International Journal of Agricultural Technology 2014 Vol. 10(1):119-131
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Abundance and Density of *Holothuria Atra* and *Bohadschia Marmorata* in Marine Protected Areas (Mpas) of Guiuan Eastern Samar and Palompon Leyte, Philippines

Cabansag, Jerome Benedict P.*, Margarita T. de la Cruz, Ma. Brenda P. Gajelan-Samson and Francel A. Diaz

University of the Philippines Visayas Tacloban College, Tacloban City 6500, Philippines

Cabansag, Jerome Benedict P., Margarita T. de la Cruz, Ma. Brenda P. Gajelan-Samson and Francel A. Diaz (2014). Abundance and density of *Holothuria atra* and *Bohadschia marmorata* in Marine Protected Areas (MPAs) of Guiuan Eastern Samar and Palompon Leyte, Philippines. International Journal of Agricultural Technology 10(1):119-131.

This study looked at the abundance of natural populations of *Holothuria atra* and *Bohadschia marmorata* in Bagonbanua Marine Reserve and Fish Sanctuary (Bagonbanua) in Guiuan, Eastern Samar and Tabuk Marine Park Fish and Bird Sanctuary (Tabuk) in Palompon, Leyte, Philippines from July – December 2012. Purposive sampling using the belt transects ($100m^2$ – $250m^2$) was deployed to monitor densities in a chosen station on each island. Also, timed hand picking of individuals were carried out on three stations with the assistance of actual sea cucumber gatherers from around the area. Three to four months of belt transect data revealed that *H. atra* was always higher in densities in Tabuk compared to that of the Bagonbanua station. However, data from the gatherers show the complete opposite. This means that *H. atra* had a different distribution outside the belts. On the other hand, *B. marmorata exhibited higher densities* in Bagonbanua than in Tabuk, both along the belts and outside. The seemingly stable populations of the two species on very specific substrate warrant more investigation like sediment analysis that should go hand in hand with more density samplings.

Keywords: *Holothuria atra*, *Bohadschia marmorata*, Marine

Introduction

Studies have been proving that marine reserves or marine protected areas (MPAs) have a number of positive effects that include amplification in the area's species diversity, the species' numerical density, its biomass, and many more (Currie and Sorokin, 2009; Lester and Warner, 2009). Preliminary surveys on the Bagonbanua Marine Reserve and Fish Sanctuary (Bagonbanua) in Guiuan, Eastern Samar and Tabuk Marine Park Fish and Bird Sanctuary (Tabuk) in Palompon, Leyte revealed 468 individuals (belonging to nine spp.)

* **Corresponding author:** Cabansag, Jerome Benedict P.; **E-mail:** jeromebpc@gmail.com

in the former and 519 individuals (10 spp.) from the latter. From these numbers, *Holothuria atra* turned out to be one of the more abundant species in these areas. In the study of Hasan (2009) on sea cucumbers of the Red Sea, involving 12 species in total, it was found out that *H. atra* was almost always the most abundant species from their stations. Also, in Reunion Island as with other Indo-Pacific reefs, *H. atra* is the most common and abundant sea cucumber species (Conand 1996; Conand, 2004; Conand and Mangion, 2002; Jaquem and Conand, 1999; Uthicke, 2001). Though not as numerous as *H. atra*, *Bohadschia marmorata* on the other hand, proved to be consistently present in most areas initially surveyed.

Consequently, these two species were monitored from July 2012 to December 2012 for their ecological and biological parameters. Buckius *et al*. (2010) emphasized that MPAs have the ability to maintain higher sea cucumber abundance, although compliance with the MPAs objectives has a strong influence on the ecological outcome (Walters *et al*., 1999; Lovatelli *et al*., 2004). Hasan (2009) also suggested that unprotected areas can be subjected to heavy fishing that lowers species diversity and density. Although located at the opposite sides of the two mainlands of Samar and Leyte, both MPAs are situated on an island separated from the mainland and each have a long history of successful protection from illegal poaching. This means the sea cucumbers community structure and function are more independent from fishing pressure effects compared to the unprotected unmanaged areas.

With things assumed to be in their natural state, this study aims to compare the natural populations of *H. atra* and *B. marmorata* from the two MPAs. Specifically, the study aims (i) to establish density values for protected natural populations of *H. atra* and *B. marmorata*, (ii) to compare the densities of both species from the two areas and their stations, and (iii) to compare abundance values throughout the monthly samplings.

Materials and methods

Study Sites

The study was carried out in locations at the opposite sides of the two mainlands of Samar and Leyte (Figure 1). The two sites, Bagonbanua and Tabuk, are situated on much smaller islands and have long history of successful protection particularly from illegal poaching. For both sites, three (3) stations, e.g. S1, S2, and S3 were established for addressing abundance of each species. Also, on one of the stations of both sites, three permanent transect lines were established and monitored monthly for density. Coordinates were obtained with *Garmin GPSMAP 76csx* then data were analyzed in Manifold System 7.0.

Bagonbanua Island in Guiuan is located 11°03’16’’N to 11°03’22’’N and 125°39’41’’E to 125°39’50’’E and can be characterized by the dominance of mangroves (*Rhizopora spp*., *Aegiceras spp*.) all over the island itself. Seagrasses (*Thallasia spp*.) prevail on the eastern side up to north-eastern tip of the island and a reef patch on its northern tip.

Station 1 (Area: 9682.86 m^2). This station is situated at the eastern portion of the island. This is also where the three (3) 50m transect lines were established and monitored from August to December. This is mostly characterized by a sandy-rocky bottom where live and dead corals are seen. This is also where the most extensive seagrass, *e.g. Thallasia spp*. meadow around the island is situated. Surrounding the area are huge coralline boulders. The area (Figure 2, top row) seldom illustrates the types of substrate characterising the area.

Station 2 (8232.24 m^2). Located on the southern tip of island is this station very similar to the first station. Sand is also the dominant substrate with some portions of rubbles. Seagrasses (*e.g. Thallasia spp*.) and seaweeds (*e.g. Sargassum spp*.) also abound (Figure 2, middle row).

Station 3 (15526.28 m^2). The deepest station located at the north-western part of the island where live hard corals dominate (Figure 2, bottom row). Depth averages 2.5 meters.

Tabuk in Palompon is very much the same as that of Bagonbanua with mangals (*e.g. Avicennia spp*.) predominantly occupying most of its land mass. Tabuk’s larger land area, and consequently the enormity of its protected area is its main difference from Bagonbanua (Figure 3).

Station 1 (98070.71 m^2). Located at the island’s southeastern side, this station (Figure 3, top row) is an almost barren landscape being almost fully exposed during low tide and is very much characterized by a sandy-silt to sandy-muddy substratum with very few coral heads (mostly dead), sea anemones, and mobile molluscs.

Station 2 (165240.99 m^2). Situated oppositely at the southwestern portion of the island, this sandy rocky station (Figure 3, middle row) is dominated by seagrassess, interspersed with live and dead corals.

Station 3 (72973.70 m^2). Predominantly sandy-muddy wherein a vast extent of sargassum and seagrassess are spread over a significant area (see Figure 3, bottom row). Bordered by vast mature *Avicennia spp.,* this is where the great number of *H. atra* was initially observed and subsequetly monitored.

Data Sampling

Initial area reconnaissance was done by skindiving all around both islands coupled with confirmation from people involve in managing the sanctuaries.

Consequently, three stations, *i.e.* 1, 2, and 3, (see Figures 1 – 3) were established and purposively sampled in Bagonbanua and Tabuk for monitoring *H. atra* and *B. marmorata* over a maximum period of five months, *i.e.* July 2012 until December (with the exception of November) of the same year. From these stations monthly timed hand-picking, *i.e.* targeting only the two species, by hired sea cucumber gatherers were carried out. The gatherers were instructed to carry out the collection within a specified area over a period of one hour. Total catch was then divided by the total area where collection took place. This roughly approximated the density for that station.

Permanent belt transects were also utilized to compute for the density. For each site, one station was designated as the location of the three (3) permanent belt transects. Station 1 in Bagonbanua was the source of the density data collected from the three 50m lines laid from August until December. For all lines geographic coordinates were taken for the 0m mark as well as on the 50m mark. The lines had to be re-laid each and every monthly survey using their starting and ending points as guides. After relaying the actual line, counting of sea cucumber individuals then commenced within the 250m^2 area (50m x 5m) or within the lesser 100m^2 (50m x 2m) when water visibility is poor and/or too many individuals were present which could have jeopardized accuracy of the data in terms of losing counts. Station 3 was chosen as the spot in Tabuk, but monitoring commenced on the month of September. Density was computed by counting all individuals inside the belt area (100m^2 or 250m^2). Total counts per line were then divided by the corresponding area where the counts were taken. Furthermore, a minimum number of 10 individuals were also collected from each line for their length, weight, sex, and maturity stage determination (data for another study).

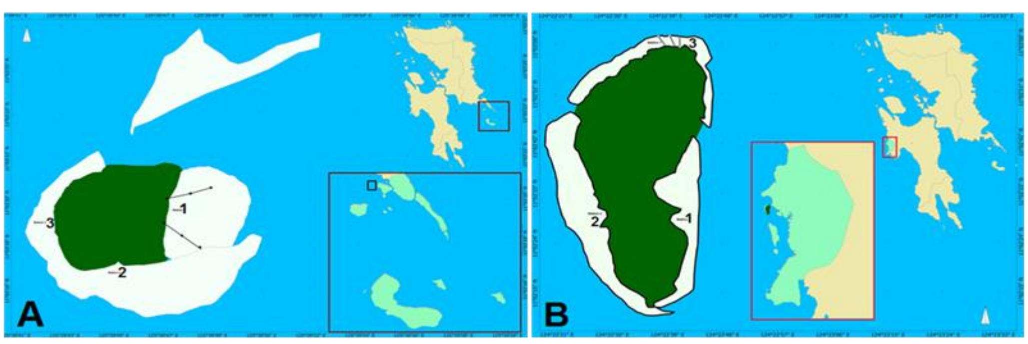

Fig. 1. Map showing the three stations and the three lines established on Bagonbanua Island (A) of Guiuan, Eastern Samar and on Tabuk Island (B) of Palompon, Leyte

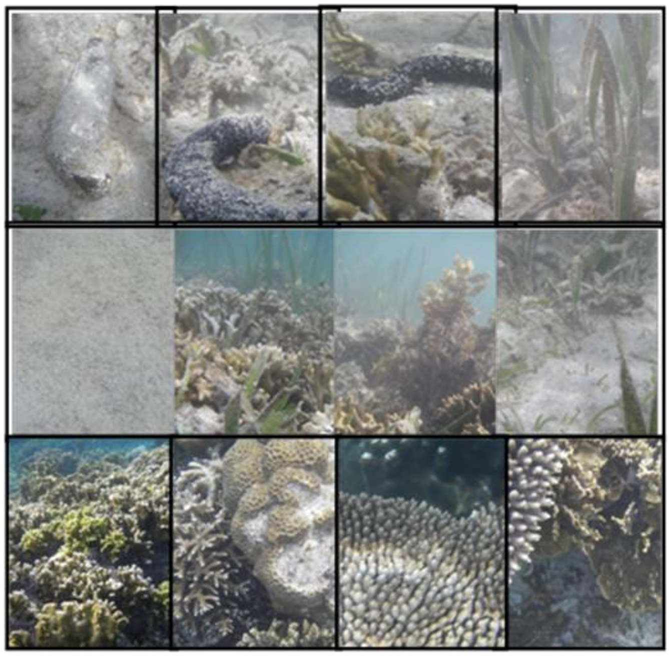

Fig. 2. Photographs of the dominant substrate types for each Bagonbanua stations

Fig. 3. Photographs of the dominant substrate types for each Tabuk stations

Results and discussions

From August until December (except November) the number of *H. atra* individuals from Tabuk outnumbered those observed in Bagonbanua by a factor of 2.31 ± 1.64 ind m^{-2}. This was also the case for most of the lines laid and monitored from both stations, *i.e.* Station 1 in Bagonbanua and Station 3 in Tabuk. Figure 4 shows the greatest density of 4.80 ind m^{-2} computed in the month of September for Tabuk, while the lowest value was computed at 0.09 ind·m^{-2} for Bagonbanua. Mangion, Taddei, Frouin and Conand (2004) found that densities in eutrophic areas can be as much as 3 ind·m^{-2}. The three lines in Bagonbanua, although exhibited density variations between lines and between each sampling months, there was really no particular trend/s observed unlike in Tabuk wherein the density for each of the lines was relatively similar over the three months of sampling with Line 1 having the least number of individuals and Line 3 the greatest. The low densities observed in Bagonbanua could partially be explained by the fact that unlike in Tabuk, *H. atra* shares the Bagonbanua area with nine other holothurian species (*e.g. H. fuscocinarea*, *Actinopyga lecanora*, *H. impatiens*, *H. scabra*, *Synapta maculata*, *Opheodesoma sp*., *Holothuria sp*., *Stichopus naso*, and *Stichopus horrens*). *H. atra* may probably be competing at the very least for space, if not also for its food. This is very significant especially as *H. atra* are found to show preference for specific habitat characteristics that are associated with their feeding and protection (Dissanayakea and Stefanssona, 2012). The highest mixed species density attained in Bagonbanua was 1.56 ind m^{-2}.

The combined Bagonbanua density for *H. atra* was 0.63 ± 0.18 ind·m^{-2}, while it was 2.94 ± 0.21 ind·m^{-2} in Tabuk (Figure 5). The small error, especially in the latter, could be explained by the adults' tendency to remain in place and to relocate only when living conditions become unsuitable (Young & Chia, 1982). In both MPAs, average monthly densities from all lines showed a general decreasing trend. Based on Figure 5, *H. atra* abundance was falling from the months of August and September. Density in Bagonbanua started at 0.89 ± 0.33 ind·m^{-2} in August finally ending at 0.56 ± 0.45 ind·m^{-2} in December. In Tabuk, the monthly average density gradually decreased from August to September to December, *i.e.* from 3.17 ± 1.82 to 2.90 ± 2.14 to 2.75 ± 2.08 ind·m^{-2}, respectively.

In the case of *B. marmorata*, densities were only calculated for Station 1 in Bagonbanua (Figure 6). Initial density counts employing three 50m lines in Tabuk revealed zero individuals. This means that besides exhibiting extremely low counts, the sea cucumber individuals were also spread out in distribution so much that no sea cucumbers fell inside any of the surveyed areas. During the next sampling months from August until December, although density counts for *B. marmorata* tend to increase through time, value remained very low, not even exceeding one individual per m^2. These resulted to 0.04 ind·m^{-2} ± 0.03 ind·m^{-2}. Its sudden disappearance in December, the last month of sampling, could never be fully explained, except that it is indicative of the species' very low density in the area.

Distribution of *H. atra* was primarily a factor of its substrate type. According to Dissanayakea & Stefanssona (2012), on their study of *H. atra* in Sri Lanka, the species has high preference towards shallow water (<10 m) seagrass habitat with sediments characterized by 2–3.5% organic content, 15–25% of gravel and coarse sand (0.7–1.2 mm). July to December data reveal that *H. atra* preferred to inhabit specific type of habitat as they were found mostly only in stations 1 and 3 in Bagonbanua and Station 3 in Palompon (Figure 7). Both stations are characterized by the predominance of sandy-silt substratum. Although slightly varying in depth, *i.e.* S3 of Tabuk being more exposed during low tide levels, they are all inhabited by a mixture of seagrasses (*e.g. Thalassia spp*.) and seaweeds (*e.g. Sargassum spp*.). What is interesting about Figure 7 is that although differing in values, Station 1 in Bagonbanua and Station 3 in Tabuk show similar trend in density fluctuation. From what the preceding section showed, the great difference in density values between the belt transects from the two MPAs were no longer reflected in Figures 7 and 8.The trend with reference to the lines overturned when the data on the numbers the gatherers caught were used. Bagonbanua stations had an overall density of 405 ± 266 ind·m^{-2}, 59.26% larger than Tabuk's 165 ± 75 ind·m^{-2} (Figure 8). This could have been brought about by the larger combined area of the stations, *i.e.* Tabuk being larger by 85% than that of Bagonbanua. This further implies that distribution of *H. atra* individuals observed from the lines did not reflect into the larger scale area of any or both of the sites.

Figures 9 and 10 shows that *B. marmorata* has a wider range than *H. atra* meaning it was found on more number of stations, *i.e.* stations 1, 2, and 3 in Bagonbanua and stations 1 and 2 in Tabuk. Furthermore, Bagonbanua collectively outnumbered the abundance in Tabuk by a factor of 99.98%.

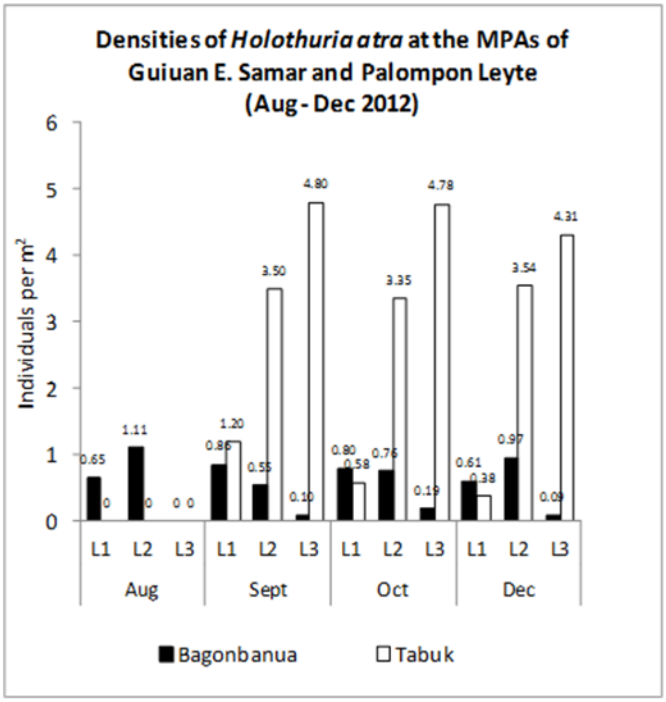

Fig. 4. Monthly densities of *Holothuria atra* encountered along the belts transects of Bagonbanua and Tabuk

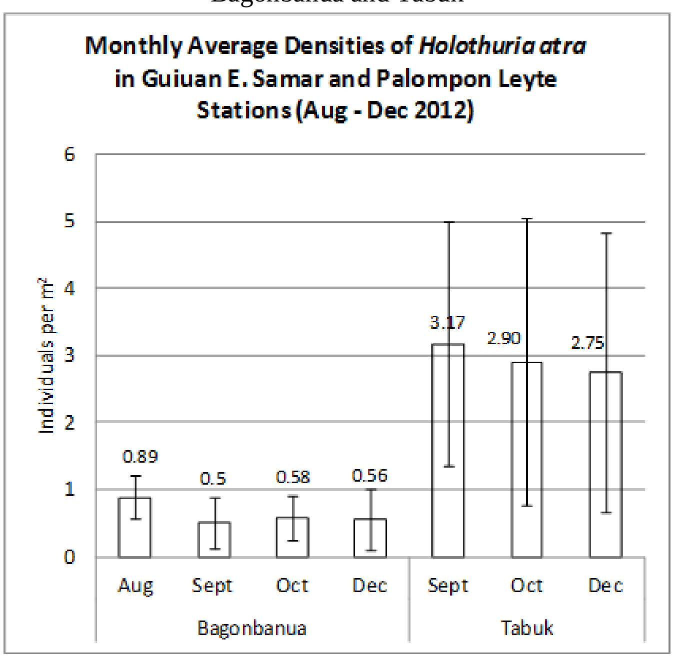

Fig. 5. Monthly average densities of *Holothuria atra* encountered along the belts transects of Bagonbanua and Tabuk

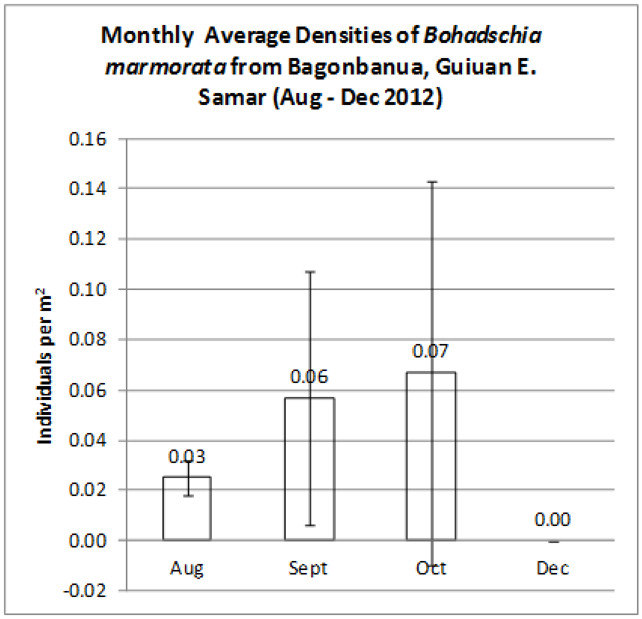

Fig. 6. Monthly average densities of *Bohadschia marmorata* along the belts transects in Bagonbanua

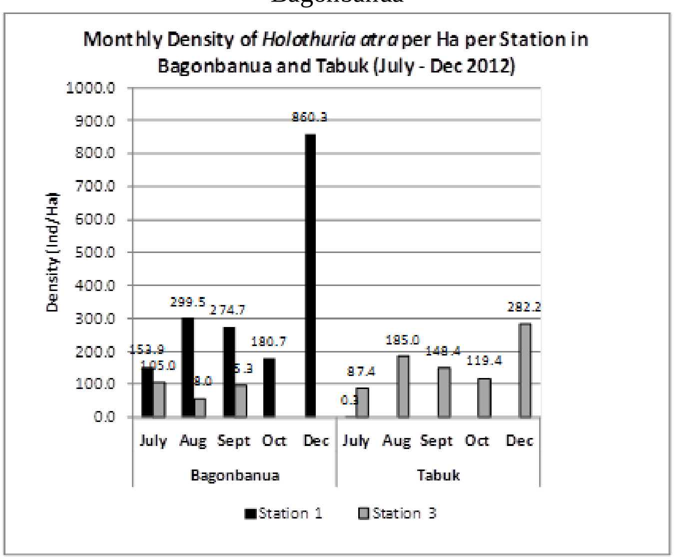

Fig. 7. *Holothuria atra* density for chosen stations in Bagonbanua and Tabuk (Jul –Dec 2012)

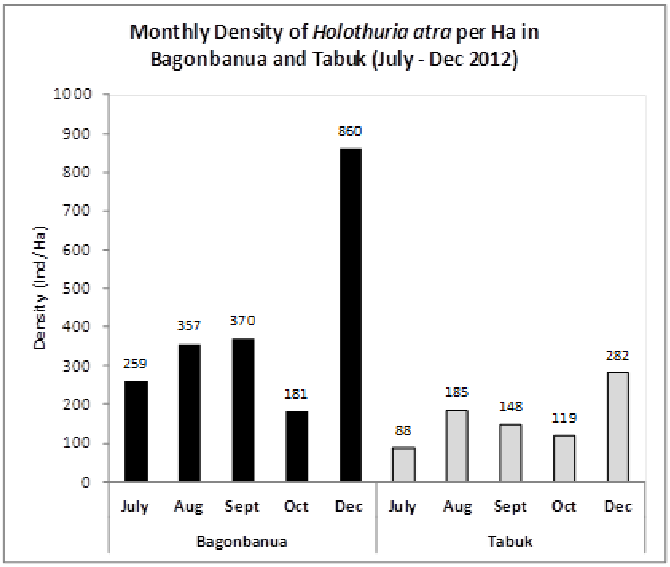

Fig. 8. Monthly average *Holothuria atra* density for Bagonbanua and Tabuk (Jul – Dec 2012)

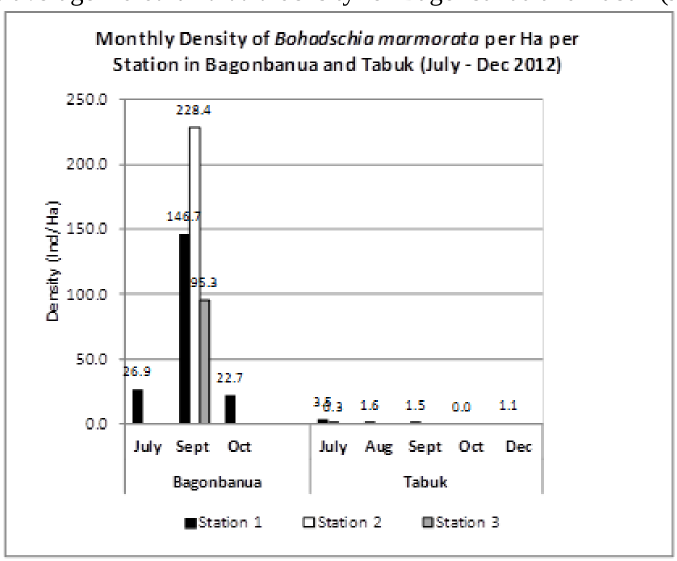

Fig. 9. Number of *Bohadschia marmorata* sea cucumbers caught per man-hour from the three stations in Bagonbanua (Aug – Dec 2012)

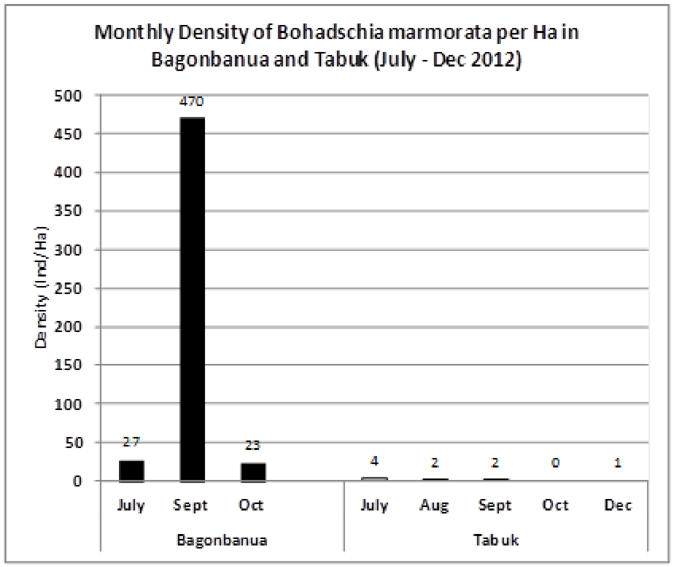

Fig. 10. Monthly average *Bohadschia marmorata* CPUE for Bagonbanua and Tabuk (Jul – Dec 2012)

Conclusion and Recommendation

Natural populations of *Holothuria atra* and *Bohadschia marmorata* were found almost constantly during each monthly sampling in Bagonbanua in Guiuan and Tabuk in Palompon. Based on the belt transects, *H. atra* was more abundant in Tabuk that generated an average density of 2.94 ± 0.21 ind·m^{-2}. Bagonbanua only averaged 0.63 ± 0.18 ind·m^{-2}. These densities were more or less maintained all throughout the three (Tabuk) to four (Bagonbanua) months of sampling. When the data on the gatherers were used however, numbers outside the lines show a different picture with the trend completely overturned. Bagonbanua stations had an overall density of 405 ± 266 ind·m^{-2}, 59.26% larger than Tabuk's 165 ± 75 ind·m^{-2}. This implies that distribution of *H. atra* individuals observed from the lines did not translate into the larger scale area of any or both of the sites. This was also the case for *B. marmorata* wherein an average density of 0.04 ± 0.05 ind·m^{-2} was computed for the Bagonbanua lines, while there were no *B. marmorata* encountered from the lines in Tabuk. Also, the fact that the two MPAs have similar monthly density trends, it means that there is seasonality in terms of *H. atra* abundance.

In order to determine what accounts for the relatively stable numbers exhibited by the two species and the seemingly site specificity of these species, it is strongly recommended to conduct thorough sediment analysis coupled with more samplings for density. Since there seems to be some degree of seasonality in terms of abundance, it would be better if this can be complemented by length-weight data, which is the focus of another study.

Acknowledgements

This research project was supported by the Commission on Higher Education (CHED) through the DOST-PCAARRD. The authors wish to thank Mary Pearl O. Escorial, Richelyn May P. Ignacio, and Rose Jean P. Diodoco for their invaluable assistance rendered for the completion of this study.

References

Abdel-Razek, F.A., Abdel-Rahman, S.H., El-Shimy, N.A. and Omar, H.A. (2005). Reproductive biology of the tropical sea cucumber *Holothuria atra* (Echinodermata: Holothuroidea) in the Red Sea coast of Egypt. Egyptian Journal of Aquatic Reserach. 31(2):383-402.

Buckius, C., Albert, S., Tibbetts, I. and Udy, J. (2010). Effect of Diel Activity Patterns and Harvesting Pressure on the Diversity and Biomass of Sea Cucumbers in Marovo Lagoon, Solomon Islands. Environmental Management 45:963–973.

Conand, C. (2004). Monitoring a fissiparous population of *Holothuria atra* on a fringing reef on Reunion Island (Indian Ocean). *SPC* Beche-de-mer Information Bulletin #20 – August 2004. pp. 22-25.

Conand, C. (1996). Asexual reproduction by fission in *Holothuria atra*: Variability of some parameters in populations from the tropical Indo-Pacific. *Oceanologica Acta* 19(3):209-216.

Conand, C. and Mangion, P. (2003). Sea cucumbers on Reunion Island fringing reefs: population diversity, distribution, abundance and structure. SPC Beche-de-Mer Information Bulletin #17:27–33.

Currie, D.R. and Sorokin, S.J. (2009). Evaluating the effects of reserve closure on algae, invertebrate and fish assemblages at a temperate South Australian marine reserve. Journal of the Marine Biological Association of the United Kingdom 89(4):651–661.

Dissanayakea, D.C.T. and Stefanssona, G. (2012). Habitat preference of sea cucumbers: *Holothuria atra* and *Holothuria edulis* in the coastal waters of Sri Lanka. Journal of the Marine Biological Association of the United Kingdom 92(3):581-590.

Dissanayake, D.C.T. and Wijey Aratne, M.J.S. (2007). Studies on the sea cucumber fishery in the North Western coastal region of Sri Lanka. Sri Lanka J. Aquat. Sci. 12:19-38.

Hasan, M.H. (2009). Stock assessment of holothuroid populations in the Red Sea waters of Saudi Arabia. SPC Beche-de-mer Information Bulletin #29 – June 2009. pp. 31-37.

Jaquemet, S., Rousset, V. and Conand, C. (1999). Asexual reproduction parameters and the influence of fission on a *Holothuria atra* sea cucumber population from a fringing reef on Reunion Island (Indian Ocean). SPC Beche-de-Mer Information Bulletin 11:12–18.

Lester, S.E., Halpern, B.S., Grorud-Colvert, K., Lubchenco, J., Ruttenberg, B.I., Gaines, S.D., Airamé, S. and Warner, R.R. (2009). Biological effects within no-take marine reserves: a global synthesis. Mar Ecol Prog Ser. 384:33-46.

Lovatelli, A. (comp./ed); Conand, C., Purcell, S., Uthicke, S. and Hamel, J.F., Mercier, A. (eds) (2004). Advances in sea cucumber aquaculture and management. FAO Fisheries Technical Paper. No. 463, Rome, pp. 13.

Mangion, P., Taddei, D., Frouin, P. and Conand, C. (2004). Feeding rate and impact of sediment reworking by two deposit feeders *Holothuria leucospilota* and *Holothuria atra* on fringing reef (Reunion Island, Indian Ocean). *In*: Heinzeller & Nebelsick (eds) Echinoderms: München, Taylor & Francis Group, London. pp. 311-317.

Mercier, A., Battaglene, S.C. and Hamel, J.F. (2000). Periodic movement, recruitment and size-related distribution of the sea cucumber *Holothuria scabra* in Solomon Islands. Hydrobiologia 440: 81–100.

Walters, C., Pauly, D. and Christensen, V. (1999). Ecospace: Prediction of mesoscale spatial patterns in trophic relationships of exploited ecosystems, with emphasis on the impacts of marine protected areas. Ecosystems 2:539–554.

Young, C.M. and Chia, F.S. (1982). Factors Controlling Spatial Distribution of the Sea Cucumber *Psolus chitonoides*: Settling and Post-Settling Behavior. Marine Biology 69:195-205.

(Received 15 October 2013; accepted 12 January 2014)