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Protected Areas as effective habitats of Pteropodid Bats (Mammalia Chiroptera): a case study of Mt. Hamiguitan, Mt. Apo and Mt. Kitanglad (Mindanao, Philippines)

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ABSTRACT Protected areas are effective reservoirs of a rich endemic bat diversity (Mammalia Chiroptera) in the Philippines but are threatened due to habitat disturbances. Hence, this study aimed to document and review the pteropodid bats in the selected protected areas in Mindanao (Philippines) such as Mt. Hamiguitan, Mt. Apo and Mt. Kitanglad. Different habitat types of fruit bats were surveyed from the lower to the higher elevation using the mist-netting method. Results showed that the two protected areas contain 10 species of fruit bats namely *Alionycteris paucidentata*, *Ptenochirus jagori*, *Ptenochirus minor*, *Megaerops wetmorei*, *Haplonycteris fischeri*, *Harpyionycteris whiteheadi*, *Rousettus amplexicaudatus*, *Macroglossus minimus*, *Cynopterus brachyotis* and *Pteropus vampyrus*. The protected areas also harbor endemic species in intact forest while non-endemic species mostly in disturbed portions. Thus, protected areas are effective habitats for endemic fruit bat species and vital indicators of a healthy forest ecosystem. This review recommends sustainable forest management and conservation for the present and future generations.

KEY WORDS Conservation; endemic; forest; fruit bats; protected areas.

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INTRODUCTION

In the world, protected areas are the major effective habitats to conserve biodiversity specially endemic species that are unique of the country and protect them from threats or human pressures. But, these protected areas are affected and exhibited declining trend in biodiversity despite its growing number (Pulido-Chadid et al., 2023). However, their habitats particularly in the lowland dipterocarp forests in the Philippines have been affected by human activities such as agricultural expansion, human encroachment, logging and mining.

Based from the IUCN, an effective protected areas (PA) is: "*a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*". Furthermore, effective protected areas are a function of many factors such as extent, design, location, connectivity, representativeness, coverage of species and ecosystems, their management effectiveness, at social, cultural and biodiversity levels (Rodrigues & Cazalis, 2020).

The protected areas in the Philippines provide enumerable benefits to the people and biodiversity.

It is specifically home to many endemic species but also generally gives ecosystem services such as regulating, controlling, cultural and aesthetic values for the present and future generations. In such biodiversity, fruit bats (Mammalia Chiroptera) have a critical role in maintaining the balance in the forest ecosystem. The country hosts 77 species of bats of which 22 species are endemics (Heaney et al., 1999). Fruit bats pollinate plants and disperse seeds naturally in the forest (Cox & Elmqvist, 1991; Rainey et al., 1995; Mildstein et al., 2005).

MATERIAL AND METHODS

Study area

This study was conducted on fruit bats in the three selected protected areas in Mindanao, Philippines, such as the Mt. Apo, Mt. Hamiguitan and Mt. Kitanglad.

The first protected area, Mt. Apo, is located at at 6°47 N to 7° 07 N and 125° 09 E to 125° 27 E which is an active strato-volcano (3,143.6 masl) and considered as the highest peak in the country covering 64,053 ha. Mt. Apo is a watershed of over 19 river systems in Davao City, Davao del Sur, Bukidnon and Cotabato (Rivera, 2007). While the second protected area, Mt. Kitanglad, is geographically located at 7° 21' to 8° 35' N and 124° 03' to 125° 16' E central Mindanao of the southern portion of the Philippines with an elevation of 2,938 masl that serves as the major watershed area of the surrounding provinces, Davao, Misamis, Agusan and Cotabato. Both protected areas have diverse forest ecosystems with varied forest quantity and quality from lower to higher elevations. The third protected area site, Mt. Hamiguitan, is located in Davao Oriental with visible bonsai or pygmy forest in the Philippines.

Sampling method and analysis

Mist-netting method was used in the selected protected areas from the lower elevation to the higher elevation with different forest types such as the agroforest, dipetrocarp forent, montane and mossy forest. Mist-nets were checked every 30 minutes to one hour from 6PM-6AM for bat captures, then retrieved, measured (Ingle & Heaney, 1992) and released back to the said area. The species were identified based from morphometrics and distinguishing phenotypic characters.

RESULTS

The three protected areas have a total of ten species of fruit bats (Chiroptera Pteropodidae) namely: *Ptenochirus jagori* (Greater Musky Fruit Bat), *P. minor* (Lesser Musky Fruit Bat), *Alionycteris paucidentata* (Mindanao Pygmy Fruit Bat), *Haplonycteris fischeri* (Philippine Pygmy Fruit Bat), *Cynopterus brachyotis* (Common Short-Nosed Fruit Bat), *Rousettus amplexicaudatus* (Geoffroy's Rousette), *Macroglossus minimus* (Long-Tongue Nectar Bat), *Harpyionycteris whiteheadi* (Harpy Fruit Bat), *Pteropus vampyrus* (Large Flying Fox) and *Megaerops wetmorei* (White-Collared Fruit Bat) (Table 1). *Ptenochirus jagori, C. brachyotis, H. fischeri* and *M. minimus* were common in three selected protected areas in Mindanao. *Ptenochirus minor, A. paucidentata, R. amplexicaudatus, H. whiteheadi, Pt. vampyrus* and *M. wetmorei* were not documented in some protected areas during the survey.

There were also more endemic and threatened fruit bat species found in Mt. Kitanglad than in Mt. Apo (Table 2). Mt. Kitanglad is home to rich, endemic and threatened species than in Mt. Apo and Mt. Hamiguitan. Endemic species are unique only to the Philippines and Mindanao and nowhere else in the world.

DISCUSSIONS

There was a relatively higher number of fruit bat species in Mt. Kitanglad than in Mt. Apo and Mt. Hamiguitan signifying that Mt. Kitanglad harbors more species (Relox et al., 2014; 2017). Generalist bat species are common in the three selected protected areas while specialist bat species are unique in some protected areas probably because of their habitat and food preferences available in a particular protected area. Protected areas offer a variety habitats for bats and diverse food items compared to unprotected forest or small forest fragments. The documentation of these species in the protected areas serve as an important baseline information for

Scientific name	Common name	Mt. Apo	Mt. Kitanglad	Mt. Hamiguitan
Ptenochirus jagori (Peters, 1861)	Greater Musky Fruit Bat	√	√	√
Ptenochirus minor Yoshiyuki, 1979	Lesser Musky Fruit Bat	√	√	×
Alionycteris paucidentata Kock, 1969	Mindanao Pygmy Fruit Bat	×	√	×
Haplonycteris fischeri Lawrence, 1939	Philippine Pygmy Fruit Bat	√	√	√
Cynopterus brachyotis (Müller, 1838)	Common Short-Nosed Fruit Bat	√	√	√
Rousettus amplexicaudatus (E. Geoffroy, 1810)	Geoffroy's Rousette	×	√	×
Macroglossus minimus (E. Geoffroy, 1810)	Long-Tongue Nectar Bat	√	√	√
Harpyionycteris whiteheadi Thomas, 1896	Harpy Fruit Bat	×	√	×
Megaerops wetmorei Taylor, 1934	White-Collared Fruit Bat	×	√	×
Pteropus vampyrus (Linnaeus, 1758)	Large Flying Fox	×	×	√

Table 1. Fruit bats found in Mt. Hamiguitan, Mt. Apo and Mt. Kitanglad protected areas, Mindanao, Philippines.

Species	Distribution	Endemism	IUCN Status
Ptenochirus jagori	Philippines	Endemic	Least Concern
Haplonycteris fischeri	Philippines	Endemic	Least Concern
Harpyionycteris whiteheadi	Philippines	Endemic	Least Concern
Ptenochirus minor	Mindanao	Endemic	Least Concern
Alionycteris paucidentata	Mindanao	Endemic	Least Concern
Cynopterus brachyotis	Southeast Asia	Non-endemic	Least Concern
Rousettus amplexicaudatus	Southeast Asia	Non-endemic	Least Concern
Macroglossus minimus	Southeast Asia	Non-endemic	Least Concern
Megaerops wetmorei	Southeast Asia	Non-endemic	Vulnerable
Pteropus vampyrus	Southeast Asia	Non-endemic	Endangered

Table 2. Distribution and endemism of fruit bats in Mt. Hamiguitan, Mt. Apo and Mt. Kitanglad, Mindanao, Philippines.

the effective management for sustainable development locally and nationally (Reyes, 2006). Hence, protected areas are the most effective tools in biodiversity conservation and ecosystem services but nowadays threatened (Gonzalez-Garcia et al., 2022).

The presence of endemic species indicates a good quality habitat that will also serve as watershed areas for the people. Most endemic species are habitat specific in a particular protected area compared to non-endemic species. Non-endemic

species can tolerate disturbed habitats or portions in the protected areas. This indicates various or multiple uses of the protected areas which serve as a balance between environmental and socio-economic benefits (Adams et al., 2023). However, the proliferation of the tolerant species compared to sensitive species may also signify degradation of protected areas, which are continuously threatened by land-use changes caused by human activities, such as in Sierra Madre (Verburg et al., 2006), which can affect the biodiversity in the area.

CONCLUSIONS

Therefore, these protected areas like Mt. Hamiguitan, Mt. Apo and Mt. Kitanglad forests are effective diverse habitats because of abundant, rich, endemic and threatened fruit bat species. They provide a very good indication of healthy forest ecosystems in protected areas that are beneficial to both people and biodiversity. Hence, this study recommends further protection of the remaining forest and the conservation of the fruit bat species in the protected areas as effective instrument for sustainability.

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