

Diversity of Fruit Bats (Pteropodidae) in Baganihan, Marilog Forest Reserve, Marilog District, Southern Philippines

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ABSTRACT

Marilog Forest Reserve is one of the priority areas on conservation by the conservation international as it is recognized as an important biodiversity area. It is known to its cold ambience, zero visibility fogs and big resorts built along the main road. Thus, the study was conducted to determine the diversity, ecological and conservation status of fruit bats in the area. The selected areas for this study are Sitio Maharlika (Site 1) and Sitio Puting Bato (Site 2) of Brgy. Baganihan, Marilog District, Davao City. The two selected sites were described in terms of vegetation and habitat type. Site 1 (Sitio Maharlika) composed of a patch of secondary forest approximately 300 meters from the main road which is disturbed due to agricultural activities such as abacca and strawberry plantations. Site 2 (Sitio Puting Bato) is also a secondary forest but with lesser disturbance which is more likely due to its farther distance from the main road. Fruit bat species were assessed using mist-nets following standard protocols with a total of 104 net nights. Fruit bat inventory and assessment revealed 7 species with a total of 249 individuals captured. One species were listed as threatened (*Megaerops wetmorei*), 2 endemic species in the Philippines (*Haplonycteris fischeri* and *Ptenochirus jagori*) and 1 species restricted only in Mindanao (*P. minor*). Diversity index was higher in site 2 with H' index of 0.736 compared to site 1 with H' index of 0.698 which can be correlated to comparable disturbance between 2 sites. Based on the results, the 2 study sites of Brgy. Baganihan is home to various fruit bat species with high species endemism. Thus, conservation measures are highly recommended to conserve and protect the fruit bats and also the other wildlife in the area.

Keywords: Biodiversity, species composition, diversity index, threatened and endemic species.

INTRODUCTION

The Philippine archipelago possesses one of the most endemic-rich and most impending endangered mammalian fauna in the world. One of the most diverse known mammalian Orders in the Philippines is Chiroptera. The order for bats is most significant assemblage of animals in the world which contributes to forest succession during reforestation as pollinators and seed dispersers to flowers and trees (Ingle et al., 1992). Fruit bats in the Philippines contributes 32% of the total bat species (Tanalogo and Hughes, 2018). They serve as an essential role of

controlling population of pest insects as predators (Sedlock, 2001). According to Voigt and Kingston (2016) as cited by Tanalgo and Hughes (2018), many bat species are threatened by anthropogenic activities. These includes deforestation, agricultural land conversions, hunting, cave exploitations, extractive industries, climate change and logging which threatened more than half of Philippine bat species, (Tanalgo and Hughes, 2018). Bats are also sensitive to changes in elevation as some species are abundant in lower elevation while some species dwell only in higher environments (Relox et al., 2009).

Marilog District has a total of 63,800.22 hectares of land area occupied by approximately 400 households, with 11,102 hectares (17.4%) of forest patches. The area is inhabited originally by Matigsalug-Manobo indigenous groups and now being occupied mostly by other migrants (e.g. Cebuano and Bul-anon). Rampant small scale logging activities, conversion of the forest land into agricultural use, the proliferation of residential and mountain resorts, overharvesting and trading of flora and fauna imposed threats into the remaining species of fruit bats in Marilog District.

Bats of Philippine islands had been documented and well-studied in terms of diversity and richness with an average of 7.9 publications a year from 2000 to 2017 in which 64% focused on diversity studies (Tanalgo and Hughes, 2018) but still there are some remote parts of the archipelago specifically in southern Mindanao which were not yet being studied and explored. To fully understand this species and provide baseline for monitoring, measurement of population densities or at least the collection of estimates is needed for the conservation of these resident species as well as the species that have yet to be discovered as Marilog District is one of the priority lands for conservation and protection in Mindanao according to Conservation International.

OBJECTIVES OF THE STUDY

This paper generally aimed to determine the diversity of fruit bats in 2 selected sites in Baganihan, Marilog District, Davao City, Philippines. Specifically, it aimed to: a. determine the species composition, b. evaluate the diversity between 2 sites and c. assess the ecological and conservation status of fruit bats.

MATERIALS AND METHODS

Study Site

The study was conducted specifically in the forest patches of Sitio Maharlika (site 1) and Puting Bato (site 2), Brgy. Baganihan, Marilog District, Davao City, Southern Mindanao, Philippines (07°27'13.74" N 125°15'1.12" E) (Figure 1). The study area was divided into 2 sites where mist nets (red flags) were evenly distributed to efficiently cover the total area.

The sites were chosen and characterized according to elevation and extent of anthropogenic disturbances. The 2 sites were selected according to elevation and extent of anthropogenic disturbances. Site 2 (1,240 masl) has higher elevation compared to site 1 (1,100 masl). The understory vegetation of both sites were dominated by vines, ferns, aroids (e.g. *Aglaonema cf. densinervium* Engl., *Alocasia heterophylla* (C. Presl) Merr., *Arisaema polyphyllum* (Blanco) Merr.), *Begonia* spp., *Impatiens platypetala* Lindl., *Cyrtandra* spp., *Elatostem* sp., *Procris cf. brunnea* Merr., *Musa* spp. and Zingiberaceae (e.g. *Alpinia* spp., *Amomum* sp., *Etilingera* spp., *Globba* sp., *Hornstedtia* spp., *Plagiostachys* spp. and *Wurfbainia mindanaensis* (Elmer) Skornick & A.D. Poulsen). Dominant trees are *Ficus* spp. *Palaquium philippense* (Perr.) C.B. Rob and *Lithocarpus* spp.

The canopy vines observed were dominated by species of *Calamus* spp., *Freydenetia* spp. *Lianas*, *Smilax* sp., *Tetrastigma* spp., *Strongylodon pulcher* C.B. Rob., *Mikania* sp. The canopy epiphytes observed in the area were Ferns, lycophytes, orchids, *Hoya* spp., *Agalmyla* spp., *Tetracera scandens* (L.) Merr., aroids (e.g. *Epipremnum pinnatum* (L.) Engl.), bryophytes, lichens and *Hedychium philippinense* K.Schum.

The ground cover plants were dominated by Ferns, Lycophytes, ground orchids, herbaceous weeds, grasses, sedges. The litter was approximately 3 inches while the soil type was loamy and clay. Fallen logs were also observed in both sites. Exposed rocks were mostly observed in site 2 than site one 1. Many water systems like creek and canals were also observed in both sites.

Anthropogenic disturbances such as agricultural activities such as abacca and strawberry plantations were mostly observed in site 1 (300 m) as it is near to anthropogenic environment compared to site 2 (1 km). The area as a whole is under severe threat from habitat destruction posed by excessive anthropogenic pressure due to tourism activities, soil erosion, landslides, and shifting cultivation.

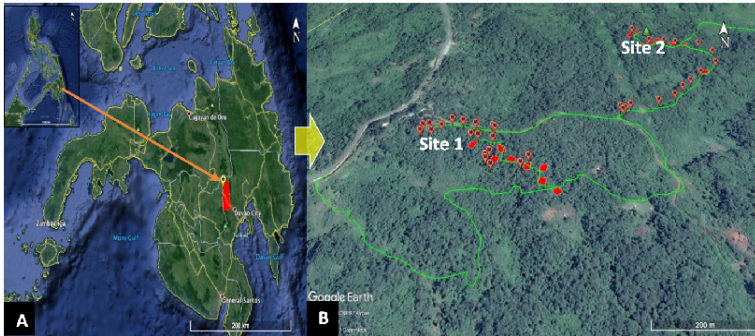


Figure 1. Study site spot map. A) Philippines (Marilog District- red) and Mindanao Island (Marilog District-red, B) Transect route (green paths). Red polygons-20x20 m established plots for extensive faunistic inventory and the location of mist nets (red flags) in Sitio Maharlika and Sitio Puting Bato, Brgy. Baganihan, Marilog Forest Reserve, Marilog District, Davao City, Philippines (red balloons) (©2018 Google, image©2018 CNES/Airbus).

Permit Statement

Prior informed consent from the communities was obtained by presenting the research to the stakeholders and members of Protected Area Management Board (PAMB). An approved Gratuitous Permit (GP) from the Department of Environment and Natural Resources was then issued. The Institutional Animal Care and Use Committee (IACUC) permit was also obtain after being examined by the Institutional Animal Care and Use Committee of Central Mindanao University.

Sampling, Processing and Identification

Mist nets were evenly installed on possible fly ways of the bats in the 2 established sites in Brgy Baganihan, Marilog District, Davao City. Captured bats were recovered from 9:00 PM to 12 am and 5 AM on the next day. Each captured bat was placed in a cloth bag individually for morphometric identification.

Captured bats were then measured for the following: head length, ear length, forearm length, tarsus length, tail length and total body length were used as basis for identification of the captured species. Individual bats were identified using Ingle and Heaney (1992), Heaney et al. (1998) and literatures were used as references to identify the bats captured. IUCN Red List of Threatened Species (www.iucnredlist.org) and publications (e.g. Relox et al., 2009) were used to

assess the conservation and ecological status of the bats.

Captured, marked and released method was employed in the study. Bat's fur in the head were trimmed to mark captured individuals to obtain accurate count on number of individuals for both sites. Captured bats were fed with sugar syrup to regain energy and relieve from stress and release frequently at capture site.

Data Analysis and Biodiversity Indices

The data on biodiversity was computed using BIOPRO software ver. 2.0. Shannon Weiner index (H' Index) was used to calculate the species diversity which includes alpha indices to evaluate how diverse the area.

RESULTS AND DISCUSSION

Species Accumulation Curve

The species accumulation curve revealed that the sampling effort represent all the possible species in the area (Figure 2). Both sites reached asymptote which revealed that conducting 104 net nights in the area was sufficient in capturing all the representative species of bats in the area.

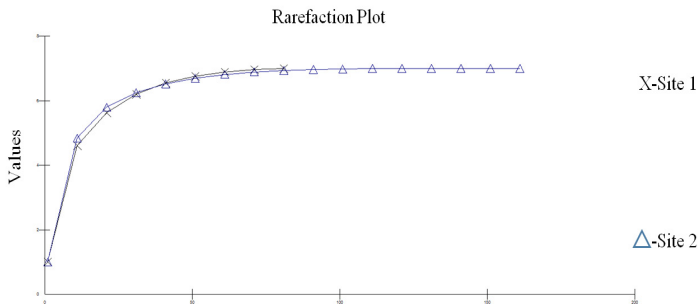


Figure 2. Species accumulation curve in Sitio Maharlika (site 1) and Sitio Puting Bato (site 2), Brgy. Baganihan, Marilog District, Davao City, Philippines showing sites reached plateau of sampling effort.

Species Composition

Species composition of bats Sitio Maharlika (site 1) and Sitio Puting Bato (site 2), Brgy. Baganihan, Marilog Forest Reserve, Southern Philippines shown 7 species belonging to family Pteropodidae. These species are *Cynopterus brachyotis*

(Common Short-nosed Fruit Bat), *Eonycteris spelaea* (Common Dawn Bat), *Haplonycteris fischeri* (Philippine Pygmy Fruit Bat), *Macroglossus minimus* (Dagger-toothed Fruit Bat), *Megaerops wetmorei* (White-collared Fruit Bat), *Ptenochirus jagori* (Greater Musky Fruit Bat) and *P. minor* (Lesser Musky Fruit Bat). The *Ptenochirus jagori* had the highest number of individuals captured with a total of 78 individuals (Table 1).

In comparison to the total number of species (17species) in Mindanao (Heaney, 1999), the present study recorded 41% of the fruit bat species in the island. The study recorded 88% of the fruit bat species recorded in selected conservation areas of North Cotabato (Achondo et al., 2014). The study also documented 58% of the fruit bats recorded in Mt. Sinaka (Gomez et al., 2005) and 70% in Mt. Hamiguitan (Relox et al., 2009). The study recorded 88% of the total number of species recorded in Oro River, Cagayan de Oro City, Philippines (Lobite et al., 2013).

Table 1

Species Composition and Relative Abundance of Fruit Bats (Chiroptera) in Sitio Maharlika (site 1) and Sitio Puting Bato (site 2) Brgy. Baganihan, Marilog Forest Reserve, Davao City, Philippines.

Species	Total	Relative Abundance (%)	
		Site 1	Site 2
1. <i>Cynopterus brachyotis</i> Muller, 1838	60	8.4	15.7
2. <i>Eonycteris spelaea</i> Dobson, 1871	8	1.2	2.0
3. <i>Haplonycteris fischeri</i> Lawrence, 1939	52	7.2	13.7
4. <i>Macroglossus minimus</i> Geoffroy, 1810	7	0.8	2.0
5. <i>Megaerops wetmorei</i> Taylor, 1934	23	2.0	7.2
6. <i>Ptenochirus jagori</i> Peters, 1861	78	12.0	19.2
7. <i>Ptenochirus minor</i> Yushiyuki, 1979	21	2.8	5.6

Some species are abundant in the area while some are not. *P. jagori* was the most common species in the area (12.0% in site 1, 19.2% in site 2). According to Heaney et al., (1998), this species is abundant in primary forest to uncommon to secondary forest and common to lowland forest. *C. brachyotis* was the second most common species in the area (8.4% in site 1, 15.7% in site 2). The study of Achondo et al. (2014) in selected conservation areas of North Cotabato, Philippines revealed that *C. brachyotis* is the most common species in the area.

The presence of this species is associated with secondary forest and also the most common seed dispersers in lowland forest (Storz and Kunz, 1999; Tan et al., 1998). *H. fischeri* was the third most common species in the area (7.2% in site 1, 13.7% in site 2). This endemic species is common in primary forest and moderately abundant in secondary forest and in agricultural areas in the archipelago (Heaney et al., 1998). *M. wetmorei* was the fourth most common species in the area (2.0% in site 1, 7.2% in site 2). This species is categorized by IUCN (2018) as vulnerable due to threats such as deforestation and anthropogenic activities in the country (Rosell-Ambal et al., 2013). *P. minor*, a Mindanao endemic, was the fifth most common species in the area with relative abundance of 2.8% in site 1 and 5.6% in site 2. *M. minimus* and *E. spelaea* (0.8% in site 1, 2.0% in site 2 and 1.2% and 2.0%, respectively) are common in habitat associated with banana plantations (Heaney et al., 1998) but more likely due to extent of anthropogenic disturbances in the area, population of these species declined.

It was noted that site 2 has higher species abundance compared to site 1. This is more likely due to the extent of anthropogenic disturbances in site 1 compared to site 2. Site 1 is also nearer to anthropogenic environment compared to site 2. Vegetation and elevation between sites are more likely also another factors but the extent of anthropogenic disturbances across the 2 sites is more clearly a factor in the decline in the population of bats in site 1 compared to site 2.

Diversity

The results revealed that both sites have low diversity indices wherein site 2 has higher diversity index compared to site 1 (Table 2). The low diversity on both sites may be attributed to the habitat destruction such as conversion of forest land such as slash and burn in the area, which affects the abundance, richness and reproduction of bat species (Kunz and Lumsden, 2003; Oliveira et al., 2017). Even with low diversity, some species in the area enable to be abundant due to the fruiting trees observed in the area namely, *Ficus* spp, *Musa* spp and *Pandanus* spp which have great importance to the overall forest food production in the forest.

Diversity studies were also been conducted in some areas of the archipelago. The study of Nuñez et al. (2015) in Mt. Matutum documented with a total of 15 bat species. The study of Relox et al. (2009) and Ong et al. (1999) has lesser number of species compared to the present study which were only both documented 5 species of bats. Low species diversity of bats was also revealed in the study of Achondo et al. (2014) in selected conservation areas in North Cotabato, Philippines with Diversity index values of 0.697 and 0.443 while the

study of Paguntalan and Jakosalem (2004) revealed 12 species of fruit bats in the isolated forest patches in Cebu.

Table 2

Diversity values of Sitio Maharlika (site 1) and Sitio Puting Bato (site 2) Brgy. Baganihan, Marilog Forest Reserve, Marilog District, Davao City, Philippines.

Diversity Index	Values	
	Site 1	Site 2
H' Index	0.698	0.736

Conservation and Ecological Status

The study documented 1 vulnerable, 2 Philippine Endemic and a Mindanao Endemic species of fruit bat in Marilog Forest Reserve, Marilog District, Davao City, Southern Mindanao, Philippines. The threatened species is *Megaerops wetmorei* (Table 3 and Figure 3). The most common species in the area was *Ptenochirus jagori*. In comparison, the present study documented lesser number of endemic species compared to the study of Nuñez et al. (2015) and Paguntalan and Jakosalem, (2004) with a total of 7 and 6 endemic species, respectively. The 3 endemic species was also recorded by Achondo et al. (2014) which has almost with the same elevation (1,191 masl) and habitat type (secondary forest) of their study area in North Cotabato, Philippines. This implies that these endemic species can be mostly be observed in a specific range of elevation and habitat type.

Table 3

Conservation and Ecological Status of Bats in Brgy. Baganihan, Marilog Forest Reserve, Marilog District, Davao City, Philippines.

Taxon	Conservation Status	Ecological Status
1. <i>Cynopterus brachyotis</i> Muller, 1838	LC	
2. <i>Eonycteris spelaea</i> Dobson, 1871	LC	
3. <i>Haplonycteris fischeri</i> Lawrence, 1939	LC	PE
4. <i>Macroglossus minimus</i> Geoffroy, 1810	LC	
5. <i>Megaerops wetmorei</i> Taylor, 1934	VU	
6. <i>Ptenochirus jagori</i> Peters, 1861	LC	PE
7. <i>Ptenochirus minor</i> Yushiyuki, 1979	LC	ME

*LC- least concern, VU-Vulnerable, PE- Philippine Endemic, ME- Mindanao Endemic



Figure 3. Endemic and threatened Fruit bats (Chiroptera) of Brgy. Baganihan, Marilog Forest Reserve, Southern Philippines. A) *Haplonycteris fischeri* (Philippine Pygmy Fruit Bat), B) *Megaerops wetmorei* (White-collared Fruit Bat), C) *Ptenochirus minor* (Lesser Musky Fruit Bat) and D) *P. jagori* (Greater Musky Fruit Bat).

CONCLUSIONS

The diversity study of fruit bats in Brgy. Baganihan, Marilog Forest Reserve, Marilog District, Davao City, Southern Mindanao, Philippines revealed 7 species belonging to Family Pteropodidae. Out of the total species, 1 is vulnerable, 2 are Philippine Endemic and 1 is Mindanao Endemic which calls for the importance for conservation efforts in the area. The study revealed that the area has low diversity (H' index < 1.5) due to anthropogenic disturbances but has high species abundance which might due to abundant forest food production or fruiting trees. The high abundance but with low endemism of fruit bats in the area can be correlated also to the area as being lowland secondary forest.

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