UNIVERSITI PUTRA MALAYSIA

TOPOGRAPHICAL CHARACTERISTICS, DIVERSITY AND UTILIZATION OF SALTLICKS BY MALAYAN TIGER (Panthera tigris Jacksoni Linnaeus) AND POTENTIAL PREY AT THE ROYAL BELUM RAINFOREST, MALAYSIA

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By

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science.

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Natural saltlick (*sira*) is a place where a diverse of animals consume geophagy or drink water for mineral supplementation. Saltlicks are believed to be a key factor towards the density and distribution of all native wildlife species in the tropical and temperate rainforests. It's also serves as rally points for wildlife species, as they determine the distribution and density of prey species which in turn affects predator population. Therefore, the objective of this study is to distinguish the topographic characteristics of different saltlicks in the Royal Belum rainforest. To achieve this objective, the topography of the saltlick and the prey-predator interactions around the saltlick were determined to identify the home-range of predator such as Malayan tiger. Three potential home ranges and their saltlick were identified based on the animal trail and foot print surrounding the home range; *Sungai Tiang* home range *(e.g. Sira Kuak* and *Sira Tanah)*, ii) *Sungai Kejar* home range *(e.g. Sira Rambai* and *Sira Bukit)*, and iii) *Sungai Papan* home range *(e.g Sira Papan*). The camera traps were placed at potential animal trails surrounding the saltlick. All captured images from the cameras were identified and tabulated according to the species density. Topography of the saltlick such as size, types, distance from the river and vegetation of the saltlick were recorded, and the wildlife densities were tabulated based on the camera traps. Results showed that *Sira Kuak* is near the main river and surrounded by dense shrubbery which provides ample camouflage for solitary herbivores such as muntjacs. *Sira Batu* is surrounded by rocky architecture and sub-canopy trees, hosting larger mammals such as elephants and tapirs whereas *Sira Tanah* is surrounded by a wide plain area with a small stream making it a suitable environment for herd animals such as sambar deer. The variation of topography has been suggested to affect the vulnerability of certain prey to predation by the predators due to changes in vegetation cover and food resources. This could indicate that topography is a crucial factor for wildlife in frequenting saltlicks for important physiological and sociological interactions. Further objectives were to determine tiger and potential prey diversity at the natural saltlicks as well as to determine species diversity utilization of saltlicks. Results also showed that all home range had non-significant different on the large bodied prey availability such as sambar deer (*Rusa unicolor*), muntjacs (*Muntiacus muntjac*) and wild pig (*Sus scrofa*). However, within a

large area of sampling with over the period of two years, only one different individual tiger at *Sungai Tiang*, *Sungai Papan* and *Sungai Kejar* home ranges were sighted, and they were identified using their stripes. This could indicate that low availability and fewer predictable sites for prey aggregation in tropical forests may limit highly selective foraging decisions by the predators. Indeed, an individual tiger located around areas at natural saltlicks are dispersed and isolated around the Royal Belum Rainforest, which negatively affect physiological conspecific interactions leading to the inevitable decline of this species. This could suggest that Malayan tiger as solitary animals and spread across a large area of tropical rainforests will greatly reduce chances of encounter and mating, thus contributing towards the potential extinction in the Malaysia rainforest. In conclusion, the density and distribution of the prey species at the natural saltlicks is important for physiological and social interaction which in turn influenced the home-range of Malayan tigers.

Keywords: natural saltlick, topography, prey, predator, Malayan tiger, Royal Belum Rainforest

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

CIRI-CIRI TOPOGRAPHI, KEPELGAIAN HAIWAN DAN PENGGUNAAN SIRA OLEH HARIMAU MALAYA (*Panthera tigris Jacksoni* Linnaeus) DAN POTENSI MANGSA DI HUTAN HUJAN BELUM

Oleh

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Sira semula jadi adalah tempat di mana pelbagai haiwan mempraktikkan geofagi atau meminum air mineral semula jadi bagi penambahan mineral. Sira dipercayai merupakan faktor utama ke arah tempat kepadatan dan penyebaran semua spesis hidupan liar yang asli di hutan hujan tropika dan sederhana. Ia juga berfungsi sebagai titik perhimpunan bagi spesis hidupan liar, kerana mereka menentukan taburan dan kepadatan spesis mangsa yang seterusnya mempengaruhi populasi pemangsa. Oleh itu, objektif kajian ini adalah untuk mengetahui kesan ketersediaan mangsa pada sira semula jadi yang mempengaruhi habitat atau jangkauan kawasan bagi harimau Malaya di Hujan Diraja Belum, Malaysia. Untuk mencapai objektif ini, interaksi topografi sira dan hubungan mangsa-pemangsa di sekitar sira ditentukan bagi mengenal pasti habitat atau jangkauan kawasan pemangsa seperti harimau Malaya. Tiga kawasan habitat atau jangkauan kawasan yang berpotensi dan sira yang terlibat dikenal pasti berdasarkan jejak haiwan dan jejak tapak kaki haiwan di sekitar kawasan jangkauan; i) Jangkauan Sungai Tiang (Contoh: Sira Kuak dan Sira Tanah), ii) Jangkauan Sungai Kejar (Contoh: Sira Rambai dan Sira Bukit), dan iii) Jangkauan Sungai Papan (Contoh: Sira Papan). Perangkap kamera diletakkan di sekitar tapak jejak haiwan di mana haiwan sangat berpotensi mengelilingi sira. Imej yang diambil dari perangkap kamera dikenal pasti dan dikaji mengikut kepadatan spesis. Topografi sira seperti ukuran, jenis, jarak dari sungai dan jenis tumbuh-tumbuhan di sekitar sira dicatatkan, dan kepadatan hidupan liar direkodkan berdasarkan imej dari kamera perangkap. Hasil kajian menunjukkan bahawa Sira Kuak berdekatan dengan sungai utama dan dikelilingi oleh semak tebal yang menyediakan penyamaran yang cukup bagi herbivora solitari seperti kijang. Sira Batu dikelilingi oleh struktur berbatu dan pohon, menempatkan mamalia yang lebih besar seperti gajah dan tapir, manakala Sira Tanah dikelilingi oleh kawasan dataran tanah yang luas dengan mempunyai sungai kecil menjadikannya persekitaran yang sesuai untuk kawasan hidupan liar seperti rusa sambar. Variasi topografi telah diketahui akan mempengaruhi kerentanan mangsa tertentu terhadap pemangsa akibat perubahan lingkungan vegetasi dan sumber makanan. Ini menunjukkan bahawa topografi adalah faktor yang penting bagi hidupan liar dalam menggunakan garam mineral dari sira, bagi interaksi fisiologi

dan sosiologi yang penting. Hasil kajian juga menunjukkan bahawa semua kawasan jangkauan mempunyai perbezaan yang tidak signifikan terhadap ketersediaan mangsa seperti sambar rusa (*Rusa unicolor*), kijang (*Muntiacus muntjac*) dan babi hutan (*Sus scrofa*). Namun, dalam jangkamasa persampelan selama dua tahun di jangkauan kawasan, hanya satu ekor harimau didapati di jangkauan kawasan Sungai Tiang, Sungai Papan dan Sungai Kejar masing-masing, dan harimau telah dikenal pasti berbeza di antara satu sama lain berdasarkan jalur pada badan mereka. Ini menunjukkan bahawa kurangnya mangsa di lokasi yang terbatas di hutan tropika akan membatasi pemangsa dalam membuat keputusan mencari makanan atau pemangsa berada di dalam keadaan yang sangat selektif untuk memburu makanan. Sesungguhnya, seekor harimau yang berada di sekitar kawasan sira akan berada di dalam keadaan isolasi dan terpencil di sekitar Hutan Diraja Belum, dan ini akan memberikan kesan negatif kepada interaksi fisiologi haiwan, seterusnya menyebabkan penurunan populasi spesis ini. Ini menunjukkan juga bahawa harimau Malaya adalah haiwan solitari dan haiwan ini bertebaran di kawasan hutan hujan tropika yang luas kerana kekurangan mangsa, dan ini akan menyebabkan interaksi atau pembiakan sesama spesis berkurangan, sehingga menyumbang kepada kepupusan harimau di hutan hujan Malaysia. Kesimpulannya, kepadatan dan penyebaran spesis mangsa di sira semula jadi amat penting bagi interaksi fisiologi dan sosial hidupan liar dan seterusnya mempengaruhi habitat atau jangkauan kawasan pemangsa iaitu harimau Malaya.

Kata kunci: sira semula jadi, topografi, mangsa, pemangsa, harimau Malaya, Hutan Hujan Diraja Belum

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
IUCN	International Union for Conservation of Nature
%	Percentage
Na	Sodium
Ca	Calcium
C	Carbon
P	Phosphorus
Mg	Manganese
N	Nitrogen
K	Potassium
Fe	Iron
Cu	Copper
Zn	Zinc
Cl	Chlorine
I	Iodine
Km^2	Kilometer square
Km	Kilometer

CHAPTER 1

INTRODUCTION

1.1 Background of study

The tropical rainforests of Southeast Asia are amongst the global biodiversity hotspot, containing over 25000 species of plants and 1800 vertebrate species, accounting to about 20-25% of the world's plants and animals (Hon and Shibata, 2013). However, there is limited information on the ecology of wildlife species in tropical rainforests such as the ones in Peninsular Malaysia due to the dense conditions of the forest combined with the elusive behaviour of wildlife species (Griffiths and Shaik, 1993; Carter *et al.*, 2012). Many species of animals have evolved to display strategies and defence mechanisms to avoid predation, such as adjusting their activity levels and specific usage of microhabitats depending on the presence of predators (Mathers and Wood, 2019). Muntjacs, for examples, use dense vegetation as cover to reduce visual detection and prevent the spread of their scent. Predatory animals such as the Malayan tiger, may change their activity period based on time of least human traffic (Griffiths and Shaik, 1993; Linkie and Ridout, 2011). Locations in the rainforest where high volume of human ecotourism occurs see a decline in tiger sightings. Thus, the study of wildlife species in the natural habitat is highly dependent on the introduction of camera-trap equipment and suitable statistical sampling techniques with degrees of variable precision to obtain an insight into the natural behaviours of these animals.

Saltlicks are naturally occurring deposits that are rich in minerals mainly sodium, potassium, fluorine, chlorine, calcium, magnesium, sodium, and zinc (Tracy and McNaughton, 1995). These minerals play a significant role in aiding many species with digestibility as well as in detoxification of plant secondary compounds via clay adsorption (Ayotte *et al*., 2006). The importance of saltlicks is linked to the lower foliar concentration of minerals in tropical plants due to depletion of major cations in the soil thus requiring herbivores to obtain minerals from another source (Siteinei *et al*., 2011). Previous study has been reported that in Deramakot (Sabah), approximately 70% of the species identified to be living in the forest reserve were recorded at the saltlicks (Matsubayashi *et al*., 2006). The species included herbivores, frugivores and carnivores such as marbled cat (*Pardofelis marmorata*), sambar deer (*Rusa unicolor*) and Bornean orangutan (*Pongo pygmaeus*). It is expected that saltlicks with higher concentrations of sodium were preferred by animals like sambar deer and bearded pigs due to their mineral demands affecting the ranging patterns and distribution of the sambar deer and bearded pigs (Matsubayashi *et al*., 2006). Thus, the vital functionality of saltlicks is significant towards the distribution and density of prey species in an area which may play a role towards the movement of predatory animals.

Different species of animals have different niches or roles in the ecosystem, that plays a part towards a balance in the natural hierarchy of the forest. Herbivorous mammals play a huge role towards the species richness and diversity of plant species, contributing

towards regulation of global ecosystems (Scott *et al.,* 2018; Roininen *et al.,* 2007). Predators in the biome of the Royal Belum Rainforest not only affect the behaviour and abundance of prey species and smaller predators, but only indirectly has a profound effect on vegetation densities and communities of small vertebrae (Glen and Dickman 2014). Resources such as food water and natural licks is a key determinant towards the density of prey species in the tropical rainforest (Janssen *et al.,* 2008). In fact, predatory density in the tropical rainforest is determined by the presence of large prey such as the sambar deer, muntjac and wild pig (Kawanishi *et al.,* 2010). The tropical rainforests of Royal Belum, rich in natural saltlicks plays host to a variety of flora and fauna, making it one of the hotspots for biodiversity in the world.

However, several factors influence the longevity of fauna in the Royal Belum Rainforest. Legal hunting of prey species, habitat fragmentation and deforestation will contribute towards the dilution and reduction prey abundance over a large area, leading to factors that will affect the viability of endangered carnivores such as the Malayan tiger. Since prey species are concentrated around areas of natural saltlicks, the adaptive physiology of the predatory Malayan tiger localises the species around areas of natural saltlicks, which are scattered in clusters in the tropical rainforest. Saltlick clusters, plays host to an adult tiger as documented, indicating the saltlick being within the home range of a Malayan tiger. It is expected that the large distance between areas of natural saltlicks coupled with low prey densities will affect the physiological and sociological interaction of Malayan tigers, reducing mating occurrence and progeny survivability, leading to the continuous decline of this species.

1.2 Objectives of study

The main objective of this study is to determine the prey availability at natural saltlick influences the home range of Malayan tiger (*Panthera tigris jacksoni*) at the Royal Belum Rainforest, Malaysia.

1.2.1 Specific objectives

i. To distinguish the topographical characteristics of different saltlicks towards wildlife preference in the Royal Belum rainforest
ii. To determine the tiger and potential prey diversity at the natural saltlicks in the Royal Belum rainforest.
iii. To determine species-diversity utilization of saltlicks in the Royal Belum rainforest.

1.3 Significance of the study

The study was primarily designed to identify tiger and potential prey diversity in terms of impact of prey availability towards predator dynamics at natural saltlicks. The Royal

Belum Rainforest is known as a tropical biodiversity hotspot containing a variety of different species of herbivores and the elusive Malayan tiger. Topography has been highlighted as important factor at natural saltlicks towards prey preference in the area. Besides that, studies in prey movement and concentration around natural saltlicks is shown to influence the presence of predators, where saltlick clusters were identified to be in the roaming area of a Malayan tiger. The naturally low prey density of the tropical rainforest coupled with legal hunting, logging, deforestation and poaching that further reduces prey densities, will influence the population and continuity of predatory species. Thus, the low prey density and poaching will lead the population of Malayan tigers towards an inevitable extinction.

1.4 Hypothesis and justification of study

The Royal Belum Rainforest, Malaysia is one of the tropical lowlands and hill dipterocarp virgin rainforests, spanning over an area of 290 hectares (Rayan *et al*., 2012). This rainforest is rich in flora and fauna which are characteristics of a typical rainforest in Peninsular Malaysia (Misni *et al*., 2017). Therefore, this study will identify the saltlicks at the rainforest and describe the topography and their influence on wildlife diversity. It is hypothesized that the topography of different saltlicks will play a role in determining the species of animals utilizing the saltlicks. Thus, information from this study will enable research on wildlife to be planned around saltlicks with specific criteria's that might influence wildlife distribution which will aid in conservation of Malaysian wildlife.

It was hypothesised that the area of each saltlick is roaming range, containing a food web that may revolve between predator and prey. It has been established that several species such as sambar deer, wild pig and muntjacs have all been identified as preferred prey for the Malayan tiger (*Panthera tigris jacksoni*) and plays an important role towards the distribution of the predator (Kawanishi *et al* 2010). Due to the low prey densities of the tropical rainforest, it could be indicated that prey concentration would be higher around natural saltlicks due to the functional requirements it provides (Matsubayashi *et al*., 2007). Since predator movement is based on the distribution of its food source, it is expected that areas around natural saltlicks would play host to a predator. A collection of images taken at each saltlick cluster has been documented below, showing a Malayan tiger and its preferred prey species in areas around natural saltlicks in the Royal Belum Rainforest.

REFERENCES

Abdullah, A. R., Chan, N. W., and Mat Som, A. P. (2011). The Potentials and Perils of Ecotourism in Belum Temengor Forest Complex. *World Applied Sciences Journal 12* (Special Issue of Tourism and Hospitality); 01-09.

Ayotte, J. B., Parker, K. L., Arocena, J. and Gillingham, M. P. (2006). Chemical composition of lick soils: Functions of soil ingestion by four ungulate species. *Journal of Mammalogy, 87*(5): 878–888.

Bakri, M. A., Ebil, Y., Jawing, A., Faizul, N.M., Rahim, M.R.A., Ilias, R., Salim, N., Saaban, S., Hussin, M.Z. and Kasim, M.R.M. (2018). The presence of wildlife species at artificial pasture and artificial salt lick sites at protected areas in Peninsular Malaysia. *Journal of Wildlife and National Parks, 33*.

Barrios-Garcia, M. N., and Ballari, S. A. (2012). Impact of wild boar (*Sus scrofa*) in its introduced and native range: A review. *Biological Invasions, 14*(11), 2283–2300.

Brightsmith, D. J., Taylor, J., and Phillips, T. D. (2008). The roles of soil characteristics and toxin adsorption in avian geophagy. *Biotropica, 40*, 766–774.

Brightsmith, D., and Aramburu, R. (2004). Avian geophagy and soil characteristics in southeastern Peru. *Biotropica, 36*(4), 534–543.

Brodie, J.F., and Brockelman, W.Y. (2009). Bed site selection of red muntjac (*Muntiacus muntjak*) and sambar (*Rusa unicolor*) in a tropical seasonal forest. *Ecological Research 24***,** 1251–1256.

Burton AC, Neilson E, Moreira D, Ladle A, Steenweg R, Fisher JT, Erin B, Boutin S. 2015. Wildlife camera trapping: a review and recommendation for linking surveys to ecological processes. *Journal of Applied Ecology*. 52:675–685.

Carter, N. H., Shrestha, B. K., Karki, J. B., Pradhan, N. M. B., and Liu J. (2012). Wildlife-human Coexistence at Fine Spatial Scales. *Proceedings of the National Academy of Sciences, 109* (34) 15360-15365.

Cho, Y. S., Hu, L., Hou, H. *et al*. The tiger genome and comparative analysis with lion and snow leopard genomes. (2013). *Nature Communications 4*, 2433.

Chong, M. H. N., Tang S. H., and Suksuwan, S. (2005). Management recommendations for wildlife saltlicks with particular reference to Sira Air Hangat at Ulu Muda Forest Reserve, Kedah, WWF Malaysia Project MY 0163c.

Choudhury, A. (2002). Distribution and conservation of the Gaur *Bos gaurus* in the Indian Subcontinent. *Mammal Review 32*: 199-226.

Cucchi, T., Fujita, M. and Dobney, K. (2009), New insights into pig taxonomy, domestication, and human dispersal in Island South East Asia: Molar shape analysis of *Sus scrofa* remains from Niah Caves, Sarawak. *International Journal of Osteoarchaeology., 19*: 508-530.

D. Buck Jolley, Stephen S. Ditchkoff, Bill D. Sparklin, Laura B. Hanson, Michael S. Mitchell, and James B. Grand. (2010). Estimate of herpetofauna depredation by a population of wild pigs, *Journal of Mammalogy, 91*(2), Pages 519–524.

Datta, A., Osuri, A. M., and Naniwadekar, R., (2008). Empty forests: Large carnivore and prey abundance in Namdapha National Park, north-east India. Biological *Conservation. 141*. 1429-1435.

David M. and Leslie, Jr., *Rusa unicolor* (Artiodactyla: Cervidae), *Mammalian Species, 43*(871) 25 January 2011, Pages 1–30.

De Bondi N, White JG, Stevens M, Raylene C. 2010. A comparison of the effectiveness of camera trapping and live trapping for sampling terrestrial small mammal communities. *Wildlife Research.* 37: 456–465.

De la Torre, J. A., Lechner A. M., Wong E. P., Magintan D., Saaban S., and Campos-Arceiz, A. (2019). Using elephant movements to assess landscape connectivity under Peninsular Malaysia's central forest spine land use policy. *Conservation Science and Practice 133.*

Department of Wildlife and National Parks Peninsular Malaysia (2008). *National Tiger Action Plan for Malaysia 2008-2020*. In: Department of National Parks and Wildlife (eds). Government of Malaysia, Kuala Lumpur.

Digby, S. N., Chadwick, M. A., and Blache, D (2011). Salt intake and reproductive function in sheep. *Animal. 5*(8):1207-1216.

Duangchantrasiri, S., Umponjan, M., Simcharoen, S., Pattanavibool, A., Chaiwattana, S., Maneerat, S., Kumar N., Jathanna, D., Srivathsa, A., & Karanth, K. (2016). Dynamics of a low-density tiger population in Southeast Asia in the context of improved law enforcement. *Conservation Biology. 30*. 639-648.

Duckworth, J.W., Sankar, K., Williams, A.C., Samba Kumar, N. and Timmins, R.J. (2016). *Bos gaurus*. *The IUCN Red List of Threatened Species*. Retrieved from: https://www.iucnredlist.org/species/2891/46363646.

Ferrari, S. F., Veiga, L. M., and Urbani, B. (2008). Geophagy in New World Monkeys (Platyrrhini): Ecological and geographic patterns. *Folia Primatologica, 79*, 402–415.

Fleischer, R.C., Perry, E.A., Muralidharan, K., Stevens, E.E. and Wemmer, C.M. (2001), Phylogeography Of the Asian Elephant (Elephas Maximus) Based on Mitochondrial Dna. *Evolution, 55*: 1882-1892.

Food and Agricultural Organization of the United Nation and United Nations Environmental Program (2020). *The State of the World's Forests 2020. Forests, biodiversity and people.* Rome.

Fortunel, C., Lasky, J. R., Uriarte, M., Valencia, R., Wright, S. J., Garwood, N. C. and Kraft, N. J. B. 2018. Topography and neighbourhood crowding can interact to shape species growth and distribution in a diverse Amazonian forest. *Ecology 99* (10): 2272-2283.

Fuller, T.K. and Sievert, P.R. (2001) Carnivore demography and the consequences of changes in prey availability. *Carnivore Conservation* (pp. 163-178). Cambridge University Press.

Glen, A. S., and Dickman, C. R. (2014). The Importance of Predators. *Carnivores of Australia: Past Present and Future*. (Pp. 1-12). CSIRO Publishing.

Gonzalez T. M., Gonzalez-Trujillo J. G., Palmer J. R. B., Pino J., and Armenteras D. (2017). Movement behaviour of a tropical mammal: The case of *Tapirus terrestris*. *Ecological Modelling, 360*: 223-229.

Graves, H. B. (1984). Behaviour and Ecology of Wild and Feral Swine (*Sus Scrofa*). *Journal of Animal Science, 58*(2), 482–492.

Griffiths, M. and Schaik, C. P. (1993), The Impact of Human Traffic on the Abundance and Activity Periods of Sumatran Rain Forest Wildlife. *Conservation Biology, 7*.

Hamdan, A., Ab Latip, M.Q., Abu Hassim, H. *et al.*, (2020). A preliminary study of mirror-induced self-directed behaviour on wildlife at the Royal Belum Rainforest Malaysia. *Scientific Report 10***,** 14105.

Hayward, M.W., Jędrzejewski, W. and Jêdrzejewska, B. (2012), Prey preferences of the tiger. *Journal of Zoology, 288*: 82-83.

Holechek, J. L., and Herbel, C. H. (1986). Supplementing range livestock. *Rangelands, 8*(1), 29-33.

Hon, J. and Shibata, S. (2013), A Review on Land Use in the Malaysian State of Sarawak, Borneo and the Recommendations for Wildlife Conservation Inside Production Forest Environment. *Borneo Journal of Resource Science and Technology 3*(2): 22-35.

Honeycutt, R., Moulton, M., Roppe, J., and Fifield, L. (1981). The Influence of Topography and Vegetation on the Distribution of Small Mammals in Southwestern Utah. *The Southwestern Naturalist, 26*(3), 295-300.

Jean Desbiez, A., Keuroghlian, A., Piovezan, U., and Bodmer, R. (2011). Invasive species and bushmeat hunting contributing to wildlife conservation: The case of feral pigs in a Neotropical wetland. *Oryx,45*(1), 78-83.

Karanth, K., Nichols, J. D., Kumar, N. S., Link W. A., and Hines, J E. (2004). Tigers and their prey: Predicting carnivore densities from prey abundance. *Proceedings from the National Academy of Sciences, 101*(14) 4854-4858.

Kawanishi, K. (2002) *Population status of tigers (Panthera tigris) in a primary rainforest of Peninsular Malaysia*. PhD thesis, University of Florida, Gainesville, USA.

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

Kawanishi K., Gumal M., Shepherd L. A., Goldthorpe G., Shepherd C. R., Krishnasamy K., and Abu Hashim A. K. (2010). Chapter 29 - The Malayan Tiger, Editor(s): Tilson, R. Nyhus, P. J. In Noyes Series in Animal Behaviour, Ecology, Conservation, and Management. *Tigers of the World* (Second Edition, pp 367-376), William Andrew Publishing.

Kawanishi, K., Clements, G., Gumal, M., Goldthorpe, G., Yasak, M., and Sharma, D. (2013). Using BAD for good: How best available data facilitated a precautionary policy change to improve protection of the prey of the tiger Panthera tigris in Malaysia. *Oryx, 47*(3), 420-426.

Kawanishi, K., Rayan, M. D., Gumal, M. T., and Shepherd, C. R. (2014). Extinction Process of the sambar in Peninsular Malaysia. *Deer Specialist Group Newsletter N 26*.

Kawanishi, K. (2015). *Panthera tigris ssp. jacksoni*. *The IUCN Red List of Threatened Species*.

Kenney, J.S., Smith, J.L.D., Starfield, A.M. and Mcdougal, C.W. (1995), The Long-Term Effects of Tiger Poaching on Population Viability. *Conservation Biology*, *9*: 1127-1133.

Kerley, L.L. (2010), Using dogs for tiger conservation and research. *Integrative Zoology*, *5*: 390-396.

Kedri, K., Hamzah, F., Sukri, S. Z., Yaacob, H N., Abd Majid, S. K. S., Mokhtar, N. N., and Amir, F. S. (2018). Distribution and ecology of Rafflesia in Royal Belum state park, Perak, Malaysia. *International Journal of Engineering & Technology*, *7*(2.29), 292-296.

King, A., Behie, A.M., Hon N., and Rawson, B.M. (2016) Patterns of salt lick use by mammals and birds in northeastern Cambodia. *Cambodian Journal of Natural History*, 40–5.

Krishnamani, R., and Mahaney, W. (2000). Geophagy among primates: Adaptative significance and ecological consequences. *Animal Behaviour, 59*, 899–915.

Kumar, N. S. (2010). Assessment of distribution and abundance of ungulate prey using spatial models in Nagarahole and Bandipur Tiger Reserves of India.

Kumar, U., Awasthi, N., Qureshi, Q., and Jhala, Y. (2019). Do conservation strategies that increase tiger populations have consequences for other wild carnivores like leopards? *Scientific reports, 9*(1).

Last Wilderness (2015). Tigers of Bandhavgarh, Tiger Stripe Identification. Retrieved from: http://thelastwilderness.org/wp-content/uploads/2016/08/guide-booklet-9-eng-web.pdf.

Leimgruber, P., Gagnon, J., Wemmer, C., Kelly, D., Songer, M., and Selig, E. (2003). Fragmentation of Asia's remaining wildlands: Implications for Asian elephant conservation. *Animal Conservation, 6*(4), 347-359.

Magintan, D., Traeholt, C., and Karuppanannan, K., (2012). Displacement of the Malayan Tapir (Tapirus indicus) in Peninsular Malaysia from 2006 to 2010. *Tapir Conservation. 21*. 13-17.

Magintan, D., Ilias, R., Ismail, A., Jawing, A., Rasdi, I. and Mohd. Sanusi, M. (2015). A preliminary observation of mammals and other species visiting artificial salt licks in Peninsular Malaysia. *Journal of Wildlife and Parks, 30*: 59-74.

Mason, A. D., Michalakidis, G., and Krause, P. J. (2012) "Tiger Nation: Empowering citizen scientists," 6th IEEE International Conference on Digital Ecosystems and Technologies (DEST), *Campione d'Italia*, pp. 1-5.

Masters, D. G., Norman, H. C., and Thomas, D. T. (2019). Minerals in pastures—are we meeting the needs of livestock? *Crop and Pasture Science 10*.

Mathers, K. L., Rice, S. P., and Wood, P. J. (2019). Predator, prey, and substrate interactions: the role of faunal activity and substrate characteristics. *Ecosphere 10*(1).

Matsubayashi, H., Lagan, P., Majalap, N., Tangah J., Sukor J. R. A., and Kitayama K. (2007). Importance of natural licks for mammals in Bornean Inland Tropical Rainforest. *Ecological Research, 22*: 742.

Matsubayashi, H., and Lagan, P. (2014). Natural Salt-Licks and Mammals in Deramakot: Their Importance and Why They Should be Conserved.

Sunquist, M., (2010) Chapter 2 - What Is a Tiger? Ecology and Behaviour. Noyes Series in Animal Behaviour, Ecology, Conservation, and Management. *Tigers of the World* (Second Edition pp 19-33), William Andrew Publishing.

Misni, A., Rauf, A., Rasam, A. and Buyadi, A. S. N. (2017). Spatial analysis of habitat conservation for hornbills: a case study of Royal Belum–Temengor forest complex in Perak Sate Park Malaysia. *Pertanika, Journal of Social Sciences and Humanity 25*(S): 11-20.

Mohd Noor, M. F., Rusli, N. D., Mat, K., Hasnita, C. H., and Mira, P. (2020). Milk Composition and Milk Quality of Saanen Crossbreed Goats Supplemented by Mineral Blocks. *Tropical Animal Science Journal, 43*(2), 169-175.

Molina E., Leon T. E., and Armenteras D. (2013). Characteristics of natural licks located in the Columbian Amazon foothills. *Environment Geochemical Health, 36*, 117–129.

Nor Liyana, M., Othman, Z., Abd Wahid, R., and Azizul Hakimie, A. (2016). Habitat Suitability Prediction Model of Wildlife at Royal Belum State Park using Geographical Information System. *International Journal of Geoinformatics, 12*(2), 1–8.

Norfatimah, M.Y., Teh, L.K., Salleh, M.Z., Mat Isa, M.N., and SitiAzizah, M.N. (2014). Complete mitochondrial genome of Malaysian Mahseer (*Tor tambroides*). *Gene, 548*, 263-269.

Nurmi, A., and Harahap, M. F. (2019). Palatability Test of Mineral Herbal Blocks on Performance of Local Sheep. *Indonesian Journal of Agricultural Research, 2*(2), 1-7.

Odden, M., and Wegge, P. (2007). Predicting spacing behaviour and mating systems of solitary cervids: A study of Hog Deer and Indian Muntjacs. *Zoology, 110* (4). P 261-270.

Panichev, A. M., Popov, V. K., Chekryzhov, I. Yu., Seryodkin, I. V., Sergievich, A. A., and Golokhvast, K. S. (2017). Geological nature of mineral licks and the reasons for geophagy among animals, *Biogeosciences, 14*, 2767–2779.

Pareja-Carrera, J., Rodríguez-Estival, J., Mateo, R. *et al.* (2020). In vitro assessment of mineral blocks as a cost-effective measure to reduce oral bioavailability of lead (Pb) in livestock. *Environmental Science and Pollution Research 27***,** 25563–25571.

Ping, X., Li, C., Jiang, Z. *et al.* (2011). Sexual difference in seasonal patterns of salt lick use by south China sika deer (*Cervus nippon*.) *Mammalian Biology 76***,** 196–200.

Rahmad, Z., Johari, S., and Akomolafe, G, F., (2018). Tree Stands and Liana Community in Royal Belum State Park, Malaysia. *Borneo Journal of Resource Science and Technology, 8(2)*: 75-83.

Ramesh, T., (2010). *Prey selection and food habits of large carnivores: tiger (Panthera tigris), leopard (Panthera pardus) and dhole (Cuon alpinus) in Mudumalai Tiger Reserve, Tamil Nadu*. Ph.D. Thesis, Saurashtra University, Gujarat, Rajkot.

Ramesh, T., Sankar, K., Qureshi, Q. *et al.* (2012). Group size, sex, and age composition of chital (*Axis axis*) and sambar (*Rusa unicolor*) in a deciduous habitat of Western Ghats. *Mammalian Biology 77***,** 53–59.

Rayan D. M., Lau C. F., Goh S. S., Shariff M., Wong C. T., Siwan S. E., Hamirul M. and Azlan M. (2012). Management recommendations on ecological linkages: Findings from a study on large mammal habitat use within the Belum-Temengor Corrisor. *WWF-Malaysia Project Report*.

Rayan, D. M. (2012). *Conservation and ecology of tigers in a logged-primary forest mosaic in Peninsular Malaysia*. PhD thesis, University of Kent, Canterbury, UK.

Roininen, H., Veteli, O. T., and Piiroinen, T. (2007). The role of herbivores in the ecosystem and management of miombo woodlands. *Working Papers of the Finnish Forest Research Institute 50*: 107-114.

Rozaini, A. A., Chan, N.W. and Ahmad P. M.S. (2011). The Potentials and Perils of Ecotourism in Belum Temengor Forest Complex. *World Applied Science Journal 12*:01-09.

Samia, D. S. M. Nakagawa S., Nomura F., Rangel T. F and Blumstein D T. (2015). Increased tolerance to humans among disturbed wildlife. *Nature Communication*, *6*, 8877.

Sanderson, E., *et al.*, (2010). Setting priorities for conservation and recovery of wild tigers: 2005-2015. Tigers of the world: The science, politics, and conservation of *Panthera tigris*. 143-161.

Shahfiz, M.A., Shukri, M.A., Kaviarasu, M., Nor Hazwani, A.R., Faradiana, N.M.F., and Nur Alwani, Z. (2019). Checklist of vertebrates at Primary Linkages 2 (PL2) of the Central Forest Spine Ecological Corridor in Belum Temengor Forest Reserves, Perak, Peninsular Malaysia. *The Malaysian Forester*, *82* (2), pp. 463-485.

Sharma, K., Wright, B., Joseph, T., and Desai, N. (2014). Tiger poaching and trafficking in India: Estimating rates of occurrence and detection over four decades. *Biological Conservation*, *179*, 33–39.

Sharma, S., Jhala, Y. and Sawarkar, V.B. (2005), Identification of individual tigers (*Panthera tigris)* from their pugmarks. *Journal of Zoology*, *267*: 9-18.

Shi, C, Liu, D, Cui, Y, Xie, J, Roberts, NJ, and Jiang, G. (2020). Amur tiger stripes: individual identification based on deep convolutional neural network. *Integrative Zoology*.; 1– 10.

Shoshani, J., and J. F. Eisenberg. (1982). *Elephas maximus. Mammalian Species*, 182:1–8.

Simcharoen, A., Savini, T., Gale, G. A., Roche, E., Chimchome, V., and Smith, J. L. D. (2014). Ecological Factors that influence sambar (*Rusa unicolor*) distribution and abundance in western Thailand: Implications for Tiger Conservation. *Raffles Bulletin of Zoology 62*: 100 - 106.

Simcharoen, A., Savini, T., Gale, G., Simcharoen, S., Duangchantrasiri, S., Pakpien, S., and Smith, J. (2014). Female tiger Panthera tigris home range size and prey abundance: Important metrics for management. *Oryx*, 48(3), 370-377.

Simpson B. K., Shukor M. N., and Magintan D. (2013). Food selection of the Malayan Tapir (*Tapirus indicus*) under semi-wild conditions. *AIP Conference Proceedings*, 317-324.

Singh, R., Chauhan, D. S., Mishra, S., Krausman, P. R., and Goyal, S. P. (2014). Tiger density in a tropical lowland forest in the Eastern Himalayan Mountains. *Springer Plus*, *3*, 462.

Sitienei, A.J., Jiwen, G., Ngene, S.M., De La Paix, M.J. and Waweru, F.K. (2011). Analysis in the concentration, determination and comparison of some mineral elements in the natural salt-licks utilized by elephants: Mt. Elgon National Park case study. *Advanced Materials Research*, *356-360*, 1796-1800.

Sobral, M., Kirsten M. S., Overman, H., Olieveira L. F. B., Raab T. K., and Fragoso J. M. V., (2017). Mammal diversity influences the carbon cycle through trophic interactions in the Amazon. *Nature Ecology and Evolution*. *1*:1670-1676.

Spinage C. (1994). *Polyperchon's Predicament; Food and Feeding*. B384.9.w9 153-168.

Stevens, A. (2010) Dynamics of Predation. *Nature Education Knowledge 3*(10):46.

Strazzullo, P., and Leclercq, C. (2014). Sodium. *Advances in Nutrition 5*(2), 188–190.

Sukumar, R. (1990). Ecology of the Asian elephant in southern India. II. Feeding habits and crop raiding patterns. *Journal of Tropical Ecology*, *6*(1), 33-53.

Talbot L.M. (1978) The Role of Predators in Ecosystem Management. In: Holdgate M.W., Woodman M.J. (eds) The Breakdown and Restoration of Ecosystems. *NATO Conference Series (Series I: Ecology), 3*. Springer, Boston, MA.

Teng L., Liu Z., Song Y-L., & Zeng. Z (2004). Forage and bed sites characteristic of Indian muntjac (*Muntiacus muntjak*) in Hainan Island, China. *Ecological Research*, *19*, 675–681.

Terborgh, J., Lopez, L., Nuñez, P., Rao, M., Shahabuddin, G., Orihuela, G., Riveros, M., Ascanio, R., Adler, G. H., Lambert, T. D., & Balbas, L. (2001). Ecological meltdown in predator-free forest fragments. *Science 294*(5548), 1923–1926.

Tracy, B. F. and McNaughton, S. J. (1995). Elemental analysis of mineral licks from the Serengeti National Park, the Konza Prairie and Yellowstone National Park. *Ecography*, *18*, 91-94.

Traeholt, C., Novarino, W., bin Saaban, S., Shwe, N.M., Lynam, A., Zainuddin, Z., Simpson, B. and Mohd, S. (2016). *Tapirus indicus*. *The IUCN Red List of Threatened Species*. Retrieved from: https://www.iucnredlist.org/search?permalink=2deed21a-0bde-46d6-9dc1-6e02ecb8c9ab.

Tempa, T., Hebblewhite, M., Goldberg, J. F., Norbu, N., Wangchuk, T. R., Xiao, W. H., and Mills. L. S., (2019). The spatial distribution and population density of tigers in mountainous terrain of Bhutan. *Biological Conservation*, *238*, 108192.

Underwood, E.C., Viers, J.H., Quinn, J.F. *et al.* (2010). Using Topography to Meet Wildlife and Fuels Treatment Objectives in Fire-Suppressed Landscapes. *Environmental Management 46***,** 809–819.

Vitousek, P., Chadwick, O., Matson, P., Allison S., Derry L., Kettley L., Luers A., Mecking E., Monastra V., and Porder S. (2003). Erosion and the Rejuvenation of Weathering-derived nutrient Supply in an old Tropical Landscape. *Ecosystems*, *6*, 762.

Weir, J.S. (1969), Chemical properties and occurrence on Kalahari sand of salt licks created by elephants. *Journal of Zoology*, *158*: 293-310.

Wildlife Conservation Act (2010). Laws of Malaysia, Act 716. Retrieved from: http://www.agc.gov.my/agcportal/uploads/files/Act%20716%20-%208%2010%202014.pdf.

Williams, K., and Petrides, G. (1980). Browse Use, Feeding Behaviour, and Management of the Malayan Tapir. *The Journal of Wildlife Management*, *44*(2), 489-494.

Yen, S., Wang, Y., and Ou, H. (2014). Habitat of the Vulnerable Formosan sambar deer *Rusa unicolor swinhoii* in Taiwan. *Oryx, 48*(2), 232-240.

Zhang, C., Minghai, Z., Philip. S., (2013). Does prey density limit Amur tiger (*Panthera tigris altaica*) recovery in northeastern China. *Wildlife Biology*. *19*. 452-461.

APPENDICES

PERBADANAN TAMAN NEGERI PERAK
TINGKAT 1 , KOMPLEKS PEJABAT KERAJAAN NEGERI
DAERAH HULU PERAK
JKR 341 , JALAN SULTAN ABD AZIZ
33300 GERIK, PERAK DARUL RIDZUAN.
Tel : 05-7914543
Faks : 05-7912641

Ruj. Tuan :
Ruj. Kami : PTNPK/T/400/4/23.Bil(7)dlm.2018
Tarikh : 24 Oktober 2018
15 Safar 1440 H

Dr Hafandi Ahmad
Jabatan Sains Praklinikal Veterinar
Fakulti Perubatan Veterinar
Universiti Putra Malaysia,
43400 UPM Serdang,
Selangor

Tuan,

MEMOHON KEBENARAN UNTUK MENJALANKAN KAJIAN DI TAMAN NEGERI ROYAL BELUM

Dengan segala hormatnya saya merujuk kepada perkara di atas.

2. Dimaklumkan bahawa pihak Perbadanan Taman Negeri Perak dengan ini memberi **KEBENARAN** dan **KELULUSAN** kepada pihak Universiti Putra Malaysia untuk menjalankan penyelidikan di kawasan Taman Negeri Royal Belum bermula **Oktober 2018 hingga Oktober 2020.**

3. Namun demikian, pihak Universiti Putra Malaysia dikehendaki untuk mematuhi beberapa peraturan semasa menjalankan penyelidikan di kawasan Taman Negeri Royal Belum iaitu;

a) Hanya kawasan yang dibenarkan oleh pihak Perbadanan Taman Negeri Perak;

b) Tidak mengambil (mematah, memotong atau mencabut) flora serta tidak mengganggu habitat fauna di kawasan Taman Negeri Royal Belum yang merupakan kawasan dilindungi "Protected Area";

c) Penyelidik perlu mengisi borang untuk membawa keluar spesimen bagi rujukan pihak Perbadanan Taman Negeri Perak dan perlu mengikut syarat-syarat seperti yang terdapat dalam borang berkenaan;

d) Segala maklumat dan data kajian mestilah dikongsi dengan pihak Perbadanan Taman Negeri Perak dan Kerajaan Negeri Perak;

e) Tidak dibenarkan membuat apa-apa penerbitan tanpa kebenaran Kerajaan Negeri Perak.

f) Pihak tuan perlu membayar Fi Penyelidik (penyelidik tempatan kajian – untuk tempoh 12 bulan) RM100.00 bagi setiap modul .

PERHILITAN

JABATAN PERLINDUNGAN HIDUPAN LIAR DAN TAMAN NEGARA
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS

W-00662-16-19

PERMIT KHAS
SPECIAL PERMIT

AKTA PEMULIHARAAN HIDUPAN LIAR 2010 [AKTA 716] WILDLIFE CONSERVATION ACT 2010 [ACT 716]

PERMIT KHAS UNTUK : Menjalankan penyelidikan atau kajian ke atas mana-mana hidupan liar yang dilindungi sepenuhnya (Seksyen 11(d) Akta 716).

SURAT KELULUSAN : KATS 600-2/2/21 JLD.9 (7)

BUTIRAN PEMILIK *OWNERS PARTICULARS*

NAMA PEMILIK *OWNER'S NAME* : BRYAN ANDREW LAZARUS

NO MYKAD / PASPORT *MYKAD / PASSPORT NO* : 940509085255

PEKERJAAN *DESIGNATION* : PELAJAR

ALAMAT *ADDRESS* : NO. 356, TAMAN LONG JAAFAR B, KAMPUNG BOYAN, 34000-TAIPING, PERAK

NAMA SYARIKAT *COMPANY'S NAME* : UNIVERSITI PUTRA MALAYSIA

NO DAFTAR PERNIAGAAN *REGISTRATION NO* :

ALAMAT SYARIKAT *COMPANY'S ADDRESS* : FAKULTI PERUBATAN VETERINAR, UNIVERSITI PUTRA MALAYSIA 43400-SERDANG, SELANGOR

TEMPOH SAH *VALIDITY*
27/06/2019 - 26/06/2020

Syarat-syarat Permit Khas Penyelidikan atau Kajian

1. Pemegang permit khas hendaklah mematuhi Akta Pemuliharaan Hidupan Liar 2010 (Akta 716) dan mana-mana Peraturan atau Perintah yang dibuat di bawahnya.
2. Permit khas penyelidikan atau kajian ini sah untuk tempoh yang telah dinyatakan pada permit khas.
3. Hidupan liar yang ditandakan dan dinyatakan di dalam permit khas ini sahaja yang dibenarkan untuk digunakan bagi penyelidikan atau kajian oleh pemegang permit khas.
4. Permit khas penyelidikan atau kajian ini tidak boleh dipindah milik.
5. Permit khas penyelidikan atau kajian hidupan liar hendaklah disimpan di alamat seperti yang dinyatakan di dalam permit khas ini kecuali dengan kebenaran Menteri.
6. Sekiranya pemilik permit khas ingin penyelidikan atau kajian hidupan liar di tempat selain dari alamat yang dinyatakan di dalam permit khas, pemilik perlu memohon permit khas mengguna yang baharu.
7. Pemegang permit khas perlu membuat permohonan permit khas penyelidikan atau kajian yang baharu dalam tempoh empat belas (14) hari dari tarikh tamat tempoh sah permit khas penyelidikan atau kajian.
8. Permit khas penyelidikan atau kajian hendaklah ditunjukkan apabila diminta oleh pegawai penguatkuasa Jabatan PERHILITAN.
9. Pemegang permit khas hendaklah memaklumkan kepada Ketua Pengarah PERHILITAN jika berlaku kematian, pertambahan atau hidupan liar yang telah diberikan permit khas terlepas.
10. Permit khas penyelidikan atau kajian ini tidak boleh dipinda. Jika terdapat perubahan pada butiran dalam permit khas, permit khas mengguna yang baharu perlu dicetak setelah butiran dikemaskini.
11. Mana-mana hidupan liar yang hilang, terlepas atau mati tidak dibenarkan diganti di bawah permit ini.
12. Pemilik permit khas perlu menyerahkan hidupan liar semula hidupan liar kepada Jabatan PERHILITAN sekiranya tidak lagi berminat menjalankan penyelidikan atau kajian hidupan liar tersebut.

BIODATA OF STUDENT

The student, Bryan Andrew Lazarus, was born on the 9th of May 1994 in Taiping, Perak, Malaysia. He graduated from Universiti Putra Malaysia in 2018 with a Degree in Doctor of Veterinary Medicine. He was active in his college years where he was the Director for Dogathon 2015/2016, Main Committee and Head of Logistics for the International Veterinary Student Association (IVSA) Congress in Malaysia which saw up to 250 international participants, as well as committee member for a number of Group Exchanges for the International Veterinary Students Association (IVSA), hosting group exchanges for students from Austria, Belgium, Denmark, Philippines, Indonesia and Thailand. He also participated in a few IVSA Asian Congresses, in Malaysia and Thailand. He was passionate about wildlife research and medicine, where he continued his postgraduate studies in Universiti Putra Malaysia in August 2018 in Environmental Physiology in the Royal Belum Rainforest. He is currently supervised by Assoc Prof Dr. Hafandi Ahmad, Dr Hasliza Hashim and Dr. Azlan Che' Amat.

LIST OF PUBLICATIONS

Lazarus, B. A., Abdul Halim, M. M., Hamdan, A., Nik Hassan, A. N., Mohammad M. S., Abu Hassim, H., Mohd Noor, M. H., Tengku Azizan T. R. P., and Ahmad, H. (2019). Topographical Differences Impacting Wildlife Dynamics at Natural Saltlicks in the Royal Belum Rainforest. *Asian Journal of Conservation Biology*, *Vol. 8 No 2*, pp. 97-101.

Lazarus, B.A., Che-Amat, A., Abdul Halim Shah, M.M. *et al.* (2021). Impact of natural salt lick on the home range of *Panthera tigris* at the Royal Belum Rainforest, Malaysia. *Scientific Reports 11***,** 10596

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