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Status of Mammals in the Expansion Sites of the Mt. Hamiguitan Range Wildlife Sanctuary, Mindanao, Philippines

ABSTRACT

Mt. Hamiguitan Range Wildlife Sanctuary is one of the biodiversity hotspots in the Mindanao faunal region, which is home to about 21 species of mammals. This study provides data on mammal assemblage and assessment on the added value of the ca. 2.99 km² MHRWS expansion sites to the already protected zone. Faunistic inventory and assessment documented 19 species of mammals belonging to 16 genera, eight families and five orders. This adds nine species to the previously reported mammals of Mt. Hamiguitan range making it a home to 30 species. Relatively low diversity of mammals (H'=0.615) in the expansion sites is attributed to poor soil resulting to low forest productivity and habitat loss due to mining, logging and shifting cultivation. This unique assemblage of vulnerable and endemic species of bats and mammals in Mt. Hamiguitan Range Wildlife Sanctuary expansion sites calls for more sampling effort and conservation strategies to maintain its bat and mammal assemblage.

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INTRODUCTION

The Philippines with its ca. 175 indigenous land mammal species and about 112 (64%) endemic species and 52 endangered species is perhaps with the greatest concentration of endemic mammals in the world (H*eaney 1986, Heaney 1993, Heaney and Regalado 1998, Mittermeier et al. 1997, Oliver 1994, WCSP 1997*) such high diversity is associated with its geological history due to the extent of Pleistocene islands, climatic variation and elevational gradients (*Balete et al. 2009, Heaney 2002*). The Philippines is a megadiversity country threatened by rapid rates of development with few strategies on maintaining its biodiversity (*Tanalgo and Hughes 2018*). The highest diversity are Greater Luzon and Greater Mindanao which each support several endemic species. Moreover, endangered species occur in all of the Philippine faunal regions. These areas were identified on the basis of distinctive animal life. The index of faunal endangerment ranks the Greater Negros-Panay faunal regions as most critical followed by Mindoro and Greater Luzon, Greater Mindanao, Greater Palawan, Sibuyan, Greater Sulu and the Batanes/Babuyan region (*Heaney 1993*). It was during the 1980s that the extent of rain-forest habitat destruction became apparent thus the need for biological diversity documentation and conservation (*Heaney and Tabaranza 2006a*). The documentation of new species in the past couple decades in the Philippines implies that mammal diversity was higher than had been believed (*Rickart et al. 2005, Heaney and Tabaranza 2006a, Heaney and Tabaranza 2006b, Heaney et al. 2006, Balete et al. 2008, Heaney et al. 2009*).

Mt. Hamiguitan Range Wildlife Sanctuary (MHRWS), Davao Oriental Province, Mindanao, is a protected area covering 68.34 km² with the maximum

elevation of 1,637 m above sea level (masl) characterized by a variety of vegetation types including a mossy pygmy forest (*Amoroso et al. 2009*). The pygmy forest inhabited by unique flora and fauna thus considered as hottest of the "hotspots" (*Ong et al. 2002*). The mountain is a UNESCO World Heritage Site, ASEAN Heritage Park and also a Mindanao Long Term Ecological Research (LTER) Site. Extensive data collection in MHRWS has provided baseline information of the mammal diversity in the area (*Balete et al. 2006, Relox et al. 2009*). Mt. Hamiguitan is of the four major mountains in the eastern Mindanao volcanic sector, the oldest independent volcanic sector in Mindanao, with geological deposits ranging from 47 to 3 Ma (*Sajona et al. 1997*).

To expand the protected area (PA) of the MHRWS, an area of ca. 2.99 km^2 expansion sites referring to specified areas outside the buffer zones (**Figure 1c**, green zone) was approved by municipal ordinances (*Amoroso et al. 2018*). It was issued with the aim of protecting and preserving the remaining biodiversity of the buffer zones referring to the identified areas outside the boundary of the core zone or PA (NIPAS Act of 1992, Section 8). Thus, this study provides data on mammal species composition, richness, diversity and status in the ca. 2.99 km^2 expansion sites. The data will be an input to the Protected Area Suitability Assessment (PASA) as required under NIPAS law (RA 7586) for legal promulgation. This study aimed to provide insights on the mammals and assessment of the added value of the ca. 299 ha expansion sites to the already protected core zone.

MATERIALS AND METHODS

Study Sites and Emersion

Fauna inventories were carried out at the MHRWS expansion sites from late October to December 2016 and on February to April 2018. The study sites were distributed in the municipalities of San Isidro, Governor Generoso and Mati City in the province of Davao Oriental, Mindanao, Philippines (**Figure 1**). The sites were classified under lowland mixed dipterocarp forest as trees belonging to family Dipterocarpaceae were dominant. The study sites were about 100 m – 5 km away from human habitation and 5 - 500 m away from bodies of water. The sites' dominant and emergent trees were *Shorea polysperma* (Blanco) Merr., *Ochrosia* spp. and *Gymnostoma rumphianum* (Miq.) L.A.S. Johnson reaching heights up to 32 m high. *Ficus* spp., other fruit plants, and fallen logs were common (80%) in study site 1 but rare (20%) in study sites 2-4. Exposed rocks were common in all the study sites.

Permit Statement

Prior informed consent from the communities was obtained by presenting the research to the stakeholders and members of the Protected Area Management Board (PAMB) of MHRWS for approval and issuance of the Gratuitous Permit (GP) from the Department of Environment and Natural Resources Region XI in the Philippines.

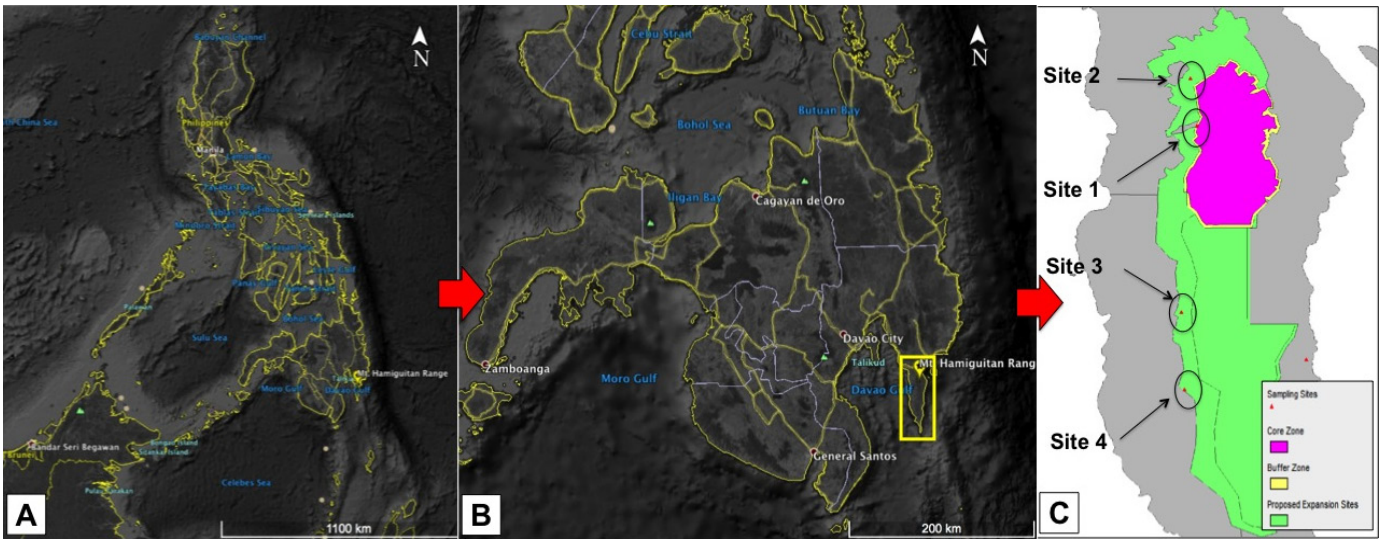

Figure 1. The study sites at Mt. Hamiguitan Range Wildlife Sanctuary expansion sites (yellow balloons). A) Philippine Map, B) Mindanao Map, C) Study Sites
Site 1- Sitio Tumalite, Barangay La Union, San Isidro, Davao Oriental (622 m a.s.l.)
Site 2- Sitio Tibanga, Barangay Maputi, San Isidro, Davao Oriental (292 m a.s.l.)
Site 3- Sitio Tagibo, Barangay Oregon, Governor Generoso, Davao Oriental (169 m a.s.l.)
Site 4- Sitio Tagaytay, Barangay Luzon, Governor Generoso, Davao Oriental (175 ma.s.l.)

Sampling, Processing, Identification and Analysis

Volant and non-volant mammals were caught during a total of 170 net nights and 223 trap-nights using the 12 m x 12 m mist nets and 30.8 x 17.78 x 17.78 cm live cage traps. Mist nets were strategically placed in flyways, forest edge, foraging areas and forest interior in a vertical forest stratum on ground (1-5 m) middle canopy (5-10 m) and upper canopy (10-15 m). The nets were left open from 1700 to 0600 hr to capture bats. The nets were monitored every 30-60 min to prevent mortality.

The live cage traps were set in various locations on the ground, including entrances of burrows, along runways, under root tangles, and under fallen logs using roasted coconut and peanut butter as bait. The traps were checked every early morning and late afternoon. To supplement faunal data, visual encounter and diurnal/ nocturnal opportunistic sampling were conducted.

The study employed captured, marked and released method. Standard external measurements such as total length, tail length, hind foot length, ear length and body length, sex and other distinguishing characters were recorded from each animal (*Cole and Woinarski 2002, Menkhors and Knight 2001*). Captured animals were identified using the field guides on volant and non-volant mammals (*Ingle et al. n.d., Heaney et al. n.d*.) and literature. The animals were assessed using the IUCN Red List of Threatened Species (*IUCN 2017*) and literature (e.g., *Relox et al. 2009*).

The Shannon-Wiener's index and Bray-Curtis cluster analysis were performed using BioDiversity Pro 2.0 statistical software (*McAleece et al. 1999*). The criteria adopted for interpreting results are as follows: H'<1 = low diversity, H'1-3 = fair diversity and H'>3 = high diversity (*Prabhu et al. 2005*).

RESULTS AND DISCUSSION

Inventory of mammals in MHRWS expansion sites documented a total of 19 species belonging to 16 genera, nine families and five orders. These include 10 species of Chiroptera belonging to Megadermatidae (1 species), Pteripodidae (8 species) and Vespertilionidae (1 species); one species of Viverriidae (Carnivora), one species Cervidae and Suidae (Cetartiodactyla); one species of Cercopithecidae and Tarsiidae (Primates) and four Murida (Rodentia) (**Table 1**). This study reports nine species of mammals not reported in previous works (*Balete et al. 2006, Relox et al. 2009*) making Mt. Hamiguitan habitat to 30 species of bats and mammals. The study revealed 63% (19 species) of mammals observed in the entire range. Overall species richness is low compared to the 53 native species of mammals previously documented in Mt. Kitanglad (*Heaney et al. 2006*).

The current work documented ten species of bats while previous works in the protected area reported only five species (*Relox et al. 2009*). *Emballonura alecto, Harpyionycteris whiteheadi, Megaerops wetmorei, Megaderma spasma, Ptenochirus minor* and *Rousettus amplexicaudatus* had not been previously documented but were documented by the current work in the expansion sites, making the Mt. Hamiguitan range home to ten bat species (**Table 2**). Species richness for bats is low relative to Mt. Kitanglad Range Natural Park, where 32 species occur.

Also documented are nine species of mammals, which is 56% of the mammals (16 spp.), reported in the protected area of MHRWS (*Balete et al. 2006*). The species reported herein is lower compared to Mt. Kitanglad Range Nature Park, which harbors 21 species of non-volant mammals (*Heaney et al. 2006*).

Diversity Index

The low Shannon-Wiener's index (H'= 0.615) of mammals in the MHRWS expansion sites. Among the four study sites Shannon-Wiener's index is highest in Site 2 (H'=0.8) and lowest in Site 4 (H'=0.43). The higher number of species in Site 2 is attributed to the adequate habitat resources, intact vegetation and less habitat disturbance (**Table 2**).

The low Shannon-Wiener's diversity index in the MHRWS expansion sites could be attributed to the poor soil, leading to low forest productivity (*Kumar and Maiti 2013*) and habitat loss due to logging, mining and shifting cultivation observed in the sampling sites.

Similarity Index

Bray-Curtis cluster analysis suggests that similarity was high between sites. Sites 3 and 4 had the most related species (84.8%) forming the first clade. This similarity can be attributed to the vegetation types since the sites were adjacently situated. Sites 1 and 2 formed the second clade with 69.76 % similarity index. The latter sites were also situated adjacent to each other, but have different vegetation types, thus, the probability that home range overlapping is high (80-90%). All the sampling sites were situated in a lowland dipterocarp forest adjacent to an agro ecosystem (**Figure 2**).

Table 1. Bats and mammals in Mt. Hamiguitan Range Wildlife Sanctuary expansion sites.

Taxon	Species	Common Name	1	2	3	4
			Study Sites			
			No. of Individuals			
Chiroptera						
Megadermatidae	1. **Megaderma spasma* Linnaeus, 1758					1
Pteripodidae	2. *Cynopterus brachyotis* Muller, 1838	Common Short-nosed Fruit Bat	20	22	50	44
	3. *Haplonycteris fischeri* Lawrence, 1939	Philippine Pygmy Fruit Bat	6	4		
	4. **Harpyionycteris whiteheadi* Thomas, 1896	Harpy Fruit Bat		1		
	5. *Macroglossus minimus* E. Geoffroy, 1810	Dagger-toothed Fruit Bat	3	2	6	2
	6. **Megaerops wetmorei* Taylor, 1934	White-collard Fruit Bat		5		
	7. *Ptenochirus jagori* Peters, 1861	Greater Musky Fruit Bat	4	3	44	37
	8. **Ptenochirus minor* Yoshiyuki, 1979	Lesser Musky Fruit Bat	1		5	
	9. **Rousettus amplexicaudatus* E. Geoffroy, 1810	Common Rousette			1	
Vespertilionidae	10. **Kerivola hardwickii*	Hardwicke's woolly bat				1
Carnivora						
Viverriidae	11. *Paradoxurus hermaphroditus*, Pallas, 1777	Asian Palm Civet		1		
Cetartiodactyla						
Cervidae	12. *Cervus mariannus* Desmarest, 1822	Brown Deer		1		
Suidae	13. *Sus philippinensis* Nehring, 1886	Philippine warty pig		1	1	1
Primates						
Cercopithecidae	14. *Macaca fascicularis* Raffles, 1821	Long tailed macaque	1			1
Tarsiidae	15. *Tarsius syrichta* Linnaeus, 1758	Philippine Tarsier			1	
Rodentia						
Muridae	16. *Bullimus bagobus* Mearns, 1905	Mindanao large forest rat		1		
	17. **Rattus argentiventer* Robinson & Kloss, 1916	Ricefield rat			2	
	18. *Rattus everetti* Gunther, 1879	Common Philippine forest rat	1	7	1	
	19. **Rattus tanezumi* Temminck, 1844	Oriental house rat				2
Total No. of Species			7	11	9	8

* Not reported by previous studies (*Balete et al. 2006, Relox et al. 2009*).

Table 2. Species richness and Shannon-Wiener's diversity index of mammals in the MHRWS expansion sites.

Sites	Coordinates	Elevation (masl)	Individuals Captured	Endemic Species	Threatened Species	Species Richness	Shannon-Wiener's Index (H')
Site 1	06° 44'15.24"N 126°08'59.36"E	622	36	4	-	7	0.7
Site 2	06°46'20.59"N 126°08'43.15"E	292	48	6	2	11	0.8
Site 3	06°36'01.87"N 126°08'21.59"E	169	111	4	-	9	0.53
Site 4	06°32'37.42"N 126°08'28.79"E	175	89	1	-	8	0.43
Average		-	-	-	-	8.75	0.615

Conservation Status Assessment

The study documented two vulnerable species *Megaerops wetmorei* and *Cervus mariannus* and eight endemic mammal species from the MHRWS expansion sites (**Table 3, Figure 3**). Two invasive rat species *R. argentiventer* and *R. tanezumi* were noted in the sites. Human activities contributing to habitat conversion and degradation such as hunting, logging, shifting cultivation and mining is apparent in the MHRWS expansion sites.

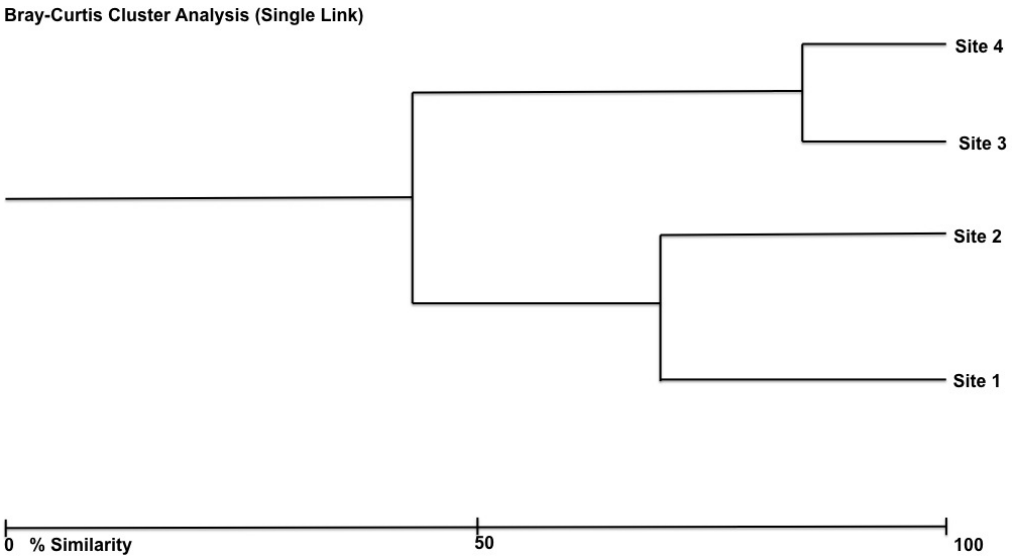

Figure 2. Dendrogram on the similarity of species composition of mammals in MHRWS expansion sites.

Table 3. Conservation and ecological status of mammals in Mt. Hamiguitan Range Wildlife Sanctuary expansion sites.

Species	Conservation Status	Ecological Status
1. *Haplonycteris fischeri* Lawrence		Philippine Endemic
2. *Harpyionycteris whiteheadi* Thomas		Philippine Endemic
3. *Megaerops wetmorei*	Vulnerable	
4. *Ptenochirus jagori* Peters		Philippine Endemic
5. *Ptenochirus minor* Yoshiyuki		Mindanao Endemic
6. *Cervus mariannus*	Vulnerable	Philippine Endemic
7. *Bullimus bagobus* Mearns		Mindanao Endemic
8. *Rattus everetti* Günther		Philippine Endemic
9. *Tarsius syrichta* Linnaeus		Philippine Endemic

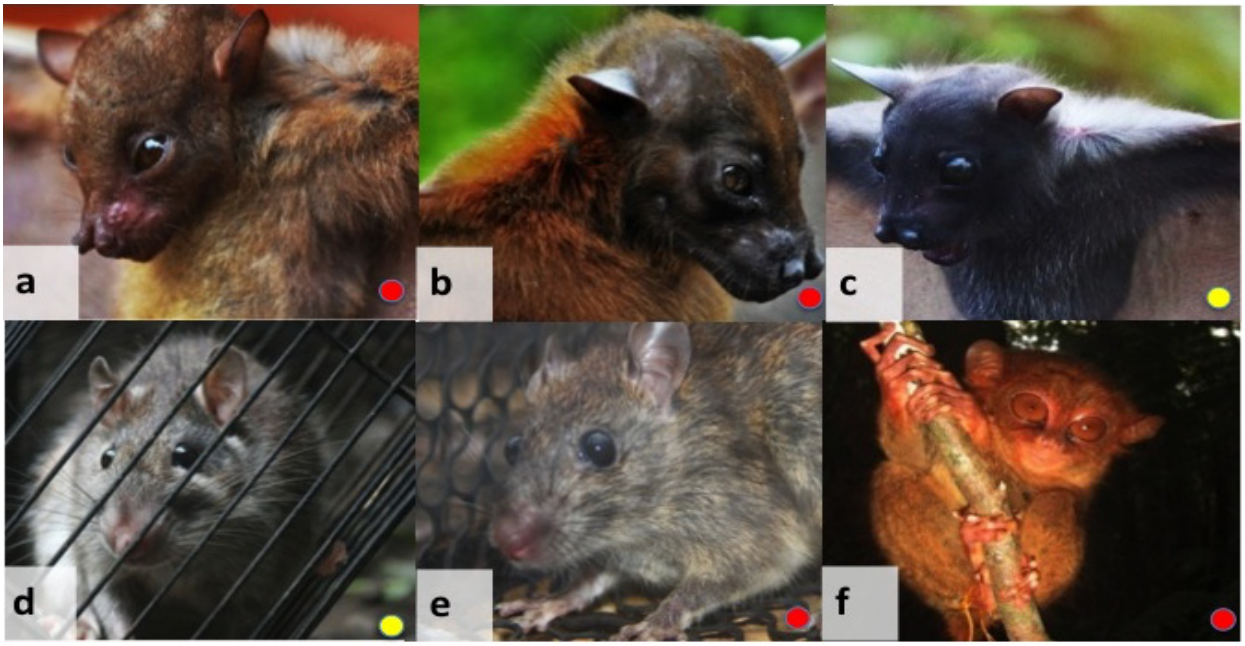

Figure 3. Some endemic mammals at the Mt. Hamiguitan Range Wildlife Sanctuary expansion sites:
a) *Haplonycteris fischeri* (Philippine Pygmy Fruit Bat); b) *Ptenochirus jagori* (Greater Musky Fruit Bat); c) *Ptenochirus minor* (Lesser Musky Fruit Bat); d) *Bullimus bagobus* (Mindanao large forest rat): e) *Rattus everetti* (Common Philippine forest rat); f) *Tarsius syrichta* (Philippine tarsier).
red dot- Philippine endemic, yellow dot- Mindanao endemic

CONCLUSION AND RECOMMENDATIONS

This diversity study of mammals in the Mt. Hamiguitan Range Wildlife Sanctuary expansion sites revealed 19 species belonging to 16 genera, nine families and five orders. This adds nine species to the previously reported mammals of Mt. Hamiguitan, bringing the total of documented mammal species to 30. The low diversity index of mammals (H'=0.615) in the MHRWS expansion sites is attributed to its poor soil resulting to low forest productivity and habitat loss inflicted by logging, mining and shifting cultivation. Species turnover between sites was low. Two species were vulnerable and eight endemics. The unique assemblage of bats and mammals in the MHRWS expansion sites appeals for more sampling effort and conservation strategies by the stakeholders to update the diversity status and maintain the mammal assemblage.

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