A CAMERA TRAP ASSESSMENT OF TERRESTRIAL VERTEBRATES IN GUNUNG BASOR FOREST RESERVE, KELANTAN, MALAYSIA

by

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A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Natural Resources Science) with honours

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APPROVAL

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Nature Resources Science) with Honors"

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DECLARATION

I declare that this thesis entitled “A Camera Trap Assessment of Terrestrial Vertebrates in Gunung Basor Forest Reserve, Kelantan, Malaysia” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	.....
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A CAMERA TRAP ASSESSMENT OF TERRESTRIAL VERTEBRATES IN GUNUNG BASOR FOREST RESERVE, KELANTAN, MALAYSIA

ABSTRACT

A study of availability camera traps assessment towards terrestrial vertebrates was conducted in Gunung Basor Forest Reserve, Kelantan. The main objective of this study is to collect baseline data on vertebrates' species richness and composition in targeted area of Gunung Basor. A few of camera traps were used in sampling the data by capture the photographs of vertebrate animals in the area within salt as the bait. A total of 27 individuals that comprises of 6 species were detected in all points selected. The relative abundance had been deliberate and use in formula of Shannon diversity index to account species evenness of in Gunung Basor Forest Reserve. Analysis of cumulative curve was interpret be used to indicate the adequacy of vertebrate's terrestrial survey in representing the fauna in the area. The factors that causes the species richness in the point's area involves of climate and weather, forest fragmentation plus the nutrient and water sources availability. Nevertheless, elevation or altitude, size of natural forest and scale of study area are also determinants for species richness. More study is needed for this study research to obtain more data. In fact, wildlife management and conservation by use this method for surveying and monitoring animal in the area was useful.

PENILAIAN KAMERA PERANGKAP TERHADAP VERTEBRATA TERESTRIAL DI HUTAN SIMPAN GUNUNG BASOR, KELANTAN, MALAYSIA

ABSTRAK

Kajian ini mengenai penilaian kamera perangkap terhadap vertebrata terestrial yang telah dijalankan di Hutan Simpan Gunung Basor, Kelantan. Objektif utama kajian ini adalah untuk mengumpul data asas mengenai kepelbagaian dan komposisi spesis vertebrata di kawasan sasaran Gunung Basor. Beberapa perangkap kamera telah digunakan untuk mengumpul data dengan merakam gambar haiwan vertebrata di dalam kawasan yang difokuskan manakala garam digunakan sebagai umpan. Sebanyak 27 individu yang terdiri daripada 5 spesies dikesan bagi keseluruhan kawasan dipilih. Data kelimpahan relatif telah dihitungkan dan digunakan dalam formula indeks kepelbagaian Shannon untuk mengambil kira kesamaan spesies di Hutan Simpan Gunung Basor. Analisis lengkung kumulatif hasil dapatan juga ditafsir untuk menunjukkan kecukupan kajian vertebrata terestrial dalam mewakili fauna di kawasan tersebut. Faktor-faktor yang menyebabkan kekayaan spesies di titik kawasan melibatkan iklim dan cuaca, pemecahan hutan serta ketersediaan nutrien dan sumber air. Walau bagaimanapun, ketinggian, saiz hutan semulajadi dan skala kawasan kajian juga merupakan penentu bagi kekayaan spesies. Lebih banyak penyelidikan diperlukan untuk kajian ini bagi mendapatkan lebih banyak data dan efektif. Malah, pengurusan hidupan liar dan pemuliharaan dengan menggunakan kaedah ini untuk meninjau dan memantau haiwan di kawasan itu juga berguna.

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LIST OF ABBREVIATION

DWPN	Department of Wildlife and National Parks Peninsular Malaysia
GBFR	Gunung Basor Forest Reserve
GIS	Geographical information system
GPS	Global Positioning System
HR	hours
IUCN	International Union for Conservation of Nature
MP	megapixel
SD	secure digital
sec	second
WWF	World Wide Fund

LIST OF SYMBOLS

E	East
ft	feet
g	gram
km^2	kilometre square
m	meter
N	North
s	second
%	percent

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Biodiversity refer to the all life form, species, populace and hereditary variety among the networks and biological system. This biodiversity gives the fundamental thing, nourishment, grain, benign stock, biomass and other for survival of mankind (Tandon *et al*., 2007). The biodiversity play an important role as maintainer of biophysical system, chemical balance of the earth and climate stabilization supporting life system. The important part about biodiversity is, it creates complex ecosystem that impossible reproduced by individual.

Biodiversity contemplates are essential to archiving the decent variety and organization of species extravagance in various timberland conditions with the end goal to oversee and save biodiversity. Vertebrate animal are the most critical taxa to be ponder the same number of types of them assume a significant role in the biological community, including predators, herbivores, seed dispersers and some of them can potential in the regeneration of the forests (Nakashima *et al.*, 2010). Most mammals also are made up of flagship species and some of them are vital as inclined wildlife, which makes them important in management and conservation apprehension (Kitamura *et al*., 2010). Unlikely, these masterpieces of biological diversity and complexity are under the on-going risk of damage from human activity (Maloney, 1985). Tropical forest changes are the main factors to the current global

biodiversity disaster, shockingly our logical comprehension of the connection between tropical deforestation and species extinction is very weak (Heywood *et al*., 1994).

In the present period, individuals are the most perilous reason for annihilation of the world's biodiversity. It can be refer by the ever-expanding human population, growing of agriculture and also usage of fertilizer and pesticides that can lead to the population and toxification. Studies on biodiversity and forest using remote sensing data gains importance in the context of increasing deforestation rates and also relating to monitoring, maintenance and conservation of biodiversity (Tandon *et al*., 2007).

Beside, global climate change is another fronting threat to the world in this century. Hence, in Malaysia, the urbanization well develops as the forest and hill were destroying every day. The impact of increasing human population and activity result in decreasing fauna species because of human-wildlife struggle, poaching and infringement wild area (Hayward *et al*., 2005). Jeli is well known as a wildlife area because 80% of land is forest (Maseri, 2009). Mammals like elephants, tigers and monkeys were freely to explore or find their foods in any area of Jeli but now, Jeli area become more develop by having lots of building, housing, education centres like Universiti Malaysia Kelantan and more developing projects. This urbanization actually caused effect on biodiversity especially to mammal's status. Humans start to hunt valuable wildlife like elephants, tiger, deer, tapir and rodentia species. Hunting the valuable mammals is an annual event for foreigner's poachers mainly from Thailand (Rayan *et al*., 2013).

1.2 Problem Statement

Focuses of animal status, some of species have been declared as rare species because of small population in Malaysia. Bouliner *et al*. (1998) reasoned that dealing with the species change of diverse categories is very important for identify the main future need and ability to evaluate community accumulation and the vigor of biological areas specially species richness and diversity. Hence, this can let them deeper understanding of the issue they face and let them bring more information and less speculate to problem solving process. Well understanding of biological flora and fauna are vital to acquire suitable conservation management of Gunung Basor. Davis & Wagner (2003) mention that ecosystem statistic not merely provide information of species behavior in breeding, foraging and resting, it also can provide the sorts and amount of territory expected to support species richness and keep species from danger.

However, seem like there is absent of any camera-trapping record done in the Gunung Basor Forest Reserve (GBFR), through WWF-Malaysia (2018). This study need to be conducted and record as documentation of terrestrial vertebrate's species exits in GBFR that could be used as an initial database for future research, to enhance the conservation and management effectiveness of GBFR.

1.3 Objectives

The main study of this project is to collect baseline data on vertebrates species richness and composition in the area

1. 4 Scope of Study

The availability of camera traps survey of vertebrates' terrestrial in GBFR affordable. The uses of triggered camera trap take image of animal's transient in front of camera automatically. This involves of wildlife management and conservation by use this method for surveying and monitoring animal (Rowcliffe *et al*., 2003). There is undeviating of fauna within to documenting the diversity and composition of animal census in study area in order to manage and conserve biodiversity. This research was focus and analyze on the species richness and diversity in GBFR. The results would edible ecological information and data of species for Kelantan Forestry Department, student research and future essential.

1.5 Significance of Study

This study was conducted by using camera-trapping where it is progressively prevalent strategy to think about biodiversity particularly wildlife. The evidence and date record related to the species in GBFR as a part of an effort to help the authorities to comprehensive conservation management plan of wildlife in the locality of the Jeli district forest. Apart from using camera-trapping method, this study also recognize the presence of several vertebrate species by distinguish their footprints left on the ground. This study was lead to collect baseline data on terrestrial species composition in the vicinity of Jeli area. The findings might be useful to develop ecotourism.

CHAPTER 2

LITERATURE REVIEW

2.1 Gunung Basor Forest Reserve

Hutan Rizab Gunung Basor, Jeli, Kelantan is a forest reserve and is located at peninsular of Malaysia. Variant forms of spelling for Hutan Rizab Gunung Basor or in other languages Gunung Basor Forest Reserve (GBFR) is located in the northest state of Kelantan encompassing about 400 km² has been selective logged previously. The estimate terrain elevation above sea level is 793 metres within different floristic zones in down mountain jungle within hill upper dipterocarp and lowland dipterocarp (Maseri, 2009) Gunung Basor Forest Reserve in Jeli, Kelantan is the forestry delegate that still keeps most of their wilderness criteria and ecosystems. According to WWF 2018, the special wild animal that can be observed in GBFR is Malayan Tiger, Asian Elephant, Tapir and crab-eating mangoose. Moreover, there are lots plants in GBFR documented that have therapeutic incentive for pharmaceutical purposes such as *Eurycoma longifolia* (Tongkat Ali), *Melastoma malabathricum* (senduduk) and *Stenochlaena palustris* (Midin). The existing of Sungai Suda and Sungai Renyok in GBFR function as water sources for biological need and use for hydroelectric dam (Maseri, 2009).

2.2 Diversity of Vertebrate Animals

In the course of the past 400 million ages, vertebrate animal obligate advanced a differing progression of adjustments for life on earth. Vertebrate animal are those with which individuals are most recognizable, and beings the most regularly use as food, utilize for work, and adopt as pets (Abitua *et* al., 2012). Vertebrates are subdivided into a few classes: fish (which involve a few classes), amphibian, mammal, reptiles and bird. All chordates advanced from a progenitor that had an adaptable rod (called a notochord) along the dorsal side (back) to offer help for the skeleton and muscles. All chordates share a typical internal body plan (Shimeld & Holland, 2000). Vertebrate advancement started early Paleozoic period with the development of fish, trailed by amphibian and after that reptiles amid center Paleozoic. Reptiles came to their "peak" (in any event in size and fierceness) amid the Mesozoic period. Some reptile like reptiles of the Mesozoic developed into little hair-shrouded mammals, birthing their young as opposed to laying eggs, while anticipating the downfall of the dinosaurs previously ascending to distinctive quality amid the Cenozoic (Abitua, *et* al., 2012). For terrestrial vertebrates the preeminent number of species is found among the aves class. Some well-known birds are major of the significant Orders, for example, falcons, hawks, hummingbirds, owls and pigeons. An investigation of vertebrates uncovers dynamic developmental adjustments to life aground and a more extensive scope of environmental specialties. Adjustments that had been create in enhanced breath, defensive and protecting body covers and more proficient propagation particularly on land, in addition to consist of paired, muscular appendages (Carbone *et al*., 2002).

2.3 Camera trap

Camera trapping uses activated cameras, triggered by infrared sensors, to 'trap' pictures of passing creatures. It is a quantitative system that has moderately low work costs, is non-invasive, causes minor ecological disturbing effect (Henschel and Ray, 2003; Silveira *et al*., 2003), is dynamic to variety in ground conditions and atmosphere and, above all, can be utilized to pick up data on highly cryptic species and in troublesome territory where other field techniques are probably incompetent (Karanth and Nichols, 1998; O'Brien *et al*., 2003; Silveira *et a.*, 2003). Additionally, camera traps are similarly effective at gathering information by day and night and give the chance to gather extra data on natural surrounding drive and species circulation (Henschel and Ray, 2003; Silveira, *et al*., 2003), structure of population and conduct (Wegge *et al*., 2004).

On a basic level, the quantity of photos taken per unit time (trapping rate) contains data about the density of an animal groups. Supporting this yearning, a remarkable relationship between trapping rates and independent assessments of density has been shown crosswise over species in Sumatra (O'Brien *et al*., 2003). In any case, the utilization of trapping rate as directory of abundance (Carbone *et al*., 2001; Silveira *et al*., 2003) is uncertain, both on hypothetical and realistic grounds (Jennelle *et al*., 2002; Karanth *et al.*, 2003). This is essentially since the fact that it does not assess the likelihood of location and may subsequently is confused by variety in this factor (MacKenzie *et al*., 2002; Pollock *et al*., 2002). In a contemptible conception, this would deduce that influences between trapping rate and density are only dependable in case they are recalibrated for every zone and period to which they are associated, so inconsistent data produce the for the index.

2.4 Pattern of species richness of terrestrial vertebrates

There is several processed use to explain the pattern in species richness which are competitive, source-sink dynamic and Ecotone effect and habitat heterogeneity and habitat complexity. The traditional between habitat are location that known as actions. Lomolino (2001) proposed that the overlapping range limited or source-sink dynamics are the zones that predicted to harbour more species. Actions are expected to have rich diversity where low diversity will be located at minor actions. Hence, least outcome on elevation diversity pattern from this process due to the difficult in identifying the critical characteristics. Wide scale pattern of species richness, particularly the claimed by Hawkins in 2001 which is latitudinal angles, are probably the best-archived environmental outlines and have been depicted since the beginning of biogeography and nature in the nineteenth century. Marquet et al in 2004 have analysed patterns of species richness and evaluate how species richness levels of different groups of terrestrial vertebrates.

Warm blooded animals and bird would in general show northsouth and to a minor degree, east-west which richness slopes, while amphibians and reptiles validated a convergence of richer regions in the focal segment of the biome. Ecological indicators of pattern of species richness of terrestrial vertebrates for birds are more- complex and this might be at any rate to a limited extent an expansive number of heterogeneous species with various biological fundamentals. Since this group of species have distinctive biological and physiological qualities related with territory utilize and react diversely to climatic variations, diverse pattern are predictable, and thus, their comparative analysis might be helpful in recognition

important ecological and developmental procedures driving spatial varieties in species richness (Hawkins *et al*., 2003).

2.5 Animal census

A broad census can be done toward the complete of the camera trapping period include three area open terrains a strategic line of counters segregated roughly between twenty to frothy meter isolated divided effectively through the zone inspection of animals pulverizing through the line as it moves forward (Lomolino, 2001). Each of these three areas should be shrouded in a solitary range and none of them abutted one another, blocking any probability of twofold counting. In Central Park, biggest animal enclosures in areas kept the utilization of this practice and minimal groups hence efficiently counted focal zones, coordinating expansions to certify complete inclusion without twofold counting (Rowcliffe *et al*., 2003). This counting method has been available and modern to ensure a high level of assurance in the last count, consequently this making sampling approach necessary for animal composition.

2.6 Disruptive Factors of Terrestrial Vertebrate

The gradation to which terrestrial vertebrate populations are depleted in tropical forests occupied by human communities has been the subject of an intense polarizing debate that has important conservation implications. Conservation ecologists and practitioners are divided over the extent to which community-based subsistence off take is compatible with ecologically functional populations of tropical forest game species (Maloney, 1985). Obviously undamaged forest cover large-scale faunal

extirpation, human network likely cutting tropical wood vertebrates, an “empty forest” situation may result, in which species larger than 2kg are almost vague (Hayward *et al*., 2005). Even though the prominence of habitat destruction and degradation are recognized, hunting is often drawn in as focal subsidize of defaunatation

At first, Peres (2000) argued, depletion in vertebrate species does not involve an absence of sustainability. Off take basic by assignment result in a spatio-transiently confined decrease in richness and even where this depletion holds on, yields might be maximized when a populace is underneath conveying limit. Besides, environmental element might be in charge of complex populace changes.

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Study Area

The study was involved of Gunung Basor Forest Reserve (GBFR) at Jeli, Kelantan (Figure 3.1). The sampling sites encompass the different land surface of GBFR including the top hill, lowland dipterocarp and upper dipterocarp forest. The initialization and set up of cameras deployed within 200m – 1000m area of research zone. By the interior of permit from Kelantan Forest Reserve Department, the sampling image and ecological survey be conduct targeted the area of GBFR.

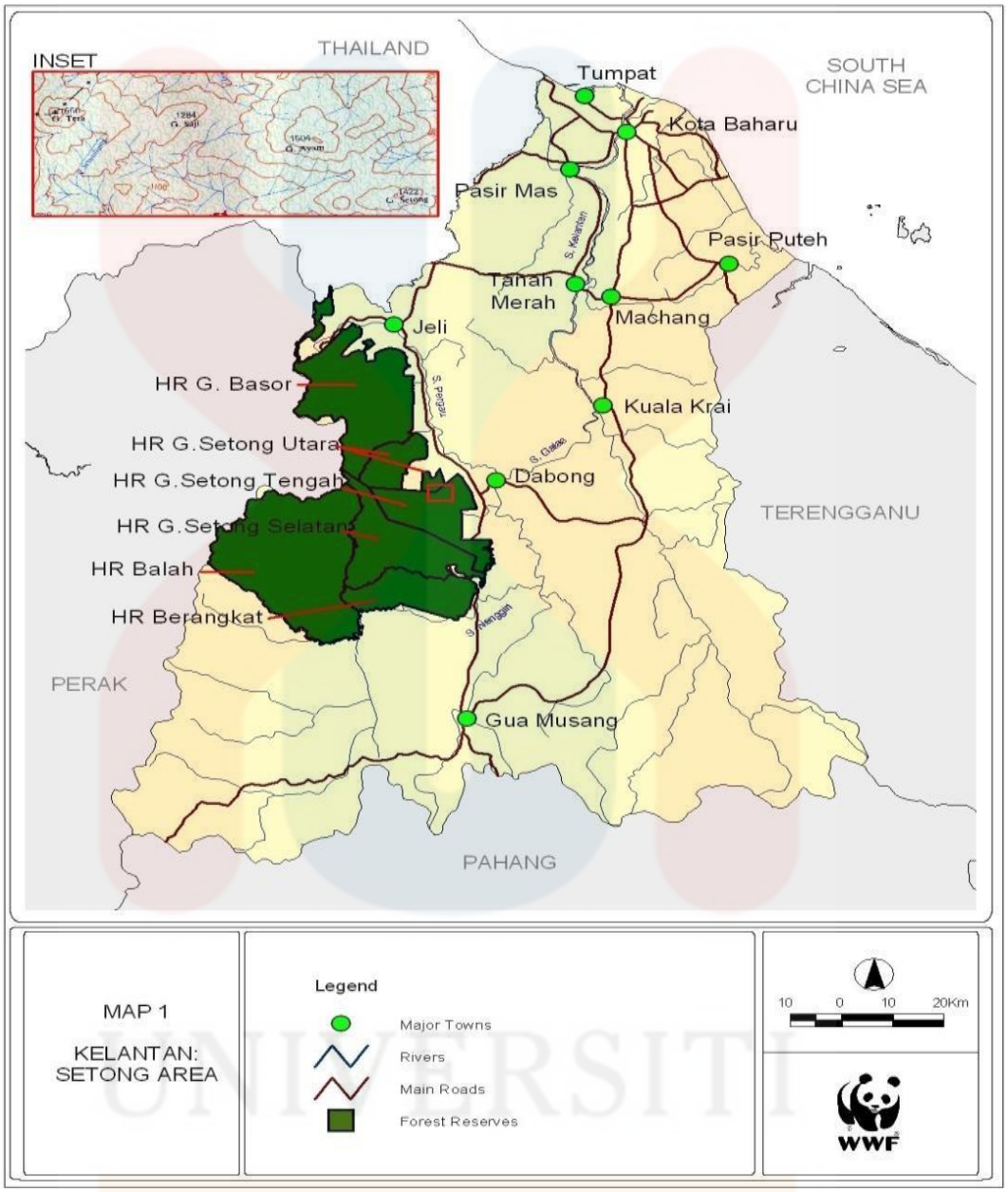

Figure 3.1: Map of study area at Gunung Basor Forest Reserve

(Source: WWF-Malaysia, 2017)

3.2 Materials

3.2.1 Global Positioning System (GPS)

A satellite-based route that utilizations to arrange the zone those investigation. GPS allow land, ocean and airborne clients to decide their correct area, speed and time 24 hour out of every day, captivating all conditions of weather. GPS comprise of 24 satellite which that circle the globe like clockwork to give worldwide position, time and velocity data. This will give correct organize to set up camera trap.

3.2.2 Camera Trap

A Camera trap that Bushnell branding made by Bushnell Corporation has 14MP high quality full colour resolution, photo quality with 24HR, day or night mode within the pre–trigger speed is 0.2 second. The programmable trigger interval is 1 sec to 60 minutes. Bushnell camera trap was professional and focusing I optic and imaging contained multi-image mode with 1 or 3 images per trigger, this camera has passive infrared sensor that can sense motion activated out to 60ft. To be able to deploy at any size object, this camera has adjustable web belt. All photographs or video that been captured will be store in SD card. The advantages of this camera trap are this camera have hybrid capture mode mean is can take video and photo for trigger.

Five camera traps (Bushnell, Trophy Cam 119577) have deployed at five different sites which have different coordinate per each site in certain time. The camera traps were set up 24 hours per day and seven days per week throughout the survey period. During installing all the camera traps, data such as coordinates, track

and elevation had been record by using a portable GPS (GPSMAP® 62s). It also serves as a guideline in avoiding losing track during data collection.

3.3 Method

3.3.1 Sampling

During locating the camera trap in suitable site, data such as coordinate and elevation were record. A GPSmap 62s, Garmin model was use to mark the point as reference in data analyses. A GPS in other function use as guidelines in avoid the loss track during the data collection.

Initialization of camera trap used to survey all ranged mammal which be detected by the camera. Human hiking trail stand as the transect line for choosing sites and set up camera trapping. Then either to left or right of the transect line (side of trail). The five camera traps had deployed at five different elevation points. Besides that, the sign of wildlife like footprint, trail and animal waste are also be factor for the site selection. The distance for one camera trap to another is approximately 200m. Each coordinate station were be recorded by using electronic gadgets (GPS) as ease for the collection of camera trap.

The camera traps were set on the tree trunk with the suitable angles and height. Test photo which caught the total study site visibly and deprived of obstructive. The cameras are collect after 2 month above, and then the camera data be transferred and saved in the computer. As prevention from theft of the camera lifted, the area deployed has cover within bush and some distance from human track. Furthermore, to enhance detection of multiple species sites, some bait make by

coarse salt were placed in front of the camera no more than 1m away from the area located.

3.3.2 Ecological Survey

This method is carry on as alternative methods to backup or complete the first data by camera trap. Using only camera trap cannot produce more result as focus target. This ecology survey relevant now days and still used by another agencies related to wildlife in determine the animal existed. These ecology surveys include all of track and sign that mammals left either in their habitat or during food searching. In addition, this technique also uses to recognize the footprints left by mammals on the ground. This method is still relevant and adopted by agencies concerned with wildlife such as DWNP in identifying the existence of wildlife.

3.3.3 Data Analysis

All the coordinates' record are sort out by the application of Earthexplorer to analyst the area of study within the plot of camera deployed. Identification the photograph have been arranging by individual location and examining to identify individual aspect. Francis (2008) "Mammals of Southeast Asia" and Robson (2005) "Birds of Southeast Asia" were used to identify of each capture individual mammal family, species and genus.

Based on the data of GPS locations, habitats of recognized by the camera trap, species-type, precise characteristics documented stood by the species richness, relative abundance, Shannon diversity index, maximum diversity, and species

evenness that be calculate using equation 3.1, 3.2, 3.3, 3.4 and 3.5 respectively. Levin *et al*. (2009) defined Species richness as the measure the total amount in each individual (species) existing at certain area, community landscape and region. Knowledgeable of the species richness in the study is vital as it useful to evaluate the conservation status based on the data. Most of researcher used Shannon-Wiener Diversity Index as diversity indices. Even though there are other indexes that can be used for it, this index used the simplest way in term of calculations (Krebs, 2014). The outcomes from the count are classified:

Species Richness, s = $\sum$ *Number of species captured* …… (3.1)

Relative Abundance = $\frac{Total\ number\ of\ individual\ per\ species}{Total\ number\ of\ individuals}$ …….. (3.2)

Shannon diversity index, H' = $-\sum p_i(lnp_i)$ ……. (3.3)

Maximum diversity, H_{max} = $\ln(\frac{1}{s})$ ……. (3.4)

Species Evenness, E = $\frac{H'}{Hmax}$ …….. (3.5)

The species cumulative curve was drowning where the species richness of the number species caught against day of sampling.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Results

The study site was demeanor at Gunung Basor Forest Reserve (GBFR) at Jeli, Kelantan, of latitude 5.7007 and 101.8432 longitude. Lowlands's dipterocarp forest altitude of 368.7m is chosen as deployed of five camera traps at five different point near the Sungai Suda river way. The sampling of date had begun from last month of July in 29/07/2018 until the second week of October 12th in same year. The coordinated positioned five camera traps were record (Table 4.1) and the targeted areas of positioned camera trap are shown in Figure 4.1.

Throughout the 75-days of sampling a total of six vertebrates' species and 27 individuals (Table 4.2) were spotted in Gunung Basor. Francis (2008) "A Guide to the Mammals of Southeast Asia" was used in identified the photographs of species captured by the cameras. These discoveries records of photograph captured comprise of medium and small mammalian, birds and primate animals. The five species that have been apprehended in sensor of camera are *Arctictis binturong, Sus scrofa, Arctogalidia trivirgata, Presbytis siamensis,* and *Macropygia unchall*. Data of each camera site were examined and IUCN status of the species was listed for each type of vertebrates (Table 4.2). The total number of species was calculated for each point.

Table 4.1: Coordinate of camera traps positioned

Point	Coordinate
1	N05°28'55" E101°48'59"
2	N 05°28'53" E101°48'58"
3	N05°28'51" E101°48'57"
4	N05°28'56" E101°48'56"
5	N05°28'57" E101°48'59"

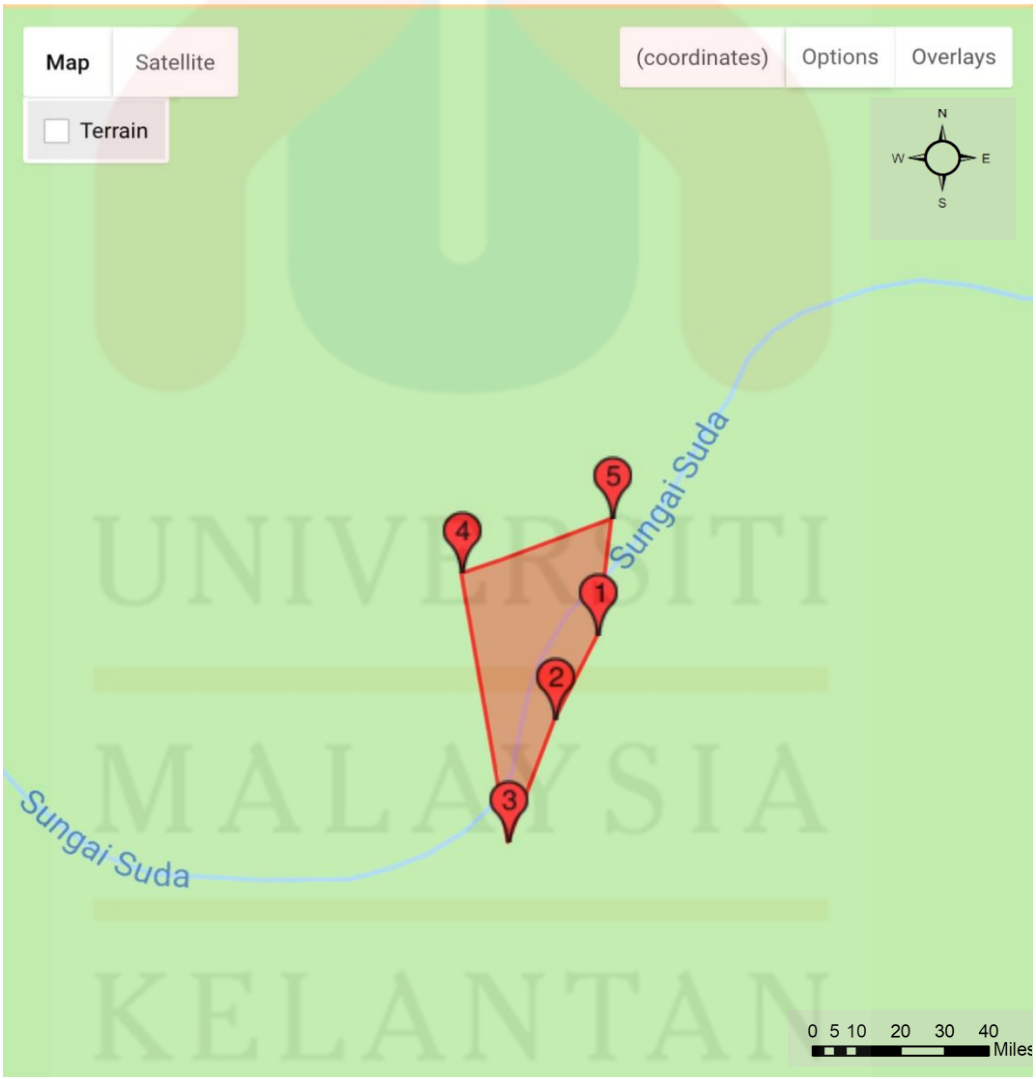

Figure 4.1: Location of camera trap deploy in Gunung Basor Forest Reserve

(Source: Earthexplorer coordinate map apps, 2018).

Table 4.2: Number of vertebrates species detected by using camera trap in Gunung Basor.

Species	Point 1 N 05°28'55" E 101°48'59"	Point 2 N 05°28'53" E 101°48'58"	Point 3 N 05°28'51" E 101°48'57"	Point 4 N 05°28'56" E 101°48'56"	Point 5 N 05°28'57" E 101°48'59"	Total	IUCN Status
Arctictis binturong	0	0	1	0	0	1	VU
Sus scrofa	0	19	1	0	0	20	LC
Arctogalidia trivirgata	0	0	1	0	0	1	LC
Presbytis siamensis	0	0	0	3	0	3	NT
Macropygia unchall	0	1	0	0	0	1	LC
Total of individual	0	20	3	3	0	26	
Number of species	0	2	3	1	0		
Trap-days	75	75	75	75	75		

4.2 Discussion

From the Table 4.2, the result showed that the highest quantity of species is located at point 2 within two types of species found *Macropygia unchall* and *Sus scrofa*. Hence, during that area setup a bunch of *Sus scrofa* pass by the camera at once. However, there is absent of animal detected in point 1 and zero number of species found in point 5. Seem the laxity of data obtained from those cameras had effect the result of species diversity aggregate at the study site.

Based on the statistics total number of individuals per species and sum of species capture, relative abundance had been deliberate. Thus, amount of relative abundance castoff in formula of Shannon Diversity Index. Shannon Diversity Index and species evenness of the study in Gunung Basor Forest Reserve are shown in Table 4.3. Next, Species accumulation curves or species-richness curves, collector's curves, species effort curves are used to estimate the number of species in a particular area. This analysis can also be used to indicate the adequacy of a fauna survey in representing the fauna in a particular area (Fedrick, 2010). According to the Figure 4.2, five of species have been recorded after 26 individuals had been caught for the period of 75 days sampling.

Table 4.3: Shannon-Wiener Diversity Index at each site of camera trap in Gunung Basor Forest Reserve.

Species	Number of individual	p_i	lnp_i	$-p_i(lnp_i)$	Evenness
Arctictis binturong	1	0.038	-3.270	0.124	
Sus scrofa	20	0.771	-0.260	0.200	
Arctogalidia trivirgata	1	0.038	-3.270	0.124	
Trachypithecus cristatus	3	0.115	-2.163	0.249	
Macropygia unchall	1	0.038	-3.270	0.124	
Total	26	1.000	-12.233	0.821	0.510

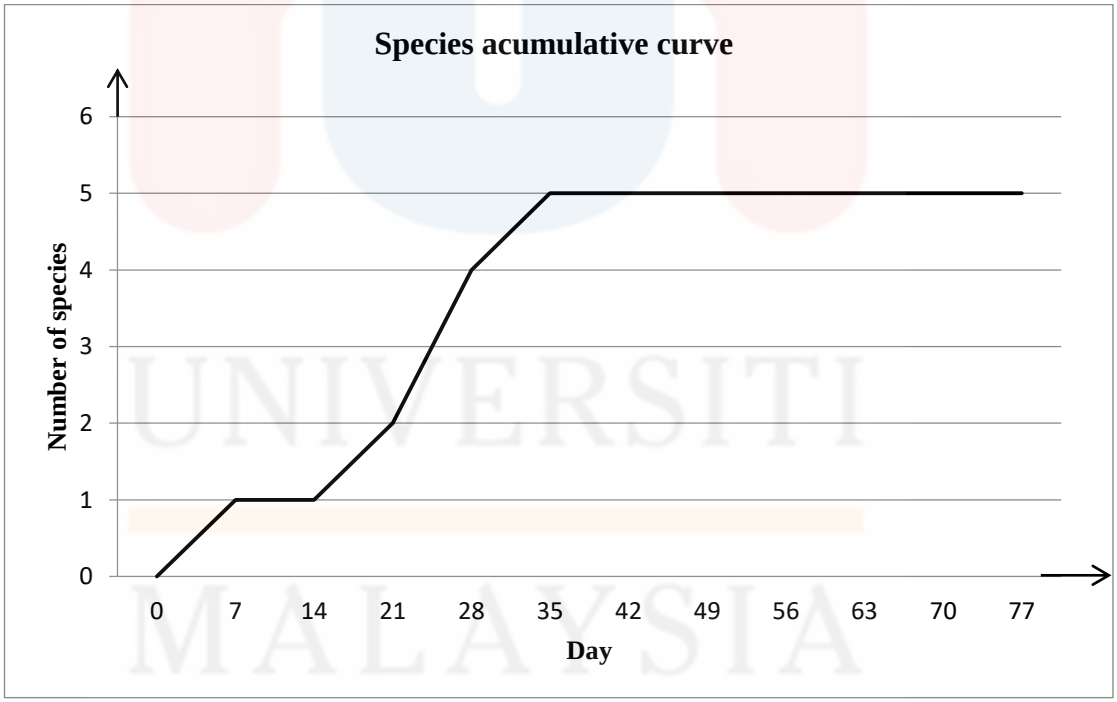

Figure 4.2: Species accumulative curve of terrestrial vertebrates at Gunung Basor Forest Reserve.

4.3 Species Account

The collective of five vertebrate species that have been identified throughout the sampling had been described under this section.

4.3.1 *Arctictis binturong*

Figure of 4.3: *Arctictis binturong*

This is the species that had been detected in point 3 whereas deep in the wood of camera located. Binturong can be obtained in lowlands's dipterocarp forest and also be found at cultivated areas near to forest (Francis, 2008). *Arctictis binturong* has identification has long, coarse black fur frosted with whitish or reddish grizzling within grizzling heaviest around head, making the head paler than body. Their ears round and edges in white with long tufts of hair at ends. Meanwhile, binturong has long, thickly haired, especially near base and prehensile. This species has assigned as vulnerable in IUCN Red List of Threatened Species due to decline population (Willcox *et al*., 2018). The species appears to be relatively rare in much of range and decline due to loss of forest as well as hunting and trapping for pet trade.

Nevertheless, ecology and habitat of *Arctictis binturong* mainly arboreal, but also seen on the ground and predominantly active at night, but sometimes also during the day. Binturong moves slowly in trees, using tail for balance and to cling at branches while feeding. They diet have consist of ripe fruits especially figs and small animals. The species had dominant in tall and secondary forest sometimes in cultivated areas near to forest.

Scientific Classification

Common name	: Binturong; Bearcat
Scientific name	: *Arctictis binturong*
Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Carnivora
Family	: Viverridae
Weight	: 6 – 9 kg
Lifespan	: 6 years
Native	: Bangladesh; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Philippines; Thailand; Viet Nam.

4.3.2 *Sus scrofa*

Figure of 4.4: *Sus scrofa*

The most abundance species detected in Gunung Basor was *Sus scrofa*. *S. scrofa* is well known as Eurasian wild pig or wild board which is distributed widely in South-East Asia, territory in wide variety of habitats, including mature forest, disturbance area, secondary forest, gardens and plantation (Francis, 2008). In Southeast Asia, *S. scrofa* observed in various forest site which include in lowland of hill dipterocarp forest, dry dipterocrap forest and coastal dipteraocrap forest (Young, 2010). Therefore, this species has listed as Least Concern (IUCN, 2008). *S.scrofa* varies in colour, from reddish to blackish due to mud colour or less size bristle (Francis, 2008). This species were the most captured using camera trap at the point 2 within a bunch of colony wild board count of 19 individuals present and one individual captured in camera point 3. The highest in the number of *S. scrofa* obtained probability cause by the least of natural predator to hunt, and peak capability toward human interference. Their main prey comprises of worm, invertebrate species, animal's eggs and birds on the ground.

Scientific Classification

Common name	: Eurasian Wild; Wild Hog; Boar
Scientific name	: *Sus scrofa*
Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Cetartiodactyla
Family	: Suidae
Weight	: 75 -200kg
Lifespan	: 20 years
Native	: South-east Asia: Myammar, Thailand, Loas, Vietnam, Cambodia and Peninsular Malaysia. Also present much of Europe, North Africa and mainland Asia.

4.3.3 *Arctogalidia trivirgata*

Figure of 4.5: *Arctogalidia trivirgata*

This enormous terrestrial civet is known as small-toothed palm civet. The order is carnivora and the family is viverridae. *A. trivirgata* can be seen by its fur varies from olive –brown to greyish, rarely reddish-brown and under fur body also reddish-brown. *A. trivirgata* has face, ears, feet and much of tail blackish. Usually have three a fine dark stripe or series of close, dark spots extending along midline from neck to base of tail. Typically small-toothed palm civet has narrow pale strip from forehead to tip of nose without spots on sides. However with fuzziness appearance in image capture in camera point 3 giving difficult to be identified. *A. trivirgata* is fabricated extensive nocturnal and arboreal, rarely descending to ground which is very agile. Their diet includes fruits and small animals that occur in tall and secondary forests (Francis, 2008). This species had been listed as Least Concern by IUCN Red List of Threatened Species in 2018.

Scientific Classification

Common name	: Small-toothed palm civet; three-striped palm civet
Scientific name	: *Arctogalidia trivirgata*
Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Carnivora
Family	: Viveridae
Weight	: 2 – 2.5 kg
Lifespan	: 5 years
Native	: Brunei Darussalam; Cambodia; India; Indonesia (Sumatera, Kalimantan, Jawa); Lao People's Democratic Republic; Malaysia (Sarawak, Peninsular Malaysia, Sabah); Myanmar; Singapore; Thailand; Viet Nam.

4.3.4 *Presbytis siamensis*

Figure of 4.6: *Presbytis siamensis*

Three individual of *P. siamensis* was the only animal's species that have been captured in point 4. Common's name called as pale-tithed langur has upper parts including top head and top of arms is vary from greyish to brown while it feet, hand and distal half of tail is black colour. They have bare face skin which are dark grey nearly black, but sometimes skin around the eye may be paler, forming indistinct rings. The infant has "cruciform" pattern-pale except for dark stripe up back and across arms. This species may be found in a wide variety of forest types from lowland to hills, including disturbed forest, orchard and plantation (Francis, 2008). Currently status of pale-tithed langur is near threatened according to IUCN Red List in 2018. The population has probably declined due to loss of forest.

Scientific Classification

Common name	: Pale-tithed langur
Scientific name	: *Presbytis siamensis*
Kingdom	: Animalia
Phylum	: Chordata
Class	: Mammalia
Order	: Primates
Family	: *Cercopithecidae*
Weight	: 4 - 6kg
Lifespan	: 20 years
Native	: South-east Asia: Peninsular Malaysia, Thailand and Sumatera

4.3.5 *Macropygia unchall*

Figure of 4.7: *Macropygia uncball*

M. unchall has size growth of 38 until 41 cm within the class of aves this species known as barred cuckoo dove. It has slender, long tail, dark-looking wing by dim rufescent above with blackish bars. Despite on that it has unbarred paler head, buffish-brown below, vinous-tinged and finely blackish-barred breast. The habitat of this species is broadleaved evergreen and semi-evergreen forest whereas altitude range between 140 – 1 800m (Robson, 2005). The status of *M. unchall* was identified as least concern by IUCN Red List.

Scientific Classification

Name : Barred cuckoo dove

Scientific name : *Macropygia unchall*

Kingdom : Animalia

Phylum : Chordata

Class : Aves

Order : Columbiformes

Family : Columbidae

Weight : 153 - 182 g

Lifespan : 5.2 years

Native : Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Thailand; Viet Nam.

4.4 Dynamics Influence of Species Richness

4.4.1 Climate and Weather

Climate indices that Malaysia has an equatorial climate of tropical atmosphere, the limitation and topographic setup of each portion-central centre with level, flanking seaside coastal plains-facilitate the inland entrance of oceanic climatic impacts. They have high temperatures and humidities, overwhelming precipitation, and a climatic year designed around the upper east and southwest storms. The monsoons further adjust the climate which difficult indicates of population change. The profitability is subject to temperature and precipitation. Climate state confines the profitability, which turn restricts the populace size and aggregate of people (Betsill, 2001). Climate is a standout amongst the most fundamental variables affecting animal populations, yet the common quality of such effects on populace elements is obscure. Local weather variable demonstrate that weather gives solid upgrades to transient population forecast precision. Climate and weather factors do,

in general, improve predictions, however problematic were barely detectable regardless of the least number of databases collected (Donner & Large, 2008).

Probability the heavy rain, lower of temperature and unfavourable condition at current time affluence the sampling records. Consequently, the results are incompetent with the poor view of species is capture whereas all the data of the study obtain was during the first month of sampling in August and early week of September. After that, absent of data collected in the rest sampling days for overall five points located at the study area. Hence, one of the most well-known and long-lived debates in ecology concerned whether the dynamics of terrestrial animal populations are mainly regulated by environmental factors. In fact, several biological, physical and chemical factors will also affect the species richness.

4.4.2 Forest Fragmentation

Habitat destruction typically leads to fragmentation, the division of habitat into smaller and more isolated fragment separated by human land cover (Nussbaum & Sinha, 1997). Fragmentation not only causes loss of the amount of habitat, but by creating small isolated patches it also changes the properties of the remaining habitat when the origin habitat is destroyed due to land use change of fragmentation which lead wildlife seeks these remaining natural habitats sanctuaries. Compressed into these smaller areas, they are greater intra and inter-species competition and some may migrate to habitat usually not conducive to them (Thompson & Seber, 1996). This could be the reason for the incompetent result attain as location of cameras deployed there are indigenous resident and foreign worker placement nearby.

Besides, there are some drainage constructions and paved roadway at Gunung Basor that have disrupts the animal habitudinal of the area.

4.4.3 Nutrient and Water Sources

Species rely upon various environmental resources within a specific unit of space for their long-term persistence; these resources contain a species' habitat resource. These resources undertake a critical role in the wildlife terrain, and any vacillation in these resources can influence an animal category at both the individual and populace level (Nussbaum & Sinha, 1997). Resources accessibility is dynamic for most if not all species. Subsequently, the challenge when developing a monitoring protocol an observing convention surveying whether changes in occurrence, abundance, or fitness in a population is independent from or related to changes in habitat availability and quality (Nussbaum & Sinha, 1997). Environmentalists have long sought to trace fluxes of materials and vitality inside and among biological systems. The sizes of these fluxes are of incredible significance to investigations of biogeochemistry, physiological environment, populace variances and worldwide change. While much advancement has been made in estimating motions of vitality or supplements among animal and investigations of water networks (as opposed to food webs) are delayed by a difficulty in measuring the relative use of water sources by animal populations (Thompson & Seber, 1996).

Select of focused path within a home range where the resources are accessible to address an individual's needs is one of the criteria in monitoring and counting animal adequate. Researcher frequently can outline a home range dependent on observed every day or regular movements of individuals continuing on ahead of feeding,

resting, and raising young (Tandon *et al*., 2007). Species with bigger mass require more energy to support that mass than smaller body species. Herbivores will in general have minor home ranges than carnivores of a similar size, because energy available to herbivores is more abundant and increases in trophic level there is a decreasing in energy availability. Generally, if food resources are less abundant or more broadly dispersed, home range size increases. However, inside a species the home range estimate has a maximum limit that is signified by balancing energy contribution from with energy loss by movement among food patches (Tandon *et al*., 2007). Hence, the focused on region of this study was close to Sungai Suda whereas become the resources access for nutrient and water depletion by the vertebrates there. Nevertheless, drinking behaviour is frequently hard to watch and difficult to evaluate. Correspondingly, it is hard to observe and difficult to quantify the contribution of consumption of moist food to an animal's body water, since there is wide variation in hydration of food. For instance, to assess the relative abundance of animals monitoring practices must measure and document appropriate habitat elements are required.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As a conclusion, this study has inclined a few terrestrial vertebrate species that domain in Gunung Basor Forest Reserve by using camera trap technique. The objective and purpose of the study had achieved then briefly discussed. Majority of the captured species was listed as least concern (LC) which is based on IUCN Red List of Threatened Species, while the other of two species are listed as vulnerable (VU) and near threatened (NT). Besides, the data of species richness and diversity of vertebrate animals at targeted place which near Sungai Suda in GBFR was provided, thus the objective of the study had attained. This information could utility improving the management effectiveness of GBSR as a protected area under Kelantan Forestry Department and assist further researcher for mien study in GBFR site.

Most of conservation and management action depend on species richness to indicate some area priority for protection and monitoring. The current main concern for local, national and international scales is by increase aware towards the status and distribution of flora and fauna and also uncommon species since insufficient quality of data for impact on effort of sampling and cost in biodiversity management. Furthermore, the local people approach can assist researcher to use data from all

sampled species to improve the estimated species richness. It also can create estimation data which might not obtain previously for rare or subtle species.

5.2 Recommendation

The research focuses on identification of terrestrial vertebrate at Gunung Basor Forest Reserve, Kelantan. The preliminary data obtained of this site study could be used as a base for further study especially on distribution, species richness and habitat population that related. In the meantime, this information is extremely valuable for protection management interventions in the site. Additionally, further study should be done in the area of unmapped in the previous study. There could be more and diverts animal live in the area that not be record and documented yet.

There are few steps supposed to be considered in order to improve the probability getting the best and accomplished data. It is better to undergo the sampling session during the fruit and dry seasons because mammals are often poignant in the wood searching for food. The camera trap need to set up alongside suspected animal trails with the observation on claw at the tree, dung, faces and footprints will also been considered. Commonly, wildlife in the protected area is less shy since the presences of human competent inhibit wildlife. It is recommended that more isolated trails should be designated to increase the probability of capture rate. Besides by, additional number of camera trap use can decrease the limitation of study as more camera trap deploys means wider of sampling area cover. This would be highest chance of animal species recognise and better result of study.

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