Kuroshio Science 13-1, 62-66, 2019

Symposium Proceedings

Fish assemblages in the coastal waters of Malabungot Protected Landscape and Seascape

Joel B. Balasta[1]* and Noel P. Umbao[2]
[1] Partido State University, Goa, Camarines Sur, 4422 Philippines
[2] Department of Agriculture − Bureau of Fisheries and Aquatic Resources Regional Office No.05, Bula, Camarines Sur, 4430 Philippines

Abstract
Coral reef fish community is one of the most diverse group of organisms with a vital role in the overall reef function. There is a scarcity of data on comprehensive assessment especially in fish assemblage. This paper was conducted to establish benchmark data as a basis for measuring the management effort of MPLS. The study specifically aims to determine the biomass, diversity, and density of fish species and assess its status. Coral reef fishes in the MPAs were identified using Fish Visual Census Method (FVC). Results showed that despite its declaration as a protected area, the fish species diversity (FS 39 species/250 m^2à no. of species/1000 m^2: SS 69 species/ 400m^2 à no. of species/1000 m^2). and density (FS 720 ind/ 1000 m^2 yielded; SS 748 individuals/1000 m^2) showed "very poor and moderate" condition at two different sampling periods, respectively. Average biomass is 10.27 kg/1000 m^2, which is under moderate status. Target fish species contributed high percentage of the total biomass. High abundance of *Pomacentrids* was observed, indicating less density of top predators that declined first following intense fishing pressure. Target fishes highly contributed to the total biomass of the reef fishes, however, non-target species dominate. Coral reef area was impacted by extensive sedimentation affecting coral reef and the reef fishes and other resident macroinvertebrates. Poor species diversity with moderately dense population and biomass may indicate disturbed habitat. There's a need for a long-term protection and a well-managed MPA to improve fish diversity, density and biomass specifically, target fish species.

Key words: Fish Density, Biomass, Reef-Fishes, Malabungot

INTRODUCTION

Coral reef fish community is one of the most diverse groups of organisms with a vital role in the overall reef function. They are highly diverse, both in number of species and in range of forms (Alcala 2001).

The Philippines is considered as a center of diversity of coral reef fishes. In order to conserve and preserve the abundance and diversity of these marine organisms, Marine Protected Areas (MPA) were established. MPAs are strategic tools in conserving coral reef habitats and other ecosystems. They play vital roles in the total conservation of marine biodiversity (Green et al. 2011). MPAs can achieve protection of well-defined coastal and marine areas and critical ecosystems. Coral reef fisheries, in particular, can be effectively managed through implementation of "no- take" areas on reefs (Roberts and Polunin 1993).

Studies have established the benefits of a well-protected marine sanctuary including increase in the diversity, density and biomass of coral reef fish and other macro-invertebrates. (Roberts and Polunin 1991). Community metrics can also determine coral reef condition. Fish biomass has been shown to be a key proxy for coral reefs where the state of reef ecosystems and the life history composition of the fish community are well predicted (McClanahan et al. 2011).

Although most of MPAs were established in the Philippines, baseline data that are significant for its management and conservation are lacking. In the case of Malabungot Protected Landscape and Seascape (MPLS) which is located at Brgy. Binagasbasan, Garchitorena

*Correspondence. E-mail: joelbalasta87@gmail.com

Camarines Sur, despite its declaration on April 23, 2000 under Proclamation No. 288, which was later formally legislated under the Senate Bill No. 2895, there is still a dearth of data on comprehensive assessment of its fish population especially on fish assemblages. This paper established benchmark data as a basis for management and conservation of biological resources of MPLS coastal waters. Specifically, this paper determined the biomass, diversity, and density of reef- associated fish species in MPLS area and assessed the status of the coral reef fishes.

METHODOLOGY

Fish Visual Census Survey (FVC) was employed adopting the method of English and Wilkinson (1997). It was conducted by identifying each variety of fish species observed within an imaginary $5m^2$ at either side of the transect. The number and sizes (total length) of fish in cm were estimated and identified to the lowest taxon possible.

Fish Abundance was classified according to the three general categories of: (1) target species, (2) indicators species and (3) non-target species.

Target species are those species that are commercially important and are targeted by fishermen (e. g *Serranidae* (groupers), *Carangidae* (jacks/trevally), *Lethrinidae* (emperor fish), *Lutjanidae* (snappers), *Haemulidae* (sweetlips), *Caesionidae* (fusiliers) *Scaridae* (parrotfish), *Siganidae* (rabbitfish), *Mullidae* (goatfish), and > 10 cm individuals of *Acanthuridae* (surgeonfish/unicornfish). Indicator species are species that rely on coral reef health for survival (e.g *Chaeto-dontidae* (butterflyfishes). Non-target species are species that serve as a tropic link and are less valued species e. g *Pomacentridae* (damselfishes).

Fish identification followed Fish Base (2004), and Allen *et al*. (1997).

Two (2) sampling periods were done. First sampling period (FS) was done in August 2017; while the second sampling (SS) was done in March 2018.

Fish Biomass was computed using Length and Weight (A and B values) relationship following.

W = a*Lb

where: W = weight in (g) a = the multiplying factor L = the estimated length (cm) b = the exponent (b < 1).

RESULTS

A total of 39 species were recorded during the first sampling period in 2017. Table 1 shows the diversity and biomass estimates of the reef fishes encountered during the visual census. As shown in Table 1, Damselfishes from family *Pomacentridae* dominate in terms of species count (12) and biomass (mean = $493.37g/250m^2$). Wrasses (family *Labridae*) contributed eight (8) species, while four (4) butterflyfishes (*Chaetodontidae*) and three cardinal fishes (*Apogonidae*) were encountered in the transect. The rest of the families have either two or one species. Apogonidae and Labridae biomass were estimated at $363.25g/250m^2$ and $208.41\ g/250m^2$, respectively (Table 1). Most of these fish species are either reef residents or reef associated. It is worthy to note the presence of economically-important species from families *Serranidae*, *Haemulidae* (sweetlips), *Nemipteridae* (breams) and *Lutjanidae* (snappers). During the second sampling period conducted in March 2018, a total of 62 species belonging to 39 genera and 23 families were recorded. The most diverse family were *Pomacentrids* (damselfishes) represent- ed by 21 species, followed by *Labridae* (wrasses) with 11 species. Only four species of *Chaetodontidae* (butterflyfishes) were observed in the area. *Scaridae* (parrotfishes) was most diverse in the target fishes category.

Table 1. Biomass of reef fishes by family in MPLS ($g/250\ m^2$).

Family	Local Name	Species	Station 3	Average
Pomacentridae	Angingitkit	12	974.73	493.37
Apogonidae	Parangan	3	723.49	363.25
Chaetodontidae	Kalibangbang	4	151.70	77.85
Serranidae	Lapu-lapu	2	242.00	122.00
Labridae	Angol/Marinyan	8	408.81	208.41
Synodontidae	Butong Panday	1	186.00	93.50
Caesiodidae	Solid	1	208.00	104.50
Balistidae	Pugot	1	199.92	100.46
Scaridae	Angol	2	229.69	115.84
Nemiteridae	Tonong	2	177.00	89.50
Lutjanidae	Banwiton	1	287.11	144.05
Haemulidae	Alatan	2	325.39	163.70
	Total	**39**	**4113.85**	2076.43

Species Diversity

A total of 39 species of reef fishes were recorded within $250\ m^2$ transect, while the second sampling showed 69 species within $400\ m^2$. To be consistent with Hilomen's criteria these were raised to the number of species in an area of $1000\ m^2$. Both yielded "Very Poor" status with 10 species in an area of $1000\ m^2$ in the first survey (39 species/$250\ m^2$ à no. of species/$1000\ m^2$) and 25 species in $1000\ m^2$ transect in the second survey period (69 species/ $400m^2$à no. of species/$1000\ m^2$).

In terms of ecological roles, a higher proportion of major fish group or non-target species dominate the reef fish assemblage in Malabungot (69%) posting 123 ind/$250\ m^2$ (Fig. 1).

As hinted in Fig. 2, the presence of economically-important species manifested in the 21% (39 ind/250 m^2) share of target group. Ten percent (10%) of the total spe- cies count are considered indicator species (18/250 m^2).

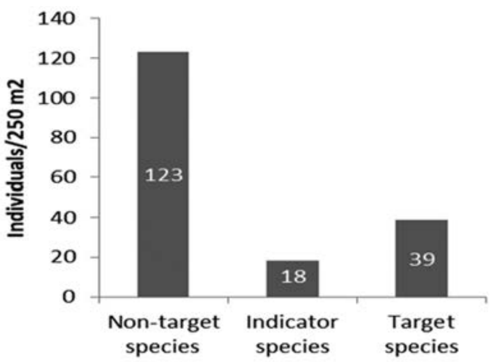

Fig. 1. Comparative abundance of three fish categories in Malabungot Protected Seascape (First Sampling)

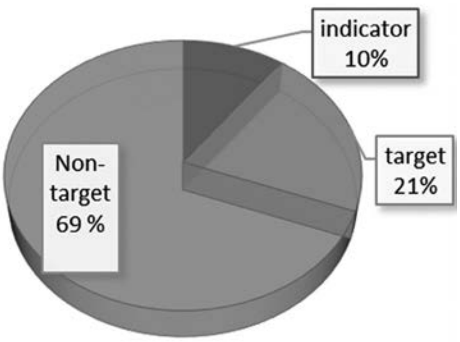

Fig. 2. Species composition based on ecological role. (First Sampling)

Fish density

The estimated abundance of reef fishes during the first sampling period within the protected area reflected a "Moderate" condition with a total of 180 ind/250 m^2 (Fig. 1). When standardized to Hilomen's (2000) criteria (Table 2), this translates to 720 individuals per 1000 m^2. In second sampling the abundance of reef fish species in the protected area appeared to be in "Moderate" condition with a total of 299 individuals per 400 m^2. When standardized to Hilomen' s (2000) criteria it translates to 748 individuals per 1000 m^2. Of this, 76% are non-target species (Fig. 3). However, it only ranks second to the overall biomass estimates with 31.46kg/ha as shown in Fig. 4. While target fishes with only 16% abundance recorded the highest biomass with 66.44 kg/ha. This group is composed mainly of small grazing parrotfishes and surgeon-fishes. This could be associated with the availability of the food algae. This group of fishes recover quickly if the area is protected and fishery regulations are enforced strictly.

Table 2. Hilomen's species richness and abundance index (Hilomen 2000).

Fish Species Diversity (no. of species/1000m^2)				
Very Poor	Poor	Moderate	High	Very High
0 - 26	27 - 47	48 - 74	76 - 100	>100
Fish Density (no. of fish/1000m2)				
Very Poor	Poor	Moderate	High	Very High
0 0- 201	2202 - 676	6677 - 2,267	22,268 - 7,592	>7,592
Biomass (kgs. /1000m2)				
Very Poor	Poor	Moderate	High	Very High
1-3kg	3.1-10kg	10.1-20kg	20.1-50kg	>50kg

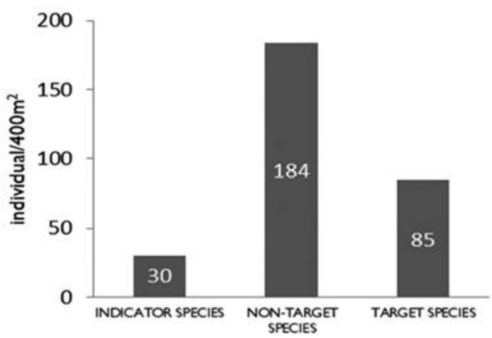

Fig. 3. Comparative abundance of the three fish categories in Malabungot Protected Seascape (2^{nd} Sampling)

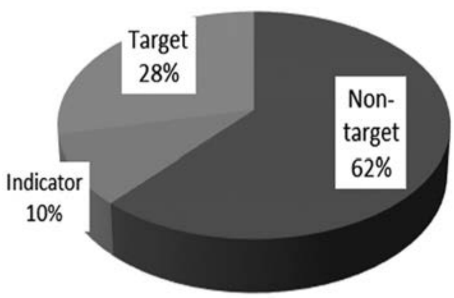

Fig. 4. Species composition based on ecological role. (Second Sampling)

Biomass

A total biomass of 2073.43 g/ m^2 as shown in Table 1 was recorded. This is equivalent to 8. 30572 kg /1000 m^2 which falls under "Poor" status. In the second sampling, a total biomass of 122.33 kg/ha was calculated equivalent to 12.23 kg /1000 m^2 which is categorized as "Moderate" status.

DISCUSSION

Fish diversity, measured in terms of species density, richness and biomass of reef fishes, gives a good indication of reef health (Koh et al. 2002). According to the study of Alba (2002), Camarines Sur had the highest number of identified species population and species diversity within Bicol Region. However, in the case of MPLS in Garchitorena Camarines Sur, despite its declaration as a protected area, the fish species diversity (first sampling = 39 species/250 m^2 @ no. of species/1000 m^2; second sampling = 69 species/ 400m^2 @ no. of species/1000 m^2). and density (First sampling = 720 ind/ 1000 m^2 ; second sampling = 748 individuals per 1000 m^2) showed "Very Poor and Moderate" conditions at the two different sampling periods, respectively.

In terms of biomass, reef fishes during the first sampling was estimated at 2,073.43 g/ 250 m^2, or 8.36 kg /1000 m^2, which is considered "Poor" status. While in the second sampling, the total biomass in kg/ha was estimated at 122.33 kg/ha, or 12.23kg /1000 m^2 which is considered in "Moderate" status based on Hilomen's index.

The average biomass estimated at 10.27 kg/1000 m^2 fall under "Moderate" status. The target fish species contributed high percentage to the total biomass. A similar result was obtained by Corrales et al. (2014), except that the reef fish biomass in their study posted in the "High" to "Very High" category.

Both sampling periods showed high abundance of *Pomacentrids*. Family *Scaridae* showed high abundance under the target fish category. However, their sizes along with other species were very depauperate, reflecting high extraction rate and disturbed habitat. According to Russ and Alcala, (1998) the observed higher abundance of damselfish (*Pomacentridae*) could probably be due to the lack of top predators whose populations had declined first following intense fishing pressure. According to Elahi, *et al*. (2015) biodiversity is declining on average at marine sites impacted by human activity.

The results from these community metrics (diversity, biomass, species density) indicated a disturbed habitat. Ground-truthing within the protected seascape showed extensive sedimentation. Recent unpublished study on the coral reef within protected area showed that coral reef habitat was disturbed due to heavy siltation (Dioneda and Dioneda 2017) thus, affecting reef fish community structure. Alleged illegal fishing activities were prevalent as mentioned by residents of Brgy. Binagasbasan Garchitorena. According to Hughes et al. (2003), harmful human activities cause poor water quality, and marine pollution. These activities may result to habitat loss and the reduction of reef fish's diversity specially the target species. High density of non-target species compared with target species was observed. This may be due to the high market value of target fish frequently collected by fishermen thus, reducing their numbers (Corrales *et al*. 2014).

CONCLUSION AND RECOMMENDATIONS

This study demonstrated that poor species diversity with moderately dense species and biomass are commonly linked with disturbed habitat. The target species showed lesser density in comparison with the two categories highlighting higher level of extraction fuelled by its high market value.

For future studies, it is recommended to assess the fish communities outside the MPLS for purposes of comparison. The recovery of the fish diversity and its habitat may take time depending on the level of management and seriousness of protecting MPLS area and the intensity of habitat alteration due to natural disturbance as well as anthropogenic perturbation. It is highly recommended to strengthen law enforcement and intensify advocacy campaign for the protection of MPLS ecosystems and the conservation of its biodiversity.

REFERENCES

Agardy, M. T. 1997. Marine Protected Areas and Ocean Conservation. 1997. Academic Press. San Diego CA.

Alcala, A. 2001. Marine Reserves in the Philippines: Historical Development, Effects and Influence on Marine Conservation Policy. Bookmark, Makati City, Philippines

Alba, S. C. Sr. 2002. Coral reef fishes: species and spatial distribution in Bicol Region, Philippines. AGRIS- ISSN: 0119- 6049

Babcock R.C., Shears N.T., Alcala A.C., Barrett N.S., Edgar G.J., Lafferty K.D., McClanahan T.R., and G.R. Russ. 2010. Decadal trends in marine reserves reveal differential rates of change in direct and indirect effects. Proc. Natl. Acad. Sci. USA. 107: 1825618261: doi: 10. 1073/pnas.0908012107

Bohnsack, J. A.1998. Applications of marine reserves to reef fisheries management. Australian Journal of Ecology 23, 298-304.

Corrales C.M., Delan GG, Rica RLV, Piquero AS and A.I. Monte 2014. A Baseline Study on Coral Reef Fishes in The Marine Protected Areas in Southern Cebu, Philippines. Tropical Technology Journal. Vol 17. ISSN: 1656-0264

Dugan, J. E., and G. E. Davis.1993. Applications of marine refugia to coastal fisheries management. *Can. J. Fish. Aquat. Sci.* 50:2029-2042.

Elahi R.2015. Recent trends in local-scale marine biodiversity reflect community structure and human impacts. *Curr Biol* 25(14):1938-1943.

Green, M.H., Ho, R.K., and M.E. Hale .2011. Movement and function of the pectoral fins of the larval zebrafish (Danio rerio) during slow swimming. *Journal of Experimental Biology* 214(18): 3111-3123

Hilomen, V.V., Nanola, Jr C.L. and A.L. Dantis.2000. Status of Philippine reef communities.

Hughes, T.P., Baird, A.H., Bellwood, D. R., Card, M., S. R. Connolly, Folke, C., Grosberg, R.O., Hoegh-Guldberg, J. B. Jackson, C., Kleypas J., Lough, J. M. , Marshall, P. M. Nyström, S. R. Palumbi, J. M. Pandolfi, B. Rosen, and J. Roughgarden. 2003. Climate change, human impacts, and the resilience of coral reefs. *Science,* 301:929-933. http://dx.doi.org/10.1126/ science.1085046

Jennings S., and N. Polunin. 1997. Impacts of predator depletion by fishing on the biomass and diversity of non-target reef fish communities. *Coral Reefs* 16(2):81-82

Koh, L.L., Chou, L.M. and KPP. Tun .2002. The status of coral reefs of Pulau Banggi and its vicinity, Sabah, based on surveys in June 2002. Unpublished technical report 2/02. Reef Ecology Study Team, Department of Biological Sciences, National University of Singapore.

McClanahan T.R., Graham N.A.J., MacNeil M.A., Muthiga, N.A., Cinner. J.E., and J.H., Bruggemann. 2011.Critical thresholds and tangible targets for ecosystem-based management of coral reef fisheries. *Proceedings of the National Academy of Sciences*. 108(41):17230-3.

Quinn, T. P., and J.C. Ogden.1984. Field evidence of compass orientation in migrating juvenile grunts (Haemulidae). *Journal of Experimental Marine Biology and Ecology*, 81 (2), 181-192. doi:10.1016/0022-0981(84)90005-4

Roberts. C. M. and N. V. C Polunin.1991. Are marine reserves effective in management of reef fisheries. *Rev. Fish Biol. Fish.* 1: 65-91

Rowley, R. J.1994. Marine reserves in fisheries management. Aquatic Conservation: *Marine and Freshwater Ecosystems* 4, 233-254.

White A., Deguit E., Jatular W., and L. Eisma-Osorio. 2006. Integrated coastal management in Philippine local governance: Evolution and benefits. *Coast. Manag*. 34: 287-302. doi: 10.1080/08920750600686687