

# ACKNOWLEDGEMENT

## Assesment Of Biodiversity At Kuala Penet and Susukan Baru Resort, WKNP

[PILI]

[Strengthening The Resort Based Management and Partnership With  
The Buffer Village for The Mitigation of Wildlife Hunting and Forest Fire  
in Way Kambas National Park]

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Agreed,

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**ASSESSMENT OF BIODIVERSITY LOSS  
IN THE AREA AFFECTED BY FOREST FIRE  
AT KUALA PENET AND SUSUKAN BARU RESORT  
WAY KAMBAS NATIONAL PARK  
LAMPUNG PROVINCE**

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## 1. Introduction

### 1.1. Background

Sumatra, the third largest island in Indonesia with an area of 443,065 km<sup>2</sup>, has a diversity of mammals as much as 257 species (37%) of the total 720 species of mammals in Indonesia. The 44 species of which are endemics, such as Sumatran tiger (*Panthera tigris sumatrae*), Sumatran elephant (*Elephas maximus sumatranus*), Sumatran rhino (*Dicerohinus sumatranus*), gibbon (*Symphalangus syndactylus*), etc. (LIPI, 2014).

Way Kambas National Park is one of the conservation areas in the form of a nature conservation area designated to protect the forest area and its biodiversity. At the beginning of its formation, Way Kambas was designated as a wildlife reserve following a decree issued by the Resident of Lampung in 1936 which was followed up by the Governor of the Dutch East Indies through *statblat* No. 38 in 1937. In its journey, there were several changes in the status area. Finally, in 1999 it was designated as Way Kambas National Park (WKNP) through the Decree of the Minister of Forestry No. 670/Kpts-II/1999 on 26 August 1999 with an area of more than 125,631.31 ha (TNWK, n.d.).

WKNP is an important habitat for the big five mammals, consisting of Malayan tapir, Sumatran elephant, Sumatran tiger, Sumatran rhino, and Malayan sun bear. The big five mammals are inhabited in areas with a large spectrum of ecosystems. WKNP has various types of forest formations, from mangrove forests, swamps, to lowland forests which forms about five types of ecosystems adjacent to each other, namely mangrove forests, beaches, riparian swamps, lowland Dipterocarpaceae and large grasslands which were formed on former of logging areas and fires (Whitten et al., 2000).

Although this area has been designated as a conservation area since 1937, habitat destruction continues to occur mainly due to logging activities when the area was opened for Forest Concession Rights in 1968-1974. Moreover, illegal settlements sprung up which had an impact on wild plants and animals in WKNP due to the impact of illegal hunting that accompanied these activities.

Besides, there is a threat of forest fires that happened almost years in and around the WKNP area with various impacts. Forest fires that were considered to have massive impacts occurred in the range of other years 1982-1983, 1987, 1991, 1994, 1997-1998 which were the impact of the El-Nino heatwave (Bowen et al., 2001) as well as 2015. Forest fires that occurred in WKNP and also in other areas in Sumatra are not only caused by natural causes but mostly man-made efforts to use land.

Land and forest fires have a very significant impact on the existence of biodiversity. This study was conducted to determine the impact of land and forest fires on biodiversity, especially mammals and herpetofauna in WKNP.

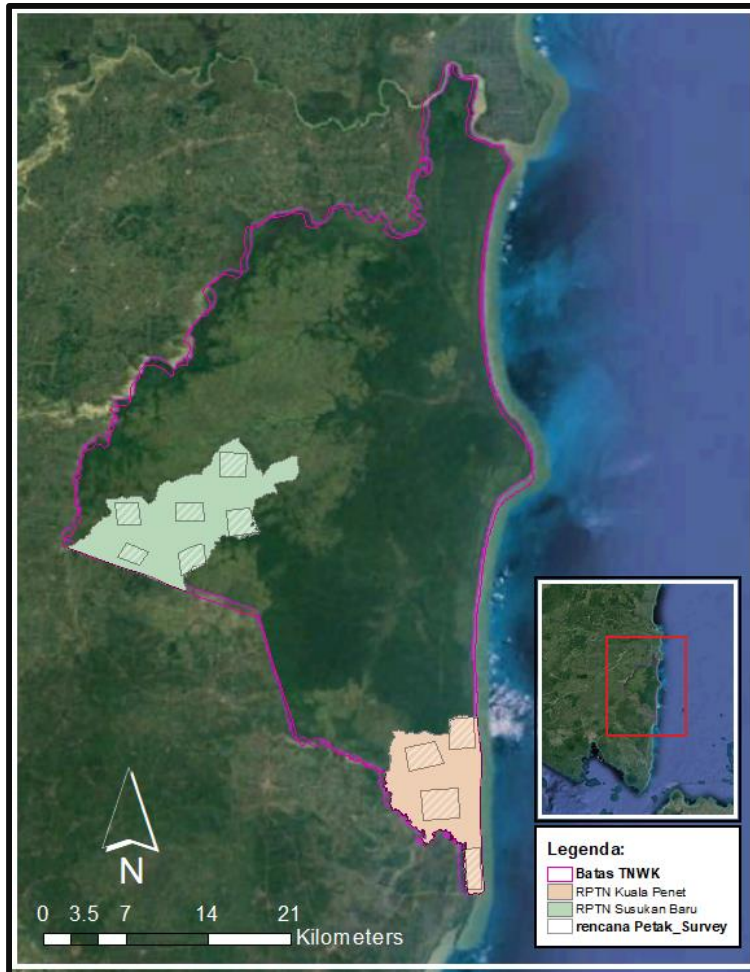
### 1.2. Objective

- a. Identifying the diversity of mammal and herpetofauna (reptiles and amphibians) species in fire-affected areas at the Kuala Penet and Susukan Baru Resort.
- b. Identifying the impact of forest fires on the existence of mammals and herpetofauna.

## 2. Methodology

### 2.1. Time and Location

The survey was conducted on 19-23 June 2020 by taking the location of the ex-burned area at the Kuala Penet and Susukan Baru Resort, Way Kambas National Park, Lampung Province (**Figure 1**). The location selection was determined following the objectives of this study, namely knowing the impact of fires on mammals and considering habitat representation. In each area, observations are made in at least four sample areas which are determined based on the results of map analysis and secondary information about fires and the results of patrols by the WKNP team.



Gambar 1.. Desain lokasi survey di RPTN Susukan Baru dan Kuala Penet, Taman Nasional Way Kambas

### 2.2. Field Data Collection Methods

#### A. Mammal

Mammal data collection was carried out through detection/non-detection surveys using a combination of transect and recce methods (Walsh et al., n.d.; Heyer et al., 1994) with a transect line along, minimum, 1 km. Observations were made in the morning (06.00 - 10.00), evening (15.00 - 18.00), and at night (20.00-22.00) to cover nocturnal animals. Observers recorded direct and indirect encounters of mammals found in the field. Signs of indirect encounters used in this survey are in the form of footprints, dirt, food containers, nests, claws, and other traces that are specifically believed to be characteristic of a species (Heyer et al., 1994; Wibisono et al., 2011).

Types of data collected were species name, type of encounter (direct/indirect), number of individuals, location of species encounter, description of habitat and habitat features as well as documentation in the form of field photos.

Apart from direct observation, 4 units of surveillance cameras (camera trap)

were installed in the observation area (2 units at each resort) to increase the possibility of detecting mammals in the research location. The surveillance camera is mounted on a strong tree/pole with a height of  $\pm$  40-60 cm from the target ground with a distance of about 2-3 meters from the point of the object. The camera is active for 24 hours and is installed with a duration of 15 days.

The mammal field survey involved eleven personnel consisting of 2 teams. Team 1 consists of 6 people located at Susukan Baru Resort and team 2 consisting of 6 people located at Kuala Penet Resort. The two

teams involved the Way Kambas National Park Office forest patrol team and Wildlife Conservation Society staff.

The equipment used includes headlamps, meters, stationery, GPS and cameras, and surveillance cameras.

## **B. Herpetofauna**

The data collection of herpetofauna was done using Visual Encounter Survey or VES (Heyer *et al.*, 1994). The observation path is as long as 1 km. In one observation path, the beginning 400 m focuses on amphibian observation, and the rest of the path focuses on reptilian and amphibian observation. Herpetofauna observation was conducted in the night, between 7 - 10 PM. Data collection including the name of species, the number of individuals, species encounter location, habitat description, habitat feature, and field pictures for documentation.

A few assumptions used in the VES method, such as 1) All individual will have the same detection level, 2) All individual will be detected only one time during the survey, and 3) No bias assumption that correlates with observer skill observation (Crump and Scott, 1994). These assumptions are caused by the indication that a few individuals might not be detected because of their camouflage skills and different seasonal behavior in herpetofauna (Bailey *et al.*, 2004). Other than that, different observation skills of the observers might result in different detection of herpetofauna species.

The herpetofauna field survey consists of six personnel which include the patrol team from WKNP and Wildlife Conservation Society. This survey was equipped with headlamps, transect meter, snake hook, stationery, GPS, and a camera as a support tool.

### **2.3. Data Analysis**

Species data found on observation plots were used to calculate frequency, data on the number of trees in the observation plots were used to calculate density. To find out the similarity in species composition, the species similarity index value was used in the Jaccard method, to determine the diversity of species was calculated based on the diversity index formula from Shannon-Wiener. (Ellenberg & Mueller-Dombois, 1974; Krebs, 1999).

#### **Species Diversity Index (H')**

Species diversity is calculated using the Shannon-Wiener diversity index equation, with the following formula:

$$H' = \sum_{i=1}^S (P_i \times \ln.P_i) \text{ where } P_i = \frac{n_i}{N}$$

Note:

$H'$  = Shannon-Wiener diversity index

$n_i$  = The number of individuals in species- $i$

$N$  = The total number of individuals of all species

The criteria for the Shannon - Wiener ( $H'$ ) diversity index value are as follows:

$H' < 1$  = low diversity, an indication of heavy ecological pressure and an unstable ecosystem

$1 < H' \leq 3$  = moderate diversity, sufficient productivity, fairly balanced ecosystem conditions, moderate ecological pressure

$H' > 3$  = high diversity, very stable ecosystem with high productivity

### **Index of Evenness (E)**

The index of evenness is used to calculate the evenness of each species in each community. The evenness index is calculated by the following equation:

$$E = \frac{H'}{\ln.S}$$

Keterangan:

- $E$  = Index of Evenness (0-1)
- $H'$  = Shannon-Wiener diversity index
- $S$  = Number of species



### 3. Results and Discussion

#### 3.1. Habitat Description

This survey was conducted in Kuala Penet and Susukan Baru Resort, Way Kambas National Park. There are 5 pathways, four of them (KP\_02, SB\_01, SB\_02, and SB\_03) in the ex-burned area (**Figure 3.**), and one of them (KP\_01) in the intermediate habitat between ex-burned and vegetated area (**Figure 4.**). The survey was done in a terrestrial habitat. *Imperata cylindrica* was found and considered as dominant vegetation in the location.

It is known that WKNP has a role as an important habitat for Sumatran elephant (*Elephas maximus sumatranus*). Habitat features for herpetofauna are water basin and puddle that can be formed in the elephant's footprint (**Figure 3.**). The puddle is formed and the water from rainfall will contain inside the footprint when rain season comes and dry up when the dry season comes. Other important features for herpetofauna are leaf litter, dead trunk, and water source. Recent habitat conditions after the forest fire cause important features of habitat loss and decrease. Litter thickness, the distance to the water source, and the total of dead trees will influence the distribution and richness of herpetofauna species (Wanger *et al.*, 2009).



**Figure 3.** Sumatran elephant colony and footprints in the ex-burned survey area in Susukan Baru Resort



**Figure 4.** Habitat feature in the form of a puddle under vegetation (left) and ex-burned grassland area (right)



### 3.2. Presence of mammals

The study on mammal was done in 10 days at Susukan Baru and Kuala Penet Resort. The study resulted in 97 species of mammal encounters (43 species in Susukan Baru, 54 species in Kuala Penet). Inventory study of mammals found 13 genera, 5 ordos, and 10 families (Table 1, Figure 4). Sumatran elephant (*Elephas maximus sumatranus*) commonly encounter, which is 48 times (49.5%), the second is Sambar deer and Sumatran wild boar 12 times (12.37%). The highest encounter times in family is Elephantidae, which is 48 times (49.5%) and the lowest is Tragulidae, represented by greater mouse deer (1 time, 1.03%) (Figure 2).

Table 1. Mammal encounters at Susukan Baru and Kuala Penet Resort

Family	Name of Species	Susukan Baru					Kuala Penet				Total
		SB-01	SB-02	SB-03	SB-04	SB-05	KP-01	KP-02	KP-03	KP-04	
Elephantidae	Sumatran elephant	3	1	2	2	10	4	10	3	13	48
Cervidae	Sambar deer	0	6	0	3	0	1	0	2	0	12
Suidae	Sumatran wild boar	1	1	0	2	4	0	0	1	3	12
Cervidae	Muntjac Deer	1	1	0	0	0	0	0	0	5	7
Hylobatidae	Siamang	2	0	0	0	0	0	0	0	0	2
Felidae	Sumatran tiger	0	0	0	0	2	0	0	0	0	2
Cerophytecidae	Long-tailed macaques	1	0	0	0	0	0	0	0	0	1
Felidae	Leopard cat	0	1	0	0	0	0	0	0	0	1
Viverridae	Civets	0	0	0	0	0	1	2	0	1	4
Cerophytecidae	Silvered lutung	0	0	0	0	0	3	0	0	0	3
Tapiridae	Malayan tapir	0	0	0	0	0	0	0	2	0	2
Ursidae	Malayan sun bear	0	0	0	0	0	0	0	0	2	2
Tragulidae	Greater mouse deer	0	0	0	0	0	0	0	1	0	1
<b>Total Number of Encounters</b>		<b>8</b>	<b>10</b>	<b>2</b>	<b>7</b>	<b>16</b>	<b>9</b>	<b>12</b>	<b>9</b>	<b>24</b>	<b>97</b>
<b>Total Number of Species</b>		<b>5</b>	<b>5</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>2</b>	<b>5</b>	<b>5</b>	<b>13</b>

Direct encounters happen with Sumatran elephant, muntjac deer, silverd lutung, and long-tailed macaque. Sumatran tiger's footprint was found in Susukan Baru Resort near the border of National Park, and the Malayan tapir's footprint was found in Kuala Penet (Figure 3, Figure 4). The installed camera trap only records the Sumatran elephant in the area. One camera trap was stolen and another camera was damaged by the Sumatran elephant.

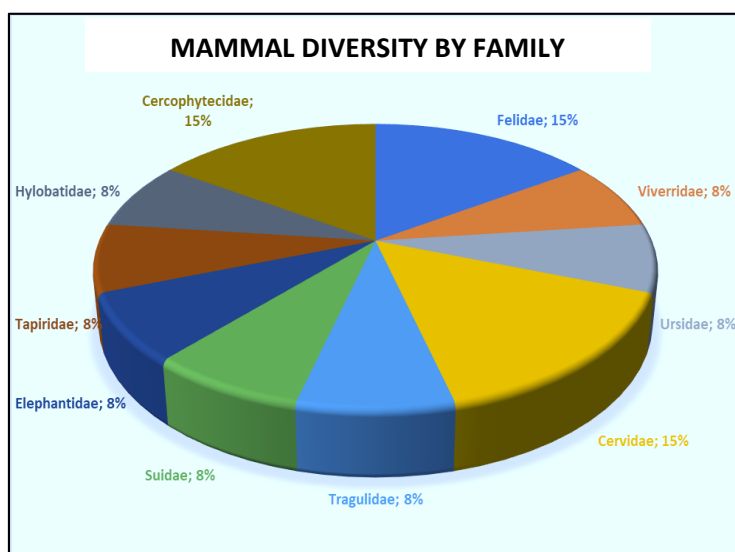


Figure 2. Mammals encounters classified by family

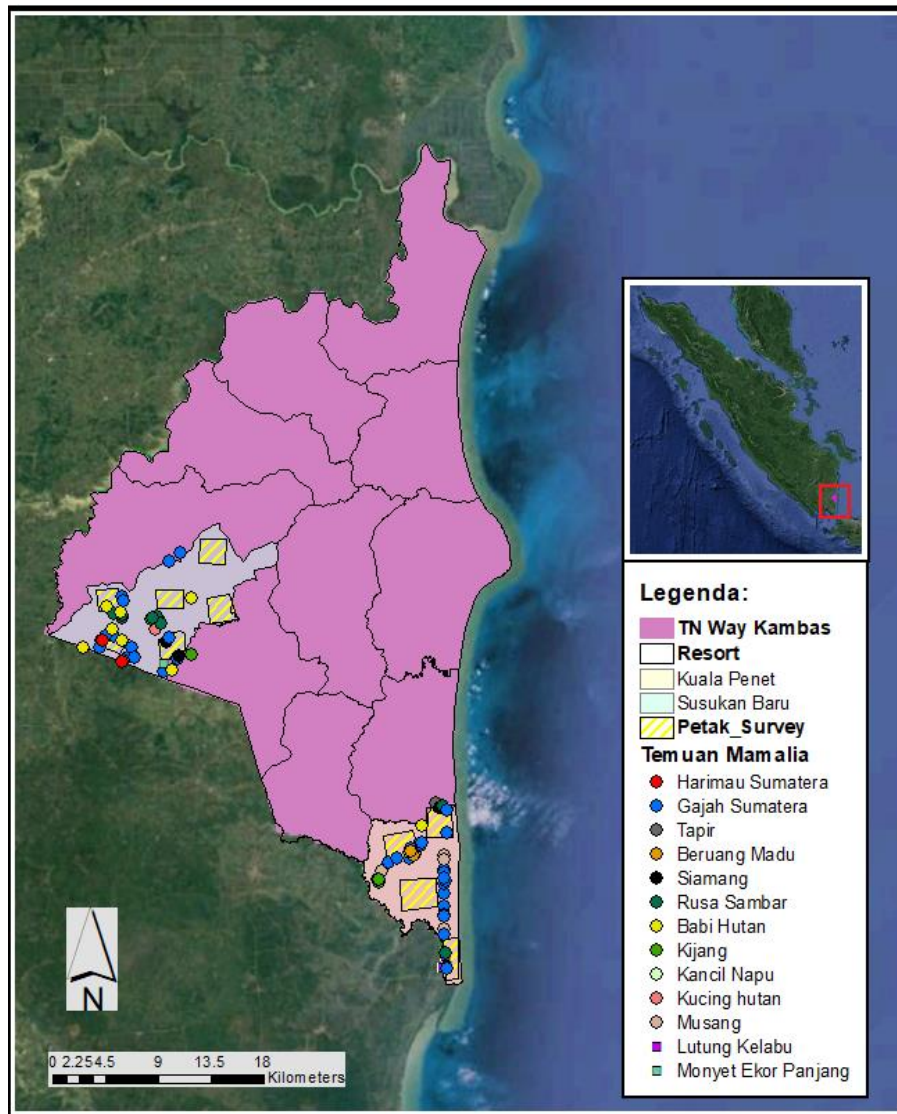


Figure 4. The map of mammals encounters at Susukan Baru and Kuala Penet Resort

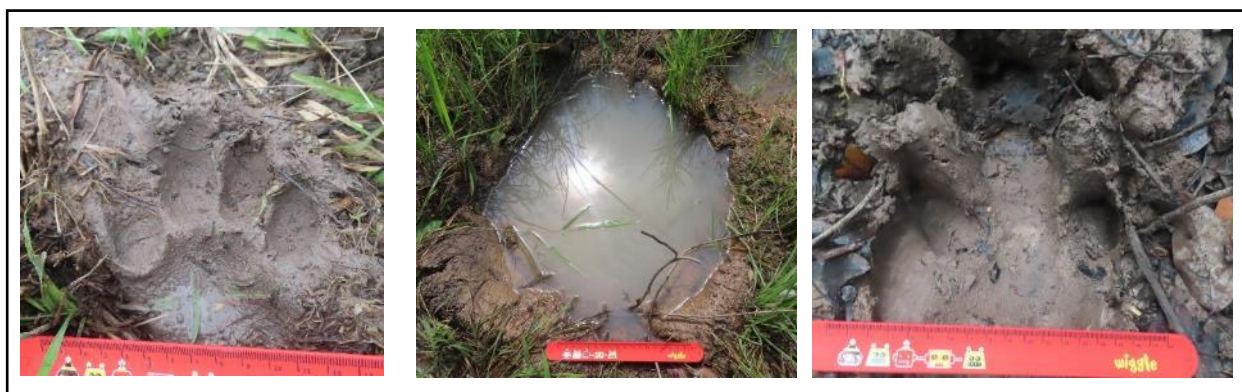


Figure 3. Mammals footprint. From right-left: Sumatran tiger - Sumatran elephant – Malayan tapir

Table 2 and Figure 5 show the results in the Index of Diversity ( $H'$ ) at every study location. The survey on Plot 3 at Kuala Penet Resort (KP-03) has the highest index of diversity (1.301), and then SB-03 is the second highest (1.244) and KP-04 (1.175). The lowest is SB-03 (Table 2). According to the Index of Evenness ( $E$ ), the SB-04 plot has the highest score, which is 0.85 and then KP-02 and SB-05, which are 0.799 and 0.75 respectively. These results present mammal biodiversity in both resorts were in moderate (1-3) and low (<1). The Index of Evenness in the SB-03 plot is worth to be ignored and interpreted differently because there is only one mammal that gets encountered in the plot.

Table 2. Mammals Index of Diversity ( $H'$ ) and Index of Evenness ( $E$ )

Resort	Survey Plot	Number of Individual	S	$H'$	$E$
Susukan Baru	SB-01	8	5	1.244	0.694
	SB-02	10	5	1.028	0.5588
	SB-03	2	1	0	1
	SB-04	7	3	0.9361	0.85
	SB-05	7	3	0.8128	0.7514
Kuala Penet	KP-01	9	4	1.048	0.7131
	KP-02	3	2	0.4698	0.7999
	KP-03	9	5	1.301	0.7344
	KP-04	24	5	1.175	0.6476

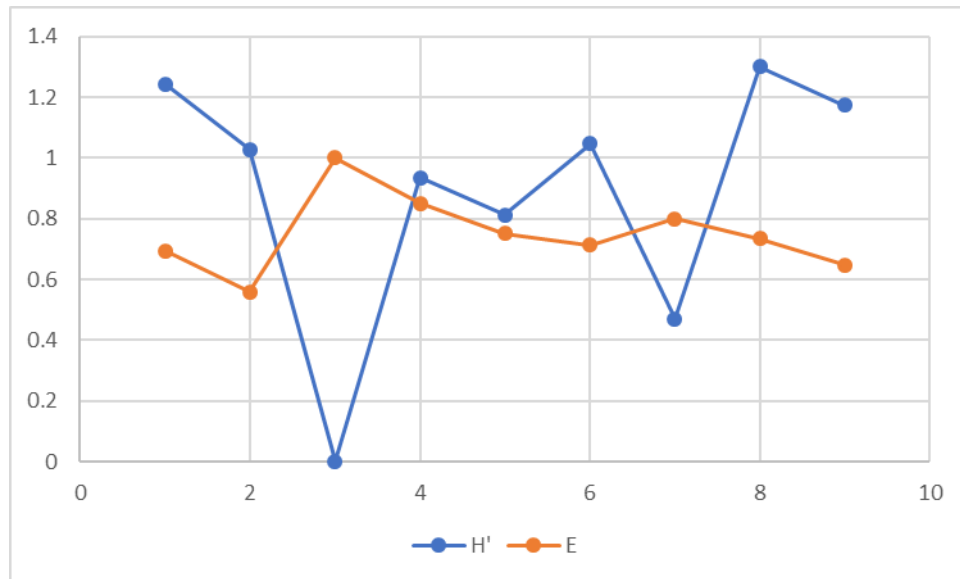


Figure 5. Index of Diversity ( $H'$ ) and Index of Evenness ( $E$ ) shows in Graph

There are 13 general of mammals found in both resorts, 10 of them were included in protected species according to the Regulation of the Minister of Environment and Forestry No. P.106, except for long-tailed macaques, Sumatran wild boar, and civet. According to the IUCN Red List, there are two species included in the Critically Endangered or CR category, which are Sumatran tiger and Sumatran elephant. Two species are included in the Endangered or EN category, which are siamang and Malayan tapir. Two species included in the Vulnerable or VU status, which are Malayan sun bear and Sambar deer. According to CITES, there are six species included in Appendix I, two species in Appendix II, and three species in non-Appendix.

### 3.3. The Presence of Herpetofauna

The total herpetofauna species identified in the survey locations are 22 species, consist of 13 amphibian species and 9 reptilian species. Encountered amphibian families are a member of Bufonidae, Dicroglossidae, Microhylidae, Ranidae, and Rhacophoridae. Encountered reptilian families are a member of Colubridae, Homalopsidae, Lacertidae, Pythonidae, Scincidae, and Geoemydidae (**Table 1**).

**Tabel 1.** Encountered species in the survey location

Family/Species	Status			Kuala Penet Resort			Susukan Baru Resort		
	P.106	IUCN	CITES	KP_01	KP_02	Misc.	SB_01	SB_02	SB_03
<b>Amphibian</b>									
<b>Bufonidae</b>									
<i>Ingerophrynus quadriporcatus</i>	-	LC	-			1			
<b>Dicroglossidae</b>									
<i>Fejervarya limnocharis</i>	-	LC	-	1	1	7	4	3	3
<i>Limnonectes blythii</i>	-	NT	-	1					
<i>Limnonectes kuhlii</i>	-	LC	-	1		1			
<i>Limnonectes malesianus</i>	-	NT	-	1					1
<i>Limnonectes microdiscus</i>	-	LC	-					1	
<i>Limnonectes paramacrodon</i>	-	NT	-	1				2	1
<i>Occidozyga lima</i>	-	LC	-					1	
<b>Microhylidae</b>									
<i>Kaloula baleata</i>	-	LC	-					1	
<b>Ranidae</b>									
<i>Hylarana erythraea</i>	-	LC	-			2	1	1	
<i>Hylarana raniceps</i>	-	LC	-			1	1		
<b>Rhacophoridae</b>									
<i>Polypedates leucomystax</i>	-	LC	-	1	1				
<b>Reptilian</b>									
<b>Colubridae</b>									
<i>Ahaetulla prasina</i>	-	LC	-			1			
<i>Dendrelaphis caolineatus</i>	-	LC	-		1				
<b>Homalopsidae</b>									
<i>Homalopsis buccata</i>	-	LC	-			2			
<i>Phytolopsis punctata</i>	-	DD	-			1			
<b>Lacertidae</b>									
<i>Takydromus sexlineatus</i>	-	LC	-			1			
<b>Pythonidae</b>									
<i>Malayopython reticulatus</i>	-	LC	II			1			
<b>Scincidae</b>									
<i>Eutropis multifasciata</i>	-	LC	-		1				
<i>Eutropis rugifera</i>	-	LC	-			1			
<b>Geoemydidae</b>									
<i>Cuora amboinensis</i>	-	ED	II				1		

**Status:**

P.106 : Regulation of the Minister of Environment and Forestry No. P.106/MenLHK/Setjen/Kum.1/12/2018 concerning the second amendment to Regulation of the Minister of Environment and Forestry No. P.20/MenLHK/Setjen/Kum.1/6/2018 concerning protected plant and animal species.

IUCN : IUCN Redlist of Threatened Species, version 2020-2; ED: *endangered*, NT: *near threatened*, LC: *least concern*, DD: *data deficient*

CITES : CITES Appendices I, II and III (26 November 2019)

The total number of individuals found was 50 individuals, 19 individuals consisting of 11 species of which were found outside the line of observation. Based on the results of the calculation of the diversity index ( $H'$ ), the type of habitat for the transition from the ex-burned area and vegetated areas at the Kuala Penet Resort had the highest  $H'$  value, namely 1.79. Meanwhile, the habitat type for the areas that experienced consecutive fires has an  $H'$  value of 1.39; 1.15; 1.68 and 0.95. Overall, the  $H'$  value in the four survey lines shows a moderate value, while the SB\_03 line at the Susukan Baru Resort has a low  $H'$  value (**Table 2**).

The Index of Evenness shows the abundance of individuals of a species in a community, with a value of 0-1 (Magurran, 1988). The  $E$  value that is closer to 1 indicates that the distribution of the number of individuals of each species is evenly distributed (Krebs, 1997). All pathways show an evenness value of species that is close to 1, that is, almost evenly to evenly distributed. Pathways KP\_01 and KP\_02 show a very even distribution of the number of individuals for each species, namely 1 individual per species (**Table 2**).

**Table 2.** Index of Diversity and Index of Evenness of herpetofauna in the survey locations

No	Number path	Location	Habitat Type	$H'$	S	E
1	KP_01	Kuala Penet Resort	Intermediate habitat between ex-burned and vegetated area	1.79	6	1.00
2	KP_02	Kuala Penet Resort	Ex-burned area	1.39	4	1.00
3	SB_01	Susukan Baru Resort	Ex-burned area	1.15	4	0.83
4	SB_02	Susukan Baru Resort	Ex-burned area	1.68	6	0.93
5	SB_03	Susukan Baru Resort	Ex-burned area	0.95	3	0.86
6	KP_Outside the path	Kuala Penet Resort	-	-	11	-

Of all the species found during the survey, no species are protected species under the Regulation of the Minister of Environment and Forestry No. P.106. Based on the IUCN red list, there are one (1) species which is included in the Endangered category, namely shell turtle (*Cuora amboinensis*) and three (3) species included in the Near Threatened category, namely *Limnonectes blythii*, *L. malesianus* and *L. paramacrodon*. Meanwhile, based on CITES trading status, there are two (2) species included in the list of Appendix II, namely *Malayophyton reticulatus* and *Cuora amboinensis*.

Near threatened is defined as a species that is not classified as Threatened, but is near threatened or can be classified as threatened in the future based on IUCN's evaluation and assessment. Meanwhile, the Endangered criteria indicate that the species has experienced a significant population decline and is considered to be facing a high threat to extinction (IUCN, 2000). *Cuora amboinensis* is included in the Endangered A2d category, which indicates that the species has experienced a population decline of 50% in the last 10 years due to current and future exploitation.

### 3.4. Discussion

Way Kambas National Park is a habitat for five iconic species, known as The Big Five. These Big Five species are Sumatran elephant, Sumatran tiger, Sumatran rhino, Malayan tapir, and Malayan sun bear. Therefore, WKNP is considered as an important area for these five iconic species. WKNP is also a habitat for 4 cat species, including the flat-headed cat (*Prionailurus planiceps*) (Subagyo et al., 2013). In the same publication, the result shows that the camera trap records 27 mammal species from 16 different families.



Most of the mammals have elusive, cryptic, secretive, and nocturnal behavior and gives a challenging observation (Griffiths & Schaik, 1993; Silveira et al., 2003; Wibisono et al., 2011). The installation of the camera traps was intended to decrease the bias factor from mammal behavior. However, this procedure did not give optimal results because two camera traps was stolen and damaged.

If the result of this study is compared to another study done by Dima in 1999, 13 species of mammals were found in the area. The result of Dima's study is not significantly different from this study. Therefore, to achieve more findings in the area, the camera trap installment needs to be more maximized in amount and distribution.



Figure 6. Sumatran elephant recorded by camera trap  
Insert: Elephant's feces



Figure 7. Silvered lutung, *Trachypithecus cristatus*, one of the mammals that need trees

The Index of Diversity and Index of Evenness results show a small difference in Susukan Baru and Kuala Penet Resort. The results present the condition in a low to moderate range. Another interpretation from the results that the distribution of the mammals, which happened to be the location of a recent forest fire, shows the diversity and distribution evenly in the area.

WKNP has various threats, consisting of poaching, the area is directly bordered with villages, and forest fire happens almost every year, even in anthropocentric or nature factor. One of the causes of forest fire is a routine activity to make open land by humans (Akbar et al., 2011). However, Amalina (2016) mentioned that the cause of forest fire is purely by nature.

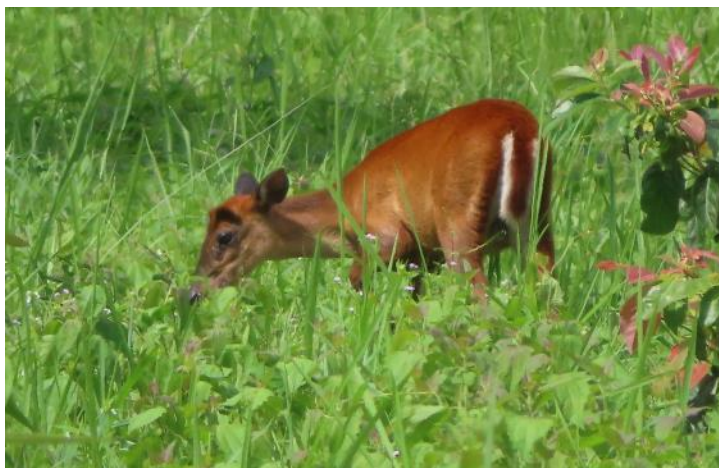


Figure 8. Female Muntjac deer, *Muntiacus muntjak*, in feeding activity.

Based on the literature study, the higher diversity of species, the higher quality of the habitat (Forman & Godron, 1986; Magurran, 1988). Alteration in the environment caused by forest fires will influence a species or community in the area. Even so, at some level, forest fire will impact plant ecology and this is a natural process, therefore fire in the natural ecosystem plays a role in the ecosystem. One of the impacts is the vegetation at the lower level will emerge, and this is needed for herbivore species, which also act as prey for carnivore species in the area, such as Sumatran tiger and panther (Dima, 1999).

Mammals that need forest for locomotion cannot be found in an open area, such as siamang. This shows that open area conditions have a significant impact on mammals that need canopy or forest dependent. This is based on the results in Susukan Baru Resort that still have some canopy, and this type of mammals can be found in the area. However, in other areas, which is in the burned areas, this type of mammals cannot be found. This results inversely proportional to other mammals, such as herbivore mammal including elephants. Sumatran elephants can be found in burned grassland. Habitat condition in swamp form acts as a barrier for the terrestrial mammal in its activity, and this confirms the observation study will not find the type of mammals in the swamp area.

The rapid survey was done as data limitation and will act as baseline data in burned grassland in Susukan Baru and Kuala Penet Resort. Therefore: 1) This study cannot be used as a conclusion to represent mammals in the WKNP area, and 2) The study design did not specify for environmental factor study that will influence mammal diversity.

Fire is a natural process that can affect plant communities, and as a natural process fire provides an important function for the health of certain ecosystems. However, at the end of the 20<sup>th</sup> century, changes in fire caused by human activities and the increasing frequency of El Nino made fires a serious threat to the forest and biodiversity in it. Previous fire events will increase the likelihood of other fires occurring. Dead trees on the ground, forest clearing to increased sun exposure to the soil, and increased growth of fire-prone plants such as *pyrophytic* grass (Nasi et al. 2012).



Figure 9. Swamp habitat in study location in Kuala Penet Resort

The alteration from forest to *pyrophytic* grasslands is the worst ecological impact due to fires in tropical forests that are common in Indonesia and the Amazon (Turvey, 1994). Fire can also harm vertebrates and invertebrates, either directly or indirectly, such as loss of habitat, home ranges, shelter, and food.

Herpetofauna is a group of vertebrates that are very vulnerable to environmental changes (Kusrini et al. 2008). Loss of habitat, shelter, and food is the impact of fire which is closely related to the presence of herpetofauna. Loss of habitat and shelter is directly correlated with the impact of fires. Loss of vegetation increases sun exposure to the soil surface, dries outstanding water, and decreases soil moisture. Herpetofauna is very sensitive to temperatures that are too high and inhibits the growth of the tadpoles due to drying out the puddles (Kurniati, 2009).

The amphibian group is the most affected by fires, due to increased soil surface temperature and loss of water basin. Therefore, the tadpoles won't be able to develop into adult frogs. Forest fire will also cause the leaf litter to disappear on the forest floor which is an important habitat feature for amphibians. Along with the decrease of amphibian populations, forest fires will also reduce rodent and insect populations which are a source of food for reptiles.

The higher the diversity of species in a habitat, the higher the quality of the habitat (Magurran, 1988). The value of species diversity in the five survey locations shows moderate to low results which indicate the pressure on their habitat, in this case, fire.

The highest diversity value of 1.79 as indicated in the type of habitat for the transition from the ex-burned area and vegetated areas. This habitat type still has some closed vegetation that keeps micro-climate stable for herpetofauna. The presence of *L. malesianus* indicates that there are still habitat features in the form of leaf litter in that habitat type (Devung, 2018). Several species found in this type of habitat, including *L. blythii* and *L. kuhlii*, are common species found in forest areas (Kurniati, 2009).

#### 4. Conclusions

- a. The number of mammals found at the survey location was 13 species of 10 families; The total number of species found at the survey location was 22 species consisting of 13 species of amphibians and 9 species of reptiles.
- b. One species is included in the endangered category based on the IUCN Red List, namely Asian box turtle (*Cuora amboinensis*).
- c. The diversity of mammals in the two resorts has a moderate and low index; The diversity index value at the survey location is in the medium to the low category which indicates the pressure on herpetofauna habitat.
- d. The frequency of encounters with Sumatran elephant is the highest compared to other mammals.
- e. Habitat conditions that are disturbed due to fires may have an impact on the presence of mammals, herpetofauna and their diversity, such as loss of habitat and shelter, as well as reduced food sources.
- f. The condition listed in point (e) is an initial hypothesis that needs to be proven by periodically monitoring the presence of mammal species versus the dynamics of habitat conditions in the two survey locations.

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## Appendix

### Appendix 1. Mammal species found in Susukan Baru and Kuala Penet Resort

Table 3. Mammal species found in Susukan Baru and Kuala Penet Resort

No	Order	Family	Scientific Name	Species Name	Conservation Status				Encounters	
					IUCN	CITES	PP-RI	Endemicity	Susukan Baru	Kuala Penet
1	Perissodactyla	Elephantidae	<i>Elephas maximus sumatrae</i>	Sumatran elephant	CR	I	Y	Sumatra	X	X
2	Artiodactyla	Cervidae	<i>Rusa unicolor</i>	Sambar deer	Vu	I	Y	Sum, Kal	X	X
3	Artiodactyla	Suidae	<i>Sus scrofa vittatus</i>	Malayan wild boar	LC	Non-app	N	Non	X	X
4	Artiodactyla	Cervidae	<i>Muntiacus muntjak</i>	Muntjac deer	LC	Non-app	Y	Non	X	X
5	Primates	Hylobatidae	<i>Symphalangus syndactylus</i>	Siamang	EN	I	Y	Sumatra	X	0
6	Carnivora	Felidae	<i>Panthera tigris sumatrae</i>	Sumatran tiger	CR	I	Y	Sumatra	X	0
7	Primates	Cerophytecidae	<i>Macaca fascicularis</i>	Long-tailed macaques	LC	Non-app	N	Non	X	0
8	Carnivora	Felidae	<i>Prionailurus bengalensis</i>	Leopard cat	LC	II	Y	Non	X	0
9	Carnivora	Viverridae	<i>Viveridae</i>	Civet	LC	Non-app	N	Non	0	X
10	Primates	Cerophytecidae	<i>Trachypithecus cristatus</i>	Silvered lutung	NT	II	Y	Non	0	X
11	Perissodactyla	Tapiridae	<i>Tapirus indicus</i>	Malayan tapir	EN	I	Y	Sum, Kal	0	X
12	Carnivora	Ursidae	<i>Helarctos malayanus</i>	Malayan sun bear	Vu	I	Y	Sum, Kal	0	X
13	Artiodactyla	Tragulidae	<i>Tragulus napu</i>	Greater mouse deer	LC	Non-app	Y	Sum, Kal	0	X

Note: CR= Critically Endangered, EN= Endangered, Vu= Vulnerable, LC= Least Concern, NT = Near Threatened.

Appendix 2. Field Encounters Data

No.	RPTN	Plot	X	Y	Scientific Name	Species Name	Encounter Type	Type of finding
1	Susukan Baru	SB-05	105.60682	-5.00766	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
2		SB-05	105.60682	-5.00766	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
3		SB-05	105.58661	-4.99533	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
4		SB-05	105.60317	-5.01023	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
5		SB-05	105.59159	-4.99123	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
6		SB-05	105.59589	-4.99216	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
7		SB-05	105.58554	-5.00040	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
8		SB-05	105.60257	-4.99523	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Footprint
9		SB-05	105.58976	-4.99222	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
10		SB-05	105.60979	-5.00106	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
11	SB-05	105.61275	-5.00831	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces	
12	SB-02	105.62793	-4.98624	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
13	SB-02	105.62793	-4.98624	<i>Prionailurus bengalensis</i>	Leopard cat	Indirect	Footprint	
14	SB-02	105.63193	-4.97994	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks	
15	SB-04	105.60212	-4.97803	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
16	SB-02	105.65565	-4.96344	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Footprint	
17	SB-02	105.63063	-4.97939	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
18	SB-05	105.60284	-5.01113	<i>Panthera tigris sumatrae</i>	Sumatran tiger	Indirect	Footprint	
19	SB-02	105.62517	-4.97944	<i>Muntiacus muntjak</i>	Muntjac deer	Indirect	Feces	
20	SB-02	105.62943	-4.97753	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
21	SB-02	105.63258	-4.98278	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
22	SB-02	105.63258	-4.98278	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
23	SB-04	105.60279	-4.97615	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint	
24	SB-02	105.62607	-4.97835	<i>Rusa unicolor</i>	Sambar deer	Indirect	Feces	
25	SB-01	105.63644	-4.99670	<i>Symphalangus syndactylus</i>	Siamang	Indirect	Voice	
26	SB-01	105.63926	-4.99357	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Cast-offs	
27	SB-04	105.59640	-4.97530	<i>Rusa unicolor</i>	Sambar deer	Direct	Visual	
28	SB-05	105.59475	-4.98664	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Direct	Visual	
29	SB-05	105.59475	-4.98664	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Direct	Visual	

No.	RPTN	Plot	X	Y	Scientific Name	Species Name	Encounter Type	Type of finding
30		SB-03	105.64781	-4.92862	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Direct	Visual
31		SB-04	105.60139	-4.97392	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Direct	Visual
32		SB-04	105.60265	-4.96205	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
33		SB-05	105.58772	-4.99546	<i>Panthera tigris sumatrae</i>	Sumatran tiger	Indirect	Footprint
34		SB-04	105.59094	-4.96984	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Footprint
35		SB-05	105.57318	-5.00076	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Footprint
36		SB-04	105.60417	-4.96549	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
37		SB-03	105.63896	-4.93520	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
38		SB-01	105.63517	-5.01858	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
39		SB-01	105.63456	-5.01211	<i>Macaca fascicularis</i>	Long-tailed macaques	Direct	Visual
40		SB-01	105.64510	-5.00891	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks
41		SB-01	105.64643	-5.00685	<i>Symphalangus syndactylus</i>	Siamang	Indirect	Voice
42		SB-01	105.65620	-5.00619	<i>Muntiacus muntjak</i>	Muntjac deer	Direct	Visual
43		SB-01	105.64078	-5.01748	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Direct	Visual
44	Kuala Penet	KP-04	105.82854	-5.15658	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Mudhole
45		KP-03	105.83387	-5.13563	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Nest
46		KP-04	105.83158	-5.14894	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Direct	Visual
47		KP-04	105.83283	-5.15000	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
48		KP-04	105.83161	-5.14874	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
49		KP-03	105.84685	-5.12119	<i>Tapirus indicus</i>	Malayan tapir	Indirect	Footprint
50		KP-04	105.83347	-5.14768	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Cast-offs
51		KP-03	105.84395	-5.11794	<i>Tapirus indicus</i>	Malayan tapir	Indirect	Scratch
52		KP-03	105.84717	-5.12114	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Cast-offs
53		KP-04	105.82477	-5.15689	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Mudhole
54		KP-04	105.80285	-5.16956	<i>Viveridae</i>	Civet	Indirect	Feces
55		KP-04	105.82399	-5.16027	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
56		KP-04	105.82485	-5.15291	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Direct	Visual
57		KP-04	105.82444	-5.15563	<i>Sus Scrofa vittatus</i>	Sumatran wild boar	Indirect	Nest
58		KP-04	105.82495	-5.15262	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Former activity
59		KP-04	105.82495	-5.15262	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Former activity
60		KP-04	105.82495	-5.15262	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Former activity

No.	RPTN	Plot	X	Y	Scientific Name	Species Name	Encounter Type	Type of finding
61		KP-04	105.82495	-5.15262	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Former activity
62		KP-04	105.82707	-5.15764	<i>Helarctos malayanus</i>	Malayan sun bear	Indirect	Scratch
63		KP-04	105.80828	-5.16263	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
64		KP-04	105.81476	-5.16020	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Path
65		KP-04	105.82499	-5.15449	<i>Helarctos malayanus</i>	Malayan sun bear	Indirect	Scratch
66		KP-01	105.84932	-5.24234	<i>Trachypithecus cristatus</i>	Silvered lutung	Direct	Visual
67		KP-01	105.85190	-5.23382	<i>Trachypithecus cristatus</i>	Silvered lutung	Direct	Visual
68		KP-01	105.85229	-5.24146	<i>Trachypithecus cristatus</i>	Silvered lutung	Direct	Visual
69		KP-01	105.85229	-5.24337	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks
70		KP-01	105.85168	-5.23193	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint
71		KP-03	105.84832	-5.12148	<i>Tragulus napu</i>	Greater mouse deer	Direct	Visual
72		KP-02	105.85064	-5.16799	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Path
73		KP-03	105.85229	-5.14014	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
74		KP-03	105.84966	-5.12095	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint
75		KP-03	105.85012	-5.12053	<i>Rusa unicolor</i>	Sambar deer	Indirect	Footprint
76		KP-02	105.85065	-5.17063	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
77		KP-03	105.85244	-5.12306	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Voice
78		KP-02	105.85116	-5.15804	<i>Viveridae</i>	Civet	Indirect	Feces
79		KP-02	105.85090	-5.16070	<i>Viveridae</i>	Civet	Indirect	Feces
80		KP-02	105.85081	-5.18632	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
81		KP-02	105.85081	-5.18632	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
82		KP-01	105.85036	-5.21334	<i>Viveridae</i>	Civet	Indirect	Feces
83		KP-02	105.85052	-5.19637	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
84		KP-02	105.85091	-5.17899	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
85		KP-01	105.85034	-5.20297	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Cast-offs
86		KP-02	105.85123	-5.17737	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Footprint
87		KP-02	105.85085	-5.17460	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks
88		KP-02	105.85085	-5.17460	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks
89		KP-02	105.85085	-5.17460	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks
90		KP-01	105.85054	-5.20383	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
91		KP-01	105.85096	-5.21793	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Rubbing marks



No.	RPTN	Plot	X	Y	Scientific Name	Species Name	Encounter Type	Type of finding
92		KP-04	105.79989	-5.17569	<i>Muntiacus muntjak</i>	Muntjac deer	Direct	visual
93		KP-04	105.79989	-5.17569	<i>Muntiacus muntjak</i>	Muntjac deer	Direct	Visual
94		KP-04	105.80029	-5.17801	<i>Muntiacus muntjak</i>	Muntjac deer	Indirect	Footprint
95		KP-04	105.79898	-5.17602	<i>Muntiacus muntjak</i>	Muntjac deer	Indirect	Feces
96		KP-04	105.80086	-5.17545	<i>Elephas maximus sumatranus</i>	Sumatran elephant	Indirect	Feces
`		KP-04	105.80093	-5.17636	<i>Muntiacus muntjak</i>	Muntjac deer	Direct	Visual