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SHORT COMMUNICATION

INTO THE HEART OF BORNEO: MAMMALS OF UPPER BALEH, SARAWAK

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Abstract: A survey of mammal species was conducted within the proposed Heart of Borneo (HoB) conservation area in Upper Baleh, Kapit Division, in the central region of Sarawak. The main objective was to assess mammalian diversity, especially small mammals. Sampling was carried out using mist nets and four-bank harp traps for bats, while collapsible cage traps were used for rodents and squirrels. The survey yielded 39 species of mammals, including 16 species of bats and two species of rodents from trapping efforts, and 21 species of small- to medium-sized mammals through sightings. Based on the 2016 IUCN Red List, 23 of these species were listed as least concern, five as near threatened, eight as vulnerable, one as endangered and two as data deficient. All 21 species of mammals sighted during the survey had been listed as protected animals under the Sarawak Wildlife Protection Ordinance 1998. The presence of various mammalian species, including those of conservation importance, highlighted the need for initiatives to protect and conserve the proposed HOB area in Upper Baleh.

KEYWORDS: Bats, conservation, diversity, inventory, Kapit, rodents.

Introduction

Borneo's tropical rainforest is renowned for the diversity and high-level endemism of its flora and fauna (Sodhi *et al.,* 2004). Unfortunately, many parts of Borneo are facing remarkable habitat loss due to unsustainable logging and conversion of forests into agricultural land (Fitzherbert *et al.,* 2008). This scenario has raised concern on the future of the island's biodiversity.

Therefore, the World Wildlife Federation has championed an international initiative between Malaysia, Brunei and Indonesia to conserve wildlife habitat through the establishment of the Heart of Borneo (HoB) (Figure 1; WWF, 2011). This transboundary project aims to preserve landscape connectivity, ecosystem services and the charismatic megafauna found in approximately 22 million hectares of continuous rainforest overlapping the three countries.

This highlights the need to document the diversity and distribution of wildlife, especially small mammals, which are an underappreciated taxa believed to exist in multitudes within this large pristine area.

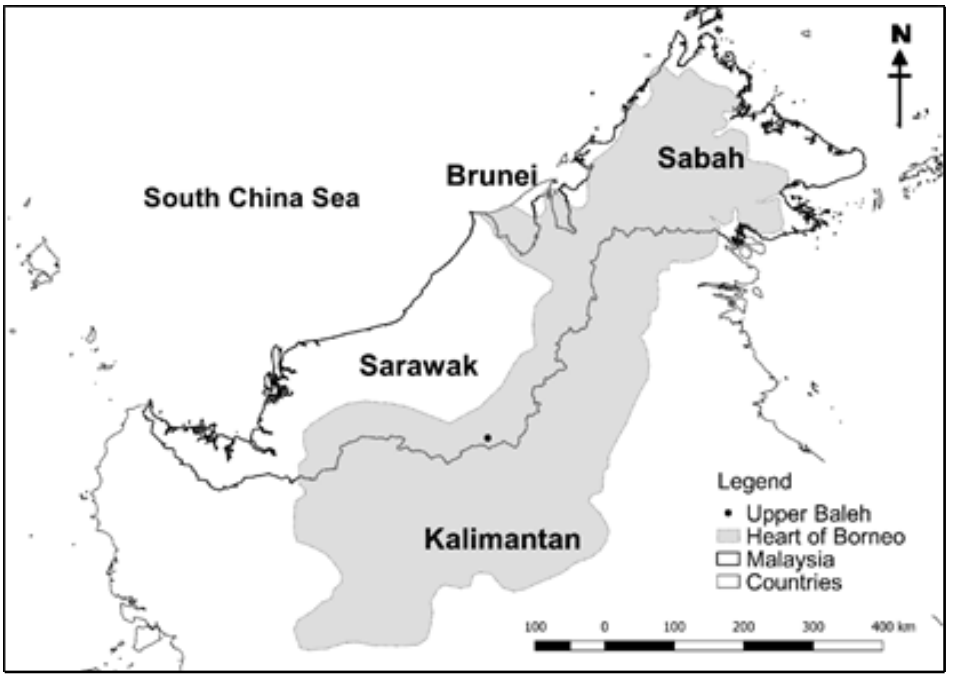

Figure 1: Location of Upper Baleh in Kapit Division of Sarawak and proposed Heart of Borneo project overlapping Malaysia, Brunei and Indonesia.

Small mammals (marsupials, rodents and bats) are widely studied and considered as indicators of habitat quality (Khan *et al.,* 2008; Kumaran *et al.,* 2011; Shazali *et al.,* 2016). But this group is mostly neglected in environmental assessments due to the animals' elusive nature and lack of charismatic features. Nonetheless, small mammals have significant ecological roles in the regeneration and sustenance of forests as seed dispersers and pollinators (Phillips & Phillips, 2016). Therefore, an understanding of their diversity can contribute to the importance of conserving a studied area. We report the diversity of small mammals, along with their medium to large species that were recorded at opportunity within the proposed HoB conservation area of Upper Baleh in Kapit as part of an environmental impact assessment exercise.

Materials and Methods

Study Area

The survey was conducted in Upper Baleh in the Kapit Division (N 01.558723° E 114.18594°) of Sarawak. Upper Baleh is one of the biologically-important localities within the proposed HoB area. It is a hilly landscape that consists of primary-mixed dipterocarp forests (MDF) and logging is very active there. A total of five locations along the main logging road were chosen as trapping sites. They contained features that attracted animals to search for food and water, such as streams flowing into the main Baleh river and banana plots.

Field Methods and Sample Processing

Fieldwork was conducted from 21 to 27 November 2015, with a total of seven trapping nights. Different types of sampling methods were used to maximize the capture rate.

For bats, five to 10 four-shelved mist nets, six four-bank harp traps and one 10-shelved mist net (7.3 m high) were deployed at their predicted flyways (across streams, forest trails, ridges and near flowering banana plots). The traps were set before their emergent time (beginning from 1800 or 1900) and checked

every 10 to 30 minutes for the first three hours, followed by every hour till midnight, and finally at 0600 the next morning.

For non-flying mammals like rodents and treeshrews, collapsible cage traps were set 5 m apart along forest transects and streams. Traps were only set at two separate sites, with 50 traps per site, and they were checked in the morning (1000) and evening (1600). Bananas, pineapples and crackers were used as bait and captured species were removed prior to re-baiting the traps.

A total of 20 pitfall traps (248 mm high and 170 mm wide) were also set for shrews. The traps were placed 5 m apart along a forest ridge near our campsite and checked in the morning at 1000. Zinc fences were constructed around the area to direct animals into the traps. Captured species were identified based on the methods outlined by Payne *et al.* (1985). External body measurements were taken with a digital caliper (Mitutoyo Corporation, Kawasaki, Japan) and weight was recorded using a spring scale (Pesola AG, Schindellegi, Switzerland). All materials were prepared as museum vouchers and housed in the Zoological Museum of Universiti Malaysia Sarawak (Unimas).

To maximize our effort, the line transect sampling was performed opportunistically during the day (between 0600 and 0700) and night (between 2200 and 2400) while heading to conduct the first and final bat trap checks. Transects were created simply by driving to our trapping sites at a speed of 20 to 30 km/h. At night, the animals were spotted along the logging road using headlamps and torchlights whereas during the day, they were spotted either directly or with the aid of binoculars.

Additionally, animal faeces, footprints and data from other researchers were collected to facilitate the identification of species.

Statistical Analysis

The number of captured animals were used to calculate the relative abundance of each species. The bat species accumulation curve was constructed using the number of nights/ days as sampling efforts. Rarefaction analysis of trapped species (rodents and bats) was used to compare the diversity in Upper Baleh with other areas within the HoB initiative. The rarefaction analysis was performed using the R software (R Foundation, Vienna, Austria) (Team Core Development, 2013).

Results and Discussion

Volant Small Mammals – Bat Species Diversity

The seven nights of sampling netted 46 bats representing 16 species from four families (Table 1; Figure 2). Among the significant species were *Rousettus amplexicaudatus* and *Dycopterus spadiceus*. Although *R. amplexicaudatus* could be found throughout Borneo, it is only known to inhabit a few localities in Sarawak (Phillips & Phillips, 2016). Similarly, there was a paucity of records for *D. spadiceus*.

The vertical stratification of tropical rainforests impeded the efficiency of the traps. This posed a problem in observing species such as *D. spadiceus*, which is known to forage in the canopy of mature rainforests (Francis, 1994). Trapping efforts at lower levels would yield very little results (Francis, 1990).

Table 1: List of bat species captured at Upper Baleh, Kapit, Sarawak, with relative abundance (%), ecological parameters and conservation status.

Oder Chiroptera Family/Species	Individuals captured	Relative Abundance (%)	IUCN Status (2016)	Wild Life Protection Ordinance (1998)	Ecological parameters
PTEREPODIDAE					
Balionycteris maculata (Thomas, 1893)	3	6.5	LC	PA	Captured in mist net and high net along small river and forest edge
Cynopterus brachyotis (Müller, 1838)	8	17.4	LC	PA	Captured in mist net and high net along small river and forest edge
Dycopterus spadiceus (Thomas, 1890)	5	10.9	NT	PA	Captured in mist net and high net at ridge area
Macroglossus minimus (E. Geoffroy, 1810)	2	4.3	LC	PA	Captured in mist net along small stream
Megaerops ecaudatus (Temminck, 1837)	1	2.2	LC	PA	Captured in high net at ridge area
Penthetor lucasi (Dobson, 1880)	8	17.4	LC	PA	Captured in mist net and high net at ridge area
Rousettus amplexicaudatus (E. Geoffroy, 1810)	2	4.3	LC	PA	Captured in high net at ridge area
HIPPOSIDERIDAE					
Hipposideros ridleyi (Robinson and Kloss, 1911)	2	4.3	V	PA	Captured in harp trap at small stream and forest edge
Hipposideros dyacorum (Thomas, 1902)	1	2.2	LC	PA	Captured in harp trap at forest edge
RHINOLOPHIDAE					
Rhinolophus trifoliatus (Temminck, 1834)	3	6.5	LC	PA	Captured in mist net and high net along the small stream and forest edge
Rhinolophus sedulus (K. Andersen, 1905)	1	2.2	NT	PA	Captured in harp trap at forest edge
VESPERTILIONIDAE					
Kerivoulinae					
Kerivoula hardwickii (Horsfield, 1824)	3	6.5	LC	PA	Captured in harp trap at small stream and banana plantation
Kerivoula intermedia (Hill and Francis, 1984)	4	8.7	NT	PA	Captured in harp trap at banana plantation
Kerivoula minuta (Miller, 1898)	1	2.2	NT	PA	Captured in harp trap at banana plantation
Murininae					
Murina suilla (Temminck, 1840)	1	2.2	LC	PA	Captured in harp trap in forest edge
Myotis muricola (Gray, 1864)	1	2.2	LC	PA	Captured in harp trap at banana plantation
Total individuals	46				
Total species	16				
Total families	4				

LC-Least Concern; NT-Near Threatened; V-Vulnerable; PA-Protected Animal

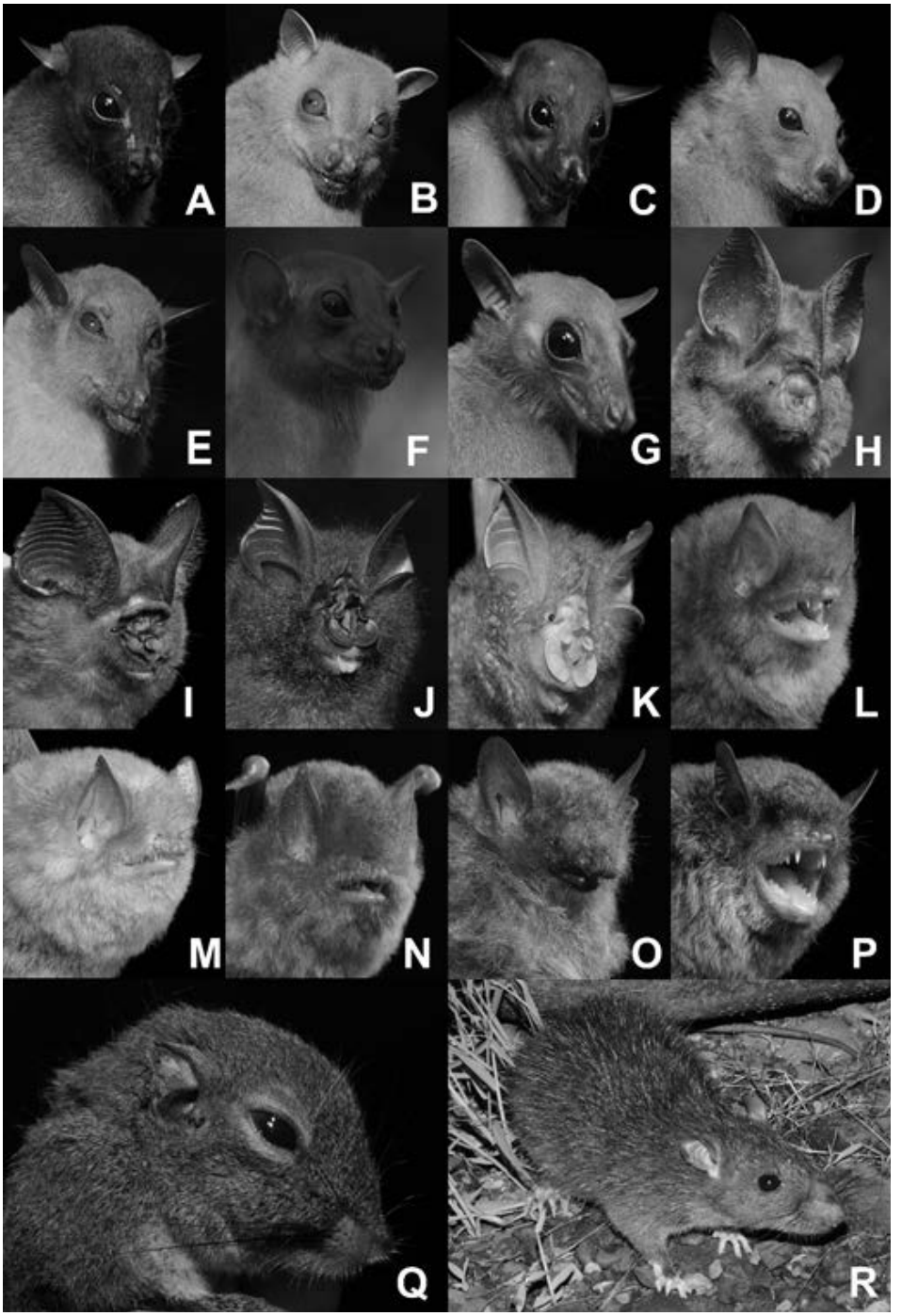

Figure 2: Small mammals trapped and recorded in Upper Baleh. A-*Balionycteris maculata*; B-*Cynopterus brachyotis*; C-*Dyacopterus spadiceus*; D-*Megaerops ecaudatus*; E-*Macroglassus minimus*; F-*Penthetor lucasi*; G-*Rousettus amplexicaudatus*; H-*Hipposideros dyacorum*; I-*Hipposideros ridleyi*; J-*Rhinolophus sedulus*; K-*Rhinolophus trifoliatus*; L-*Kervioula hardwickii*; M-*Kerivoula intermedia*; N-*Kerivoula minuta*; O-*Murina suilla*; P-*Myotis muricola*; Q-*Exilisciurus exilis*; and, R-*Sundamys muelleri*.

The most abundant bat species caught in Upper Baleh were *Cynopterus brachyotis* and *Penthetor lucasi*, with an equivalent relative abundance of 17.4%. The least captured species represented in singletons were *Megaerops ecaudatus*, *Hipposideros dyacorum*, *Rhinolophus sedulus*, *Kerivoula minuta*, *Murina suilla*, and *Myotis muricola*. The capture of bats, such as *P. lucasi* and *R. amplexicaudatus*, along the ridge across the valley suggested the location of caves nearby as these species were known to roost in large colonies inside caves. This observation indicated that there were potentially more cave-dwelling species yet to be documented in the area. It was further strengthened by the increasing species accumulation curve (for captured species) after the seventh day (Figure 3).

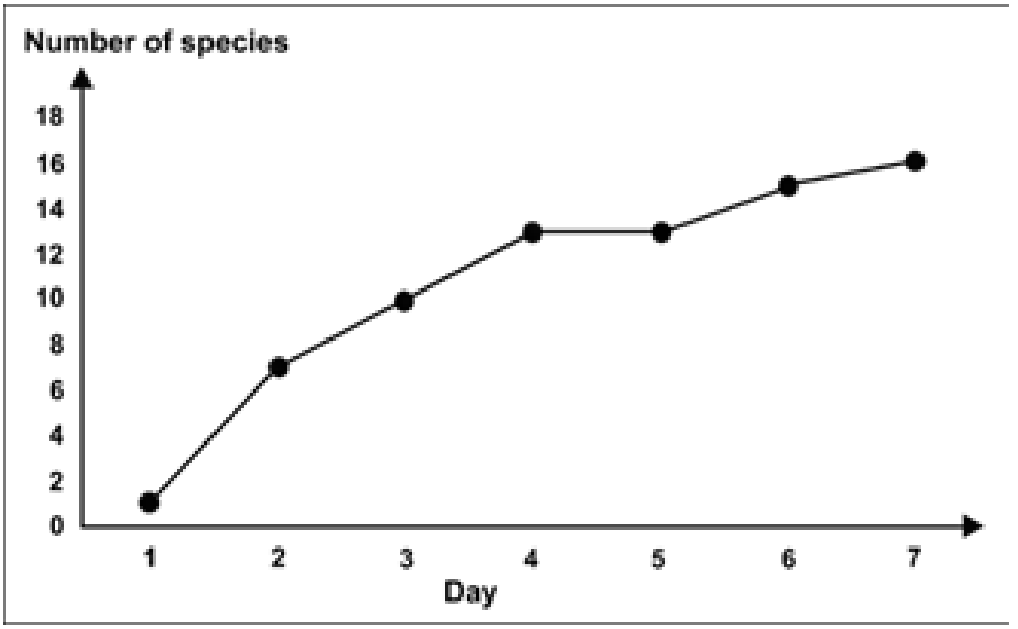

Figure 3: The species accumulation curve in Upper Baleh, Kapit, Sarawak, after seven days of sampling.

Two species of bats only from the Rhinolophidae and Hipposideridae families were commonly found in other national parks (Khan *et al.,* 2008; Kumaran *et al.,* 2011; Shazali *et al.,* 2016). One reason for this observation might be the manner of sampling in those studies, which were mostly carried out along established paths (walking trails, forest trails). These are preferred habitats of lowland understorey bats, such as *Hipposideros* spp. and *Rhinolophus* spp.

However, in this study, none of the bats were caught near established paths in the forest. Most of the flyways were determined on site, including at forest gaps caused by fallen trees. Traps were not set in fragmented forests near logging sites due to the loss of bat assemblages (Struebig *et al.,* 2008).

Bat diversity in Ulu Baleh (16 species) was about half of that in Niah National Park (38 species), which was also the highest in Sarawak (Shazali *et al.* 2018). However, diversity in Ulu Baleh was comparable to other sites in the proposed HoB domain, such as Batang Ai National Park (12 species) and the Lanjak Entimau Wildlife Sanctuary (11 species) (Shazali *et al.* 2018).

Non-volant Small Mammals – Rodents and Squirrel Species Diversity

Only three rodents were caught within the four transect lines where cage traps were deployed (Table 2). They were members of the Muridae (*Sundamys muelleri*) and Sciuridae (*Exilisciurus exilis*) families. The *S. muelleri* were caught in

cage traps while *E. exilis* was an opportunistic catch in a mist net.

The pitfall traps were a failure as they did not capture anything throughout the sampling period. Although the success of trapping non-volant small mammals was lower than bats, it was also observed that there was a very low presence of rodents in the forest.

We believe that the logging activities nearby had caused the non-volant small mammals to flee the sampling area. This conclusion was backed by studies that showed terrestrial animals being significantly affected by anthropogenic sounds, causing them to select a habitat away from the noise pollution (Sawyer *et al.,* 2006; Barton and Holmes, 2007; Laurance *et al.,* 2008).

This phenomenon had resulted in a restructuring of animal communities (Barber *et al.,* 2010). Known as "masking", noise pollution could inhibit the perception of sounds, and sciurid rodents had been observed to shift their vocalisations during mating and interactions to reduce the masking effect of noise (Brumm and Slabbekoorn, 2005; Warren *et al.,* 2006; Barber *et al.,* 2010).

Table 2: List of non-volant mammals (Order Rodentia) captured in Upper Baleh, Kapit, Sarawak, with their relative abundance (%), ecological parameters andconservation status.

Family/Species	Individuals captured	Relative abundance (%)	IUCN status (2016)	Wildlife Protection Ordinance (1998)	Ecological parameters
MURIDAE					
Sundamys muelleri (Jentink, 1879)	2	66.7	LC	NPA	Captured in cage trap that set up in transect along small stream
SCIURIDAE					
Exilisciurus exilis (Müller, 1838)	1	33.3	DD	NPA	Captured accidently in mist net at bird flyways
Total individuals	3				
Total species	2				
Total families	2				

LC-Least Concern; DD-Data Deficient; NPA-Non-Protected Animal

Sighting of Mammals

Mammal sightings yielded surprising results despite active logging and poaching by the locals. A total of 21 species comprising small to large mammals from 13 families were recorded (Table 3).

Of these, eight species were of conservation concern, listed as either "Endangered" or "Vulnerable" in the IUCN Red List of Threatened Species (2016). As for local legislation, three species were listed as "Totally Protected Animal" and 11 as "Protected Animal" under the Sarawak Wildlife Protection Ordinance 1998 (WLPO 1998).

Despite the active logging activities in the surveyed area, the presence of numerous protected species in a single area within a short time suggested that the Upper Baleh forest could sustain important wildlife diversity. Most of the animals were sighted along the logging road during the wee hours or at dawn. The presence of a Bornean Sun Bear (*Helarctos malayanus*) was evidenced by the remains of an animal, which was slaughtered by villagers at the roadside.

Our opportunistic mammal sightings were comparable with those recorded in other national parks using camera traps (Maludam National Park=11 species, Loagan Bunut National Park=10 species, Lambir Hills National Park=13 species, Kubah National Park=eight species, Tanjung Datu National Park=20 species and the Lanjak Entimau Wildlife Sanctuary=21 species; as reviewed in Mohd-Azlan *et al.,* 2018).

Table 3: List of medium and large mammals observed through sighting and vocalization.

Family/Species	Common name	IUCN status (2016)	Wildlife Protection Ordinance (1998)
CYNOCEPHALIDAE			
Galeopterus borneanus	Bornean Colugo	LC	PA
LORISIDAE			
Nycticebus coucang	Sunda Slow Loris	V	TPA
CERCOPITHECIDAE			
Presbytis hosei	Hose's Grey Langur	V	TPA
Macaca fascicularis	Long-Tailed Macaque	LC	PA
Macaca nemestrina	Pig-Tailed Macaque	V	PA
HYLOBATIDAE			
Hylobates muelleri	Müller's Gibbon	E	TPA
SCIURIDAE			
Aeromys tephromelas	Black Flying Squirrel	DD	PA
Petaurista petaurista	Red Giant Flying Squirrel	LC	PA
URSIDAE			
Helarctos malayanus	Bornean Sun Bear	V	PA
MUSTELIDAE			
Martes flavigula	Yellow-Throated Marten	LC	NPA
Mustela nudipes	Malay Weasel	LC	NPA
VIVERRIDAE			
Arctictis binturong	Binturong	V	PA
Arctogalidia trivirgata	Three-Striped Palm Civet	LC	PA
Paradoxurus hermaphroditus	Common Palm Civet	LC	PA
PRIONODONTIDAE			
Prionodon linsang	Banded Linsang	LC	PA
FELIDAE			
Prionailurus bengalensis	Leopard Cat	LC	PA
SUIDAE			
Sus barbatus	Bearded Pig	V	NPA
TRAGULIDAE			
Tragulus napu	Greater Mousedeer	LC	NPA
CERVIDAE			
Muntiacus muntjak	Barking Deer	LC	NPA
Muntiacus atherodes	Bornean Yellow Muntjac	NT	NPA
Cervus unicolor	Red Muntjac or Sambar Deer	V	NPA
Total species	21		
Total families	13		

LC-Least Concern; V-Vulnerable; E-Endangered; DD-Data Deficient; NT-Near Threatened; TPA-Totally Protected Animal; PA-Protected Animal; NPA-Non-Protected Animal

Sampling Effort

The species accumulation curve suggested that the inventory needed more effort (Figure 3). Future surveys should include more efficient techniques, such as acoustic monitoring for bats (Struebig *et al.,* 2012) and camera trappings for medium to large mammals (Mohd-Azlan, 2009). The rarefaction graph showed that the Upper Baleh (non-protected area) and Gunung

Mulu National Park (protected area) had similar richness of species (18 species) for the 49th species captured (Figure 4). Therefore, Upper Baleh could be considered to have similar potential as other rainforests in Sarawak that had been earmarked for conservation of their wildlife. However, species documentation in this proposed HoB area is still lacking as information on species occurrence, especially small mammals, are scarce.

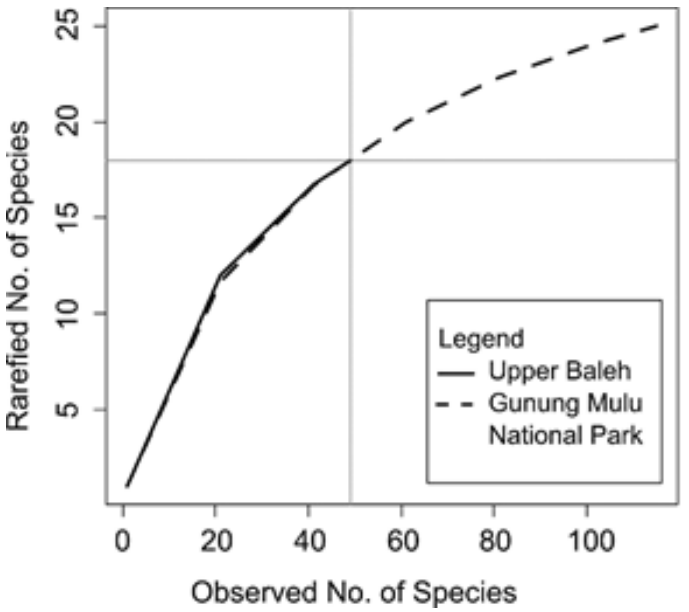

Figure 4: Rarefaction curve of all species captured (rodents and bats) in Upper Baleh and Gunung Mulu National Park, Sarawak. At 49th individuals captured, both sites showed an equal number of species captured which is 18 species. Species richness of small mammals in Gunung Mulu National Park was based on Shazali *et al.* (2016).

Conclusion

Our survey highlighted the ecological significance of Upper Baleh in protecting the biodiversity of mammalian fauna in the proposed HoB domain and its adjacent areas. Furthermore, the results also indicated that more interesting findings could be revealed through continuous surveys with the inclusion of various trapping and detection methods, specifically for extremely elusive wildlife. Initiatives to protect and conserve wildlife in Upper Baleh might contribute to the future and survival of Borneo's biodiversity.

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References

Fitzherbert, E. B., Struebig, M. J., Morel, A., Danielsen, F., Brühl, C. A., Donald, P. F. & Phalan, B. (2008). How will oil palm expansion affect biodiversity? *Trends in Ecology and Evolution, 23*(10), 538-545.

Francis, C. M. (1990). Trophic structure of bat communities in the understorey of lowland dipterocarp rainforest in Malaysia. *Journal of Tropical Ecology, 6,* 421-431.

Francis, C. M. (1994). Vertical stratification of fruit bats (Pteropodidae) in lowland dipterocarp rainforest in Malaysia. *Journal of Tropical Ecology, 10*, 523-530.

IUCN 2016. The IUCN Red List of Threatened Species. http://www.iucnredlist.org.

Khan, F. A. A., Swier, V. J., Solari, S., Larsen, P. A., Ketol, B., Marni, W., Ellagupillan, S., Lakim, M., Abdullah, M. T. & Baker, R. J. (2008). Using genetics and morphology to examine species diversity of old world bats: Report of recent collection from Malaysia. *Museum of Texas Tech University, 281,* 1-27.

Kumaran, J. V., Ketol, B., Marni, W., Sait, I., Mortada, M. J., Anwarali, F. A. A., Fong, P. H., Hall, L. S. & Abdullah, M. T. (2011). Comparative distribution and diversity of bats from selected localities in Sarawak. *Borneo Journal of Resource Science and Technology, 1*, 1-13.

Mohd-Azlan, J. (2009). The use of camera traps in Malaysian rainforests. *Journal of Tropical Biology and Conservation, 5*, 81-86.

Mohd-Azlan,J., Nurul-Asna, H., Jailan, T. S. Tuen, A. A., Engkamat, L., Abdillah, D. N., Zainudin, R.,and Jedediah F. B. 2018. Camera trapping of terrestrial animals in Tanjung Datu National Park, Sarawak, Borneo. *Raffles Bulletin of Zoology, 66,* 587-594.

Payne, J., Francis, C. M. & Phillips, K. (1985). *A Field Guide to the Mammals of Borneo.* Kuala Lumpur: The Sabah Society and World Wildlife Fund. 332 pp.

Phillips, Q. & Phillips, K. (2016). *Mammals of Borneo and Their Ecology: Sabah, Sarawak, Brunei and Kalimantan.* Kota Kinabalu: Natural History Publications. pp. 84–137.

Shazali, N., Rahman, S. P. H., Tahir, N. F. D. A., Murni, R., Latip, N. A., Naharuddin, N. M., Azhar, I., McArthur, E., Khalik, M. Z., Rahman, M. R. A. & Khan, F. A. A. (2016). Small mammals from Miri, north-eastern region of Sarawak, Malaysian Borneo: note on new locality records, *Check List, 12*(2), 1863.

Shazali, N., Rajasegaran, P. Azhar, Rahman, M. R. A., Tingga, R. C. T. & Khan, F. A. A. (2016). Bats of Sarawak in totally protected areas: a review on its diversity, distribution and conservation status. In *Glimpses of Bornean Biodiversity* (eds.) Chong, Y. L., Yeo, F. K. S. and Khan F. A. A. Kota Samarahan: UNIMAS Publisher. pp. 33–50.

Sodhi, N. S., Koh, L. P., Brook, B. W. & Ng, P. K. L. (2004). Southeast Asian biodiversity: an impending disaster. *Trends in Ecology and Evolution, 19*(12), 654-660.

Struebig, M. J., Kingston, T., Zubaid, A., Mohd-Adnan, A. & Rossiter, S. J. (2008). Conservation value of forest fragments to Palaetropical bats. *Biological Conservation, 141*(1), 2112-2126.

Struebig, M. J., Bożek, M., Hildebrand, J., Rossiter, S. J. & Lane, D. J. (2012). Bat diversity in the lowland forests of the Heart of Borneo. *Biodiversity and Conservation, 21*(14), 3711-3727.

WWF. (2011). Business Solutions: Delivering the Heart of Borneo Declaration. *WWF Green Network Report.* 82 pp.