Feasibility of Natural Salt-licks for Wildlife-Watching in Segaliud-Lokan Forest Reserve, Sandakan, Sabah

Lim Wing-Shen1*, Yip Pui-Mun1, Andy Russel Mojiol1, Collin Goh2, Paul Liau2, Liaw Yi-Chuang2, and Sanchez Vincent John2

1 Forestry Complex, Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, MALAYSIA
2 KTS Plantation Sdn. Bhd., Level 1, Blok 5, Jalan Utara Batu 4, Bandar Pasaraya, 90000 Sandakan, Sabah, MALAYSIA

E-mail: limwingshen@gmail.com

Abstract. Natural salt-licks are well-recognized as wildlife-watching hotspots that can provide visitors with high opportunities for sighting many different outstanding mammals at close-range. Various natural salt-licks were discovered throughout Segaliud-Lokan Forest Reserve (SLFR), but then the physical availability of local mammals at given licks were yet to be examined scientifically by past researchers. Henceforth, this study intended to investigate mammal species that were available for wildlife-viewing at the licks in SLFR. Four natural wet licks that were accessible from the main road and situated close to Sungai Rawog were selected as sampling areas to identify mammal species that visited given licks across different times through camera trapping survey. A total of 676 independent sightings of 12 different mammal species were recorded in 197 trap nights, especially at SL59 and during night-time. Sighted mammal individuals were mainly comprised of large-sized, threatened and non-carnivorous species, where Sambar Deer, Bearded Pig, Orang-utan, and Banteng were identified as the top 4 mammal species that were detected frequently at the licks in SLFR. In sum, it is feasible to conduct wildlife-viewing activity at the licks in SLFR, although further research is required to investigate the actual sighting probability and viewing duration of different mammal species by visitors at given licks and across different times or seasons.

1. Introduction

Natural salt-licks are acknowledged as mammal-watching hotspots worldwide, as large-sized mammals can be observed easily at the licks, especially in tropical rainforests of Malaysia [2,5]. Henceforth, protected areas with natural salt-licks and rich mammal diversity are gaining fame as wildlife-watching destinations in Malaysia, including Tabin Wildlife Reserve in Sabah [6]. In recent years, natural salt-licks were discovered in different regions of Sabah, including the Segaliud-Lokan Forest Reserve (SLFR). Within the secondary forest of SLFR housed a wide variety of Bornean mammals, and then some of these species were reported visiting the salt-licks in this forest reserve as well [3]. Henceforth, natural salt-licks can provide mammal-watching opportunities to visitors in SLFR, just like the natural salt-licks in Tabin Wildlife Reserve.

However, there was lacking information on the visitation pattern of local mammals to natural salt-licks in SLFR. Hence, this study intended to determine mammal species that were available as potential attractions for wildlife-watching at the licks in SLFR, across different times. Mammal species that are
available and prometable as local core attractions, as well as the natural salt-licks and times of day that are suitable for mammal-watching, will be further discussed in this study.

2. Methods

2.1 Study Site

SLFR (FMU 19B) is currently managed by KTS Plantation Sdn. Bhd., as a Class II Commercial Forest Reserve in Sabah. This forest reserve is comprised of 70 forest compartments or 57,247 ha, and then 10 forest compartments are conserved as Protection Areas (6,447 ha), while Compartment 1 is used as Plantation Research Area (777 ha). The remaining 48 and 17 compartments are managed as Industrial Tree Planting (ITP = 37,420 ha) and Natural Forest Management (NFM = 12,306 ha) areas respectively [9]. SLFR is hot and humid throughout the year, and then its steep undulating hills are dominated by regenerating lowland mixed dipterocarp forests. Four natural wet licks situated close to Sungai Rawog and accessible from the main road were selected from the Protection (SL56), ITP (SL50_A & SL50_B), and NFM (SL59) areas respectively as sampling areas for the present study. The selected licks have the rocky and muddy surface, and then a mineral-rich spring is presented within the vicinities of given licks throughout the year. SL59 is surrounded by a selective-logged forest, while SL56 is situated within a least-disturbed forest, and then both SL50_A and SL50_B are located inside the plantation forests. Figure 1 displays the locations of the four natural wet licks selected as sampling areas in this study.

![Figure 1. Locations of the four natural wet licks selected as sampling areas at SLFR in the present research.](image-url)
2.2 Camera Trapping Survey
Camera trapping survey was conducted at the four selected natural wet licks in SLFR from July until November in 2019 (5 months). Four passive infra-red camera traps (HC-800M, HongKong Suntek International Co. Ltd.) were deployed at the field, where each camera trap was set-up at 0.5 m height on a tree and faced towards the natural spring (5.0 to 10.0 m apart), to detect medium to large-sized mammal individuals that visited the lick. All deployed camera traps were remained active 24 hours a day at the field, and then the setting 60-sec delay for every three consecutive photographing was applied to given camera traps. A 30-minutes time gap was applied to distinguish between two independent detections of a mammal species at a particular lick and time. Last but not least, data transferring and batteries replacements were applied to the 4 deployed camera traps twice a month.

2.3 Data Analysis
Information regarding the mammal species and its traits, as well as the date and time of its detection, were identified and extracted from camera trapping data. Photographs without any mammal individual were excluded, leaving 9389 photographs that were included for later data analysis. Species traits (e.g.: body size, feeding guild, and IUCN status) of mammal species were identified based on the field guide written by Phillipps and Phillipps [12], as well as the data provided by the official website of IUCN [8]. Since that Greater Mousedeer (Tragulus napu) and Lesser Mousedeer (Tragulus kanchil) were hard to be distinguished from one another based on the taken images, hence both species were identified and assumed as Mousedeer (Tragulus spp.) in the present research.

Body size of mammals were categorized into three groups, based on their body masses (Small < 1.0 kg; 1.0kg < Medium <45.0 kg; Large > 45.0 kg), as suggested by Andrews et al. [1]. Then, mammal species that visited the licks in Sabah were mostly insectivorous, herbivorous-frugivorous, carnivorous, or omnivorous species [10], and then their IUCN statuses were defined as either one of the seven proposed classes (LC, NT, VU, EN, CR, EW, and EX) that represented their current local and global population sizes and conservation statuses [8]. The detection frequency and relative abundance index (RAI) were calculated for each species, across the 4 different salt-licks and times of the day. Times of the day are comprised of nocturnal (19:01 to 05:00 hours), crepuscular (17:01 to 19:01 hours and 05:01 to 07:00 hours) and diurnal (07:01 to 17:00 hours) hours [7]. Moreover, RAI is estimated as the number of independent detection per 100 trap nights (100TN⁻¹) [15].

Differences in composition and abundance of the recorded mammal species between different salt-licks and times of day were examined using Chi-Square Test. Then, the relationship between RAI and species traits of recorded mammal species were determined by using Spearman’s Rank Correlation Test. Packages “MASS” and “vegan” were used to run Chi-Square Test and Spearman’s Rank Correlation Test respectively in the statistical software RStudio ver. 1.2.5001 [11, 13, 16], at 95.0 % confidence interval level (p=0.05).

3. Results
Mammal individuals belonged to 12 different species and 9 different families were recorded visiting the four selected natural salt-licks in SLFR, for a total of 676 times within 197 trap nights. Detection frequency of mammals at given licks in SLFR were varied very significantly between species ($\chi^2_{11} = 48.6$, p<0.001), and then a majority of the detected mammal individuals were large-sized (95.1 %), threatened (95.4 %) and non-carnivorous (99.7 %) species. Table 1 displays the list of mammal species recorded visiting the four selected licks in SLFR through camera trapping survey.

Table 1. List of mammal species recorded visiting the four selected natural licks in SLFR through camera trapping survey.
Detection frequency for a mammal species at a certain salt lick and time was dependent on its feeding guild, body size, and IUCN status. The threatened (vulnerable, endangered and critically endangered), non-carnivorous (herbivore, frugivore and omnivore) and large-sized mammal species were reported visiting frequently, especially to SL59 (Threatened, \( n = 262 \) or 38.8 \%, \( \chi^2 = 4.06 \), \( p < 0.001 \)); Large, \( n = 262 \) or 38.8 \%, \( \chi^2 = 4.06 \), \( p < 0.001 \)) and during nighttime (Threatened, \( n = 277 \) or 41.0 \% \( \chi^2 = 7.12 \), \( p = 0.02 \); Non-carnivorous, \( n = 297 \) or 43.9 \%, \( \chi^2 = 53.0 \), \( p < 0.001 \)). This result showed that these four natural salt-licks, especially SL59, were mainly visited by the non-carnivorous, threatened and large-sized mammals, during nocturnal hours.

Regarding the difference in RAI between different mammal species, Sambar Deer (Cervus unicolor) was verified with the highest detection frequency at the licks in SLFR (n = 285, RAI = 144.67 100TN\(^{-1}\)), and then followed by the Bearded Pig (Sus barbatus, n = 266, RAI = 135.03 100TN\(^{-1}\)); Orang-utan (Pongo pygmaeus, n = 45, RAI = 22.84 100TN\(^{-1}\)); Banteng (Bos javanicus, n = 36, RAI = 19.80 100TN\(^{-1}\)); Thick-spined Porcupine (Hystrich crassispinis, n = 16, RAI = 8.12 100TN\(^{-1}\)); both Mousedeer (Tragulus spp.) and Asian Elephant (Elephas maximus) (n = 8, RAI = 2.02 100TN\(^{-1}\)); the Red Leaf Monkey (Presbytis rubicunda, n = 3, RAI = 1.52 100TN\(^{-1}\)); both Pig-tailed Macaque (Macaca nemestrina) and Malayan Porcupine (Hystrich brachyura) (n = 2, RAI =1.01 100TN\(^{-1}\)) and finally both Common Palm Civet (Paradoxurus hermaphroditus) and Malay Civet (Viverra tangalunga) (n = 1, RAI = 0.51 100TN\(^{-1}\)). Figure 2 illustrates the ranking of the 12 recorded mammal species according to their RAIs at the natural salt-licks in this forest reserve in decreasing order.

![Figure 2. Ranking of the 12 recorded mammal species according to their RAIs at the natural salt-licks in SLFR in decreasing order. Species rank is arranged as: 1) Sambar Deer; 2) Bearded Pig; 3) Orang-](image-url)
utan; 4) Banteng; 5) Thick-spined Porcupine; 6) Asian Elephant; 7) Mousedeer; 8) Red Leaf Monkey; 9) Pig-tailed Macaque; 10) Malayan Porcupine; 11) Malay Civet, and; 12) Common Palm Civet.

Actually, RAI was highly and positively affected by IUCN status, feeding guild, and body size of the recorded mammal species (R>0.5, p<0.05). Mammal species that visited the four selected licks in SLFR frequently was actually the large-sized, threatened and non-carnivorous species, and vice versa. Then, a high, positive and very significant correlation was obtained between body size and IUCN status (R = 0.871, p<0.01), in which threatened mammal species that visited the given licks frequently were also large-sized species. In other words, these correlations explained the high detection frequencies of large-sized, threatened and non-carnivorous mammals liked Sambar Deer, Bearded Pig, Orang-utan and Banteng to the natural salt-licks in SLFR, hence making them the top 4 mammal species that visited frequently to given licks in present study. Table 2 shows the strengths and patterns of correlation between RAI and the species traits of the 12 recorded mammal species.

Table 2. Correlations between RAI and the species traits of 12 species of mammals recorded in this study.

| Variables      | Body Size |                           | IUCN Status |                           | Feeding Guild |
|----------------|-----------|-----------------------------|-------------|-----------------------------|---------------|
|                | R         | Std. Err                   | R           | Std. Err                   | R             |
| RAI            | 0.788***  | 0.113                       | 0.597*      | 0.180                       | 0.614*        | 0.259         |
| Body Size      | 0.871**   | 0.092                       | 0.535       | 0.217                       |               |
| IUCN Status    | 0.519     | 0.222                       |             |                             |               |

*Note: RAI = Relative Abundance Index; IUCN = International Union for Conservation of Nature and Natural Resources; R = Correlation Coefficient; Std. Err = Standard Error; * = Significant (p<0.05), and; ** = very significant (p<0.01) (Spearman’s Rank Correlation).

4. Discussions
This study gives an initial understanding of the visitations of Bornean mammals to the natural salt-licks in SLFR across different times. Generally, non-carnivorous mammal species, especially the herbivorous-frugivorous species, exhibit high dependencies onto natural salt-licks for mineral intake, unlike carnivorous species that visit the licks rarely and most likely for prey-hunting [10], which can explain the high detection of non-carnivorous mammals at the licks in SLFR. Then, large-sized mammal species in Borneo are mostly threatened species [8], and then their large body sizes may require them to visit natural salt-licks frequently for high daily mineral intake [3]. Henceforth, the low detection frequencies of non-threatened and smaller-sized species liked the medium-sized carnivorous Malay Civet and Common Palm Civet at the licks in SLFR are considered common, because similar situations have occurred to natural salt-licks at the adjacent Deramakot Forest Reserve [10] and other forest areas in Borneo [7]. Additionally, setting of camera traps used in this study is more towards detecting medium to large-sized mammals, therefore may further reduce the detection frequencies of small to medium-sized mammal individuals that visit the licks in this forest reserve.

A selective-logged forest can provide higher variation and abundance of foods for many different mammal species and individuals at a time when compared to the least-disturbed and plantation forests [17]. At the same time, mammal individuals avoid visiting a natural salt-lick that is surrounded by a highly disturbed forest [4]. Since that both SL50_A and SL50_B are situated within plantation forests, thus detection frequency of mammal is considered minimal at given licks. In fact, higher detection rate of mammals was ascertained at SL59 that was situated within a selective-logged forest when compared to the SL56 with least-disturbed surrounding habitat. Furthermore, certain mammal species exhibit nocturnality and are sensitive towards disturbance [17]. This avoidance response may result in these species being detected more frequently at the natural salt-licks during night-time, which can lead to a high detection rate of mammal at the licks during night-time in this study.

Most of the mammal species recorded in this study could be sighted at natural salt-licks in other forests of Borneo [7, 10], except for Red Leaf Monkey that was recorded visiting tropical salt-licks for the first time in the present study. Red Leaf Monkey rarely visits salt-licks [12], therefore it is hardly
being detected at the licks in this study, which can be a leading factor behind the zero detection of this species at other forests in Borneo as well [7, 10]. Furthermore, critically endangered Sunda Pangolin (*Manis javanica*) was detected at SL50_A by Bernard et al. [3], but not in this study. Low local population of this species in this forest reserve [8], and also the different placement strategy of camera trap, can affect the detection rate of Sunda Pangolin at SL50_A and other salt-licks in this study.

Among the 12 species of mammal recorded in the present study, Sambar Deer visited salt-licks in SLFR more frequently than Bearded Pig, which was similar to the findings obtained by Matsubayashi et al. [10], Hon and Shibata [7], and Bernard et al. [3]. Sambar Deer shows high dependency onto salt-licks to replenish its body minerals, unlike Bearded Pig can obtain additional minerals through consuming earthworm and insect, thus can result in detecting Sambar Deer more frequently than Bearded Pig at the licks in SLFR [10]. Likewise, lower local abundance and lick dependencies of Orang-utan, Banteng and Asian Elephant can also result in lower detection frequencies of these three threatened species at given licks in SLFR when compared to Bearded Pig and Sambar Deer [8,10].

Generally, mousedeer visit salt-licks more frequently than many other mammal species besides Bearded Pig and Sambar Deer at forests of Borneo [3, 7, 10]. However, mousedeer was detected less often than Sambar Deer and Bearded Pig, as well as Orang-utan, Banteng, and Thick-spined Porcupine in this study. These five species of mammal may have dominated the usages of salt-licks in SLFR, thus can affect the mousedeer by reducing its visitation to the licks to reduce competition with the five given species [7]. Moreover, thick-spined Porcupine was reported more abundant than Malayan Porcupine in SLFR [3], which could result in more individuals of Thick-spined Porcupine to visit and be detected at natural licks in this forest reserve than Malayan Porcupine [8,12].

Low detection rate of Pig-tailed Macaque at salt-licks was obtained, not only in this study, but also at Deramakot Forest Reserve by Matsubayashi et al. [10]. On the other hand, this species was reported as the second main visitor to natural salt-licks at Anap Sustainable Development Unit of Sarawak [7], mostly taking the licks as its water sources. Dissimilarities in findings between the two past studies and with this study may be due to the presences of alternative water sources near to the selected licks, hence can lead to this species in visiting other areas for drinking water and subsequently reducing its visit to the licks at both SLFR and Deramakot Forest Reserve.

Reynolds and Braithwaite [14] emphasized the fact that an area with natural forest setting and allow clear sighting view, at the same time could provide high wildlife-viewing chances were highly preferred as a wildlife-watching destination to the tourists. Then, natural salt-licks in SLFR were mainly visited by rare and large-sized mammal individuals, which were also the main expectations of visitors during mammal-watching [14]. Henceforth, natural salt-licks in SLFR are feasible for conducting wildlife-viewing activity, especially at SL59 and during nocturnal hours. Then, the high detection frequencies of Sambar Deer, Bearded Pig, Orang-utan, and Banteng at the licks can act as a guarantee for high viewing success of given species by visitors, and also help to distinguish the uniqueness of this forest reserve with other wildlife tourism destinations in Sabah [14]. Last but not least, the remaining eight mammal species can become additional attractions that may motivate the tourists to visit the natural salt-licks in this forest reserve for mammal-watching opportunity as well in the future.

5. Conclusion

Natural salt-licks in SLFR are mainly visited by threatened, large-sized and non-carnivorous mammal species with unique traits. Presently, Red Leaf Monkey is the primate and arboreal species that was recorded visiting the lick in tropical forests of Borneo for the first time in this study. Likewise, Sambar Deer, Bearded Pig, Orang-utan, and Banteng, are determined as the top four highly viewable mammal species at the licks in SLFR, thus can be promotable as the main attractions for mammal-viewing activities at this forest reserve in the future. As for the remaining eight species of mammal, which were Thick-spined Porcupine Mousedeer, Red Leaf Monkey, Malay Civet, Asian Elephant, Common Palm Civet, Malayan Porcupine, and Pig-tailed Macaque, they can act as the additional attractions that attract attentions and increase motivations of tourists to visit given licks and this forest reserve in the future.
Among the four selected natural salt-licks, SL59 is verified with the highest visitation rate by local mammals, henceforth making this salt-lick feasible for conducting wildlife-watching activity in the future, especially during night-time, although certain mammal species can only be encountered at SL56 and SL50_A, and also during diurnal hours. In conclusion, natural salt-licks in SLFR are feasible for wildlife-viewing, although further research is required in the future to examine the actual sighting probability and viewing duration of these species at given licks and across different times or seasons.

Acknowledgements
The authors would like to express our sincere gratitude to KTS Plantation Sdn Bhd and Sabah Forestry Department for permitting us in conducting this study at the natural salt-licks in Segaliud-Lokan Forest Reserve. Contributions of the KTSP staff members in assisting the authors throughout the period of data collection were highly appreciated as well. Last but not least, gratitude is expressed to the anonymous reviewers for willing to spend their precious time in helping the authors to improve the accuracy and quality of information written in this article. This study was conducted as part of the Memorandum of Agreement between Sabah Forestry Department, KTSP and Universiti Malaysia Sabah, which was supported and funded by both External Collaboration Research Grant “GKP0023-2018” and UMS Great Research Grant “GUG0322-1/2019”.

References
[1] Andrews, P, Lord, JM, & Nesbit Evans, EM 1979. Biological Journal of the Linnean Society, 11, 177–205.
[2] Ang, SC & Chan, NW 2010. World Applied Sciences Journal, 10(10), 1153–1159.
[3] Bernard, H, Sompud, J, Kee, SL., Abdul Hamid Ahmad, Nilus, R, Mohd Aminur Faiz, Miun, J, Muin, H, Jaikim, R, Aznandy Md. Yakub, Awang Basri, Aidde Jamali, Anson, M, Sukok, J, Alim, E, Justin, D, Jefli, & Widy. 2019. Seminar on Sungai Rawog Conservation Area Scientific Expedition, Segaliud-Lokan Forest Reserve (FMU 19B). Sabah. Session 2: Paper 1.
[4] Blake, JG, Mosquera, D, & Salvador, J 2013. Animal Conservation, 16(4), 430–437.
[5] Chew, MY, Hymeir, K, Nosrat, R, & Shahfiz, MA 2014. Journal of Tropical Forest Science, 26(4), 554–559.
[6] Chong, MHN, Tang, SH, & Suksuwan, S 2005. Management Recommendations for Wildlife Saltlicks with Particular Reference to Sira Air Hangat at Ulu Muda Forest Reserve, Kedah. WWF-Malaysia, Petaling Jaya, Selangor.
[7] Hon, J & Shibata, S 2013. International Journal of Environmental Science and Development, 4(1), 44–48.
[8] International Union for Conservation of Nature and Natural Resources. 2020. The IUCN Red List of Threatened Species. (http://www.iucnredlist.org). Accessed on 4th January 2020.
[9] KTS Plantation Sdn. Bhd. 2020. Segaliud Lokan Forest Reserve. (http://www.segaliudlokan.com). Accessed on 5th January 2020.
[10] Matsubayashi, H, Lagan, P, Majalap, N., Tangah, J, Sukor, J RA, & Kitayama, K 2007 Ecological Research, 22(5), 742–748.
[11] Oksanen, J, Blanchet, FG, Friendly, M, Kindt, R, Legendre, P, McGlinn, D, Minchin, PR, O’Hara, RB, Simpson, GL, Solymos, P, Stevens, MHH., Szoecs, H, & Wagner, H 2019. vegan: Community Ecology Package. R package version 2.5-6. (https://CRAN.R-project.org/package=vegan)
[12] Phillips, Q. & Phillips, K 2018. Phillips’ Field Guide to the Mammals of Borneo and Their Ecology: Sabah, Sarawak, Brunei and Kalimantan (2nd Ed.). John Beaufoy Publishing Ltd., Oxford.
[13] R Core Team. 2020. R Foundation for Statistical Computing, Vienna, Austria. (https://www.R-project.org/).
[14] Reynolds, PC, & Braithwaite, D 2000. Tourism Management, 22(1), 31–42.
[15] Rovero, F & Marshall, AR 2009. Journal of Applied Ecology, 46(5), 1011–1017.
[16] Venables, WN & Ripley, BD 2002 *Modern Applied Statistics with S.* (4th Ed.), Springer, New York.

[17] Wearn, OR, Rowcliffe, JM, Carbone, C, Pfeifer, M, Bernard, H, & Ewers, RM 2017. *Biological Conservation*, **212**, 162–171.