

REMOTE CAMERA TRAPPING IN MIXED-USED PLANTATION LANDSCAPE AND HIGH BIODIVERSITY VALUE AREA OF GLENEALY PLANTATIONS, OIL PALM PLANTATION.

BELDEN Gimán¹ RENDALL Richard¹ and CHIENG Kai Soon¹

¹SUSTAINABILITY DEPARTMENT, Glenealy Plantations Sdn Bhd, Bintulu, Sarawak, Malaysia

Corresponding author: Belden Gimán, email: beldengiman@gmail.com

ABSTRAK

Methodologi perangkap kamera secara khususnya telah digunakan dari bulan Julai 2021 sehingga bulan November 2023 untuk mengkaji kepelbagaian mamalia sederhana sehingga ke mamalia besar di kawasan kepelbagaian biodiversiti tinggi (HBV) di kawasan Perkebunan sawit Glenealy Plantations Sdn Bhd, yang terletak di 3 bahagian Kapit, Bahagian Bintulu dan Lahad Datu, Sabah. Kesemua kawasan HBV adalah berdampingan dan bersempadan dengan kawasan operasi Glenealy Plantations Sdn Bhd. Sejumlah 36,826 gambar telah diperolehi dengan mencatatkan sebanyak 1,692 gambar mempunyai spesies haiwan mamalia. Antaranya, 23 spesies mamalia telah dapat dikenalpasti setakat projek dijalankan dan komposisi spesies mamalia didominasi oleh primat iaitu spesies Beruk Ekor Pendek (Short-tailed Macaque), *Macaca nemestrina* yang telah mencatatkan sejumlah 637 gambar dan diikuti oleh Babi Janggut (Bearded Pig), *Sus barbatus* dengan kiraan 354 gambar. Hasil dari projek ini amat meyakinkan dan ini menunjukkan pengurusan Glenealy Plantations di dalam aspek pemuliharaan hutan dan hidupan ditunjukkan berkesan dan perlu diteruskan untuk jangka masa panjang. Dengan penemuan dan kajian sebegini menunjukkan komitmen Syarikat untuk Bersama menjaga kepelbagaian biodiversiti di kawasan operasi jagaannya.

ABSTRACT

Remote camera traps were utilised from April 2021 until November 2023 to determine mammal species composition and species richness in three High Biodiversity Value areas (HBV) of Glenealy Plantations Sdn Bhd Oil Palm Plantation. These areas are located in Bintulu and Kapit Divisions of Sarawak and Lahad Datu of Sabah. All are adjacent to and bordering Glenealy Plantations Sdn Bhd operation blocks and coupes. A total of 36,826 photographs were obtained and examined, in which 1,692 photographs contained an identifiable species. A total of 23 mammal species were determined during the study period. Of all species recorded, the Short-tailed Macaque, *Macaca nemestrina* comprising of 637 photos, and the Bearded Pig, *Sus barbatus* with 354 photographs respectively were dominant. The result from this study is encouraging as it showed that the Glenealy Plantations' Conservation management has so far been effective, although long-term monitoring will be required to ensure all these species will remain. Our study demonstrates thus far that the company's

commitment to the conservation of wildlife, specifically Rare, Endangered and Threatened (RTE) species that inhabit the surrounding operational areas, has shown a degree of success.

INTRODUCTION

Over the last several decades, extensive areas of Sarawak have been converted from logged over forests or ex-rubber (*Hevea brasiliensis*) plantations to oil palm (*Elaeis guineensis*) (Sodhi, et al., 2010). The dearth of naturally forested areas has raised the issue of biodiversity loss in these same areas, particularly those in which no naturally forested areas were maintained (Koh, L.P. and D. Wilcove 2008) leading to a dramatic reduction in species diversity, specifically for species of forest mammals. More recently however, in order to achieve certification of the crop (such as from MSPO or even RSPO) many oil palm companies have worked to ensure the inclusion of so-called High Conservation Value (HCV) areas embedded within oil palm plantings. The survival of biodiversity within such mixed-use areas in theory can provide for the survival of many forest species, but in only a few instances has there been an effort to provide empirical proof that this strategy is actually working. Unfortunately, however, many Bornean mammals are difficult to detect, either due to their elusive behaviour, nocturnal or crepuscular habits. In the case of many predators (*Neofelis diardii*, *Arctogalidia trivirgata* and *Paradoxurus hermaphroditus*), nocturnally active in the forest canopy making them even more difficult to see. Thus, conventional surveys do not yield much success, compared to the current use of automated trail cameras. Thus, the growing use and development of these remote “camera traps” over the past several decades has brought significant improvements, that greatly improve the probability of detection for both common and cryptic mammal species (Mohd-Azlan and Sanderson, 2007; Cheyne, et al., 2010a, b). The Glenealy Plantations Sdn Bhd (here referred to as GPSB), is a locally owned and operated oil palm plantation company in Sarawak and Sabah of East Malaysia and in Bulungan (North Kalimantan) of Indonesia. GPSB is a major oil palm producers that has adopted the industry’s best agricultural and sustainability practices for its planted area, occupying approximately 40,000 hectares out of a total land bank of 74,044ha. GPSB operates four (4) palm oil mills across Malaysia and Indonesia as well as one composting plant in Sabah, Malaysia. The establishment of Conservation unit was set up in July 2020 to further improve conservation management within the GPSB Sustainability Department.

The present study has been undertaken, to provide empirical evidence of the success or failure of this species conservation management effort in the short term, and with extended effort, determine how this approach affects the long diversity, distribution, and abundance of mammals. In April 2021, the Sustainability Department team of Glenealy Plantations Sdn Bhd (GPSB) began an intensive study, to document the species of Rare, Threatened or Endangered (RTE) in particular and other mammal species generally, in the conservation area of Jelalong, Belaga, Lana and Timora Oil Palm plantation, located in Bintulu Division, Sarawak and Lahad Datu of Sabah respectively.

STUDY AREA

The two years of preliminary camera trapping survey was initiated in selected conservation areas (High Biodiversity Value Area, HBV) across Jelalong, Belaga and Lana estates of Sarawak Region and Timora estate of Lahad Datu region of Sabah. All study area were located within Glenealy Plantation's land title/land banks. The focus of this survey was on remnants of the original land cover, ranging from regenerating secondary to riparian and mixed dipterocarp forest, either characterised as dryland or wetland habitats (McShea ref). Most of the riparian forest are consists of secondary forest patches with small trees and shrubs which predominantly *Macaranga spp.*, with shrubs and gingers that lie along riverbanks where the canopy is less than 8-10 meters tall. The "core" conservation areas, are comprise of old-logged forest currently recovering and regenerating with most of the commercially available timber species still intact and survive. Some of the edible dipterocarp fruits (*Shorea spp.*) and *Ficus spp* are also available and scattered throughout almost all of the conservation areas studied. These areas have not been used by local people for fruit and forest resource use as most of the local communities surrounding these sites concentrate their use in their Native Customary Rights (NCR) land for such daily activities.

METHODOLOGY

The main objective of this camera trapping study was to determine and monitor the occurrence and existence of Rare, Threatened and Endangered species inhabits the forested area that affected by the changes in landscape due to development of oil palm plantation by Glenealy Plantations Sdn Bhd (GPSB) in some portions of Kapit and Bintulu divisions of Sarawak and Lahad Datu of Sabah. Our study utilized commercially available HC108A and HC108B remote cameras, which function well under local tropical conditions. A total number of 15 cameras were rotated between each study areas throughout the study period. The study area was specifically chosen inside the existing Conservation areas and a minimum distance of 300 m was set between each camera location. Each camera was positioned adjacent to game trails, pathways, natural salt licks and other positions that indicated the potential presence of terrestrial mammals. The HC108A and HC108B use a 16MP camera combined with a built-in Infrared (IR) / motion sensor that detects heat from an animal passing in front of it. Time and date are automatically recorded on each exposure. Cameras are mounted on trees at about 50 cm above ground, at least 2.5m from the center of target area. No scent used during the study period. All camera trap sites were marked using a Global Positioning System (GPS) (Garmin 60 CS). The remote cameras were checked (batteries and cards) and the lure was replenished after approximately 25-30 days and removed on the third month or last rotation before shifted to the new estates. Although the camera trapping still carries on, the preliminary result from 2021 – 2023 will be used and analysed. All identifications were done through Mammals of Borneo (*Payne et. al, 1985*)

RESULTS

A total no of 1414 trap nights was achieved over two (2) years (April to November 2023), yielded a total of 32 faunal species detected and photographed, comprising 23 species of mammals, 7 species of birds and 2 species of reptiles. Only the larger mammals such as (*Rusa unicolor*) Sambar Deer, (*Sus barbatus*) Bearded Pig, (*Muntiacus atherodes*) Bornean Yellow Muntjac, (*Helarctos malayanus*) Sun Bear and (*Macaca nemestrina*) Pig-tailed Macaque, left detectable signs in the camera area. The remaining 27 species would not have been detected without the cameras. Out of 32 species detected, 13 species of mammals are considered as Rare, Threatened or Endangered (RTE), under the IUCN list of threatened species. Approximately, 36826 photos were taken from 33 sample sites, and 1692 were photographed with animals. The species detected are summarized as below;

Table 2: No. of Camera Trap Photo Obtained for each site sampled in Glenealy Plantations Sdn Bhd Conservation Area.

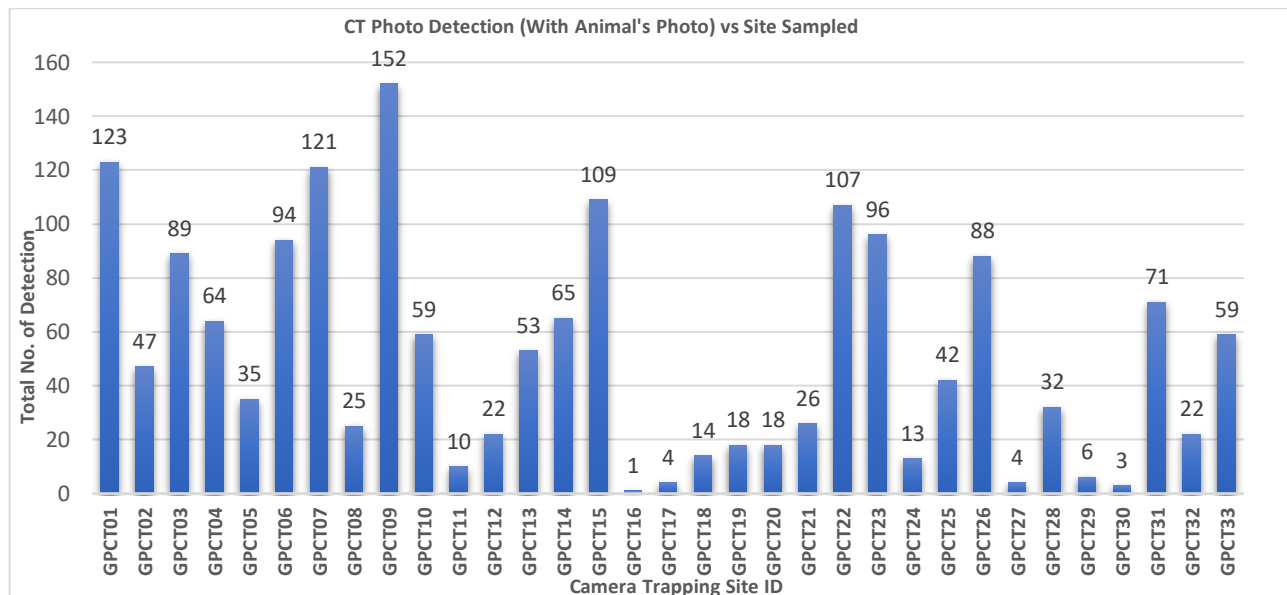


Table 2: No. of photographed per species of mammals detected in all 33 sites of HBV areas within Glenealy Plantations Sdn Bhd. TMR = Timora Estate (Sabah), JEL = Jelalong Estate, BEL = Belaga Estate and LAN = Lana Estate

NO	Order Family	Latin Name	Local Name	No. of Images	Estate	Conservation Status, IUCN
1.	ARTIODACTYLA Suidae	<i>Sus barbatus</i>	Bearded Pig	354	TMR, JEL, BEL, LAN	Vulnerable
2.	Cervidae	<i>Rusa unicolor</i>	Sambar deer	86	TMR, JEL, BEL	Vulnerable
3.	Cervide	<i>Muntiacus atherodes</i>	Bornean-yellow Muntjac	63	JEL, BEL, LAN	Near Threatened
4.	Tragulidae	<i>Tragulus spp</i>	Mousedeers	78	JEL, BEL, LAN, TMR	Least Concern
5.	PRIMATES Cercopithecidae	<i>Macaca fascicularis</i>	Long-tailed Macaque	115	JEL, BEL, TMR	Endangered

NO	Order Family	Latin Name	Local Name	No. of Images	Estate	Conservation Status, IUCN
6.	Cercopithecidae	<i>Macaca nemestrina</i>	Short-tailed Macaque	637	JEL, BEL, LAN, TMR	Vulnerable
7.	CARNIVORA Ursidae	<i>Helarctos malayanus</i>	Bornean Sun Bear	26	JEL	Vulnerable
8.	Viveridae	<i>Hemigalus derbyanus</i>	Banded Palm Civet	62	JEL	Near Threatened
9.	Viveridae	<i>Viverra tangalunga</i>	Malay Civet	62	JEL, BEL, TMR	Least Concern
10.	Viverridae	<i>Paradoxurus hermaphroditus</i>	Asian Palm Civet	2	JEL	Least Concern
11.	Viverridae	<i>Arctictis binturong</i>	Binturong	2	JEL	Vulnerable
12.	Viverridae	<i>Cynogale bennettii</i>	Otter-Civet	1	JEL	Endangered
13.	Mustelidae	<i>Mustela nudipes</i>	Malay Weasel	1	JEL	Least Concern
14.	Mustelidae	<i>Martes flavigula</i>	Yellow-throated marten	7	JEL, BEL	Least Concern
15.	Herpestidae	<i>Urva brachyurus</i>	Short-tailed Mongoose	5	JEL, BEL	Near Threatened
16.	Herpestidae	<i>Urva semitorquatus</i>	Semi-collared Mongoose	10	JEL	Near Threatened
17.	Mephitidae	<i>Mydaus javanensis</i>	Sunda Stink Badger	11	TMR	Least Concern
18.	Felidae	<i>Pardofelis marmorata</i>	Marbled Cat	3	JEL	Near Threatened
19.	Felidae	<i>Prionailurus bengalensis</i>	Leopard Cat	4	JEL, BEL, TMR	Least Concern
20.	RODENTIA Hystricidae	<i>Hystrix brachyura</i>	Common Porcupine	56	JEL, BEL, LAN, TMR	Least Concern
21.	Hystricidae	<i>Hystrix crassispinis</i>	Thick-spined Porcupine	93	JEL, BEL, LAN, TMR	Least Concern
22.	Hystricidae	<i>Trichys fasciculata</i>	Long-tailed Porcupine	13	JEL, BEL	Least Concern
23.	Sciuridae	<i>Rheithrosciurus macrotis</i>	Tufted-ground Squirrel	1	JEL	Vulnerable

All the primates (Macaques) and mustelids (Yellow-throated Marten, Short-tailed Mongoose and Collared Mongoose) were photographed during the day, confirming that these species are highly diurnal. Unlike the mustelids, other carnivores such as the civets (Viverridae) are nocturnally active as all photos of these species were obtained after dark. Among the viverrids photographed, only *Viverra tangalunga* and *Hemigalus derbyanus* are terrestrial carnivores.

Sus barbatus (Bearded Pig) and *Rusa unicorn* (Sambar Deer) were active both day and night. Most the photos of Bearded pigs indicate that that this species was foraging in troops and seldom on its own except for a few photos (less than 50 photos) of the occasional adult. Groups detected ranged from 2-8 individuals, foraging

with little piglets. Unlike bearded pig, Sambar deer tended to be solitary as all photos collected and analysed were shown of only a single individual (mostly males).

Although only two species of felids (*Prionailurus bengalensis* and *Pardofelis marmorata*) were detected (combined total of 7 photos). Both species were photographed during daytime *Neofelis diardii* (Bornean Clouded Leopard), although not photographed during the survey period, their existence was confirmed through their tracks.

Tragulid spp (Mousedeer/Chevrotain). were grouped in one genus as detail visible in our photos, did not allow identification to the species level. Approximately 78 photos of Mousedeer were obtained during the two years of our camera trapping survey. Over 90% of these photos were during night time to early morning, suggesting that these species, as has been speculated (*Belden et. al; Wahyudi and Stuebing, 2013*) are crepuscular.

The species most commonly encountered was *Macaca nemestrina* (Pig-tailed macaque), detected 637 times comparing to its relative, *Macaca fascicularis* (Long-tailed Macaque) generating detection of 115 photos. All Primate species are Protected under Sarawak Wildlife Protection Ordinance, 1998 (*State of Sarawak, 1998a, b*) Both *M. nemestrina* and *M. fascicularis* were conspicuously active during a day although some photos of *Macaca fascicularis* were obtained during the late evening, ranging between 1800-1900hrs.

DISCUSSION

Results of this species conservation survey have been encouraging since due to large forested landscape area bordering the High Biodiversity Value (HBV) Areas, adjacent to other concessions. This work has provided a positive preliminary input for long-term species conservation for GPSB Since no such species inventory was conducted except for the general surveys involved in the Environmental Impact Assessment (EIA) done by professional consultants.

Significantly, several RTE species such as Marbled Cat (*Pardofelis marmorata*), Bornean Sun Bear (*Helarctos malayanus*) and Otter-Civet (*Cynogale bennettii*), all assumed to be threatened by plantation development and operations still persist in the area, and were recorded by our cameras from 2021-2023. Thus far, no conspicuous loss of species has been indicated even in the case of species such as the Otter Civet *Cynogale bennettii*, the Malayan Weasel, *Mustela nudipes* and the Tufted Ground Squirrel *Rheithrosciurus macrotis* that were rarely encountered (one photo each) during the study period, but whose presence was confirmed within the two years of the initiation of our surveys of the GPSB operational and conservation areas.

Generally, in remote camera trap studies, many surveys are implemented over a brief time period as such as those of Mohd-Azlan and Engkamat in totally protected forests (*Azlan and Engkamat 2006; Mohd-Azlan and Engkamat 2013*), primarily focusing on determining an overall picture of mammal; species inhabiting the area and not on individual species (*Cheyne et. al.,2010a; Mathais et al. 2010*). Other studies that produced more than 1000 traps night, such as in mixed-use forest plantation (*Belden, et al. 2007*), were done to determine

the occurrence of mammal species might be predicted to inhabit disturbed forests close to human settlement.

In comparison, the remote camera trap study of GPSB show a great number of species on North-East site of the area (in Sarawak) comparing to sites in North-West, South-West of Jelalong, all sites in Belaga, Lana and Sabah areas. Approximately 13 species exclusively recorded on one site (GPCT15) located on North-East of Jelalong and three (3) other sites on the same area (GPCT04 = 10 species, GPCT09 = 11 species, and GPCT10 = 10 species) recorded relatively high number of species respectively. These results might likely be affected by trapping effort particularly on GPCT09 site where 73 comparing to other sites with a range of between 13 to 67 trapping nights. However, those four (4) sites are less disturbed comparing to the other sites and further to human disturbance and bordering large forested landscape of other concessions and native customary right lands. This might indeed play a vital role for the stability and occurrence of these species of mammals. Site selection however is mostly identical, which focusing only on game trails, possible salt lick and as close as possible to streams and rivers.

Although there was no species specific targeted for this remote camera trapping project, rare, threatened, and endangered species such as *Cynogale bennettii* (Otter-Civet) and *Helarctos malayanus* (Bornean Sun Bear) were always a species of conservation concern for GPSB. For instance, *Cynogale bennettii* was only found on few locations throughout its geographical range (Heydon and Ghaffar, 1997; Veron et al., 2006; Cheyne et al., 2010b) including our study area and this indicate that the High Biodiversity Value (HBV) area designated for biodiversity conservation are actually play a pivotal role for RTE species survivalism. The company always concerns on poachers and illegal hunting also demonstrated through annually Conservation trainings and briefings to all members as well as installation of awareness signage on strategic location on all sites demarcated as HBV area. The routine inspection (once in three months) by person-in charge for all estates also an initiative by operational area to participate in conservation of biodiversity and not just species specific of genera-specific.

In Hulu Belayan, Wahyudi and Stuebing (Wahyudi and Stuebing, 2013) identified 36 species of mammals for over 4.5 years generating over 8000 trap nights by remote camera trapping in PT. REA Kaltim oil palm plantations and its embedded Conservation Reserves. Pig-tailed Macaque (*Macaca nemestrina*) was the most frequently photographed with a total of 1450 photos and followed by the Bearded Pig (*Sus barbatus*) with a total 1126 of photos. They cited that the hunting of large mammals or game species from 2008-2012 could not be proven as the cause of species declines despite the fact that traditional hunting was widespread, i.e., hunting activity was locally intense. By comparison, GPSB area where neighbouring with NCR and other concessions, hunting is routinely practiced, although there has yet no attempt been made to quantify how much meat has been harvested and which species were affected. Nevertheless, most of the game species such as *Muntiacus atherodes*, *Sus barbatus* and *Rusa unicolor* continued to be routinely detected in GPSB area. Thus, it is more likely that all these differences in abundance of large mammals or game species that are

consumptively harvested in forested and protected areas of Borneo in general, may have less to do with hunting, but more likely due to the nature of the habitat and changes in the surrounding ecosystem. Interestingly in GPSB area, although most of the pig populations were assumed by some local people to have been wiped out by the outbreak of African Swine Fever (ASF), that based on numerous tracks of the species within oil palm blocks adjacent to conservation areas and carcasses left by hunters of the surrounding longhouse communities, the local pig population either was resistant to the disease or perhaps continued to reproduce without significant losses.

Other taxa such as carnivores were detected in relatively low numbers during most of our camera trapping efforts. This probably is attributable to their wary behaviour, as well as the fact that many of the carnivores are arboreal and only few species, *Viverra zangalunga* and *Hemigalus derbyanus* for instance, forage on the ground, feeding for insects or carrion. Other mustelids and viverrids encountered in low numbers of detection, were *Mustela nudipes*, *Arctictis binturong* and *Paradoxurus hermaphroditus*. *Paradoxurus hermaphroditus* and *Arctictis binturong* are semi-arboreal and prefer to stay in the canopy to look for food than descend to the ground. This behaviour indeed makes it less likely for them to be detected by completely terrestrial camera traps. Small species, such as *Mustela nudipes* however, may actually elude detection by walking beneath the camera and thus making it difficult to detect them. Although *Neofelis diardii*, the biggest carnivore in Borneo, was not detected during this study period but in the recent past has been reported several times by the workers that work near boundary of the oil palm blocks and forested areas.

Bornean Sun Bear was one of the mammal's species that is commonly associated in human-wildlife conflicts. Although there were few reports from Oil Palm harvesters that they encountered Sun Bears, we found no evidence that a Sun Bear had been killed or hunted. Most of the cases, the harvesters merely fled the area, or just ignored the animals. Bear encounters apparently occur at a relatively low rate and only in specific in more remote areas along estate boundaries with forested conservation areas. Nevertheless, Sun Bears still appeared in 26 photos from the study area.

As for Felids, of two (2) species detected by camera traps (*Prionailurus bengalensis* and *Pardofelis marmorata*), *Prionailurus bengalensis* was the most commonly photographed (4 photos) felid in all site selected within GPSB conservation areas. The reason behind this low detection rate was probably due to the abundance of forest rats in oil palm blocks, where this species tends to come out from the forested area to ambush in the area where foods are more abundance. They appear to prefer a diet of murid rodents common in all oil palm blocks (Grassman et al., 2005; Rajaratnam et al., 2007). However, for murid rodents, we have excluded this group from the analysis due to the difficulty in obtaining any accurate identification of the species from our photos. It is obvious that these results emphasise on the importance of maintaining the remaining forested areas (HBV) networks, although the surrounding mixed-use landscape continues to be dominated by a single species of monoculture. Through in planting of native species such as figs (*Ficus spp*) and other edible forest fruit species inside the logging trails or along the edge of HBV forest a beneficial increase increase the habitat heterogeneity

can occur (Syafiq *et al.*, 2016). This can help to create additional resources that are much needed especially for the survival and stability of forest dependent species. It is pivotal to learn and understand how the impacts of large-scale land conversion to oil palm can be properly managed, and perhaps subsequently reduced. Furthermore, by managing all these isolated small populations in a so-called High Biodiversity Value area whereby small forest fragments as part of a larger metapopulation to prevent their extirpation, is indeed a way forward. Our study shows that many mammal's species are thriving in these forest fragments. By trying to improve habitat connectivity will undoubtedly facilitate the persistence of, and the very least, slow the decline (extinction debt) of large-medium sized mammal's communities in the plantation mixed-used landscape mosaic.

ACKNOWLEDGEMENTS

The author and co-author are very pleased to the Management of Glenealy Plantations Sdn Bhd for their continuous and keen support of the all the conservation projects of the GPSB Conservation Unit within the Sustainability Department. Our sincere thanks also to all estate members of Lana, Belaga, Jelalong East and West of Sarawak region, as well as Timora, AKB and Pertasa of Sabah region who were either directly involved in the field efforts, or who provided much support and kind assistance for this project. Our sincere thanks also to Tuan Han Boon Kwang, Tuan Andy Lau Seng Kee, Mr. Moses Kawi, Mr. Rendall Richard, Mr. Nahewing, Mr. Syaiful, Mr. Awang Khairuddin, Mr. Stanley Aseng, Mr. Rusdi Bastami, Mr. Raymond Naga, Mr. Albert Bujoi, Mr. Frankie Eban, Mr. Louis Robert, Mr. Spencer Bugat and Mr. Alexander Kuti who were either directly or indirectly involved in the advice and field efforts, or who provided much support and assistance for this project. We also received much valuable advice, comments and suggestions from Mr. Robert B. Stuebing that helped us to improve the manuscript. Last but not least, to all friends and families that their name was not being mentioned, their help and advice is much appreciated and not forgotten.

REFERENCES

- Azlan, M.J. and L. Engkamat (2006). Camera trapping and conservation in Lambir Hills National Park, Sarawak. *Raffles Bulletin of Zoology* 54(2): 469-475
- Belden, G., R. Stuebing, R., Nyegang, M., McShea, W. and C. Stewart (2007). A camera trapping inventory for mammals in a mixed-use planted forest in Sarawak. *Raffles Bulletin Of Zoology* 55: 209-215.
- Cheyne SM, Husson SJ, Chadwick RJ & Macdonald DW (2010a) Diversity and activity of small carnivores of the Sabangau Peat-swamp Forest, Indonesian Borneo. *Small Carnivore Conservation*, 43: 1–7.
- Cheyne SM, Husson SJ & Macdonald DW (2010b). First otter civet *Cynogale bennettii* photographed in Sabangau Peat-swamp Forest, Indonesian Borneo. *Small Carnivore Conservation*, 42: 25–26.
- Grassman, L.I., Tewes, M.E., Silvy, N.J. and K. Kreetiyutanont (2005). Spatial organization and diet of the leopard cat (*Prionailurus bengalensis*) in north central Thailand. *Journal of Zoology* 266:45–54.

- Heydon MJ & Ghaffar N (1997) Records of otter civet (*Cynogale bennettii*) from northern Borneo. *Small Carnivore Conservation*, 16: 27.
- Koh, L.P. and D. Wilcove (2008). Is oil palm agriculture really destroying biodiversity? *Conservation Letters* 1: 60-64.
- Mathais, J., J. Hon, J. Ngumbang, Peter, A. and M. Gumal 2010. Small carnivores in a logging concession in the Upper Baram, Sarawak, Borneo. *Small Carnivore Conservation* 42: 1-9
- Mohd-Azlan, J., & Engkamat, L. (2013). Camera trapping and conservation in Lanjak Entimau Wildlife sanctuary, Sarawak, Borneo. *The Raffles Bulletin Of Zoology*, 61(1), 397-405.
- Mohd-Azlan, J. & J. Sanderson, 2007. Geographic distribution and conservation status of the bay cat (*Catopuma badia*), a Bornean endemic. *Oryx*, 31: 1–4.
- Payne, J., C. M. Francis & K. Phillips, 1985. A field guide to the mammals of Borneo. The Sabah Society, Malaysia. 332 pp.
- Rajaratnam, R., Sunquist, M., Rajaratnam, L. and L. Ambu (2007). Diet and habitat selection of the leopard cat (*Prionailurus bengalensis borneoensis*) in an agricultural landscape in Sabah, Malaysian Borneo. *Journal of Tropical Ecology* 23: 209–217.
- State of Sarawak, 1998a. Wildlife Protection Rules. *Sarawak Government Gazette*, Pt. II-III (41): 183-204. Kuching.
- State of Sarawak, 1998b. Wildlife Protection Ordinance. *Sarawak Government Gazette*, Pt. I, VI (2): 1-46. Kuching.
- State of Sarawak, 1998b. Wildlife Protection Ordinance. *Sarawak Government Gazette*, Pt. I, VI (2): 1-46. Kuching.
- Sodhi, N.S., Posa, M.R.C., Lee, T.M., Bickford, D., Koh, L.P. and B.W. Brook (2010). The state and conservation of Southeast Asian biodiversity. *Biodiversity Conservation* 19:317-328.
- Syafiq, M; Atiqah, A R N; Ghazali, A; Asmah, S; Yahya, M S; Aziz, N; Puan, C L and Azhar, B (2016). Responses of tropical fruit bats to monoculture and polyculture farming in oil palm smallholdings. *Acta Oecologica*, 74: 11-18.
- Veron G, Gaubert P, Franklin N, Jennings AP, Grassman LI Jr (2006) A reassessment of the distribution and taxonomy of the Endangered otter civet *Cynogale bennettii* (Carnivora: Viverridae) of South-east Asia. *Oryx*, 40: 42–49.
- D. Wahyudi, R. Stuebing (2013). Camera trapping as a conservation tool in a mixed-use landscape in East Kalimantan *Journal of Indonesian Natural History*, 1 (2013), pp. 37-46.

APPENDICES

1.



Sus barbatus (Muller, 1838) - Bearded Pig

IUCN Status: Vulnerable

2.



Rusa unicolor (Kerr, 1972) – Sambar Deer

IUCN Status: Vulnerable

3.



Muntiacus atherodes (Groves & Grub, 1982) – Bornean Yellow Muntjac

IUCN Status – Near Threatened

4.



Tragulus spp – Mousedeer

IUCN Status – Least Concern

5.



Macaca fascicularis (Raffles, 1821) – Crab-eating Macaque

IUCN Status: Endangered

6.



Macaca nemestrina (Linnaeus, 1766) – Southern Pig-tailed Macaque

IUCN Status: Endangered

7.



Helarctos malayanus (Raffles, 1821) – Bornean Sun Bear

IUCN Status: Vulnerable

8.



Hemigalus derbyanus (Gray, 1837) – Banded Palm Civet

IUCN Status: Near Threatened

9.



Viverra zibetha (Gray, 1832) - Malay Civet

IUCN Status – Least Concern

10.



Paradoxurus hermaphroditus (Pallas, 1777) – Asian Palm Civet

IUCN Status – Least Concern

11.



Arctictis binturong (Temminck, 1824) - Bearcat

IUCN Status: Vulnerable

12.



Cynogale bennettii (Gray, 1836) – Otter civet

IUCN Status: Endangered

13



Mustela nudipes (Desmarest, 1822) – Malayan Weasel

IUCN Status – Least Concern

14.



Martes flavigula (Boddaert, 1785) – Yellow-throated Marten

IUCN Status – Least Concern

15.



Urva brachyurus (Gray, 1837) – Short-tailed Mongoose

IUCN Status: Near Threatened

16.



Urva semitorquatus (Gray, 1846) – Collared Mongoose

IUCN Status: Near Threatened

17.



Mydaus javanensis (Desmarest, 1820) – Sunda Stink Badger

IUCN Status – Least Concern

18.



Pardofelis marmorata (Martin, 1836)

IUCN Status: Near Threatened

19.



Prionailurus bengalensis (Kerr, 1792) – Leopard Cat

IUCN Status – Least Concern

20.



Hystrix brachyura (Linnaeus, 1758) – Malayan Porcupine

IUCN Status – Least Concern

21.



Hystrix crassispinis (Günther, 1877) – Thick-spined Porcupine

IUCN Status – Least Concern

22.



Trichys fasciculata (Shaw, 1801) – Long-tailed Porcupine

IUCN Status – Least Concern

23.



Rheithrosciurus macrotis (J. E. Gray, 1857) – Tufted Ground Squirrel

IUCN Status – Vulnerable