Fauna & Flora International's Indonesia Programme

Wildlife Inventory from Camera – Trapping Survey in PT Global Alam Nusantara (PT GAN) Riau Ecosystem Restoration

REPORT 2021

WILDLIFE INVENTORY FROM CAMERA-TRAPPING SURVEY IN PT GLOBAL ALAM NUSANTARA (PT GAN) RIAU ECOSYSTEM RESTORATION

Authors:

Ryan Avriandy, Dwiyanto, Jarian Permana, Yogi Satriyo Wibowo

Field members:

Imas Hendry Kurniawan, Zulamri, Agung Purnomo Adjie, Erwin Santoso, Indra Gunawan, Wawan Lukmanul Hakim, Kevin Aprilio Adeplo, Ginting, Supri, Rangga

Supported by:

Donny Gunaryadi, Fransisca Noni Tirtaningtyas, Husnul Fikri, Gareth Goldthorpe

FAUNA & FLORA INTERNATIONAL

FFI protects threatened species and ecosystems worldwide, choosing solutions that are sustainable, based on sound science and take account of human needs. Operating in more than 40 countries worldwide, FFI saves species from extinction and habitats from destruction, while improving the livelihoods of local people. Founded in 1903, FFI is the world's longest established international conservation body and a registered charity.

FFI's conservation program in Indonesia (FFI IP), started in 1996 and has a memorandum of understanding with the Ministry of Environment and Forestry in Indonesia. Communities are the center of conservation initiatives other than species. Therefore, FFI IP assists communities through social forestry schemes and obtains formal recognition of their rights to manage these forests sustainably. In addition, they participate in ensuring the survival of threatened species through a sustainable funding mechanism, based on the Reducing Emissions from Deforestation and Forest Degradation (REDD) and Payment for Environmental Services (PES) approaches.

FFI IP has a broader approach to conservation efforts at the landscape level. For example, through a High Conservation Value (HCV) assessment, FFI IP has helped protect forests with high carbon stock potential and essential habitats for various threatened species, such as the Sumatran tiger, Sumatran elephant, and orangutan since 2007.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

OVERVIEW

A biodiversity survey, using camera-traps, was carried out from September 2020 to February 2021 in PT Global Alam Nusantara. This survey is a continuation and completion of surveys in Riau Ecosystem Restoration (RER) that was initiated in 2015 that aims to provide reliable biodiversity baseline data in the 130,095 ha Riau Ecosystem Restoration program area located on the Kampar Peninsula in Sumatra.

84 camera-traps were systematically deployed, in a grid of 91, 2x2 km cells covering 36,524 ha. A total of 23 species were captured, including Sumatran tiger (*Panthera tigris sumatrae*), sunda pangolin (*Manis javanica*), and clouded leopard (*Neofelis diardii*), which are considered IUCN globally threatened species. One additional species was identified as Common porcupine *(Hystrix sumatrae)* that was not observed in previous surveys in RER.

The relative abundance of each species is presented along with the highest abundance respectively being bearded pig (*Sus barbatus*), pig-tailed macaque (*Macaca nemestrina*) and sun bear (*Helarctos malayanus*).

The report includes analysis on tiger distribution and interactions with prey, with the highest prey preferences being mousedeer (*Tragulus sp*), long-tailed macaque (*Macaca nemestrina*), and bearded pig (*Sus barbatus*). All prey species have a high degree of spatial and temporal overlap and are widely distributed throughout PT GAN. According to the *Maxent* habitat suitability model, tigers in this landscape prefer to congregate around the Serkap River, but potentially occupying 44% of the total concession area.

I. INTRODUCTION

1.1 Background

Peat swamp forest is a unique and fragile ecosystem which is under threat from human disturbance. Peat swamp forests in Indonesia are spread across Sumatra, Kalimantan, Papua and Sulawesi. Previously, the largest peatland in Indonesia was in Sumatra, with an area of 7,151,887ha. However, due to forest conversion from plantation development, illegal logging, encroaching agriculture and forest fires, Sumatra has experienced a 78% loss of peatland forest, compared to Kalimantan and Papua, (Purba, 2014). Today, Riau Province has the largest peatland area, which had 4,004,434ha in Sumatra and about 671,125 hectares in the Kampar Peninsula . The Kampar Peninsula contains the largest remaining peatland forest in Riau, which is an important area for biodiversity conservation. This area is an important habitat for Sumatran tiger, other globally threatened species, and is recognized by Birdlife International as an Important Bird Area (IBA). Kampar Peninsula also provides important ecosystem services such as carbon storage (potentially ranges from 2.14 to 2.68 billion tonnes CO_2e), the preservation of water resources and flood control (Tropenbos International Indonesia Program, 2010).

The Riau Ecosystem Restoration (RER) program was formed by APRIL Group in 2013, with an area of about 150,000 hectares. RER's focus is the protection, restoration and conservation of peat swamp forest ecosystems in Kampar Peninsula and Padang Island, as part of the Ministry of Environment and Forestry's programme to protect and restore 2.6 million hectares of degraded production forest (IUPHHK-RE). The location is spread over two landscapes in Riau Province: the Kampar Peninsula landscape, with a total area of 130,095 ha, and Pulau Padang, covering 20,599 ha. One of the concessions located on the Kampar Peninsula is PT Global Alam Nusantara (PT GAN), with an area of 36,524 ha. Since 2013, RER has been collaborating with FFI-IP in designing the framework, policies, and management plans relating to the Community, Climate and Biodiversity (CCB) assessment. This camera trap survey in PT GAN is a continuation from previous biodiversity surveys conducted in 2015 by FFI-IP on Kampar Peninsula in three other RER concessions. The RER program will ensure that ecosystem services from the peat swamp forest remain available to people, especially those communities that live within this landscape.

Biodiversity is an important component of the peat swamp forest ecosystem in Kampar Peninsula. Restoration and conservation management efforts require data on biodiversity as a reference for formulating management strategies and conservation plans. Therefore, it is essential to study the diversity of fauna and flora in the PT GAN area. The use of camera-traps to survey faunal diversity offers many advantages, especially in the tropical forests where access is difficult. This method can find cryptic species that are otherwise difficult to detect by direct observation. By setting the camera-trap in a strategic location and position, a deeper understanding of wildlife activity patterns, occupancy, and even densities in the landscape can be documented.

1.2 Objective

This report provides baseline data to RER management for developing a long-term management and monitoring plan for the RER area, according to the HCV concept and with the following objectives:

1. Build a baseline dataset on faunal diversity to support the long-term vision of the RER in the conservation of wildlife in Kampar peninsula.
2. Identify and map the distribution of areas with high biological and ecological value based on the High Conservation Value guidelines.

II. METHODS

2.1 Study Area

The Kampar Peninsula area has an area of 6,711 km^2, located in the eastern part of Riau Province and geographically located between 101° 50'-103° 07' East Longitude and 0°10'-1°14' North Latitude. The Kampar Peninsula is divided into two regencies: Siak Regency (38%) and Pelalawan Regency (62%) with the RER fully located within Pelalawan Regency. Kampar Peninsula has a topography ranging from 2-16m, with a wet tropical climate with relative humidity ranging from 81-84% and annual rainfall ranging from 1,949-2,951mm/year. The average monthly air temperature ranges from 26.1-27.5°C.

The Kampar Peninsula is primarily peat swamp forest with minor amounts of mangrove and riparian forests on the coastline. For the RER area, the dominant ecosystem is peat swamp forest which can be classified, based on vegetation type: (1) Mixed peat swamp forests with uneven canopy heights; (2) peat swamp forests with relatively flat-high tree canopy and uniform diameter trees (tall pole forest); (3) peat swamp forests with low canopy (low pole forest) and (4) riparian forest (Figure 1).

Riparian forests in RER are located along three rivers: the Turip, Serkap, and Sangar rivers. At the highest tide, flood water inundation width of these rivers can reach 1-1.5 km radial distance. The depth of peat in the RER ranges from 3-15m, with acidity (pH) ranging from 3.1 to 3.9 (Tropenbos International Indonesia Program, 2010; Avriandy et al., 2016).

This survey was carried out in PT GAN, which covers an area of 365.25 km^2. The PT GAN is in the western part of the RER area, surrounded by acacia plantation to the west, an ecosystem services concession (PT Putra Riau Perkasa) to the north; while in the east and south, it is bordered by RER concessions, PT TBOT and PT SMN. The majority (23,549 ha or 65%) of PT GAN is a primary peat swamp dome forest dominated by low pole trees, in the western half of the concession. The dominant tree species in PT GAN is Terentang (*Campnosperma sp*), Meranti (*shorea sp*), Bintangur (*Chalopylum sp*) and Mengkuang (*Pandanus sp*). The remainder of PT GAN in the eastern half of the concession is mixed peat swamp forest (12,840 ha), in which 4,021 ha is degraded due to past drainage, intensive logging and possibly impacts from past forest fires.

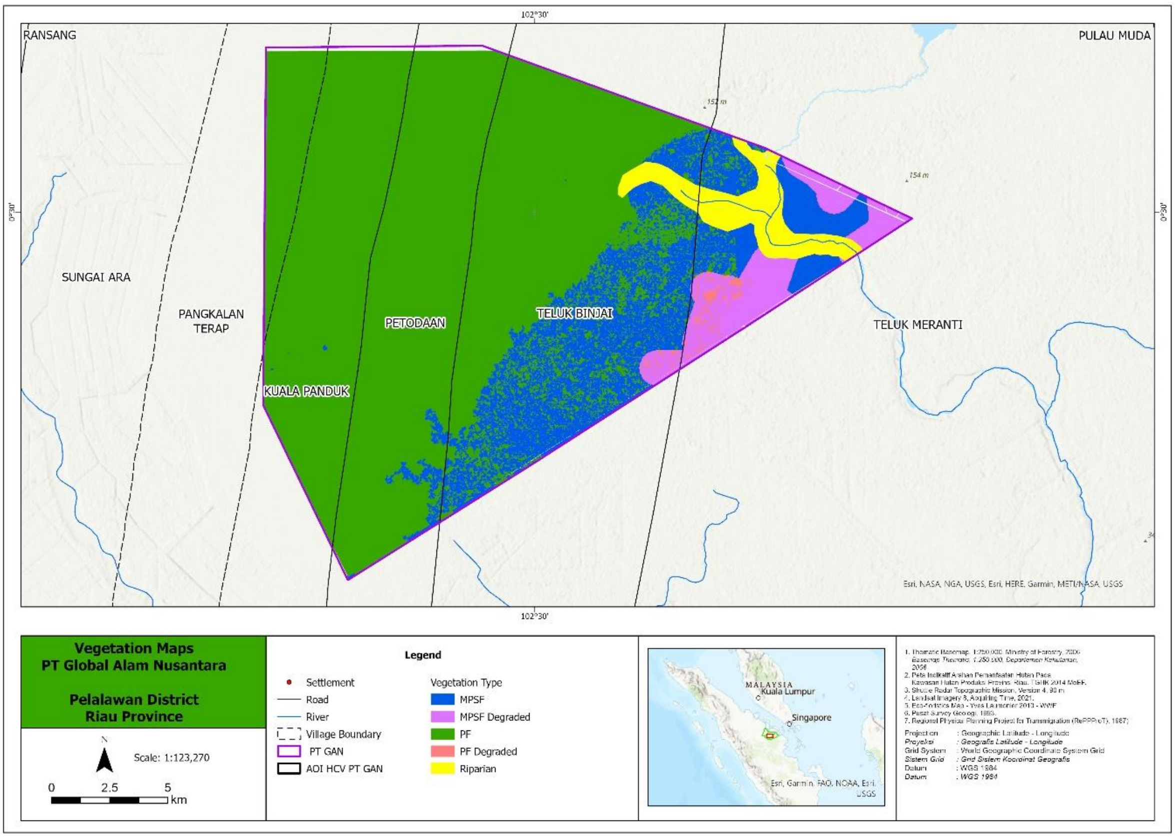


Figure 1. Vegetation type distribution on PT GAN.

2.2 Data Collection

The survey was conducted from September 2020 to February 2021, utilizing a total of 81 camera traps across 91 camera trap stations (Figure 2). 75 units Bushnell Trophy Cam HD and 6 units Reconyx Hyperfire Camera's were deployed.

Camera traps were set-up in each 2x2km grid cell. 82 Grid cells had a single station, while 9 grids had a paired camera trap station. The camera trap arrangement covered 300km^2, almost the entire area of PT GAN. This survey was divided into two periods: the first in the western area of PT GAN and the second in the east.

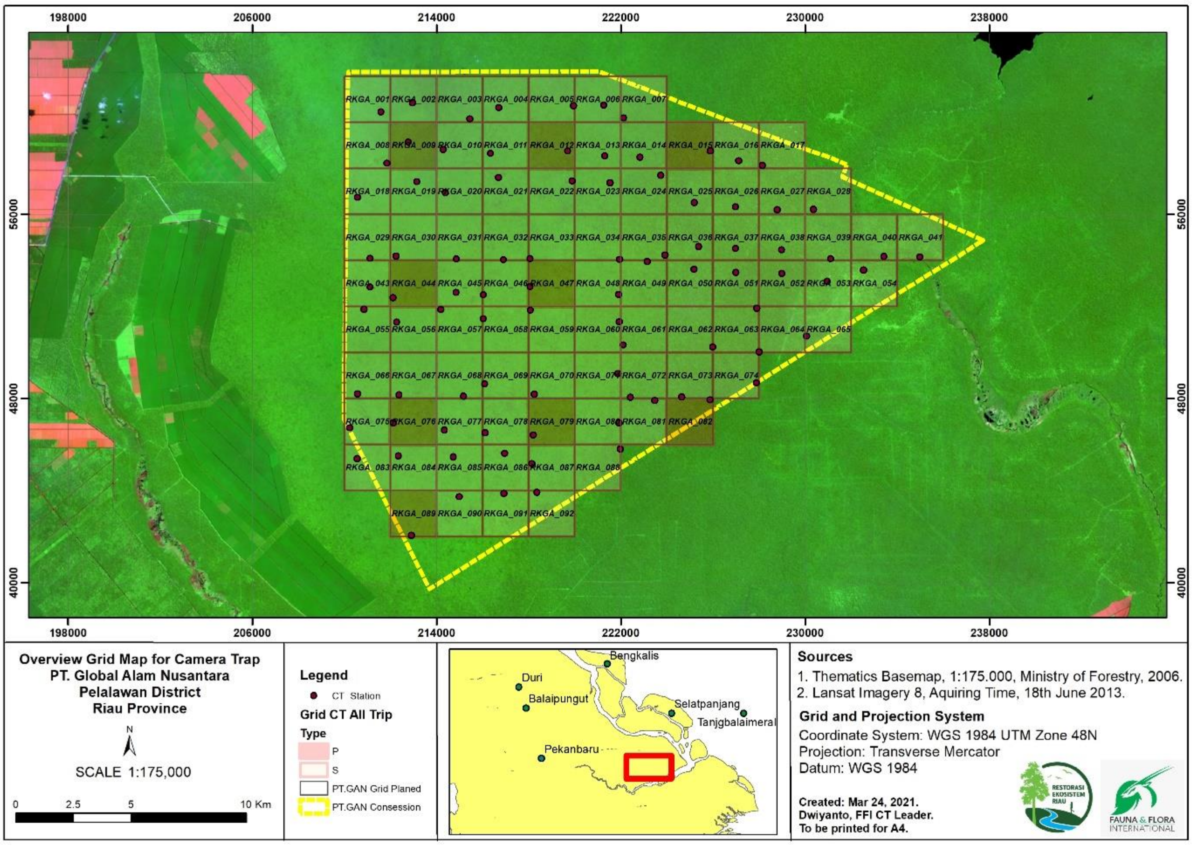


Figure 2. Map of survey design and camera trap placement in PT GAN.

In each grid cell, one camera station was selected, based on the possibility of getting pictures of wildlife, such as a location with scent marks, scats, pugmarks of large wildcats or at least a wildlife trail. In each station, the camera was mounted on a tree at the height of 40-50cm and a distance of 4-6m from the midpoint of active animal tracks (optimal placement for detecting tigers), where the animal is expected to pass through (Karanth & Nichols, 2002). The distance between each camera trap was at least 1-km, to maintain independence of animal detections. One of two types of camera-set up were used in each cell; either a single camera set to record video (at 10 second bursts), or an opposing pair of cameras programmed to take still images at 10 second time intervals. The cameras were continuously active for 30 days.

2.3 Data Analysis

2.3.1 Sampling effort

The camera-trap data were organized and analysed using the software 'CameraSweet', developed by Sanderson & Harris (2013). The output generated from the program is a species detection table, an information table for each camera station, total trap days, total picture, and total independent event. Photos/videos were categorized as independent if (1) they were produced from different species or different individuals on a single frame, (2) they were in a sequence from the same individual (the same species) in a single file of photo/video with a span of more than 30 minutes or a sequence of different individuals if they are clearly distinguishable, and (3) photos/video of the same individual or the same species that were not sequential in one frame (O'Brien et. al. 2003).

2.3.2 Species compositions and distributions

Species exclusions

To evaluate the survey's effectiveness and adapt it to the initial survey design, the species that will be analysed further are only medium to large terrestrial and semi-terrestrial mammals (>1 kg). Therefore arboreal, small-sized mammals and any other taxa were excluded from further analysis (Appendix 1).

Species richness and diversity

Species records were compiled to measure, the number of species at each grid cell, the species accumulation curve, the species richness index, and the relative abundance index. All analyses were carried out using the R software (R Development Core Team, 2011) with packages '*biodiversityR'*, *'camtrapR'*, *'unmarked*' and *'wiqid'* (Kindt & Kindt, 2015; Meredith, 2017; Fiske et. al. 2019; Mathai & Timothy, 2020).

Species accumulation curves

Species accumulation curves were used to measure survey effectiveness. This analysis illustrates the relationship between the number of species detected and the survey effort (total camera-trap days). These results are used to estimate the number of species in a particular area and can also be used to indicate the adequacy of a survey in representing the wildlife in a particular area (Chao et al., 2013).

Species diversity index

The Shannon-Wiener index was used to estimate species diversity (Krebs, 2014), providing information on species richness and evenness of species composition within a community. The higher the index value, the higher the richness and evenness.

Relative abundance index

The relative abundance index (RAI) is the number of independent events, per 100 total trap days (O'Brien, 2011). This index is often used to compare results between landscapes because it also represents information about survey effort. In some studies, the index is directly proportional to the actual abundance estimate (Palmer et. al. 2018).

Species distribution

The occupancy model was used to analyse the species distribution model (MacKenzie et. al. 2002). The results obtained from this model are the proportion of the area (PAO) used in a landscape for each species. In principle, this model estimates how widely a species inhabits the surveyed landscape by considering the detection ratio of that species at each camera trap station. In this study, 15-day intervals were used as one detection. All calculations use the basic model, assuming all detection and occupancy probabilities are constant in all survey periods and camera trap stations.

2.3.3 Activity pattern

Activity patterns for each species were analysed using R (R Development Core Team, 2011) with package '*overlap*' (Meredith et. al. 2020). The activity period of each felid species was analysed by dividing the activity into three time-periods; night-time (19:00-05:00), daytime (07:00-17:00) and dawn/dusk (crepuscular) (05:00-07:00 and 17:00-19:00) (Azlan & Sharma, 2006).

2.3.4 Tiger – prey interaction

The interaction of tigers with prey can be measured by calculating the degree of overlap between species, both spatially and temporally, adjusted for the preference of tigers for larger bodied prey species (Allen et al., 2021).

The analysis was carried out in three stages: first by quantifying the degree of temporal overlap between tigers and their prey, using a density estimation kernel (Linkie & Ridout, 2011). Second, by quantifying the spatial overlap (modified by calculating the co-occurrence probability), which is measuring the probability of both species using the same space (Griffith et al., 2014). The third stage is assigning weights and adjusting scores by considering the average weight of prey (Nowak & Walker, 1999) with the following formula:

$$mass\ adjusted = (spatial\ overlap\ \ x\ temporal\ overlap) \times\ body\ mass$$

The last stage is to provide a weight adjustment between the spatial and temporal overlap with the adjusted prey weight as follows:

$$Spatial\ \&\ prey\ mass\ adjusted = ((spatial\ overlap\ x\ 0{,}6) + (temporal\ Overlap\ x\ 0{,}4)) \times mass\ adjusted$$

A higher score can be translated as prey with more favourable preferences and a higher encounter rate.

2.3.5 Species distribution modelling of Sumatran tiger

The Sumatran tiger distribution model used MaxEnt version 3.4.1 (Phillips et al., 2017) to model the distribution in the PT GAN area. This software produces more accurate and reliable models with few data (Hernandez et al., 2006; Wisz et al., 2008). The data needed to create a distribution model with MaxEnt are presence data and environmental predictors. We use whole RER concession as the area of interest to update as well as refining previous model, but for this report, we cropped and narrowed the result for PT GAN concession.

The data on species occurrence were compiled from camera traps and tiger track conducted at different times between this survey and previous camer traps surveys in 2015. Final environmental variables used were vegetation type (Arief et al 2022), prey availability, distance from forest edge, distance from canals, distance from main river (LandSat 8), forest percentage per pixel (Hansen. et al., 2013), annual mean temperature and monthly mean temperature (www.worldclim.org) (Fick & Hijmans, 2017). All raster layer were resampled to 250 m resolution. Multi-collinearity between variable has been checked with 'ENMtools' (Warren et al., 2021) and none of the variables indicate correlation. Vegetation type was generated by combining vegetation survey and peat depth survey which explain more on the vegetation report and serve as categorical variable as follows; (0) MPSF, (1) MPSF disturb, (2) PF, (3) PF disturbed and (4) Riparian. Prey availability is gained by running the maxent models for long tailed macaque, pig tailed macaque, mouse deer and bearded pig with previously mentioned predictors and combine the threshold raster which has value from 1 to 4, that indicated prey species availability within each raster.

The parameter used are test percentage (30%), maximum iteration (1000), replicated run type (Bootstrap 100 times), regularization multiplier (1) and linear feature with output format (logistic). This parameters are selected by the pre-run model with 'ENMevals' (Kass et al., 2021) to avoid overfiting (Elith et al., 2011; Merow et al., 2013).

One of the data generated by MaxEnt is the AUC value (Area Under the Curve), which is a value that shows the strength of the model used, where the AUC value closest to 1 is the best model (Merow et al., 2013); this value is often used to evaluate the combination of variables used. If the AUC value is close to, or even less than 0.5, then the variables and parameters used may be inaccurate. In addition, MaxEnt produces a map of animal distribution models, in the form of a raster, with a value range of 0-1. Often to facilitate data visualization, the raster is displayed in two or three categories, namely suitable habitat, and non-suitable habitat, with a raster value limit resulting from the "equal training sensitivity and specificity" as it provides the most accurate estimates (Cao et al., 2013).

III. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Sampling efforts

A total of 81 camera traps were deployed in 91 grid cells for a total of 4,048 trap-days; using a minimum convex polygon (MCP) this covered an area of 300km^2 of a possible 365km^2 (the area of PT GAN). A total of 837 images were recorded, with 370 independent events calculated. However, 23% (21/91) of the grid cells had camera traps that were damaged during the survey period (typical damage included: only taking photo/video during installation, taking pictures continuously and so quickly filling the memory card, and a corrupted memory card).The camera trapping days in PT GAN represents 26% of the total sampling effort by FFI`s IP in the RER (Table 1).

Table 1. Comparison of camera-trap efforts in FFI-RER surveys on Kampar Peninsula.

Descriptions	GAN[a]	GCN[b]	SMN[b]	TBOT[b]
Sampling Period	Sep ‘20 – Feb ‘21	Mar-Jun 2015	Apr-Aug 2015	Sep-Nov 2015
Camera trapping days	4,048	1,460	5,950	4,070
Mean trapping days per camera	44.5	29.2	79.3	42.4
Total Photos/Video	837	1,662	4,140	8,152
Total Independent Event	370	415	1,217	1,804
Covered area (km^2)	300	189	301	354
Successful cameras	70	48	70	96
Cameras broken/stolen	21	2	5	0

Notes: a. this study; b. *Avriandy et al., 2016*

3.1.2 Species compositions and distributions

A total of 23 species, 15 mammals and 8 birds, were identified; an additional four mammals and one bird could not be identified to species (Appendix 1). The species most frequently found, in sequence, were the bearded pig (*Sus barbatus*), pig-tailed macaque (*Macaca nemestrina*) and sun bear (*Helarctos malayanus*). Important (endangered) species included the Sumatran tiger (*Panthera tigris sumatrae*), Sunda pangolin (*Manis javanica*) and Sunda clouded leopard (*Neofelis diardi*) (Table 2).

One additional mammal species was identified in PT GAN that was not observed in the 2015 camera trap surveys. A single photo of the Common porcupine *(Hystrix sumatrae)* was observed on 1st September in Grid station 53 near Serkap River (Appendix 3).

Table 2. List of protected terrestrial mammals recorded in PT GAN based on IUCN and Indonesian Government.

No	Species	Common Name	Status		
			P.106*	IUCN	Trend**
1	*Helarctos malayanus*	Sun bear	P	VU	Decreasing
2	*Macaca fascicularis*	Long-tailed macaque	-	VU	Decreasing
3	*M. nemestrina*	Pig-tailed macaque	-	VU	Decreasing
4	*Manis javanica*	Sunda pangolin	P	CR	Decreasing
5	*Neofelis diardi*	Sunda clouded leopard	P	EN	Decreasing
6	*Panthera tigris sumatrae*	Sumatran tiger	P	CR	Decreasing
7	*Pardofelis marmorata*	Marbled cat	P	NT	Decreasing
8	*Sus barbatus*	Bearded pig	-	VU	Decreasing
9	*Tragulus* sp.	Mouse-deer	P	LC	-

Notes: * Ministerial Decree, Ministry of Forestry No P106, 2018; **based on global assessment by IUCN

The species accumulation curve (Figure 3) shows that asymptote was not reached, indicating that there are more species to be recorded, given more sampling time. When the species richness was estimated, using the jackknife estimator (Heltshe & Forrester, 1983) the estimated species richness value was 33.90.

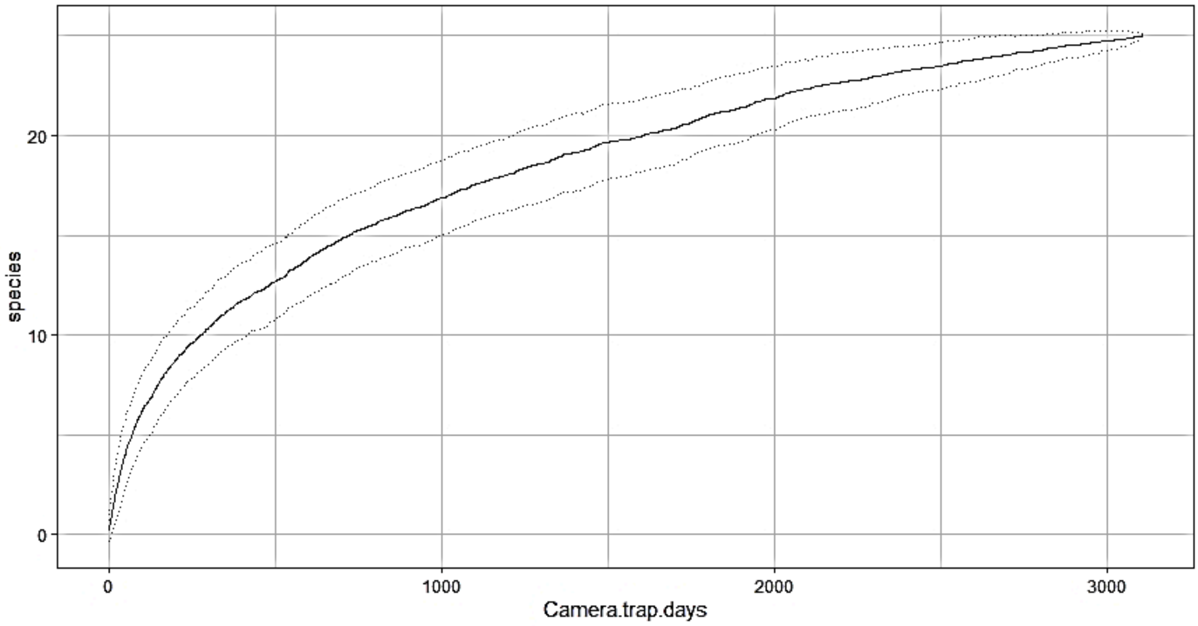


Figure 3. Species accumulation curves in PT GAN.

The Shannon-Wiener species diversity index value in PT GAN is 1.97; this value is much lower than that estimated for the other concessions in the RER area (PT GCN, PT TBOT dan PT SMN) with values of 2.40, 2.34 and 2.36, respectively (Avriandy et al., 2016). This low value correlates with the much lower effectiveness of camera traps in GAN as compared with the three other RER concessions.

From the results of the occupancy model, the species with the largest proportion of area use was the sun bear, Malay civet (*Viverra tangalunga*) and pig-tailed macaque, with values of 22%, 24% and 31%, respectively (Appendix 1). Animals with high conservation priority (Sumatran tiger, Sunda pangolin and Sunda clouded leopard) occupy a very small proportion of the area, with values of 2%, 1% and 5%, respectively.

3.1.3 Activity pattern

Only seven species can be grouped according to their period of activity because other species identified in less than 15 detections (n); the minimum needed for accurate conclusions (Blake et al., 2012). In Table 3, detections of less than 15 are marked with an asterisk (*). This includes some important species but, in Appendix 2, a graph of activity patterns for all mammals is presented.

Table 3. Activity periods of mammal species in PT GAN.

No	Common name	n	Diurnal	Nocturnal	Crepuscular	Classification
1	Bearded pig	299	144	82	73	Mostly Diurnal
2	Clouded leopard	9	3	2	4	*
3	Common porcupine	1	0	1	0	*
4	Long-tailed macaque	16	1	0	15	Crepuscular
5	Malay civet	52	0	29	23	Mostly nocturnal
6	Marbled cat	1	0	0	1	*
7	Mouse deer	45	33	4	8	Diurnal
8	Pig-tailed macaque	191	180	0	11	Diurnal
9	Short-tailed mongoose	2	1	0	1	*
10	Sumatran tiger	9	9	0	0	*
11	Sun bear	138	86	18	34	Mostly Diurnal
12	Sunda pangolin	1	0	1	0	*
13	Yellow-throated marten	18	14	0	4	Diurnal

3.1.4 Tiger – prey interaction

Species captured from camera-traps and references by (Hayward et al., 2012) found only four species that may considered tiger-prey species: bearded pig, mouse deer, long-tailed macaque, and pig-tailed macaque. As PT GAN and the other RER concessions are in the same landscape, we compared the results in this survey and overall across all RER concessions in the Kampar Peninsula to obtain more accurate results.

Table 4 shows the preference index of tigers and their prey in PT GAN and all RER concessions in the Kampar Peninsula; mouse deer and pig-tailed macaque have the highest index values in PT GAN (0.12 and 0.05, respectively) while overall, in the RER concession, mouse deer, pig-tailed macaque and bearded pig have the highest index values (0.20, 0.19, and 0.19, respectively).

Table 4. Relative Abundance Index (RAI) scores for potential tiger-prey species in PT GAN and RER

Prey Species	RAI of GAN	RAI of RER	GAN*	RER*
Bearded pig	2.76	2.02	0.04	0.19
Mouse deer	0.81	4.82	0.12	0.20
Long-tailed macaque	0.12	0.31	0.01	0.17
Pig-tailed macaque	1.67	7.65	0.05	0.19

*Spatial and prey mass adjusted

3.1.5 Species distribution modelling of Sumatran tiger

The results of modelling the distribution of tigers, by MaxEnt, produced an evaluation value (AUC) of 0.81 (±0.05), indicating that the model used is adequate (close to 1). The environmental variables with the most influence on tiger distribution relate to the vegetation type, distance from forest edge and prey availability. The tiger distribution model is presented in Figure 4, below, which indicates that tigers are more likely to inhabit the area on mixed peat swamp forest and riverine areas. The map also shows the distribution of the Sumatran tiger presence, which is more dominant in the area around the Serkap River.

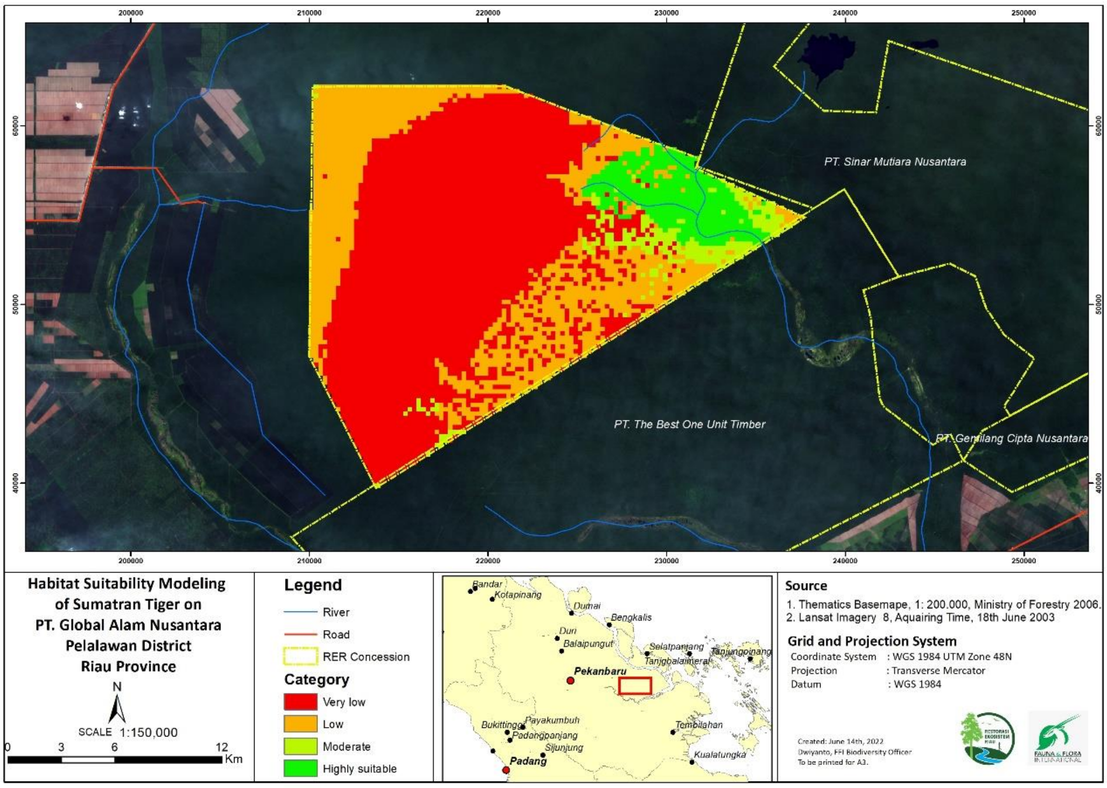


Figure 4. Tiger distribution model in PT GAN.

3.2 Discussion

3.2.1 Sampling effort

The number of camera traps that did not function optimally at the time of the survey (Table 1) resulted in a relatively low number of independent events (IE) with only 370 IE compared to the previous concessions at PT GCN, PT SMN, and PT TBOT with 415, 1,217 and 1,804 IE respectively (Avriandy et al., 2016). In addition, the total number of species discovered is lower than in earlier concessions with only 23 species in GAN as compared to SMN, TBOT and GCN with 47, 52 and 37 species respectively. The age of the camera traps that have been operating for more than five years maybe negatively affecting the performance of the camera traps. Furthermore, the camera trap condition is harmed by high use intensity and landscape conditions with high humidity and rainfall.

Figure 5, below, shows the distribution of camera-trap stations that were not functioning optimally for the entire 30-day deployment period. The distribution of damaged cameras does not have a particular pattern, thus making the design of this survey less systematic. As such, the data needs to be interpreted carefully, especially in relation to the spatial distribution of animals.

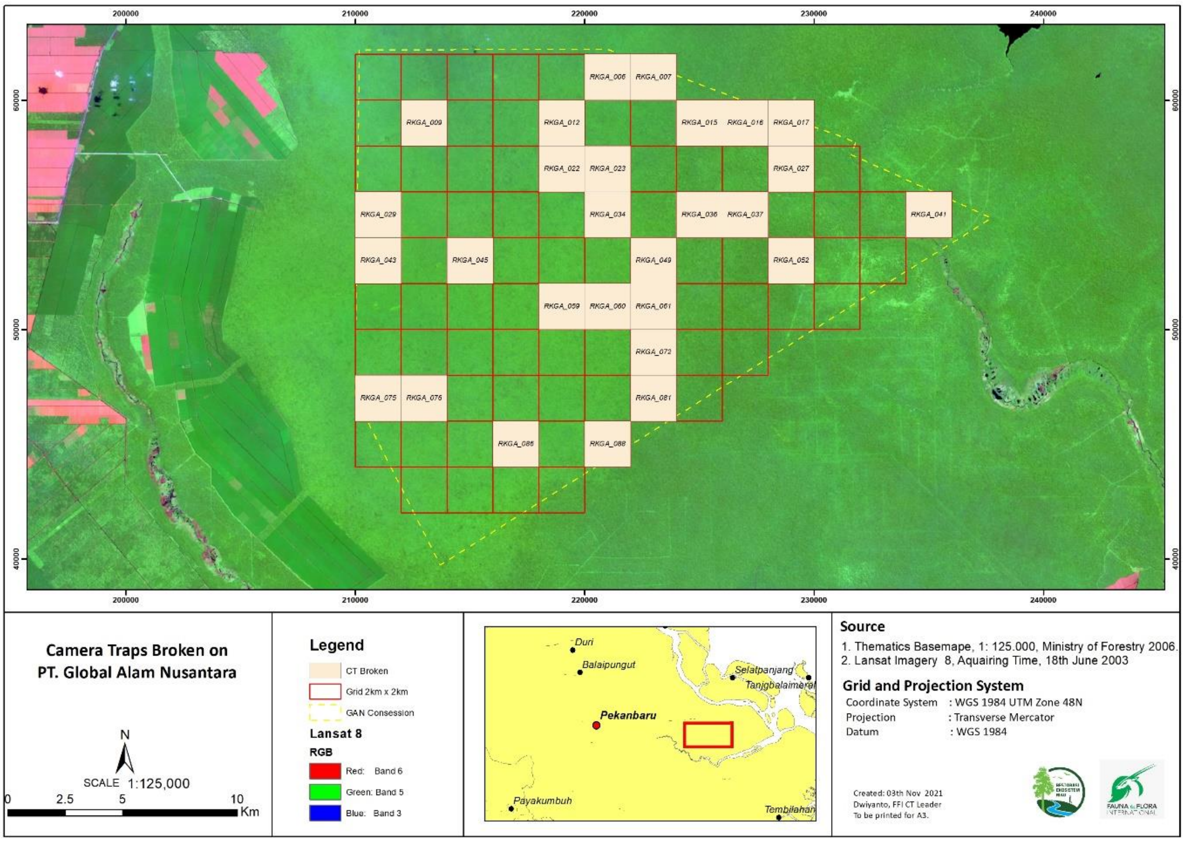


Figure 5. Broken camera trap stations in PT GAN.

3.2.2 Species compositions and distributions

In PT GAN, two Critically Endangered (CR) species were identified: the Sumatran tiger and the Sunda pangolin (Linkie et al., 2008; Challender et al., 2019). Both species face extinction in Sumatra as high levels of poaching and forest conversion have driven declines in populations. Moreover, one Endangered (EN) species: Sunda clouded leopard, and six Vulnerable (VU) species were observed: Sun bear, Pig-tailed macaque, Long-tailed macaque, Bearded pig, and Malay crestless fireback (*Melanoperdix niger*).

The species accumulation curve (Figure 3) indicates that there are still additional species records to be made if observations were to continue (i.e., the curve has not reached its asymptote). In contrast, surveys in PT GCN, PT SMN, and PT TBOT, which used the same survey design in the same landscape with no natural barriers, recorded several species that were not found in PT GAN. These included binturong (*Arctictis binturong*), moonrat (*Echinosorex gymnura*), banded civet (*Hemigalus derbyanus*), common palm civet (*Paradoxurus hermaphroditus*), leopard cat (*Prionailurus bengalensis*), flat-headed cat (*P. planiceps*), and banded linsang (*Prionodon linsang*).

In Figure 6, the relative abundance index (RAI), the proportion of area occupied (PAO), and the probability of species detection in PT GAN are compared to the mean value of the concessions around it. The comparison of these three values is consistent for each species, with conservation priority animals such as the Sumatran tiger, Sunda pangolin, and Sunda clouded leopard having very low RAI, PAO and detection rate. Herbivorous tiger-prey species, such as bearded pigs, pig-tailed macaques, long-tailed macaques, and mouse deer, have a high RAI and PAO, covering more than half of the entire area surveyed, as well as a high detection rate. This shows that these four species are relatively common in the landscape surveyed.

The leopard cat was not detected in PT GAN despite being a relatively common wildcat in the RER area. The flat-headed cat was also not detected in PT GAN, though this is more in-keeping with patterns observed elsewhere in the RER area, where it has a very low detection rate and relative abundance. However, failure to record these two species in the PT GAN does not necessarily mean they are not present there. With 23% of camera-traps failing, their absence from the records may be more a reflection of their typically low rate of detection and it is possible that both species would be recorded with a more reliable grid, particularly as the species accumulation curve did not reach its asymptote.

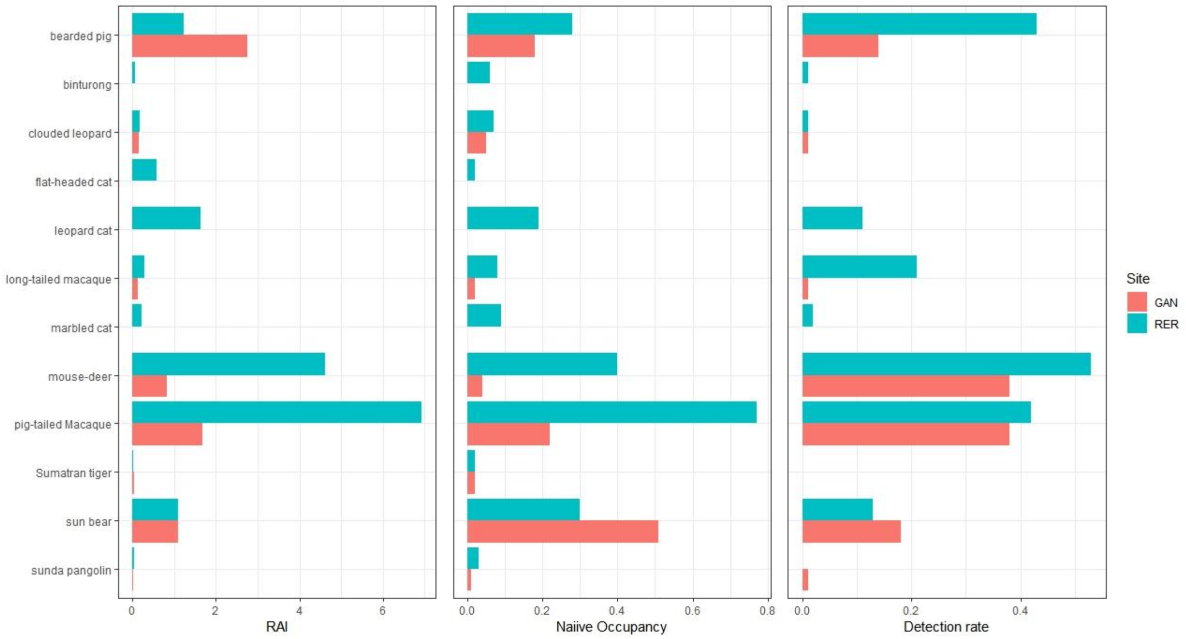


Figure 6. Comparison of RAI, occupancy and detection rate of terrestrial mammals in PT GAN and RER.

3.2.3 Activity patterns

Activity patterns for each species are presented in Table 3 and Appendix 2. In general, our study drew the same conclusion as much of the available literature has, with the following descriptions.

Artiodactyla

The identified species of this group were mouse deer and bearded pig. The pattern of mouse deer activity, in this study, tended to be diurnal with peak activity occurring around 08:00, but showing a bimodal pattern with a second peak in the afternoon. In several studies (e.g., Lading, 2006; Phillipps, 2016), this species is active both at night and day. Bearded pigs show activity patterns that tend to be diurnal but can also be active at night. In this study, they can be categorized as cathemeral (irregularly active) and many studies have shown that wild pigs change their active period during times of stress, such as elevated predation levels or from anthropogenic pressure (Posa et al., 2011; Love et al., 2018; Davison et al., 2019).

Carnivora

From the carnivores, the only activity patterns that can be determined are sun bear, Malay civet, and yellow-throated martens. The number of records (photographs; n<15) for other species (Sunda clouded leopard, marbled cat, and Sumatran tiger) were not high enough to assign activity patterns. The pattern of sun bear activity, in this study, shows a tendency towards diurnal, even though it is recorded in all time groups. The activity pattern of the Malay civet shows a nocturnal trend, beginning to be active at dusk and gradually decreasing at dawn. The pattern of yellow-throated martens shows bimodal activity; active during the day and at dusk but with a peak during the middle of the day (14:00-15:00). These three patterns are in-line with (Phillipps, 2016).

Primates

The long-tailed and pig-tailed macaques are sympatric species with similar diets and habitat preferences. Not surprisingly, then, they also share activity patterns, with peak times in the morning and evening (Supriatna & Wahyono, 2000; Gursky-Doyen & Supriatna, 2010), resting during the day to digest their food. In this study, pig-tailed macaque has a highly active time in the morning whilst long-tailed macaques were very active in the evening; presumably, due to having similar niches, these two species display temporal separation to reduce competition.

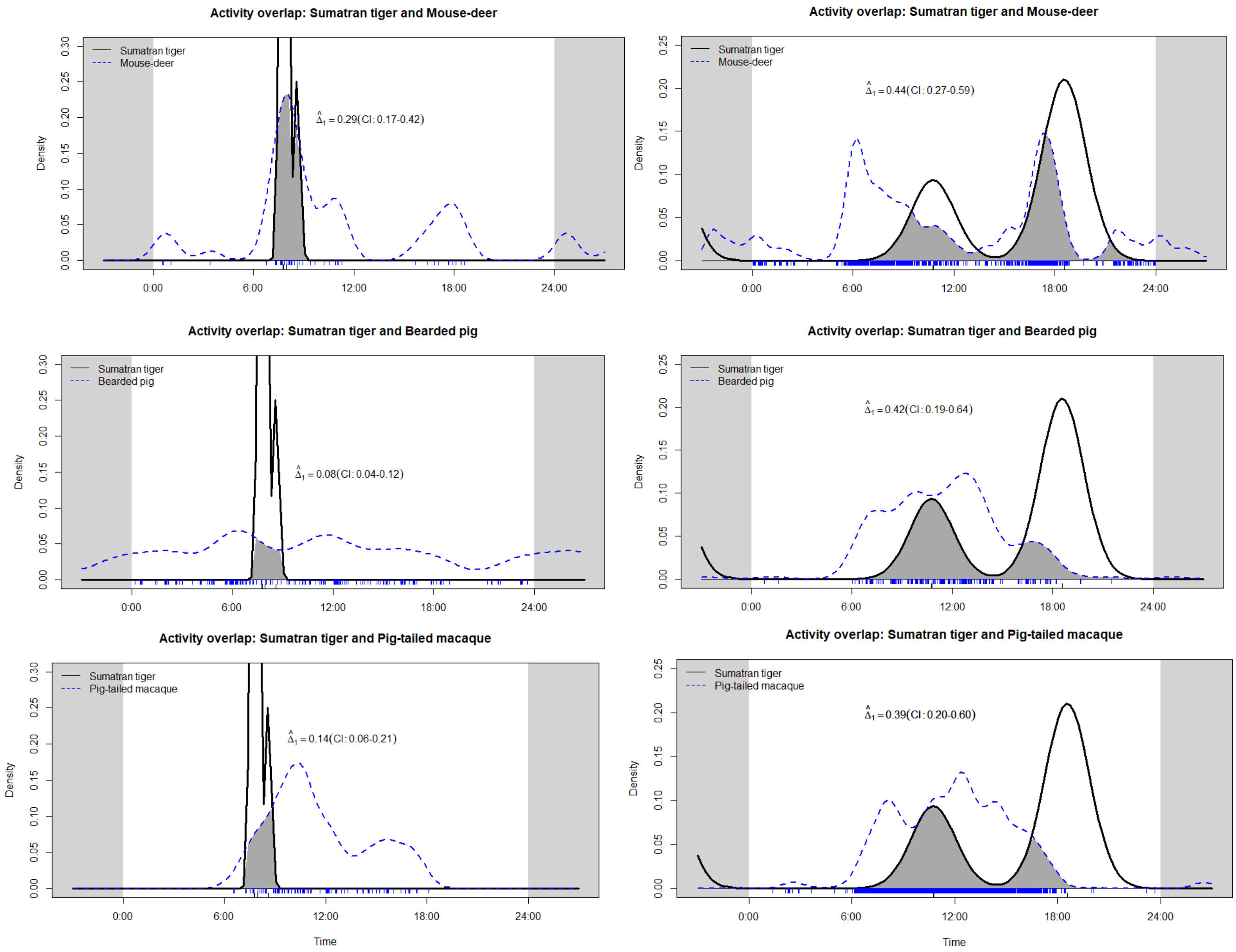
3.2.4 Tiger–prey interaction

We recorded 837 images, with 551 of them (66%) being potential tiger-prey species (bearded pig, pig-tailed and long-tailed macaque, and mouse deer) with relative abundance index values (RAI) of 2.76, 1.67, 0.12, and 0.81, respectively. These relatively abundant species are also more widely and evenly distributed throughout the landscape. Tigers prefer to prey on species that have the same body mass as themselves, similar to other solitary predators (Gittleman, 1985; Vézina, 1985; Hayward et al., 2012; Smith et al., 2018). For example, in Sumatra, tigers significantly prefer wild boar (*Sus scrofa*) and Sambar deer (*Rusa unicolor*) (Allen et al., 2021). Preying on large animals is more effective than hunting for smaller prey that requires a higher hunting frequency to balance calorific needs.

The results of the current survey, and those in the other RER concessions, show the mouse deer as the favoured prey, followed by bearded pig, with spatial & prey mass adjusted values of 0.20 and 0.19, respectively. Their importance as tiger-prey species probably reflects the absence of much larger species, such as sambar deer, in this peat forest, effectively shifting preferences to these smaller, but readily available species. Tigers in Sumatra have a diurnal or crepuscular activity pattern, with the highest activity occurring before dawn (O'Brien et al., 2003; Pusparini et al., 2018). Although tiger detection was rarely present in this study, the graph in Figure 7 illustrates that tiger activity in the area most likely follows a diurnal and crepuscular pattern.

The overlap coefficient value ($\hat{\Delta}$) of the overlapping activities of tigers and their prey in the RER area (Figure 7b) is close to 0.5, where a value of 1 represents perfect overlap and a value of 0 indicates that they do not have the same active time. In the current study, most overlap occurred during the day and at dusk. This data suggests that, while detecting tigers with camera-traps is difficult, the prey species that can support tigers in this landscape are still viable. A priority conservation management activity that can improve tiger conservation (and potentially minimize Human-Tiger

Conflict) is to ensure that tiger prey availability remains abundant by preventing the hunting of tiger prey species in PT GAN.



(a) (b)

Figure 7. Temporal overlap between tiger and their preferred prey species (a). Temporal overlap in PT GAN (b). Combined temporal overlap between PT GAN, PT SMN, PT GCN, and PT TBOT.

3.2.5 Species distribution modelling of Sumatran tiger

One of the outcomes of this model is to identify the most significant variables for predicting the presence of the Sumatran tiger, as well as the interaction between variables and the chance of tigers being present. Table 5 shows a list of the variables used in the prediction model and a ranking of their contributions to the model. It can be shown that the most influential variables are vegetation type, distance from the forest edge, and prey availability.

Table 5. Important variable and contribution of each variable.

Variable	% Contribution	Permutation Importance
Vegetation Type	52	46
Distance from forest edge	17	14
Prey Availability	12	12
Average annual temperature	5	7
Distance from canal	4	3
Tree proportions	4	3
Average monthly temperature	3	5
Distance from main river	2	6

The response curves from the most influential variables of tiger presence are shown in Figure 8. For vegetation type, riparian areas are preferable for tiger. For prey availability, tiger presence is positive and tigers are more likely to inhabit areas where prey is abundant. Distance from forest edge shows a negative response, indicating that tiger presence decreases as distance from the forest edge increases. This can be explained by the fact that forest edge in PT GAN is defined by riparian zones of Serkap and Turip Rivers since the distribution model covers the entire area of RER concessions on Kampar Peninsula. These findings are consistent with the previous explanation that tigers prefer riparian areas where many prey species are found near water sources (rivers). This survey reinforces the fact that tigers can survive in a variety of environments as long as there is enough prey and water (Seidensticker et al., 1999; Wibisono & Pusparini, 2010).

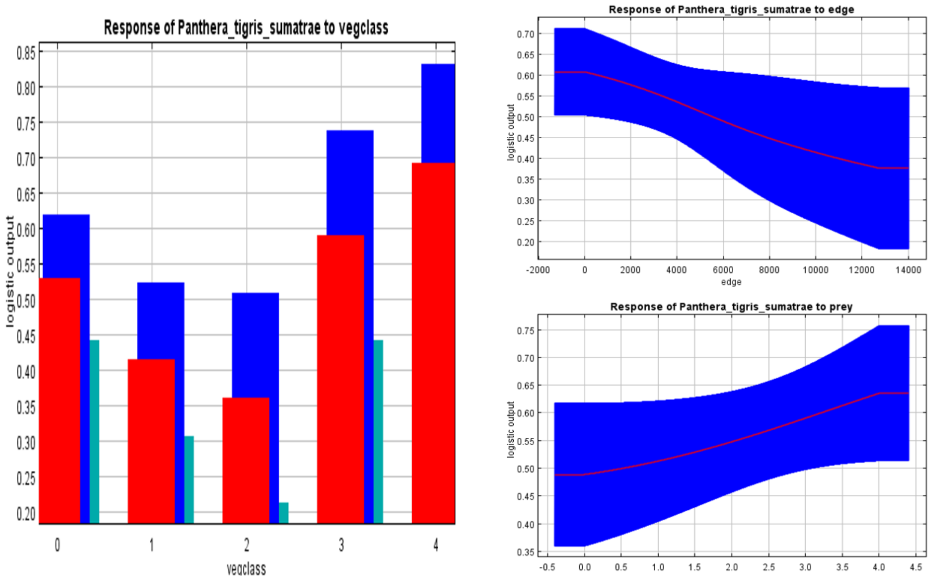


Figure 8. Response curves from most influential variables on tiger presence in PT GAN.

When considering all four RER concessions on Kampar Peninsula, tiger encounters mostly occurred in riparian and southern areas of PT TBOT and PT GCN. Both areas are adjacent to RAPP's acacia plantation and where a majority of human activity is located relating to fiber plantation activities (harvesting, planting, maintenance, inventory, and forest protection). According to Tropenbos International Indonesia Program (2010), tigers are often encountered in and around acacia plantations. This is supported by research conducted by Sunarto et. al. (2011), which found that the probability of occupancy is negative to forest centroid in a landscape surrounded by plantation. We suggest that the area surrounding the concessions may represent an extended home range for tigers. Furthermore, actively managed fiber plantation adjacent to RER concessions may act as a buffer to reduce unwanted human disturbance (i.e. snaring, encroachment, illegal logging), reducing forest threats. To maintain safe coexistence between humans and tigers, plantation managers need to conduct regular awareness briefings for plantation workers to avoid actions and activities which may cause human-tiger conflict.

IV CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

1. Due to a 23% camera failure rate in this study, it is likely that some mammal or bird species were not detected in PT GAN. Only 15 mammal species and eight bird species were recorded. Moreover, more than 70% of PT GAN is low pole forest which generally has lower species richness and abundance due to lower vegetative diversity and longer periods of seasonal flooding.
2. Analysis on the interaction between tigers and their prey found that the prey animal's relative abundance and occupancy could support tiger survival in this landscape.
3. The results of the tiger distribution model show the most suitable habitat was located in undisturbed and degraded Mixed Peat Swamp Forest near the Serkap River in the east and the southern area near PT TBOT boundary. Tigers had no preference for the peat dome low pole forest.

4.2 Recommendations

1. It is preferable to use camera traps that are less than 5-years old to minimize potential failure rate.
2. The Sumatran tiger habitat can be protected and enhanced in this area by preventing hunting of its main prey animals that include mouse deer, bearded pig, and pig-tailed macaque.
3. Because the tiger distribution modelling results show that tigers prefer areas near rivers, acacia plantations, and roads; plantation managers should educate their employees and contractors, especially those living/working in harvesting/planting blocks, on the possibility of encountering tigers on a regular basis. To avoid human-tiger conflicts, humans should not hunt tiger prey, appear as prey during dawn/dusk (crepuscular) periods, and not posses domesticated pets in field camps. These recommendations also extend to fishermen that have huts along the Serkap river.

V. REFERENCES

ALLEN, M.L., SIBARANI, M.C. & KROFEL, M. (2021) Predicting preferred prey of Sumatran tigers Panthera tigris sumatrae via spatio-temporal overlap. *Oryx*, 55, 197–203. Cambridge University Press.

AVRIANDY, R., GUNARYADI, D., MARGARETH RP, I., FAJAR ART C, A.A., TRISNAWATI, S.A., MAULANA, N.P., ET AL. (2016) Camera Trap Report In Restorasi Ekosistem Riau. Jakarta.

AZLAN, J.M. & SHARMA, D.S.K. (2006) The diversity and activity patterns of wild felids in a secondary forest in Peninsular Malaysia. *Oryx*, 40, 36–41. Cambridge University Press.

BLAKE, J.G., MOSQUERA, D., LOISELLE, B.A., SWING, K., GUERRA, J. & ROMO, D. (2012) Temporal activity patterns of terrestrial mammals in lowland rainforest of eastern Ecuador. *Ecotropica*, 18, 137–146. Society for Tropical Ecology.

CAO, Y., DEWALT, R.E., ROBINSON, J.L., TWEDDALE, T., HINZ, L. & PESSINO, M. (2013) Using Maxent to model the historic distributions of stonefly species in Illinois streams: the effects of regularization and threshold selections. *Ecological Modelling*, 259, 30–39. Elsevier.

CHALLENDER, D., WILLCOX, D.H.A., PANJANG, E., LIM, N., NASH, H., HEINRICH, S. & CHONG, J. (2019) Manis javanica (Sunda Pangolin). *The IUCN Red List of Threatened Species*, e.T12763A123584856.

CHAO, A., WANG, Y.T. & JOST, L. (2013) Entropy and the species accumulation curve: a novel entropy estimator via discovery rates of new species. *Methods in Ecology and Evolution*, 4, 1091–1100. Wiley Online Library.

DAVISON, C.W., CHAPMAN, P.M., WEARN, O.R., BERNARD, H. & EWERS, R.M. (2019) Shifts in the demographics and behavior of bearded pigs (Sus barbatus) across a land-use gradient. *Biotropica*, 51, 938–948. Wiley Online Library.

ELITH, J., PHILLIPS, S.J., HASTIE, T., DUDÍK, M., CHEE, Y.E. & YATES, C.J. (2011) A statistical explanation of MaxEnt for ecologists. *Diversity and distributions*, 17, 43–57. Wiley Online Library.

FICK, S.E. & HIJMANS, R.J. (2017) WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas. *International Journal of Climatology*, 37, 4302–4315.

FISKE, A.I., CHANDLER, R., MILLER, D., ROYLE, A., KERY, M., HOSTETLER, J., ET AL. (2019) Package ‵ unmarked ′ R topics documented :

GITTLEMAN, J.L. (1985) Carnivore body size: Ecological and taxonomic correlates. *Oecologia*, 67, 540–554.

GRIFFITH, D.M., VEECH, J.A., MARSH, C.J. & GRIFFITH, M.D.M. (2014) Package ‘cooccur’. *Journal of Statistical Software*, 69, 1–17.

GURSKY-DOYEN, S. & SUPRIATNA, J. (2010) Indonesian primates. Springer.

HANSEN., M.C., POTAPOV., P. V., MOORE, R., HANCHER, M., TURUBANOVA, S.A., TYUKAVINA, A., ET AL. (2013) High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, 342, 850–853.

HAYWARD, M.W., JĘDRZEJEWSKI, W. & JEDRZEJEWSKA, B. (2012) Prey preferences of the tiger Panthera tigris. *Journal of Zoology*, 286, 221–231. Wiley Online Library.

HELTSHE, J.F. & FORRESTER, N.E. (1983) Estimating species richness using the jackknife procedure. *Biometrics*, 1–11. JSTOR.

HERNANDEZ, P.A., GRAHAM., C.H., MASTER., L.L. & ALBERT, D.L. (2006) The effect of sample size and species characteristics on performance of different species distribution modeling methods. *Ecoghrapy*, 29, 773–785.

KARANTH, K.U. & NICHOLS, J.D. (2002) Monitoring tiger populations: why use capture–recapture sampling. *Monitoring Tigers and Their Prey: A Manual for Researchers, Managers and Conservationists in Tropical Asia*, 153–166.

KASS, J.M., MUSCARELLA, R., GALANTE, P.J., BOHL, C.L., PINILLA- BUITRAGO, G.E., BORIA, R.A., ET AL. (2021) ENMeval 2.0: Redesigned for customizable and reproducible modeling of species' niches and distributions. *Methods in Ecology and Evolution*, 12, 1602–1608. Wiley Online Library.

KINDT, R. & KINDT, M.R. (2015) Package 'BiodiversityR'. *R Proj*.

KREBS, C.J. (2014) Ecology: The Experimental Analysis of Distribution and Abundance. In *Pearson Education Limited* p. , 6th edition. Pearson, United States of America.

LADING, E. (2006) Camera trapping and conservation in lambir hills national park, sarawak. *The Raffles Bulletin of Zoology*, 54, 469–475.

LINKIE, M. & RIDOUT, M.S. (2011) Assessing tiger–prey interactions in Sumatran rainforests. *Journal of Zoology*, 284, 224–229.

LINKIE, M., WIBISONO, H.T., MARTYR, D.J. & SUNARTO (2008) Panthera tigris ssp. sumatrae. *The IUCN Red List of Threatened Species 2008*, 8235, 1–10.

LOVE, K., KURZ, D.J., VAUGHAN, I.P., KE, A., EVANS, L.J. & GOOSSENS, B. (2018) Bearded pig (Sus barbatus) utilisation of a fragmented forest–oil palm landscape in Sabah, Malaysian Borneo. *Wildlife Research*, 44, 603–612. CSIRO Publishing.

MACKENZIE, D.I., NICHOLS, J.D., LACHMAN, G.B., DROEGE, S., ANDREW ROYLE, J. & LANGTIMM, C.A. (2002) Estimating site occupancy rates when detection probabilities are less than one. *Ecology*, 83, 2248–2255. Wiley Online Library.

MATHAI, J. & TIMOTHY, S. (2020) Package ' camtrapR ' R topics documented :

MEREDITH, A.M., RIDOUT, M. & MEREDITH, M.M. (2020) Package ' overlap '.

MEREDITH, M.E. (2017) wiqid: Quick and Dirty Estimates for Wildlife Populations. R package version 0.1. 3.

MEROW, C., SMITH, M.J. & SILANDER, J.A. (2013) A practical guide to MaxEnt for modeling species' distributions: What it does, and why inputs and settings matter. *Ecography*, 36, 1058–1069.

NOWAK, R.M. & WALKER, E.P. (1999) Walker's Mammals of the World. JHU press.

O'BRIEN, T.G. (2011) Abundance, density and relative abundance: a conceptual framework. In *Camera traps in animal ecology* pp. 71–96. Springer.

O'BRIEN, T.G., KINNAIRD, M.F. & WIBISONO, H.T. (2003) Crouching tigers, hidden prey: Sumatran tiger and prey populations in a tropical forest landscape. *Animal Conservation*, 6, 131–139. John Wiley & Sons, Ltd.

PALMER, M.S., SWANSON, A., KOSMALA, M., ARNOLD, T. & PACKER, C. (2018) Evaluating relative abundance indices for terrestrial herbivores from large‐scale camera trap surveys. *African journal of ecology*, 56, 791–803. Wiley Online Library.

PHILLIPPS, Q. (2016) Phillipps' field guide to the mammals of Borneo and their ecology: Sabah, Sarawak, Brunei, and Kalimantan. Princeton University Press.

PHILLIPS, S.J., ANDERSON, R.P., DUDÍK, M., SCHAPIRE, R.E. & BLAIR, M.E. (2017) Opening the black box: an open-source release of Maxent. *Ecography*, 40, 887–893.

POSA, M.R.C., WIJEDASA, L.S. & CORLETT, R.T. (2011) Biodiversity and conservation of tropical peat swamp forests. *BioScience*, 61, 49–57. American Institute of Biological Sciences Circulation, AIBS, 1313 Dolley ….

PURBA, C.P.P. (2014) Potret keadaan hutan Indonesia: periode 2009-2013. Forest Watch Indonesia.

PUSPARINI, W., BATUBARA, T., SURAHMAT, F., ARDIANTIONO, SUGIHARTI, T., MUSLICH, M., ET AL. (2018) A pathway to recovery: The Critically Endangered Sumatran tiger Panthera tigris sumatrae in an 'in danger' UNESCO World Heritage Site. *Oryx*, 52, 25–34.

R DEVELOPMENT CORE TEAM, R. (2011) R: A Language and Environment for Statistical Computing. In *R Foundation for Statistical Computing* p. .

SANDERSON, J. & HARRIS, G. (2013) Automatic data organization, storage, and analysis of camera trap pictures. *Journal of Indonesian Natural History*, 1, 310.

SEIDENSTICKER, J., CHRISTIE, S. & JACKSON, P. (1999) Riding the Tiger. Tiger conservation in human-dominated landscapes. *Cambridge University Press, New York(USA). 383*, 383.

SMITH, O., WANG, J. & CARBONE, C. (2018) Evaluating the effect of forest loss and agricultural expansion on Sumatran tigers from scat surveys. *Biological Conservation*, 221, 270–278. Elsevier.

SUNARTO, KELLY, M.J., VAUGHAN, M.R., KLENZENDORF, S., PRISLEY, S.P., NICHOLS, J.D. & STAUFFER, D.F. (2011) Ecology and restoration of Sumatran tigers in forest and plantation landscapes. *Department of Fish and Wildlife Conservation*, PhD, 286.

SUPRIATNA, J. & WAHYONO, E.H. (2000) Panduan lapangan primata Indonesia. Yayasan Obor Indonesia.

TROPENBOS INTERNATIONAL INDONESIA PROGRAM (2010) Buku I: Data dan informasi dasar penilaian menyeluruh nilai konservasi tinggi Semenanjung Kampar.

VÉZINA, A.F. (1985) Empirical relationships between predator and prey size among terrestrial vertebrate predators. *Oecologia*, 67, 555–565.

WARREN, D.L., MATZKE, N.J., CARDILLO, M., BAUMGARTNER, J.B., BEAUMONT, L.J., TURELLI, M., ET AL. (2021) ENMTools 1.0: An R package for comparative ecological biogeography. *Ecography*, 44, 504–511. Wiley Online Library.

WIBISONO, H.T. & PUSPARINI, W. (2010) Sumatran tiger (Panthera tigris sumatrae): A review of conservation status. *Integrative Zoology*, 5, 313–323. Wiley Online Library.

WISZ, M.S., HIJMANS, R.J., LI, J., PETERSON, A.T., GRAHAM, C.H., GUISAN, A., ET AL. (2008) Effects of sample size on the performance of species distribution models. *Diversity and Distributions*, 14, 763–773.

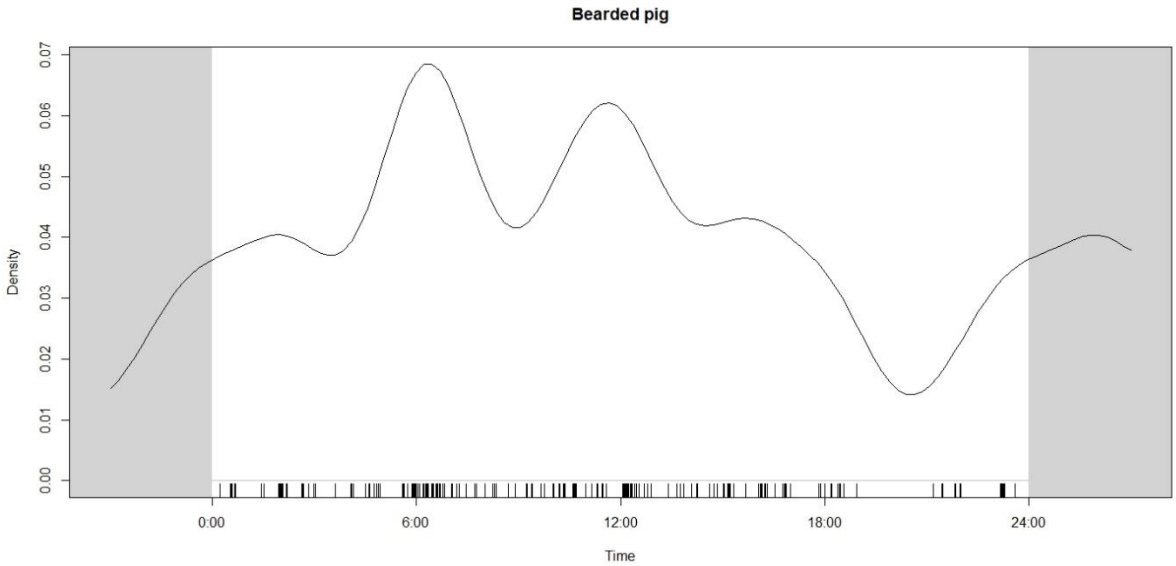
APPENDICES

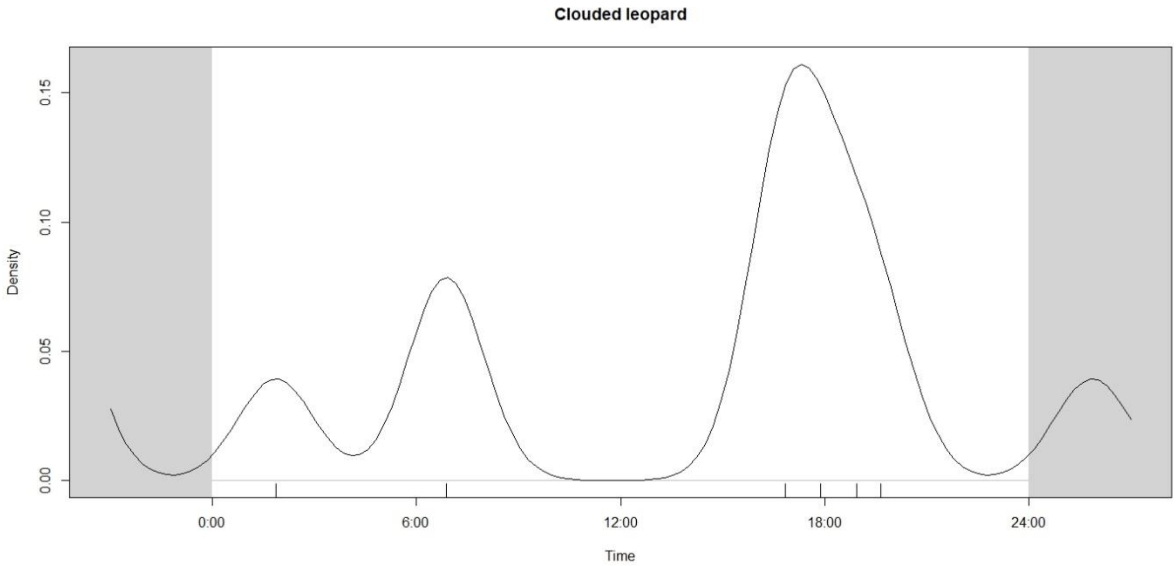
Appendix 1. Composition of all Species Recorded by Camera Traps in PT GAN.

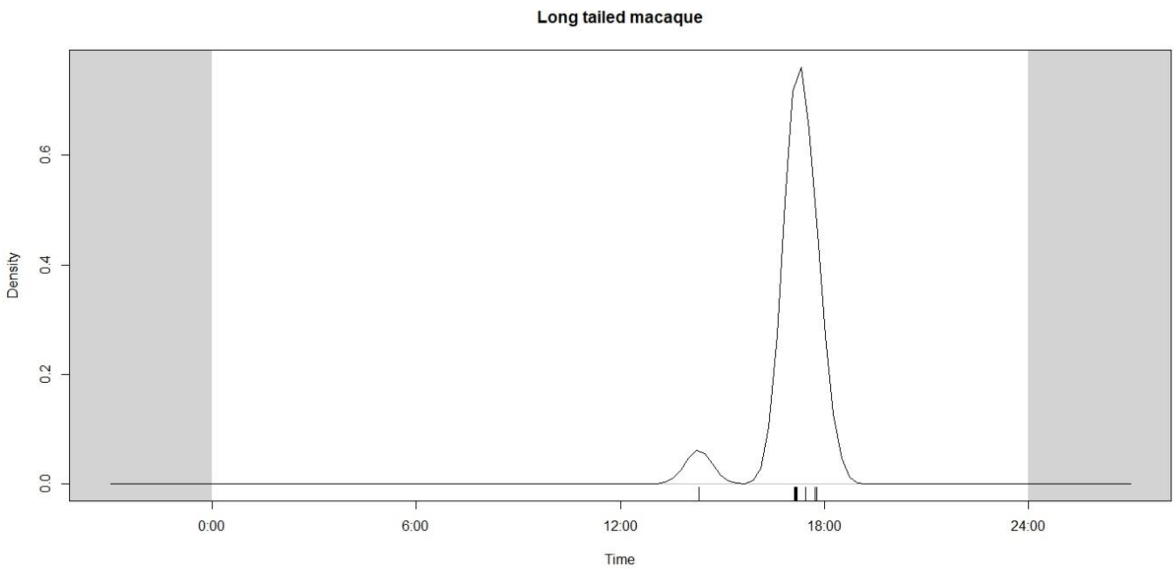
Family	*Species*	Common Name	Habitat	Capture	IE	RAI	PAO
Mammalia							
Cercopithecoidea	*Macaca nemestrina*	Pig-tailed macaque	Semi-terrestrial	191	67	1,25	0,22
	Macaca fascicularis	Long-tailed macaque	Semi-terrestrial	16	5	0,09	0,02
Felidae	*Neofelis diardi*	Clouded leopard	Semi-terrestrial	9	6	0,11	0,05
	Panthera tigris sumatrae	Sumatran tiger	Terrestrial	9	2	0,04	0,02
	Pardofelis marmorata	Marbled cat	Semi-terrestrial	2	2	0,04	0,02
Herpestidae	*Herpestes brachyurus*	Short-tailed mongoose	Terrestrial	2	2	0,04	0,02
Hystricidae	*Hystrix sumatrae**	Common porcupine	Terrestrial	1	1	0,02	0,01
Manidae	*Manis javanica*	Sunda pangolin	Terrestrial	1	1	0,02	0,01
Muridae	*Rattus* sp.	Rats	Terrestrial	13	10	0,19	0,08
Mustelidae	*Martes flavigula*	Yellow-throated marten	Terrestrial	16	12	0,22	0,13
Suidae	*Sus barbatus*	Bearded pig	Terrestrial	299	111	2,07	0,18
Tragulidae	*Tragulus* sp.	Mouse deer	Terrestrial	45	31	0,58	0,04
Ursidae	*Helartos malayanus*	Sun bear	Terrestrial	137	44	0,82	0,31
Viverridae	*Viverra tangalunga*	Malay civet	Terrestrial	47	31	0,58	0,24
	Arctogalidia trivirgata	Small-toothed palm civet	Arboreal	1	1	0,02	0,01
*Not previously identified in RER concessions on Kampar Peninsula.							

Family	*Species*	Common Name	Habitat	Capture	IE	RAI	PAO
Birds							
Accipitridae	*Spilornis cheela*	Crested serpent-eagle	Arboreal	2	1	0,02	0,01
Cuculidae	*Centropus sp*	Coucal	Arboreal	1	1	0,02	0,01
Pellorneidae	*Pellorneum capistratum*	Rufous-browed babbler	Arboreal	2	2	0,04	0,01
	Trichastoma rostratum	White-chested babbler	Arboreal	3	3	0,06	0,02
Phasianidae	*Melanoperdix niger*	Black partridge	Terrestrial	2	2	0,04	0,01
	Lophura erythrophthalma	Malay crestless fireback	Terrestrial	12	8	0,15	0,03
Pittidae	*Pitta moluccensis*	Blue-winged pitta	Arboreal	4	4	0,07	0,02
Timaliidae	*Cyanoderma erythropterum*	Chestnut-winged babbler	Arboreal	1	1	0,02	0,01

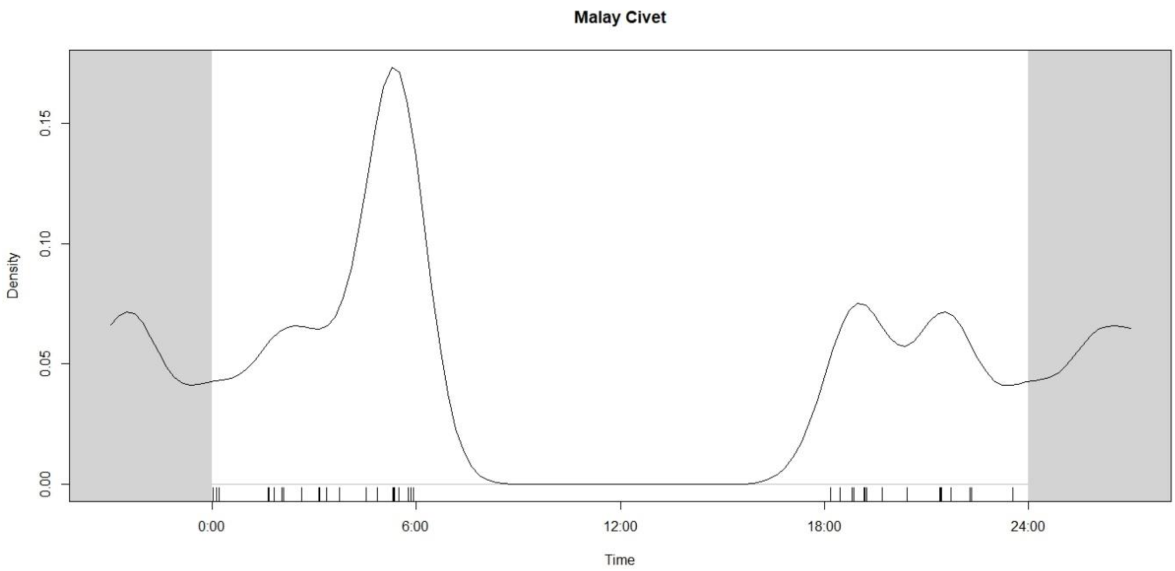
Appendix 2. Activity Patterns of Terrestrial Mammals and Potential Tiger-Prey in PT GAN.



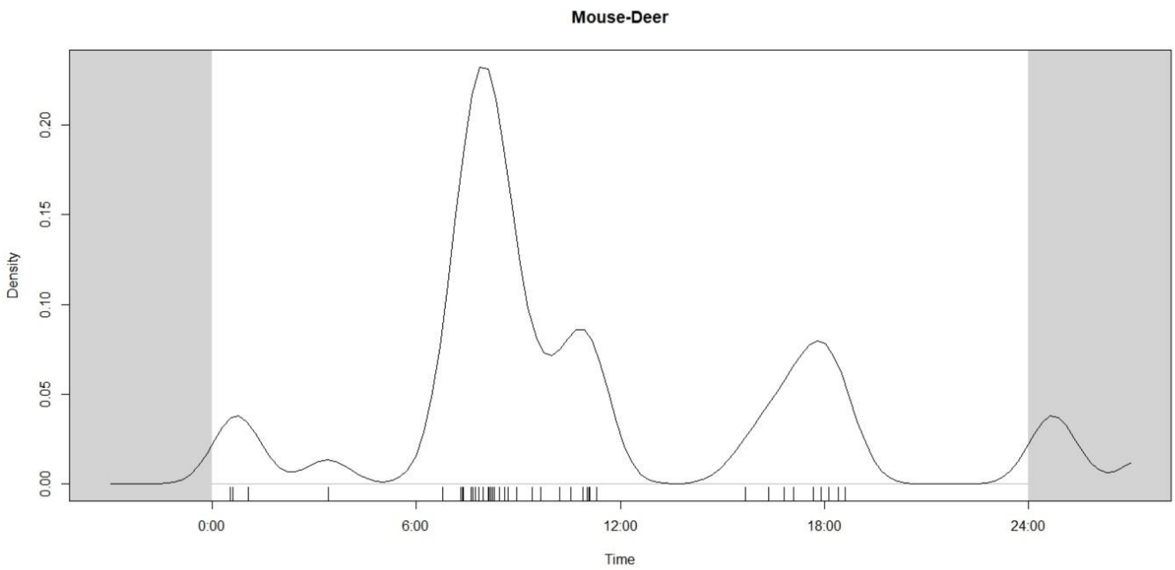




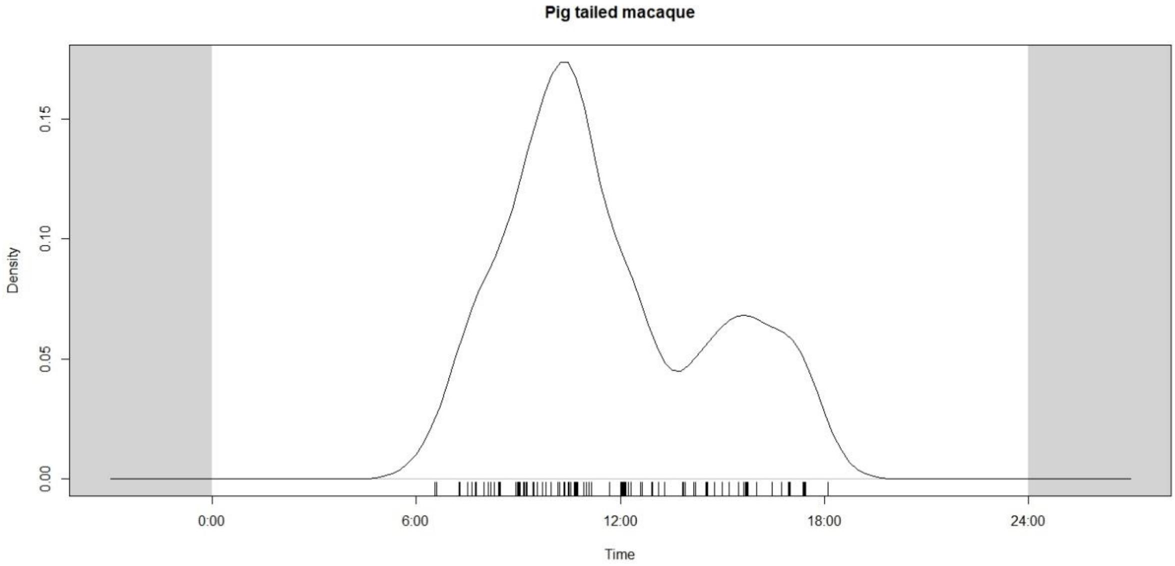
Long tailed macaque
Density
0.0
0.2
0.4
0.6
0:00
6:00
12:00
18:00
24:00
Time

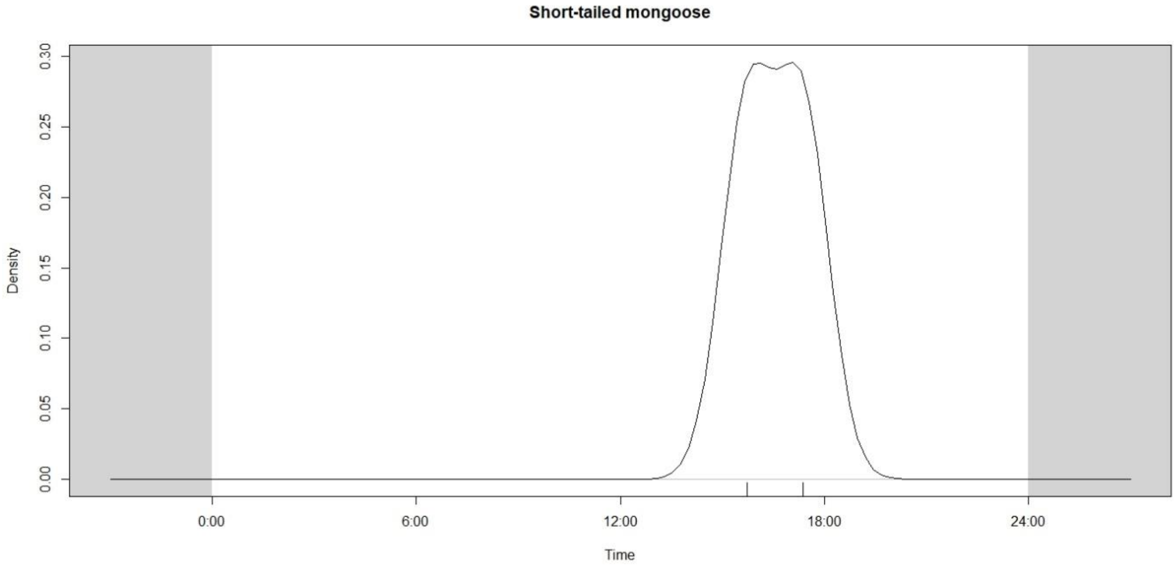


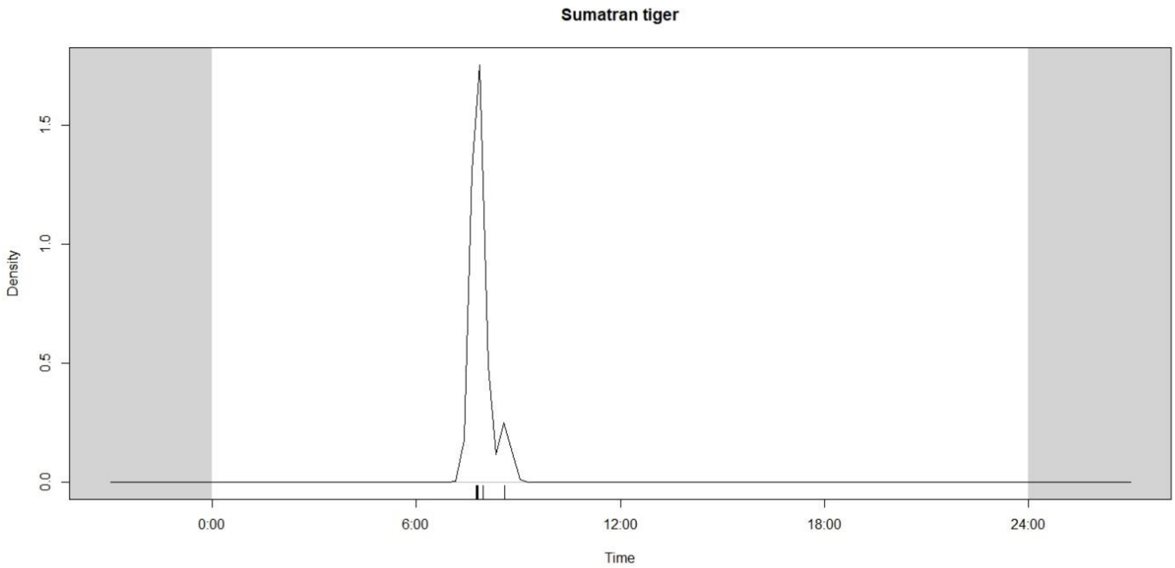
Malay Civet
Density
0.00
0.05
0.10
0.15
0:00
6:00
12:00
18:00
24:00
Time



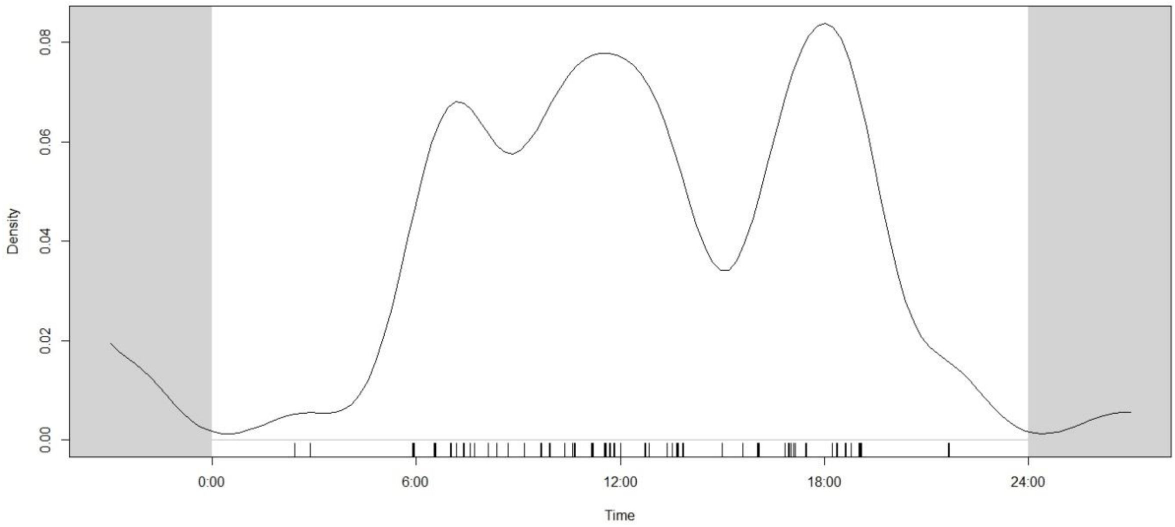
Mouse-Deer
Density
0.00
0.05
0.10
0.15
0.20
0:00
6:00
12:00
18:00
24:00
Time


Pig tailed macaque
Density
0.00
0.05
0.10
0.15
0:00
6:00
12:00
18:00
24:00
Time

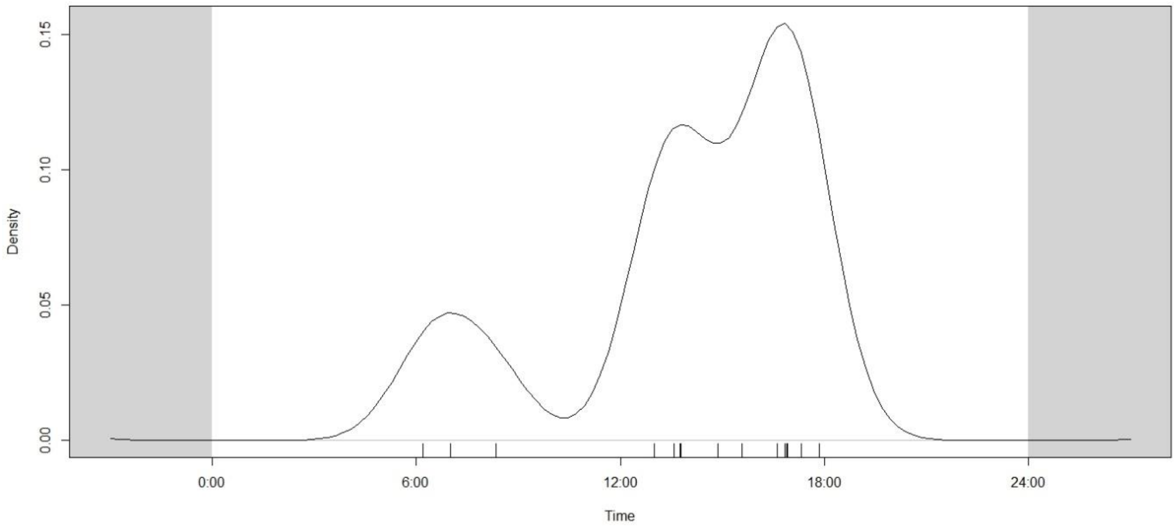

Short-tailed mongoose
Density
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0:00
6:00
12:00
18:00
24:00
Time


Sumatran tiger
Density
0.0
0.5
1.0
1.5
0:00
6:00
12:00
18:00
24:00
Time

Sun bear



Yellow-Throated marten



Appendix 3. Photographs of Species Captured in Camera Trap in PT GAN.

Carnivora

Clouded leopard (*Neofelis diardi*)

Sumatran tiger (*Panthera tigris sumatrae*)

Malayan civet (*Viverra tangalunga*)

Sun bear (*Helarctos malayanus*)

Yellow-throated marten (*Martes flavigula*)

Ungulate

Bearded pig (*Sus barbatus*)

Mouse deer (*Tragulus* sp.)

Porcupine

Common porcupine (*Hystrix sumatrae*)

Birds

Crestless fireback (*Lophura erythropthalma*)

Black partridge (*Melanoperdix niger*)

FAUNA & FLORA INTERNATIONAL

The David Attenborough Building,
Pembroke Street, Cambridge,
CBZ 3QZ, United Kingdom

Tel: +44 (0) 1223 571 000
Email: info@fauna-flora.org
www.fauna-flora.org

If you have any questions
or would like more information,
please contact:

Ryan Avriandy
Biodiversity Conservation Officer
ryan.avriandy@fauna-flora.org

Dwiyanto
Camera Trap Leader
dwiyantoduwez@gmail.com