PRIMATE POPULATION STATUS AND DISTRIBUTION ASSESSMENT USING POOLED LOCAL EXPERT OPINION AND GEOGRAPHIC INFORMATION SYSTEM IN PENINSULAR MALAYSIA

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

Faculty of Applied Sciences and Technology
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OCTOBER 2023

ACKNOWLEDGEMENT

I am grateful to Allah s.w.t for giving me His blessing, rizq and for always strength my soul to keep moving and never give up to complete my PhD journey. I would like to acknowledge and give my highest thanks to my respectful supervisor Assoc. Prof. Ts. Dr. Muhammad Abdul Latiff Abu Bakar for his unconditional guidance, patience, motivation, and advice to me through all the stages of my PhD journey. He always believes that I can do anything in this life despite I feel that I unable to achieve anything. I would also like to give special thanks to my co – supervisor, Assoc. Prof. Ts. Dr. Suliadi Firdaus Sufahani and Sr. Ts. Dr. Nazirah Binti Mohamad Abdullah for all their support, guidance and advice regarding my research journey. I also would like to give thanks to Puan Hani and all staff from PERHILITAN, Forestry Department and local people of Muar that participated in this study. This research was supported by the Ministry of Higher Education Malaysia (MOHE) under the Fundamental Research Grant Scheme FRGS, 1, 2018, WAB13, UTHM, 03, 2 and conducted under research permits JPHL&TN (IP):100-34, 1.24 Jld 20(07) by Department of Wildlife and National Parks Malaysia. Besides that, warmest thanks to my beloved parents, Encik Mohd Faudzir and Puan Raba'iah, my siblings; Solehuddin, Ahmad, Imad, Amin, Hassan, Fathiah, Arif, in laws; Hajar, Sarah, Amirah, Ain and family members for their unconditional love, financial support, encouragement, sacrifices and moral support. Big thanks to my researchmates; Hidayah, Syuhada, Kavi, Fara, Hartini, Fatihah, Atikah, for all your support, and special thanks to Mr. Ilham Norhakim for helping in every expedition and fieldwork. I owe all of you a lot. Last but not least, special thanks to Jabatan Perkhidmatan Awam (JPA) the financial support given to me through PPC scholarship along my PhD journey.

ABSTRACT

Primate population and distribution studies are conventionally based on field study and expert estimation for a population in certain area. To provide data at larger scale, the researcher estimates the primate population and distribution based on recent finding and extrapolation of data from specific area to represent larger are such as for state or country. Though the method was readily accepted for scientific study and international report, another stakeholder was left aside which is locals such as villagers, park manager and wildlife ranger. This study employed pooled local expert opinion (PLEO) which targeted experts from the Department of Wildlife and National Park (PERHILITAN) (*n=311*), Johor Forestry Department (*n=150*), and local people (*n=386*). The result shows the reliability of local experts for only on the presence-absence of primate species and human-wildlife conflict (Cronbach's alpha *0.8*). PERHILITAN and Johor Forestry Department show reliability on primate population estimation, distribution, and human-wildlife conflict as government authorities (Cronbach alpha: *0.94* and *0.97*, respectively). The total population estimation for primates were as follow: *M. fascicularis* (97200), *M. nemestrina* (30900), *M. arctoides* (3000), *T. obscurus* (23420), *P. robinsoni* (3920), *P. femoralis* (2800), *P. siamensis* (10510), *T. cristatus* (8900), *N. coucang* (4410), *H. lar* (4700), *H. agilis* (3050), and *S. syndactylus* (2950). Though the method can be refined into specific area for other wildlife as well, the improvement that should be considered are the target respondent, structure of the question and complementary data to increase its reliability, robustness, and impact for policy maker.

ABSTRAK

Kajian populasi dan taburan primata biasanya dilaksanakan secara konvensional berdasarkan kajian lapangan dan anggaran pakar untuk menentukan populasi di kawasan tertentu. Untuk menyediakan data pada skala yang lebih besar, penyelidik menganggarkan populasi dan taburan primata berdasarkan penemuan terkini dan ekstrapolasi data dari kawasan tertentu untuk mewakili kawasan yang lebih besar seperti untuk negeri atau negara. Walaupun kaedah itu mudah diterima untuk kajian saintifik dan laporan antarabangsa, pemegang taruh lain seperti penduduk tempatan, pengurus taman dan renjer hidupan liar.. Kajian ini menggunakan himpunan pendapat pakar tempatan (PLEO) yang menyasarkan pakar dari Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN) (*n=311*), Jabatan Forestry Department Johor (*n=150*), dan penduduk tempatan (*n=386*). Hasilnya menunjukkan kebolehpercayaan penduduk tempatan hanya untuk kewujudan spesies primata dan konflik manusia-hidupan liar (nilai Cronbach: *0.8*). Jabatan PERHILITAN dan Forestry Department Johor menunjukkan kebolehpercayaan terhadap anggaran populasi primata, taburan, dan konflik hidupan liar (nilai Cronbach: *0.94* dan *0.97* mengikut turutan). Jumlah anggaran populasi primat adalah seperti berikut: *M. fascicularis* (97200), *M. nemestrina* (30900), *M. arctoides* (3000), *T. obscurus* (23420), *P. robinsoni* (3920), *P. femoralis* (2800), *P. siamensis* (10510), *T. cristatus* (8900), *N. coucang* (4410), *H. lar* (4700), *H. agilis* (3050), and *S. syndactylus* (2950). Walaupun kaedah ini boleh diperluaskan kegunaanya lagi ke untuk kawasan hutan dan hidupan liar lain, penambahbaikan yang perlu dipertimbangkan ialah sasaran responden, struktur soalan dan data pelengkap untuk meningkatkan kebolehpercayaan, integriti dan manfaatnya kepada pembuat dasar.

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LIST OF SYMBOLS AND ABBREVIATIONS

ha	-	hectar
PERHILITAN	-	Department of Wildlife and National Park
FORESTRY	-	Johor Forestry Department
PLEO	-	Pooled Local Expert Opinion
LEK	-	Local Ecological Knowledge

CHAPTER 1

INTRODUCTION

1.1 Background study

Malaysia is one of the megadiverse countries in terms of biodiversity and is also listed as a hotspot in the Sundaland region (Mittermeier *et al.*, 2011). On top of being biological diversity hotspot, Malaysia had listed out its National Policy on Biological Diversity to address the key issues related to biological diversity pressure and threats as part of its commitment to conserve biodiversity (NRE 2016). Though that, from 2002 to 2022, Malaysia lost 2.85 million hectares of humid primary forest, making up 33% of its total tree cover loss in the same time period. Total area of humid primary forest in Malaysia decreased by 18% in this time period (WRI, 2023). This has directly impacted the viability of wildlife including mammals. Out of 306 species of mammals in Malaysia, 25 of them are currently declining in numbers and facing habitat loss (CBD, 2014; Md-Zain *et al.*, 2019). Primates that are primarily arboreal rely heavily on the intact forests and keep moving from one surroundings to another in the search of food, mates and territories (Cartmill, 2017). Among the main factors which lead to the habitat loss of the primates are industrial agriculture, large-scale cattle ranching, logging, oil and gas drilling, mining, dam building and the construction of new road networks in the primates' regions (Estrada *et al.*, 2017).

As a tropical country and is currently progressively developing, Malaysia is also experiencing this situation as there are ongoing agricultural projects and megaprojects for example the East Coast Rail Link (ECRL) which connects four states in the east coast of the Peninsular Malaysia i.e., Kelantan, Terengganu, Pahang and Selangor as well as the development of 12 mega dams in Sarawak (Kitzes and Shirley, 2016; Tat *et al.*, 2018). Other than that, direct anthropogenic stress such as

wildlife consumption, hunting and pet trading also increases the rate of the declining population of primates (Estrada *et al.*, 2017; Abdul-Latiff *et al.*, 2021).

In Malaysia, there are 25 primate species with 12 of them are in Peninsular Malaysia (Md-Zain *et al.*, 2022). Most of the primates are arboreal with the exception of three species that can be adapted to terrestrial behaviour i.e., the genus *Macaca* (*Macaca fascicularis, Macaca nemestrina, Macaca arctoides*) (Hanna and Schmitt, 2010). This adaptation enables the primates to cross between forest patches, plantation and even enter the urban area to search for nutritional needs (Ruslin *et al.*, 2019; Najmuddin *et al.*, 2019; Mohd-Daut *et al.*, 2021). With different species comprising different niches, the challenges for primate conservation keep rising as the specialist species e.g., white-handed gibbon (*Hylobates lar*) or banded langur (*Presbytis femoralis*) and generalist species e.g., long-tailed macaque (*M. fascicularis*) are in mixed habitats across human border. Despite the diverse characteristics of primates comprising various ecological niches, the fundamental question regarding primate conservation is still unknown e.g., the population and distribution factor. Thus, the urge to assess the primate population and distribution for primate conservation is the main motive for this study.

The main problem in primate conservation is the unknown total population of each species and their location. For example, for *M. fascicularis*, the area of occurrence is estimated by PERHILITAN includes up to 13 million hectares in the Peninsular Malaysia, which is the total land area of Peninsular Malaysia itself (PERHILITAN, 2018). Pinpointing the exact location of the primate is inaccurate, this there is a need to rely on the locals who encounter them frequently. Another example of endemic species is the southern banded langur, *Presbytis femoralis* in Johor. The species is estimated to be around 500 individuals in the regions of Mount Lambak, Mount Panti and the greater Kota Tinggi which are currently heavily covered by oil palm plantations (Najmuddin *et al.*, 2020). While the previous report showed that *P. femoralis* distribution did extend to the southern and middle parts of Pahang, the current extant of the species remains vague (PERHILITAN 2018). Due to the current method of primate population assessment that is either site-specific or species-specific, the estimation of the population relies only on expert estimation from basic data in certain areas. Various methods for primate population assessment were established over half century ago from direct observation (line transect,

acoustic luring) to indirect observations using camera trap, passive acoustic monitoring and molecular approach (Campbell *et al.*, 2016).

In this sense, all methods have their own advantages and disadvantages especially in terms of financial cost, human labour, coverage and targeted species. The direct observation method is conventionally based on the observer ability to directly count primate and actively walking into the primate habitat (Ferrari *et al.*, 2010). While it is labour intensive and requires replication to achieve good results, it is one of the most established methods in counting wildlife (Leca *et al.*, 2013; Ferrari *et al.*, 2010; Shanee & Shanee 2011). Indirect approach includes the use of camera trap and acoustic monitoring (Savage *et al.*, 2010; Olson *et al.*, 2012). One previous study was done on assessing the diversity of mammals using camera trap method (Kawanishi *et al.*, 2014), however it was limited to terrestrial camera trap method which usually obtained terrestrial primates such as long-tailed macaque (*M. fascicularis*) and pig-tailed macaque (*M. nemestrina*). Another indirect approach is using molecular census that contributed to primate population census as it can give insights on the dispersal of population over time (Vigilant & Guschanski, 2009).

This comes to the main question on what method can cover most of the species, with less financial and labour costs yet still able to deliver reliable results in short time. Campbell *et al.* (2016) described the comparison between each established method in determining primate abundance and distribution by stating the lowest reliability method is interview method. This is also the fastest way for preliminary assessment on presence absence of primate species. Interview method is known to provide low accuracy data for primate distribution and it cannot provide deeper information such as abundance, density and trends (Campbell *et al.*, 2016; Kühl *et al.*, 2008).

However, the shortcoming of interview method can be strengthened by better questionnaire design, adequate targeted respondent and integration with other techniques such as geographic information system (GIS) analysis (Zeller *et al.*, 2011; Braga-Pereira 2021; Meijaard *et al.*, 2011). Interview method can utilise local ecological knowledge (LEK) that existed within local community for generations regarding the species of interest (Von-Glasenapp & Thorton, 2011). In advance to simple interview method, pooled local expert opinion (PLEO) can be used for expert respondents to increase its reliability (Van de Hoeven *et al.*, 2004; Meijaard *et al.*, 2011). In the context pf this country, the PLEO for ecological data had been done for

butterflies in 2015, though the land cover was limited only to citizen scientists that participated in the survey (Wilson *et al.*, 2015). Up to now, the primate population was never assessed at national scale except for *M. fascicularis* in 2014 (Karuppannan *et al.*, 2014).

1.2 Problem statement

In this study, the idea of using LEK seemed feasible to assess the population and distribution of primates in Peninsular Malaysia. This was where the first problem statement surfaced in which the viability of using LEK to get the primate population data became questionable. The approach was proven successful for other mammals and primates in other countries; however, it was yet to be tested in Malaysia for its reliability and feasibility (Camino *et al.*, 2020; Wotoko *et al.*, 2022). The problem regarding sample sizes, targeted respondents and questionnaire design must be solved before replicating this for a larger scale.

The second problem in that PERHILITAN is known as the authority responsible for the wildlife affairs in Peninsular Malaysia and they have collected reports of wildlife conflicts to solve the human primate conflict (PERHILITAN, 2018). Primate group has been one of the wildlife groups that engage with human wildlife conflicts especially generalist species such as *M. fascicularis* and *M. nemestrina* (Abdul-Latiff *et al.*, 2017; Ruslin *et al.*, 2019). On top of that, the reports on wildlife conflicts are released and published annually for the public but their potential regarding the intensity of conflicts and spatial information are relatively untapped. This comes the second idea if those reports on human-primate conflicts can be utilised further to obtain the estimation of primate distribution and population data. This conflict report database is useful in strategizing mitigation and management of human primate conflicts in the future. Additionally, there are cases where the LEK is feasible and reliable enough to be used for primate distribution and population assessment at community level, however, the next issue is whether the method can be optimised for a more specific respondent such as an expert on primate subject.

This leads to the third problem concerning the effectiveness of PLEO method for assessing the population and distribution of primates throughout Peninsular

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