	-70.9	4.5	93.1	1.3	-72.2	~	N/A	3.8	N/A	3.1	-19.8
Foliose Cup (CFO)	0.5	0	-100.0	0.5	+	0.3	-50.0	0.6	142.1	0.5	0.6	20.0	3	400.0	0	-100.0	~	N/A	0.9	N/A	0.7	-24.7
Total Hard Coral	37.3	55.9	49.9	23	-58.9	18.0	-21.7	35.3	96.1	52.1	28.3	-45.8	42.6	50.7	48	12.7	14.1	-70.6	32.3	128.8	27.1	-16.1
Total Soft Coral	2.7	5.3	96.3	1.5	-71.7	5.5	264.6	7.3	34.3	4.7	11.3	141.1	5.4	-52.3	0.5	-90.7	0.4	-20.0	1.5	276.8	1.7	15.9
Subtotal Coral	***40***	***61.2***	53.0	***24.5***	-60.0	***23.5***	-4.2	***42.7***	81.7	***56.8***	***39.6***	-30.3	***48***	21.2	***48.5***	1.0	***14.5***	-70.1	***33.8***	132.9	***28.8***	-14.7
Sponges	~	~	N/A	~	N/A	1.7	N/A	1.9	16.0	~	~	N/A	~	N/A	~	N/A	~	N/A	0.6	N/A	0.1	-80.6
Other animals	~	~	N/A	~	N/A	0.2	N/A	1.2	674.7	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A	0.1	211.1
Algae																						
Turf algae	~	~	N/A	~	N/A	6.6	N/A	0.9	-85.6	~	~	N/A	~	N/A	~	N/A	~	N/A	2.9	N/A	0.2	-92.4
Fleshy algae	~	~	N/A	~	N/A	0.8	N/A	0.9	10.1	~	~	N/A	~	N/A	~	N/A	~	N/A	2.0	N/A	3.3	67.0
Coralline algae	~	~	N/A	~	N/A	2.8	N/A	1.2	-58.4	~	~	N/A	~	N/A	~	N/A	~	N/A	1.3	N/A	0.2	-80.6
Seagrass	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	~	~	N/A	~	N/A	***12.1***	N/A	***6.2***	-49.0	~	~	N/A	~	N/A	~	N/A	~	N/A	***6.8***	N/A	***4.0***	-41.0
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Paramenters																						
Mean Slope (degrees)	~			9.1		13.5		37.2		~	~		~		~		0.9		15.0		3.0	
Mean Topography (m) *	2.4	2.2		1.6		1.1		1.0		2.1	1.5-2		1.5-4		~		0.8		1.2		0.9	
Mean Depth/Range (m)	1.5-15	6-7		5.6		7.2		7.4		2-8	3-7		2-5		2-3		2.2		2.9		3.1	
Horizontal Visibility (m)	~	18		20.3		23.7		29.0		~	~		~		25		22.2		22.7		29.2	
No. of 50 m Transects	1	4		15		16.0		19.0		1	3		6		2		14		14.0		15.0	

~ 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 2008.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	6.7	0.9	28.4	71.7	8.6	1.0	109.7	40.7
Rabbitfish (Siganids)*	0.3	0.2	0.0	0.4	0.2	0.0	0.7	0.3
Groupers (Serranids)*	3.9	0.5	4.4	13.2	4.6	1.7	23.9	5.3
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	3.2	0.7	0.3	0.4	13.3	3.6	17.7	8.1
Sweetlips (Haemulids)*	0.7	0.3	0.0	0.0	0.9	2.9	3.8	2.3
Emperors (Lethrinids)*	1.1	0.3	0.0	10.7	4.4	0.1	15.2	6.5
Jacks (Carangids)*	1.3	0.3	0.1	0.4	6.6	1.3	8.4	3.0
Fusiliers (Caesionids)*	1.6	0.6	5.6	49.4	5.9	0.0	60.9	28.9
Spinecheeks (Nemipterids)*	0.7	0.2	0.0	8.7	0.0	0.0	8.7	6.5
Goatfish (Mullids)*	1.8	0.4	1.4	12.3	0.3	0.0	14.1	4.3
Parrotfish (Scarids)*	4.3	1.0	3.9	5.8	12.7	1.7	24.0	3.0
Bumphead parrotfish	0.1	0.1	0.0	0.0	0.8	0.8	1.6	1.3
Rudderfish (Kyphosids)*	0.3	0.2	0.0	0.0	2.0	0.2	2.2	1.3
Triggerfish (Balistids)	4.7	0.6	1.7	376.1	42.9	0.1	420.8	158.7
Butterflyfish (Chaetodonids)	12.2	1.0	55.9	8.3	1.1	0.0	65.3	6.8
Angelfish (Pomacanthids)	2.8	0.4	11.7	3.0	1.0	0.1	15.8	7.6
Wrasses (Labrids)	9.3	1.8	33.2	14.2	3.8	0.4	51.7	10.4
Humphead wrasse	0.3	0.2	0.0	0.0	0.2	0.1	0.3	0.2
Damselfish (Pomacentrids)	8.4	2.0	1013.6	0.0	0.0	0.0	1013.6	419.3
Fairy Basslets (Anthids)	2.1	0.3	983.3	0.0	0.0	0.0	983.3	346.9
Moorish Idols (*Zanclus cornutus*)	1.0	0.2	0.1	4.0	0.9	0.0	5.0	1.3
Total (target reef spp.):	**25.9**	**3.1**	**15.8**	**173.1**	**60.2**	**13.2**	**262.3**	**41.6**
Total (all reef spp.):	**66.9**	**7.6**	**2143.7**	**578.8**	**110.1**	**14.0**	**2846.6**	**793.9**

* Target species/families

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

Fairly high density for target families

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 2008.

Family	(N=1) 1992 Species	(N=2) 1996 Species	% Change 1992 1996	(N=5) 2000 Species	% Change 1996 2000	(N=8) 2004 Species	% Change 2000 2004	(N=9) 2008 Species	% Change 2004 2008
Surgeonfish (Acanthurids)*	9.0	8.0	-11.1	5.6	-30.0	9.3	65.2	6.7	-27.9
Rabbitfish (Siganids)*	0.0	1.0	+	0.6	-40.0	0.3	-58.3	0.3	33.3
Groupers (Serranids)*	2.0	3.0	50.0	2.6	-13.3	2.4	-8.7	3.9	63.7
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	2.0	1.0	-50.0	2.2	120.0	1.9	-14.8	3.2	71.9
Sweetlips (Haemulids)*	1.0	0.5	-50.0	0.0	-100.0	0.3	+	0.7	166.7
Emperors (Lethrinids)*	0.0	0.5	+	0.8	60.0	1.0	25.0	1.1	11.1
Jacks (Carangids)*	1.0	1.0	0.0	0.8	-20.0	0.8	-6.3	1.3	77.8
Fusiliers (Caesionids)*	4.0	1.5	-62.5	0.4	-73.3	0.6	56.3	1.6	148.9
Spinecheeks (Nemipterids)*	0.0	1.0	+	12.6	1160.0	0.6	-95.0	0.7	6.7
Goatfish (Mullids)*	1.0	1.0	0.0	1.4	40.0	1.9	33.9	1.8	-5.2
Parrotfish (Scarids)*	1.0	1.0	0.0	2.0	100.0	3.3	62.5	4.3	33.3
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.1	+
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.2	+	0.0	-100.0	0.3	+
Triggerfish (Balistids)	2.0	3.5	75.0	4.2	20.0	4.3	1.2	4.7	9.8
Butterflyfish (Chaetodonids)	11.0	11.0	0.0	9.6	-12.7	9.8	1.6	12.2	25.4
Angelfish (Pomacanthids)	2.0	3.0	50.0	2.6	-13.3	1.8	-32.7	2.8	58.7
Wrasses (Labrids)	5.0	4.0	-20.0	6.6	65.0	8.6	30.7	9.3	8.2
Humphead wrasse	~	~	N/A	~	N/A	0.1	N/A	0.3	166.7
Damselfish (Pomacentrids)	10.0	11.0	10.0	5.2	-52.7	6.9	32.2	8.4	22.8
Fairy Basslets (Anthids)	2.0	2.0	0.0	1.0	-50.0	1.5	50.0	2.1	40.7
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	1.0	0.0	0.8	-25.0	1.0	33.3
Total (target reef spp.):	**21.0**	**19.5**	**-7.1**	**29.2**	**49.7**	**22.1**	**-24.2**	**25.9**	**17.0**
Total (all reef spp.):	**54.0**	**55.0**	**1.9**	**59.4**	**8.0**	**55.8**	**-6.1**	**66.9**	**20.0**

* 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 2008.

Family	(N=1) 1992 Density	(N=2) 1996 Density	% Change 1992 1996	(N=5) 2000 Density	% Change 1996 2000	(N=8) 2004 Density	% Change 2000 2004	(N=9) 2008 Density	% Change 2004 2008
Surgeonfish (Acanthurids)*	222.0	123.0	-44.6	104.0	-15.4	128.3	23.3	109.7	-14.5
Rabbitfish (Siganids)*	0.0	3.0	+	1.0	-66.7	0.4	-62.5	0.7	77.8
Groupers (Serranids)*	6.0	16.0	166.7	13.8	-13.8	9.8	-29.3	23.9	145.0
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	42.0	21.0	-50.0	15.0	-28.6	8.6	-42.5	17.7	104.8
Sweetlips (Haemulids)*	3.0	1.5	-50.0	0.0	-100.0	0.5	+	3.8	655.6
Emperors (Lethrinids)*	0.0	4.5	+	4.0	-11.1	7.8	93.8	15.2	96.4
Jacks (Carangids)*	9.0	6.0	-33.3	1.2	-80.0	24.1	1910.4	8.4	-65.0
Fusiliers (Caesionids)*	324.0	97.5	-69.9	51.6	-47.1	50.9	-1.4	60.9	19.7
Spinecheeks (Nemipterids)*	0.0	18.0	+	13.8	-23.3	2.4	-82.8	8.7	264.9
Goatfish (Mullids)*	129.0	21.0	-83.7	14.8	-29.5	21.4	44.4	14.1	-34.0
Parrotfish (Scarids)*	129.0	33.0	-74.4	45.8	38.8	15.3	-66.7	24.0	57.4
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	1.6	+
Rudderfish (Kyphosids)*	0.0	0.0	N/A	0.6	+	0.0	-100.0	2.2	+
Triggerfish (Balistids)	5.0	109.5	2090.0	69.0	-37.0	326.4	373.0	420.8	28.9
Butterflyfish (Chaetodonids)	44.0	75.0	70.5	65.0	-13.3	44.4	-31.7	65.3	47.2
Angelfish (Pomacanthids)	38.0	9.0	-76.3	34.2	280.0	9.6	-71.9	15.8	63.9
Wrasses (Labrids)	189.0	27.0	-85.7	48.8	80.7	199.0	307.8	51.7	-74.0
Humphead wrasse	~	~	N/A	~	N/A	0.1	N/A	0.3	166.7
Damselfish (Pomacentrids)	420.0	3153.0	650.7	616.8	-80.4	834.5	35.3	1013.6	21.5
Fairy Basslets (Anthids)	162.0	354.0	118.5	242.0	-31.6	402.6	66.4	983.3	144.2
Moorish Idols (*Zanclus cornutus*)	9.0	9.0	0.0	4.8	-46.7	3.0	-37.5	5.0	66.7
Total (target reef spp.):	**864.0**	**344.5**	**-60.1**	**265.6**	**-22.9**	**228.5**	**-14.0**	**262.3**	**14.8**
Total (all reef spp.):	**1731.0**	**4081.0**	**135.8**	**1346.2**	**-67.0**	**2088.9**	**55.2**	**2846.6**	**36.3**

* 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 2008.

	SCUBA SURVEYS:							SNORKEL SURVEYS:								
SUBSTRATE COVER	1992 % cover	2000 % cover	% Change 1992-2000	2004 % cover	% Change 2000-2004	2008 % cover	% Change 2004-2008	1992 % cover	1996 % cover	% Change 1992-1996	2000 % cover	% Change 1996-2000	2004 % cover	% Change 2000-2004	2008 % cover	% Change 2004-2008
Sand (s) and Silt (SI)	20.2	8.1	-59.9	8.8	8.8	2.2	-74.8	20.3	22.3	9.9	16.2	-27.4	6.4	-60.7	4.6	-27.5
Coral Rubble (R)	0.5	33.3	6560.0	22.1	-33.7	21.3	-3.3	24.9	7.1	-71.5	17.6	147.9	18.2	3.3	10.7	-41.3
Rock and Block (RK)	38.8	11.1	-71.4	13.2	18.5	4.0	-69.6	10	6.3	-37.0	23.1	266.7	18.7	-19.2	23.1	23.9
White Dead Standing Coral (DC)	6.3	0.9	-85.7	0.2	-82.6	1.3	716.0	6.1	7.8	27.9	0.3	-96.2	0.8	170.7	1.1	34.1
Dead Coral with Algae (DCA)	0	32.6	+	3.5	-89.2	8.3	135.8	0	0	N/A	10.1	+	8.0	-20.9	12.8	59.7
Subtotal Non-living Substrate	***65.8***	***86***	**30.7**	***47.7***	**-44.5**	***37.2***	-22.1	***61.3***	***43.5***	**-29.0**	***67.3***	**54.7**	***52.0***	**-22.7**	***52.3***	0.5
Branching (CB)	25.5	8.9	-65.1	26.9	202.7	44.3	64.5	22.6	51	125.7	~	N/A	30.4	N/A	32.1	5.3
Massive (CM)	1.2	1.9	58.3	6.0	214.1	3.6	-40.5	6.5	4.7	-27.7	~	N/A	7.5	N/A	9.2	21.8
Flat/Encrusting (CFD)	5.7	1.9	-66.7	7.8	311.2	2.5	-67.7	4.4	0	-100.0	~	N/A	3.1	N/A	2.6	-15.9
Foliose Cup (CFO)	0	0.2	+	1.2	478.1	0.5	-56.8	2	0	-100.0	~	N/A	0.8	N/A	0.8	7.8
Total Hard Coral	32.4	12.9	-60.2	41.9	224.6	50.9	21.6	35.5	55.7	56.9	31.3	-43.8	41.9	33.8	44.7	6.7
Total Soft Coral	1.8	1.1	-38.9	1.7	50.6	9.0	441.9	3.2	0.8	-75.0	1.4	75.0	0.7	-51.2	1.4	111.3
Subtotal Coral	***34.2***	***14***	**-59.1**	***43.5***	**210.9**	***59.9***	37.5	***38.7***	***56.5***	**46.0**	***32.7***	**-42.1**	***42.6***	**30.2**	***46.2***	8.4
Sponges	~	~	N/A	3.6	N/A	1.4	-62.4	~	~	N/A	~	N/A	0.5	N/A	0.4	-23.7
Other animals	~	~	N/A	1.0	N/A	0.6	-43.2	~	~	N/A	~	N/A	0.9	N/A	0.3	-69.4
Algae				0.0									0.0			
Turf algae	~	~	N/A	0.4	N/A	0.2	-40.0	~	~	N/A	~	N/A	0.9	N/A	0.3	-66.3
Fleshy algae	~	~	N/A	0.5	N/A	0.3	-50.0	~	~	N/A	~	N/A	1.1	N/A	0.2	-82.1
Coralline algae	~	~	N/A	3.3	N/A	0.6	-81.9	~	~	N/A	~	N/A	1.6	N/A	0.4	-75.7
Seagrass	~	~	N/A	0.0	N/A	0.0	N/A	~	~	N/A	~	N/A	0.3	N/A	0.0	-100.0
Subtotal Others	***0***	***0***	N/A	***8.8***	+	***3.0***	-66.0	***0***	***0***	N/A	***0***	N/A	***5.4***	+	***1.6***	-70.9
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**	0.0	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**	0.0
Environmental Parameters																
Mean Slope (degrees)	~	15.6		53.6		34.2		~	~		3.4		12.2		2.0	
Mean Topography (m) *	4	2.9		2.1		2.5		1-3	~		1.6		1.1		1.3	
Mean Depth/Range (m)	5	6.5		7.4		7.7		1-10	3		2.8		3.0		3.0	
Horizontal Visibility (m)	~	23.8		26.2		32.3		~	25		20.8		9.9		31.9	
No. of 50 m Transects	1	16		16		20		6	2		13		14		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 11. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at NR-2 (North Reef) Ranger Station in 2008.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	7.8	0.5	19.5	31.8	18.9	1.1	71.3	8.7
Rabbitfish (Siganids)*	1.8	0.4	0.0	3.1	1.1	0.0	4.3	0.9
Groupers (Serranids)*	3.8	0.5	3.1	6.0	4.5	1.5	15.1	4.1
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	3.9	0.4	0.0	0.8	3.8	4.3	8.8	1.6
Sweetlips (Haemulids)*	0.8	0.3	0.0	0.0	2.0	3.5	5.5	4.5
Emperors (Lethrinids)*	1.4	0.5	0.0	6.4	1.8	0.8	8.9	3.1
Jacks (Carangids)*	1.6	0.5	0.0	0.0	0.4	28.0	28.4	24.6
Fusiliers (Caesionids)*	2.1	0.5	12.5	117.4	7.6	0.5	138.0	52.3
Spinecheeks (Nemipterids)*	0.6	0.3	0.3	1.0	0.1	0.0	1.4	0.7
Goatfish (Mullids)*	1.1	0.3	0.0	3.3	4.5	0.0	7.8	4.1
Parrotfish (Scarids)*	3.8	0.8	4.8	14.4	1.9	6.0	27.0	9.4
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	4.1	0.9	0.4	28.1	2.1	1.3	31.9	18.4
Butterflyfish (Chaetodonids)	12.4	0.9	26.4	29.6	1.9	0.0	57.9	16.2
Angelfish (Pomacanthids)	3.4	0.4	7.0	8.4	0.1	0.1	15.6	4.6
Wrasses (Labrids)	10.4	2.1	47.4	7.5	1.3	1.3	57.4	11.3
Humphead wrasse	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
Damselfish (Pomacentrids)	8.8	2.4	3423.9	0.0	0.0	0.0	3423.9	924.6
Fairy Basslets (Anthids)	1.9	0.4	2544.0	0.0	0.0	0.0	2544.0	696.0
Moorish Idols (*Zanclus cornutus*)	1.1	0.1	0.4	3.8	0.9	0.0	5.0	1.1
Total (target reef spp.):	**28.5**	**2.5**	**20.6**	**184.0**	**46.5**	**43.6**	**294.8**	**58.9**
Total (all reef spp.):	**70.6**	**7.9**	**6089.5**	**261.4**	**52.8**	**48.4**	**6452.0**	**1451.1**

* Target species/families

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

Fairly high density for target families

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 2008.

Family	(N=1) 1992 Species	(N=6) 2000 Species	% Change 1992-2000	(N=8) 2004 Species	% Change 2000-2004	(N=8) 2008 Species	% Change 2004-2008
Surgeonfish (Acanthurids)*	8.0	6.8	-14.6	8.1	18.9	7.8	-4.6
Rabbitfish (Siganids)*	1.0	1.5	50.0	1.3	-16.7	1.8	40.0
Groupers (Serranids)*	5.0	4.3	-13.3	2.9	-33.7	3.8	30.4
Barramundi cod	~	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	1.0	2.5	150.0	4.5	80.0	3.9	-13.9
Sweetlips (Haemulids)*	0.0	0.7	+	0.9	31.3	0.8	-14.3
Emperors (Lethrinids)*	1.0	0.7	-33.3	1.4	106.3	1.4	0.0
Jacks (Carangids)*	0.0	2.0	+	1.3	-37.5	1.6	30.0
Fusiliers (Caesionids)*	0.0	1.3	+	2.5	87.5	2.1	-15.0
Spinecheeks (Nemipterids)*	1.0	0.7	-33.3	0.5	-25.0	0.6	25.0
Goatfish (Mullids)*	1.0	1.8	83.3	1.1	-38.6	1.1	0.0
Parrotfish (Scarids)*	1.0	3.5	250.0	2.6	-25.0	3.8	42.9
Bumphead parrotfish	~	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.2	+	0.1	-25.0	0.0	-100.0
Triggerfish (Balistids)	2.0	2.7	33.3	1.9	-29.7	4.1	120.0
Butterflyfish (Chaetodonids)	14.0	10.2	-27.4	11.4	11.9	12.4	8.8
Angelfish (Pomacanthids)	2.0	3.5	75.0	2.5	-28.6	3.4	35.0
Wrasses (Labrids)	9.0	10.8	20.4	6.6	-38.8	10.4	56.6
Humphead wrasse	~	~	N/A	0.0	N/A	0.1	+
Damselfish (Pomacentrids)	13.0	12.7	-2.6	12.4	-2.3	8.8	-29.3
Fairy Basslets (Anthids)	2.0	1.2	-41.7	2.1	82.1	1.9	-11.8
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	0.9	-12.5	1.1	28.6
Total (target reef spp.):	**19.0**	**26.0**	**36.8**	**27.1**	**4.3**	**28.5**	**5.1**
Total (all reef spp.):	**62.0**	**68.0**	**9.7**	**64.9**	**-4.6**	**70.6**	**8.9**

* 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 2008.

Family	(N=1) 1992 Density	(N=6) 2000 Density	% Change 1992-2000	(N=8) 2004 Density	% Change 2000-2004	(N=8) 2008 Density	% Change 2004-2008
Surgeonfish (Acanthurids)*	90.0	193.7	115.2	128.5	-33.6	71.3	-44.6
Rabbitfish (Siganids)*	4.0	5.2	29.2	2.4	-54.0	4.3	78.9
Groupers (Serranids)*	8.0	16.8	110.4	7.6	-54.7	15.1	98.4
Barramundi cod	~	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	5.0	18.0	260.0	19.6	9.0	8.8	-55.4
Sweetlips (Haemulids)*	0.0	3.8	+	1.8	-54.3	5.5	214.3
Emperors (Lethrinids)*	9.0	1.3	-85.2	24.3	1718.8	8.9	-63.4
Jacks (Carangids)*	0.0	13.0	+	9.3	-28.8	28.4	206.8
Fusiliers (Caesionids)*	0.0	104.0	+	1396.5	1242.8	138.0	-90.1
Spinecheeks (Nemipterids)*	3.0	2.5	-16.7	1.4	-45.0	1.4	0.0
Goatfish (Mullids)*	129.0	12.7	-90.2	7.8	-38.8	7.8	0.0
Parrotfish (Scarids)*	33.0	70.7	114.1	29.5	-58.3	27.0	-8.5
Bumphead parrotfish	~	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	5.5	+	4.1	-25.0	0.0	-100.0
Triggerfish (Balistids)	3.0	14.8	394.4	8.6	-41.9	31.9	269.6
Butterflyfish (Chaetodonids)	50.0	30.8	-38.3	35.5	15.1	57.9	63.0
Angelfish (Pomacanthids)	34.0	28.2	-17.2	7.5	-73.4	15.6	108.3
Wrasses (Labrids)	117.0	120.0	2.6	117.4	-2.2	57.4	-51.1
Humphead wrasse	~	~	N/A	0.0	N/A	0.1	+
Damselfish (Pomacentrids)	1020.0	994.8	-2.5	2578.0	159.1	3423.9	32.8
Fairy Basslets (Anthids)	258.0	905.3	250.9	1061.8	17.3	2544.0	139.6
Moorish Idols (*Zanclus cornutus*)	3.0	4.0	33.3	5.3	31.3	5.0	-4.8
Total (target reef spp.):	**281.0**	**447.2**	**59.1**	**1587.0**	**254.9**	**294.8**	-81.4
Total (all reef spp.):	**1766.0**	**2545.2**	**44.1**	**5446.6**	**114.0**	**6452.0**	18.5

* Target species/families

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

(-) = decrease

(+) = increase

Table 14. Changes in substrate composition (% mean ±SE) in SR-3 (South Reef) Black Rock from 1984 to 2008.

	SCUBA SURVEYS:									SNORKEL SURVEYS:											
	1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	2008	% Change 2004-2008	1984	1989	% Change 1984-1989	1992	% Change 1989-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	2008	% Change 2004-2008
SUBSTRATE COVER	% cover	% cover		% cover		% cover		% cover		% cover	% cover		% cover		% cover		% cover		% cover		% cover	
Sand (s) and Silt (SI)	1.1	3.8	245.5	3.8	0.0	8.9	135.2	8.4	-5.7	1.1	6.1	454.5	14.4	136.1	6.0	-58.3	4.1	-31.7	8.3	101.7	3.8	-54.3
Coral Rubble (R)	17.6	22.5	27.8	40.5	80.0	16.7	-58.8	17.0	2.0	16.3	26.6	63.2	9.0	-66.2	6.5	-27.8	12.7	95.4	9.6	-24.7	10.7	11.8
Rock and Block (RK)	4.9	7.4	51.0	14.8	100.0	5.0	-66.3	3.5	-29.8	12.2	18.3	50.0	32.3	76.5	4.5	-86.1	41.9	831.1	24.7	-41.0	11.2	-54.7
White Dead Standing Coral (DC)	0.6	1.8	200.0	2.6	44.4	0.3	-90.4	0.4	60.0	5.2	4.0	-23.1	2.1	-47.5	18.0	757.1	2.0	-88.9	0.4	-78.7	1.0	144.8
Dead Coral with Algae (DCA)	0.0	0.0	N/A	8.4	+	4.4	-47.2	6.1	37.5	0.0	0.0	N/A	0.0	N/A	0.0	N/A	9.2	+	6.6	-28.6	6.1	-7.3
Subtotal Dnon-living Substrate	***24.2***	***35.5***	***46.7***	***70.1***	***97.5***	***35.3***	***-49.6***	***35.5***	0.4	***34.8***	***55.0***	***58.0***	***57.8***	***5.1***	***35.0***	***-39.4***	***69.9***	***99.7***	***49.5***	***-29.1***	***32.8***	-33.8
Branching (CB)	17.9	27.7	54.7	17.5	-36.8	39.1	123.2	39.9	2.1	32.7	15.7	-52.0	19.3	22.9	41.0	112.4	~	N/A	27.5	N/A	49.2	79.2
Massive (CM)	8.1	2.1	-74.1	3.4	61.9	2.8	-17.5	4.6	63.0	8.8	3.6	-59.1	8.6	138.9	9.0	4.7	~	N/A	8.9	N/A	3.8	-56.9
Flat/Encrusting (CFD)	0.7	2.7	285.7	4.8	77.8	5.3	9.9	3.4	-35.5	5.4	0.0	-100.0	5.1	+	4.5	-11.8	~	N/A	6.5	N/A	3.0	-54.6
Foliose Cup (CFO)	2.4	1.1	-54.2	0.9	-18.2	0.8	-13.2	1.2	47.2	2.0	0.0	-100.0	0.7	+	1.5	114.3	~	N/A	1.2	N/A	6.4	417.0
Total Hard Coral	29.0	33.6	15.9	26.5	-21.1	47.9	80.8	49.0	2.2	48.9	19.3	-60.5	33.7	74.6	56.0	66.2	29.4	-47.5	44.2	50.2	62.4	41.4
Total Soft Coral	46.8	30.9	-34.0	3.4	-89.0	11.4	234.6	12.6	10.3	16.3	25.7	57.7	8.5	-66.9	9.0	5.9	0.7	-92.2	2.9	307.2	4.2	46.6
Subtotal Coral	***75.8***	***64.5***	***-14.9***	***29.9***	***-53.6***	***59.3***	***98.3***	***61.6***	3.8	***65.2***	***45.0***	***-31.0***	***42.2***	***-6.2***	***65.0***	***54.0***	***30.1***	***-53.7***	***47.0***	***56.2***	***66.6***	41.7
Sponges	~	~	N/A	~	N/A	1.8	N/A	1.3	-32.2	~	~	N/A	~	N/A	~	N/A	~	N/A	0.6	N/A	0.0	-100.0
Other animals	~	~	N/A	~	N/A	0.5	N/A	0.5	-5.9	~	~	N/A	~	N/A	~	N/A	~	N/A	0.2	N/A	0.0	-77.0
Algae																						
Turf algae	~	~	N/A	~	N/A	0.8	N/A	0.2	-77.6	~	~	N/A	~	N/A	~	N/A	~	N/A	1.3	N/A	0.1	-95.0
Fleshy algae	~	~	N/A	~	N/A	0.1	N/A	0.1	-46.7	~	~	N/A	~	N/A	~	N/A	~	N/A	0.2	N/A	0.0	-79.8
Coralline algae	~	~	N/A	~	N/A	2.2	N/A	1.0	-52.3	~	~	N/A	~	N/A	~	N/A	~	N/A	1.2	N/A	0.4	-63.7
Seagrass	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A	~	~	N/A	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	***0.0***	***0.0***	N/A	***0.0***	N/A	***5.4***	+	***3.0***	-44.4	***0.0***	***0.0***	N/A	***0.0***	N/A	***0.0***	N/A	***0.0***	N/A	***3.5***	+	***0.6***	-83.3
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters																						
Mean Slope (degrees)	~	~		16.9		32.3		38.3		~	~		~		~		5.8		11.4		2.5	
Mean Topography (m) *	1.9	2.5		2.9		1.5		2.1		1.9	~		1.5		~		1.3		0.7		1.1	
Mean Depth/Range (m)	8-15	8-9		6.8		7.3		7.3		3.5	~		2-7		1-2.7		2.6		2.7		3.5	
Horizontal Visibility (m)	~	25.0		27.9		28.8		32.5		~	~		~		~		23.9		28.7		32.9	
No. of 50 m Transects	4	4		16		16		20		1	2		3		2		12		15		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/500m2) per family at SR-3 (South Reef) Black Rock in 2008

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	6.9	0.5	15.0	49.1	6.5	2.1	72.8	20.1
Rabbitfish (Siganids)*	1.0	0.2	0.3	2.4	0.8	0.0	3.4	0.8
Groupers (Serranids)*	2.9	0.3	2.6	9.3	5.1	0.0	17.0	4.1
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	2.9	0.5	0.0	2.9	10.9	4.3	18.0	7.1
Sweetlips (Haemulids)*	0.8	0.4	0.0	0.0	1.1	4.5	5.6	3.4
Emperors (Lethrinids)*	1.3	0.4	0.0	4.0	4.0	0.1	8.1	4.6
Jacks (Carangids)*	1.3	0.2	0.0	0.0	3.0	1.8	4.8	1.6
Fusiliers (Caesionids)*	0.8	0.4	0.0	15.5	16.1	0.6	32.3	20.7
Spinecheeks (Nemipterids)*	0.5	0.2	0.5	0.8	0.0	0.0	1.3	0.6
Goatfish (Mullids)*	1.6	0.4	0.3	5.9	0.0	0.0	6.1	1.3
Parrotfish (Scarids)*	2.9	0.9	0.0	7.3	2.3	5.5	15.0	4.6
Bumphead parrotfish	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	4.9	0.6	0.5	27.6	3.6	0.5	32.3	7.8
Butterflyfish (Chaetodonids)	10.9	1.2	17.1	14.5	1.4	0.0	33.0	4.5
Angelfish (Pomacanthids)	2.5	0.6	6.0	1.8	0.6	0.5	8.9	2.8
Wrasses (Labrids)	8.8	2.0	19.6	7.8	3.4	0.5	31.3	5.8
Humphead wrasse	0.5	0.2	0.0	0.0	0.0	0.8	0.8	0.4
Damselfish (Pomacentrids)	8.9	1.8	2424.3	0.0	0.0	0.0	2424.3	522.6
Fairy Basslets (Anthids)	1.6	0.5	1117.5	0.0	0.0	0.0	1117.5	429.6
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	2.5	4.1	1.9	0.0	8.5	2.5
Total (target reef spp.):	**22.6**	**2.4**	**3.6**	**97.0**	**49.8**	**19.0**	**169.4**	**32.5**
Total (all reef spp.):	**61.8**	**5.7**	**3606.1**	**152.8**	**60.6**	**21.3**	**3840.8**	**867.5**

* Target species/families

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

Fairly high density for target families

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 2008.

Family	(N=2)	(N=5)	% Change 1996-2000	(N=8)	% Change 2000-2004	(N=8)	% Change 2004-2008
	1996	2000		2004		2008	
	Species			Species		Species	
Surgeonfish (Acanthurids)*	7.5	7.2	-4.0	6.1	-14.9	6.9	12.2
Rabbitfish (Siganids)*	1.5	1.2	-20.0	1.4	14.6	1.0	-27.3
Groupers (Serranids)*	2.0	2.4	20.0	3.1	30.2	2.9	-8.0
Barramundi cod	~	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	1.0	2.0	100.0	2.8	37.5	2.9	4.5
Sweetlips (Haemulids)*	0.5	0.6	20.0	0.6	4.2	0.8	20.0
Emperors (Lethrinids)*	0.0	0.6	+	1.5	150.0	1.3	-16.7
Jacks (Carangids)*	0.0	1.0	+	1.4	37.5	1.3	-9.1
Fusiliers (Caesionids)*	1.5	1.2	-20.0	0.1	-89.6	0.8	500.0
Spinecheeks (Nemipterids)*	0.5	0.2	-60.0	0.3	25.0	0.5	100.0
Goatfish (Mullids)*	1.0	1.2	20.0	1.8	45.8	1.6	-7.1
Parrotfish (Scarids)*	1.0	0.8	-20.0	3.4	321.9	2.9	-14.8
Bumphead parrotfish	~	~	N/A	0.0	N/A	0.1	+
Rudderfish (Kyphosids)*	0.0	0.6	+	0.0	-100.0	0.0	N/A
Triggerfish (Balistids)	2.5	4.2	68.0	2.5	-40.5	4.9	95.0
Butterflyfish (Chaetodonids)	8.0	12.0	50.0	11.1	-7.3	10.9	-2.2
Angelfish (Pomacanthids)	1.5	2.6	73.3	2.8	5.8	2.5	-9.1
Wrasses (Labrids)	4.5	5.4	20.0	8.6	59.7	8.8	1.4
Humphead wrasse	~	~	N/A	0.0	N/A	0.5	+
Damselfish (Pomacentrids)	7.5	9.0	20.0	12.5	38.9	8.9	-29.0
Fairy Basslets (Anthids)	2.0	2.0	0.0	2.1	6.3	1.6	-23.5
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	0.9	-12.5	1.0	14.3
Total (target reef spp.):	**16.5**	**19.0**	**15.2**	**22.4**	**17.8**	**22.6**	**1.1**
Total (all reef spp.):	**43.5**	**55.2**	**26.9**	**62.9**	**13.9**	**61.8**	**-1.8**

* 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 2008.

Family	(N=2) 1996 Density	(N=5) 2000 Density	% Change 1996-2000	(N=8) 2004 Density	% Change 2000-2004	(N=8) 2008 Density	% Change 2004-2008
Surgeonfish (Acanthurids)*	84.5	156.6	85.3	97.6	-37.7	72.8	-25.5
Rabbitfish (Siganids)*	7.5	3.0	-60.0	4.5	50.0	3.4	-25.0
Groupers (Serranids)*	3.5	11.6	231.4	15.6	34.7	17.0	8.8
Barramundi cod	~	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	9.0	7.2	-20.0	11.8	63.2	18.0	53.2
Sweetlips (Haemulids)*	1.5	3.0	100.0	3.5	16.7	5.6	60.7
Emperors (Lethrinids)*	0.0	2.6	+	20.3	678.8	8.1	-59.9
Jacks (Carangids)*	0.0	9.8	+	7.3	-26.0	4.8	-34.5
Fusiliers (Caesionids)*	193.5	81.4	-57.9	4.1	-94.9	32.3	681.8
Spinecheeks (Nemipterids)*	16.5	0.2	-98.8	0.8	275.0	1.3	66.7
Goatfish (Mullids)*	66.0	28.2	-57.3	10.9	-61.4	6.1	-43.7
Parrotfish (Scarids)*	69.0	58.2	-15.7	23.6	-59.4	15.0	-36.5
Bumphead parrotfish	~	~	N/A	0.0	N/A	0.1	+
Rudderfish (Kyphosids)*	0.0	17.8	+	0.0	-100.0	0.0	N/A
Triggerfish (Balistids)	3.5	21.6	517.1	8.6	-60.1	32.3	273.9
Butterflyfish (Chaetodonids)	25.5	24.8	-2.7	32.5	31.0	33.0	1.5
Angelfish (Pomacanthids)	3.5	16.2	362.9	9.4	-42.1	8.9	-5.3
Wrasses (Labrids)	67.5	154.2	128.4	85.5	-44.6	31.3	-63.5
Humphead wrasse	~	~	N/A	0.0	N/A	0.8	+
Damselfish (Pomacentrids)	919.5	2096.8	128.0	2309.9	10.2	2424.3	5.0
Fairy Basslets (Anthids)	1618.5	890.8	-45.0	1733.5	94.6	1117.5	-35.5
Moorish Idols (*Zanclus cornutus*)	33.0	9.4	-71.5	5.3	-44.1	8.5	61.9
Total (target reef spp.):	**451.0**	**379.6**	**-15.8**	**175.5**	**-53.8**	**169.4**	**-3.5**
Total (all reef spp.):	**3122.0**	**3593.4**	**15.1**	**4384.5**	**22.0**	**3840.8**	**-12.4**

* 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 2008.

	SCUBA SURVEYS:							SNORKEL SURVEY:				
SUBSTRATE COVER	1992 % cover	2000 % cover	% Change 1992-2000	2004 % cover	% Change 2000-2004	2008 % cover	% Change 2004-2008	1992 % cover	2004 % cover	% Change 1992-2004	2008 % cover	% Change 2004-2008
Sand (s) and Silt (SI)	2.3	1.7	-26.1	4.0	137.0	3.0	-26.3	4.3	3.9	-9.0	4.1	3.7
Coral Rubble (R)	11.8	10.3	-12.7	8.9	-14.0	14.1	59.8	5.0	3.1	-37.7	5.2	67.0
Rock and Block (RK)	41.6	26.5	-36.3	11.5	-56.5	9.0	-21.9	21.0	36.0	71.4	45.7	26.8
White Dead Standing Coral (DC)	~	0.8	N/A	0.2	-74.3	0.2	-14.3	3.0	0.0	-100.0	0.1	+
Dead Coral with Algae (DCA)	0.3	12.7	4133.3	3.2	-74.8	6.5	101.8	0.0	2.7	+	2.3	-16.0
Subtotal Non-living Substrate	***56.0***	***52.0***	***-7.1***	***27.8***	***-46.5***	***32.8***	17.8	***33.3***	***45.8***	37.3	***57.3***	25.3
Branching (CB)	19.2	20.0	4.2	27.2	36.0	18.1	-33.6	37.3	17.0	-54.4	10.4	-39.2
Massive (CM)	7.7	9.6	24.7	10.3	6.9	8.8	-14.6	15.3	13.4	-12.9	16.0	19.9
Flat/Encrusting (CFD)	6.0	10.6	76.7	10.5	-0.9	12.9	22.7	12.2	15.8	29.8	8.0	-49.6
Foliose Cup (CFO)	2.3	0.8	-65.2	1.0	25.0	1.1	8.8	0.7	2.8	314.3	0.4	-83.9
Total Hard Coral	35.2	41.0	16.5	49.0	19.4	40.8	-16.7	65.5	48.9	-25.3	34.8	-28.9
Total Soft Coral	8.8	7.0	-20.5	11.7	67.6	15.3	30.6	1.2	1.0	-12.4	1.1	10.6
Subtotal Coral	***44.0***	***48.0***	***9.1***	***60.7***	***26.5***	***56.1***	-7.6	***66.7***	***49.9***	-25.1	***35.9***	-28.1
Sponges	~	~	N/A	3.2	N/A	2.9	-10.2	~	0.4	N/A	0.2	-55.6
Other animals	~	~	N/A	1.1	N/A	3.1	191.7	~	0.1	N/A	0.3	296.1
Algae												
Turf algae	~	~	N/A	0.5	N/A	1.2	127.8	~	0.2	N/A	0.7	223.2
Fleshy algae	~	~	N/A	0.9	N/A	0.9	0.0	~	0.0	N/A	4.9	24249.2
Coralline algae	~	~	N/A	5.9	N/A	3.1	-46.7	~	3.6	N/A	0.7	-81.4
Seagrass	~	~	N/A	0.0	N/A	0.0	N/A	~	0.0	N/A	0.0	+
Subtotal Others	***0.0***	***0.0***	N/A	***11.5***	+	***11.1***	-3.1	***0.0***	***4.3***	+	***6.8***	57.1
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**	
Environmental Parameters												
Mean Slope (degrees)	~	21.8		46.5		55.0		~	6.3		1.4	
Mean Topography (m) *	2.0	1.6		1.4		1.3		~	1.3		0.9	
Mean Depth/Range (m)	2-7	6.5		7.6		7.5		2.0	2.4		2.5	
Horizontal Visibility (m)	~	27.8		28.5		27.3		~	28.7		28.6	
No. of 50 m Transects	3	18		17		17		3	15		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 2008.

Family	Species		Size Class				Abundance	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.8	0.8	21.5	14.5	7.5	1.5	45.0	11.8
Rabbitfish (Siganids)*	0.3	0.2	0.0	0.0	0.3	0.0	0.3	0.3
Groupers (Serranids)*	3.8	0.5	1.7	9.3	7.8	1.8	20.7	5.1
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	2.0	0.6	0.0	1.2	4.8	3.7	9.7	5.5
Sweetlips (Haemulids)*	1.0	0.4	0.0	0.0	1.3	7.8	9.2	3.9
Emperors (Lethrinids)*	0.8	0.2	0.0	0.5	1.5	0.2	2.2	0.7
Jacks (Carangids)*	1.5	0.2	0.0	0.0	2.0	3.3	5.3	1.7
Fusiliers (Caesionids)*	1.5	0.6	0.0	86.0	30.5	0.0	116.5	62.0
Spinecheeks (Nemipterids)*	0.2	0.2	0.0	0.5	0.0	0.0	0.5	0.5
Goatfish (Mullids)*	0.8	0.5	0.3	1.8	12.5	0.0	14.7	14.1
Parrotfish (Scarids)*	3.7	0.8	0.0	3.5	6.8	7.8	18.2	6.7
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	3.8	1.1	0.7	61.8	93.8	0.7	157.0	77.4
Butterflyfish (Chaetodonids)	9.5	2.3	15.0	9.8	0.7	0.0	25.5	6.3
Angelfish (Pomacanthids)	3.5	0.6	4.0	2.8	0.5	1.0	8.3	3.0
Wrasses (Labrids)	9.7	2.7	39.5	8.2	0.8	0.3	48.8	13.2
Humphead wrasse	0.3	0.2	0.0	0.0	0.0	0.3	0.3	0.2
Damselfish (Pomacentrids)	7.5	1.5	1050.7	8.3	0.0	0.0	1059.0	335.9
Fairy Basslets (Anthids)	2.5	0.4	1582.0	0.0	0.0	0.0	1582.0	379.7
Moorish Idols (*Zanclus cornutus*)	1.0	0.0	0.3	4.8	0.7	0.0	5.8	1.2
Total (target reef spp.):	**21.5**	**2.4**	**23.0**	**117.3**	**73.2**	**26.2**	**239.7**	**77.8**
Total (all reef spp.):	**59.3**	**8.0**	**2715.7**	**213.2**	**171.7**	**28.5**	**3129.0**	**318.9**

* Target species/families

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

Fairly high density for target families

Table 20. Mean (±SE) fish species richness (species/500m2) and percentage change between years at SR-4 (South Reef) North West Corner from 1992 to 2008.

Family	(N=1) 1992 Species	(N=6) 2000 Species	% Change 1992-2000	(N=8) 2004 Species	% Change 2000-2004	(N=6) 2008 Species	% Change 2004-2008
Surgeonfish (Acanthurids)*	12.0	7.0	-41.7	7.8	10.7	5.8	-24.7
Rabbitfish (Siganids)*	0.0	0.8	+	1.0	20.0	0.3	-66.7
Groupers (Serranids)*	3.0	4.3	44.4	3.4	-22.1	3.8	13.6
Barramundi cod	~	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	3.0	1.2	-61.1	3.1	167.9	2.0	-36.0
Sweetlips (Haemulids)*	1.0	0.2	-83.3	0.3	50.0	1.0	300.0
Emperors (Lethrinids)*	0.0	0.5	+	0.9	75.0	0.8	-4.8
Jacks (Carangids)*	1.0	0.5	-50.0	1.6	225.0	1.5	-7.7
Fusiliers (Caesionids)*	1.0	0.5	-50.0	0.4	-25.0	1.5	300.0
Spinecheeks (Nemipterids)*	0.0	1.0	+	0.4	-62.5	0.2	-55.6
Goatfish (Mullids)*	0.0	1.7	+	1.1	-32.5	0.8	-25.9
Parrotfish (Scarids)*	1.0	2.5	150.0	2.1	-15.0	3.7	72.5
Bumphead parrotfish	~	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	1	+	0	-100.0
Triggerfish (Balistids)	5.0	5.0	0.0	3.0	-40.0	3.8	27.8
Butterflyfish (Chaetodonids)	17.0	13.8	-18.6	12.5	-9.6	9.5	-24.0
Angelfish (Pomacanthids)	2.0	3.7	83.3	2.5	-31.8	3.5	40.0
Wrasses (Labrids)	5.0	8.3	66.7	8.5	2.0	9.7	13.7
Humphead wrasse	~	~	N/A	0.4	N/A	0.3	-11.1
Damselfish (Pomacentrids)	10.0	7.8	-21.7	10.8	37.2	7.5	-30.2
Fairy Basslets (Anthids)	3.0	1.2	-61.1	1.5	28.6	2.5	66.7
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	0.8	-25.0	1.0	33.3
Total (target reef spp.):	**22.0**	**16.7**	**-24.1**	**22.6**	**35.5**	**21.5**	-5.0
Total (all reef spp.):	**65.0**	**61.0**	**-6.2**	**62.5**	**2.5**	**59.3**	-5.1

* 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 2008.

Family	(N=1) 1992 Density	(N=6) 2000 Density	% Change 1992-2000	(N=8) 2004 Density	% Change 2000-2004	(N=6) 2008 Density	% Change 2004-2008
Surgeonfish (Acanthurids)*	324.0	215.2	-33.6	106.3	-50.6	45.0	-57.6
Rabbitfish (Siganids)*	0.0	2.7	+	2.1	-20.3	0.3	-84.3
Groupers (Serranids)*	17.0	21.5	26.5	15.0	-30.2	20.7	37.8
Barramundi cod	~	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	75.0	7.2	-90.4	28.6	299.4	9.7	-66.2
Sweetlips (Haemulids)*	3.0	0.5	-83.3	0.5	0.0	9.2	1733.3
Emperors (Lethrinids)*	0.0	27.2	+	12.9	-52.6	2.2	-83.2
Jacks (Carangids)*	9.0	22.2	146.3	13.6	-38.5	5.3	-60.9
Fusiliers (Caesionids)*	129.0	15.8	-87.7	5.5	-65.3	116.5	2018.2
Spinecheeks (Nemipterids)*	0.0	24.3	+	5.5	-77.4	0.5	-90.9
Goatfish (Mullids)*	0.0	20.0	+	8.4	-58.1	14.7	75.1
Parrotfish (Scarids)*	129.0	39.5	-69.4	24.9	-37.0	18.2	-27.0
Bumphead parrotfish	~	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	128	+	0	-100.0
Triggerfish (Balistids)	537.0	1422.5	164.9	491.5	-65.4	157.0	-68.1
Butterflyfish (Chaetodonids)	86.0	62.8	-26.9	48.6	-22.6	25.5	-47.6
Angelfish (Pomacanthids)	36.0	63.7	76.9	12.9	-79.8	8.3	-35.3
Wrasses (Labrids)	213.0	123.8	-41.9	111.5	-10.0	48.8	-56.2
Humphead wrasse	~	~	N/A	0.6	N/A	0.3	-46.7
Damselfish (Pomacentrids)	978.0	2508.8	156.5	1010.4	-59.7	1059.0	4.8
Fairy Basslets (Anthids)	2307.0	1558.8	-32.4	1679.0	7.7	1582.0	-5.8
Moorish Idols (*Zanclus cornutus*)	33.0	7.7	-76.8	3.6	-52.7	5.8	60.9
Total (target reef spp.):	**686.0**	**395.8**	**-42.3**	**292.6**	**-26.1**	**239.7**	**-18.1**
Total (all reef spp.):	**4876.0**	**6144.2**	**26.0**	**3709.0**	**-39.6**	**3129.0**	**-15.6**

* 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 2008

	SCUBA SURVEYS:											SNORKEL SURVEYS:								
	1984	1992	% Change 1984-1992	1996	% Change 1992-1996	2000	% Change 1996-2000	2004	% Change 2000-2004	2008	% Change 2004-2008	1984	1989	% Change 1984-1989	1992	% Change 1989-1992	2004	% Change 1992-2004	2008	% Change 2004-2008
SUBSTRATE COVER	% cover	% 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	2.4	84.9	0.5	3.6	620.0	14.6	305.6	3.0	-79.5	12.6	321.6
Coral Rubble (R)	8.3	13.1	57.8	16.7	27.5	16.6	-0.6	18.4	10.7	20.9	13.7	3.5	20.6	488.6	20.5	-0.5	0.5	-97.7	8.6	1734.9
Rock and Block (RK)	32.1	35.1	9.3	9.5	-72.9	3.4	-64.2	7.2	112.1	2.0	-71.9	37.0	39.6	7.0	40.2	1.4	36.4	-9.3	40.1	10.1
White Dead Standing Coral (DC)	0.2	0.3	50.0	2.5	733.3	3.3	32.0	0.4	-86.6	0.8	80.0	5.0	5.1	2.0	0.5	-90.2	0.3	-37.9	2.8	812.1
Dead Coral with Algae (DCA)	0.0	0.0	N/A	0.0	N/A	19.3	+	3.0	-84.4	5.5	81.3	0.0	0.0	N/A	0.0	N/A	2.3	+	2.5	6.7
Subtotal Non-living Substrate	***42.3***	***50.5***	**19.4**	***28.7***	**-43.2**	***45.5***	**58.5**	***30.4***	**-33.2**	***31.6***	4.1	***46.0***	***68.9***	**49.8**	***75.8***	**9.9**	***42.5***	**-43.9**	***66.6***	56.7
Branching (CB)	33.6	29.5	-12.2	51.6	74.9	41.6	-19.4	25.9	-37.8	47.3	83.1	25.0	15.2	-39.2	15.1	-0.7	13.2	-12.3	18.5	39.5
Massive (CM)	10.1	6.5	-35.6	3.0	-53.8	1.9	-36.7	6.5	243.3	1.3	-80.6	10.2	7.2	-29.4	3.8	-47.9	16.6	341.5	8.7	-47.4
Flat/Encrusting (CFD)	10.3	1.5	-85.4	3.8	153.3	3.3	-13.2	5.3	61.5	1.4	-74.6	9.2	3.2	-65.2	0.0	-100.0	17.4	+	2.1	-87.7
Foliose Cup (CFO)	0.1	1.1	1000.0	0.9	-18.2	0.5	-44.4	0.5	-1.2	0.4	-22.6	1.8	0.9	-50.0	2.8	205.6	2.3	-16.8	0.7	-68.0
Total Hard Coral	54.1	38.9	-28.1	59.3	52.4	47.3	-20.2	38.2	-19.2	50.3	31.7	46.2	26.5	-42.6	21.6	-18.5	49.5	129.0	30.0	-39.3
Total Soft Coral	3.6	10.6	194.4	12.0	13.2	7.2	-40.0	25.1	248.9	16.3	-35.0	7.8	4.6	-41.0	2.7	-42.4	0.6	-77.8	0.3	-48.9
Subtotal Coral	***57.7***	***49.5***	**-14.2**	***71.3***	**44.0**	***54.5***	**-23.6**	***63.3***	**16.2**	***66.7***	5.3	***54.0***	***31.1***	**-42.4**	***24.3***	**-22.0**	***50.0***	**106.4**	***30.3***	-39.4
Sponges	~	~	N/A	~	N/A	~	N/A	1.7	N/A	0.5	-70.4	~	~	N/A	~	N/A	0.8	N/A	0.2	-74.1
Other animals	~	~	N/A	~	N/A	~	N/A	1.0	N/A	0.5	-53.8	~	~	N/A	~	N/A	0.4	N/A	0.0	-90.6
Algae																				
Turf algae	~	~	N/A	~	N/A	~	N/A	0.8	N/A	0.2	-74.6	~	~	N/A	~	N/A	1.1	N/A	0.7	-31.0
Fleshy algae	~	~	N/A	~	N/A	~	N/A	0.3	N/A	0.3	1.9	~	~	N/A	~	N/A	1.2	N/A	1.5	28.6
Coralline algae	~	~	N/A	~	N/A	~	N/A	2.5	N/A	0.2	-91.6	~	~	N/A	~	N/A	4.0	N/A	0.5	-86.8
Seagrass	~	~	N/A	~	N/A	~	N/A	0.0	N/A	0.0	N/A	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	***0.0***	***0.0***	N/A	***0.0***	N/A	***0.0***	N/A	***6.3***	+	***1.7***	-72.9	***0.0***	***0.0***	N/A	***0.0***	N/A	***7.4***	+	***3.0***	-59.1
TOTAL	**100.0**	**100.0**		**100.0**		**100.0**		**100.0**		**100.0**		**100.0**	**100.0**		**100.0**		**100.0**		**100.0**	
Environmental Parameters																				
Mean Slope (degrees)	~	~		~		16.2		21.7		27.2		~	~		~		8.3		2.5	
Mean Topography (m) *	1.5	4.0		2.3		2.7		1.6		1.7		1.5	1.5		0.5		0.6		1.6	
Mean Depth/Range (m)	1.5-15	5-10		7-10		7.5		7.7		7.6		2-7	2-7		1.5		2.9		2.3	
Horizontal Visibility (m)	~	30.0		25.0		27.8		25.0		31.3		~	~		~		25.9		28.8	
No. of 50 m Transects	1	4		8		16		17		17		1	3		2		17		10	

~ no data available

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

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

(-) = decrease

(+) = increase

Table 23. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at SR-1 (South Reef) Lighthouse Islet in 2008.

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	6.6	0.9	24.4	33.9	6.9	1.4	66.6	14.4
Rabbitfish (Siganids)*	0.9	0.3	0.0	1.6	0.0	0.3	1.9	0.6
Groupers (Serranids)*	4.0	0.9	1.9	8.7	7.1	0.7	18.4	5.0
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	3.1	1.3	0.0	2.1	5.7	3.4	11.3	5.9
Sweetlips (Haemulids)*	0.3	0.3	0.0	0.0	0.1	2.0	2.1	2.1
Emperors (Lethrinids)*	1.3	0.5	0.0	5.3	0.6	0.1	6.0	5.2
Jacks (Carangids)*	1.9	0.6	0.0	0.0	1.3	117.0	118.3	114.5
Fusiliers (Caesionids)*	1.4	0.7	0.0	134.0	28.6	0.0	162.6	80.2
Spinecheeks (Nemipterids)*	0.7	0.3	0.0	2.6	0.0	0.0	2.6	1.6
Goatfish (Mullids)*	0.1	0.1	0.0	0.7	0.0	0.0	0.7	0.7
Parrotfish (Scarids)*	2.3	0.6	0.6	2.9	0.6	2.9	6.9	1.6
Bumphead parrotfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rudderfish (Kyphosids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Triggerfish (Balistids)	3.6	0.4	0.0	17.6	2.3	0.6	20.4	3.8
Butterflyfish (Chaetodonids)	11.4	1.2	30.1	14.0	1.3	0.3	45.7	11.5
Angelfish (Pomacanthids)	2.6	0.4	8.9	0.9	0.6	0.1	10.4	3.1
Wrasses (Labrids)	6.9	1.7	47.1	3.6	0.4	1.0	52.1	23.4
Humphead wrasse	0.3	0.2	0.0	0.0	0.1	0.3	0.4	0.3
Damselfish (Pomacentrids)	7.9	1.9	2282.6	0.0	0.0	0.0	2282.6	745.7
Fairy Basslets (Anthids)	2.1	0.4	1945.7	0.0	0.0	0.0	1945.7	716.5
Moorish Idols (*Zanclus cornutus*)	0.9	0.1	0.4	2.7	0.3	0.0	3.4	1.1
Total (target reef spp.):	**17.4**	**4.3**	**2.4**	**191.7**	**50.9**	**127.9**	**372.9**	**137.4**
Total (all reef spp.):	**58.1**	**9.8**	**4341.7**	**230.4**	**55.9**	**130.1**	**4758.1**	**1518.2**

* Target species/families

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

Fairly high density for target families

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 2008.

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	(N=7) 2008 Species	% Change 2004 2008
Surgeonfish (Acanthurids)*	8.0	5.0	-37.5	5.7	13.3	5.9	3.7	6.6	11.9
Rabbitfish (Siganids)*	2.0	1.0	-50.0	1.8	83.3	0.3	-86.4	0.9	242.9
Groupers (Serranids)*	4.0	2.3	-43.8	2.5	11.1	2.6	5.0	4.0	52.4
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	2.0	0.8	-62.5	0.8	11.1	1.6	95.0	3.1	93.4
Sweetlips (Haemulids)*	1.0	0.0	-100.0	0.2	+	0.1	-25.0	0.3	128.6
Emperors (Lethrinids)*	0.0	0.3	+	1.0	300.0	1.0	0.0	1.3	28.6
Jacks (Carangids)*	1.0	0.5	-50.0	1.0	100.0	0.9	-12.5	1.9	112.2
Fusiliers (Caesionids)*	1.0	1.0	0.0	0.3	-66.7	0.6	87.5	1.4	128.6
Spinecheeks (Nemipterids)*	0.0	0.8	+	0.5	-33.3	0.6	25.0	0.7	14.3
Goatfish (Mullids)*	1.0	0.8	-25.0	0.5	-33.3	1.5	200.0	0.1	-90.5
Parrotfish (Scarids)*	1.0	2.0	100.0	4.0	100.0	2.3	-43.8	2.3	1.6
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	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	3.6	-13.4
Butterflyfish (Chaetodonids)	8.0	12.3	53.1	10.2	-17.0	12.0	18.0	11.4	-4.8
Angelfish (Pomacanthids)	2.0	1.5	-25.0	2.8	88.9	3.9	36.8	2.6	-33.6
Wrasses (Labrids)	5.0	4.8	-5.0	5.8	22.8	9.4	60.7	6.9	-26.9
Humphead wrasse	~	~	N/A	~	N/A	0.1	N/A	0.3	128.6
Damselfish (Pomacentrids)	13.0	7.0	-46.2	7.3	4.8	8.5	15.9	7.9	-7.6
Fairy Basslets (Anthids)	2.0	2.5	25.0	1.8	-26.7	2.1	15.9	2.1	0.8
Moorish Idols (*Zanclus cornutus*)	1.0	1.0	0.0	1.0	0.0	0.9	-12.5	0.9	-2.0
Total (target reef spp.):	**21.0**	**14.3**	**-31.9**	**18.3**	**28.0**	**17.4**	**-5.1**	**17.4**	**0.3**
Total (all reef spp.):	**56.0**	**45.0**	**-19.6**	**51.7**	**14.9**	**58.4**	**12.9**	**58.1**	**-0.4**

* 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 2008.

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	(N=7) 2008 Density	% Change 2004 2008
Surgeonfish (Acanthurids)*	232.0	82.0	-64.7	158.0	92.7	145.1	-8.1	66.6	-54.1
Rabbitfish (Siganids)*	2.0	4.5	125.0	4.5	0.0	0.6	-86.1	1.9	197.1
Groupers (Serranids)*	13.0	8.3	-36.5	17.8	116.2	13.4	-25.0	18.4	37.8
Barramundi cod	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Snapper (Lutjanids)*	18.0	11.3	-37.5	1.8	-83.7	6.6	261.4	11.3	70.4
Sweetlips (Haemulids)*	9.0	0.0	-100.0	0.3	+	5.6	1587.5	2.1	-61.9
Emperors (Lethrinids)*	0.0	0.8	+	11.5	1433.3	46.6	305.4	6.0	-87.1
Jacks (Carangids)*	9.0	2.5	-72.2	3.7	46.7	7.6	108.0	118.3	1451.3
Fusiliers (Caesionids)*	129.0	21.0	-83.7	5.2	-75.4	29.6	473.4	162.6	448.8
Spinecheeks (Nemipterids)*	0.0	42.8	+	0.8	-98.1	1.3	50.0	2.6	105.7
Goatfish (Mullids)*	9.0	66.8	641.7	22.2	-66.8	10.3	-53.8	0.7	-93.0
Parrotfish (Scarids)*	129.0	43.5	-66.3	140.2	222.2	14.0	-90.0	6.9	-51.0
Bumphead parrotfish	~	~	N/A	~	N/A	0.0	N/A	0.0	N/A
Rudderfish (Kyphosids)*	0.0	0.0	N/A	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	20.4	-93.9
Butterflyfish (Chaetodonids)	33.0	35.3	6.8	34.0	-3.5	45.4	33.5	45.7	0.7
Angelfish (Pomacanthids)	34.0	14.0	-58.8	26.8	91.7	17.9	-33.4	10.4	-41.7
Wrasses (Labrids)	87.0	40.0	-54.0	179.0	347.5	62.4	-65.2	52.1	-16.4
Humphead wrasse	~	~	N/A	~	N/A	0.3	N/A	0.4	71.4
Damselfish (Pomacentrids)	1221.0	2232.0	82.8	2805.2	25.7	2042.5	-27.2	2282.6	11.8
Fairy Basslets (Anthids)	1026.0	802.5	-21.8	762.0	-5.0	1557.3	104.4	1945.7	24.9
Moorish Idols (*Zanclus cornutus*)	33.0	27.0	-18.2	13.8	-48.8	4.9	-64.8	3.4	-29.7
Total (target reef spp.):	**550.0**	**283.3**	**-48.5**	**366.0**	**29.2**	**235.5**	**-35.7**	**372.9**	**58.3**
Total (all reef spp.):	**3132.0**	**3479.3**	**11.1**	**4316.7**	**24.1**	**4344.5**	**0.6**	**4758.1**	**9.5**

* Target species/families

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

(-) = decrease

(+) = increase

Table 26. Changes in substrate composition (% mean ±SE) in Jessie Beazley from 1984 to 2008.

	SCUBA SURVEYS			SNORKEL SURVEYS:						
	2004	2008	% Change 2004-2008	1984	1989	% Change 1992-1996	2004	% Change 1996-2000	2008	% Change 2004-2008
SUBSTRATE COVER	% cover	% cover		% cover	% cover		% cover		% cover	
Sand (s) and Silt (SI)	7.0	3.7	-47.4	5.0	3.0	-40.0	5.4	78.5	10.2	90.0
Coral Rubble (R)	16.0	6.3	-60.7	11.9	10.6	-10.9	3.6	-65.9	15.8	338.1
Rock and Block (RK)	13.1	14.4	9.6	35.9	48.0	33.7	33.5	-30.3	33.3	-0.6
White Dead Standing Coral (DC)	2.0	0.3	-85.0	7.0	6.3	-10.0	0.1	-98.8	0.5	600.0
Dead Coral with Algae (DCA)	4.3	4.8	11.1	0.0	0.0	N/A	3.4	+	4.4	28.6
Subtotal Non-living Substrate	***42.5***	***29.5***	-30.6	***59.8***	***67.9***	13.5	***45.9***	-32.4	***64.2***	39.8
Branching (CB)	18.4	18.5	0.5	14.6	4.3	-70.5	14.1	228.0	18.4	30.6
Massive (CM)	5.9	6.7	12.8	10.5	9.3	-11.4	6.9	-26.0	9.3	35.4
Flat/Encrusting (CFD)	10.6	13.7	28.7	10.5	4.0	-61.9	24.2	503.8	5.1	-78.7
Foliose Cup (CFO)	1.3	1.5	17.1	0.8	2.3	187.5	0.8	-64.3	2.2	163.0
Total Hard Coral	36.3	40.4	11.4	36.4	19.8	-45.6	46.0	132.1	35.0	-23.8
Total Soft Coral	15.6	25.1	61.3	3.8	12.3	223.7	2.5	-79.9	0.1	-97.9
Subtotal Coral	***51.8***	***65.5***	26.4	***40.2***	***32.1***	-20.1	***48.4***	50.9	***35.1***	-27.6
Sponges	1.4	1.3	-11.1	~	~	N/A	0.5	N/A	0.5	1.5
Other animals	0.5	0.9	86.7	~	~	N/A	0.0	N/A	0.1	+
Algae										
Turf algae	0.2	0.7	332.0	~	~	N/A	1.3	N/A	0.0	-100.0
Fleshy algae	0.3	0.1	-60.0	~	~	N/A	1.7	N/A	0.1	-97.0
Coralline algae	3.4	2.2	-37.5	~	~	N/A	2.1	N/A	0.1	-97.3
Seagrass	0.0	0.0	N/A	~	~	N/A	0.0	N/A	0.0	N/A
Subtotal Others	***5.7***	***5.1***	-11.7	~	~	N/A	5.6	N/A	***0.7***	-86.9
TOTAL	**100.0**	**100.0**		**100.0**	**100.0**		**100.0**		**100.0**	
Environmental Paramenters										
Mean Slope (degrees)	17.3	46.7					7		3.5	
Mean Topography (m) *	0.7	0.7					1.5		0.7	
Mean Depth/Range (m)	6.9	7.2					2.7		2.5	
Horizontal Visibility (m)	29.7	29.7					26.7		28.5	
No. of 50 m Transects	16.0	20.0					13		13.0	

~ 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 27. Mean (±SE) fish species richness (species/500m^2) and density (fish/500m^2) per family at Jessie Beazley in 2008

Family	Species		Size Class				Density	
	Mean	SE	1-10 cm**	11-20 cm	21-30 cm	>30 cm	Mean	SE
Surgeonfish (Acanthurids)*	5.5	0.9	28.8	35.0	8.7	6.8	81.0	15.3
Rabbitfish (Siganids)*	0.2	0.2	0.0	0.0	0.3	0.0	0.3	0.3
Groupers (Serranids)*	2.2	0.5	0.3	7.8	3.3	0.3	12.3	2.9
Barramundi cod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Snapper (Lutjanids)*	0.8	0.3	0.0	0.5	0.0	1.2	1.5	0.6
Sweetlips (Haemulids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Emperors (Lethrinids)*	0.7	0.3	0.0	0.8	1.0	0.3	2.2	1.1
Jacks (Carangids)*	1.0	0.3	0.0	0.0	1.0	2.0	8.5	5.4
Fusiliers (Caesionids)*	1.7	0.5	0.0	21.2	3.8	0.0	68.3	43.7
Spinecheeks (Nemipterids)*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goatfish (Mullids)*	1.3	0.4	0.3	5.3	1.5	0.0	3.8	1.3
Parrotfish (Scarids)*	1.3	0.8	0.2	0.8	1.8	2.2	4.3	2.1
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)	3.3	0.8	0.7	21.8	5.2	0.5	110.2	82.7
Butterflyfish (Chaetodonids)	6.2	1.2	15.3	47.7	0.0	0.7	46.7	30.4
Angelfish (Pomacanthids)	3.0	1.4	6.5	1.7	0.0	0.0	8.8	2.0
Wrasses (Labrids)	7.5	1.9	54.5	7.0	0.3	0.0	48.5	13.2
Humphead wrasse	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damselfish (Pomacentrids)	6.2	1.5	311.2	14.8	0.0	0.0	295.2	47.9
Fairy Basslets (Anthids)	2.0	0.4	806.3	0.0	0.0	0.0	881.3	311.3
Moorish Idols (*Zanclus cornutus*)	0.8	0.2	0.7	6.2	0.0	0.0	6.8	4.7
Total (target reef spp.):	**16.5**	**1.9**	**0.8**	**71.5**	**21.5**	**12.8**	**150.8**	**44.7**
Total (all reef spp.):	**43.7**	**4.7**	**1224.8**	**170.7**	**27.0**	**14.0**	**1579.8**	**416.7**

* Target species/families

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

Fairly high density for target families

Table 28. Mean (±SE) fish species richness (species/500m^2) and percentage change between years at Jessie Beazley from 2004 to 2008.

Family	(N=7) 2004	(N=8) 2008	% Change 2004-2008
	Species		
Surgeonfish (Acanthurids)*	5.9	5.5	-6.1
Rabbitfish (Siganids)*	0.3	0.2	-41.7
Groupers (Serranids)*	2.3	2.2	-5.2
Barramundi cod	0.0	0.0	N/A
Snapper (Lutjanids)*	0.6	0.8	45.8
Sweetlips (Haemulids)*	0.1	0.0	-100.0
Emperors (Lethrinids)*	1.3	0.7	-48.1
Jacks (Carangids)*	0.1	1.0	600.0
Fusiliers (Caesionids)*	0.4	1.7	288.9
Spinecheeks (Nemipterids)*	0.0	0.0	N/A
Goatfish (Mullids)*	1.4	1.3	-6.7
Parrotfish (Scarids)*	1.1	1.3	16.7
Bumphead parrotfish	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.1	0.0	-100.0
Triggerfish (Balistids)	3.6	3.3	-6.7
Butterflyfish (Chaetodonids)	7.6	6.2	-18.6
Angelfish (Pomacanthids)	2.4	3.0	23.5
Wrasses (Labrids)	9.0	7.5	-16.7
Humphead wrasse	0.0	0.0	N/A
Damselfish (Pomacentrids)	9.0	6.2	-31.5
Fairy Basslets (Anthids)	1.7	2.0	16.7
Moorish Idols (*Zanclus cornutus*)	0.7	0.8	16.7
Total (target reef spp.):	**13.7**	**16.5**	20.3
Total (all reef spp.):	**47.7**	**43.7**	-8.5

* Target species/families

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

(-) = decrease

(+) = increase

Table 29. Mean (±SE) density (fish/500m^2) and percentage change of fish families between years at Jessie Beazley from 2004 to 2008.

Family	(N=7) 2004 Density	(N=8) 2008 Density	% Change 2004-2008
Surgeonfish (Acanthurids)*	172.9	81.0	-53.1
Rabbitfish (Siganids)*	0.7	0.3	-53.3
Groupers (Serranids)*	12.0	12.3	2.8
Barramundi cod	0.0	0.0	N/A
Snapper (Lutjanids)*	3.1	1.5	-52.3
Sweetlips (Haemulids)*	0.4	0.0	-100.0
Emperors (Lethrinids)*	4.6	2.2	-52.6
Jacks (Carangids)*	0.1	8.5	5850.0
Fusiliers (Caesionids)*	20.3	68.3	236.9
Spinecheeks (Nemipterids)*	0.0	0.0	N/A
Goatfish (Mullids)*	12.9	3.8	-70.2
Parrotfish (Scarids)*	3.7	4.3	16.7
Bumphead parrotfish	0.0	0.0	N/A
Rudderfish (Kyphosids)*	0.1	0.0	-100.0
Triggerfish (Balistids)	192.9	110.2	-42.9
Butterflyfish (Chaetodonids)	34.9	46.7	33.9
Angelfish (Pomacanthids)	17.6	8.8	-49.7
Wrasses (Labrids)	105.4	48.5	-54.0
Humphead wrasse	0.0	0.0	N/A
Damselfish (Pomacentrids)	592.3	295.2	-50.2
Fairy Basslets (Anthids)	564.9	881.3	56.0
Moorish Idols (*Zanclus cornutus*)	12.4	6.8	-45.0
Total (target reef spp.):	**185.4**	**150.8**	-18.7
Total (all reef spp.):	**1751.1**	**1579.8**	-9.8

* Target species/families

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

(-) = decrease

(+) = increase

Table 31. Statistical test results of comparisons between live hard cover between years per site, and between sites for 2008 (significance level = 0.05). Years with only one data point were excluded from the analysis. SS = snorkel surveys, SC = scuba surveys.

1985-2008: Comparisons within sites between years					
SNORKEL (SS)					
Site	**Test**	**DF**	**p**	**F**	**Tukey's Test**
NR1	1-ANOVA	5	0.000	9.48	2000 < 1992 = 1996 = 2004 = 2008
NR2	1-ANOVA	4	0.002	5.03	1992 = 2000 < 1996
					1992 = 2000 = 2004 = 2008
NR5	1-ANOVA	4	0.000	7.4	1996 = 2000 < 2004 = 2008
					1996 = 2004 = 2008
SR1	1-ANOVA	4	0.001	6.57	1985 has only 1 data point
SR3	1-ANOVA	3	0.000	16.89	1992 = 2000 < 2008
					2000 < 2004 < 2008
					1992 = 2004
SR4	1-ANOVA	2	0.000	11.58	2008 < 1992 = 2004
JB	1-ANOVA	3	0.147	1.89	not significant
SCUBA (SC)					
Site	**Test**	**DF**	**p**	**F/T**	**Tukey's Test**
NR1	1-ANOVA	4	0.000	10.41	2000 = 2004 < 2008 < 1992
NR2	1-ANOVA	3	0.000	25.56	2000 < 2004 = 2008
NR5	1-ANOVA	5	0.000	8.62	2000 < 1992 = 1996 = 2004 = 2008
SR1	1-ANOVA	5	0.286	1.27	not significant
SR3	1-ANOVA	4	0.000	0.000	1992 = 2000 < 2004 = 2008
	1-ANOVA				1996 = 2004 = 2008
SR4	1-ANOVA	3	0.077	2.42	not significant
JB	T-test	21	0.397	-0.86	not significant
2008: Comparisons between sites					
Site	**Test**	**DF**	**p**	**F/H**	**Tukey's Test/Ranking**
SS	1-ANOVA	9.34	0.000	11.43	NR2 = NR5 = JB =SR1 SR4 < SR3
					NR1 < SR2 < SR3
					NR1 = NR5 = JB =SR1 = SR4
SC	Kruskal-Wallis	6	0.000	34.68	NR1<JB<SR4=SR3<SR1<NR5<NR2

Table 32. Statistical test results of comparisons between target fish families biomass (kg/500m2) within sites for 2008 (significance level = 0.05)

Comparisons between families within sites

Site	Test	DF	p	H	Ranking	Familes not represented
NR1	Kruskal-Wallis	15	0.000	47.44	15<11<14<10<7<6<4<2<8<5<13<1<12<3<9	16, 17
NR2	Kruskal-Wallis	16	0.015	30.65	7<11<1215<6<9<16<1<14<5=8<13<4<10<2<3	17
NR5	Kruskal-Wallis	16	0.000	44.44	12<7<11<6<2<8<1<13<9<14<3<5=10<4	12,15,16,17
SR1	Kruskal-Wallis	16	0.001	39.9	12<11<15<6<13<9<8<14<1<10<4<3<2<5	16,17
SR3	Kruskal-Wallis	16	0.009	32.38	2<15<11<9<4<13<6<5<14<2<1<5<8<3<10	7, 16,17
SR4	Kruskal-Wallis	16	0.006	33.83	15<11<4<9<1<10<13<8<5<6=2<3<14	15,16,17
JB	Kruskal-Wallis	16	0.007	32.98	11<6<2<8<1<13<9<14<3<10<5<4	2,3,7,12,13,15,16,17

Comparisons between sites

Site	Test	DF	p	F	Tukey's Test
All sites	1-ANOVA	6	0.00	6.21	JB < NR1=NR2=NR5=SR1=SR4
					JB = SR3

Acanthuridae-herbivores (1), Acanthuridae-plnaktivores(2), Balistidae (3), Caesionidae(4), Canrangidae (5)
Haemulidae (6), Kyphosidae(7), Labridae (8), Lethrinidae (9), Lutjanidae (10), Mullidae (11), Nemipteridae (12)
Scaridae (13), Epinephilinae (14), Siganidae (15), Sphyraenidae (16), Scombridae (17)

Note: Families in red are generally composed of piscivore species
Scombridae (17), species in this family are classified as non-reef

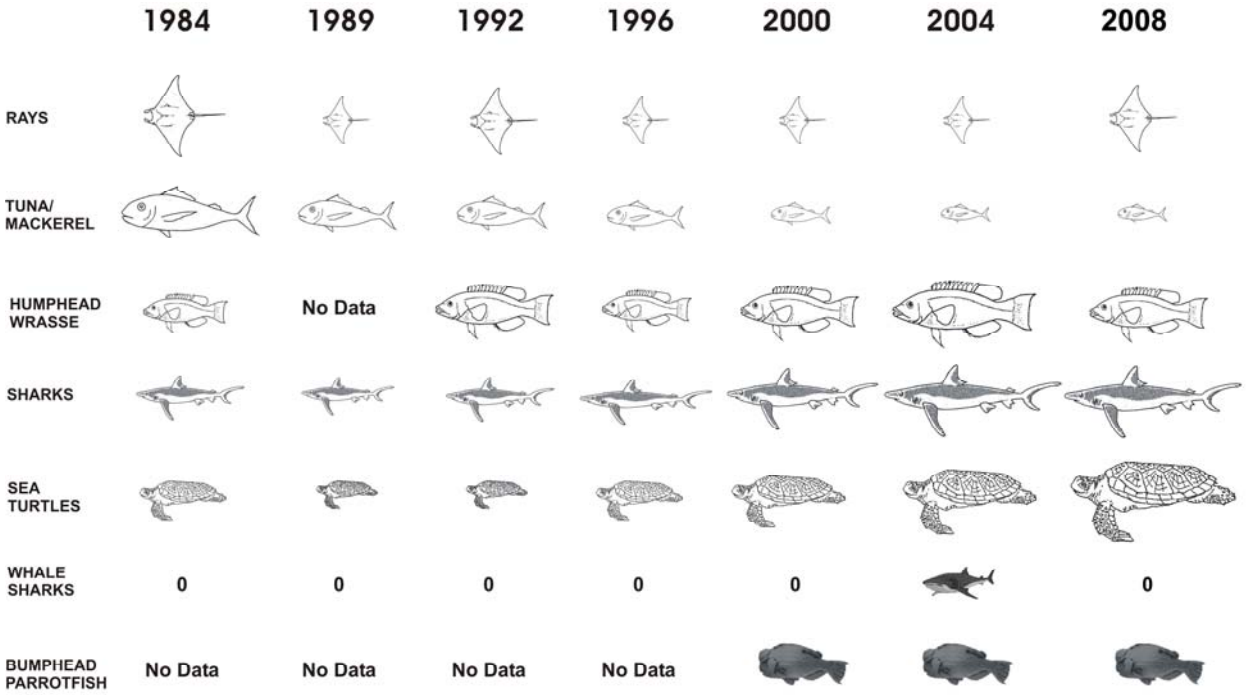
Table 33. Statistical test results of target fish density comparisons (significance level = 0.05). Years with only one data point were excluded from the analysis.

1985-2008: Comparisons within sites between years					
Site	**Test**	**DF**	**p**	**F**	**Tukey's Test**
NR1	1-ANOVA	3	0.218	1.64	not significant
NR2	1-ANOVA	3	0.003	8.44	2008 = 2000 < 2004
NR5	1-ANOVA	3	0.990	0.04	not significant
SR1	1-ANOVA	3	0.83	0.29	not significant
SR3	1-ANOVA	3	0.004	8.01	1996 = 2000 < 2008
SR4	1-ANOVA	2	0.000	24.24	2000 = 2004 < 2008
JB	1-ANOVA	2	0.102	2.62	not significant
2008: Comparisons between sites					
	Test	**DF**	**p**	**F**	**Tukey's Test**
	1-ANOVA	6	1.000	1.91	not significant

SUMMARY OF RESULTS AND TRENDS

Large Marine Life. The changes in large marine life can be a gauge of reef health and/or fishing pressure of an area (Green et al. 2003). Tubbataha Reefs Natural 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, and sharks and turtles, along with Humphead wrasses, were seen on almost every dive. The numbers of sharks, sea turtles and manta rays appear to be slightly more compared to the survey in 2004 (Figure 32). No whale sharks were sighted this year and the number of Humphead wrasse sightings, especially mature ones, decreased slightly in 2008. Not many tuna or mackerel were sighted in 2008 which is an indicator of the effects of increased fishing pressure in the Sulu Sea and other parts of the country through commercial fishing.

Figure 32. Changes in abundance of large marine life since 1984.

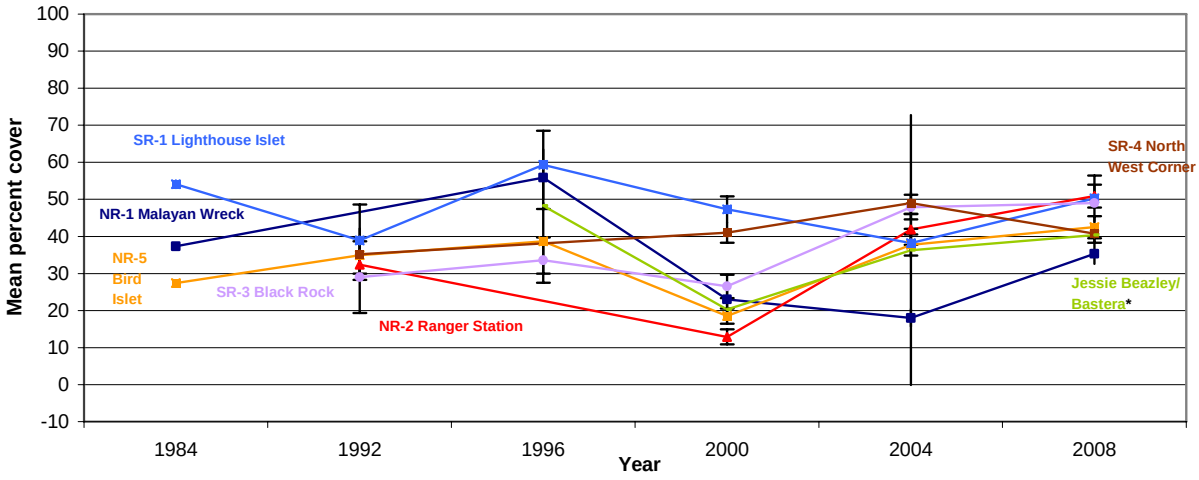


Coral Reef and other substrate. Live hard coral for all 2008 surveyed sites in Tubbataha reef is fair to good (Figure 33a). Comparison between sites in the shallows gave a highly variable result, but generally the significantly highest cover was recorded in SR3, the lowest was in NR1. In the deeper zone, however, NR2 had the highest cover followed by NR5 while NR1 consistently exhibited the lowest cover (Table 31).

In the year 2004, these sites showed a variable response to ENSO in terms of recovery: (1) no significant change in coral cover-NR1, (2) recovery in terms of increase in coral cover – NR2, NR5, and (3) recovery in terms of increase in coral cover coupled with a phase shift in the living substrate composition; decline in soft corals and simultaneous increase of LHC-SR3 and decline in continued decline of LHC and a simultaneous increase of soft-corals (Maypa et al.

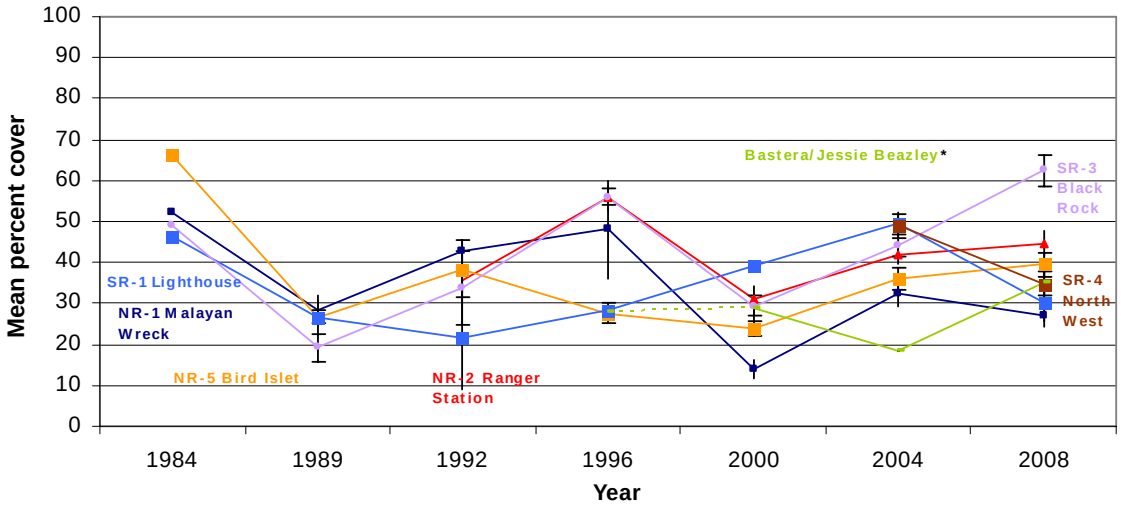
2004). By 2008, no significant changes were observed except for an increase in the shallow zone of SR3.

Figure 33a. Changes in live hard coral (%mean ±SE) in sites at Tubbataha Reefs Marine Park from 1984 to 2008 (7-10 m depth).



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park up to 2004. Included in the protected area in 2007.

Figure 33b. Changes in live hard coral (%mean ±SE) in sites at Tubbataha Reefs Marine Park from 1984 to 2008 (3-4 m depth).



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park up to 2004. Included in the protected area in 2007.

It appears that ENSO is a major factor in shaping the trajectory of the trend in coral growth in Tubbataha reefs. The absence of significant increases in coral cover in almost all of the sites suggests no significant recovery over four years. Nevertheless, in relation to years past, average LHC in 2008 is higher than in all sample years except for 1996, just before the ENSO bleaching event. Overall trends since 1984 show the living hard coral cover to be stable and improving.

Tubbataha is, most likely, an isolated system relying on propagules from within, rather than being able to import many propagules from other reef systems. Certainly the atoll lagoons play a role in providing recruits to the Tubbataha reef system. If this is the case, sustained strict protection of this reef system is a must. Our conclusions and hypotheses are, however, very limited and should used with caution. This is only a one-point-in-time survey. No recruitment, larval, or current studies were done. However, if our hypothesis is true, it is important that strict protection in Tubbataha reefs be sustained for both the local recruitment to maintain the reefs, and also for export of larvae into the Sulu Sea. Ongoing studies will help answer this hypothesis by the University of the Philippines (Visayas and Marine Science Institute).

Fish diversity and abundance. Fish abundance and biomass reflects the relative success of Tubbataha Park management rather than species richness since diversity can be affected readily by observer proficiency (Figures 34, 35, 36, and 37).

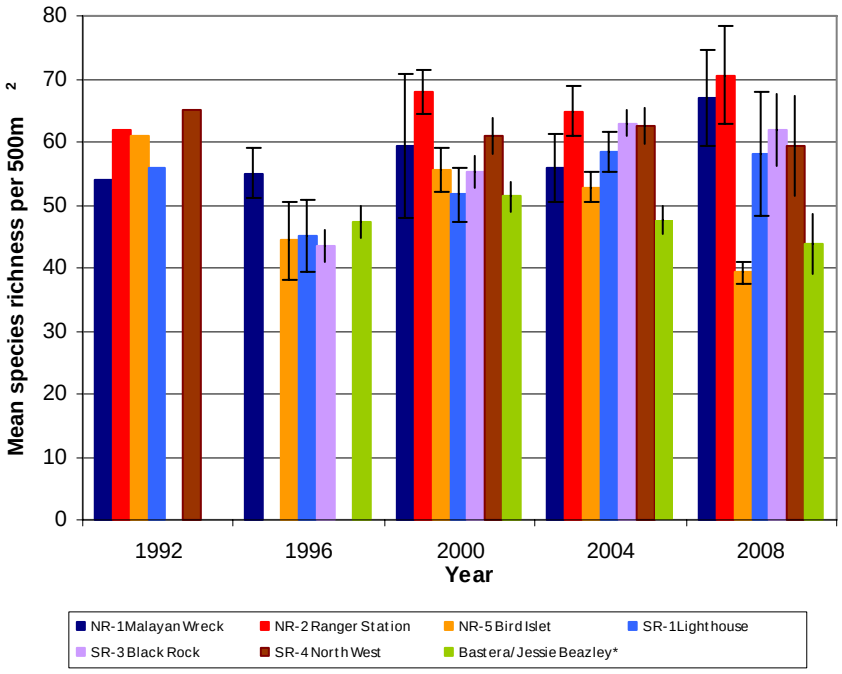
For fish density, target abundance was not significantly different between sites, including the newly protected Jessie Beazley. However, significant differences in fish biomass between sites was seen (Table 33). All sites (except SR3) had significantly higher biomass compared to Jessie Beazley, a newly protected site within Tubbataha Reefs. This indicates the strong effect of protection on fish populations in main Tubbataha Reefs biomass as compared to that in Jessie Beazley which is still not fully protected from fishing. This further suggests that in a system like Tubbataha reef fish diversity and densities are fairly high compared to the rest of the country (Deocadez et al. 2003; Coral Reef Information Network of the Philippines (PhilReefs. 2008)), fish size, thus biomass may be the best indicator for gauging improvement over time. It is also noteworthy that observers saw much evidence of recent fishing activity on Jessie Beazly reef which helps explain its lower fish density and biomass.

Further, it is also important to note that although fish biomass did not differ significantly between most sites, the trophic levels do vary, as reflected by the differences of fish families and species that dominate within. SR4, for example, had the highest piscivore biomass represented by groupers, a species, primarily targeted by fishers. It has also been observed that this site had fish populations not observed in other Tubbataha sites (or maybe in most areas in the Philippines) which are so much larger in sizes (e.g., a school of *Symphorichtys spirulus*, equal to or greater than 30 cm). Further, the Families that dominated Jessie Beazley are triggerfishes and larger sized wrasses (e.g. not primary target species of fishers).

Another major fish pattern observed in Tubbataha is the consistent numerical and biomass dominance of the family Balistidae. Species recorded included invertebrate feeders and planktivores. The observation that invertebrates in Tubbataha reefs, especially mollusks, appear to be low compared to other reefs in the Philippines might be explained by the high number of predators in this reef. Low recruitment of invertebrates may also be a factor in these remote reefs.

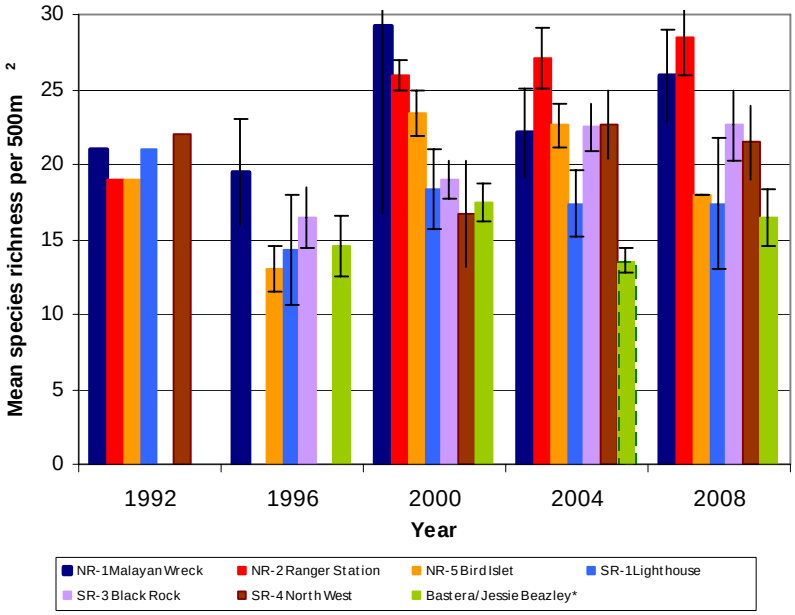
A major difference in fish densities between Tubbataha and most reefs in the Philippines can be seen in the quality of its fish fauna. Fish abundance and biomass in Tubbataha is not only derived from herbivores, benthivores or species belonging to the base of the food chain. Rather, the majority are piscivores and apex predators that are primarily sought commercially, not found in most areas in the Philippines. Large marine life is also common in every site indicate a healthy reef. A comparison of Tubbataha reefs to other SPR sites only supports our conclusion that Tubbataha is a healthy reef (e.g., see other SPR reports mentioned in the reference section—2006, 2007; Coral Reef Information Network of the Philippines (PhilReefs. 2008)).

Figure 34. Mean (±SE) species richness (species/500m^2) of all reef species at seven sites in Tubbataha Reef National Marine Park.



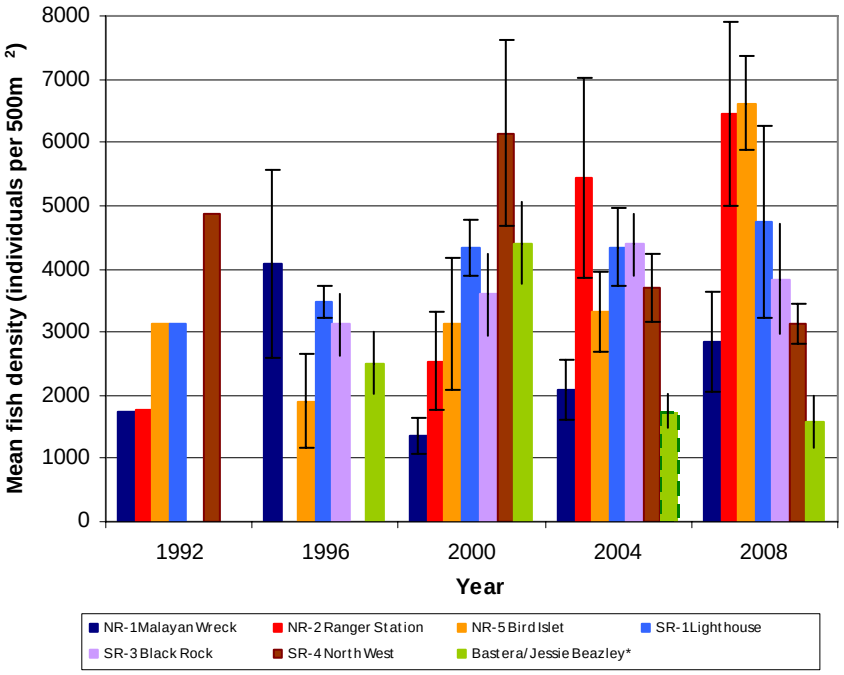
*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park for 1992-2004. 2008 data is Jessie Beazley only and is already part of marine park.

Figure 35. Mean (±SE) species richness (species/500m^2) of target species at seven sites in Tubbataha Reefs National Marine Park.



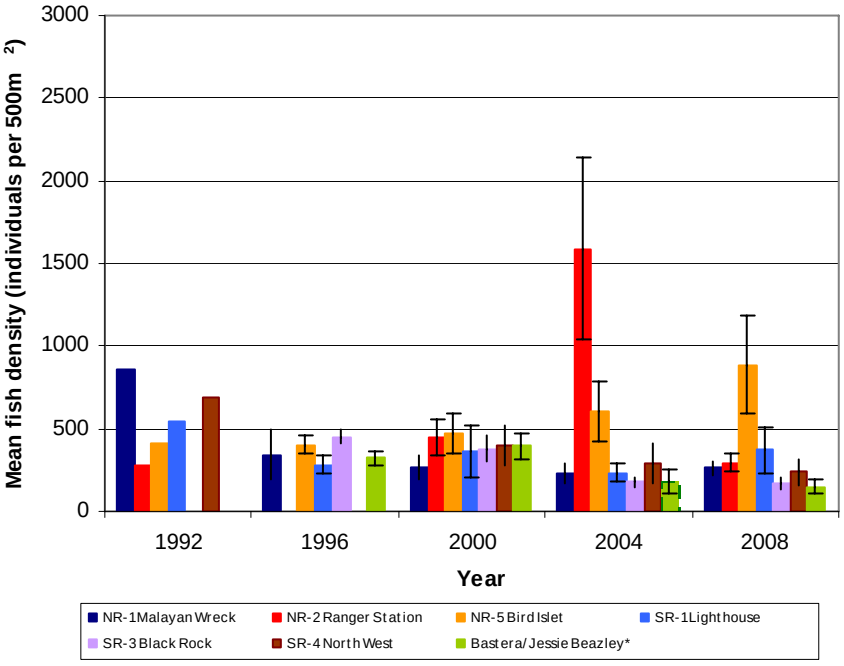
*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park for 1992-2004. 2008 data is Jessie Beazley only and is already part of marine park.

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



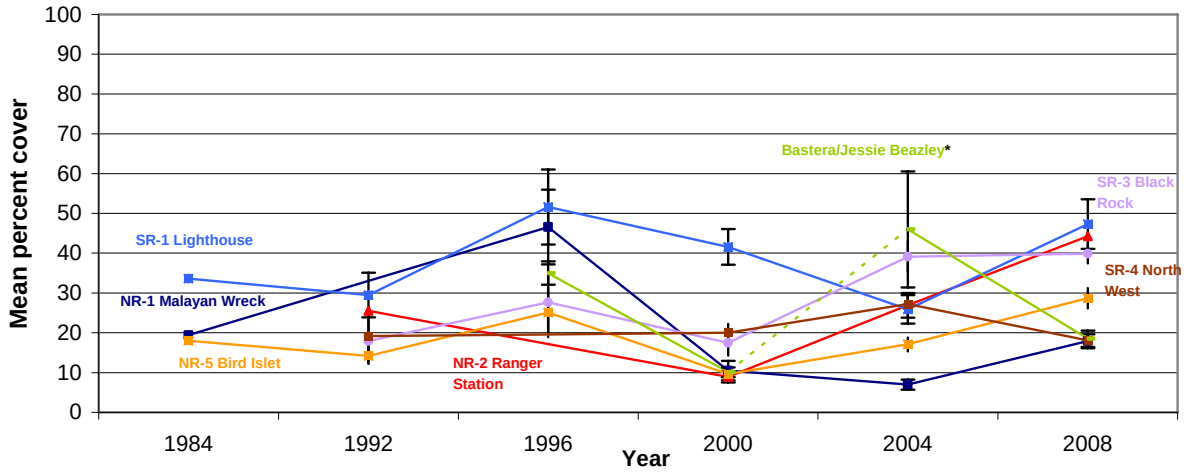
*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park for 1992-2004. 2008 data is Jessie Beazley only and is already part of marine park.

Figure 37. Mean (±SE) density (fish/500m^2) of target species at seven sites in Tubbataha Reefs National Marine Park.



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park for 1992-2004. 2008 data is Jessie Beazley only and is already part of marine park.

Figure 38. Changes in branching coral cover (%mean ±SE) for all sites of Tubbataha Reefs Marine Park from 1984 to 2008



*Bastera/Jessie Beazley results conjoined and serve as comparative data for control sites outside the marine park up to 2004. Included in the protected area in 2007.

RECOMMENDATIONS FOR IMPROVED MANAGEMENT

After 20 years of implementation, the Tubbataha Reefs Natural Park (TRNP) has come a long way. 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 gradually 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.

However, there is still the challenge that lies in sustaining efforts to enforce the law and manage the growing volume of tourism and the threat of illegal and commercial fishing. Continuing to strengthen the protection of Tubbataha through an integrated management approach that is consistent with the preservation of biodiversity is vital for Tubbataha's sustainable and equitable use of resources. With the current findings in this report for 2008, there are indicators that while fishing inside of the Park boundaries is not great, there may be some amount of fishing on parts of the reefs. Certainly, there is fishing still occurring on the Jessie Beazley reef, the newest addition to the Park. The following are recommendations to further enhance conservation of TRNP:

1. **Additional boats are needed for use in patrolling.** Active patrols are essential in preventing illegal fishermen and boats from entering the park. There needs to be an upgrading of a functional boat and well-maintained surveillance system that functions year-round. The vigilance of patrolling is especially important during the non-tourist season, from June through February, when tourist boats do not enter Tubbataha Park. The Park Manager reports that plans are being implemented to achieve this end.

2. **Improved management of tourism to Tubbataha.** With the increase in tourism in Tubbataha Reefs, there is a continuous need to enhance the management of visitors and their activities. More coordination among dive boats, TMO, and the PAMB, and dive

operators. Diver education and awareness to marine conservation has improved nationwide, however, there is still a need to better educate some boat operators, as well as the visitors, in Tubbataha. The current management team for the Park has made significant inroads in tourism management since 2004 while they need all the support they can get.

3. **More diver, boat operator, and visitor 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 trained divemasters and guides on board who can make this briefing to all visitors to the area.

4. **Monitoring and evaluation information needs to be shared among all stakeholders.** Sharing collected information has improved, but 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 and for raising awareness about the benefits from protection over the years.

5. **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 human damage.

6. **More research to be conducted for the benefit of reef management.** More research needs to be initiated in this area that studies, not only coral reef or fish health, but more specialized topics such as current patterns and larvae distributions in Tubbataha in relation to other reefs. This is important in improving management, especially in terms of anticipating whether or not certain activities should be done in certain areas, or if management should extend outward and beyond the Tubbataha Marine Park.

7. **Crown-of-Thorns clean-up needed near Ranger Station sites.** During this survey period, it was observed that there was a Crown-of-Thorns infestation in the reef areas close to the Ranger Station. At such close proximity to the affected areas, the Rangers should be trained to address such problems as they happen as well as continue to be educated on the diverse sealife around them. Visiting divers could also be recruited to help remove these starfish.

REFERENCES

Alino, P.M. and M.C. Quibilan. 2003. **The Kalayaan Islands: Our Natural Heritage**. Marine Science Institute, University of the Philippines Diliman, Quezon City, Philippines. 90 pp.

Arquiza, Y.D. and A. T. White. 1999. **Tales from Tubbataha, natural history, resource use, and conservation of the Tubbataha Reefs, Palawan, Philippines.** Second Edition. Sulu Fund for Marine Conservation Foundation, Inc. The Bookmark, Inc., and Coastal Resource Management Project. Cebu City, Philippines.

Deocadez, M.R., P. Aliño, A.L.S. Bautista, P.A. Gaite, B.S. Ronquillo and V.V. Prado. 2003. **Reef fish community dynamics indicators: deriving lessons from Lingayen gulf.** The Philippine Scientist 40: 143-163.

Gomez, E.D., P.M. Alino, H.T. Yap and W.Y. Licuanan. 1994. **A Review of the Status of Philippine Reefs**. Marine Pollution Bulletin 29 91-93: 62-68.

Maypa, A.P., A.T. White, S.Tesch, A.B. Meneses and V. White. 2004. **Long-term changes I coral reef benthic composition of Tubbataha Reefs: response to bleaching in 1998 and protection.** Silliman Journal 45(2): 60-75.

Natural Resource Management Center (NMRC) 1983. **Field Survey Report of Tubbataha Reef, Palawan, April 6-May 8 1982.** Marine Parks Inter-agency Task Force, Ministry of Natural Resources, Manila.

Palaganas, V.P., J. Sy and P. Aliño. 1985. **Coral communities of the Tubbataha atolls (Southern Philippines).** Proceedings of the 5th International Coral Reef Congress. Tahiti 6: 237-242.

Protected Area and Wildlife Bureau/Department of Environment and Natural Resources (PAWB/DENR). 1992. **NIPAS Act, R.A. No. 7586 and Implementing rules and regulations, DAO 25, S. 1992.** 38 pp.

World Wide Fund for Nature. 2006. **Tubbataha Reefs: A Marine Protected Area That Works. A Case Study on the Philippines.** Quezon City, Philippines. 39 pp.

White, A.T., P. Christie, A. Meneses, A. Maypa, B. Stockwell, S. Tesch, E. White and T.J. Mueller. 2004**. Summary Field Report: Coral Reef Monitoring Expedition to Tubbataha Reefs National Marine Park, Sulu Sea, Philippines, April 3-11, 2004**. The Coastal Conservation and Education Foundation, Inc. and Coastal Resource Management Project, Cebu City, 113 p.

White, A.T., C.A. Courtney, M.C. Meyer, A. Alvarado, E. White, J. Apurado and P. Christie, 2000. Summary Field Report: **Coral Reef Monitoring Expedition to Tubbataha Reef National Marine Park, Sulu Sea, Philippines, May 21-30, 2000.** Coastal Resource Management Project and the Sulu Fund for Marine Conservation Foundation, Inc., Cebu City, 79 p.

White, A.T., M.C. Ledesma and M. Ovenden. 2003. **Tubbataha Reefs National Park, Palawan.** In: Coral Reef Information Network of the Philippines (PhilReefs). Philippine Coral Reefs through Time: Workshop Proc. Second of the Atlas of the Philippine Coral

Reef Series. PhilReefs, UP Marine Sci. Inst., Q.C., Philippines and Marine Parks Center, Tokyo, Japan. pp. 144-145.

White, A.T. and V.P. Palaganas. 1991. **Philippine Tubbataha Reef National Marine Park: status, management issues and proposed plan.** Environmental Conservation, 18 (2): 148-157.

Coral Reef Information Network of the Philippines (PhilReefs). 2008. **Reefs Through Time 2008: Initiating the State of the Coasts Reports.** Coral Reef Information Network, Marine Environment and Resources Foundation, Inc. and the Marine Science Institute, University of the Philippines, Diliman, Quezon City. 152 pp.

White, A.T., A. Maypa, S. Tesch, A. Meneses, B. Stockwell, E. White and R. Martinez. 2006. **Summary Field Report: Coral Reef Monitoring Expedition to Calamianes Islands, Palawan, Philippines, April 8-16, 2006.** The Coastal Conservation and Education Foundation, Inc. and the Fisheries Improved for Sustainable Harvest (FISH) Project, Cebu City, 92p.

White, A.T., A. Meneses, S. Tesch, A. Maypa, B. Stockwell, E. White and R. Martinez, 2007. **Summary Field Report: Coral Reef Monitoring in Bohol, Philippines, March 26-April 3, 2007.** The Coastal Conservation and Education Foundation, Inc. and Fisheries Improved for Sustainable Harvest Project, Cebu City, 111 p.

APPENDIX 1. Itinerary Of Events

ITINERARY OF EVENTS
Saving Philippine Reefs, Tubbataha Expedition
March 23-31, 2008

DAY	DATE & SITE	TIME	ACTIVITIES
1	Sunday, March 23 Puerto Princesa And travel to Tubbataha National Marine Park	10:00 12:30 PM 1:00 2:00 7:00	Rendezvous Puerto Princesa airport Proceed to Oceanic boat/pier Welcome and Short briefing - Alan White; - Oceanic Boat Manager; - Angelique Songco, Tubbataha Park Manager; and - Ethan Lucas, SPR Dive Instructor/Master Lunch on boat Briefing on SPR project by Alan White and Aileen Maypa/ Review Method Practice snorkel and scuba dive, Puerto Princesa Bay (White beach crossing) Dinner Slide show/ Quiz and identification (Roxie Diaz and Agnes Sabonsolin)
2	Monday, March 24 North Reef 5 (Bird Islet) First day in Tubbataha Lots of sharks!	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 electronically or by forms Dinner Slides show on Butterfly fish/ discussion (Aileen Maypa and Alan White)
3	Tuesday, March 25 NR 1 Amos Rock (Malayan Wreck) Jelly fish City!	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 Dinner Slide show on CCEF's update (Sheryll) and Tubbataha Conservation, History and Trends (Alan)
4	Wednesday, March 26 SR 3 (Black Rock) Manta Rays and Sea turtles!	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 Night dive (can be done dusk time/before dinner) Slide show

DAY	DATE & SITE	TIME	ACTIVITIES
5	Thursday, March 27 SR1 (Lighthouse Reef) Manta rays, sea turtles and A deep leopard shark!	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)
6	Friday, March 28 Bastera Good dives, clear water	 7:00 12:00 5:00 7:00	Morning fun dive Breakfast Conduct surveys (snorkel and scuba) Picnic lunch on beach Compile and submit completed data forms Dinner Presentation on *i-Dive (Ethan)
7	Saturday, March 29 NR 2 (Ranger Station) Bleached coral area!	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 Night dive Slide Show Presentation: (SPR 2007 results)
8	Sunday, March 30 (Black Rock Anchorage Area) S4 survey area) Last dive	 7:00 AM 	Fun Dive Breakfast Morning briefing Conduct surveys (snorkel and scuba) Depart for Puerto Princesa Summary of Impressions and Debriefing (Alan)
9	Monday, March 31 Puerto Princesa “Reality”	6:00 AM 9:00 AM	Arrive Puerto Princesa Breakfast Closing Summary Depart boat for airport or hotels to some Check in at the airport for those leaving Palawan

APPENDIX 2. Expedition Volunteers and Staff

Saving Philippine Reefs Volunteers
March 23 - 31, 2008
Tubbataha, Philippines

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
1	**Denise Illing** 34 Oakland Drive Warrandyte 3113 Australia	Home: +613 9844 1583 Mobile: +61 429 146 147 denise@illing.com.au	Technical Librarian, UNICO Computer Systems. BA in Geography and Sociology. Interested in marine life, reefs, and diving. 6th Saving Philippine Reefs expedition. Wildlife artist. Watercolourist.
2	**Geoff Illing** 34 Oakland Drive Warrandyte, VIC 3113 Australia	Phone: 03 9865 9140 Office Phone: +613 9865 9118 Home Phone: +613 9844 1583 Mobile: +61 419307047 geoff@illing.com.au or geoff@unico.com.au	Originally a mathematician, but now director/owner of software development company. 6th Saving Philippine Reefs Expedition. Amateur musician, playing clarinet, bass clarinet, sax and bassoon in concert bands, orchestra and small ensembles.
3	**Julia Cichowski** 41 Gray Street Boston, MA 02116 U.S.A.	Home Phone: (617) 451-6976 Office Phone: (617) 563-0881 Julia.cichowski@fmr.com	V.P, Development, Fidelity Investments; Computer Science graduate; interest in underwater photography; 8th Saving Philippine Reefs Expedition; Divemaster.
4	**Thomas J. Mueller** 29905 Rainbow Crest Drive Agoura Hills, CA 91301 U.S.A.	Mobile Phone: 917-592-7074 (prefered) Home Phone: 818-865-2133 tj@tjmueller.com	Self employed educational consultant to Higher Education; PhD in Biology; small boat experience, especially sail; underwater photographer; SCUBA instructor; 9th "Saving Philippine Reefs" expedition CCE Foundation, Institutional Development Advisor – Board Member
5	**Sandra Breil** 608 First Ave Farmville, Virginia 23901 U.S.A.	Phone: 434 392 4568 sbreil@kinex.net	PhD in Biology; retired Biology teacher; experienced in reef survey; experienced scuba diver; has interest in photography. 9th Saving Philippine Reefs Expedition.
6	**Vittoria Annoscia-Thornley** Kemble Mill Somerford Keynes Cirencester, Glos. GL7 6ED U.K.	Phone: +44 1285 861303 Fax: +44 1285 860888 Mobile: +44 7866 458125 vittoria@kemblemill.com	BA Human Sciences (Oxon); MSc in Ecology (Bristol); volunteer with the Marine Conservation Society (UK); Advanced open water scuba diver. 8th Saving Philippine Reef expedition.
7	**Heather D'Agnes** 1740 Q Street NW #101 Washington DC 20009	Tel: 206-769-3121 hdagnes@gmail.com or hdagnes@usaid.gov	USAID Population-Environment Technical Advisor. 4th Saving Philippine Reefs Expedition.

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
8	**Leona D'Agnes** 284 Ilikaa Place, Kailua, Hawaii 96734	Tel: 808-254-1282 ldagnes@gmail.com	PATH Foundation Philippines Inc.; 2nd Saving Philippine Reefs Expedition.
9	**Alexander Douglas Robb** 4 Nevada Retreat, Bulleen, Victoria 3105 Australia	Tel 61-3-92438460 Wk 61-3-9850- 5497 Hm sandy.robb@griffithhack.com.au	Civil Engineer BSC (Hons) Edinburgh MSC Melbourne – History & Philosophy of Science; Interest - History & Philosophy of Science. 3rd Saving Philippine Reefs Expedition.
10	**Alastair Pennycook** 408/1 Poplar Street, Surry Hills, NSW 2010, Australia	61 2 92680870 61 401182509 alastair.pennycook@uts.edu.au	Professor of Language in Education, University of Technology Sydney. Yachting Australia Coastal Skipper and PADI Master Diver, with an interest in underwater photography. 2nd Saving Philippine Reefs Expedition.
11	**Jane Jones** 1096 Lunaanela St. Kailua Hawaii 96734	H: (757) 271-3654 Cell: (757) 613-0734 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; 8th Saving Philippine Reefs Expedition.
12	**Dean White** 1117 Del Mar Ave. Santa Barbara, California 93109 USA	805-962-7157 dean@hep.ucsb.edu	Development Engineer at University of California, Santa Barbara Like ocean swimming, sailing, surfing
13	**Peter Coard** 62 Brookside Crescent Cuffley, Hertfordshire EN6 4QJ, UK	Tel: +44 (0)1707 876828 peter.coard@tiscali.co.uk	Semi-retired; diving, fish and invertebrates, underwater photography, motorbikes, boats and boating (RIBS), Assistant Club Instructor (Hertford Barracudas)
14	**Frank Kleinitz** 20th Floor, Qtel Westbay, PO 217, Doha, Qatar	Tel: (74) 559 9647 fkleinitz@qtel.com.qa	Engineer, diving, photography, motorbikes, skiing etc.. Rescue, deep, and wreck diver.

Saving Philippine Reefs Staff
March 23 – March 31, 2008
Tubbataha Reefs, Philippines

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
1	**Dr. Alan T. White** Principal Investigator 322 Aoloa St. #412 Kailua, HI 96734 U.S.A.	Phone: 808-262-1091 alan_white@tnc.org	Senior Scientist MPA Global Marine Initiative The Nature Conservancy President Coastal Conservation and Education Foundation, Inc.
2	**Aileen Maypa** Co-Principal Investigator Zoology Department University of Hawaii at Manoa 2538 McCarthy Mall Edmondson 152 Honolulu, Hawaii 96822	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 aimaypa@yahoo.com or maypa@hawaii.edu	Ph.D. candidate (on Fulbright scholarship through the Philippine Department of Agriculture and PAEF)
3	**Evangeline White** SPR Project Organizer 322 Aoloa St. #412 Kailua HI 96734 USA	Phone: (808) 2621091 vangiewhite@hawaiiantel.net	SPR Expedition Project Organizer Waikiki Aquarium Volunteer Program Office Honolulu HI 96815 Kailua Baptist Preschool Kailua HI 96734
4	**Sheryll Tesch** Data and Logistics Coordinator 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 sheryll.tesch@gmail.com	Administrative Officer IEC Coordinator CCE Foundation, Inc.
5	**Rafael Martinez** GIS Specialist FISH Project, 5th Floor CIFC Towers, North Reclamation Area Cebu City, 6000 Philippines	Phone: (6332) 232-1821 to 22 Fax: (6332) 232-1825 raffy.martinez@gmail.com	GIS Specialist and Database Programmer Fisheries Improved for Sustainable Harvest (FISH) Project
6	**Ethan Lucas** Divemaster 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 416-2040 233-6947 Fax: (6332) 233-6891 ethanylucas@yahoo.com	Peace Corps Volunteer/Dive Instructor (NAUI) CCE Foundation, Inc.
7	**Roxie Diaz** Assistant Divemaster 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 roxcdiaz@yahoo.com	Marine Biologist - Fish Taxonomy, Research Monitoring Team CCE Foundation, Inc.

	Name/Address	Contact numbers/fax/email	Profession/Affiliations/Interests
8	**Agnes Sabonsolin** Data and Logistics Assistant 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 ac_sabonsolin@yahoo.com	Marine Biologist – Substrate Research Monitoring Team IEC Assistant CCE Foundation, Inc
9	**Ian White** Volunteer 322 Aoloa St. #412 Kailua HI 96734 USA	Home Tel. (808) 2621091 IanWhite1@hawaiiantel.net	Grade 8 Student, Le Jardin Academy. Hawaii State Swimmer.
10	**Jimmy Paguio** Staff 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 japaguio@gmail.com	Municipal Cluster Coordinator Local Governance for Coastal Management Project CCE Foundation, Inc.
11	**Tata Osorio** Staff 3rd Floor, PDI Condominium, Archbishop Reyes Ave., Banilad Cebu City, 6000 Philippines	Phone: (6332) 233-6909 233-6947 Fax: (6332) 233-6891 jesosorio@lycos.com	Tourism and Investment Officer of Dalaguete Municipality / Municipal Historian

APPENDIX 3

FISH SPECIES LIST

	Tubbataha Reef National Marine Park Fish Species List as of March 2008	**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) in 2004**	**ALL SITES (including Jessie Beazley)**
	Family and species/site	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2004**	**2008**	**2000**	**1992/1996**	**2008**
	CHONDRICHTHYES: Cartilaginous fishes																							
	SHARKS																							
I	**Carcharhinidae - Requiem sharks**																							
	Carcharhinus melanopterus		**1**			**1**			**1**	**1**		**1**			**1**			**1**					**1**	
	Carcharhinus albimarginatus			**1**			**1**			**1**			**1**			**1**			**1**					
	Carcharhinus amblyrhchos											**1**				**1**							**1**	
II	**Ginglymostomatidae - Nurse sharks**																							
	Nebrius ferrugineus										**1**					**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**													**1**	
VIII	**Mobulidae - Manta/Devil rays**																							
	Manta birostris			**1**			**1**			**1**				**1**									**1**	
IX	**Myliobatidae - Eagle ray**																							
	Aetobatus narinari														**1**		**1**						**1**	
X	**Rhinobatidae - Guitarfishes**																							
	Rhynchobatus djiddensis																						**1**	
	OSTEICHTHYES: Bony fishes																							
XI	**Acanthuridae - Surgeonfishes**																							
	Acanthurus achilles																						**1**	
	Acanthurus bleekeri									**1**			**1**											**1**
	Acanthurus dussummieri						**1**	**1**		**1**													**1**	**1**
	Acanthurus guttatus																						**1**	
	Acanthurus japonicus		**1**	**1**		**1**	**1**		**1**	**1**		**1**	**1**		**1**	**1**		**1**	**1**	**1**	**1**			**1**
	Acanthurus leucocheilus			**1**			**1**			**1**			**1**			**1**			**1**					
	Acanthurus lineatus	**1**	**1**	**1**	**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 March 2008

		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) in 2004	ALL SITES (including Jessie Beazley)
	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Acanthurus mata												1		1		1		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		1		1	1		1	1
	Acanthurus pyroferus		1	1	1	1	1	1	1	1			1		1	1	1	1	1				1	1
	Acanthurus sp.									1														1
	Acanthurus thompsoni		1	1	1	1	1	1	1	1			1	1	1	1	1	1	1		1		1	1
	Acanthurus triostegus		1			1	1					1			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		1	1		1		1	1		1	1
	Ctenochaetus cyanocheilus						1														1			1
	Ctenochaetus striatus	1	1	1		1	1	1	1	1	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							1	1
	Naso brevirostris	1		1	1	1		1	1	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		1	1	1	1	1		1		1	1
	Naso lituratus		1	1		1	1	1		1	1	1	1		1	1	1	1	1		1	1	1	1
	Naso lopezi	1																					1	
	Naso minor							1			1	1					1			1	1			1
	Naso thynnoides			1									1		1	1	1			1	1	1		1
	Naso tuberosus											1											1	
	Naso unicornis	1	1	1	1			1			1				1			1					1	1
	Naso vlamingii		1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	Paracanthus hepatus	1	1																	1			1	
	Zebrasoma scopas	1	1	1	1	1	1	1	1	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	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	1	1
XV	**Balistidae - Triggerfishes**																							
	Balistapus undulatus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Balistoides conspicillum	1	1	1	1		1	1		1	1	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		1	1		1	1	1	1		1	1
	Melichthys niger	1	1	1	1	1	1	1		1	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	1	1	1	1	1	1		1	1
	Odonus niger	1	1		1		1	1			1	1	1		1		1	1	1	1	1		1	1

Tubbataha Reef National Marine Park Fish Species List as of March 2008		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) in 2004	ALL SITES (including Jessie Beazley)
	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Pseudobalistes flavimarginatus			1	1	1	1	1			1			1		1	1		1		1	1	1	1
	Rhinecanthus aculeatus					1		1															1	
	Rhinecanthus rectangulus	1					1					1						1	1		1	1	1	1
	Rhinecanthus verrucosus						1											1	1		1		1	1
	Sufflamen bursa	1	1	1	1			1			1					1	1	1		1		1	1	1
	Sufflamen chrysopterus	1	1	1			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										
	Cirrepectes chelomatus						1																	1
	Ecsenius dilemma							1		1				1										1
	Ecsenius sp.																						1	
	Meiacanthus atrodorsalis																		1					1
	Plagiotremus rhinorhynchus	1		1				1		1	1		1	1										1
	Plagiotremus tapeinosoma																						1	
	Salarias fasciatus	1									1													
XVIII	**Bothidae - Flounders**																							
	Bothus mancus																						1	
XIX	**Caesionidae - Fusiliers**																							
	Caesio caerulaurea	1		1		1	1	1	1	1			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		1		1	1				1	1		1	1
	Caesio teres			1		1	1		1	1			1		1	1			1		1			1
	Pterocaesio lativittata																						1	
	Pterocaesio marri						1																1	1
	Pterocaesio pisang			1	1		1						1	1	1	1					1		1	1
	Pterocaesio randalli		1	1	1	1	1	1	1	1			1	1	1	1		1	1				1	1
	Pterocaesio tesselata										1													
	Pterocaesio tile			1	1	1	1		1	1			1	1	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	1														1	1
	Carangoides ferdau		1		1	1		1				1			1			1					1	
	Carangoides gymnostethus																						1	
	Carangoides orthogrammus					1		1			1													
	Carangoides plagiotaenia						1			1			1											1
	Caranx ignobilis			1	1		1	1		1		1	1		1		1	1					1	1
	Caranx lugubris				1			1			1		1	1										1

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Caranx melampygus	1	1	1	1	1	1	1	1	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					1	1
	Elagatis bipinnulatus			1		1	1			1			1		1	1	1	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		1		1	1	1	1
	Chaetodon auriga	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1
	Chaetodon baronessa	1		1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon bennetti		1	1	1	1	1	1	1	1	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	1	1
	Chaetodon ephippium	1	1	1	1	1	1	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	1	1	1	1	1	1	1	1
	Chaetodon lineolatus	1	1		1	1	1	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		1	1	1	
	Chaetodon lunulatus	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon melannotus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chaetodon mertensii							1															1	
	Chaetodon meyeri	1				1	1																1	1
	Chaetodon ocellicaudus	1		1	1	1	1	1		1	1	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	1	1	1	1	1	1	1	1
	Chaetodon oxycephalus	1	1		1		1	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	1	1	1	1	1	1	1	1
	Chaetodon rafflesi	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1			1	1	1
	Chaetodon reticulatus	1								1														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	1	1	1	1	1	1	1	1
	Chaetodon trifascialis	1	1	1	1	1	1	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	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	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	1	1	1	1	1	1	1
	Forcipiger longirostris	1	1	1	1		1	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	1	1	1	1	1	1	1
	Heniochus acuminatus	1			1			1			1			1			1				1	1	1	

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	Family and species/site	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2004**	**2008**	**2000**	**1992/1996**	**2008**
	Heniochus chrysostomus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Heniochus diphreutes																	1	1	1				1
	Heniochus monoceros	1							1															
	Heniochus singularis	1	1	1	1	1	1	1	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	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		1		1	1			1			1		1		1	1
	Cirrhitichthys oxycephalus		1															1	1	1				1
	Cirrhitus pinnulatus		1																					
	Oxycirrhites typus																				1		1	1
	Paracirrhites arcatus	1	1		1			1	1	1	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	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	1		1														1
	Platax pinnatus								1															
	Platax teira																1						1	
XXVIII	**Fistulariidae - Cornetfishes**																							
	Fistularia commersonii																			1		1	1	
XXIX	**Heterocongridae - Garden eels**																							
	Heteroconger hassi				1	1								1	1								1	
XXX	**Gobiidae - Gobies**																							
	Amblyeleotris hectori								1															
	Amblygobius phalaena					1																		
	Eviota pellucida											1												
	Istigobius rigilus									1														1
	Valenciennea randalli	1						1																
	Valenciennea sexgutata																				1			1
	Valenciennea strigata																						1	
XXXI	**Haemulidae - Sweetlips**																							
	Diagramma menalarcum														1									

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Plectorhinchus celebicus																							
	Plectorhinchus chaetodonoides	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1		1		1	1
	Plectorhinchus gaterinus																						1	
	Plectorhinchus lessoni								1						1	1							1	1
	Plectorhincus lineatus	1	1	1			1		1	1			1		1	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	1				1	1
	Myripristis berndti	1						1	1		1			1									1	
	Myripristis kuntee									1													1	1
	Myripristis murdjan	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1	1	1
	Myripristis violacea	1			1				1	1			1								1		1	1
	Myripristis sp.			1			1			1			1			1			1		1			1
	Neoniphon argenteus							1																
	Neoniphon opercularis																						1	
	Neoniphron sammara							1	1	1			1								1		1	1
	Neoniphron sp.			1			1			1			1								1			1
	Sargocentron caudimaculatum	1	1	1	1		1	1	1	1	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	1	1	1	1	1	1		1	1
	Sargocentron violaceum																					1	1	
	Sargocentron sp.			1									1			1			1		1			1
XXXIII	**Kyphosidae - Drummers**																							
	Kyphosus cinerascens	1		1	1			1		1	1			1								1	1	1
	Kyphosus vaigiensis		1						1			1		1								1		
XXXIV	**Labridae - Wrasses**																							
	Anampses geographicus																							
	Anampses meleagrides				1													1		1				
	Anampses melanurus	1		1				1		1	1			1			1		1					1
	Anampses twistii		1	1	1		1	1	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		1	1	1	1	1	1		1	1
	Bodianus mesothorax			1		1	1	1	1	1			1			1		1	1		1		1	1
	Cheilinus celebicus																		1					1
	Cheilinus chlorourus	1									1				1		1	1				1	1	
	Cheilinus fasciatus	1	1	1		1	1	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	1	1	1	1		1	1	1	1
	Cheilio inermis							1			1													
	Choerodon anchorago							1			1													

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Choerodon oligacanthus															1								1
	Cirrhilabrus cyanopleura		1		1	1	1	1				1	1		1	1		1	1	1				1
	Cirrhilabrus exquisitus		1											1							1			1
	Cirrhilabrus lubbocki						1																	1
	Coris aygula													1										
	Coris batuensis	1		1			1	1			1	1	1		1	1				1	1	1		1
	Coris gaimard	1	1	1		1	1	1			1	1			1	1	1	1		1	1		1	1
	Coris pictoides			1																				1
	Coris variegata																						1	
	Diproctacanthus xanthurus	1			1			1															1	
	Epibulus insidiator		1	1	1	1	1	1		1			1	1	1	1			1		1			1
	Gomphosus varius	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1
	Halichoeres argus			1																				1
	Halichoeres biocellatus																						1	
	Halichoeres chrysus	1	1	1	1		1	1	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	1	1	1	1	1		1	1
	Halichoeres margaritaceus		1												1			1					1	
	Halichoeres melanurus																			1			1	
	Halichores nebulosa		1	1								1						1	1		1			1
	Halichoeres prosopeion								1						1								1	
	Halichoeres richmondi									1														1
	Halichoeres scapularis	1			1			1				1			1	1	1		1			1		1
	Halichoeres trimaculatus					1					1											1		
	Halichoeres tripunctatus														1									
	Hemigymnus fasciatus	1		1	1	1	1	1		1	1				1	1		1	1	1	1		1	1
	Hemigymnus melapterus	1	1	1	1	1	1	1		1	1	1	1		1	1		1	1				1	1
	Hologymnosus annulatus		1	1					1											1				1
	Hologymnosus doliatus		1									1		1	1		1		1					1
	Labrichthys unilineatus			1	1	1	1	1	1	1	1		1		1	1	1		1	1	1			1
	Labroides alleni									1			1											1
	Labroides bicolor	1	1	1		1	1	1	1	1		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	1	1	1	1	1	1	1	1
	Labroides pectoralis			1	1	1	1	1	1	1			1	1	1	1	1		1		1			1
	Leptojulis cyanopleura	1						1			1													
	Macropharyngodon meleagris	1		1	1	1		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	1		1	1	1
	Oxycheilinus bimaculatus																							
	Oxycheilinus celebicus		1	1	1		1	1	1		1		1			1	1		1		1			1
	Oxycheilinus diagrammus										1							1				1	1	
	Oxycheilinus rhodochrous									1														1
	Oxycheilinus unifasciatus						1						1		1	1		1		1	1			1

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Pseudocheilinus evanidus			1	1	1	1	1			1	1	1	1		1	1		1				1	1
	Pseudocheilinus hexataenia	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1		1	1
	Pseudocheilinus octotaenia			1		1	1	1				1	1	1	1		1	1	1				1	1
	Pseudodax mollucanus		1	1		1		1	1		1	1			1		1							1
	Stethojulis bandanensis		1			1	1				1				1	1		1	1	1				1
	Stethojulis strigiventer	1			1									1								1		
	Stethojulis trilineata	1												1								1		
	Thalassoma amblycephalum		1	1	1	1	1	1	1	1	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	1	1	1	1	1	1	1	1
	Thalassoma janseni	1	1			1						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	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		1		1	1
	Wetmorella albofasciata														1									
	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	1	1			1	1		1	1
	Lethrinus atkinsoni				1			1																
	Lethrinus erythracanthus					1						1	1		1	1								1
	Lethrinus erythropterus			1			1			1	1		1		1	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	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	1	1	1	1	1	1	1	1
XXXVII	**Lutjanidae - snappers**																							
	Aphareus furca			1	1	1	1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1
	Aprion virescens	1	1	1	1					1		1				1		1					1	1
	Lutjanus argentimaculatus							1	1														1	
	Lutjanus biguttatus			1	1		1						1						1					1
	Lutjanus bohar	1	1		1	1	1	1	1	1		1	1	1	1	1	1	1	1				1	1
	Lutjanus decussatus	1	1	1	1	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	1	1	1			1		1	1	1	1
	Lutjanus gibbus	1	1	1		1	1	1		1	1	1	1	1	1	1		1	1	1			1	1

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Lutjanus kasmira		1			1		1															1	
	Lutjanus monostigma		1	1	1		1		1	1	1		1		1	1	1	1	1			1	1	1
	Lutjanus rivulatus		1	1				1		1		1			1	1						1	1	1
	Lutjanus russelli							1																
	Lutjanus semicinctus	1						1																
	Macolor macularis		1	1	1	1	1	1		1	1	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		
82	*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	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										1	1
	Amanses scopas			1			1				1		1	1					1	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						1			1
	Mulloidichthys vanicolensis	1													1					1		1		
	Parupeneus barbarinoides			1						1						1							1	1
	Parupeneus barberinus	1	1		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	1	1	1	1
	Parupeneus cyclostomus	1	1	1	1	1	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	1	1	1	1	1	1	1	1
	Parupeneus pleurostigma				1			1							1	1								1
	Upeneus tragula		1																					
XLII	**Muraenidae - Moray eels**																							
	Gymnothorax flavimarginatus																						1	
	Gymnothorax javanicus	1	1					1						1			1	1					1	
	Gymnothorax melanospilus																1							
	Gymnothorax meleagris		1																	1			1	
XLIII	**Nemipteridae - Breams**																							

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	Family and species/site	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2004**	**2008**	**2000**	**1992/1996**	**2008**
	Pentapodus bifasciatus																							
	Scolopsis bilineatus	1	1	1	1	1	1	1	1	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				1					1								1
XLIV	**Ostraciidae - boxfishes**																							
	Ostracion cubicus	1	1		1	1		1							1			1				1	1	
	Ostracion meleagris		1				1			1		1				1	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	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	1		1		1	1
	Centropyge bicolor	1	1	1	1	1	1	1	1		1	1			1	1			1		1		1	1
	Centropyge bispinosus				1	1	1	1	1			1			1	1	1	1			1		1	1
	Centropyge flavicauda											1		1										
	Centropyge flavissimus											1												
	Centropyge heraldi													1									1	
	Centropyge multifasciatus		1				1						1			1					1		1	1
	Centropyge nox						1														1			1
	Centropyge tibicen		1				1	1	1		1	1			1		1	1	1	1	1		1	1
	Centropyge vroliki	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Genicanthus lamarcki																						1	
	Pomacanthus imperator		1	1		1		1	1			1	1		1	1	1	1			1		1	1
	Pomacanthus navarchus							1														1	1	
	Pomacanthus semicirculatus			1																				1
	Pomacanthus sextriatus			1		1		1	1	1			1	1	1	1	1	1	1			1		1
	Pomacanthus xanthometopon		1			1			1			1	1		1		1				1			1
	Pygoplites diacanthus	1	1	1	1	1	1	1	1	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	1	1	1
	Amblyglyphidodon aureus	1	1	1	1	1	1	1	1	1		1	1		1	1		1	1		1		1	1

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Amblyglyphidodon curacao						1	1		1	1			1	1						1	1	1	1
	Amblyglyphidodon leucogaster					1	1	1	1				1		1						1		1	1
	Amphiprion chrysopterus																						1	
	Amphiprion clarkii			1		1		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 sandaracinos																						1	
	Chromis agilis					1			1														1	
	Chromis amboinensis			1		1	1		1	1			1		1	1		1	1		1		1	1
	Chromis analis			1	1	1	1		1			1	1		1	1	1	1	1	1	1			1
	Chromis atripectoralis									1			1			1							1	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	1	1	1	1	1	1		1	1
	Chromis retrofasciata			1	1	1	1		1	1	1		1	1	1	1		1	1	1	1		1	1
	Chromis ternatensis	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chromis viridis			1	1	1	1			1	1	1	1		1	1			1		1		1	1
	Chromis weberi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Chromis xanthura		1		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				1	1	1
	Chrysiptera leucopoma																					1		
	Chrysiptera parasema				1																			
	Chrysiptera rex																	1						
	Chrysiptera rollandi					1									1									
	Chrysiptera springeri			1			1									1								1
	Chrysiptera talboti		1	1		1	1		1	1					1				1				1	1
	Dascyllus aruanus	1		1		1	1	1															1	1
	Dascyllus reticulatus	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	Dascyllus trimaculatus	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1		1	1
	Dischistodus chrysopoecilus					1					1		1											1
	Dischistodus melanotus					1					1		1		1									1
	Dischistodus perspicillatus		1			1					1													
	Hemiglyphidodon plagiometopon												1											1
	Neoglyphidodon melas		1	1			1	1		1	1		1	1	1						1	1	1	1
	Neoglyphidodon nigroris						1							1			1						1	1
	Neoglyphidodon thoracotaeniatus			1	1	1	1									1					1			1
	Neopomacentrus violascens						1																	1
	Plectroglyphidodon dickii	1	1		1						1	1	1	1	1	1		1		1	1	1	1	1

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Plectroglyphidodon lacrymatus	1	1	1	1	1	1	1			1	1	1			1			1	1	1		1	1
	Plectroglyphidodon leucozonus		1			1					1									1				
	Pomacentrus adelus																		1	1				1
	Pomacentrus alexanderae						1								1									1
	Pomacentrus alleni								1															
	Pomacentrus amboinensis					1	1								1	1			1	1			1	1
	Pomacentrus armillatus																		1		1			1
	Pomacentrus auriventris	1	1		1	1		1		1	1	1		1	1	1	1	1	1	1	1			1
	Pomacentrus bankanensis		1									1			1			1	1					1
	Pomacentrus brachialis		1		1	1	1		1							1		1	1		1		1	1
	Pomacentrus caeruleolineata								1															
	Pomacentrus caeruleus																			1				
	Pomacentrus caudalis																	1						
	Pomacentrus coelestis			1					1	1		1				1		1					1	1
	Pomacentrus cyanea														1									
	Pomacentrus dickii						1														1			1
	Pomacentrus imperator								1															
	Pomacentrus lepidogenys		1	1		1	1	1	1	1			1	1	1	1		1	1	1	1	1	1	1
	Pomacentrus magaritifer		1			1												1						
	Pomacentrus moluccensis			1	1		1	1	1	1	1		1		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	1		1	1	1	1	1
	Pomacentrus xanthura		1	1		1	1			1			1		1	1		1	1		1			1
	Stegastes lividus										1													
XLIX	**Priacanthidae - Bigeyes**																							
	Priacanthus hamrur			1		1								1						1		1	1	1
L	**Pseudochromidae**																							
	Pseudochromis marshallensis																						1	
LI	**Scaridae - Parrotfishes**																							
	Bolbometopon muricatum	1	1	1							1		1										1	1
	Cetoscarus bicolor		1	1		1	1	1	1	1	1	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	1	1	1	1			1	1	1
	Chlororus sordidus	1	1	1	1	1	1	1	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		1	1		1		1	1
	Scarus altipinnis																						1	
	Scarus bowersi		1		1	1					1												1	
	Scarus chameleon			1			1						1			1			1				1	1
	Scarus dimidiatus	1	1		1	1	1	1		1	1	1	1	1	1	1			1			1	1	1
	Scarus festivus																						1	
	Scarus flavipectoralis															1			1					1

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	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Scarus forsteni	1	1		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					1			1								1
	Scarus javanicus																						1	
	Scarus microrhinos	1	1	1		1	1	1	1	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	1	1		1	1	1	1	1		1
	Scarus oviceps		1		1	1	1	1			1				1	1	1	1	1			1	1	1
	Scarus prasiognathus		1	1		1					1			1									1	1
	Scarus psittacus			1			1									1							1	1
	Scarus pyrrhurus	1																				1		
	Scarus rivulatus						1						1			1								1
	Scarus rubroviolaceus							1										1				1		
	Scarus russelli			1												1			1		1			1
	Scarus scaber																						1	
	Scarus schlegeli	1	1		1	1		1			1	1		1	1	1	1	1				1	1	
	Scarus spinus		1	1			1				1	1			1							1		1
	Scarus tricolor	1	1	1			1	1		1		1	1							1	1		1	1
LII	**Scombridae - tunas/ mackerels**																							
	Gymnosorda unicolor			1			1		1					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		1	1		1	1	1	1		1	1
	Pseudoanthias huchtii	1	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1		1	1
	Pseudoanthias octofasciatus									1									1					1
	Pseudoanthias pleurotaenia		1	1		1									1						1		1	1
	Pseudoanthias randalli																						1	
	Pseudoanthias smithvanizi											1			1								1	
	Pseudoanthias squamipinnis	1	1	1					1	1		1	1					1	1	1	1		1	1
	Pseudoanthias tuka	1	1	1		1	1	1	1	1	1		1		1	1	1	1	1	1	1		1	1
	Gramistinae																							
	Grammistes sexlineatus													1										
	Pogonoperca punctata																			1		1		
	Aethaloperca rogaa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Epinephilinae																							

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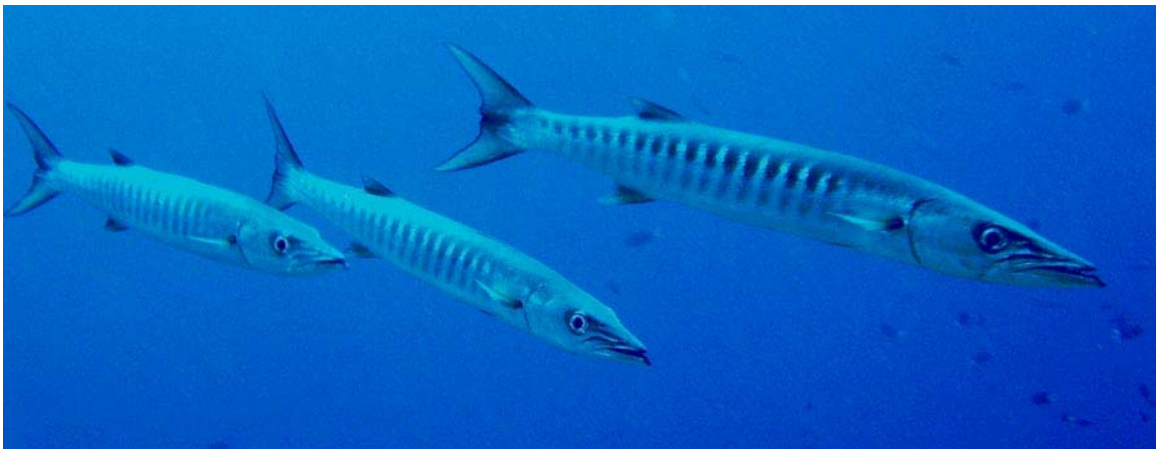
	Family and species/site	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2000	2004	2008	2004	2008	2000	1992/1996	2008
	Anyperodon leucogrammicus			1			1			1			1	1	1								1	1
	Cephalopolis argus	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Cephalopolis boenak	1																		1			1	
	Cephalopholis leopardus		1												1			1						
	Cephalopolis miniata	1	1						1				1			1	1	1		1	1		1	1
	Cephalopolis polleni													1									1	
	Cephalopholis sexmaculata												1						1					1
	Cephalopolis sonnerati																1							
	Cephalopolis urodotea	1	1	1	1	1	1	1	1	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	1			1		1	1
	Ephinephelus fuscoguttatus														1				1				1	1
	Ephinephelus hexagonatus																						1	
	Ephinephelus merra				1	1	1					1				1		1	1			1	1	1
	Ephinephelus microdon																						1	
	Ephinephelus ongus															1			1					1
	Epinephelus polyphekadion														1									
	Epinephelus sexfasciatus					1		1							1			1		1				
	Epinephelus tauvina																					1	1	
	Gracila albomarginata			1	1			1	1	1			1										1	1
	Plectropomus areolatus				1																		1	
	Plectropomus laevis		1	1	1	1			1		1	1	1						1				1	1
	Plectropomus leopardus		1																				1	
	Plectropomus oligacanthus					1		1											1					1
	Variola albimarginata		1																				1	
	Variola louti			1	1		1				1	1	1	1	1								1	1
LV	**Siganidae - Rabbitfishes**																							
	Siganus argentus																						1	
	Siganus corallinus	1			1		1	1		1					1	1							1	1
	Siganus puellus							1			1			1	1		1	1					1	
	Siganus punctatissimus			1	1	1	1				1				1			1	1					1
	Siganus punctatus				1	1									1									
	Siganus stellatus						1																	1
	Siganus tetrazonus					1												1						
	Siganus unimaculatus					1																		
	Siganus virgatus							1			1			1										
	Siganus vulpinus			1	1	1	1	1			1	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	
	Sphyraena qenie			1			1																	1

Tubbataha Reef National Marine Park
Fish Species List as of March 2008

		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) in 2004	ALL SITES (including Jessie Beazley)
	Family and species/site	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2000**	**2004**	**2008**	**2004**	**2008**	**2000**	**1992/1996**	**2008**
LVIII	**Synotodontidae -Lizardfishes**																							
	Saurida gracilis	1						1						1									1	
	Synodos variegatus																						1	
LIX	**Tetraodontidae - Puffers**																							
	Arothron hispidus						1								1			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	1		1	1	1		1	1	1
	Arothron stellatus	1						1						1				1					1	
	Canthigaster bennetti																						1	
	Canthigaster compressa	1																					1	
	Canthigaster papua			1															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	1	1	1	1	1	1		1	1
	TOTAL	**182**	**202**	**183**	**171**	**185**	**192**	**221**	**144**	**159**	**170**	**152**	**165**	**141**	**205**	**178**	**156**	**190**	**169**	**130**	**153**	**119**	**329**	**285**

333 species in 57 families in 1992 and 1996
327 species in 44 familes in 1999
329 species in 43 families in 2004
285 species in 43 families in 2008

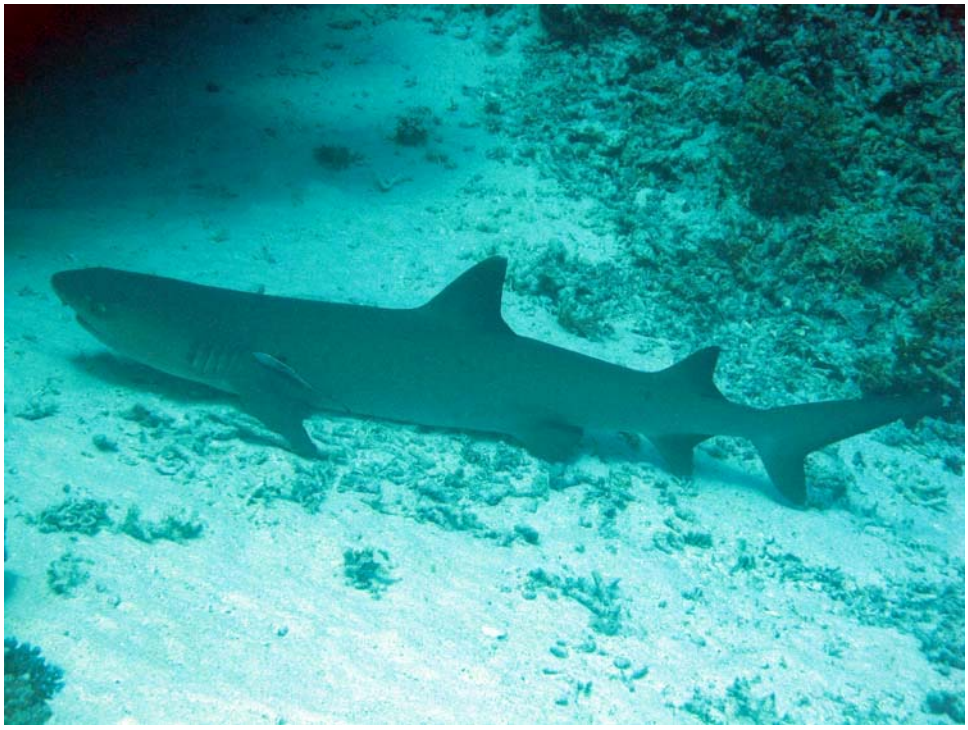
APPENDIX 4. EXPEDITION PHOTOS



A team of barracuda caught on camera. (A. Maypa)

Julia and a school of jacks. (A. Maypa)

A turtle poses for a diver. (A. Pennycook)

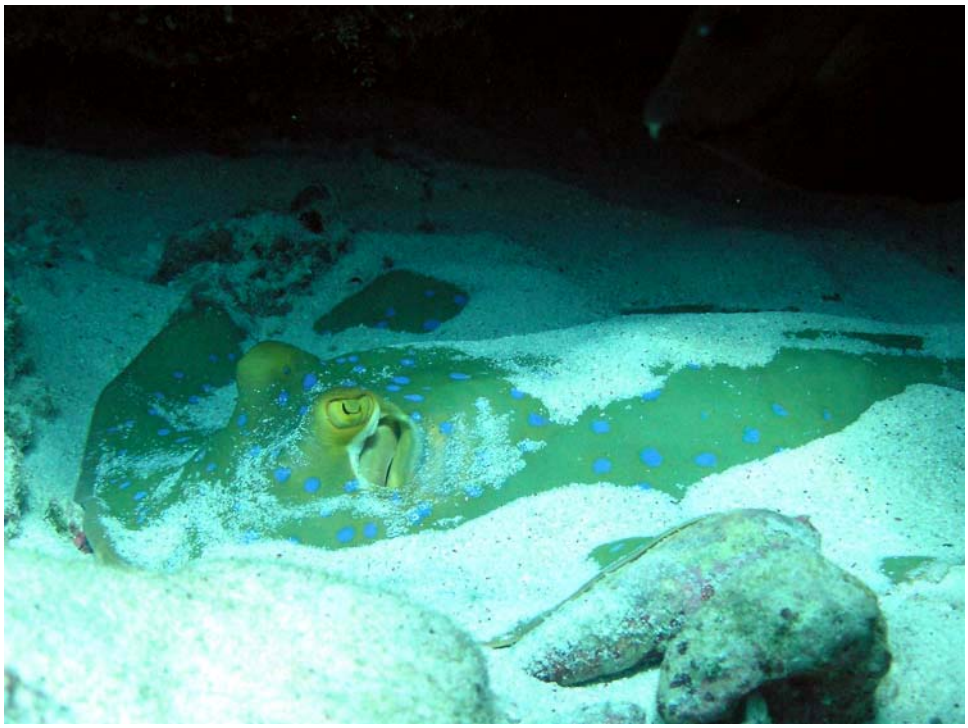


Black tip shark resting on the sea floor. (A. Pennycook)

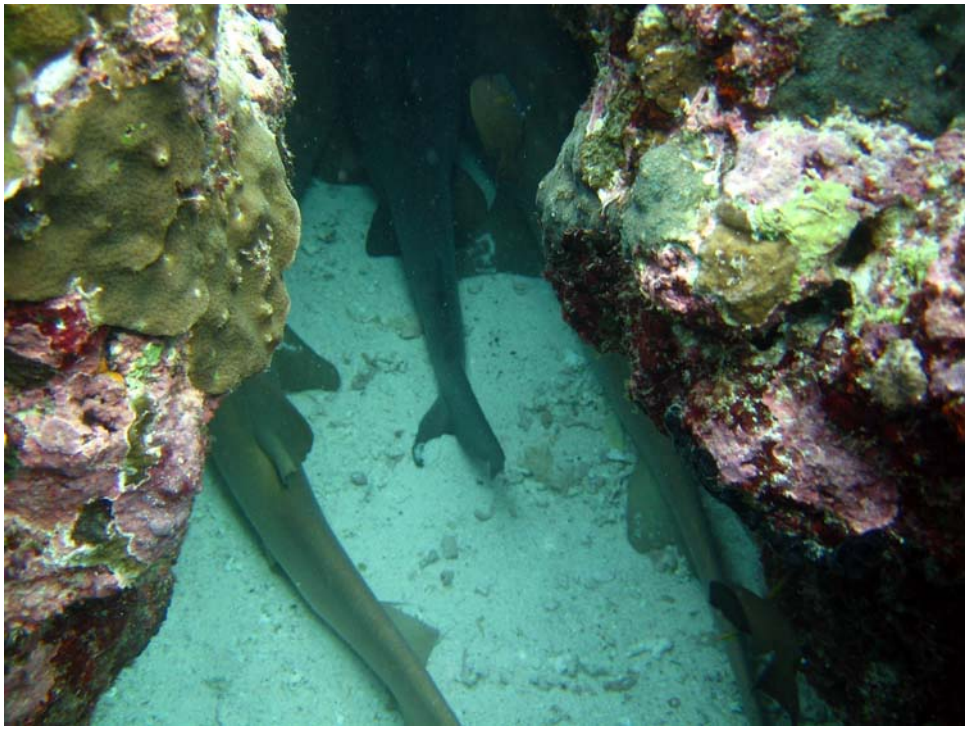
Sharks circle around Ethan on the sea floor. (E. Lucas)

Juvenile Napoleon wrasse swimming along the reef. (E. Lucas)

Ian lays out a transect line for data collection. (E. Lucas)



A sting ray rests in the sand. (E. Lucas)



Several sharks sleep under the rocks. (I. White)

Geoff swims alongside a friendly turtle. (P. Huxley)

Boat #3 volunteers and staff. (P. Huxley)

A manta ray surprises a diver. (P. Stretton)

A bumphead parrotfish. (P. Stretton)

A beautiful soft coral photographed on a night dive. (R. Diaz)

A nurse shark. (R. Diaz)

Volunteers and staff share underwater pictures after an exciting dive. (J. Osorio)

Getting ready to visit the rangers at the Ranger station. (J. Osorio)

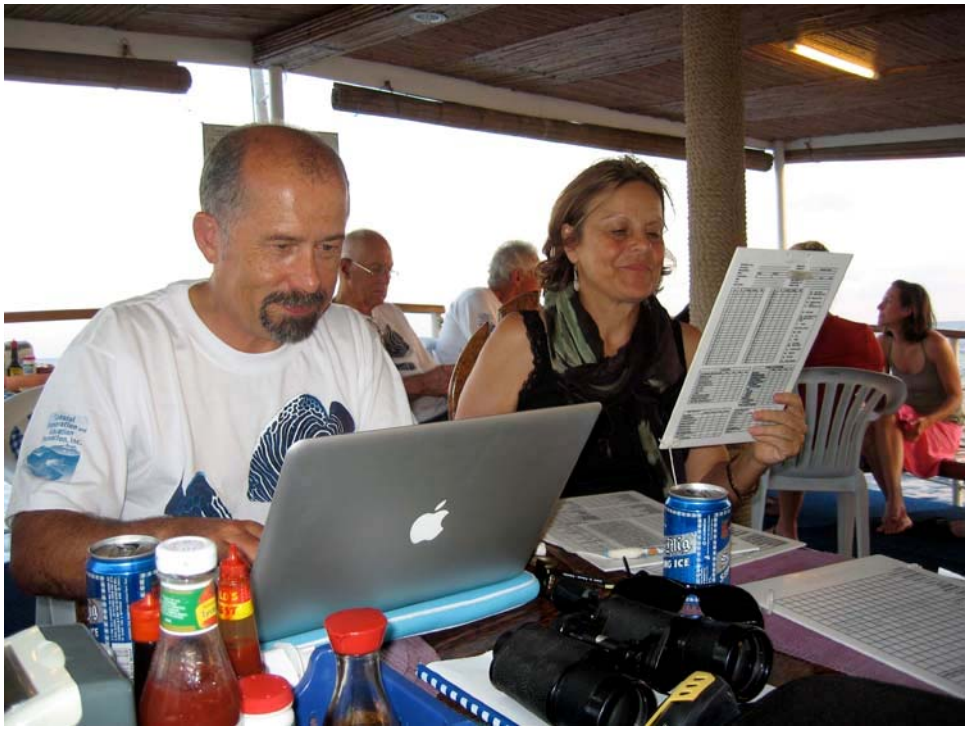
Volunteer Sandy meets the Rangers. (J. Osorio)

The volunteers visit the park rangers. (Sandy Robb)

The volunteers and staff enjoyed a picnic on the beach with the rangers. (J. Osorio)

The ranger station at sunset. (J. Osorio)

Ian, Vangie, and Alan White are filmed for a television documentary. (J. Osorio)



Al and Leona encoding their data. (E. White)

The M/V Oceanic Explorer research/dive vessel. (E. White)

The 2008 Saving Philippine Reefs research team (sitting L-R): Vittoria Thornley, Heather D'Agnes, Ian White, Julia Cichowski, Aileen Maypa, Vangie White, Agnes Sabonsolin, Sheryll Tesch, Pamela Huxley (DM); (lying front): Roxie Diaz; (standing L-R): boatman, Ethan Lucas, Jane Jones, Sandra Breil, Alan White, Raffy Martinez, Geoff Illing, Dean White, Denise Illine, Leona D'Agnes, Sandy Robb, Jimmy Paguio, Al Pennycook, TJ Mueller, Paul Stretton (DM), Peter Coard. (R. Diaz)