ECOLOGY OF MAMMALS AND IMPLICATION ON PARK MANAGEMENT

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A thesis submitted in
fulfilment of the requirement for the award of the
Doctor of Philosophy in Science

Faculty of Applied Sciences and Technology
Universiti Tun Hussein Onn Malaysia

AUGUST 2023

DEDICATION

With genuine gratitude and warm regard, I dedicate this work project to my late father, Ahmad Bakri, my loving mother, Zuhairi, my supportive family, Fidya Wahyu, Nurul Izzatie and Muhammad Zulfadli who have supported me through the ups and downs. A special feeling to my beloved nephews and niece, Muhammad Dhani Yusuf, Anna Nurnaema and Aali Nukman who always motivate me again after having a series of emotional rollercoasters during my PhD journey. I also dedicated this work and special thanks to my wonderful best friends (Gadis Vavavoom, Shafiq Hamdin, Lepat Pisang, Ce Ceghita, Girl Power, Bawang Army, Kami Awesome, As Long As We Are Together, and a few others namely Balqis, Soleha and Diyana) for being there throughout the entire doctorate program, before and hopefully forever. This is also for those who helped me in all great things and even small things. The people who helped me during the sampling, mainly Adlil Ikram, TNJGL staffs namely JMacdey Jengkeng, Muhazam Syah and others who always lent me their hands during the field work. Not to forget the amazing girls (Ng Yin Hui, Najwa Afifah and the girls, staffs of TNJGL; Ana, Syura, Ain) who always accompanied me during my stays in TNJGL. Not to forget all my previous lecturers and teachers who taught and gave me so much knowledge. They are people whom I cherish, have meant and continue to mean so much to me. They inspired me throughout this project. Thank you.

ACKNOWLEDGEMENT

This research was supported by the Commemorative Grant Fund for Capacity Building of Young Scientists of Nagao Natural Environment Foundation (NEF). In addition, I would like to express my gratitude to Universiti Tun Hussein Onn Malaysia for providing Postgraduate Research Grant (GPPS) Vot H347 during this study. Many thanks to the PTNJ for the permit to conduct this research in TNJGL. I acknowledged UTHM, PTNJ and Nagao for providing the necessary funding, facilities and assistance throughout the research study. Thank you to my supervisor, Prof. Em. Datin Dr. Maryati Mohamed and co-supervisor, Dr. Masatoshi Yasuda who guided me in this process and kept me on track.

ABSTRACT

Lack of current checklist and ecological knowledge are drawbacks for conservation and management efforts of wildlife in a protected area, such as Taman Negara Johor Gunung Ledang (TNJGL). This research aims to make TNJGL a successfully managed protected area based on results of current research, leading to sustainable conservation of biodiversity. The objectives of this research are to i) document the diversity, distribution and activity patterns of mammals along five trails in Gunung Ledang by using camera trapping, ii) translate the ecological information of mammalian fauna in TNJGL and coming up with a recommendation of wildlife management of the park, and iii) determine priority areas to conserve based on the results obtained from the sampling, interviews and reviews of document. This study employs an intensive camera trapping methodology along altitudinal gradient of five different trails. In total, 60 camera traps were set up, yielding 4245 videos in a span of 24 months. To formulate recommendations and determine priority areas for conservation, occupancy analysis was conducted, accompanied by a review of relevant documents, management plans and reports. From this research, 31 species of terrestrial mammals were recorded and together with previous findings produces the current checklist for TNJGL comprising of 60 mammal species. Mammals such as the Leopard (*Panthera pardus*), Sumatran Serow (*Capricornis sumatraensis*), and Malayan Tapir (*Tapirus indicus*) are recorded providing evidence of the presence of these rare species thriving in TNJGL. Using the occupancy analysis, areas to be prioritized for mammals' conservation were presented in a map. Other than that, six issues were identified; conservation, lack of current database and information, the need to enhance TNJGL prescribed activities (CEPA and tourism), the need to upskill training of staff, enforcement and problems with wildlife. Results obtained from analyses of data, add on to the better understanding of mammal ecology in the park. Based on these results as well as taking into account the resources available, recommendations were made to address the six issues identified.

ABSTRAK

Kekurangan senarai semak dan pengetahuan ekologi terkini adalah kelemahan untuk usaha pemuliharaan dan pengurusan hidupan liar di kawasan perlindungan, seperti Taman Negara Johor Gunung Ledang (TNJGL). Penyelidikan ini bertujuan menjadikan TNJGL sebagai kawasan perlindungan yang berjaya diurus berdasarkan hasil penyelidikan semasa, yang membawa kepada pemuliharaan biodiversiti yang mampan. Objektif penyelidikan ini adalah untuk i) mendokumentasikan kepelbagaian, taburan dan corak aktiviti mamalia di sepanjang lima denai di Gunung Ledang dengan menggunakan perangkap kamera, ii) menterjemah maklumat ekologi fauna mamalia di TNJGL dan mengemukakan cadangan pengurusan hidupan liar taman, dan iii) menentukan kawasan utama untuk dipulihara berdasarkan keputusan yang diperoleh daripada analisis penghunian. Kajian ini menggunakan metodologi perangkap kamera di sepanjang kecerunan altitudinal lima laluan berbeza. Secara keseluruhan, 60 perangkap kamera digunakan, menghasilkan 4245 video sepanjang tempoh 24 bulan. Untuk merumuskan cadangan dan menentukan kawasan utama untuk pemuliharaan, analisis penghunian dijalankan, disertai dengan semakan dokumen yang berkaitan, rancangan pengurusan dan laporan. Daripada penyelidikan ini, 31 spesies mamalia darat telah direkodkan dan beserta dengan penemuan terdahulu telah menghasilkan senarai semak terbaru untuk TNJGL yang terdiri daripada 60 spesies mamalia. Dari analisis penghunian, kawasan yang perlu diberi keutamaan telah dibentangkan di dalam peta. Selain itu, enam isu dikenal pasti; pemuliharaan kekurangan pangkalan data dan maklumat semasa, keperluan untuk meningkatkan aktiviti yang ditetapkan TNJGL (CEPA dan pelancongan), keperluan untuk meningkatkan latihan kakitangan, penguatkuasaan dan masalah dengan hidupan liar. Keputusan yang diperoleh daripada analisis data, menambah pemahaman yang lebih baik tentang ekologi mamalia di TNJGL. Berdsarkan keputusan ini serta mengambil kira sumber yang ada, cadangan telah dibuat untuk menangani enam isu yang telah dikenal pasti.

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LIST OF SYMBOLS AND ABBREVIATIONS

ATM	-	Angkatan Tentera Malaysia
CBD	-	Convention on Biodiversity
CEPA	-	Communication, Education and Public Awareness
CR	-	Critically Endangered
D	-	Simpson's Diversity Index
DD	-	Data Deficient
DNA	-	Deoxyribonucleic acid
DWNP	-	Department of Wildlife and National Parks
EN	-	Endangered
GMT	-	Greenwich Mean Time
GPPS	-	Postgraduate Research Grant
H'	-	Shannon-Wiener Diversity Index
IUCN	-	International Union for Conservation of Nature's
JPM	-	Jabatan Penerangan Malaysia
LC	-	Least Concern
MCO	-	Movement Control Order
MET	-	Malaysia Meteorological Department
MONRE	-	Ministry of Natural Resources and Environment
NEF	-	Natural Environment Foundation
NGO	-	Non-governmental Organisation
NRE	-	National Resources and Energy
OBK	-	Operasi Bersatu Khazanah

PAST	-	Paleontological Statistics
PCA	-	Principal Component Analysis
PERHILITAN	-	Jabatan Perlindungan Hidupan Liar dan Taman Negara
PERHUTANAN	-	Jabatan Perhutanan
PTNJ	-	Perbadanan Taman Negara Johor
SMART	-	Spatial Monitoring and Reporting Tool
TELEKOM	-	Syarikat Telekomunisasi Malaysia
TNJGL	-	Taman Negara Johor Gunung Ledang
UTHM	-	Universiti Tun Hussein Onn Malaysia
VETOA	-	Veteran Angkatan Tentera Malaysia dan Orang Asli
VU	-	Vulnerable
WWF	-	World Wildlife Foundation

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LIST OF PUBLICATIONS

i) **Faiznur, A. A. B**., Yasuda, M., Maryati, M., Adlil, I. S., & Halid, M. S. (2020). The first record of Sumatran serow, *Capricornis sumatraensis* (Bovidae, Cetartiodactyla), in Gunung Ledang Johor National Park, a tropical forest remnant on the southern Malay Peninsula. *Mammal Study*, *45*(3), 259-264. **(SCOPUS)**

ii) **Bakri, F. A. A.,** Yasuda, M., Mohamed, M., Sharuddin, A. I., & Hambar, M. S. (2020). Mammalian Diversity of Gunung Ledang, Johor, Peninsular Malaysia. *HAYATI Journal of Biosciences*, *27*(3), 221-221. **(SCOPUS)**

iii) **Faiznur, A. A. B.,** Wong, C. H., McAfee, A., & Maryati, M. (2019, July). Bird Diversity of Lingai, Terengganu, Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 269, No. 1, p. 012017). IOP Publishing. **(SCOPUS)**

iv) **Ahmad-Bakri, F. A.,** Abd-Rahman, N. A., Ahmad, Z. A. M., Maryati, M., & Abu-Bakar, M. F. (2021, April). Activity pattern of *Scotophilus kuhlii* at agriculture and urban landscape area in Tasik Chini and Universiti Kebangsaan Malaysia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 736, No. 1, p. 012005). IOP Publishing. **(SCOPUS)**

v) **Faiznur, A. A. B.,** Maryati, M., Yasuda, M. & Adlil, I. S. (in press). The diversity and activity patterns of Felidae family in Taman Negara Gunung Ledang, Malaysia. *Journal of Tropical Biodiversity and Biodiversity.*

Oral Presentations:

i) **Bakri, F. A. A.,** Yasuda, M., Mohamed, M., Sharuddin, A. I., & Hambar, M. S. (2020). Mammalian Diversity of Gunung Ledang, Johor, Peninsular Malaysia in The 6th International Conference on Biological Science ICBS 2019 on 10th – 11th October 2019 at Eastparc Hotel, Yogyakarta, Indonesia

ii) **Ahmad-Bakri, F. A.,** Abd-Rahman, N. A., Ahmad, Z. A. M., Maryati, M., & Abu-Bakar, M. F. (2021, April). Activity pattern of *Scotophilus kuhlii* at agriculture and urban landscape area in Tasik Chini and Universiti Kebangsaan Malaysia in The International Conference on Biodiversity 2020 on 4^{th} – 5^{th} November 2020 virtually in UTHM

CHAPTER 1

INTRODUCTION

1.1 Introduction

Mammals have important roles in the forest ecosystem. For example, they provide vital services such as seed dispersal and pollination. Other than that, they regulate insect populations and can act as indicators of general ecosystem health (Jones & Safi, 2011). In Malaysian forests, they include orang utans, tigers, wild boars, gaurs and tapirs. Many mammals are declining globally, such as elephants and large cats (Ripple *et al*., 2016).

Mammals live in major habitats of the world, on the ground, on trees, in the ocean and in caves. The most striking characteristic of mammals is their ability to learn. This is due to their well-developed sense organs, responsible for hearing and vision. This helps them adapt to the changing world (Brooker, 2008). Some mammals, usually top predators like tigers, live solitary lives. However, some live in groups such as lions and otters. Some herbivores are even more social, especially hoofed animals like deer. Despite the differences, all mammals have the same four traits. They have hair, mammary glands, a hinged jaw and three tiny middle ear bones (Brooker, 2008).

Malaysia is one of the most mega-diverse countries in the world and is a part of the Sundaland biodiversity hotspot (Myers *et al.,* 2000). In the world, Malaysia ranks 12th according to the National Biodiversity Index, which is based on the country's richness and endemism estimation in four terrestrial vertebrate classes and vascular plants (CBD, 2021). To date, an estimated 5,801 mammal species worldwide have been described and the species conversation status has been evaluated (IUCN, 2018). In Malaysia, there are 361 mammal species (Tajuddin, 2013), meaning they are 6.2% of the global mammal species. To illustrate another aspect of biodiversity

uniqueness is the occurrence of 66 species of endemic mammal species found in Malaysia making up 18.3% of endemism, in general (Zahidin *et al.*, 2016).

Malaysia is a home to globally significant populations of endangered megafauna such as the Malayan tigers (*Panthera tigris*), Asian elephants (*Elephas maximus*), and Malayan tapirs (*Tapirus indicus*) (Clements *et al.*, 2010). They were threatened by rapid deforestation and habitat fragmentation, poaching, and human-wildlife conflicts (Saaban *et al.*, 2011; Rayan & Linkie, 2015). Despite the global significance, Malaysia was ranked relatively low (57 out of 152 countries) in its efforts to conserve megafauna (Lindsey *et al*., 2017).

Between 2000 and 2012, Malaysia had a high rate of forest loss according to a global forest map developed in partnership with Google. Malaysia's experiencing total forest loss during the period of 12 years amounted to 14.4% of the 2000 forest cover. Most forest loss in Malaysia occurred in its densest forests, where the tree cover exceeded 50%. These forest types generally store the most carbon and are richest with wildlife, including endangered orang utans, elephants, Sumatran rhinos, and clouded leopards (Mongabay, 2013).

In 2016, the total human population of Malaysia was estimated at 31.7 million (JPM, 2017). A study by Islam & Siwar, (2012) found that deforestation was carried out as agricultural activity and urban development, to accommodate the increase in the human population. This could be witnessed in Selangor, which had already lost up to 10 percent of its forests in the 22 years between 1990 and 2012, and is continuing to face the problem. This might be the same for other parts of forests in Malaysia too.

Besides forest clearing for development, recently, human-wildlife conflicts have been increasing in Malaysia. According to PERHILITAN (2021), large mammal encounters had been occurring more frequently. For example, during the Covid-19 pandemic, an elephant was spotted checking out classrooms in Perak. While in Pahang, a tapir was seen falling into a school drain while an examination was held in the hall. The department had to capture and relocate all those animals that have been wandering in human settlements, in agricultural plots and even on highways. As in Johor, it has been reported that elephant sightings in developed and residential areas have been on the rise. Experts believe that such sightings of wild elephants are due to the rapid fragmentation of the forest as these animals do not have safe passage to move from one forest patch to another.

This is not a good sign for wildlife. These encounters underscore the reality that animal habitats are shrinking and fragmented, due to deforestation for plantations and urban development. This, in other words, means that the animals, especially the big mammals, are facing habitat loss. There are many parks, reserves, and sanctuaries areas in Malaysia that are established to protect wildlife. Being a protected area helps conserve the biodiversity of the forests and the animals that live in them. Taman Negara, for instance, has almost all jungle fauna species found in Peninsular Malaysia and is a wildlife protected area (PERHILITAN, 2021).

1.2 Research background

The national park is an area set aside by a national government to preserve the natural environment. This is an incentive by the government where all flora and fauna in that park are being left in their natural state. In recent years, Malaysia currently classified 8% of the total land area as protected and a further 8% is set aside as forest reserves. Protected areas include national and state parks, wildlife sanctuaries, wildlife reserves and marine parks (PERHUTANAN, 2010).

Protected areas, like national parks have an important role in securing local biodiversity (Ozyavuz, 2012). They are efficient and effective means to address biodiversity loss, help buffer society from the effects of climate change, and maintain the critical ecosystem services on which all societies depend. Taman Negara Gunung Ledang (TNJGL) is chosen as the site to study for this research. October 3rd 2015 marked Gunung Ledang when it was gazetted as a Johor National Park. With a size of 86.11 km^2, TNJGL contain more than 1000 species of plants. There are flowering plants, non flowering plants, timber trees and many other types of plants. Those plants have many commercial, nutritional and medicinal value.

According to Ridley (1901), the flora in Gunung Ledang consists of three elements such as a Malayan element of lowland types, an alpine element found on hill ranges, and the Australian element. There are four vegetation types: lowland dipterocarp forest, hill dipterocarp forest, lower montane forest, and montane ericaceous forest from lowland to the summit (Kiew, 1992).

In this thesis, the ecology of mammals in TNJGL is studied in many ways. The diversity, distribution and activity pattern of the mammals were studied. As a research

site, Gunung Ledang is a suitable habitat for different species of mammals. Gunung Ledang has an ecosystem that can support flora and fauna inside it.

1.3 Research problem

Published literature on the fauna of montane rainforest in Malaysia is lacking (Tuen *et al.*, 2000; Jayaraj *et al*., 2006; Chan *et al.*, 2010b). Similarly, at TNJGL where relatively few research had been carried out to produce baseline data on the ecology of the animals in it. Over the 10 years (2011-2021), the few previous studies only focused on rapid assessment to produce fragmented mammal species list (Madinah *et al*., 2011; Ilyas & Ebil, 2017; Wazir *et al*., 2017; Farid *et al.*, 2017). A comprehensive list of fauna groups is essential for any management effort. In addition, a good understanding of wildlife ecology is critically needed, as this information is a prerequisite to the effective management of the park. Currently, TNJGL is lacking both of these – a comprehensive checklist and updated ecological information (Tuen *et al*., 2000, Jayaraj *et al.*, 2006, Shahrul-Anuar *et al*., 2006, Khan *et al*., 2007, Chan *et al.*, 2010). Thus, this study was done to produce an updated checklist of small to large sized mammals, as well as ecological information such as distribution and activity patterns. These are essential in management and education activities (including nature tourism), needed by researchers working or planning research at the park. The problems can be solved by the diversity, distribution and behaviour study as well as ecological information planned for this research.

For the second problem, human commercial activities around Gunung Ledang areas is increasing nowadays. The area is shrinking due to land encroachment linked to economic projects, prompting concerns over problems such as elephant-human conflicts (SCMP, 2021). Human intervention with wildlife is also a problem here (SCMP, 2021). TNJGL is mostly surrounded by oil palm plantations, with a quarry operating in a small area at Gunung Ledang. It is hoped that some solutions to this problem could be found within the recommendations made in this research.

1.4 Objectives of the study

This research aims to make TNJGL a successfully managed protected area and wildlife management and it is based on current sound research results, leading to sustainable

conservation of biodiversity. This would need an updated checklist of mammals in TNJGL, knowing the diversity, distribution and behaviour as well as to get a clear understanding of the ecology of its mammal fauna. With these information, recommendations are made that could facilitate getting solutions for managing the human-related issues at the parks such as encroachment of the park. This then would enable TNJGL to comply to the norm that management of protected areas should be based on research findings. To achieve the aims stated above this research outline the following objectives:

i. To document the diversity, distribution and activity patterns of mammals along five trails in TNJGL by using camera trapping.
ii. To translate the ecological information of mammalian fauna in TNJGL and coming up with a recommendation of wildlife management of the park.
iii. To determine priority areas to conserve based on the results obtained from the sampling, interviews and reviews of document.

1.5 Theoretical framework

The theory underlying this study is the use of camera trapping and subsequent surveys in TNJGL. The method of camera trapping in the field for ecological research has been used for years (Kucera & Barrett, 2011). They are indeed helpful in many aspect, cost-effective and invasive method for the animals (Kucera & Barrett, 2011). (More elaboration of camera trapping were mentioned in Chapter 2 later). Subsequent surveys such as interviews with staffs of TNJGL and also reviews of documents related to TNJGL were also done. The interview, and also secondary data research were done to collect information that complement the results of field study (camera trapping) in TNJGL. This was done to integrate some knowledge about other factors that may be crucial in understanding the mammals in TNJGL (Meijaard *et al*., 2011).

This research however, incorporate both the ecology and wildlife management concern of the mammals in TNJGL. Both were the main focus in this study as it can really be applied in real life problem. The methods used for this research were also a mix of both camera trapping and subsequent surveys which complement each other. The

translation of the ecology results were integrated with the short interviews and reviews of documents in formulating the recommendation of wildlife management in TNJGL; and other protected areas as well.

Several of the stakeholders that would be benefitted from this study include (government and non-profit organizations):

- Ministry of Energy and Natural Resources (KATS)
- Malaysia Science and Technology Information Centre (MESTECC)
- State and federal forestry department (PERHUTANAN)
- Department of Wildlife and National Parks (DWNP)
- Johor National Park Corporation (JNPC)
- World Wildlife Fund (WWF)
- Malaysian Nature Society (MNS)
- Wildlife Consevation Society (WCS)
- Any parks or protected areas that could use the thesis

1.6 Significance of research

The findings of this study would benefit several groups of people in the field of protected area management in Malaysia. A better conservation and management of the wildlife in the park can be formulated and proposed using the results of this study. Using the results obtained based on this research, stakeholders can pinpoint areas with high conservation values depending on their target species. This is a more effective approach in developing the recommendation for the management of the wildlife in the park. Secondly, PTNJ in charge of all Taman Negara Johor, may use the results from this research for their nature education and tourism activities. Next, this study provided new information and an updated checklist of mammals, opening new possibilities for the next generation of biodiversity research. The study in TNJGL also would benefit future researchers when selecting their study site for detailed studies of certain species of their choice. Other than that, in Johor, many research were focused on Taman Negara Johor Endau Rompin. With supporting information achieved in this research, perhaps would attract more researchers to do their study at TNJGL, thus, balancing out the number of biodiversity studies in the state of Johor.

Previous studies of tropical mammals and other elusive animals mostly depended on indirect evidence of animal presence such as tracks, scats, or scrapes (Sunarto *et al.*, 2013). These indirect evidence area still beneficial but using camera trap offer reliable evidence of the animal presence and absence and offer wide range of opportunities to investigate mammals' ecology. This must be incorporated with the right study design and also analysis based on the aim of the specific study. The results of this research showed evidence of the presence of several important and charismatic species. Moreover, this evidence then resolved the speculation of some stakeholders on the occurrence of those species in the park. Their existence would perhaps require additional management strategies from the park's management.

Maniam & Singaravelloo (2015) stated that most forested areas in Johor are facing pressure from the rapid development of the Southern Corridor. Thus, other than documenting the mammals in TNJGL and managing protected areas, this study also aims to answer several research questions as follows:

i) How diverse is the mammals in TNJGL? Where is the distribution of these mammals in TNJGL? What is the activity pattern of the mammals in TNJGL? Essential study on mammal species are needed in TNJGL due to limited knowledge of the species here. Objective 1 will focus on this research gap.

ii) What are the environmental variables that affect the ecology of the mammals in TNJGL? Objective 2 will address this part of research.

iii) What are the recommendations of wildlife management that can be used for the other parks and protected areas? Objective 2 will answer this research question.

iv) How can this study help in wildlife management? Prioritization of conservation areas is needed to make room for well-organized management of forested areas in TNJGL or in Malaysia. Objective 3 can be accomplished from the completion of objective 1 and 2.

1.7 Scope and limitations of the study

Firstly, this study focuses only on Gunung Ledang. In addition, the study focuses only on five specific trails as determined at the beginning of the research. The trails were used by hikers and park staffs. Other areas in the forest were not covered. These parts that might contain other species of mammals and not reported in this thesis. Permission was also not granted to areas which are difficult to access as well as when weather became bad which was hazardous for safety of the people during the fieldwork. The

final limitation is that this study only uses camera trapping as its methodology. By doing so, failure on getting images of the volant small mammal, would be expected.

REFERENCES

Aihara, Y., Hosaka, T., Yasuda, M., Hashim, M., & Numata, S. (2016). Mammalian wildlife tourism in South-east Asian tropical rainforests: the case of Endau Rompin National Park, Malaysia. *Journal of Tropical Forest Science*, 167-181.

Ancrenaz, M. (2012). *Handbook for wildlife monitoring using camera-traps*. BBEC II Secretariat.

Anuar, S. (2012). The dominant species of monkeys (Macaca fascicularis) in northern region of Peninsular Malaysia. *Pakistan Journal of Zoology*, *44*(6).

Athreya, V., Odden, M., Linnell, J. D. C., Krishnaswamy, J. & Karanth, U. (2013). Big cats in our backyards: Persistence of large carnivores in a human dominated landscape in India. *Plos-One*, 8(3): 1-8.

Azlan, J. (2006). Mammal diversity and conservation in a secondary forest in Peninsular Malaysia. *Biodiversity & Conservation*, *15*(3), 1013-1025.

Azlan, J. M. & Engkamat, L. (2006). Camera trapping and conservation in Lambir Hills National Park, Sarawak, *The Raffles Bulletin of Zoology*, 54(2), 468-475.

Azlan, J. M. & Sharma, D. S. K. (2003). Camera trapping the Indochinese Tiger (*Panthera tigris corbetti*) in a Secondary Forest, Peninsular Malaysia, *Raffles Bulletin of Zoology*, 51

Azlan, J. M., & Sharma, D. S. (2006). The diversity and activity patterns of wild felids in a secondary forest in Peninsular Malaysia. *Oryx*, *40*(1), 36-41.

Batin, Z., Shukor, M. N. & Yusoff, A. M. (2002). Influence of elevational habitat changes on non-volant small mammal species distribution and diversity on Mount Nuang, Hulu, Langat, Selangor, Malaysia. *Pakistan Journal of Biological Sciences*, 5(8): 819–824.

Bailey, L. L., Simons, T. R. & Pollock, K. H. (2004). Spatial and temporal variation in detection probability of plethodon salamanders using the robust capture-recapture design. *The Journal of Wildlife Management*, *68*(1), 14-24.

Barrett, J. H. (1987). The Field Studies Council: how it all began. *Biological Journal of the Linnean Society*, *32*(1), 31–41.

Beaudrot, L., Ahumada, J. A., O'Brien, T., Alvarez-Loayza, P., Boekee, K., Campos-Arceiz, A. & Andelman, S. J. (2016). Standardized assessment of biodiversity trends in tropical forest protected areas: the end is not in sight. *PLoS biology*, *14*(1), e1002357.

Bennie, J. J., Duffy, J. P., Inger, R. & Gaston, K. J. (2014). Biogeography of time partitioning in mammals. *Proceedings of the National Academy of Sciences*, *111*(38), 13727-13732.

Benson, J. F., Sikich, J. A. & Riley, S. P. (2016). Individual and population level resource selection patterns of mountain lions preying on mule deer along an urban-wildland gradient. *PLOS One, 11*, e0158006.

Bernard, H., Sompud, J., Kee, S. L., Ahmad, A. H., Nilus, R., Faiz, M. A., Miun, J., Muin, H., Jaikim, R., Md Yakub, A., Basri, A., Jamali, A., Anson, M., Sukok, J., Alim, E., Justin, D. & Jefli, W. (2019). An initial assessment on terrestrial mammal community in and around Sungai Rawog Conservation Area, Sandakan, Sabah Proceedings of the Seminar on Sungai Rawog Conservation Area Scientific Expedition (Sabah: Sabah Forestry Department and KTS Plantation Sdn Bhd) pp. 137

Bernard, H., Ahmad, A. H., Brodie, J., Giordano, A. J., Lakim, M., Amat, R., Sinun, W. (2013). Camera-trapping survey of mammals in and around Imbak canyon conservation area in Sabah, Malaysian Borneo.*Raffles Bulletin of Zoology*, *61*(2), 861–870.

Bernard, H., Baking, E.L., Matsubayashi, H., Ahmad, A.H., (2013). Records of Bornean felids in and around Tabin wildlife reserve, Sabah, Malaysia. *Cat News*, 56: 4–7.

Boonratana, R. (2003). Of road kills and dead langurs. *Malaysian Naturalist*, 57(2): 34-39.

Borregaard, M. K., Hendrichsen, D. K., & Nachman, G. (2008). Spatial distribution.

Brooker, R. J. (2008). *Biology. McGraw-Hill.* pp. 1326. *ISBN 978-0072956207* .

Buzan, E., Potušek, S., Urzi, F., Pokorny, B. & Šprem, N. (2020). Genetic characterisation of wild ungulates: Successful isolation and analysis of DNA from widely available bones can be cheap, fast and easy. *Zookeys*, *965*, 141.

Ceballos, G. & Ehrlich, P. R. (2006). Global biodiversity hotspots and conservation: insights from mammal distributions. *Proceedings of National Academy of Science, USA*, *103*, 19374-19379.

Chew, M. Y., Hymeir, K., Nosrat, R. & Shahfiz, M. A. (2014). Relation between grasses and large herbivores at the Ulu Muda salt licks, Peninsular Malaysia. *Journal of Tropical Forest Science*, 26(4), 554-559

Chong, M. H. N., Tang, S. H. & Suksuwan, S. (2005). Management recommendations for wildlife saltlicks with particular reference to Sira Air Hangat at Ulu Muda Forest Reserve, Kedah (Selangor: WWF-Malaysia).

Chong, J. L., Panjang, E., Willcox, D., Nash, H. C., Semiadi, G., Sodsai, W. & Cheema, S. (2020). Chapter 6—Sunda pangolin *Manis javanica* (Desmarest, 1822).

Clements, R., Rayan, D. M., Ahmad Zafir, A. W., Venkataraman, A., Alfred, R., Payne, J. & Sharma, D. S. K. (2010). Trio under threat: can we secure the future of rhinos, elephants and tigers in Malaysia? *Biodiversity and Conservation*, *19*(4), 1115-1136.

Coffin, A. W. (2007). From roadkill to road ecology: A review of the ecological effects of roads. *Journal of Transactions in Geography*, *15*(5), 396–406.

Corbet, G. B., & Hill, J. E. (1992). *The mammals of the Indomalayan region: a systematic review* (Vol. 488). Oxford: Oxford university press.

Cove, M. V. (2011). *Occupancy modeling of medium and large mammal diversity in a Central American Biological Corridor* (Doctoral dissertation).

David, M. C. (2015). *The potential and promotion of entotourism in Gunung Ledang, Johor, Malaysia* (Doctoral dissertation, Universiti Tun Hussein Onn Malaysia).

Davison, G. W. H. & Kiew, B. H. (1987). Mammals of Ulu Endau, Johore, Malaysia. *Malayan Nature Journal*, 4, 435

Davison, G. W. H. & Zubaid, A. (2007). The Status of Mammalian Biodiversity in Malaysia. In: Proceedings of the Seminar and Workshop on Status of Biological Diversity in Malaysia and Threat Assessment of Plant Species in Malaysia. Kuala Lumpur: FRIM. pp. 21-27.

Downs, C. T., Bredin, I. P. & Wragg, P. D. (2019). More than eating dirt: a review of avian geophagy. *African Zoology*, *54*(1), 1-19.

Duckworth, J. W., & Pine, R. H. (2003). English names for a world list of mammals, exemplified by species of Indochina. *Mammal Review*, *33*(2), 151-173.

DWNP. (2008a). *Laporan Inventori Biodiversiti Rezab Hidupan Liar Bukit Fraser 2008*. Kuala Lumpur: Department of Wildlife and National Parks. Unpublished.

DWNP. (2008b). *Laporan Inventori Biodiversiti Rezab Hidupan Liar Endau-Kluang 2008*. Kuala Lumpur: Department of Wildlife and National Parks. Unpublished.

DWNP. (2008c). *Laporan Inventori Biodiversiti Rezab Hidupan Liar Sungai Dusun 2008*.

DWNP. (2008d). *Laporan Inventori Biodiversiti Taman Negara Pahang & Kelantan 2008*. Kuala Lumpur: Department of Wildlife and National Parks. Unpublished.

DWNP. (2009a). *Laporan Inventori Biodiversiti Rezab Hidupan Liar Sungkai 2009*. Kuala Lumpur: Department of Wildlife and National Parks. Unpublished.

DWNP. (2009b). *Laporan Inventori Biodiversiti Tapak Ramsar Tasek Bera 2009*. Kuala Lumpur: Department of Wildlife and National Parks. Unpublished.

DWNP. (2008e). *Laporan Program Tangkapan Badak Sumatera Di Kawasan Hutan Simpan Temenggor, Perak Pada Januari Hingga Ogos 2008*. Kuala Lumpur: Department of Wildlife and National Parks. Unpublished.89

Eisenberg, J. E. & McKay, G. M. (1974). Comparison of ungulate adaptations in the New World and Old World tropical forests with special reference to Ceylon and the rainforests of Central America. Pp. 585- 602 in The behavior of ungulates and its relation to management (V. Geist and E Walther, eds.). International Union for Conservation of Nature, Morges, Switzerland

Elton, C. S. (2020). *The ecology of invasions by animals and plants*. Springer Nature.

Faiznur, A. A. B., Yasuda, M., Maryati, M., Adlil, I. S. & Halid, M. S. (2020). The first record of Sumatran serow, Capricornis sumatraensis (Bovidae, Cetartiodactyla), in Gunung Ledang Johor National Park, a tropical forest remnant on the southern Malay Peninsula. *Mammal study*, *45*(3), 259-264.

Farid, M. I., Mohd-Salleh, D., Ruzed, M. E. and Faizee, K. M. Z. 2017. The large mammals of Gunung Ledang Johor National Park. In (Naqiyuddin, A. B., Rauf, A. A., Zuraina, F. M. Y., Harinder, R. S. and Lili, T., eds.) Gunung Ledang: Geology, Biodiversity and Socio-economic Environment, pp. 115–120. Universiti Teknologi MARA Press, Shah Alam.

Ghazali, A. N., Meisery, A. A. H. A., Adam, L., Hasnan, M. H. S., Yazi, M. F., Patah, P. A., & Tan, C. C. (2019). Wildlife monitoring at Labis Timur Ecological

Corridor (CFS2: PL1) in Johor, Malaysia. *Journal of Wildlife and Parks*, *34*, 9-22.

Gómez, H., Wallace, R.B., Ayala, G. & Tejada, R., (2005). Dry season activity periods of some Amazonian mammals. Studies on Neotropical Fauna and Environment, 40(2), 91-95.

Gopalawasmy, A. M., Delampady, M., Karanth, K. U. & Kumar, N. S. (2012). Bayesian occupancy modeling to identify factors that influence tiger occupancy in the Western Ghats of India. *Conservation Biology, 26(1),* 101-111.

Griffiths, M. & van Schaik, C. P. (1993). The impact of human traffic on the abundance and activity periods of Sumatran rain-forest wildlife. *Conservation Biology*, 7: 623–626.

Groves C.P. (2001). *Primate Taxonomy*. Smithsonian Institution Press, Washington, DC, USA.

Guillera-Arroita, G., & Lahoz-Monfort, J. J. (2017). Species occupancy estimation and imperfect detection: shall surveys continue after the first detection? *AStA Advances in Statistical Analysis*, *101*(4), 381-398.

Haidir, I., Macdonald, D. W., & Linkie, M. (2021). Sunda clouded leopard *Neofelis diardi* densities and human activities in the humid evergreen rainforests of Sumatra. *Oryx*, *55*(2), 189-196.

Halle, S. & Stenseth, N. C. (Eds.). (2000). *Activity Patterns in Small Mammals: An Ecological Approach; with 11 Tables* (Vol. 141). Springer Science & Business Media.

Havmøller, R. W., Jacobsen, N. S., Scharff, N., Rovero, F., & Zimmermann, F. (2020). Assessing the activity pattern overlap among leopards (*Panthera pardus*), potential prey and competitors in a complex landscape in Tanzania. *Journal of Zoology*, *311*(3), 175-182.

Hayward, A. D., Moorad, J., Regan, C. E., Berenos, C., Pilkington, J. G., Pemberton, J. M., & Nussey, D. H. (2015). Asynchrony of senescence among phenotypic traits in a wild mammal population. *Experimental gerontology*, *71*, 56-68.

Hayward, M. W., O'Brien, J., Kerley, G. I. H. (2007). Carrying capacity of large African predators: predictions and tests. *Biology Conservation, 139*, 219–229

Hon, J., Hearn, A. J., Ross, J., Samejima, H., Augeri, D. M., Mathai, J., & Wilting, A. (2016). Predicted distribution of the yellow-throated marten *Martes flavigula* (Mammalia: Carnivora: Mustelidae) on Borneo. *Raffles Bulletin of Zoology*.

Ickes, K. (2001). Hyper-abundance of Native Wild Pigs (*Sus scrofa*) in a Lowland Dipterocarp Rain Forest of Peninsular Malaysia 1. *Biotropica*, *33*(4), 682-690.

Ilyas, R., & Ebil, Y. (2017). Comparison of small mammal species composition between disturbed and undisturbed forest areas of Gunung Ledang Johor National Park. *Gunung Ledang: Geology, Biodiversity and Socio-economic Environment*, 95-107.

Islam, R. & Siwar, C. (2012). The Analysis of Urban Agriculture Development in Malaysia rates when detection probabilities are less than one. *Ecology, 83*, 2284–2255.

IUCN. (2022). The IUCN Red List of Threatened Species. Version 2022-1. https://www.iucnredlist.org. Accessed on [12th of July 2022].

Jambari, A., Elagupillay, S. T., Halim, H. R. A., Saharudin, M. H., Mohamed, K. A., Mohd, A., & Azmi, I. S. M. (2015). A camera trap assessment of terrestrial vertebrates in Taman Negara Kelantan and Terengganu, Malaysia. *Journal of Wildlife and Parks*, *30*, 45-57.

Jayaraj, V. K, Siti Hajjar, M. D., Mohd-Isham, A., Shahrul Anuar, M. S, Seri Intan, M. & Abdullah M.T. (2013). Diversity and conservation status of mammals in Wang Kelian State Park, Perlis, Malaysia. *Check List*, 9(6): 1439–1448.

Jenny, D. & Zuberbuhler, K. (2005). Hunting behaviour in West African forest leopards. *African Journal of Ecology, 43*, 197–200.

Johann, F., Handschuh, M., Linderoth, P., Dormann, C. F., & Arnold, J. (2020). Adaptation of wild boar (*Sus scrofa*) activity in a human-dominated landscape. *BMC Ecology*, *20*(1), 1-14.

Johns, A. 1996. Effects of selective logging on the behavioural ecology of West Malaysian primates. *Ecology* 67, 684-694.

Jones, K. E., & Safi, K. (2011). Ecology and evolution of mammalian biodiversity. Philosophical transactions of the Royal Society of London. Series B, *Biological sciences*, *366*(1577), 2451–2461.

Jost, L. (2006). Entropy and diversity. *Oikos*, *113*(2), 363-375.

Junaini, M. A. (1986). Small mammals survey at various altitude of Kinabalu Park. (Tinjauan mammalia kecil di beberapa paras altitud di Taman Kinabalu). B.

Sc. Honours Thesis, Universiti Kebangsaan Malaysia, Sabah Campus, Kota Kinabalu.

Kamler, J. F., Johnson, A., Vongkhamheng, C., & Bousa, A. (2012). The diet, prey selection, and activity of dholes (*Cuon alpinus*) in northern Laos. *Journal of Mammalogy*, *93*(3), 627-633.

Karanth, K. K., Nichols, J. D., Karanth, K. U., Hines, J. E. & Christensen, N. L. (2010). The shrinking ark: patterns of large mammal extinctions in India. *Proceedings of Biological Sciences Society, 277*, 1971–1979.

Karanth, K. U., Gopalaswamy, A. M., Kumar, N. S., Vaidyanathan, S., Nichols, J. D., & MacKenzie, D. I. (2011). Monitoring carnivore populations at the landscape scale: occupancy modelling of tigers from sign surveys. *Journal of Applied Ecology*, *48*(4), 1048-1056.

Kawanishi, K. (2001). Standardized data management for camera trapping studies in Malaysia. *Journal of Wildlife and Parks*, 19, 75-88.

Kawanishi, K., Sahak, A. M., & Sunquist, M. (1999). Preliminary analysis on abundance of large mammals at Sungai Relau, Taman Negara. *Journal of Wildlife and National Parks*, *17*, 62-82.

Kawanishi, K. (2002). *Population status of tigers (Panthera pardus) in a primary rainforest of peninsular Malaysia* (Doctoral dissertation, Ph. D. Thesis. University of Florida).

Kawanishi, K. & Sunquist, M. E. (2004). Conservation status of tigers in a primary rainforest of Peninsular Malaysia. *Biological Conservation*, *120*(3), 329-344.

Kays, R., Parsons, A. W., Baker, M. C., Kalies, E. L., Forrester, T., Costello, R., Rota, C. T., Millspaugh, J. J. & McShea, W. J. (2017). Does hunting or hiking affect wildlife communities in protected areas? *Journal of Applied Ecology*, *54*, 242-252.

Kumaran, J. V., Khan, F. A. A., Azhar, I., Wee Chen, E., Ali, M. R. M., Ahmad, A., & Yusoff, A. M. (2016). Diversity and conservation status of small mammals in Kelantan, Malaysia. *Songklanakarin Journal of Science & Technology*, *38*(2).

Lameed, A. G. & Adetola, J. O. (2012). Species-Diversity utilization of salt lick sites at Borgu Sector of Kainji Lake National Park, Nigeria. *Biodiversity enrichment in a diverse world*, 35-62.

Lim, B. L & Ratnam, L. (1999). A Study of the Vertebrate Fauna in the Tasek Chini Nature Reserve, Pahang in Relation to Land Use. *Malayan Nature Journal*, 53(3), 217-238.

Lim, B. L. & Chai, K. S. (2002). A survey on the vertebrate fauna (small mammals, birds, amphibians and reptiles) at Genting Highlands, Pahang. *Journal of Wildlife and Parks, 20,* 59-65.

Lim, B.L., Ramlah, A.M. & Norsham, Y. (1999). Studies on the mammal fauna of Bukit Kutu Wildlife Reserve, Hulu Selangor. *Journal of Wildlife and Parks*, 17, 1–16.

Lindsey, P. A., Chapron, G., Petracca, L. S., Burnham, D., Hayward, M. W., Henschel, P. & Dickman, A. (2017). Relative efforts of countries to conserve world's megafauna. *Global Ecology and Conservation*, *10*, 243-252.

Linkie, M. & Ridout, M. S. (2011). Assessing tiger–prey interactions in Sumatran rainforests. *Journal of Zoology*, *284*(3), 224-229.

Lwin, Y. H., Wang, L., Li, G., Maung, K. W., Swa, K., & Quan, R. C. (2021). Diversity, distribution and conservation of large mammals in northern Myanmar. *Global Ecology and Conservation*, *29*, e01736.

Lynam, A. J., Laidlaw, R., Wan Noordin, W. S., Elagupillay, S., Bennett, E. L. (2007). Assessing the conservation status of the tiger *Panthera tigris* at priority sites in Peninsular Malaysia. *Oryx. 41*, 454–462.

Mackenzie, D. I., Nichols, J. D., Lachman, G. B., Droege, S., Royle, J. A. & Langtimm, C.A. (2002). Estimating site occupancy rates when detection probabilities are less than one. *Ecology*, *83*(8), 2248-2255.

MacKinnon, J. (1974). The behaviour and ecology of the orang-utan (*Pongo pygmaeus*). *Animal Behaviour*, *22*, 3–74.

Madinah, A., Isham, M. M. A., Fizl, M. S. R., Hanif, M. R. M. D., Fadzil, M. A., Sarina, M.Y. and Tajuddin, M. A. 2017. Rapid assessment of vertebrate fauna in Gunung Ledang Johor. In (Naqiyuddin, A. B., Rauf, A. A., Zuraina, F. M. Y., Harinder, R. S. & Lili, T., eds.) Gunung Ledang: Geology, Biodiversity and Socio-economic Environment, pp. 79–93. Universiti Teknologi MARA Press, Shah Alam.

Magurran, A. E. (2004). Measuring Biological Diversity. Blackwell Publishing. Malaysia. *Journal of Wildlife and Parks, 19,* 75–88.

Mathers, K. L., Rice, S. P. & Wood, P. J. Predator, prey, and substrate interactions: the role of faunal activity and substrate characteristics. *Ecosphere*, *10*(1).

Matsubayashi, H., P. Lagan, N. Majalap, J. Tangah, J. R. A. Sukor & K. Kitayama, (2006). Diversity of mammalian species at natural licks in rain forest of Deramakot and their conservation. In: Lee, Y. F., A.Y.C. Chung & K. Kitayama (eds.), *The 2nd Workshop on Synergy between Carbon Management and Biodiversity Conservation in Tropical Rain Forests*. DIWPA, Sandakan, Sabah, Malaysia. pp. 61–68.

Matsuda, I., Ancrenaz, M., Akiyama, Y., Tuuga, A., Majalap, N., & Bernard, H. (2015). Natural licks are required for large terrestrial mammals in a degraded riparian forest, Sabah, Borneo, Malaysia. *Ecological research*, *30*(1), 191-195.

Matsukawa, A., Ahmad, A. H., & Kohshima, S. (2019). Social structure and reproduction of long-tailed porcupine (*Trichys fasciculata*). *Mammalia*, *83*(1), 23-33.

Medway, L. (1972). Phenology of a tropical rain forest in Malaya. *Biological Journal of the Linnean Society*, *4*(2), 117-146.

Mikunski, G., Urquiza-haas, T., & Kappeler, P. M. (2019). Mammal conservation: Multidisciplinary approaches and new challenges. Biology Conservation, 237, 1-7.

Owen-Smith, N. (2002). Trophic cascades in African Savanna: What are the real drivers? *Oikos, 99(1),* 4-19.

Mohd Azlan J., Lisa, D. P. A., Lading, E. & Mohidin, R. (2007). Camera Trapping and Conservation in Kubah National Park. *Proceedings of the eight Hornbill Workshop on protected areas and biodiversity conservation*, Kuching.

Mohd Azlan, J. & Lading, E. (2006). Camera trapping and conservation in Lambir Hills National Park, Sarawak. *The Raffles Bulletin of Zoology*, *54*, 469–475.

Mohd Azlan, J. (2006). Mammal diversity and conservation in a secondary forest in Peninsular Malaysia. *Biodiversity and Conservation, 15*, 1013–1025.

Mohd-Azlan, J. (2004). Camera trapping survey in the Maludam National Park, Betong Division Sarawak. *WU Alterra, The Netherlands. Forest Department Sarawak, and Sarawak Forestry Corporation*, 36.

Mohd-Azlan J., Andrew, A. T., Mohamad Khombi, I. S. & Abdullah M. T. (2004). Diversity and Abundance of Mammal in Loagan Bunut National Park. *Loagan Bunut Scientific Expedition Seminar*, 2-3 Aug 2004.

Mohd-Azlan, J., Ka-Yi, M. C., Lip, B., & Hon, J. (2019). Camera trapping of wildlife in the newly established Baleh National Park, Sarawak. *Journal of Sustainability Science and Management*, *14*(4), 51-64.

Mohd-Azlan, J., & Engkamat, L. (2013). Camera trapping and conservation in Lanjak Entimau wildlife sanctuary, Sarawak, Borneo. *Raffles Bulletin of Zoology*, *61*, 397-405.

Mohd-Azlan, J., Nurul-Asna, H., Jailan, T. S., Tuen, A. A., Engkamat, L., Abdillah, D. N., & Brodie, J. F. (2018). Camera trapping of terrestrial animals in Tanjung Datu National Park, Sarawak, Borneo. *Raffles Bulletin of Zoology*, *66*.

Mongabay. (2018). Palm oil company revs up deforestation in Malaysia. Available from https://news.mongabay.com/2015/11/palm-oil-company-revs-up-deforestation-in-malaysia. (Version on July 2018).

Moreno, C. E., & Halffter, G. (2000). Assessing the completeness of bat biodiversity inventories using species accumulation curves. *Journal of Applied ecology*, *37*(1), 149-158.

Mori, E., Bagnato, S., Serroni, P., Sangiuliano, A., Rotondaro, F., Marchianò, V., Cascini, V., Poerio, L. & Ferretti, F. (2020). Spatiotemporal mechanisms of coexistence in an European mammal community in a protected area of southern Italy. *Journal of Zoology, 310*, 232–245.

Mulekar, M. S., & Mishra, S. N. (2000). Confidence interval estimation of overlap: equal means case. *Computational statistics & data analysis*, *34*(2), 121-137.

Muul, I., & Lim, B. L. (1970). Ecological and morphological observations of *Felis planiceps*. *Journal of Mammalogy*, *51*(4), 806-808.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*(6772), 853-858.

Nakabayashi, M., Kanamori, T., Matsukawa, A., Tangah, J., Tuuga, A., Malim, P. T., & Hanya, G. (2021). Temporal activity patterns suggesting niche partitioning of sympatric carnivores in Borneo, Malaysia. *Scientific reports*, *11*(1), 1-12.

Nekaris, K. A. I. & Nijman, V. (2007). CITES proposal highlights rarity of Asian nocturnal primates (Lorisidae: *Nycticebus*). *Folia Primatologica, 78*, 211-214.

Nekaris, K. A. I. & Starr, C.R. (2015). Conservation and ecology of the neglected slow loris: priorities and prospects. *Endangered Species Research. 28*(1), 87-95.

Network, T. E. A. M., Ahumada, J. A., Silva, C. E. F., Gajapersad, K., Hallam, C., Hurtado, J., & Hambuckers, A. (2008). Terrestrial vertebrate (camera trap) monitoring protocol implementation manual. *USA: Arlington, VA*.

Newsome, D., Moore, S. A., & Dowling, R. K. (2012). Natural area tourism: Ecology, impacts and management.

Nor, S. M. (2001). Elevational diversity patterns of small mammals on Mount Kinabalu, Sabah, Malaysia. *Global Ecology and Biogeography*, *10*(1), 41-62.

Nor, S. M., Batin, Z., & Akbar, Z. (2001). Elevational diversity pattern of non-volant small mammals on Mount Nuang, Hulu Langat, Selangor. *Journal of Biological Sciences*, *1*(11), 1081-1084.

Norsham, Y., Fuad, S., Norhayati, A., Nordin, M. & Lim, B.L. (1999). Pre-logging survey of mammal fauna at Sungai Weng sub-catchment, Ulu Muda Forest Reserve, Kedah. *Journal of Wildlife and Parks*, *17*, 28–43.

Noss, R. F., Quigley, H. B., Hornocker, M. G., Merrill, T., Paquet, P. C. (1996). Conservation biology and carnivore conservation in the Rocky Mountains. *Wildlife Rescue*, *10*(4), 949–963.

Nowak, R. M. (1991). Walker's mammals of the world. 5th ed. The Johns Hopkins University Press, New York.

Nowak, R. M. & Walker, E. P. (1999). *Walker's Mammals of the World* (Vol. 1). JHU press.

Nowell, K. & Jackson, P. (1996). *Wild Cats. Status Survey and Conservation Action Plan*. IUCN/SSC Cat Specialist Group, Gland, Switzerland and Cambridge, UK.

NRE (2006). *Management Effectiveness of National and State Parks in Malaysia*. (Putrajaya: Ministry of Natural Resources and the Environment)

O'Brien, T. G. (2008). On the use of automated cameras to estimate species richness forlarge- and medium-sized rainforest mammals. *Animal Conservation, 11,* 179-181.

Onrizal, O. & Mansor, M. (2016). *Biodiversitas, 17*(1), 44-54.

Onrizal, O., Kusmana, C. & Saharjo, B. H. (2005). *Jurnal Biologi, 6*(4), 359-372.

Paolucci, L. N., Pereira, R. L., Rattis, L., Silvério, D. V., Marques, N. C., Macedo, M. N., & Brando, P. M. (2019). Lowland tapirs facilitate seed dispersal in degraded Amazonian forests. *Biotropica, 51*(2), 245-252.

Pardo Vargas, L. E., Cove, M. V., Spinola, R. M., de la Cruz, J. C., & Saenz, J. C. (2016). Assessing species traits and landscape relationships of the mammalian carnivore community in a neotropical biological corridor. *Biodiversity and Conservation*, *25*(4), 739-752.

Payne, J., Francis, C. M. & Phillipps, K. (1985). *Field guide to the mammals of Borneo*. Sabah Society.

PERHILITAN. (2013). *Kompendium PERHILITAN 2013*. Kuala Lumpur: Department of Wildlife and National Parks. pp. 104.

Perrin, M. R., Carranza, I. D. (2000). Activity patterns of spotted-necked otters in the Natal Drakensberg, South Africa. *South African Journal of Wildlife Research 30*, 1-7.

Petersen, W. J., Savini, T. & Ngoprasert, D. (2020a). Strongholds under siege: Range-wide deforestation and poaching threaten mainland clouded leopards (*Neofelis nebulosa*). *Global Ecology and Conservation*, 1-20.

Prakash, N., Mudappa, D., Raman, T. S., & Kumar, A. (2012). Conservation of the Asian small-clawed otter (*Aonyx cinereus*) in human-modified landscapes, Western Ghats, India. *Tropical Conservation Science*, *5*(1), 67-78.

Putz, F.E. (1978). A survey of Virgin Jungle Reserves in Malaysia. Research Pamphlet

Rabinowitz, A. (1993). Estimating the Indochinese tiger *Panthera tigris corbetti* population in Thailand. *Biological Conservation*, *65*(3), 213-217.

Rabinowitz, A. (1990). Notes on the behavior and movements of leopard cats, *Felis bengalensis*, in a dry tropical forest mosaic in Thailand. *Biotropica, 22*, 397–403.

Ramesh, T., Kalle, R., Sankar, K. & Qureshi, Q. (2012). Dietary partitioning in sympatric large carnivores in a tropical forest of Western Ghats, India. *Mammal Study*, *37*(4), 313-321.

Ratnam, L., Lim, B. L. & Nor Azman, H. (1995). Mammals of the Sungai Singgor Area in Temengor Forest Reserve, Hulu Perak, Malaysia. *Malayan Nature Journal, 48*, 409-423.

Rayan, D. M., & Linkie, M. (2015). Conserving tigers in Malaysia: A science-driven approach for eliciting conservation policy change. *Biological Conservation*, *184*, 18-26.

Razak, A. B., Hambali, M. H. S., Amaludin, K. N. A., & Rak, A. E. (2018). A study on activity pattern of clouded leopard (*Neofelis nebulosa*) in Gunung Basor

and Stong Utara Forest Reserves, Kelantan, Malaysia. *Malayan Nature Journal*, *70*(2), 149-155.

Razali, N. B., Shafie, M. S. H., Jobran, R. A. M., Karim, N. H. A., Khamis, S., Mohd-Taib, F. S. & Hussein, M. S. R. (2020). Physical factors at salt licks influenced the frequency of wildlife visitation in the Malaysian tropical rainforest. *Tropical Zoology, 33*(3).

Razali, N. B., Mansor, M. S., Ismail, N. A., Patah, P. A., Husin, S. M., Hussein, M. S. R., & Nor, S. M. (2022). The use of salt licks by birds in Peninsular Malaysia. *Global Ecology and Conservation, 38*.

Reilly, M. L., Tobler, M. W., Sonderegger, D. L. & Beier, P. (2017). Spatial and temporal response of wildlife to recreational activities in the San Francisco Bay ecoregion. *Biology Conservation, 207,* 117-126.

Rexstad, E. & Burnham, K. P. (1991). User's Guide for Interactive Program CAPTURE.

Ridout, M. S. & Linkie, M. (2009). Estimating overlap of daily activity patterns from camera trap data. *Journal of Agricultural, Biological, and Environmental Statistics*, *14*(3), 322–337.

Ridley, H. N. (1901). Garu and Chandan. *Journal of the Straits Branch of the Royal Asiatic Society*, (35), 73-82.

Ripple, W. J., Chapron, G., López-Bao, J. V., Durant, S. M., Macdonald, D. W., Lindsey, P. A. & Zhang, L. (2016). Saving the world's terrestrial megafauna. *Bioscience*, *66*(10), 807-812.

Rosi-Marshall, E. J., Bernhardt, E. S., Buso, D. C. (2016). *Proceedings of the National Academy of Sciences*, *113*(27), 7580-7583.

Ross, C., Srivastava, A., Pirta, R. S. (1993). Human influences on the population density of Hanuman langurs *Presbytis entellus* and rhesus macaques *Macaca mulatta* in Shimla, India. *Biology Conservation, 65*, 159–163

Ross, J., Hearn, A. J., Johnson, P. J., & Macdonald, D. W. (2013). Activity patterns and temporal avoidance by prey in response to Sunda clouded leopard predation risk. *Journal of Zoology*, *290*(2), 96–106.

Rowcliffe, J. M., Field, J., Turvey, S. M. & Carbone, C. (2008). Estimating animal density using camera traps without the need for individual recognition. *Journal of Applied Ecology*. *45*(4), 1228-1236.

Rufino, M. B. M., Magintan, D., Ngau, C., Zahrim, A. I, Hamidi, J., Zainal, A. M., Idlan, R., Abdul Kadir, A. H., Dennis, T. C. Y. & Fauzul Azim, Z. A. (2008). Mammals of Temenggor Forest Reserve: evidence through camera trapping. In *Proceeding of National Biodiversity Seminar 2008* (Yasak, M. N., Nor, S. M., Rahmah, I., Khadiejah, S. S. M. K., Rufino, M. B. M. & Sitam, F.T.), pp 7–16. Kuala Lumpur: Department of Wildlife and National Parks.

Saaban, S., Othman, N. B., Yasak, M. N. B., Burhanuddin, M. N., Zafir, A., & Campos-Arceiz, A. (2011). Current status of Asian elephants in Peninsular Malaysia. *Gajah*, *35*(1), 67-75.

Sampson, C., McEvoy, J., Oo, Z. M., Chit, A. M., Chan, A. N., Tonkyn, D. & Leimgruber, P. (2018). New elephant crisis in Asia— Early warning signs from Myanmar. *PLoS One*, *13*(3), e0194113.

Setiawan, B. I. (2020). A simple method to determine patterns of wet and dry seasons. In *IOP Conference Series: Earth and Environmental Science*, *542*(1), pp. 12055. IOP Publishing.

Shrestha, T. K. (2003). *Wildlife of Nepal*. B. Shrestha, Kathmandu, 720 pp.

Shultis, J. D., & Way, P. A. (2006). Changing conceptions of protected areas and conservation: linking conservation, ecological integrity and tourism management. *Journal of Sustainable Tourism*, *14*(3), 223-237.

Silveira, L., Jácomo, A. T. & Diniz-Filho, J. A. F. (2003). Camera trap, line transect census and track surveys: a comparative evaluation. *Biological conservation*, *114*(3), 351-355.

Sinclair, A. R., Mduma, S. A., & Arcese, P. (2002). Protected areas as biodiversity benchmarks for human impact: agriculture and the Serengeti avifauna. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *269*(1508), 2401-2405.

Singer, A., Schweiger, O., Kühn, I., & Johst, K. (2018). Constructing a hybrid species distribution model from standard large-scale distribution data. *Ecological Modelling*, *373*, 39-52.

Simpson, B. K., Nasaruddin, N., Traeholt, C., & Nor, S. M. (2020). Mammal Diversity at Artificial Saltlicks in Malaysia: A Targeted Use. *Frontiers in Environmental Science*, *8*, 556877.

Siti Khairiyah, M. H., Usman, S., Suzita, Y., Florinsiah, L. & Nur Shahirah, N. (2013).The effect of elevations on diversity and abundance of class insecta at

Taman Negara Gunung Ledang, Johor. In M. K. Hamzah, O. H. Hassan, & N. Md Tahir (Eds.), *2013 Business Engineering and Industrial Applications Colloquium (BEIAC)*. New Jersey: IEEE. pp. 246–250

Srivathsa, A., Karanth, K. K., Jathanna, D., Kumar, N. S., & Karanth, K. U. (2014). On a dhole trail: examining ecological and anthropogenic correlates of dhole habitat occupancy in the Western Ghats of India. *PloS one*, *9*(6).

Sivasothi, N. & Burhanuddin, N. (1994). A review of otters (Carnivora: Mustelidae: Lutrinae) in Malaysia and Singapore. *Hydrobiologia*, *285,* 151-170.

Sodhi, N. S., Posa, M. R. C., Lee, T. M., Bickford, D., Koh, L. P., & Brook, B. W. (2010). The state and conservation of Southeast Asian biodiversity. *Biodiversity and Conservation*, *19*(2), 317-328.

Sofaer, H. R., Jarnevich, C. S., Pearse, I. S., Smyth, R. L., Auer, S., Cook, G. L. & Hamilton, H. (2019). Development and delivery of species distribution models to inform decision-making. *BioScience*, *69*(7), 544-557.

Sompud, J., Sompud, C. B., Pei, K. J-C., Sun, N. C-M., Repin, R. & Tuh, F. (2019). Sunda Pangolin *Manis javanica* (Mammalia: Pholidota: Manidae) of Gaya Island, Sabah. *Journal of Threatened Taxa, 11,* 13552-13556.

Sunarto, S., Kelly, M. J., Parakkasi, K. & Hutajulu, M. B. (2015). Cat coexistence in central Sumatra: ecological characteristics, spatial and temporal overlap, and implications for management. *Journal of Zoology*, *296,* 104–115.

Sunquist, M. & Sunquist, F. 2002. *Wild Cats of the World*. University of Chicago Press.

Suratman, S., Pitoyo, A., Mulyani, S., & Suranto, S. (2015). Assessment of genetic diversity among soursop (Annona muricata) populations from Java, Indonesia using RAPD markers. *Biodiversitas Journal of Biological Diversity*, *16*(2).

Swinnen, K. R., Reijniers, J., Breno, M., Leirs, H. (2014). A novel method to reduce time investment when processing videos from camera trap studies. PLoS One.

Tan, W. S., Hamzah, N. B. A., Saaban, S., Zawakhir, N. A., Rao, Y., Jamaluddin, N., Cheong, F., Khalid, N. B., Mohd Saat, N. L. & Zaidee, E. E. N. B. (2018). Observations of occurrence and daily activity patterns of ungulates in the Endau Rompin Landscape, peninsular Malaysia. *Journal of Threatened Taxa, 10*, 11245–11253.

Tawa, Y., Sah, S. A. M., & Kohshima, S. (2022). Salt-lick use in Malaysian tropical rainforests reveals behavioral differences by food habit in medium and large-sized mammals. *European Journal of Wildlife Research*, *68*(5), 1-12.

Touzot, L., Schermer, É., Venner, S., Delzon, S., Rousset, C., Baubet, E. & Gamelon, M. (2020). How does increasing mast seeding frequency affect population dynamics of seed consumers? Wild boar as a case study. *Ecological Applications*, *30*(6).

Traeholt, C. & Sanusi, M. (2009). Population estimates of Malay Tapir, *Tapirus indicus*, by camera trapping in Krau Wildlife Reserve, Malaysia. *Tapir Conservation*, *18*(1): 18–26.

Tremlová, K., & Münzbergová, Z. (2007). Importance of species traits for species distribution in fragmented landscapes. *Ecology*, *88*(4), 965-977.

Trouwborst, A. (2015). Global large carnivore conservation and international law. *Biodiversity and conservation*, *24*, 1567-1588.

van Schaik, C. P., & Griffiths, M. (1996). Activity periods of Indonesian rainforest mammals. *Biotropica*, 105-112.

Van Weers, D. J. (1993). On the tooth morphology of the long-tailed porcupine *Trichys fasciculata* (Hystricidae: Rodentia), with notes on the genera Atherus and Hystrix. *Raffles Bulletin of Zoology*, *41*(2), 251-261.

Voigt, M., Wich, S. A., Ancrenaz, M., Meijaard, E., Abram, N., Banes, G. L. & Kühl, H. S. (2018). Global Demand for Natural Resources Eliminated More Than 100,000 Bornean Orangutans. *Current Biology*, *28*(5), 761–769.

Wahab, S. A. K., & Yacob, M. R. (2019). Perception and satisfaction of ecotourism resource development in Gunung Ledang Johor National Legendary Park in Malaysia: Ecotourists perspective. *Australian Journal of Basic and Applied Sciences*, *13*(6), 82-92.

Wai, L., Evans, M. N., Bernard, H., & Goossens, B. (2020). Holt-based activity patterns of smooth-coated otter (*Lutrogale perspicillata*) in the lower Kinabatangan Wildlife Sanctuary, Sabah, Malaysia. *IUCN/SCC Otter Specialist Group Bulletin*, *37*(1), 20-28.

Wazir, A. A. S., Nadiah, N. M. Y., Hajar, S. J., Florinsiah, L. and Shahirah, N. N. 2017. A survey of non-volant small mammals at two different elevations inhabiting Gunung Ledang Johor National Park. In (Naqiyuddin, A. B., Rauf, A. A., Zuraina, F. M. Y., Harinder, R. S. and Lili, T., eds.) Gunung Ledang:

Geology, Biodiversity and Socio- economic Environment, pp. 109–114. Universiti Teknologi MARA Press, Shah Alam

Wearn, O. R. & Glover-Kapfer, P. (2017). Camera-trapping for conservation: a guide

Wevers, J., Beenaerts, N., Casaer, J., Zimmermann, F., Artois, T., & Fattebert, J. (2021). Modelling species distribution from camera trap by-catch using a scale-optimized occupancy approach. *Remote Sensing in Ecology and Conservation*, *7*(3), 534-549.

Wolfheim, J. H. (1983). Primates of the world. Distribution, abundance and conservation. University of Washington Press, Seattle.

Woodroffe, R. (2000) Predators and People: Using Human Densities to Interpret Declines of Large Carnivores. *Animal Conservation, 3,* 165-173.

Yanuar, A., David, J.C., Sugardjito, J., Deborah, J.M. And Jeremy, T.H. (2009). The population distribution of pig-tailed macaque (*Macaca nemestrina*) and long-tailed macaque (*Macaca fascicularis*) in West Central Sumatra, Indonesia. *Asian Primates Journal, 1,* 2-11.

Yasuda, M., & Tsuyuki, S. (2012). Comparison of mammalian communities in a human-disturbed tropical landscape in East Kalimantan, Indonesia. *Mammal Study, 37,* 299-311.

Zahidin, M. A., Roslan, Azuan, Marni, Wahap, Kombi, Mohamad, & Abdullah, M. T. (2016). Biodiversity assessment and updated checklist of faunal diversity in Bako National Park, Sarawak, Malaysian Borneo. *Journal of Sustainability Science and Management*, *11*(1), 53-72.

Zylstra, E.R., Steidl, R.J. & Swann, D.E. (2010). Evaluating survey methods for monitoring a rare vertebrate, the Sonoran desert tortoise. *The Journal of Wildlife Management, 74*, 1311–1318.

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