ECOSYSTEM RESEARCH AND MONITORING REPORT 2014

TUBBATAHA REEFS NATURAL PARK AND WORLD HERITAGE SITE
TUBBATAHA MANAGEMENT OFFICE

TUBBATAHA REEFS NATURAL PARK
WORLD HERITAGE SITE

Ecosystem Research and Monitoring Report 2014

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EXECUTIVE SUMMARY

Ecosystem research and monitoring is conducted to determine temporal and spatial changes in the coral reef community and other associated ecosystems and species in the Tubbataha Reefs Natural Park and World Heritage Site (TRNP). Regular monitoring of benthos, fish and seabirds are conducted annually between the months of April and May. The fish and benthos surveys are conducted simultaneously, while the seabirds census is done on a separate trip. Since 2012, there are five monitoring sites being assessed in TRNP; 2 in the North Atoll, 2 in the South Atoll and one in Jessie Beazley Reef. In each of the sites, there are two stations that consist of two transects; one deep (10 meters) and one shallow (5 meters). Both the fish and benthos monitoring follow the methods of English et al (1997).

The mean hard coral cover in the deep transects decreased from 54% in 2013 to 45.38% in 2014. Mean soft coral cover increased by 2.8%, from 15.25% in 2013 to 18.44% this year. Overall, the live coral cover (hard and soft corals) of 63.82%at deep sites puts the Tubbataha Reefs under the 'good' category based on the quartile scaling of reef health by Gomez et al (1994).

For the shallow sites, the mean hard coral cover was 72.34%. Soft coral cover was estimated at 7.95%, which is much less compared to the soft coral cover in the deeper sites. The live coral cover of 80.20% at 5 meters categorizes the reef as 'excellent' per Gomez et al (1994).

The research team was unable to locate Station B in Jessie Beazley Reef, thus the data for Jessie Beazley Reef only covers Station A. The percentage of hard coral cover in the deep transect of Jessie Beazley was 21%, while soft corals covered 74%. Abiotic components only covered 2.62% as opposed to last year's record of 22% at this site.

A total of 252 fish species under 94 genera belonging to 30 families were recorded this year. The overall mean fish biomass decreased by almost half; 115.26 mt/km^2 as opposed to 227.9 mt/km^2 during the previous year. Despite this decrease, TRNP still holds the highest fish biomass record among all sites surveyed in the country. According to Alcala and Gomez (1985), a 'healthy' reef in the Philippines can produce 7 to 35 mt/km^2 of fish. With reference to biomass data collected from 1997 to 2014, the average fish biomass in TRNP is stable at 200 mt/km^2.


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Peach fairy basslet (*Pseudanthias dispar*) ranked first in terms of abundance at 6,774 total individuals recorded.

Hence, anthiases (Serranidae: sub. Anthiinae) also ranked first among families in terms of abundance at 15,897 total individuals.

Among the commercially important/target species, Darkfin hind (*Cephalopholis urodeta*) was the most abundant (234 individuals). Parrotfishes (Scaridae) were the highest contributors in terms of biomass at 324.38 mt/km^2 followed by unicornfishes (Acanthuridae: sub. Nasinae) at 321.41mt/km^2. Bignose unicornfish (*Naso vlamingii*) ranked first in the biomass category among species (255.65 mt/km^2). Unlike in the previous year's survey, the quantity of pelagic species (outliers) is relatively lower this year, although it comprised 32% of the total biomass in the deep transects and 23% in the shallow transects.

Two major grounding incidents occurred in TRNP last year within a span of four months. First was the US minesweeper, USS Guardian (USSG), which crashed into the South Atoll in January and damaged 2345.67 m^2 of coral reefs. Three months later, a Chinese fishing boat, F/V Min Ping Yu (MPY), ran aground at the North Atoll, damaging 3902 m^2 of coral reefs. This year's survey marked the first time that these grounding sites were assessed for both fish and corals.

Two transects, one deep and one shallow, were laid at the USSG site while only one transect (at 10 meters depth) was laid at MPY site. There were 83 different species under 41 genera belonging to 17 fish families recorded at the USSG site. The mean abundance was 2409 individuals/500 m^2 translating to a mean biomass of 118.86 mt/km^2.

On the other hand, the MPY grounding site registered 82 species of fish under 43 genera belonging to 16 families, though only one transect was surveyed (deep). Only 898 individuals/500 m^2 with a biomass of 57.14 mt/km^2 were calculated at this site.

The monitoring method for seabirds in TRNP was established in 2004 (Jensen 2004). Direct counts of adult birds, juveniles, eggs and nests are conducted quarterly by the marine park rangers detailed in TRNP. This report only includes counts during the second quarter of the year. A total of 28 different bird species were recorded this year. Thirteen of the species were pelagic or coastal seabirds, of which six species breed in TRNP: Red-footed Booby (*Sula sula)*, Brown Booby (*Sula leucogaster)*, Great Crested Tern (*Thalasseus bergii)*, Sooty Tern (*Sterna fuscata*), Brown Noddy (*Anous stolidus*) and Black Noddy (*Anous minutus)*.

A total of 22,704 adult individuals of six breeding seabird species were recorded. Bird Islet was found to host 64% of the population and South Islet 36%. The result for 2014 is lower than the results for 2013 (28,901 individuals) due to the lower number of Great

Crested Tern and Black Noddy. The combined total population of all breeding seabirds in 2014 was 68% higher than the first inventory conducted in 1981 (Kennedy 1982). There was an increase in the number of the adult Red-footed Booby population by 34% compared to the average population for the five-year period 2009-2013 (2,298 individuals). There is a stable population of Brown Booby with a very high reproduction rate. The population of Great Crested Tern decreased to 4,780 adult birds from 9,794 in 2013. This year's population size is similar to that of 2010 (4,790 individuals) but 29% below the average for the five-year period 2009-2013 (6,766 individuals). Also, the Sooty Tern population (3,800) is 28% below the average for the past five-year period (5,257 individuals). There is a gradual increase in the population of Brown Noddy. This year's count (1,862 individuals) is just 12% below the 1981 baseline count. There is a 13% decrease in the adult population of Black Noddy (7,556 individuals in 2014), compared to the five-year average (2009-2013) of 8,678 individuals. One uncommon, migratory avifauna species was recorded for the first time within TRNP: Grey's Grasshopper Warbler *Locustella fasciolata*. The warbler species record is also a range expansion for Palawan.

CHAPTER 1: INTRODUCTION

I. OVERVIEW

The Tubbataha Reefs Natural Park (TRNP) and World Heritage Site comprise 78% of all no-take marine protected areas in the Philippines combined (Weeks 2010). Its protection is therefore imperative due to its significance to the achievement of marine conservation goals in the country and globally. More importantly, its rich biodiversity contributes to the replenishment of fisheries throughout the Sulu Sea, and contributes to the food security of the Philippines.

Tubbataha is found in the middle of the Sulu Sea with the following coordinates: N 8°50'677" E 119°55'734", and is composed of the South and the North Atolls and the Jessie Beazley Reef (JBR). The South and the North Atolls are separated by a five- nautical mile channel, while the JBR is located some 12nm northwest of the North Atoll. There is one uninhabited islet in each of the atolls and an unstable cay of marl at the Jessie Beazley Reef.

TRNP was established as a 33,200-hectare no-take national marine park in 1988 through Presidential Proclamation 306 issued by Pres. Corazon Aquino. It was later expanded to 97,030 hectares in 2006. In 2010, RA 10067 was issued by the Philippine government providing the institutional and organizational framework for the management of the park. It also established a 10-nm buffer zone around to the TRNP. The total area of TRNP, including its buffer zone, is 453,500 hectares.

Tubbataha is internationally recognized, having been inscribed in the UNESCO World Heritage list in 1993 and in the Ramsar List of Wetlands of International Importance in 1999. It is classified as an Important Bird Area for the conservation of congregating seabirds, recognized globally as IBA No. PH057 (Mallari et al 2001 in Jensen 2004, unpublished).

Tourism and research and monitoring are the only activities allowed in the park. Tourism revenues fund the bulk of management costs, e.g., enforcement, administration, etc. Ten percent of the annual tourism revenue is remitted to the Municipality of Cagayancillo to fund livelihood activities. Research is undertaken to determine resource status and long-term trends and the impacts of large-scale disturbances, such as climate change impacts and crown-of-thorns starfish (COTS) outbreaks. Monitoring also provides the inputs for evaluating the biophysical indicators of management effectiveness, and for the development and design of information and education initiatives. At a broader scale, research and monitoring informs management decision-making and adaptive management.

Biophysical monitoring in TRNP was standardized by WWF-Philippines beginning in 1997. Since then it has led, and to date continues to support, the Ecosystem Research and Monitoring (ERM) program of TRNP. Through the years, ERM in Tubbataha is made possible through the assistance of various government agencies like the DENR, PCSDS, Philippine Navy, Philippine Coastguard, Provincial Government of Palawan, LGU of Cagayancillo. Non-government organizations, such as Conservation International-Philippines and GIZ, have likewise provided the wherewithal to conduct ERM. Academic institutions, such as the De La Salle University, University of the Philippines and Western Philippines University, have contributed expertise and knowledge/skill transfer for the further development of in-house research capability.

TRNP is considered by marine scientists as 'a reference oceanic reef'. It is viewed as an outstanding example of a healthy coral reef, which scientists attribute to effective management. It has the highest reef fish density and biomass among all sites studied in the Philippines and a relatively high coral cover. However, regular monitoring activities show that biological conditions in the park are vulnerable to damages due to natural causes, like bleaching (1998), storms (2008), and COTS infestation (2008-2010), as well. Human impacts, like ship groundings (e.g., Greenpeace Rainbow Warrior, USS Guardian, Min Ping Yu), and poaching (e.g., topshell harvesting from 2006 to 2009), also impinged on the health of the reefs.

This report presents the results of the monitoring surveys conducted in 2014 and provides an analysis of the temporal and spatial trends of the benthic, reef fish and seabird populations.

II. GENERAL OBJECTIVE

ERM is one of the four major programs implemented by TMO to ensure the effective conservation of TRNP. The goal of ERM is to determine ecosystem health, measure biophysical indicators of management effectiveness, and to provide the scientific basis for the formulation of proactive strategies and responses to emerging issues.

Annual monitoring is conducted to determine any temporal and spatial changes in the coral reef community and other associated ecosystems and species in the area.

III. RESEARCH AND MONITORING DESIGN

Study Sites

From 2008 to 2011, a total of 10 permanent monitoring sites were established in TRNP: four sites in the North Atoll and three in the South Atoll, and three in JBR. The coordinates of the sites were taken with the use of a Global Positioning System (GPS), and were marked using cement blocks that were fastened onto the rock substratum. Since 2012, however, the number of monitoring sites was reduced to five: two in the North Atoll, two in the South Atoll and one in JBR. This was because analysis of the benthos data from 1997-2011 showed that five of the 10 sites were not homogenous and therefore did not yield sufficient data to show temporal and spatial changes (W. Licuanan, pers. comm.). Monitoring of these sites was therefore halted. The decrease in the number of monitoring sites coincided with the transition to the modified Reef Check survey method employed in 2012.

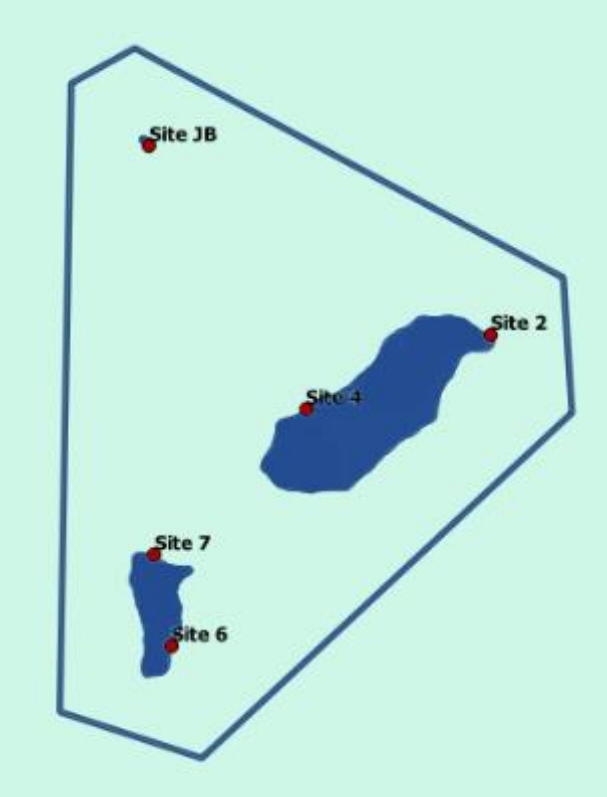

Figure 1. 2014 TRNP Monitoring Sites

Additional stations were added in each of the five sites. Therefore, there is a total of ten stations across five sites (Table 1). In each station, two transects are laid: one at 10 meters (deep transect) and another at 5 meters (shallow transect). These five sites with two stations each were monitored this year. However, Station B in Jessie Beazley was not located this year. The fish team therefore laid another transect near the location of Station B and marked it using GPS.

Meanwhile, the grounding sites were also monitored. These sites were assessed using the Coral Reef Targeted Research (CRTR) method employed by DLSU and UP-MSI. Fish visual census was conducted in the two grounding sites, both deep

and shallow transects in the USS Guardian site and only a deep transect at the Min Ping Yu site.

Table 1. Location of the TRNP monitoring stations and grounding sites.

Site Name	Stations	Location	Latitude (N)	Longitude (E)
Sea Fan Alley (Site 2)	Station 2A	North of north atoll	8.93532 °	120.01302 °
	Station 2B	North of north atoll	8.93781 °	120.00851 °
Malayan Wreck (Site 4)	Station 4A	West of north atoll	8.89236 °	119.90627 °
	Station 4B	West of north atoll	8.89128 °	119.90453 °
Delsan Wreck (Site 6)	Station 6A	Southeast of south atoll	8.75591 °	119.82881 °
	Station 6B	Southeast of south atoll	8.75186 °	119.82784 °
T-wreck (Site 7)	Station 7A	North of south atoll	8.80850 °	119.81907 °
	Station 7B	North of south atoll	8.80656 °	119.82169 °
Jessie Beazley	Station JBA		9.04393 °	119.81599 °
	Station JBB		9.04557 °	119.81348 °
Grounding sites	USSG	North of south atoll	8 49.297°	119 48.187°
	MPY	Southeast of north atoll	8 51 183°	119 56.188°

Field Surveys

Part of the long-term monitoring program for TRNP, the field surveys are conducted between the months of March to June, when weather and sea conditions are favorable. Two monitoring trips were conducted this year: one for the fish and benthos on 28 April – 05 May, and another for the seabird census on 08 – 12 May.

The major limiting factor for the conduct of regular research and monitoring expeditions in TRNP is weather condition. The unhampered conduct of the surveys depends on the opportunity to sail to the park as scheduled, and when there, on the opportunity to dive safely. Rough sea conditions impede the conduct of underwater

monitoring and pose a risk to life and property. Other limitations, specifically for fish and benthos surveys, include a dearth of manpower and expertise. For the seabird monitoring, extreme heat or cold, during rains, generally take a toll on the researchers. Boarding and alighting from the vessel is also a dangerous exercise during rough sea conditions. Generally, the distance of the park from the mainland limits the management's ability to sail on short notice and re-provision the vessel, when necessary. The distance also limits the ability to conduct unexpected repairs or secure parts for malfunctioning equipment.

Another consideration throughout the years is the failure to locate the concrete markers installed in the permanent monitoring stations. Some of the marker blocks are overgrown with corals or dislodged by strong wave action.

Survey Teams

Fish and Benthos Monitoring Team. Segundo, Jr. (TMO) and Prof. Jerome Cabansag (UPV-Tacloban) conducted fish monitoring in all sites this year. The benthic community was assessed by Rowell Alarcon and Noel Bundal of TMO. They were assisted by Mr. Eulalio Calagui (divemaster), Jeric Dejucos and Maria Retchie Pagliawan (TMO) (see Annex 1. 2014 Monitoring Teams). The WWF-Philippines research vessel, M/Y Navorca, was utilized as the platform for research. A team of scientists from the DLSU and UP-MSI also joined the trip to conduct CRTR and coral recruitment studies in the vicinity of the established monitoring sites and in the two grounding sites.

Seabird Monitoring Team. A total of 17 TMO staff, park rangers and volunteers, headed by the Protected Area Superintendent (PASu), and an external ornithological consultant, participated in the seabird inventory (Annex 1. 2014 Monitoring Teams). The team included five park rangers and researchers from the TMO, two rangers from the Philippine Navy, one ranger from the Philippine Coast Guard and two rangers representing the municipal government of Cagayancillo. In addition, volunteers representing the Philippine Biodiversity Conservation Foundation, Inc., the University of the Philippine - Los Baños, Marine Wildlife Watch of the Philippines and the tourism sector were part of the team. WWF Philippines and the crew of M/Y Navorca likewise assisted the team and made the field work possible.

IV. REFERENCES

Jensen, A (2004) Monitoring and Inventory of the seabirds of Tubbataha Reef National Marine Park and Cawili: with notes on the population and habitat status and development. Unpublished

Weeks, R. (2010) Developing Marine Protected Area Networks in the Philippines: Reconciling Regional-Scale Planning with Community-Based Implementation. A thesis submitted for the degree of Doctor in Philosophy in the School of Marine and Tropical Biology, James Cook University.

CHAPTER 2: BENTHIC COMMUNITY STRUCTURE

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I. INTRODUCTION

Coral reefs are one of the most diverse ecosystems in the world. They support a large number of marine organisms and their ecological importance cannot be undervalued. The composition of the benthic community is therefore very essential to assess since it is significant to the overall marine ecosystem health. Benthic surveys are done annually in TRNP. Changes in benthic composition may be linked to certain processes, either naturally driven or anthropogenic. In the case of TRNP, more than a decade's worth of data show that coral reefs can bounce back from degradation, given that they are protected and free from anthropogenic disturbances. This year's survey marks the 18th year of consistent monitoring made possible through collaboration between NGOs, academe, partners and volunteers, e.g., WWF-Philippines, De La Salle University (DLSU) and University of the Philippines - Marine Science Institute (UP-MSI). This section presents the results of the benthos monitoring survey of 2014 and provides an overview of spatial and temporal changes and trends since 1997.

II. METHODS

Field Methods

To minimize variability in coral cover, the original 10 sites was trimmed down to five, namely; Site 2, 4, 6, 7 and JBR. Statistically-valid replication was applied over homogenous sites, and in 2012, Stations A and B were established. This change was applied in order to produce data that reflects the actual coral cover and allow for detection of changes in coral cover over time and space (Licuanan et. al. 2012 unpublished).

The researchers followed the life form categories in English et al (1997). In order to contribute to the global database, the data required in the Reef Check method will be culled from the more comprehensive benthic data collected. This method is used to determine the relative cover of benthic organisms and the non-living components of the reef. A 100-meter transect line was laid along the bottom. The line was divided into 20-meter segments with 5-meter breaks in-between. The life form directly beneath the 0.5-meter marks were then recorded along a 20-meter segment of the transect line.

In order to increase accuracy, the number of points for each segment was increased. The modification introduced in the Reef Check method was the use of a V-bar. The V-bar was placed at every 0.5-meter mark with its two proximal ends pointing to the right (McManus, 1997). The life form directly beneath the proximal ends of the V-bar were then identified and recorded. The V-bar was then flipped to the left, and the life forms at the two ends were again identified and recorded. This yields a total of 5 data points for every 0.5 meter segment or 200 data points per 20 meters. This procedure was done in the next three 20-m segments along the transect line. Hence, there were four replicate segments per transect.

Data Analysis

Percentage Cover

The percentage cover of each life form was generated by dividing the total number of points in which each life form was observed by the total number of points of all identified life forms (200), multiplied by 100. The formula is shown below:

$$\text{Percentage cover of life form A} = \frac{\text{Number of points of life form}}{\text{Total number of points in the transect (200)}} \times 100$$

For the graphs presented in this report, mean values for all eight segments (both shallow and deep transects) were computed, along with standard deviation and standard error.

Regression

A regression analysis was done to predict whether the populations are stable, increasing or decreasing. This is represented by the linear trendline plotted together with the data series in the charts. A trendline is most reliable when its R-squared value is near or equal to 1. The R-squared value is the coefficient of

determination and basically reveals how closely the estimated values for the trendline correspond to the actual data.

Correlation

To determine whether there were any differences in the results of benthic cover of hard (HC) and soft coral (SC) over the years, data on the percentage cover of the benthic categories for the deep site were correlated with the shallow sites. High correlation would suggest how strongly the variables are related.

III. RESULTS AND DISCUSSION

Benthic cover at 10 meters

The mean hard coral cover recorded for this year's survey was 45.38% (Figure 2). This suggests a 24.5% decrease from 2013. However, this decrease in hard coral cover is not statistically significant, t (7) = 1.564, p (two-tailed) = 0.162, suggesting that there were no major changes or disturbances which occurred during the previous year. The lowest recorded hard coral cover was at 32.88% (Site 6A) and highest at 57% (Site 7B) (Figure 3). Mean soft coral cover recorded this year was 18.44% (Table 2), which increased by 2.8% from last year. Overall, the live coral cover (hard and soft corals) at deep sites puts the Tubbataha Reefs under the "good" category. A comparison of the sites show that Site 2B has the highest live coral cover at 76.75% (Annex 4. 2014 Benthic cover across sites).

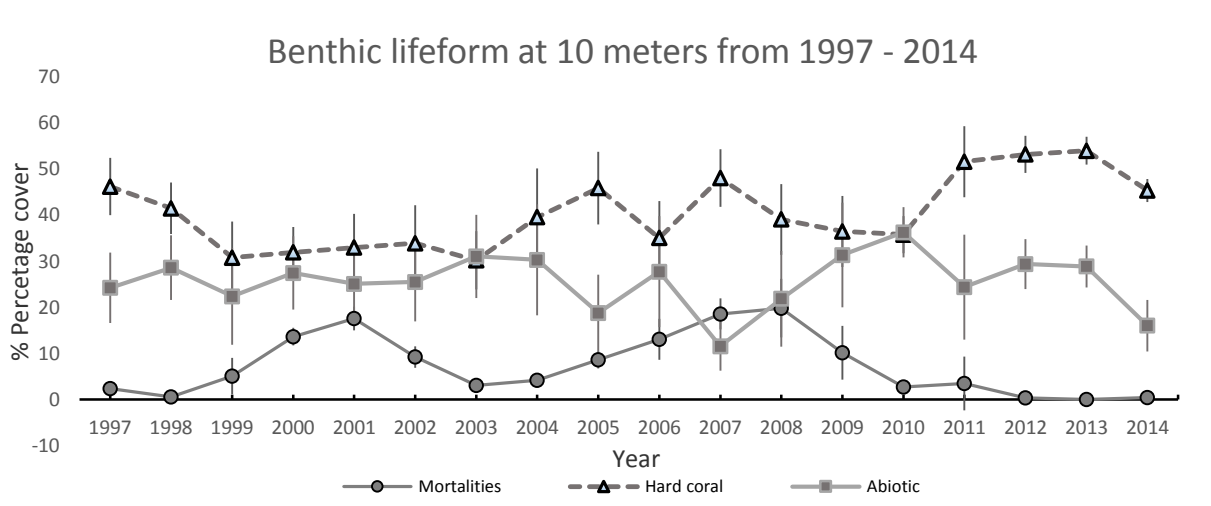

Figure 2. Mean percentage cover of benthic categories (10m depth) from 1997 to 2014. Error bars represent standard error of mean.

Figure 2 illustrates the percentage cover of benthic organisms over the last 18 years. A more detailed list is presented in Annex 4. 2014 Benthic cover across sites. Since 2008, mortalities displayed a downward trend, and this year, it was recorded at 0.47%. The abiotic components have shown a decrease from 28.88% in 2013 to 16.04% while algal cover increased this year. It was noted that this increase in algal cover was highest in both stations of Site 4. Abiotic components were particularly high in Sites 4 and 6. Site 6 is dominated by branching corals which are more vulnerable to storm damage as it faces the eastern part of Sulu Sea, the entry point of storms. On the other hand, increased of abiotic component in Site 4 may be attributed to high amount of rubbles and rocks recorded in this year's survey.

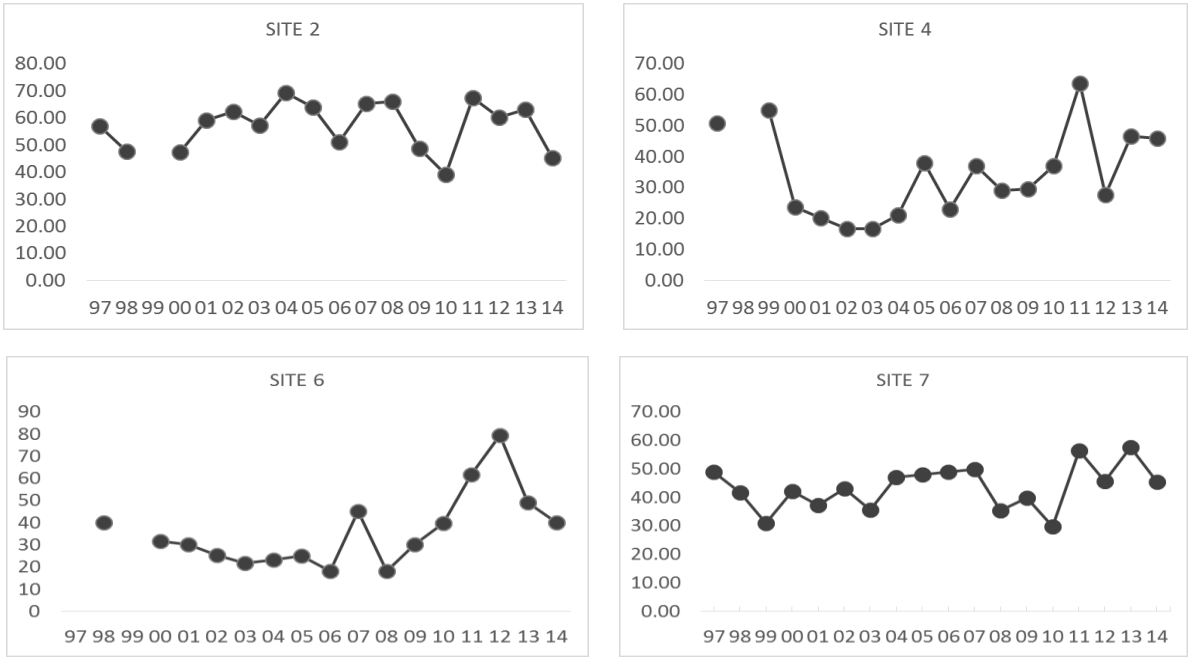

Figure 3. Temporal trends in the mean hard coral cover values of the sites at 10 meters from 1997 to 2014. Completed set only obtained in 4 sites (Site 2, 4, 6 & 7).

Over the last 18 years, the site that seems to be the most stable in terms of hard coral cover is Site 2, which is located at the northern tip of the north atoll, followed by Site 7, which is at the northern portion of South atoll. These two sites are characterized by diverse hard coral communities compared to the other sites in Tubbataha. Site 6 consists of monospecific Acropora coral beds, which make them more vulnerable to natural disturbances like storms, diseases and predation (Ledesma et al. 2008). However, Site 2 appeared to have the largest decrease in hard coral cover this year. This decrease may be attributed to the increase of both algae and other fauna compare to the last year's survey. Meanwhile, Site 4 continues to show gradual increase in hard coral cover after the 1998 bleaching event.

Table 2 Mean percentage cover of the different benthic attributes at 10m and 5m depths in the TRNP monitoring sites.

BENTHIC LIFEFORM	DEEP (10 M)	SHALLOW (5M)
HARD CORAL	45.38 %	72.25 %
SOFT CORAL	18.44 %	7.95 %
MORTALITIES	0.47 %	0.95 %
OTHERS	5.77 %	4.47 %
ALGAE	13.91 %	4.41%
ABIOTIC	16.04 %	21.33 %
TOTAL	**100 %**	**100 %**

Benthic cover at 5 meters

Live coral cover at 5 meters puts the reef in "excellent" condition based on the quartile scaling of reef health (Gomez et. al. 1994). The mean hard coral cover recorded this year at the shallow sites was 72.34%, showing an increased since 2012 (Figure 4). Hard coral cover was generally high, ranging from 57% in Site 2B to 88% in Site 6A, which was the highest estimated coral cover in TRNP (Annex 4. 2014 Benthic cover across sites). The increase in hard coral cover indicates that there is no significant difference at t (7) =3.21, (two-tailed) p=0.014 compared with last year's records. Soft coral cover was estimated at 7.95%, which is much less compared to the deep sites.

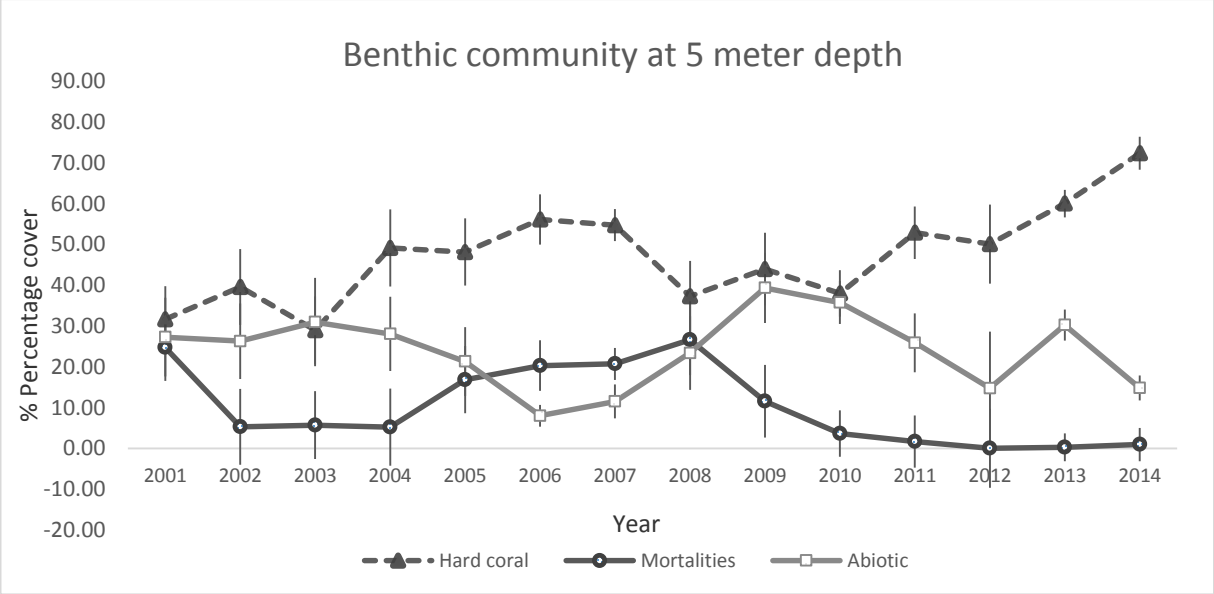

Figure 4. Benthic cover at 5 meter depths from 2001 to 2014. Error bar represent standard error of mean.

On the other hand, the abiotic component decreased this year at 14.80% compared to last year's 30.25% record, t (7) =-4.68, two-tailed p=0.002. This notable decrease may be attributed to the other fauna and algae cover in some sites. Site 4A & 4B showed the highest record of abiotic component both this year and last.

In 1997, monitoring only covered the deep sites (10 meters). Shallow sites were added to the monitoring sites in 2001 in order to detect reef responses in both depths (Ledesma et al. 2006, unpublished). The shallow site that displayed the most stable hard coral cover condition is Site 7 (Figure 5), which is situated at the northern tip of the South Atoll. This site is composed of a diverse coral structure, from encrusting to massive formation, which withstand disturbances such as strong currents brought by typhoon and monsoon seasons (Ledesma et al 2009, unpublished). The shallow transect in Site 6 is dominated of branching Acropora species that are known to easily break. However, it seems to remain stable and continues to thrive over the last two years (2013 and 2014) as opposed to the deep transect of the same site.

Sites 2 and 4, which in the past were extremely affected by natural disturbances such as typhoons, have slowly recovered. Sites 4 in the North Atoll had the lowest coral cover through time.

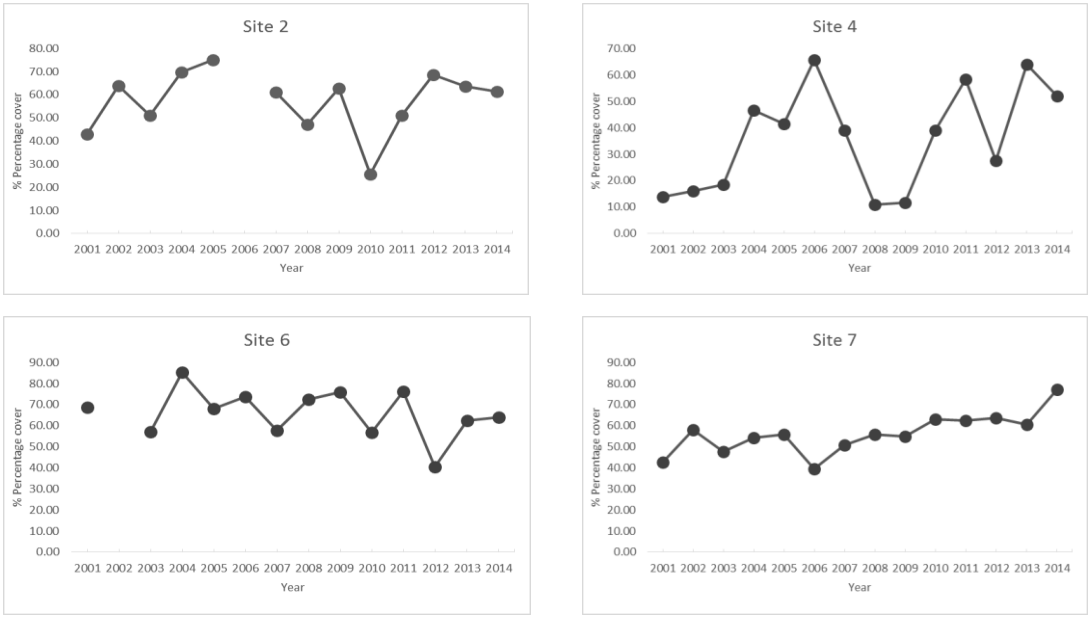

Figure 5. Hard coral cover values of sites of 4 sites at 5 meters from 2001 to 2014 (Site 2, 4, 6 & 7).

Correlation of hard and soft coral cover between depths

Monitoring of the reefs at two different depths was done in order to compare responses to disturbances and recovery over time. Hard coral cover relationship between depths displayed a correlation coefficient of *r* =0.768. This suggests that through time the increase and decrease in hard coral cover in deep transects also corresponds to the increase and decrease in the hard coral cover in the shallow transects (See Figure 6).

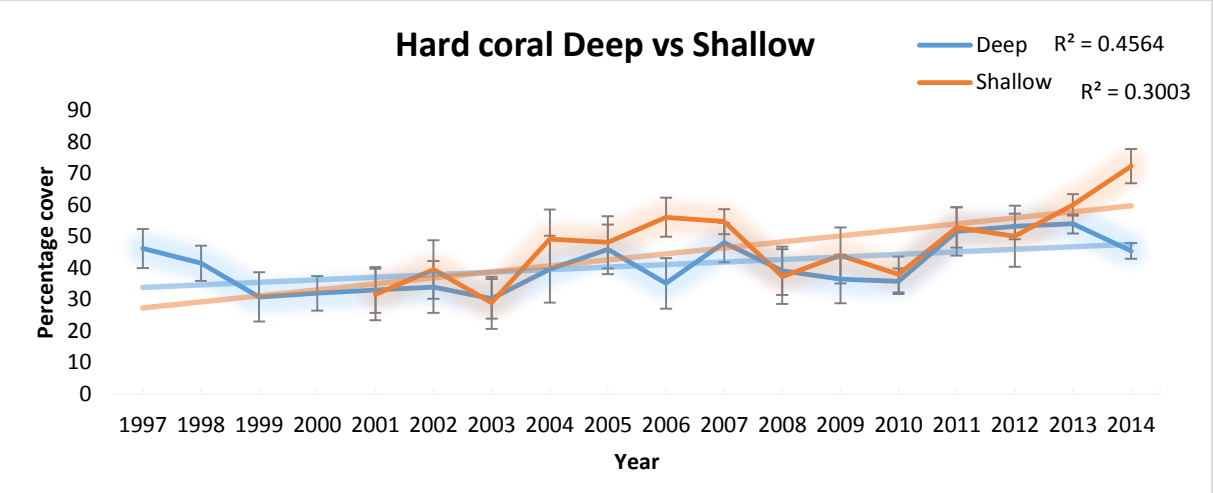

Figure 6. Mean percentage hard coral cover in the deep (blue line) and shallow (purple line) stations of Tubbataha Reefs from 1997 to 2014. Error bars represent the standard error of the mean.

Figure 7 shows the mean soft coral cover from 1997 to 2014. In general, the percentage cover of soft corals in both deep and shallow transects is increasing. However, unlike the hard coral cover, the changes in soft coral cover in deep transects do not follow the same increase/decrease in the changes in soft coral cover in shallow transect. This is supported by the low correlation coefficient of *r*=0.103. During the surveys, it was observed that soft corals thrive more in the deep sites. Being filter-feeders, soft corals may favor the deeper sites where strong current flows carry nutrients that serve as food.

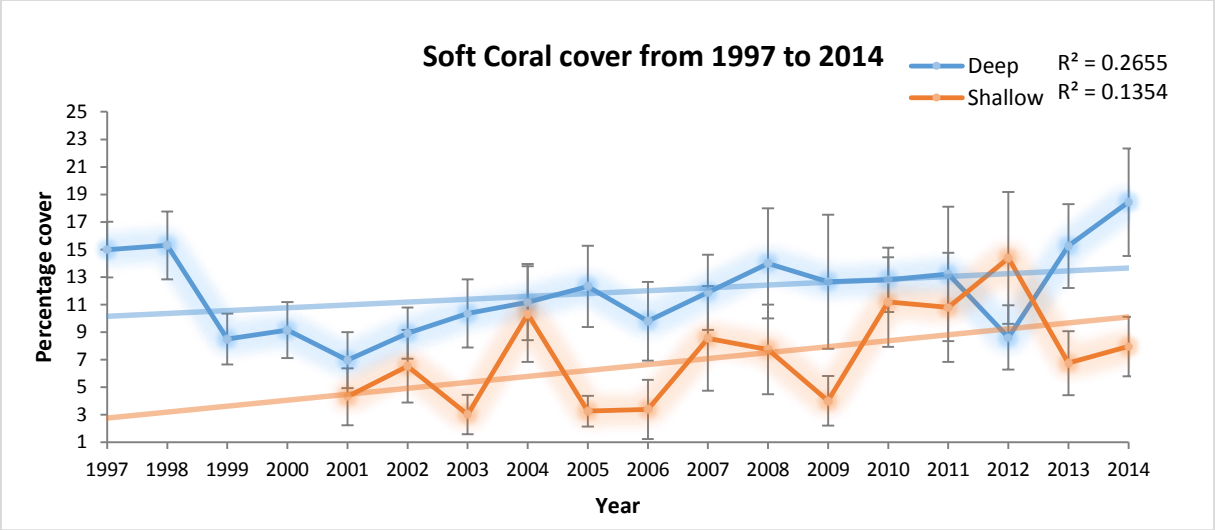

Figure 7. Mean soft coral cover in the deep (blue line) and shallow (purple line) stations of Tubbataha Reefs from 1997 to 2014. Error bar represent standard error of the mean.

Jessie Beazley Reef

Due to logistical and weather constraints, monitoring in Jessie Beazley Reef was not possible in some years. This year, the team was unable to locate Station B (shallow), thus the sampling data covers only Station A. The percentage of hard coral cover in the deep transect of Jessie Beazley was 21%, while soft corals covered 74% (Table 3).

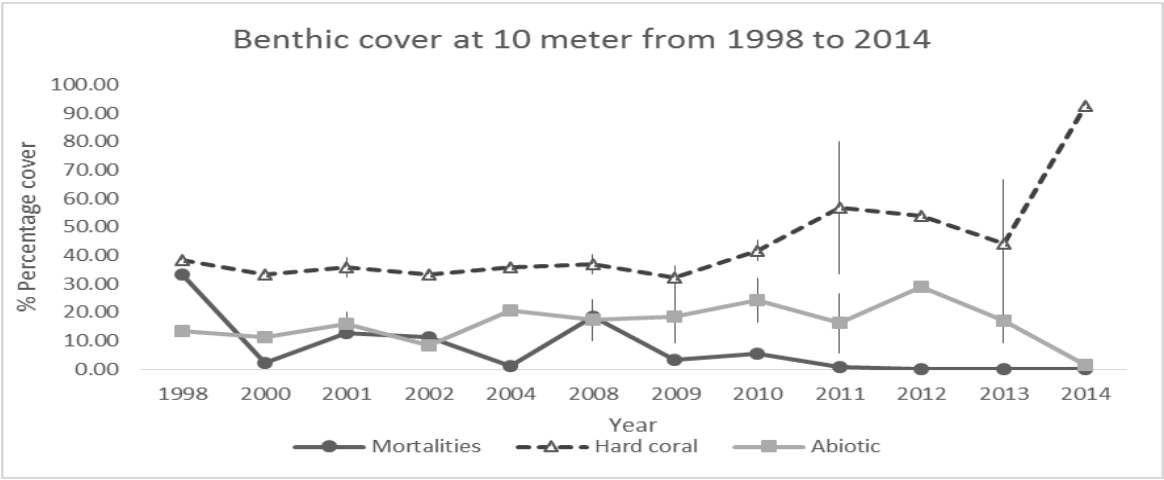

Figure 8. Benthic cover at 10 meter depths from 1998 to 2014. Error bar represent standard error of mean. This year study covered only one station due to logistical constraint.

This hard coral record is higher compared to last year which was only 13% (Figure 8). Abiotic components only covered 2.62% as opposed to the last year's record of 22% at this site. Other fauna and algae cover also increased this year. Mortalities were not observed at both depths.

Table 3 Mean percentage cover of benthic community at both depths (5 meter and 10 meter) in Jessie Beazley Reef.

Benthic Lifeform	*Deep (10m)*	*Shallow (5 m)*
Hard Coral	21 %	93.37 %
Soft Coral	74 %	5.0 %
Mortalities	0	0
Others	0.125 %	0.125 %
Algae	2.25 %	0
Abiotic	2.625 %	1.5 %
TOTAL	**100 %**	**100 %**

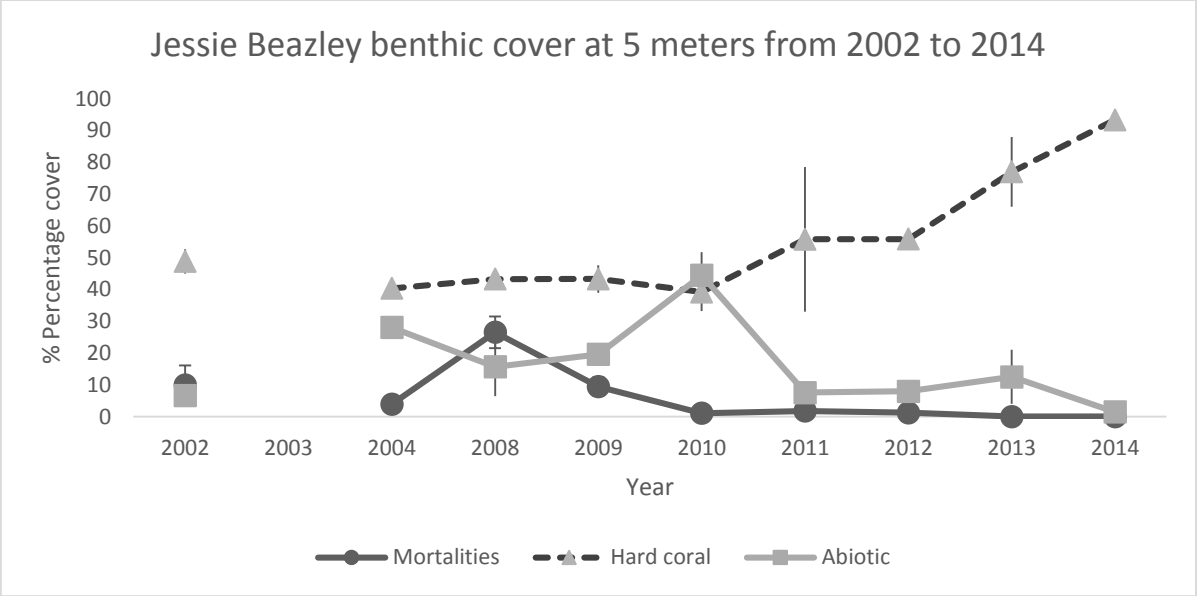

Figure 9. Benthic cover at 10 meter depths from 1998 to 2014. Error bar represent standard error of mean. This year covered only one station due to logistical constraint.

Hard coral cover recorded at five meter depth was 93%, the highest value for all of the sites in TRNP (Figure 9). This site is dominated by foliose coral, plate-like corals known to overgrow other benthic organisms, thereby contributing to the high percentage cover. Soft coral cover observed in this site was estimated at 5%. Abiotic component and other fauna were not very common in this site.

IV. CONCLUSION

This year marks the 18th year of biophysical monitoring in the Tubbataha Reefs. Monitoring is done in order to determine the status of benthic communities, particularly live coral cover. In determining live coral cover, percentage cover is by far the most widely used metric of coral reef condition and is commonly used in studies that document the decline and recovery of coral reefs (Bruno and Selig 2007).

Years of monitoring showed that live coral cover of TRNP continuously displayed an increasing trend. On the average, the live coral cover recorded in Tubbataha at 10 meters was 63.82% and 80.20% at 5 meters. Based on the quartile scaling of reef condition (live coral cover = hard corals + soft corals) by Gomez et al. (1994), Tubbataha Reefs falls under 'good' to 'excellent' condition. Meanwhile, due to the lack of representation at station level in Jessie Beazley, the data collected is inadequate to describe the present reef condition.

Coral cover increased despite large scale disturbances in the past. During the El Nino event in 1997 – 1998, total live coral cover drastically decreased from 61.20% in 1997 to 39.30% in 1998 (Jontila et al 2010, unpublished). The mass coral bleaching event was followed by the proliferation of algae over almost 30% of the reef in 1998.

In 2008, a strong typhoon struck the reefs resulting in massive coral cover decline in most of the sites. Severe damages were notable in Site 2 located in North atoll and Site 6 in the South atoll. Furthermore, a crown-of-thorns starfish (*Acantaster planci*) infestation which was first observed in 2007 and lasted till 2010, resulted in a decline in coral cover. However, this decline in coral cover was not observed in the monitoring sites and was therefore not reflected in the monitoring results. According to Pan et. al. (2010), the COTs population in TRNP are native to the park and an outbreak is possible in 2-4 years. Marine park rangers regularly monitor the reef for COTS and have so far not observed an increase in COTS population.

Despite its remoteness, the park is not free from anthropogenic threats such as increase in the volume of marine debris, impacts of marine traffic around the park, and grounding incidents. It can be recalled that last year, two incidents of ship groundings occurred: the US Navy minesweeper (USS Guardian), and a

Chinese fishing vessel (F/V Min Ping Yu). Coral reef damage covered an estimated area of 2,345 square meters (USS Guardian) and 3,902 square meters (F/V Min Ping Yu). The numerous threats faced by this global marine treasure highlight the importance of continuous management activities and long-term monitoring program (TMO 2013, unpublished).

Despite all of the disturbances in the past, TRNP continues to show recovery and resilience. The implementation management strategies are key to its protection. Tubbataha Reefs Natural Park serves as a model of a reef protected from fishing pressure and other human impacts, and therefore, may provide greater understanding of reef dynamics and natural processes.

V. RECOMMENDATIONS

Tubbataha has gone through many changes in terms of benthic community assessment methods. Currently, benthic community is being assessed using lifeform categories, however, during a conversation with Dr. Wilfredo Licuanan (pers comm), it was suggested that TMO research team should now identify corals at the *Genus* level in order to generate more robust data. It is recommended that TMO research staff be trained in coral taxonomy.

Also, separate schedules for fish and benthos monitoring could provide opportunity for more researchers to join the monitoring trip, and for other researchers in the same field to conduct studies.

Permanent visual records (such as photographs) of transects should be generated to allow for a more detailed retrospective analysis in the future (Licuanan et al 2012, unpublished).

Lastly, TMO has two in-house staff who conduct benthos monitoring in TRNP. Since there are two depths being monitored, it is recommended that additional researchers be engaged as this will help lessen the bottom time of researchers, especially in the deep transects. Meanwhile, engaging the services of a dive master will ensure safety during the dives.

The current monitoring design provides management with an outlook of the condition of the reef in the five sampling sites. However, it is not able to describe the state of corals and fish populations in the whole park. It is recommended that a baseline study on coral cover and reef fish composition and abundance be conducted in TRNP following a stratified random sampling design in order to come up with a more accurate and generalized finding for TRNP.

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CHAPTER 3: REEF FISH COMMUNITY STRUCTURE

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I. INTRODUCTION

Marine Protected Areas (MPAs) are an important strategy for the conservation of marine biodiversity and productivity, particularly for the maintenance of fish stocks (Wilkinson et al. 2003). Food security through fisheries is the most basic service which we derive from such designated area. Fish surveys are being done in TRNP to check the status of the fish community at a given time. As a biological parameter, it can also be used to assess the extent of damage to coral reefs from natural and human disturbances (Wilkinson et al. 2003). Though TRNP is a no-take zone, retrospective data show that fish biomass values are fluctuating which could be attributed to a number of factors. Results of fish monitoring could also reflect the performance and evaluate success (or failure) in achieving the goals and objectives of the management body. This information could play a key role in adaptive management.

This year's fish survey was done simultaneously with the coral and benthos survey in 28 April to 05 May with technical assistance provided by the University of the Philippines – Visayas.

II. METHODS

Field Methods

Fish Visual Census (FVC) modified from English, et al. (1997) was used to determine the biomass, abundance, and density, as well as species and family diversity of fish in the survey sites. A 100-meter transect was divided into two 50-meter segments. A diver recorded all the fishes up to species level inside a 50-meter long x 5-meter wide segment (note: an imaginary 2.5 meters from the transect line to either side comprise the 5-meter width). Recording was done every 10 meters. Highly mobile species were recorded first before the slower ones. The count and length of each species were also taken into account with the length estimated up to the nearest centimeter (cm). From this information, the density (individuals/500 m^2) and biomass (metric tons/km^2) of fish were derived.

This survey assessed five regular monitoring sites (2, 4, 6, 7, and JBR) and two special monitoring sites (USS Guardian and Min Ping Yu grounding sites). There were two sampling stations (A and B) on each of the regular monitoring sites with four (4) 50-meter transects laid on each station, two in deep (30-35 feet) and two in shallow (15-18 feet). Transects used were the same of that of the benthos monitoring. Due to some unanticipated reasons, only two capable observers were able to survey all transects. Transects in each depth were set 15 meters apart.

Data Analysis

Collected data from the survey were encoded and synchronized with the format introduced by DENR-BMB under the Coral Reef Visualization and Assessment (CoRVA) Project. A database with embedded vital information on known fish species in the country was provided by the said project. The biomass estimates were calculated using the length-weight relationship (Kublicki et al. 1993) with the formula:

Equation 1 $$\mathbf{W = (a \cdot 1^b)}$$

Where:
W = weight (g)
l = length estimate (cm)
a = multiplicative factor (varies from sp. to sp.)
b = exponent (>1, varies from sp. to sp.)

Results were expressed in metric tons per square kilometer (mt/km^2). Values for *a* and *b* parameters were taken from existing length-weight relationship data from

Fishbase (fishbase.org). Density was set to number of *individuals per 500 square meters* in this survey. Twenty (20) transects in the regular monitoring sites were surveyed with an additional three (6) in the special sites.

III. RESULTS AND DISCUSSION

Overall mean biomass for TRNP this year decreased by almost half to 115.26 mt/km^2 from 227.9 mt/km^2 of the previous year. However, this is still much higher than the established 'healthy' values (Alcala and Gomez 1985, Nañola et al. 2004). A paired t-test was performed to determine if there is a significant variation between the two values. The mean difference (M = 112.65, SD = 30.34, N = 5) is significantly greater than zero. The two-tailed p = 0.0011 strongly provides evidence that there is a significant difference between the values of successive years (2013 and 2014). The 95% confidence interval (CI) value suggests that the variation could be as 'low' as 74.98 mt/km^2 or as high as 150.32 mt/km^2. The mean biomass on deep transects also decreased to 171.41 mt/km^2 this year from 361.12 mt/km^2 in 2013. However, an upward trend was exhibited. Mean values of biomass at deep transects through the years can be seen in Figure 10.

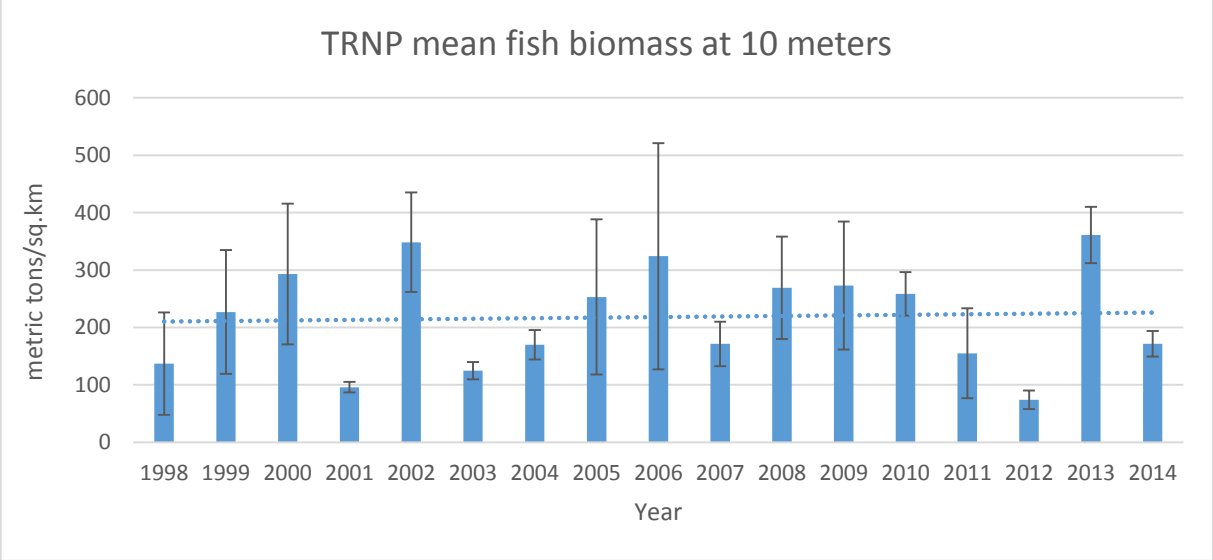

Figure 10. Mean fish biomass at deep transects through the years. Error bars represent standard error of the mean.

Two hundred fifty two (252) fish species under 94 genera belonging to 30 families were recorded during this survey. The actual values of abundance, biomass, and species and family richness per site are in Annex 9. Family richness ranged from 10 in Jessie Beazley A – shallow, to 21 in Site 6A – deep (Delsan Wreck). Thirty nine (39) species of fish were recorded in Site 4A – shallow, (Malayan Wreck), the lowest

among the study sites; while both deep sites of Site 7 (T- Wreck) had 86 different fish species each.

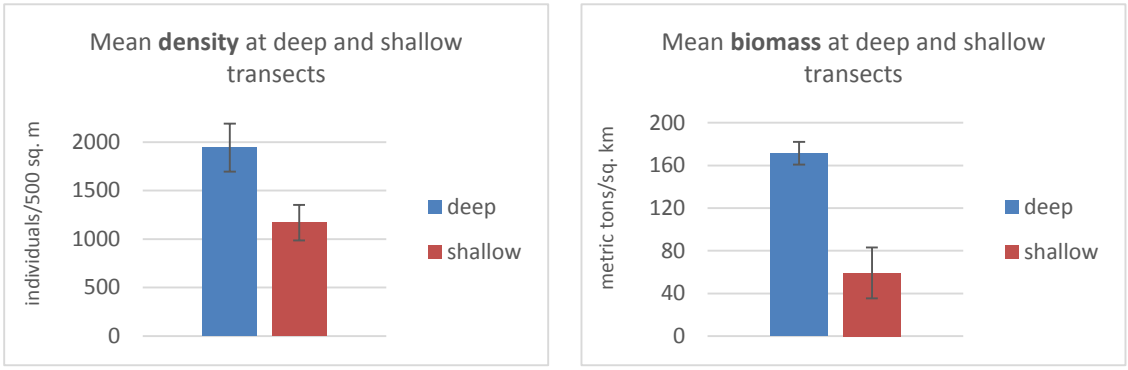

Figure 11. Mean abundance and biomass at depths.

The deep portion of Site 2A (Seafan Alley) has the highest reef fish density at 2,857 individuals/500 m^2 while the shallow portion of Site 4A has the lowest density with only 452 individuals/500 m^2. The mean fish density for this year is 1557 individuals/500 m^2. An encounter with a meter-long Whitetip reef shark *Triaenodon obesus* and an 800-cm Humphead wrasse *Cheilinus undulatus* significantly influenced the biomass output of Site 2A – deep, making it the highest in terms of biomass with 304.49 mt/km^2. In contrast, Jessie Beazley A – shallow, only registered fish biomass of 17.96 mt/km^2.

The top 15 families and species in terms of abundance and biomass are shown in (Annex 7. Top 15 fish families and species in terms of biomass in the 2014 FVC Peach fairy basslet *Pseudanthias dispar* ranked first in terms of abundance at 6,774 total individuals recorded. Hence, anthiases (Family Serranidae sub. Anthiinae) also ranked first among families in terms of abundance at 15,897 total individuals. Parrotfishes (Family Scaridae) were the highest contributors in terms of biomass this survey at 324.38 mt/km^2 with unicornfishes (Family Acanthuridae sub. Nasinae) ranking second with 321.41 mt/km^2. Bignose unicornfish *Naso vlamingii* ranked first in biomass among species with 255.65 mt/km^2.

Among the commercially important/target species, the Darkfin hind (*Cephalopholis urodeta*) was the most abundant with 234 total individuals, but too few to be included in the top 15. The coral indicator species Pyramid butterflyfish (*Hemitaurichthys polylepis*), last year's most abundant indicator species, is still in the top 15, with a total of 363 individuals (Annex 6. 15 Most abundant fish families and species in the 2014 FVC).

Unlike in the previous year's survey, the quantity of pelagic species (outliers) is relatively lower this year, although it comprised 32% of the total biomass in the deep transects and 23% in the shallow transects. The biggest school recorded, that of Dark-banded fusiliers *Pterocaesio tile*, was estimated to consist of only 100 individuals. Members of the said pelagic group are jacks and trevallies (*Carangidae*), fusiliers (*Caesionidae*), sharks (*Carcharhinidae*), tunas and mackerels (*Scombridae*), barracudas (*Sphyraenidae*), and unicornfishes (*Acanthuridae sub. Nasinae*). These species are known for their large sizes, large schools, and highly mobile nature.

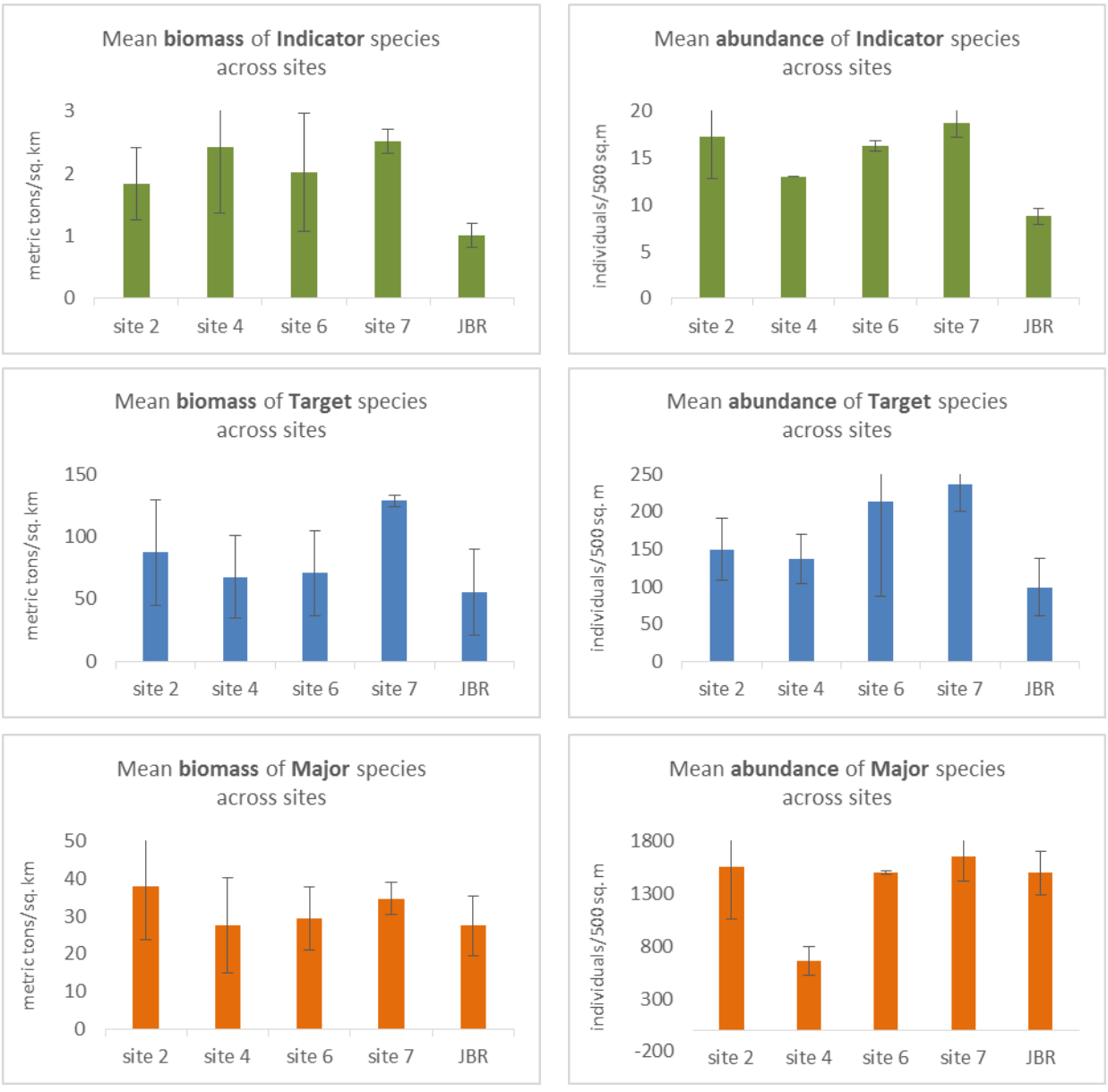

Figure 12. Mean fish abundance (individuals/500 m²) and biomass (metric tons/km²) across 2014 monitoring sites. Error bars represent standard error.

Four (4) Humphead wrasse *Cheilinus undulatus* were spotted and recorded this year. The biggest was about 0.8 meters while the smallest was around 0.15 meters. Two (2) Blacktip reef shark *Carcharhinus melanopterus* were also observed in the survey area, one was 1.5 meters long and the other was about a meter. Three Whitetip reef shark *Triaenodon obesus*, averaging almost a meter in length, were also recorded.

The observer of the second segment (second 50 m) of Site 7B – shallow was 15 meters short of completing the whole transect, thereby significantly influencing the mean biomass output of the said transect (Table 4). Still, Site 7 emerged as the monitoring area with the biggest mean biomass among all sites. Mean fish abundance, density, and biomass were generally higher in deep transects than in the shallow ones.

Table 4. Density and biomass values of the 2014 fish monitoring sites (refer toAnnex 9 for actual values)

	Site 4			Site 2			Site 6		
	deep	shallow	**mean**	deep	shallow	**mean**	deep	shallow	**mean**
Density (ind./500 sq.m)	1047	568	**807**	2488	963	**1725**	1943	1530	**1736**
Target	183	91	137	208	92	150	393	35	214
Coral Indicator	13	13	13	24	11	17	17	16	16
Major	851	464	657	2257	860	1559	1533	1480	1506
Biomass (mt/sq.km)	163.98	31.01	**97.50**	208.10	46.04	**127.07**	163.07	40.88	**101.97**
Target	114.49	20.54	67.52	147.36	27.15	87.25	118.54	22.63	70.58
Coral Indicator	3.92	0.92	2.42	2.66	1.01	1.84	3.36	0.68	2.02
Major	45.57	9.55	27.56	58.09	17.88	37.99	41.17	17.57	29.37

	Site 7			JBR		
	deep	shallow	**mean**	deep	shallow	**mean**
Density (ind./500 sq.m)	2287	1529	**1908**	1956	1256	**1606**
Target	287	186	236	153	46	99
Coral Indicator	17	21	19	10	8	9
Major	1984	1323	1653	1794	1203	1498
Biomass (mt/sq.km)	178.12	153.42	**165.77**	143.79	24.16	**83.98**
Target	135.08	121.97	128.52	103.83	7.08	55.45
Coral Indicator	2.24	2.79	2.51	1.29	0.73	1.01
Major	40.80	28.67	34.73	38.68	16.35	27.51

Site 7 (T-Wreck) had the highest mean concentration of coral indicator species (19 ind./500 m^2), which translated to a mean biomass value of 2.51 mt/km^2. Indicator species, particularly Chaetodontids, mostly feed on algae, while some are exclusive corallivores. The presence of such group indicates that the coral populations in the area are in good shape (Sabater 2002). Commercially important/target species were highest in Site 7 in terms of both abundance and biomass (See Figure 3).

Families which are said to be commercially important are *Acanthuridae*/surgeonfishes and unicornfishes, *Labridae*/wrasses, *Lethrinidae*/emperors, *Lutjanidae*/snappers, *Scaridae*/parrotfishes, *Serranidae*/groupers, and *Siganidae*/rabbitfishes. Remaining families that did not belong to either indicator or commercially important groups were referred to as major/other group (White and Palaganas 1991, Sabater 2002).

Special Sites: USS Guardian and Min Ping Yu Grounding Sites

Two grounding incidents occurred in TRNP last year. First is the US minesweeper, USS Guardian (USSG), which crashed into the South Atoll in January damaging 2345.67 m^2 of coral reefs. Three months later, F/V Min Ping Yu (MPY) ran aground in the North Atoll, damaging 3902 m^2 of coral reefs. This year's survey is the first time that these grounding sites were assessed for both fish and coral communities. Two transects (deep and shallow) were established in the USSG grounding site and one deep transect was established at the MPY grounding site.

There were 83 different species of fish recorded at the USSG site from 41 genera belonging to 17 families. The mean abundance was 2,409 individuals/500 m^2 resulting to a mean biomass of 118.86 mt/km^2. This value exceeded the mean biomass of three out of the five regular monitoring sites. However, this may be due to the absence of a replicate station or to the two shark sightings in the deep transects (*Triaenodon obesus and Carcharhinus melanopterus*).

Table 5 Distribution of biomass and density of fish groups in USS Guardian and Min Ping Yu grounding sites.

USS Guardian grounding site	density ind./500 sq. m	biomass mt/sq. km
mean	**2409**	**118.86**
Target	141 (6%)	56.07 (47%)
Indicator	18 (1%)	3.32 (3%)
Major	2250 (93%)	59.46 (50%)

Min Ping Yu grounding site	density ind./500 sq. m	biomass mt/sq. km
mean	**892**	**56.01**
Target	117 (13%)	38.34 (68%)
Indicator	29 (3%)	2.57 (5%)
Major	746 (84%)	15.09 (27%)

An average of 18 individuals/500 m^2 of indicator species for USSG site may be a good sign for the recovery of the damaged site. Butterflyfishes are known to feed

on algae and graze on coral polyps which would play a key role in keeping algae populations at bay for the damaged corals to recover faster.

On the other hand, 82 species of fish under 43 genera belonging to 16 families were observed in the MPY grounding site, with a density of 898 individuals/500m2 and biomass of 57.14 mt/km^2. Continued monitoring of these sites in the coming years could yield information to help us better understand the rate and dynamics of recovery of damaged coral reefs as well as the critical factors which facilitate the recovery.

IV. CONCLUSION

The substantial decline in the overall mean fish biomass might be caused by temporal variations as shown by the data over the years. It can be recalled that in 2012, fish biomass reached an all-time low of 74.03 mt/km^2 in the deep transects but ballooned to 361.12 mt/km^2 in the same depth the following year. No major disturbances were noted during these years. Observer factor might have also played a big role in the variation from last year. Only two capable resource persons were able to survey all transects this year compared to three last year. The said bias may be rooted in the *length estimate* of the observers, the function which drives the biomass output aside from the specificity of the fish species. The fish abundance/density was set to individuals/500 m^2 in this survey (following White et al. 2008) and values can be said to be stable (1557 individuals/500 m^2). These values exceed the national standards (Alcala and Gomez 1985).

V. RECOMMENDATIONS

Through the years, transects of the fish surveys followed those of the coral/benthos survey; thus, both biomass and abundance outputs were subject to diver crowding in the survey areas. Separating the fish from the coral survey could eliminate this factor; thereby improving results. Five sites for the entire TRNP may be an underrepresentation of the park and increasing the number of sites could result in a more comprehensive outlook of the corals and fish within it.

Fish expeditions are also good to further explore the yet undiscovered resident fish species of TRNP. The fish database (both of TMO and CoRVA) needs updating, especially the values for *a* and *b* parameters.

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CHAPTER 4: SEABIRD COMMUNITY

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I. INTRODUCTION

The avifauna field work in the Tubbataha Reefs Natural Park (TNRP) was conducted from 8 May to 11 May, 2014. Visits to the South Islet, Black Rock, Amos Rock and the Ranger Station were conducted on 8 May. The Bird (North) Islet was visited on 9-11 May, and the Jessie Beazley Reef on 11 May. Evaluation of the Tubbataha Management Office (TMO) park rangers' monitoring and inventory reports since May 2013 was conducted in Puerto Princesa on 7 May. On 8 May, discussions and validation of the inventory methods were held and individual field work assignments finalized. However, deliberations on methods and other protocols continued on a daily basis.

The weather was dominated by high temperatures, occasionally up to 36° Celsius, absence of or limited wind and daily build-up of cumulus clouds ranging from 3/8 to 5/8 cloud cover. Rain showers in the evenings of 9 and 10 May 2014 were experienced.

II. METHODS

The field work followed methods laid out in 2004 and used since (see Jensen 2011). The team camped overnight at Bird Islet in order to carry out optimal work. South Islet was only visited in the afternoon of 8 May for a three-hour period. The counts

of the breeding bird populations represent a combination of count methods which includes direct day-time inventories of adults, immatures, juveniles, pulli, eggs and nests. In order to determine the total seabird population numbers, an afternoon count of birds flying in to roost was conducted from 4:30PM to 6:30PM on 9 May on Bird Islet (Annex 3). A partial in-flight count of booby species was piloted on South Islet on 8 May from 4:30PM to 5.30PM. For the first time, all dead birds were collected to assess the number of mortalities per species.

Calculations of breeding populations

The methods used to calculate the adult seabird populations are:

- the average distance monitoring results of the birds present at day time;
- day time counts birds as a results of nest counts;
- and, in-flight count results (Red-footed Booby *Sula sula,* Brown Booby *Sula leucogaster*, Brown Noddy *Anous stolidus*, Common Noddy *Anous minutus*).

An additional source of data is the result of species-specific control counts of adult Brown Booby, Great Crested Tern *Thalasseus bergii*, and Sooty Tern *Sterna fuscata* carried out at high tide along the shorelines and/or at 'Plaza' early evening or right before dawn. The results are used for comparison with the total result of the standardized day-counts and in-flight counts. The average distance monitoring results are also used as a comparative tool. However, where the total population of a species, such as the Red-footed Bobby on South Islet, has not been accurately determined, distance counts may be used. For calculation details per breeding species, see Table 6.

Table 6. Population calculation method per breeding species

Species	Calculation method
Red-footed Booby ***Sula sula***	The active adult breeding population size is expressed as the number of nests multiplied by two = the minimum number of active adult breeding birds. This result is compared to the day-time number of adult birds counted next to the eggs/pulli/juveniles. Whichever is higher represents the daytime population. The in-flight counts of adult birds are added to the day-time results in order to express the total minimum population. Although more adult birds arrive during the night and disperse to roost in the vegetation, there is currently no method used to capture this part of the population given that night counts with flashlight is highly disturbing to the birds.
	The results from South Islet are added to the result for Bird Islet in order to express the total population of the species present at TRNP in May.
	Reproduction rate is expressed as the number of nests, eggs and/or pulli, juvenile and immature birds recorded. For the immature population the result of the in-flight count is added.

Brown Booby ***Sula leucogaster***	The active adult breeding population size is expressed as the number of nests multiplied by two = the minimum number of active adult breeding birds. This result is compared to the day-time number of adult birds counted next to the eggs/pulli/juveniles. Whichever count is higher is used to represent the daytime population. The in-flight result of adult birds is added to the day-time result in order to express the minimum adult population present. Since more adult birds arrive during the night, two to three distance counts of adults present at dawn at 'Plaza" is carried out and the average result is compared with the combined results of the day-count and the inflight-count. Whichever of these two counts is the highest is used to express the maximum adult population present.
	Since the species is not breeding at South Islet, the count result from this islet is not included in the calculation of the total population of the species present at TRNP in May.
	Reproduction rate is expressed as the number of nests, eggs and/or pulli, juvenile and immature birds recorded. For the immature population the result of the in-flight count is added.
Eastern Reef Egret: ***Egretta sacra***	The number of adult birds counted at high tide represents the breeding population. The results from South Islet are added to the result for Bird Islet in order to express the total population of the species present at TRNP in May.
	Reproduction rate is expressed as the number of nests, eggs and/or pulli and juveniles found during the inventory of other breeding species.
Barred Rail ***Gallirallus torquatus***	The number of adult birds noted during counts of other breeding species represents the breeding population. Nests are difficult to find. If nest is found, one nest = 2 adult birds
Great Crested Tern ***Thalasseus bergii***	Population size is expressed as the number of eggs and/or pulli and juvenile found multiplied by two = minimum number of active breeding birds. This result is compared to the day-time number of adult birds counted next to the eggs/pulli/juveniles plus the average result of two to three high tide counts. Whichever of these two results is the highest is used to express the maximum breeding population. At South Islet where breeding only occurs irregularly, the number of territorial adult birds are counted and added to the figure for Bird Islet in order to express the total population of species present at TRNP in May.
	Since the species is not breeding at either Black Rock, Amos Rock or Ranger Station, the count result from these localities are not included in the calculation of the total population as it is presumed that the birds observed in these sites belong to the population from Bird (Bird Islet.
Sooty Tern ***Sterna fuscata***	Population size is expressed as the number of eggs and/or pulli and juveniles recorded multiplied by two = minimum number of active breeding birds. This result is compared to the day-time number of adult birds counted next to the eggs/pulli/juveniles and the average results of two to three evening estimates of the total adult population present at that time. Whichever of these three results is the highest is used to express the breeding population present at TRNP in May.
	Since the species is not breeding at South Islet, the count result from this islet is not included in the calculation of the total population as it is presumed that the birds belong to the population from Bird Islet.

Brown Noddy ***Anous stolidus***	The population size is expressed as the number of nests found multiplied by two = minimum number of adult birds. This result is compared to the day-time number of adult birds counted next to the nests, the number of birds roosting along the shoreline and the results of the in-flight count. The total of these three count is used to express the maximum adult population present at TRNP in May.
	At South Islet in-flight counts are not carried out and only two data sets are used to determine the population at this islet: The number of nests found compared to the number of adult birds counted next to the nests and the birds roosting along the shoreline and on the wreck. The results from South Islet are added to the result for Bird Islet in order to express the total population of the species present at TRNP in May.
	Reproduction rate is expressed as the number of nests, eggs and/or pulli, juveniles and immatures found during the inventory.
Black Noddy ***Anous minutus***	The population size is expressed as the average number of nests found during two to three separate counts multiplied by two = the total active breeding population. This result is compared to the average result of two to three daytime counts of birds carried out during nest counts plus the results of the in-flight count. Whichever of the two count results is the highest is used. The results from South Islet are added to the result for Bird Islet in order to express the total population of the species present at TRNP in May.
	Reproduction rate is expressed as the number of nests, eggs and/or pulli and juveniles found during the inventory. Because of the nest heights in the vegetation, total counts of eggs and pulli is only possible at Bird Islet. Immature (2nd- 3rd year old birds) cannot be separated from adult birds.
Eurasian Tree Sparrow ***Passer montanus***	Population size is expressed as presence of adult birds since nests have not been found.

Photos were taken from permanent photo documentation sites in Bird Islet and South Islet. These sites were established in 2004 in order to measure changes in land area and in vegetation. In addition, aerial photography was carried out. GPS readings were taken measuring the land area at high tide of both Bird Islet and South Islet. Major equipment used was handheld binoculars (10 x 50), spotting scope (20 x), GPS and cameras.

The results of the fieldwork was compared with data sets from the second quarter of previous years; mainly data sets data gathered by TMO staff from 2004 to 2014 but also by WWF Philippines from 1998 to 2004. These data sets are analyzed in detail in the 28- year seabird population development report released in 2009 and in the 2004 to 2006 and the 2010 to 2013 seabird field reports (see Jensen 2004, 2005, 2006, 2009, 2010, 2011, 2012 and 2013). In addition, relevant literature and published data on seabirds were used as references. David James, Australia, kindly assisted in the identification of juvenile frigate birds.

Vegetative cover was monitored by conducting a census of the condition of trees on the islets. Trees, mostly of *Argusia argentia and Pisonia alba (grandis),* were classified as either in optimal (good), moderately deteriorating (fair) or severely

deteriorating (bad) condition and lastly, as dead. The inventory of 2014 was carried out by the same team as all other years, except in 2013, and the trend over time is therefore comparable. Plastic debris, posing a potential threat the breeding populations, were removed by the field team.

III. RESULTS AND DISCUSSION

Monitoring of Changes in Land Areas

Independent sets of measurements were taken using two separate GPS instruments. There were minimal differences in the two measurement results: < 1.5% variation in the measurement of land area of Bird Islet and about 1% difference in the measurement result of the land area of South Islet, the size of 'Plaza' at Bird Islet and in the circumference of both islets. However, at Bird Islet fewer way-points were used compared to 2013 and the calculated increase in the overall land area is contradicted by a calculated decrease in the size of 'Plaza' and a decrease in the circumference of the islet.

Bird Islet: Overall, the land area has decreased by 45.5%; from 18,760 m^2 in 1981(Kennedy 1982) to about 10,220 m^2 in 2014 (

Table 7). From 2004, the first year when GPS - equipment was introduced, the decline in the land area is 40%.

The circumference of the islet is about 503 meters (548 meters in 2013) measured one meter along the vegetation line and the average high tide line. Based on fewer way-points used, the land area was measured to be 12,290 m^2 (10,936 m^2 in 2013) or 12% larger than in 2013. However, this result is not supported by a comparison of aerial photographs from 2013 and 2014 and the result of the calculation of the circumference or a more than 700 m^2 calculated decline in the land area of 'Plaza'. A conservative conclusion is that the size of Bird Islet is about 6% smaller than in 2013 with erosion mainly continuing along the northeastern coastline and along segments of the southern shoreline of 'Plaza'. Severe erosion of the island's core of cemented calcite sandstone along a portion of the Bird-eastern shoreline had continued since 2012 (Plate 1).

Table 7. Changes in the land area of Bird Islet, Tubbataha Refs Natural Park, from 1911- 2014. Source: Worcester 1911, Kennedy 1982, Heegaard and Jensen 1992, Manamtam 1996, WWF Philippines 2004 and Tubbataha Management Office 2004 – 2014.

Year	Land area (length x width)/circumference (m)	Land area (high tide) (m^2)	Open area ("Plaza") (m^2)	Major sandbars position and condition	Erosion area
1911	400 x 150	60,000	No data	>40,000 m^2 (?)	No data
1981	268 x 70	18,760	18,000	NW, SE	South coast
1991	>220 x 60	>13,200	>8,000 (est.)	NW, SE	South coast
1995	265 x 82	21,730	8,000 (est.)	NW, SE	South coast
2004	219 x 73	17,000	1,100	NW: Stable SE : Decrease	South coast
2005	No data	15,987	4,000 (est.)	NW, SE: Stable	South coast
2006	No data	14,694	7,900 (est.)	NW, SE: Stable	South coast
2007	No data	11,794	8,000 (est.)	NW, SE: Stable	South coast
2008	No data	10,921	< 8,000	NW: Decreasing SE : Stable	South coast
2009	No data	10,726	< 7,000	NW: Eroded SE : Decreasing	West coast
2010	No data	11,038	4,367	NW: Eroded SE : Stable	South coast
2011	No data	12,965	4,000 (est.)	NW: Stable SE : Stable	Bird East coast
2012	590	12,494	3,892	NW: Stable SE : Stable	Bird East coast
2013	548	10,936	4,840	NW: Decreasing SE : Stable	Bird East coast
2014	503	> 10,220	4,124	NW: Decreasing SE: Stable	Bird East coast

Plate 1. Severe erosion of Bird Islet's core of calcite sandstone photographed at the northeastern shoreline on 11 May 2014. Photo: Arne E. Jensen.

Plate 2. Aerial photography of Bird Islet 12 May 2014. Photo: Terry Aquino, TMO

South Islet: The circumference of the islet as measured in 2014 was about 236 meters or about the same as the previous year (230 meters in 2013). Based on one GPS-reading, the land area in 2014 was measured to about 2,926 m² (2,860m² in 2013). The variation may have been caused by inaccuracy of the equipment used.

Plate 3. Aerial photography of South Islet taken 12 May 2014. Photo: Yvette Lee.

South Islet was originally part of a large sandbar but a circumferential concrete seawall was constructed in 1978 (PLATE 3). The land area remained the same at least until 1981 based on photographic evidence from 1981 (Kennedy 1982). In 1991, an ocular inspection revealed that about 1/3 of the seawall had collapsed and it was partly submerged (Heegaard and Jensen 1992). The collapse of the seawall hastened the erosion of the islet.

Monitoring of Changes in Habitats

Bird Islet: In 2010 all larger trees on Bird Islet, many of which were observed to be growing well in 1991 (Heegaard and Jensen 1992), had died and most of the other remaining vegetation has deteriorated as a result of the intensive nesting density of the Red-footed Booby (Jensen 2010). The vegetation in 2014 is of trees in bush-

height and included about 200 very small trees in a deteriorating condition. Fifty eight percent of the vegetation is in severely deteriorating condition with a likelihood of dying soon (Table 8). The number of seedlings had declined by 90% to 27 seedlings compared to 275 seedlings recorded in 2012 (Table 8). Three coconut palms, planted several years back, were found dead and had collapsed.

Table 8. Condition of vegetation on Bird Islet, May 2011, 2012 and 2014.

Bird Islet															
Trees/Condition	**GOOD (optimal)**			**FAIR (moderately deteriorating)**			**BAD (severely deteriorating)**			**Dead**			**Total (live trees)**		
	2011	**2012**	**2014**	**2011**	**2012**	**2014**	**2011**	**2012**	**2014**	**2011**	**2012**	**2014**	**2011**	**2012**	**2014**
Dead trees										45	45	0			
Mature, live trees (> 3 feet)	16	0	0	19	22	73	8	3	105				**43**	**25**	**178**
Small, live trees (2- 3 feet)	33	154	17	38	0	30	20	0	92				**91**	**154**	**139**
SEEDLINGS (< 1 feet)	190	275	23	0	0	2	0	0	2				**190**	**275**	**27**
Total	**239**	**429**	**40**	**57**	**22**	**105**	**28**	**3**	**199**	**45**	**45**	**0**	**324**	**454**	**344**
Note: Coco Palms 2011: 3, 2012: 2, 2014: 0															

South Islet: The construction of the seawall in 1978 facilitated the establishment of a beach forest vegetation of about 100 trees with several trees up to about 30 feet tall. Up to 2009, almost all trees were in an optimal condition. In 2014 a total of 70 trees were recorded. Of these none were in a good condition compared to 6% in 2013, 59% in 2012 and 73% in 2011. Only one seedling was found in 2014 compared to 19 seedlings in 2011 (

Table 9). Of ten planted coconut palms found in 2013 all had died since May 2013. This is suspected to be the result of the establishment and increase in the nesting and roosting population of Red-footed Booby.

Table 9. Condition of vegetation on South Islet, May 2011, 2012 and 2014.

South Islet															
Trees/Condition	**GOOD (optimal)**			**FAIR (moderately deteriorating)**			**BAD (severely deteriorating)**			**Dead**			**Total (live trees)**		
	2011	**2012**	**2014**	**2011**	**2012**	**2014**	**2011**	**2012**	**2014**	**2011**	**2012**	**2014**	**2011**	**2012**	**2014**
Dead trees										6	9	22			
Mature, live trees (> 3 feet)	70	69	0	28	30	38	5	6	30				**103**	**105**	**68**
Small, live trees (2-3 feet)	2	1	1	0	0	0	0	0	0				**2**	**1**	**1**
Seedlings (<1 feet)	19	9	1	0	0	0	0	0	0				**19**	**9**	**1**
Total	**91**	79	**2**	**28**	**30**	**38**	**5**	**6**	**30**	**6**	**9**	**22**	**124**	**115**	**70**
NOTE: COCO PALMS 2011: 13, 2012: 14, 2014: 0															

Compared to the first set of photographs taken from fixed points established in 2004 (Jensen 2004), both Bird and South Islet have undergone radical changes in vegetation cover due to the increased presence of Red-footed Booby (

Table 9). The islets are in transition to become islets with minimal vegetation cover as was the case in 1981 (Kennedy 1982).

Review of Park Ranger's Monitoring Data

The TMO park rangers conduct inventories and distance counts of the breeding seabird species regularly as part of their seabird monitoring protocol. Since the externally-assisted inventory was conducted in May 2013, the Park Rangers made three inventories (direct counts): August 2013 (Bird Islet 3 August and South Islet 17 August), October 2013 (Bird Islet 18 November and South Islet 15 November), and February 2014 (Bird Islet 7 February and South Islet 8 February) and 11 distance counts of Bird Islet and South Islet. The TMO park rangers did not include in-flight counts or counts of other breeding species (Eastern Reef Egret, Barred Rail and Eurasian Tree Sparrow). The results revealed some important observations (Table 10).

Table 10. Selected results of TMO park rangers distance monitoring and inventories from June 2013 to April 2014.

Species	Bird Islet	South Islet
Red-footed Booby	Nest average of 432 nests equivalent to the nest count result for May 2014. High number of adults noted in November (2,010 individuals). If in-flight figure is added, this count represents > 3,200 adults (among the highest counts ever)	An average of > 300 nests recorded or 240 more nests than counted in May 2014.
Brown Booby	Unusual high number of adults in November 2013 (2,155 individuals) supported by comparative high distance monitoring data (1,764 individuals). If in-flight figure is added, the count represents more than 3,000 adult individuals, or the highest count since the TMO was established in 2001	No breeding population
Great Crested Tern	Population not present from end of September 2013 to March 2014	No breeding population
Sooty Tern	A second breeding population present from September to December 2013 (>1,946 individuals)	No breeding population
Brown Noddy	No population present from November 2013 to March 2014	No population present from November 2013 to March 2014
Black Noddy	No population present from November 2013 to March 2014	No population present from November 2013 to March 2014

Comparison of the results produced by TMO park rangers headed by Roy Magbanua and by Segundo Conales showed some differences in the population numbers of the two booby species. The differences may be real but could also be a result of different approaches to and accuracy in the use of methodologies.

Avifauna Inventory

A total of 28 different bird species were identified. For details, see Annex 3. Thirteen of the species were pelagic or coastal seabirds of which six species are breeding in the TRNP: Red-footed Booby, Brown Booby, Great Crested Tern, Sooty Tern,

Brown Noddy and Black Noddy. Other breeding species include Eastern Reef-Egret, Barred Rail, and Eurasian Tree Sparrow.

Overall, the seabirds of TRNP breed year round (Heegaard and Jensen 1992, Manamtam 1996, Kennedy et al 2000, Jensen 2009). The inventory result therefore represent only the breeding population present during the time of the inventory.

A total of 22,704 adult individuals of six breeding seabird species were recorded. Bird Islet hosts 64% of the population and South Islet which host 36% (

Table 11). The result for 2014 is lower than the results for 2013 (28,901 individuals) due to lower number in the populations of Great Crested Tern and Black Noddy. The combined total population of all breeding seabirds in 2014 was 68% higher than the first inventory conducted in 1981 (Kennedy 1982). In comparison, the 2013 and the 2012 inventories showed a minimum of 28,901 individuals and 30,168 individuals of adult breeding seabirds (Table 13). The count results for 2014 showed:

- an increase in the number of the adult Red-footed Booby population by 34% compared to the average population for the five-year period 2009-2013 (2,298 individuals). The number of actively breeding birds represented less than 30% of the population;

- compared to the five-year population average 2009-2013 (1,574 individuals) a stable population of Brown Booby with a very high reproduction rate;

- decreased presence of Great Crested Tern similar to the population size in 2010 (4,790 individuals) but 29% below the average for the five-year period 2009-2013 (6,766 individuals);

- decreased numbers of Sooty Tern, 28% below the average for the past five-year period (5,257 individuals);

- a continued increase in the population of Brown Noddy to the highest number counted since 1981 and just 12% below this baseline count (2,136 individuals);

- a 13% decrease in the Black Noddy population compared to the five-year average 2009-2013 (8,678 individuals).

Table 11. Total count numbers of adult resident seabirds present on Bird Islet and South Islet of Tubbataha Reefs Natural Park, 8-11 May, 2014.

Species/ Number	Bird Islet	South Islet	Total
RED-FOOTED BOOBY *Sula sula*	1,763	1,311	3,074
BROWN BOOBY *Sula leucogaster*	1,632	-	1,632
GREAT CRESTED TERN *Sterna bergii*	4,240	540	4,780
SOOTY TERN *Sterna fuscata*	>3,800	0	>3,800
BROWN NODDY *Anous stolidus*	1,284	578	1,862
BLACK NODDY *Anous minutus*	1,824	5,732	7,556
Total	**14,543**	**8,173**	**22,704**

Species Account

Data on the number of the immature, juvenile and pullus populations and on the number of eggs and nests recorded since 2004 on Bird Islet and South Islet are presented in Table 12. The combined results from the two islet of the adult populations and their development over time is shown in Table 13.

Table 12. Seabird breeding data (April to June 2004- 2014) Tubbataha Reefs Natural Park (Bird and South Islets). Source: WWF Philippines 2004 and Tubbataha Management Office 2004 – 2014.

Species/Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
RED-FOOTED BOOBY											
Immatures	398	1,455	606	597	780	477	677	795	799	426	134
Pulli/1st year juvenile	> 35	71	105	116	69	180	88	171	243	312	277

Eggs	+	+	+	+	+	+	+	68	>166	>185	>57
Nests	279	217	225	404	361	367	451	369	739	848	431
BROWN BOOBY											
Immatures	0	81	26	55	55	61	126	110	140	62	51
Pulli/1st year juvenile	43	2	7	12	91	126	125	225	46	28	266
Eggs	1	0	18	95	317	48	106	52	69	532	466
Nests	117	43	250	89	497	453	513	575	507	618	816
GREAT CRESTED TERN											
Immatures	0	1	0	0	0	0	0	0	0	0	0
Pulli/1st year juvenile	0	2,100	0	0	0	0	0	0	0	0	0
Eggs	0	1,829	0	0	0	515	2,341	498	1,456	3,939	2,120
SOOTY TERN											
Immatures	0	0	0	0	0	0	0	0	0	0	0
Pulli/1st year juvenile	0	1,750	0	458	0	846	0	1,764	0	1,258	0
Eggs	9	0	0	63	2	3	5,515	2	1,534	146	37
BROWN NODDY											
Immatures	0	2	0	0	0	4	1	1	2	3	5
Pulli/1st year juvenile	0	0	0	0	0	0	0	0	0	0	0
Eggs	0	0	0	3	17	126	438	253	>147	>607	679
Nests	115	124	20+	25+	218	384	653	571	709	771	931
BLACK NODDY											
Immatures	0	0	0	0	0	0	0	0	0	0	0
Pulli/1st year juvenile	0	0	0	0	0	0	0	0	0	0	0
Eggs	ND	+	0	+	+	430	+	+	>80	>700	>351
Nests	208	3,203	1,131	1,734	1,824	2,680	3,525	3,827	4,282	5,156	3,778

Red-footed Booby: Despite an increasing scarcity of optimal breeding space, the breeding population keeps increasing; from 2,202 individuals in 2013 to 3,074 adults in 2014, of which 43% were recorded on South Islet. The population is now 26% higher than in the baseline year of 2004 when about 2,435 adults were recorded.

Compared to 2013 the number of nests was remarkably lower: from 848 nests found in 2013 to 431 nests in 2014. The number of 277 pulli and juveniles was also lower by 11% compared to 2013. On South Islet, despite the presence of more than 1,300 adults, only 60 nests were recorded compared to 279 nests counted in 2013.

On Bird Islet a total of four adults and up to 52 pulli, mostly mummified, were found dead. It was the first time dead individuals were counted. The cause of death is unknown. But given that the species normally feeds and raises one pullus out of two eggs normally laid and incubated, it is assumed that the mortalities are natural.

Brown Booby: The breeding population is found on Bird Islet. The number of 1,632 adult birds was about the same as in 2013 (1,690 individuals) and 3.5% higher than the average for the five-year period from 2009 to 2013 (1,575 individuals). However, the population is about 57% lower than the count by Kennedy in 1981 (Kennedy 1982). Given the reduction of the land area by almost half since 1981 (45.5%), there may not be enough land area available for the species to increase its breeding population at one time to the 1981-levels. However, on 18 November 2013 the park rangers counted 2,155 adult birds. If in-flight data was gathered and added, the total would have been 3,082 individuals or the second highest count since the baseline year of 1981 (Kennedy 1982).

The species continues to be highly reproductive and the number of nest and eggs and pulli in 2014 was the highest ever documented (816 nests and 732 eggs and pulli). This very positive trend has continued since 2008. In contrast, the 51 immature birds counted was low and lower than the average since 2005, when 80 individuals were counted.

On Bird Islet, a total of six adults and up to 29 pulli were found dead. Several of the pulli found were less than a week old. As the species normally lays and incubates two eggs but feed and raise only one pullus, it is assumed that the mortalities are natural.

Great Crested Tern: The breeding population is confined to the Bird Islet where 4,780 adult were counted. This is the same population number as in 2010, but about 30% lower than the average of the five-year period 2009-2013 (6,766 individuals). Compared to the baseline population size in 1981 (Kennedy 1982), the population in 2014 is about 110% higher. In May 2014 the species was in the early stages of the egg-laying period and, as in 2013, the colonies were mainly found at the eastern section of 'Plaza'.

A relatively high number of adult birds, 540 individuals, were observed on South Islet. Several of these showed territorial and breeding behaviors. The species has not been documented breeding on the islet since 2003.

Sooty Tern: The breeding population is confined to the Bird Islet. In 2014 egg-laying birds were only found in a narrow vegetated area at the northwestern section of 'Plaza'. The species was in the very beginning of its breeding cycle and largely only present from sunset to dawn. Around sunset birds arrived from extreme heights in the sky and build up thermaling flocks of up to 250 individuals over the islet before they landed in smaller flocks of up to 20 individuals at a time. On land, individuals were either occupied with establishing breeding territories, defending these, or incubating. Very few birds, 37 individuals, were seen laying eggs.

The population number in 2014 is 28% lower than the average for the five-year period 2009-2013, 5,257 individuals, and 25% lower than the baseline population in 1981 (Kennedy 1982). However, the 2014-count of 3,800 adults was based on quick flash-light counts around 8 pm, and the population may very well turn out to be higher. The species undergoes cyclic breeding with fluctuation extremes. These range from years with near absence (1998, 2003) to peak years, (2010), where more than 10,800 individuals were present. The species is still absent from South Islet where it was last found breeding in 2002.

Brown Noddy: The species is found breeding on both Bird Islet (69%) and South Islet (21%). The total population in 2014 was 1,862 adults (1,688 adults in 2013) which was the highest count since Kennedy's count in 1981 (Kennedy 1982). The population is now just 12% lower than in 1981. A record high of 931 nests with 679 eggs was found during the inventory.

Black Noddy: The species is found breeding on both Bird Islet (24%) and South Islet (76%). In 2012, 77% of the population was breeding on South Islet. After a continued population increase since 2009, the 2014-population fell to 7,556 individuals with 3,778 nests. The percentage decline is the same on both Bird Islet and South Islet. This may be due to the decline in suitable vegetation in optimal condition, which serves as its nesting habitat (Table 8 and

Table 9). The population decline on Bird Islet since 2005 is more than 70%.

Other breeding species

Eastern Reef-Egret: In 2014, the breeding population of the Eastern Reef Egret on Bird Islet and South Islet was 11 adults, compared to 17 adults in 2013. Of two nests found, one nest contained four new-born pulli.

Barred Rail: The species was first documented in 2003 on both Bird and South Islets. In 2005 a nest was found on Bird Islet. In 2014 two individuals were recorded on Bird Islet. The species has not been recorded on South Islet since 2007.

Eurasian Tree Sparrow: The species was not recorded at Bird Islet where, except for 2011, it has been documented every year since 2004. On South Islet four individuals were noted. It has been recorded on South Islet annually since 2010.

New Species Records

One uncommon, migratory avifauna species was recorded for the first time within TRNP: Grey's Grasshopper Warbler *Locustella fasciolata*. The warbler species record is also a range expansion for Palawan.

Longman's beaked whale *Indopacetus pacificus,* was recorded only for the second time within TRNP on 11 May 2014 between Bird Islet and Jessie Beazley Reef and photo-documented by Godfrey Jakosalem. The species was first documented during the 2010 cetacean survey (Aquino 2010) (Figure *13*).

The whale species which is uncommon in the Philippines is known from pelagic waters off Arena Reef, Cagayancillo (Aquino 2010) and off Negros in the Sulu Sea and from a record in pelagic waters of Cagayan Province and a stranding in Davao City (Alava *et al.* 2012). Longman's beaked whale is found in the Indian and Southern Pacific Oceans. Sightings include Hawaii, Guadalupe Island, Maldives and the Gulf of Mexico. Strandings have occurred in Kenya, Somalia, South Africa, Birdern Australia, the Maldives, the Philippines, South Japan, and Sri Lanka (Dalebout 2003, Whaleopedia). The species is listed by IUCN as Data Deficient (IUCN 2014).

Figure 13. Longman's beaked whale first recorded within TRNP between the North Atoll and Jessie Beazley Reef in 2010. Photo: Teri Aquino

Table 13. Population results and population trend of breeding seabirds in Tubbataha Reefs Natural Park, April to June 1981 – 2014. Baseline years are underlined. Source: Kennedy 1982, Manamtam 1996, WWF Philippines 1998-2004 and Tubbataha Management Office 2004.

Species/ Numbers	1981	1995	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Trend (%)
Ground-breeders Sub-total	13,388	3,949	1,744	4,695	7,529	7,635	2,804	5,200	13,825	16,957	7,746	10,534	9,721	18,669	13,592	18,383	15,988	12,074	**- 10**
Masked Booby	150	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Extinct**
Brown Booby	3,768	1) 2,060	1,716	1,045	850	577	623	856	1,877	1,108	1,016	1,059	1,018	1,438	1,846	1,879	1,690	1,632	**- 57**
Great Crested Tern	2,264	335	0	150	414	4,160	2,064	2,808	7,858	6,894	4,700	4,875	4,433	4,790	6,160	8,653	9,794	4,780	**+ 111**
Sooty Tern	5,070	1) 910	28	3,000	6,228	2,123	2	1,200	3,500	7,920	>1,500	3,800	2,700	10,866	3,544	6,359	2,816	>3,800	**- 25**
Brown Noddy	2,136	643	0	500	37	775	115	336	590	1,035	530	800	1,570	1,575	2,042	1,492	1,688	1,862	**- 12**
Tree-breeders Sub-total	156	7,128	3,250	3,502	7,042	5,003	1,630	3,240	8,353	8,727	7,902	10,403	9,525	9,975	10,746	11,776	12,858	10,630	**+6,714**
Red-Footed Booby	9	0	0	2	44	43	20	2,435	1,947	1,877	2,902	2,513	2,220	2,331	2,395	2,340	2,202	3,074	**+ 26**
Black Noddy	147	7,128	3,250	3,500	6,998	4,860	1,610	805	6,406	6,850	> 5,000	7,890	> 7,305	7,644	8,351	9,436	10,656	7,556	**+ 6**
TOTAL	**13,544**	**11,077**	**4,994**	**8,197**	**14,571**	**12,638**	**4,434**	**8,440**	**22,178**	**25,684**	**15,648**	**20,937**	**19,246**	**28,644**	**24,338**	**30,159**	**28,846**	**22,704**	**+ 68**

Notes: 1) End of March data

IV. RECOMMENDATIONS

The Tubbataha Reefs Natural Park is a World Heritage Site and it is the only documented site in the Philippines of global importance for seabird conservation as well as the most important area of about seven breeding sites for seabirds of national importance. The Bird Islet and the South Islet and their seabird population are in need of continued monitoring and protection. Recommended seabird management initiatives include:

Methodology

1. Conduct a mini-workshop among the TMO rangers to level off approaches to and compliance with inventory methodologies in order to identify possible differences in approaches and to increase accuracy.

2. During inventories, include counts of other breeding species (Eastern Reef Egret, Barred Rail and Eurasian Tree Sparrow) and of the migratory Ruddy Turnstone. During distance monitoring, include counts of Ruddy Turnstone and Eastern Reef Egret.

3. Include count of the numbers of dead seabirds during inventories.

4. Investigate if mortalities are caused by plastic objects.

5. Institutionalize a protocol of regular removal of plastic debris from both Bird Islet and South Islet.

6. To increase capabilities of the park rangers, provide copies of the May Inventory Report at the Ranger Station.

Habitat

7. Increase planting of beach forest seedlings on South Islet.

8. Explore environmentally friendly, soft-engineering solutions to mitigate loss of land area on Bird Islet with a goal to increase it.

Species

9. Continue population and habitat monitoring, which includes monthly distance count estimations and four seasonal inventories in the months of January/February, May, August and October/early November.

10. Increase recapture of banded seabirds (Brown Booby, Sooty Tern and Black Noddy) to gain more population knowledge in dispersal movements, mortality rates, life expectancies etc.

11. Seek funding for sample radio-transmitter tacking and tracking of the adult and juvenile seabird species.

Public awareness and knowledge raising:

12. Seek funding for production of a video documentary on the seabirds of Tubbataha to be used in public media and educational campaigns.

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ANNEXES

ANNEX 1. 2014 MONITORING TEAMS

Benthos

Rowell Alarcon, Research Assistant TMO

Noel Bundal, Park Ranger TMO

Fish

Segundo Conales Jr, Researcher/Park Ranger TMO

Jerome Cabansag, Professor, UP-Visayas Tacloban Campus

Seabirds

Arne Jensen, Ornithologist

Angelique Songco, Protected Area Superintendent

Rowell Alarcon, Research Assistant TMO

Noel (Manny) Bundal, Park Ranger TMO

Segundo Conales Jr, Researcher/Park Ranger TMO

Jeric Dejucos, Research Assistant TMO

Ma. Retchie C. Pagliawan, Research Officer TMO

Darius Cayanan, MY Navorca

Ronald de Roa, MY Navorca

Jason Jed Delos Reyes, PCG

Lucio Familaran, PN

Willian Toledana, PN

Dennis Favila, LGU Cagayancillo

Narciso Cayao, LGU Cagayancillo

Teri Aquino, Research Volunteer TMO

Janet Oquendo, Volunteer TMO

Juan Carlos Gonzales, Professor and Curator, UP - Los Baños

Godfrey Jakosalem, Ornithologist, Philippines Biodiversity Conservation Foundation, Inc.

ANNEX 2. METHODS FOR FISH AND BENTHOS MONITORING

Fish Monitoring Methods (1997 – 2014)

Year	No. of sites surveyed	Transect belt	Method	Unit of measurement
1997 - 2000	Tubbataha - 7 JB – 2 (2000)	Two 50 x 10 m (50 m interval)	Fish Visual Census	# of species, density and biomass
2001	Tubbataha – 6 JB - 3			
2002-2004	Tubbataha - 7 JB - 3 (2004)			
2005-2006	Tubbataha - 7	One 50 x 5 m		
2007	Tubbataha - 7	Two 50 x 5 m (50 m interval)		
2008-2011	Tubbataha - 7 JB - 3			
2012-2013	Tubbataha - 4 JB - 1 2 stations per site			
2014	Tubbataha - 4 JB - 1 2 stations per site	Two 50 x 5 m (15 m interval)		

Benthos Monitoring Methods (1997 – 2014)

Year	Method/s	No. of sites surveyed	Unit of measurement	Remarks
1997 - 1998	Video transect	Tubbataha - 6 JB – 1 (1998)	% cover (live, hard, soft, abiotic and other fauna for deep and shallow transects)	JB added for monitoring in 1998
1999	Benthos point intercept	Tubbataha – 6		
2000	Benthos point intercept Video transect	Tubbataha - 7		
2001 - 2002	Benthos point intercept	Tubbataha - 6 JB - 2 (2001)		1 more site added in JB in 2001
2003 – 2004	Benthos point intercept Video transect	Tubbataha - 7 JB - 2 (2004)		
2005 - 2006	Line intercept transect	Tubbataha - 7		
2007 - 2011	Benthos point intercept	Tubbataha - 7 JB - 3 (2008 - 2011)		3 sites monitored in JB 2008 - 2011
2012	Benthos Reef Check Plus	Tubbataha - 4 JB- 1		
2013 - 2014	Benthos point intercept	Tubbataha - 4 ; JB - 1 Station A & B		2 stations established per site

ANNEX 3. BENTHIC COVER AT 10M AND 5M DEPTHS

Tubbataha Deep

Category	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MORTALITIES	2.40	0.55	5.10	13.65	17.61	9.23	3.09	4.17	8.66	13.09	18.57	19.83	10.13	2.70	3.52	0.34	0.00	0.47
HARD CORAL	46.21	41.50	30.80	31.95	32.99	33.94	30.22	39.59	45.88	35.08	48.06	39.08	36.49	35.78	51.62	53.19	54.00	45.38
SOFT CORAL	14.99	15.30	8.50	9.15	6.96	8.92	10.36	11.17	12.31	9.79	11.90	13.99	12.66	12.80	13.22	8.61	15.25	18.44
OTHER FAUNA	10.85	13.72	3.30	16.61	11.69	10.97	10.18	9.48	3.81	3.22	3.89	2.13	8.11	7.80	2.39	2.67	2.25	5.77
ALGAE	1.29	0.32	29.90	1.15	5.65	11.41	13.43	5.24	9.93	9.96	6.00	3.12	1.25	4.62	4.85	5.79	0.13	13.91
ABIOTIC	24.24	28.62	22.40	27.48	25.09	25.52	31.07	30.33	18.80	27.75	11.58	21.86	31.36	36.29	24.40	29.41	28.88	16.04
UNKNOWN	0.02	0	0	0	0	0	1.65	0.02	0.60	1.11	0	0	0	0	0	0	0	0
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.01	100.00	100.00

Tubbataha Shallow

Category	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Mortalities	24.73	5.26	5.70	5.18	16.82	20.29	20.69	26.64	11.57	3.61	1.67	0.00	0.25	0.92
Hard coral	31.59	39.53	28.92	49.13	48.14	56.10	54.70	37.25	43.95	37.96	52.86	50.08	60	72.34
Soft coral	4.30	6.52	3.02	10.32	3.26	3.39	8.55	7.74	4.01	11.19	10.80	14.39	6.75	5.47
Other fauna	10.09	6.16	2.78	3.33	4.08	2.32	2.37	1.62	0.71	6.02	2.55	4.00	2.375	4.23
Algae	1.85	16.26	26.15	3.99	6.03	9.28	2.19	3.38	0.43	5.48	6.26	16.79	0.25	2.23
Abiotic	27.26	26.26	30.95	28.06	21.28	8.00	11.50	23.38	39.33	35.74	25.87	14.76	30.25	14.80
Unknown	0.18	0	2.48	0	0.38	0.62	0	0	0	0	0	0	0	0
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

JBR deep

Category	*1998*	*2000*	*2001*	*2002*	*2004*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Mortalities	33.33	2.14	12.77	11.14	1.31	18.54	3.24	5.39	0.93	0.93	0	0
Hard coral	38.33	33.33	35.74	33.27	35.69	36.99	32.35	41.76	56.76	56.33	44.00	21.00
Soft coral	11.19	38.33	26.70	10.00	25.97	17.48	34.02	9.58	20.54	19.54	37.50	74.00
Others	1.43	13.57	8.71	22.40	5.14	6.02	3.33	7.75	0.88	0.78	0.50	0.13
Algae	2.14	1.43	0	14.84	11.11	3.66	8.43	11.21	4.56	4.46	0	2.25
Abiotic	13.57	11.19	16.08	8.35	20.78	17.32	18.63	24.31	16.32	17.94	18.50	2.63
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

JBR shallow

	2002	**2004**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
MORTALITIES	9.94	3.89	26.54	9.44	1.08	1.76	1.24	0	0
HARD CORAL	48.84	40.35	43.25	43.30	39.22	55.78	55.85	77	93.38
SOFT CORAL	11.65	17.97	7.76	21.08	6.01	15.05	15.77	7	5
OTHERS	2.99	4.15	4.39	1.86	6.93	4.02	3.81	4	0.13
ALGAE	19.94	5.58	2.36	4.71	2.29	15.78	15.37	0	0
ABIOTIC	6.65	28.05	15.69	19.61	44.48	7.60	7.97	12.5	1.5
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

ANNEX 4. 2014 BENTHIC COVER ACROSS SITES

Tubbataha deep sites

Category	Site 2A	Site 2B	Site 4A	Site 4B	Site 6A	Site 6B	Site 7A	Site 7B
Mortalities	0.63	0.25	0.75	0.125	1.125	0	0.375	0.5
Hard coral	49.03	41.50	49.00	42.875	32.875	47.25	43.5	57
Soft coral	26.16	35.25	8.38	12	2.75	17.5	29.25	16.25
Others	8.14	5.63	5.50	6.5	4.5	6.375	5.5	4
Algae	5.14	13.63	28.75	22.875	4.75	15	9.375	11.75
Abiotic	10.92	3.75	7.63	15.625	54	13.875	12	10.5
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Tubbataha shallow sites

Category	Site 2A	Site 2B	Site 4A	Site 4B	Site 6A	Site 6B	Site 7A	Site 7B
Mortalities	2.5	0.5	0.25	2.5	0.5	0.37	0.12	0.62
Hard coral	65.625	57	58.62	71.12	88.12	83.62	80.5	74.12
Soft coral	10.75	16.25	3.25	5	0.37	0	2.12	6
Others	2.75	4	2.75	0.5	2.12	6.875	6.5	8.37
Algae	0.375	11.75	2.5	0.125	0	2.375	0.5	0.25
Abiotic	18	10.5	32.62	20.75	8.87	6.75	10.25	10.62
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

JBR Deep station A

Category d	1	2	3	4
Mortalities	0	0	0	0
Hard coral	19.50	26.00	13.50	25.00
Soft coral	80.00	70.50	85.00	60.50
Others	0	0.00	0.50	0
Algae	0.50	2.50	1.00	5.00
Abiotic	0	1.00	0	9.50
Total	100.00	100.00	100.00	100.00

JBR Shallow station A

Category	1	2	3	4
Mortalities	0	0	0	0
Hard coral	94.00	93	94.5	92
Soft coral	3.00	6	4.5	6.5
Others	0.50	0	0	0
Algae	0	0	0	0
Abiotic	2.50	1	1	1.5
Total	100.00	100.00	100.00	100.00

ANNEX 5. ACTUAL VALUES OF BIOMASS ESTIMATES

YEAR	MT/KM2
1998	**137.06**
1999	**226.79**
2000	**293.11**
2001	**96.04**
2002	**348.44**
2003	**124.76**
2004	**169.87**
2005	**253.14**
2006	**324.15**

YEAR	MT/KM2
2007	**171.41**
2008	**268.96**
2009	**273**
2010	**258.50**
2011	**155.07**
2012	**74.03**
2013	**361.12**
2014	**171.41**

ANNEX 6. 15 MOST ABUNDANT FISH FAMILIES AND SPECIES IN THE 2014 FVC

TOP 15 FISH FAMILIES IN 2014 TRNP FVC (Abundance)		Total
Serranidae: subfamily Anthiinae	Anthiases	**15897**
Pomacentridae	Damselfishes	**14155**
Acanthuridae	Surgeonfishes (excluding Naso sp.)	**1401**
Balistidae	Triggerfishes	**823**
Chaetodontidae	Butterflyfishes	**765**
Labridae: subfamily Corinae	Wrasses (most are not commercially important)	**732**
Labridae	Wrasses	**617**
Serranidae: subfamily Epinephelinae	Groupers	**359**
Caesionidae	Fusiliers	**356**
Scaridae	Parrotfishes	**305**
Pomacanthidae	Angelfishes	**298**
Holocentridae	Squirrelfishes, Soldierfishes	**255**
Acanthuridae: Nasinae	Unicornfishes	**207**
Lethrinidae	Emperors	**129**
Zanclidae	Moorish Idols	**115**

TOP 15 FISH SPECIES IN 2014 TRNP FVC (Abundance)		Total
Pseudanthias dispar	Peach fairy basslet: *Anthiinae*	**6774**
Chromis margaritifer	Bicolor chromis: *Pomacentridae*	**5358**
Pseudanthias huchtii	Red-cheeked fairy basslet: *Anthiinae*	**4598**
Pseudanthias tuka	Yellowstriped fairy basslet: *Anthiinae*	**3573**
Chromis ternatensis	Ternate chromis: *Pomacentridae*	**2717**
Chromis weberi	Weber's chromis: *Pomacentridae*	**1632**
Chromis xanthura	Paletail chromis: *Pomacentridae*	**965**
Pomacentrus auriventris	Goldbelly damsel: *Pomacentridae*	**658**
Pseudanthias smithvanizi	Princess anthias: *Anthiinae*	**600**
Ctenochaetus striatus	Striated surgeonfish: *Acanthuridae*	**597**
Odonus niger	Red-toothed triggerfish: *Balistidae*	**525**
Dascyllus reticulatus	Reticulate dascyllus: *Pomacentridae*	**482**
Chromis amboinensis	Ambon chromis: *Pomacentridae*	**453**
Hemitaurichthys polylepis	Pyramid butterflyfish: *Chaetodontidae*	**363**
Pseudanthias squamipinnis	Sea goldie: *Anthiinae*	**347**

Common names obtained from *Fishbase.org*. 28 Aug 2014

ANNEX 7. TOP 15 FISH FAMILIES AND SPECIES IN TERMS OF BIOMASS IN THE 2014 FVC

TOP 15 FISH FAMILIES IN 2014 TRNP FVC (Biomass)		Total (MT)
Scaridae	Parrotfishes	**324.38**
Acanthuridae: Nasinae	Unicornfishes	**321.41**
Acanthuridae	Surgeonfishes (excluding Naso sp.)	**303.28**
Carangidae	Jacks, Trevallies	**262.28**
Pomacentridae	Damselfishes	**259.54**
Balistidae	Triggerfishes	**213.19**
Chaetodontidae	Butterflyfishes	**122.26**
Carcharhinidae	Sharks	**117.05**
Serranidae: subfamily Anthiinae	Anthiases	**112.06**
Serranidae: subfamily Epinephelinae	Groupers	**107.60**
Holocentridae	Squirrelfishes, Soldierfishes	**73.66**
Caesionidae	Fusiliers	**68.58**
Lutjanidae	Snappers	**59.47**
Lethrinidae	Emperors	**53.29**
Haemulidae	Sweetlips, Grunts	**50.70**

TOP 15 FISH SPECIES IN 2014 TRNP FVC (Biomass)		Total (MT)
Naso vlamingii	Bignose unicornfish: *Nasinae*	**255.65**
Caranx melampygus	Bluefin trevally: *Carangidae*	**223.58**
Acanthurus mata	Elongate surgeonfish: *Acanthuridae*	**153.53**
Scarus microrhinos	Steephead parrotfish: *Scaridae*	**140.82**
Chromis xanthura	Paletail chromis: *Pomacentridae*	**130.98**
Odonus niger	Red-toothed triggerfish: *Balistidae*	**120.96**
Ctenochaetus striatus	Striated surgeonfish: *Acanthuridae*	**97.51**
Hemitaurichthys polylepis	Pyramid butterflyfish: *Chaetodontidae*	**68.57**
Cetoscarus bicolor	Bicolour parrotfish: *Scaridae*	**58.99**
Carcharhinus melanopterus	Blacktip reef shark: *Carcharhinidae*	**58.60**
Triaenodon obesus	Whitetip reef shark: *Carcharhinidae*	**58.45**
Pseudanthias tuka	Yellowstriped fairy basslet: *Anthiinae*	**47.12**
Cephalopholis urodeta	Darkfin hind: *Serranidae*	**45.76**
Naso hexacanthus	Sleek unicornfish: *Nasinae*	**44.62**
Pterocaesio tile	Dark-banded fusilier: *Caesionidae*	**35.22**

Common names obtained from *Fishbase.org*. 28 Aug 2014

ANNEX 8. ACTUAL VALUES OF MEAN DENSITY PER DEPTH AND PER FISH GROUP IN 2014 FVC

MEAN	**DENSITY** INDIVIDUALS/500 M^2	**BIOMASS** METRIC TONS/KM^2
SHALLOW (5 METERS)	1169	59.10
DEEP (10 METERS)	1944	171.41

MEAN	**DENSITY** IN **INDIVIDUALS/500 M^2**				
	SITE 2	SITE 4	SITE 6	SITE 7	JESSIE BEAZLEY
INDICATOR	17	13	16	19	9
TARGET	150	137	214	236	99
MAJOR	1559	657	1506	1653	1498

MEAN	**BIOMASS** IN **METRIC TONS/KM^2**				
	SITE 2	SITE 4	SITE 6	SITE 7	JESSIE BEAZLEY
INDICATOR	1.84	2.42	2.02	2.51	1.01
TARGET	87.25	67.52	70.58	128.52	55.45
MAJOR	37.99	27.56	29.37	34.73	27.51

ANNEX 9. ACTUAL DENSITY AND BIOMASS VALUES OF THE 2014 FVC (D=DEEP, S=SHALLOW)

	site 4				mean			site 2				mean		
	4A-D	4A-S	4B-D	4B-S	4-Deep	4-Shallow	4	2A-D	2A-S	2B-D	2B-S	2-Deep	2-Shallow	2
Species Richness	85	39	70	63	**77.5**	**51**	**64.25**	81	64	78	54	**79.5**	**59**	**69.25**
Family Richness	20	13	17	15	**18.5**	**14**	**16.25**	18	15	19	15	**18.5**	**15**	**16.75**
Abundance (ind/500m2)	1300	452	793	683	**1046.5**	**567.5**	**807**	2857	946	2119	979	**2488**	**962.5**	**1725.25**
Target Species	234	93	132	88	183	90.5	**136.75**	211	127	204	56	207.5	91.5	**149.5**
Coral Indicator Species	13	10	13	16	13	13	**13**	23	11	24	11	23.5	11	**17.25**
Other Species	1053	349	648	579	850.5	464	**657.25**	2623	808	1891	912	2257	860	**1558.5**
Biomass (MT/km2)	207.49	19.73	120.47	42.30	**163.98**	**31.01**	**97.50**	304.49	52.58	111.71	39.51	**208.10**	**46.04**	**127.07**
Target Species	173.56	11.78	55.42	29.31	114.49	20.54	**67.52**	219.52	31.24	75.19	23.05	147.36	27.15	**87.25**
Coral Indicator Species	2.95	0.76	4.89	1.08	3.92	0.92	**2.42**	2.81	1.13	2.51	0.90	2.66	1.01	**1.84**
Other Species	30.97	7.19	60.17	11.91	45.57	9.55	**27.56**	82.16	20.21	34.01	15.56	58.09	17.88	**37.99**

	site 6				mean			site 7				mean		
	6A-D	6A-S	6B-D	6B-S	6-Deep	6-Shallow	6	7A-D	7A-S	7B-D	7B-S	7-Deep	7-Shallow	7
Species Richness	76	45	78	51	**77**	**48**	**62.5**	86	61	86	55	**86**	**58**	**72**
Family Richness	21	11	18	13	**19.5**	**12**	**15.75**	12	15	20	16	**16**	**15.5**	**15.75**
Abundance (ind/500m2)	1345	1659	2540	1401	**1942.5**	**1530**	**1736.3**	2805	1308	1769	1750	**2287**	**1529**	**1908**
Target Species	232	30	554	40	393	35	**214**	209	284	365	87	287	185.5	**236.25**
Coral Indicator Species	16	10	18	21	17	15.5	**16.25**	14	22	19	20	16.5	21	**18.75**
Other Species	1097	1619	1968	1340	1532.5	1479.5	**1506**	2582	1002	1385	1643	1983.5	1322.5	**1653**
Biomass (MT/km2)	121.05	43.35	205.08	38.42	**163.07**	**40.88**	**101.97**	129.95	223.61	226.29	83.24	**178.12**	**153.42**	**165.77**
Target Species	89.23	27.06	147.84	18.21	118.54	22.63	**70.58**	92.42	187.48	177.73	56.46	135.08	121.97	**128.52**
Coral Indicator Species	2.40	0.42	4.33	0.94	3.36	0.68	**2.02**	1.42	2.41	3.06	3.17	2.24	2.79	**2.51**
Other Species	29.43	15.87	52.90	19.27	41.17	17.57	**29.37**	36.10	33.72	45.50	23.61	40.80	28.67	**34.73**

	JBR				mean		
	JBA-D	JBA-S	JBB-D	JBB-S	JBR-Deep	JBR-Shallow	JBR
Species Richness	71	43	75	41	**73**	**42**	**57.5**
Family Richness	14	10	15	12	**14.5**	**11**	**12.75**
Abundance (ind/500m2)	2144	1214	1768	1298	**1956**	**1256**	**1606**
Target Species	203	61	102	31	152.5	46	**99.25**
Coral Indicator Species	10	5	10	10	10	7.5	**8.75**
Other Species	1931	1148	1656	1257	1793.5	1202.5	**1498**
Biomass (MT/km2)	214.86	17.96	72.73	30.36	**143.79**	**24.16**	**83.98**
Target Species	171.90	7.21	35.76	6.95	103.83	7.08	**55.45**
Coral Indicator Species	1.30	0.53	1.27	0.92	1.29	0.73	**1.01**
Other Species	41.65	10.22	35.70	22.48	38.68	16.35	**27.51**

ANNEX 10. IN-FLIGHT TO ROOST STATISTICS OF BOOBIES AND NODDIES ON BIRD ISLET, TUBBATAHA REEFS NATURAL PARK 2005 – 2014

Species/Numbers	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Average (Apr-May) counts**
	May 10: 17.00-18.15	Apr 28: 16.30-18.25	May 8: 16.30-18.20	May 7: 16.00-18.00	May 7: 16.30-18.30	May 13: 16.30-18.30	May 9: 16.30-18.30	May 10: 16.30-18.30	May 10: 16.30-18.30	May 9: 16.30-18.30	
Red-footed Booby											
Adult: Daytime	823	655	631	1,241	686	982	1,011	382	830	950	
In-flight	960	1,171	2,082	1,272	1,534	1,259	1,259	1,680	779	813	
Adjusted to 2-hour period	1,012	1,222	2,271	1,272	1,534	1,259	1,259	1,680	779	813	
Total	1,835	1,877	2,902	2,513	2,220	2,241	2,270	2,062	1,609	1,763	
%-in-flight population	55%	65%	78%	51%	69%	56%	55%	81%	48%	46%	**60.4%**
Immature: Daytime	514	>205	275	239	179	194	106	174	125	61	

In-flight	588	401	295	541	298	483	483	249	149	5	
Adjusted to 2-hour period	941	419	322	541	298	483	483	249	149	5	
Total	1,455	>606	597	780	477	677	589	423	274	66	
%-in-flight population	65%	69%	54%	69%	63%	71%	82%	59%	54%	8%	**59.4%**
Brown Booby											
Adult: Daytime	629	405	660	691	650	930	1,338	1,060	968	834	
In-flight	360	225	326	368	368	508	508	819	722	798	
Adjusted to 2-hour period	576	235	356	368	368	508	508	819	772	798	
Total	1,205	640	1,016	1,059	1,018	1,438	1,846	1,879	1,690	1,632	
%-in-flight population	48%	37%	35%	35%	36%	35%	28%	44%	43%	49%	**39.0%**
Immature: Daytime	22	20	21	20+?	22	30+	96	81	30	13	
In-flight	37	6	31	34	39	96	14	59	32	39	
Adjusted to 2-hour period	59	6	34	34	39	96	14	59	32	39	
Total	81	26	55	54	61	126	110	140	64	51	

%-in-flight population	73%	23%	62%	63%	64%	76%	13%	42%	50%	76%	**54.2%**
Brown Noddy											
Adult: Daytime							618	607	1,004	1,045	
In-flight							1,124	525	142	239	
Adjusted to 2-hour period							1,124	525	142	239	
Total							1,742	1,132	1,146	1,284	
%-in-flight population							65%	46%	12%	19%	**35.5%**
Black Noddy											
Adult: Daytime							421	1,098	2,243	1,506	
In-flight							1,334	1,124	272	318	
Adjusted to 2-hour period							1,334	1,124	272	318	
Total							1,755	2,222	2,515	1,824	
%-in-flight population							76%	51%	11%	17%	**38.8%**

ANNEX 11. SYSTEMATIC LIST OF AVIFAUNAL RECORDS, BIRD AND SOUTH ISLETS AND JESSIE BEAZLEY REEF, TUBBATAHA REEFS NATURAL PARK 8-11 MAY, 2014

Breeding species are indicated in bold letters. Taxonomic treatment follows IOC/Wild Bird Club of the Philippines 2014. Sequence follows Kennedy *et al.* 2000.

Status/Abundance (within Sulu Sea)	Species name	Number of individuals	Locality	Notes
Migrant Rare	Bulwer's Petrel *Bulweria bulwerii*	1	Bird of Jessie Beazley Reef	N 09 17.656, E119 25.060 Two more birds, probably of this species
Resident Locally uncommon	**Red-footed Booby** *Sula sula*	Adults: 1,763 Immatures: 66 Pulli/1st y. juv.: 220 Nests: 371	Bird Islet	
		Adults: > 1,311 Immatures: 68 Pulli/1st y. juv.: 57 Nests: 60	South Islet	
Resident Rare	**Brown Booby** *Sula leucogaster*	Adults: 1,632 Immatures: 51 Pulli/1st y. juv.: 266	Bird Islet	

		Nests: 816		
		Adults: 9	South Islet	Not breeding
		Immature (2nd year): 1?	South Islet	Same individual as on Bird Islet
Migrant/Resident? Locally uncommon	Great Frigatebird *Fregata minor*	Adults: 6 Immatures: 5	Bird Islet	Adults: 2 males + 4 females
		Adults: 10 Immatures: 2 Juveniles: 5	South Islet	Adults: 5 males + 5 females
Migrant Locally uncommon	Lesser Frigatebird *Fregata ariel*	Adults: 0 Immatures: 2	Bird Islet	Male + female
		Adults: 1 Immatures: 3 Juveniles: 1	South Islet	Male
	Unidentified Frigatebird *Fregata sp.*	Juveniles: 2	Bird Islet	
Resident Uncommon	**Eastern Reef-Egret** *Egretta sacra*	Adults: 3	Bird Islet	Dark phase
		Adults: 8 Pulli: 4	South Islet	Dark phase

		Nests: 2		
Resident/Migrant Fairly Common	Little Heron *Butorides striata*	2	South Islet	
Resident Common	Yellow Bittern *Ixobrychus sinensis*	1	Bird Islet	
Resident/Migrant Locally Common	Eastern Cattle Egret *Bubulcus coromandus*	1	Bird Islet	
Resident Locally uncommon	**Barred Rail** *Gallirallus torquatus*	2	Bird Islet	
Resident Fairly Common	Watercock *Gallicrex cinerea*	1	South Islet	Same date and locality as previous year's record
Migrant Common	Grey Plover *Pluvialis squatarola*	2	Bird Islet	
Migrant Fairly common	Ruddy Turnstone *Arenaria interpres*	1	Bird Islet	
		2	Ranger Station	
Migrant Uncommon	Red-necked Phalarope *Phalaropus lobatus*	5	Black Rock	
		19	Pelagic	Migrating birds between North Reef and Jessie Beazley Reef
Resident Uncommon	Black-naped Tern *Sterna sumatrana*	8	Bird Islet	Six passing by and two on rocks at the reef crest
		2	South Islet	Two at the reef crest

Resident Fairly common	**Great Crested Tern** *Thalasseus bergii*	Adults: Eggs:	4,240 2,120	Bird Islet	Based on number of eggs
		Adults:	540	South Islet	Not breeding
		Adults:	50	Jessie Beazley	Not breeding
Resident Rare	**Sooty Tern** *Sterna fuscata*	Adults: Eggs:	3,800 37	Bird Islet	Nearly all adults only present at night
		Adults:	0	South Islet	
Migrant Fairly common	White-winged Tern *Chlidonias leucopterus*		10	Bird Islet	Migrating north
			6	South Reef	Migrating north
			5	Ranger Station	Feeding
Migrant Common	Whiskered Tern *Chlidonias hybrida*		1	South Islet	2nd year bird
Resident Locally rare	**Brown Noddy** Anous stolidus	Adults: Immatures: Nests:	1,264 2 642	Bird Islet	Based on number of nests. Actual counts of adults 991 individuals
		Adults: Immatures: Nests:	578 3 289	South Islet	Based on number of nests. Actual counts of adults 469 individuals
Resident Rare	**Black Noddy** *Anous minutus*	Adults: Nests:	1,824 912	Bird Islet	Based on number of nests. Actual count of adults was 1,350 individuals

		Adults: 5,732 Nests: 2,866	South Islet	Based on number of nests. Highest count of adults was 5,362 individuals
Resident/Migratory Uncommon	Brown Hawk-Owl *Ninox scutulata*	1	South Islet	One found dead 5555
Migratory Uncommon	Gray's Grasshopper Warbler *Locustella fasciolata*	1	Bird Islet	New record for Tubbataha Reefs and Palawan
Migrant Uncommon	Lanceolated Warbler *Locustella lanceolata*	2-3	Bird Islet	
Migrant Common	Yellow Wagtail *Motacilla flava*	1	Bird Islet	
		1	South Islet	
Migrant Uncommon	Pechora Pipit *Anthus gustavi*	1	South Islet	
Resident Common	**Eurasian Tree Sparrow** *Passer montanus*	0	Bird Islet	
		4	South Islet	

ANNEX 12. COMPARISON OF THE LANDSCAPE AND HABITATS SEEN FROM THE PERMANENT PHOTO DOCUMENTATION SITES ON BIRD ISLET AND SOUTH ISLET, MAY 2014 AND MAY 2004

Bird Islet:

Viewing angle for photo: facing NW 180° Comments: panoramic view Photo name code: BI 01

Photo name code: B1 01 Comments: Stitched images (Microsoft ICE) Date: May 09, 2014

Photo nos.: DSC_1203 – DSC_1208

Viewing angle for photo: facing NE 038°
Film no: 27, 28
Photo name code: BI 02
Comments: 2 shots good angle
Photo Doc Site NI No. 02 - 2004

Photo no (camera):
Photo no (negative):
Date: May 7, 2004

Photo name code: BI 02
Comments: 3 shots (Stitched by Microsoft ICE)
Photo nos.: DSC_1189 – DSC_1191
Date: May 9, 2014

Photo Doc Site NI No. 02 - 2014

Viewing angle for photo: facing E 067°
Film no: 14 Photo no (negative):
Photo name code: BI 04 Photo no (camera):
Comments: 1 shot plaza Date: May 7, 2004
Photo Doc Site NI No. 04 - 2004

Viewing angle for photo: facing E 067°
Film no: 14 Photo no (negative):
Photo name code: BI 04 Photo no (camera):
Comments: 1 shot plaza Date: May 7, 2004
Photo Doc Site NI No. 04 - 2004

Photo name code: BI 04
Comments: 1 shot plaza
Date: May 9, 2014
Photo Doc Site NI No. 04 - 2014

Photo name code: BI 04

Viewing angle for photo: facing S 165°

Comments: 3 shots panoramic view

Photo name code: BI 03

Film no: 22, 23, 24

Date: May 7, 2004

Photo no (camera):

Photo name code: BI 03
Date: May 10, 2014

Comments: 14 shots stitched (Microsoft ICE)
Photo no (camera): DSC_1217 – DSC_1222

South Islet:

Photo name code: SI 01
Date: May 9, 2014
Comments: single shot including parola at the background
Photo no (camera): DSC_0632