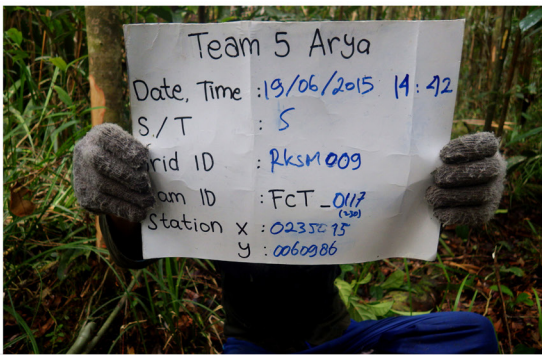
CAMERA TRAP REPORT IN RESTORASI EKOSISTEM RIAU

CAMERA TRAP REPORT



FAUNA & FLORA INTERNATIONAL

RESTORASI EKOSISTEM RIAU

APRIL

Camera Trap Report
In Restorasi Ekosistem Riau

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FAUNA & FLORA INTERNATIONAL

Fauna & Flora International (FFI) is the first international organization which engaged in the field of conservation. Since its establishment in 1903, FFI had contributed to many important conservation areas for biodiversity. In the early year of its establishment, FFI has helped and supported the determination of the various conservation areas in Africa, including Kruger National Park and the Serengeti. Currently, FFI has contributed substantially to the protection of threatened biodiversity and ecosystems in more than 40 countries spread over 5 continents with a total of more than 13.50 million acres of important conservation area, either on land or sea.

FFI with its vision believed that biodiversity could effectively being conserved by having communities living side by side in any protected landscape. To achieve its goal, FFI has implemented various scientific approach as a basis for creating conservation solutions that are sustainable and still take into account of human needs. FFI-IP helps communities to map the indigenous forests and get the its recognition officially to manage the forest in a sustainable way. In addition, FFI participate for guarding the survival of endangered species through sustainable funding mechanisms based on the program of REDD and PES.

FFI-IP has a broader its approach in the conservation efforts, mainly focused in the landscape level. Currently, FFI-is doing several conservation efforts at various locations in Indonesia like Sumatra, Kalimantan, Papua (Waigeo), Java (Nusakambangan) and Lombok. Through the assessment of High Conservation Value (HCV), FFI-IP has helped community to protect forests with a high potential for carbon reserves as well as the important habitats of the various endangered species (Sumatran elephant, Sumatran tiger, Orangutan) since 2007.

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OVERVIEW

Biodiversity surveys using camera trap have been undertaken during March-December 2015 in three APRIL concession areas, namely PT. GCN, PT. SMN and PT. TBOT. These surveys aimed to provide a reliable biodiversity baseline data across the determined concession areas. A single and pair of camera traps were set up in a total of 220 stations. Camera traps were set up systematically in the grid cell with the size of 2 x 2 km, in both single and paired setting method. From the surveys, we obtained interesting findings of some cryptic species which would otherwise be hard to find using other methods. They included storm stork in understory vegetation, black quail and red partridge which are rare records for Sumatra. From mammalian group, at least five of the seven species of small cats in Sumatra were found in this area, and two of them were Sumatran tiger and flat-headed cat which are known as charismatic species. The Sumatran tiger has presently been categorized as a critically endangered species, whereas the flat-headed cat is known as wetland specialist. Discovery of the flat-headed cat in this region supports the study conducted by Wilting et al. (2010) who previously stated that Kampar peninsula is one of the largest habitats in Sumatra for flat-headed cat. This implies that it is an important landscape for maintaining the existence of flat-headed cat in Sumatra. During the survey, the camera trap captured only two pictures of Sumatran tigers. However, the results of the MaxEnt modelling showed that the number of Sumatran tiger was predicted to be higher in the Southern part of the concession areas of PT. TBOT and PT. GCN up to the adjacent Acacia woodland. This result suggests that with good management, Sumatran tiger can harness Acacia woodland as part of their home range.

I. PREFACE

1.1 Background

Peat swamp forest is a unique ecosystem, but it is susceptible to human disturbances. Previously, Sumatra was the largest peat swamp forest in Indonesia with the area of 7,151,887 ha. However, due to illegal logging, habitat changes into both agriculture land and plantation, and also the incidents of forest and land fires, Sumatra encountered the greatest loss of peatland compared to Kalimantan and Papua, which was about 78% from its initial status (Purba et al., 2014). Compared to the other provinces in Sumatra, Riau has the largest peatland area covering 4,004,434 ha and the largest part of about 671,125 ha exists in Kampar peninsula (Tropenbos International Indonesia Program, 2010), which is the important area for biodiversity conservation. This area is also an important habitat for Sumatran Tiger and other endangered species. Birdlife International found that this landscape met the criteria as an Important Bird Area (IBA). In addition, Kampar peninsula provides important ecosystem services such as the storage for carbon stocks which potentially ranges from 2.14 to 2.68 billion tons, the preservation of water resources and the system for flood reduction (Tropenbos International Indonesia Program, 2010). However, the pressure of land exploitation by some parties has resulted in the constriction of forest cover in this area.

Riau ecosystem Restoration (RER) is a non-profit organization established by APRIL in 2013 with the area of about 150,000 ha. It has the purpose of attempting restoration and conservation of degraded peat swamp forest ecosystem in the area of Kampar peninsula as a response to the program developed by the Ministry of Environment and Forestry of the Republic of Indonesia to protect 2.6 million ha of forests through the Ecosystem Restoration scheme by giving a business license for utilization of wood forest products (IUPHHK-RE).

Three of the four concessions under the supports of the RER in Kampar peninsula, which are PT. Gemilang Cipta Nusantara (20.265 ha), PT. Sinar Mutiara Nusantara (32.830 ha) and PT. The Best One Uni Timber (39.412 ha), have obtained the license of IUPHHK-RE. Efforts on RER restoration and conservation are essential as the area of RER concession is relatively large, which is approximately 150,000 ha or 29% of the total coverage of the Tasik Besar Serkap-Forest Management Unit (513,276 ha). The RER initiates collaboration with Fauna Flora International-Indonesia Program (FFI-IP) for designing framework, policies and management plans related to the Community, Climate and Biodiversity (CCB) assessment more widely in the landscape profile. The management plan resulted from this assessment is expected to help restoring the important ecological process and function in Kampar Peninsula landscape. Additionally, this initiative will ensure that many people could benefit from the ecosystem services provided by the peat swamp forest, especially the communities that coexist with this landscape (Restorasi Ekosistem Riau, 2015). If this restoration and conservation program is successful, it could be used as a model and applied in other areas with broader landscape level (Kristi, 2014).

Biodiversity is one of the most important biotic components making up the peat swamp forest ecosystem in Kampar Peninsula. The availability and updated biological diversity baseline data at a certain study site are

often very limited or difficult to obtain. Unfortunately, the data is required as a reference for the preparation of programs related to the management of restoration and conservation efforts. Therefore, several studies concerning the diversity of fauna and flora in the region mentioned previously are essential. The use of camera trap to survey fauna diversity offers many advantages especially in the tropical forests where the area are mostly unaccessible. This method is able to find cryptic species which might be hard to find by other techniques. By setting the camera trap in the right position can provide deeper information on wildlife ecological aspects examined including its pattern of activity, detection of its occupancy, or and even its density in a certain landscape.

1.2 Objectives

This report is expected to provide basic reference to the authority of RER management in term of developing a long term management plan of the RER area according to the HCV concept, with the following objectives :

1. Build a baseline dataset on fauna diversity in order 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. METHOD

2.1 Study Site

Kampar Peninsula (671,125 ha), is located on the Eastern part of Riau province (101° 50‘ to 103° 07‘ E and 0° 10‘ to 1° 14‘ N). Based on the administrative boundary, Kampar peninsula is divided into two districts of Siak Regency (38%) and Pelalawan regency (62%). The west side is bordered by a dry land, the East side is adjacent to Panjang strait, the North part is bordered by Siak river and the South part is bordered by Kampar river. Kampar peninsula has a topography ranging between 2 and16 m. The area has a tropical wet climate with a relative humidity ranging between 81 and 84% and an annual average of about 82%. The annual precipitation ranges between 1,949 and 2,951 mm/year. Its monthly air temperature ranges between 26.1 and 27.5° Celcius with an annual average of 26.7° C (PT. GCN, 2012). This area can be reached via Siak river or through the road along the river edge. It could also be reached via Kampar River.

In general, there are three main types of ecosystems in Kampar Peninsula i.e. mangrove ecosystems, peat swamp forests and riparian forests. For the RER area, the main ecosystem is in the form of peat swamp forest which can be classified based on the type of vegetation, i.e. 1. A mixture of peat swamp forests with uneven canopy heights (mixed peat swamp forest), 2. Peat swamp forests with relatively even high canopy and uniform tree diameter and density (tall pole forest), 3. peat swamp forests with low canopy (low pole forest), and 4. Riverbank forests (riparian forest). Riparian forests in the RER is along the pherypery of three rivers flowing in that area i.e. Turip River, Serkap River and Sangar River. At the highest tide season, these river may form puddles of 1-1.5 km wide. The peat depth in the RER area reaches 15 m with the level of acidity (pH) of water ranges from 3.1 to 3.9 (Tropenbos International Indonesia Program, 2010).

The survey was conducted in three concessions which are under the area of Riau Ecosystem Restoration (RER). PT Gemilang Cipta Nusantara (GCN) (20,265 ha), PT. Sinar Mutiara Nusantara (SMN) (32,830 ha) and PT. The Best One Uni Timber (TBOT) (39,412 ha). The survey was conducted from March to December 2015.

a. PT. Gemilang Cipta Nusantara (GCN)

The concession area of PT. GCN is the smallest area compared to the other two concessions. PT. GCN is directly adjacent to the other companies as well as the most accessible by the surrounding community, which makes it most susceptible to interferences. PT. GCN is a secondary peat swamp forest dominated by Mengkuang (Pandanus spp.) and Meranti (Shorea spp.). Sangar River with the width of 5-7 m is the only main river that flows from the Northeast to the Southwest.

b. PT. Sinar Mutiara Nusantara (SMN)

PT. SMN is located between two branches of the Serkap river to the Tasik Besar Serkap. Its area is directly adjacent to the area of PT. GCN. In general, the sampling site is a secondary swamp peat ecosystem with

dry land containing relatively densed sapling composition. There is also a water source such as a trench or canal, several inundation due to a falling trees, puddles, water in the tree hole and water that comes from Nepenthes (Nepenthes sp.). The dominant vegetations that can be found throughout the concession area are Meranti (Shorea teysmanniana), Punak (Tetramerista glabra) and Bintangur (Calophyllum ferrugineum) as well as shrubs and Pandanus sp.

c. PT. The Best One Unitimber (TBOT)

Most of the PT. TBOT is a secondary peat swampforest with a puddle depth of 15-50 cm. Mengkuang (Pandanus sp.) in the form of living trees are very rare, but they are predominating in the form of living shrubs. Unlike the concessions of PT. GCN and PT. SMN where Nepenthes plants (Nepenthes sp.) are very common, these plants are relatively rare here.

2.2 Sampling Scheme

The survey was conducted between March and November 2015, with the target of 500 trapday/100 km2. A trapday is the time for the camera to become active for 24 hours. Camera trap (the Bushnell Trophy Cam type HD 2014) were installed on those three concession areas, i.e. PT. GCN, PT. SMN and PT. TBOT. Camera trap were set up in both single (S) and pairs (P) mode alternately in each grid cell of survey plots with the size of 4 km2 (2 x 2 km) (Figure 1). The number of camera trap installed in each concession block were 83 from 50 grids, 115 from 80 grids and 152 from the 100 grids. In each survey grid, one camera station was selected based on the possibility of getting pictures of wildlife, such as a location which has scent marks, scats and former footprint of predation or at least is a wildlife trails. In each station, the camera was mounted on a tree at the height of 40-50 cm with the distance of 4-6 m from the midpoint of animal active tracks where the animal is expected to pass through.

The setting of camera trap was divided into two, a video mode with a duration of 10 seconds on a single station and a photo mode on the pair stations with the 10 seconds time interval. The camera was activated 24 hours per day with the duration of at least 25 trapdays.

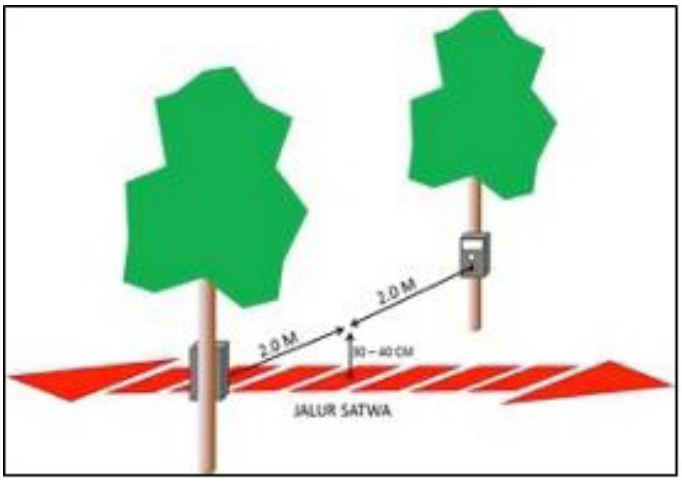
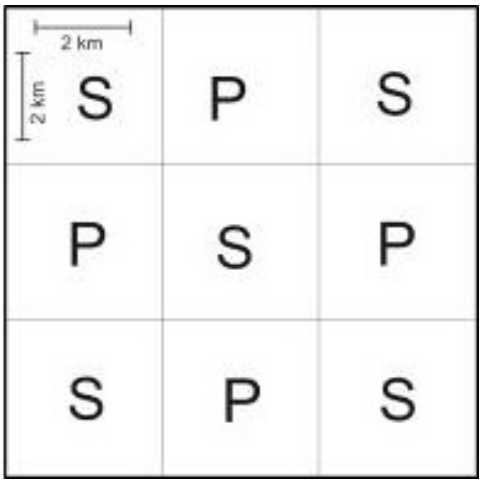


Figure 1 (a) Position of camera trap, and



(b) Scheme of camera trap deployment in grids

2.3 Data Analysis

a. Camera Trap Effort

The camera trap data were organized and analyzed using ReNamer program developed by Sanderson & Harris (2013). The analysis was conducted using total trapdays, the number of pictures and the number of independent pictures. 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).

b. Diversity and Species Richness Index

Diversity index was analyzed using R version 3.2.3 program, with Biodiversity R package (Kindt, 2016) and script from Gardener (2014). The diversity index used was Shannon index (Krebs, 1999) which enables us to see the richness and composition of species in a community. Richness was estimated using Richness estimator with a permutation of 1000 times and the results of Jackknife 1 (Tobler et al., 2008).

c. Activity Pattern

The period of activity of each felids species was analyzed by dividing the activity into three periods (Azlan & Sharma, 2006), i.e. the evening activity (19:00-05:00), daytime (07:00-17:00) and by night/morning (05:00-07:00 and 17:00-19:00). The pattern of activity of the felidae was defined as very nocturnal (> 88% between 19:00-05:00), nocturnal (50-85%, between the hours of 7:00 am-05:00), crepuscular (> 50%, between 05:00-07:00, and 50%, between > 17:00-19:00), diurnal (50-85%, between 07:00-17:00), or highly diurnal (> 85%, between 07:00-17:00) (Pusparini et al., 2014). The comparison of activity time between two species was analyzed using the R version 3.2.3 program with Overlap package created by Meredith & Ridout (2013).

d. Tiger Distribution Modelling

The probability distribution of the sumatran tiger was modelled using MaxEnt software version 3.3.3(Phillips et al., 2004). This software has proven to produce a more accurate and reliable model, even with very limited data (Hernandez et al., 2006; Wisz et al., 2008). Data required for creating the model of tiger distribution by using MaxEnt was obtained from the camera traps, the tiger trail during the survey, and environment variables which were predicted to affect the presence of the Tiger. Those variables were vegetation density (Hansen et al., 2013), peat depth, land cover, distance from main roads, rivers and trails (Database GIS FFI-IP, 2016). The parameter used were test percentage = 25%, maximum iteration = 5000, replicated run type = "bootstrap" 20 cycle, and output format = "logistic".

One of the data generated by the MaxEnt is AUC value which indicates the strength of the model used. The reliability of a model increases as AUC value gets closer to 1 (Merow et al., 2013). This value is often used to evaluate the combination of variables. If the value of AUC is close to or even less than 0.5, then the variables and parameters used are probably not precise enough. In addition, the MaxEnt model generates a model map of wildlife distribution in the form of raster data with values from 0-1 to simplify data visualization; the raster is often displayed as 2 categories i.e. suitable habitat and non-suitable habitat. The raster threshold values was defined based on the '10 percentile training presence logistic threshold' (Young et al., 2011).

III. RESULTS AND DISCUSSION

3.1 Results

a. Camera Trap Survey Effort

A nine (effective) months of camera trap installations accumulated 11.385 trapdays and 14.504 pictures of animals. The number of installation stations for each concession area were PT. GCN 50 stations of 50 stations, PT. SMN 74 stations of 80 stations, PT. TBOT 96 stations of 100 stations (Table 1). Approximately 20% of the installed camera traps suffered physical and electronical damage, such as taking pictures continuously causing the duration of the installation to become very short due to lack of memory card space which in turn made the camera incapable of recording pictures, malfunctioning sensors, and the quality of the resulting image not being representative for identification due to its color (blurred or damaged).

Table 1 Camera trap survey effort

Concession	Number of Picture		Duration date		Duration day	Total trap nights	Total stations	Camera trap placement (Km)			
	All	Independent	Start	End				Min	Mean	Maks	Covered (km^2)
PT. GCN	1,662	415	3/26/2015	6/22/2015	89	1,460	50	0.37	1.33	2.69	189
PT. SMN	4,140	1217	4/12/2015	8/31/2015	142	5,948	74	0.7	1.37	2.16	301
PT. TBOT	8,252	1804	9/15/2015	11/20/2015	67	3,977	96	0.46	1.48	2.32	354

b. Animal Species Richness

A total of 37 species were recorded by camera traps in PT. GCN, consisting of 21 mammals, 13 aves, and three reptiles. The PT. SMN concession acquired 47 species, consisting of 28 mammals, 18 aves, and one reptile, whereas the area of PT. TBOT consession found 52 species of fauna comprising 30 mammals, 18 aves, and four species of reptiles (Figure 2). The total number of species caught on camera traps in RER are 75 species of 34 mammals, 35 aves, and 6 reptiles. As many as 20% of those animals are protected wildlife species by both government regulations as well as the red list of IUCN (Appendix 1).

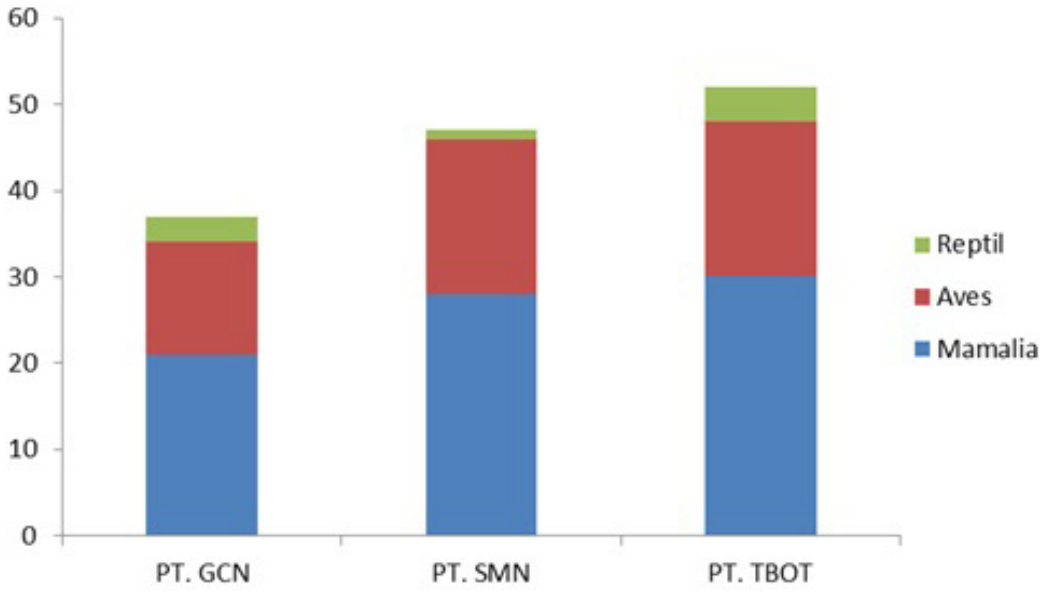


Figure 2 The richness of species in the region of the RER

c. Mammals Diversity Index

The species richness of mammals in PT. TBOT concession was higher than other concessions, but analysis results of the index of diversity (H') showed slightly different results (table 2). The richness index in PT. GCN concession was slightly higher than other concessions, which shows that although PT. GCN had the lowest richness, the abundance of each species was more even than in other concessions.

Table 2 The richness and diversity index on the RER

Concession	Species richness				Diversity index
	Observed	Jack 1	Lower CI	Upper CI	(Shannon`s index)
PT. GCN	22	27.92	25.5	30.34	2.40
PT. SMN	28	33.96	31.52	36.39	2.34
PT. TBOT	30	36.89	34.29	39.5	2.36

Predator animals that were succesfully caught on camera traps were the leopard cat (Prionailurus bengalensis), marbled cat (Pardofelis marmorata), clouded leopard (Neofelis diardi), sumatran tiger (Panthera tigris sumatrae) and the flat-headed cat (Prionailurus planiceps). Those five species are carnivores of the felidae family. From the overall lowland area of the RER, the leopard cat was the most common species recorded by camera traps (Figure 3), these findings were parallel to Pusparini et al (2014), who stated that the leopard cat are mostly found in lowlands (<150 mdpl).

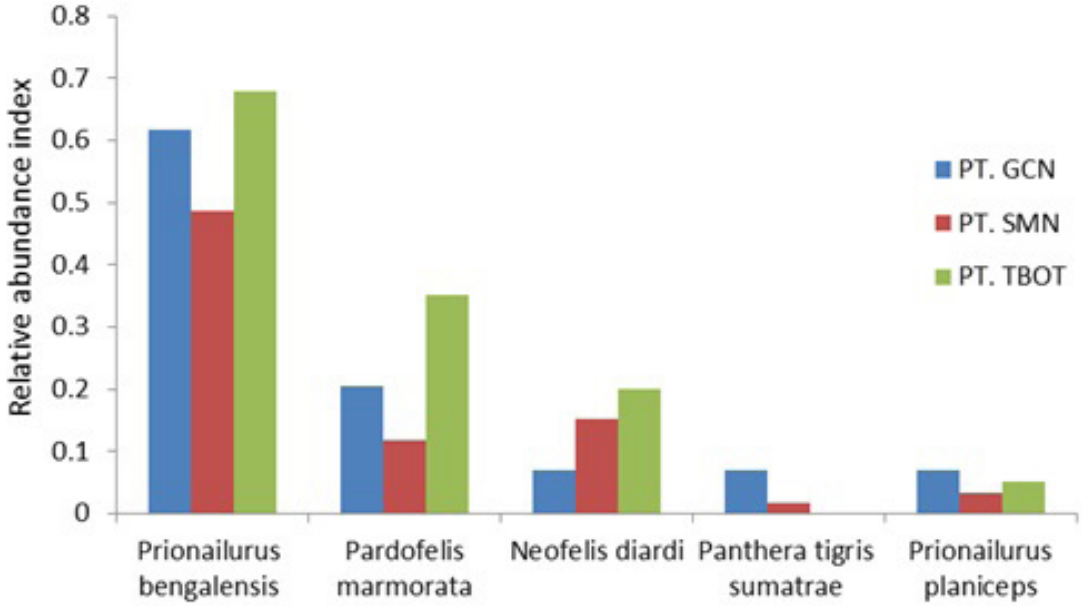


Figure 3 Predator species on RER

d. Felidae Activity Pattern

Leopard cats and flat-headed cats tend to be diurnal with peak patterns at noon, each 61.3% and 66,8% respectively. Marbled cats tend to be nocturnal with an activity peak of 63.5%, while the flat-headed cats are very nocturnal, with peak activity of 85.6% (Figure 5). Sumatran tigers are inclined to be active during the day and evening, with a rate of 50% and 50%. Sumatran tigers have a high degree of temporal overlap with flat-headed cats (95% CI, 0.50 = 0.32-0.66) (Figure 4), while the degree of temporal overlap is quite high (50%) between leopard cats and flat-headed cats (95% CI, 0.67 = 0.47-0.82) and clouded leopards with marbled cats (95% CI, 0.60 = 0.50-0.70) (Appendix 3).

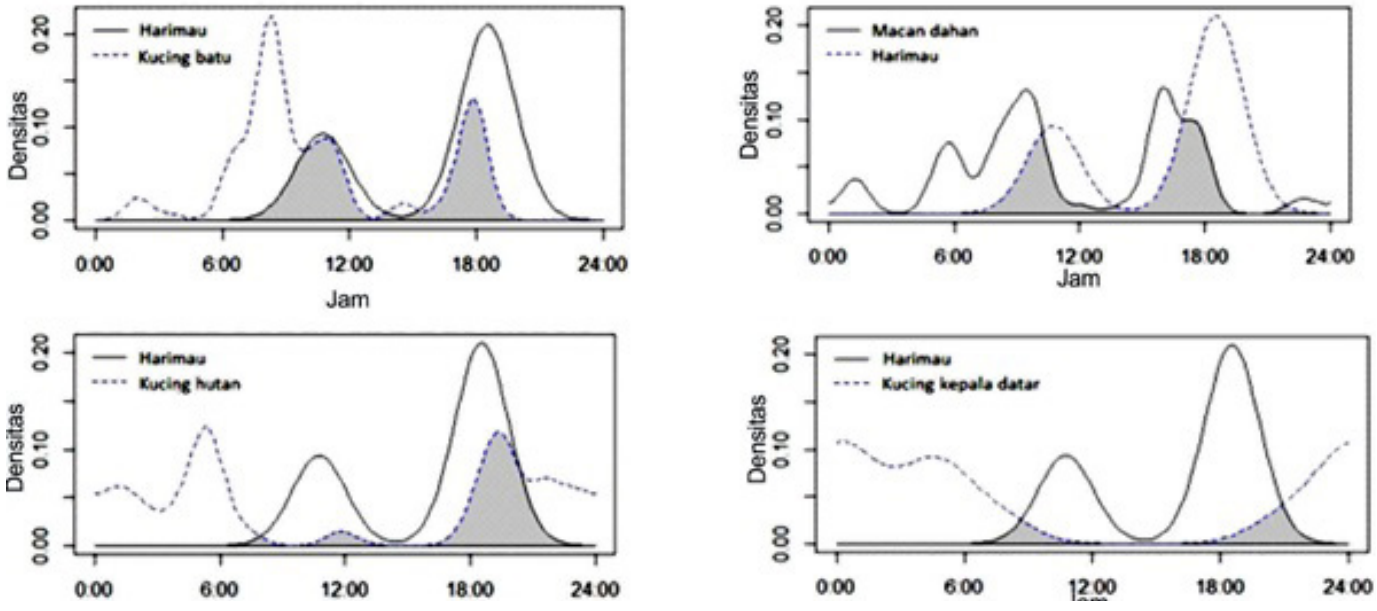


Figure 4 Overlapping activities of Felidae

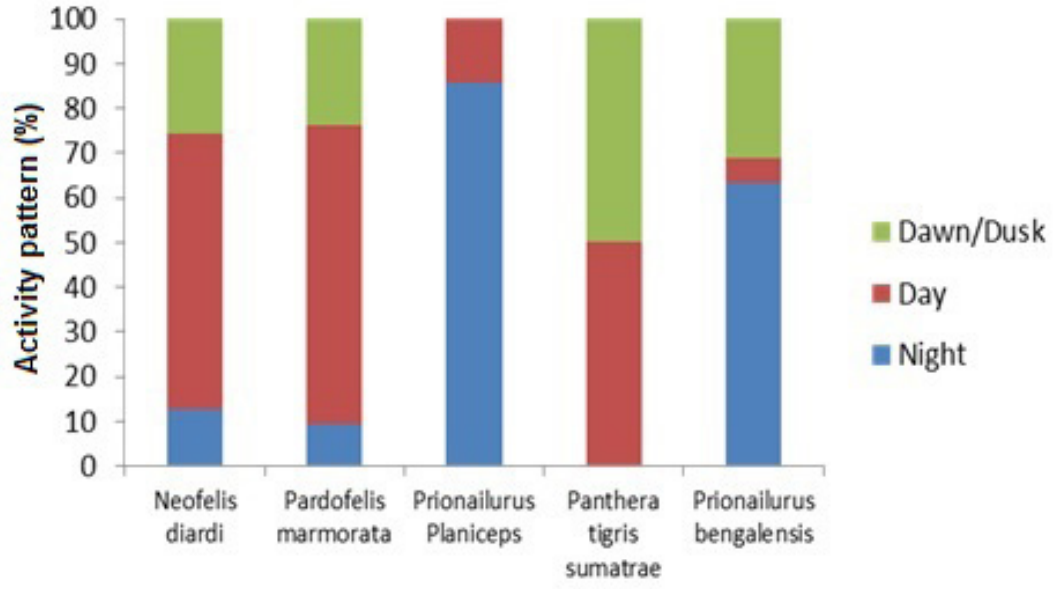


Figure 5 Felidae activity pattern on RER

e. Tiger Distribution Modelling

The survey only managed to capture two Sumatran tiger photos without any replicates. In addition, the position of one of the tigers made it impossible to identify whether the two photos were two different individuals. Therefore, a robust estimate of the tiger number is not possible due to the low sample size. Previous studies in the Kampar peninsula did not even manage to acquire a photo of the Sumatran tiger (Sunarto et al., 2015). Therefore, camera trap data and other findings are used to model the tigers distribution in the Kampar peninsula. The distribution model of the Tiger by MaxEnt produce a value (AUC) of (0889 ± 0.034). This means the model used is adequate, as the value is close to 1. Variables with the highest correlation to the distribution of tigers consecutively are distance from the trail, land cover, distance from roads, tree density, distance from river and peat depth.

3.2 Discussion

Of the 75 species found in RER, two species are classified as Critically Endangered, i.e. the sumatran tiger (Panthera tigris sumatrae) and malayan pangolin (Manis javanica) (IUCN, 2001). Both species have high threat of extinction, particularly from the poaching of wildlife and change of land use. Two species of wildlife are stated as Endangered (EN = Endangered,) which are the flat-headed cat dan storm stork (Ciconia stormii). The camera traps also captured 11 species categorized as Vulnerable, such as the marbled cat (Neofelis diardi) and sunbear (Helarctos malayanus). Based on the Convention on International Trade in Endangered Species (CITES, 2016), there are six species in the concession area categorized as Appendix I, i.e. animals that are prohibited to be traded in any form of international trade, unless it follows a certain strict procedure. Furthermore, there are a total of 19 animals stated as Appendix II, i.e. animals that are not endangered but will experience extinction if trades continue without any regulation (Appendix 1).

A total of 12 species found in the area are protected by PP No. 7/1999, and all species of the Felide family in the area are protected in Indonesia. According to the assessment of the region based on High Conservation Value (HCV), there are two species in the RER categorized as HCV 1.2 and 2 species categorized as HCV 1.3 (Appendix 1).

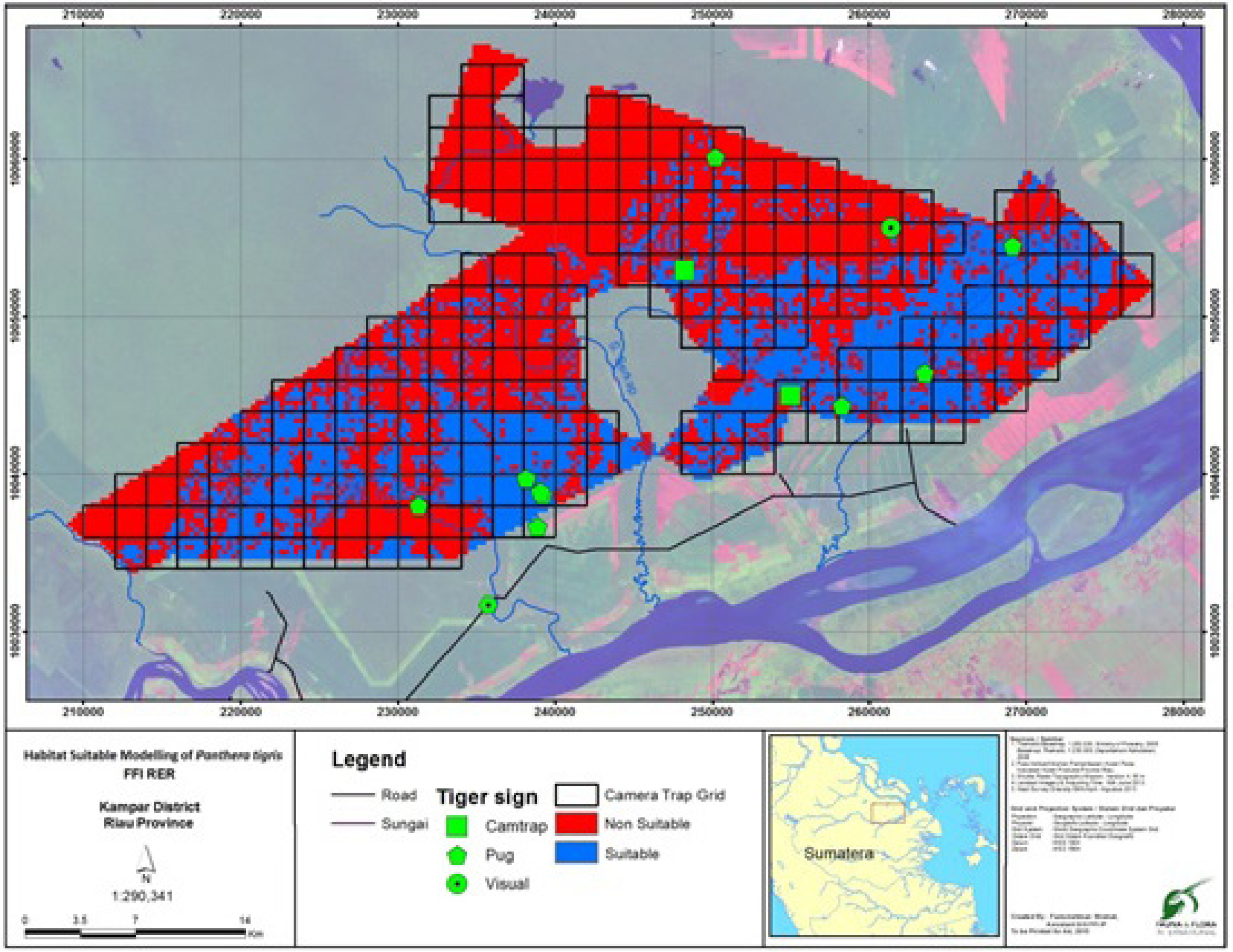


Figure 6 Map of tiger Distribution Model

a. Predator and Potential Prey

The camera trap survey results show the existence of a predator species that occupy the peat forests in the RER. The five predator species of the Felidae family in this area are the marbled cat, the flat-headed cat, the leopard cat, the clouded leopard and the sumatran tiger. Indonesia has nine species of wildcats, seven of which are in Sumatra (Nowell & Jackson, 1996). Golden cats (Catopuma temminckii) and fishing cats (Prionailurus viverrinus) were not found in this survey. This is due to the Golden cats being commonly found in mountains (900-2500 > mdpl) (Griffiths, 1996; W Pusparini et al., 2014). As for the fishing cat, there has not been a valid confirmation about its existence in Sumatra to this day (Duckworth & Shepherd, 2009; Sanderson, 2009).

The discovery of flat-headed cats in this area have already been predicted by previous studies (Wilting et al., 2010), which states that Riau has the widest wingspan habitat for flat-headed cats in Sumatra, and since flat-headed cat are wetland specialists. This species, therefore, can be considered as a flagship species for wetland habitats, particularly in peat swamp forests of the Kampar peninsula.

Predators can be defined as animals that prey on other animals and also act as carnivores. Large predators such as wildcats can be an umbrella species, since they require large areas to meet their needs of life which include feeding, shelter, and space (Mangas et al., 2008). Moreover, the existence of large predators have an impact on the health of an ecosystem in that area (Miller et al., 2001). The tiger is one of the top predators found in the RER, a tiger will prey on smaller animals or those equivalent to its size, so do other predators (Karanth&Nichols, 2002). The tigers' ability to prey on a variety of species of different sizes can guarantee their survival in nature. Declining populations of animals they prey on can reduce the abundance of tigers in a location (Karanth&Nichols, 2002).

A total of 10 prey animals were recorded in the RER. Bearded pigs are a large size prey animal in the RER, while medium-sized prey consists of monkeys and long-tailed macaques, small-sized prey animals include the mouse-deer, squirrels, forest mice, squirrels, mouse-type mices, and black partridges.

From its size, the sumatran tigers are the largest predators in the RER. Bearded pigs, pig tail macaques, and long-tailed macaques are potential prey animals for Sumatran tigers, while sambar deers, one of the tigers' potential prey, were never spotted during the study. All three of these prey animals are also prey of Clouded Leopards. Natural mechanisms developed by wild cat species exist to avoid competition, among which are having separate time of activity, selection of the prey size, a vertical strata segregation, as well as habitat selection based on altitude (Sunarto et al., 2011). The flat-headed cat and marbled cat prey on smaller-sized species, especially on birds such as the black partridge, or squirrels, shrews, mice and mouse deer from the class of Mammals. The prey for wildcats and flat-headed cats are mice, squirrels and birds (Nowell & Jackson, 1996).

Table 3 provides a comparison of photographic rate between wildcats in the Sumatra region, and it shows that RER possesses the most number of wildcat species in comparison to other similar areas of study. One of the reasons for this was most likely due to the camera trap efforts having longer duration and wider coverage. It should be noted that the camera traps installed in this study were designed to maximize the chances of capturing a tiger image, so other smaller mammals, in this case the marbled cats, leopard cats and flat-headed cats were less likely caught on these camera traps. If further studies were conducted where the camera trap installation designs are maximized for capturing smaller cats, then the photographic rate of smaller cats in this area would most likely increase.

Table 3. Comparison of photographic rate (independent pictures per 100 record days) from the survey of camera traps in Sumatra

Area	RER[a]	Kerumutan[b]	South-west of Kampar Peninsula [b]	Bukit Barisan NP[c]	Gunung Leuser NP[d]
Total trap days	11.385	1.868	1.132	34.166	3.452
Neofelis diardii	0.16	0.05	0.71	0.15	0.41
Panthera tigris	0.02	0.7	-	0.16	N/A
Pardofelis marmorata	0.21	0.21	-	0.1	0.23
Prionailurus bengalensis	0.57	0.05	0.71	0.08	0.2
Prionailurus planiceps	0.04	-	-	-	-

a This Study, peat
b (Sunarto et al., 2015), peat
c (McCarthy et al., 2015), mineral
d (Wulan Pusparini et al., 2014), mineral

b. Felidae Activity Pattern

Leopard cats and flat-headed cats have the same activity pattern, i.e., nocturnal. The nocturnal activity of leopard cats is in agreement with other comparable studies in Indonesia in Bukit Barisan Selatan National Park (Mccarthy et al., 2015) , Sebangau peat swamp forest (Cheyne & Macdonald, 2011), central Kalimantan (Adul et al., 2015) and Gunung Leuser National Park (Pusparini et al., 2014), and in Annapurna conservation zone (Appel et al., 2013) and a tropical forest in the Mid-Southern part of Thailand (Grassman Jr, (2000). The nocturnal activity exhibited by leopard cats tend to follow its main prey, the muridae, which also exhibits nocturnal activity (Rabinowitz, 1990; Grassman Jr, 2000; Grassman et al., 2005). Flat-headed cats tend to be a very nocturnal > (85%) in this area. This is in contrast to the study of flat-headed cats in Central Kalimantan which exhibited diurnal activity (Adul et al., 2015).

The highest degree of temporal overlap observed was between leopard cats and flat headed cats, by 67%. Although the degree of overlap was considerably high, the leopard cats and flat-headed cats had different prey type and potential. (Bezuijen, 2000; Meijaard et al., 2005; Ario, 2010). Leopard cats are able to reside in any type of habitat with Muridae as its main prey (Grassman Jr, 2000; Grassman et al., 2005). For flat-headed cats, they reside in semi-aquatic habitat with fish as its main prey (Ario, 2010), so although the temporal overlap between these two species are quite high, they seemed to be not spatially overlap.

Clouded leopards, sumatran tigers and flat-headed cats exhibited activity that tend to be diurnal. The tendency of diurnal activity pattern exhibited by clouded leopards contradicts various studies which show that they tend to be nocturnal, such as in Peninsular Malaysia (Azlan & Sharma 2006) , Sebangau peat swamp forest (Cheyne & Macdonald 2011), Central Kalimantan (Adul et al. 2015) in Ulu Segama wildlife reserve (Hearn et al. 2013) and Thailand (Lynam et al. 2013). However, the flat-headed cats were recorded having diurnal activity (41.5%) and is consistent with several studies (Lyngdoh et al., 2011; Lynam et al., 2013; dan Adul et al., 2015; Sunarto et al., 2015). Marbled cat activity showed a high degree of temporal overlap with clouded leopards (60%) and the sumatran tiger (50%) (Appendix 3).

c. Tiger Distribution Modelling

MaxEnt model concluded that the variable having the most influence is the distance from the trail. Response curve shows a significant pattern that further distance from the trail lowered the probability of a tiger appearing (Figure 7). This is in line with the research by Cusack et al., (2015), which stated that the capture probability for terrestrial mammals would be higher if camera traps were installed on the trail. The second most significant variable is the land cover of the second class i.e. wetland forest area with dense vegetation density (Appendix 4). The third variable is the main road. The closer to the main road of RER concessions, the higher the probability of a tiger appearing.

Figure 7 Sumatran tiger (*Panthera tigris sumatrae)*

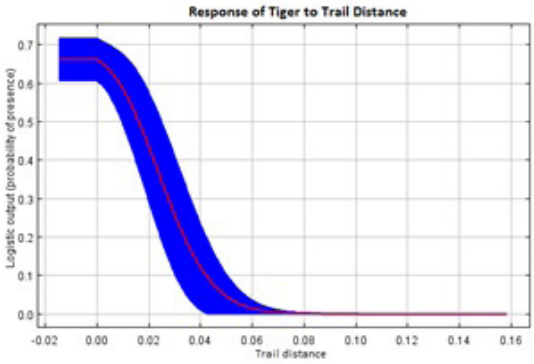
This statement is backed by local staffs who often encounter sumatran tigers along the main road of the RER, especially near the bridge of Serkap river. One staff of PT GCN even received a report from a villager who spotted an adult female tiger along with its two cubs near Serkap river bridge (Personal comm, 2015).

In the RER area, encounters with sumatran tiger happen more frequently in PT. GCN area and in the southern part of PT. TBOT. Both areas are adjacent to Acacia plantation. Based on the study by Tropenbos International Indonesia Program (2010), a number of tiger encounters occurred in and around the area of Acacia plantation. This statement is supported by research conducted by Sunarto (Sunarto et al., 2011), which found that tigers are able to use acacia plantation areas, even though it ecologically prefers natural forest areas. If the management of the area is well-maintained, then the sumatran tiger may potentially use those forest areas of acacia plantation as part of their home range.

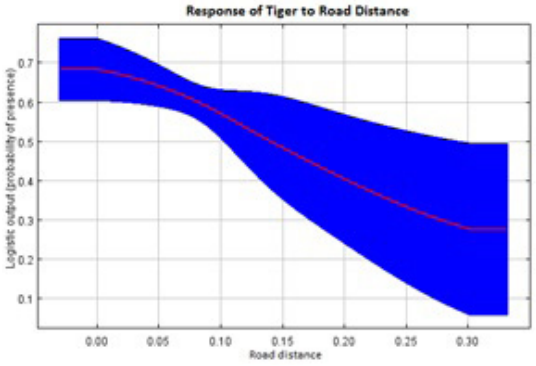
The existence of sumatran tigers as the predator in an area indicates that the area provides potential prey animals for its survival, and an acacia plantation area is no exception. Bearded pigs as one of the potential prey for sumatran tiger may also inhabit acacia plantation areas along with other potential prey animals. Some herbivores prefer to inhabit forest areas with a more open canopy density (secondary forest) because it provides more understorey plants for its food source.

Table 4 The influence of variable against the distribution of sumatran tiger

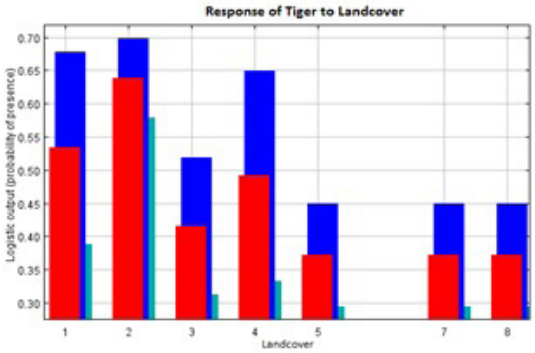
Variable	Percent Contribution (%)	Permutation Importance (%)
Distance to trails	46.2	60.3
Land cover	20.7	15.8
Distance to road	13.2	9.4
Tree density	12.5	13.3
River	5.8	0.1
Peat depth	1.6	1.3



a



c



b

Figure 8 Response curve variable (a) Distance to trails (b) Land cover (c) Distance to road

IV. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

1. Camera traps installed in concession areas were able to detect a number of important cryptic species which cannot be obtained using other methods. Those cryptic species are the black quail, the red partridge, and the storm stork from the aves taxon, as well as five wildcats and pangolin from the mammalia taxon.
2. RER in Kampar peninsula indicate a higher number of mammal species diversity compared to other lowlands in Sumatra, especially species of wetland specialists.
3. Flat-headed cats as wetland habitat specialist can be promoted as a flagship species for the protection of the Kampar peninsula peat swamp, especially in the concession areas.

4.2 Recommendations

1. Based on the MaxEnt modeling used to monitor Sumatran tigers in concession areas, it would be best if camera traps were installed in the trail especially along the southern part of PT. TBOT and PT. GCN.
2. RER should initiate a camera trap survey outside their concession, especially in acacia plantation forests in the southern areas across of PT. TBOT and PT. GCN to confirm the possibility of the use of acacia plantation forests as Sumatran tiger home range in both concessions.
3. As one of the charismatic species, a separate exclusive survey for the flat-headed cat should be conducted since the utilization design of the camera traps for tigers differ from the design for smaller cats. With a separate study for smaller cats, it is hoped that the probability to capture an image of the flat-headed cat is increased as most of the habitat in the three concession areas are fit for them.

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VI. APPENDICES

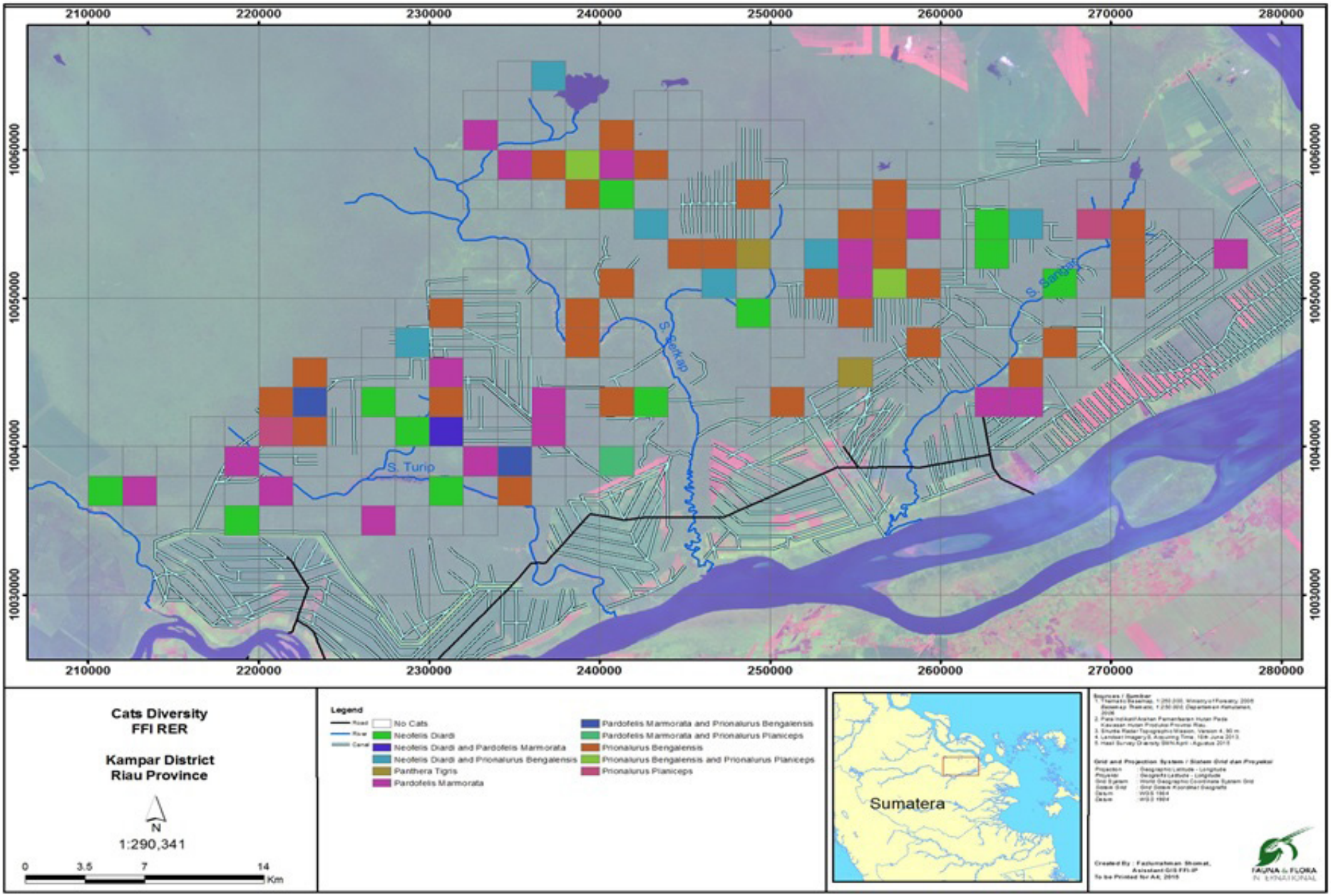
Appendix 1 Conservation status of captured species

No	Family	Scientific Name	English Name	IUCN	CITES	GOI	NKT	Concession		
								PT. GCN	PT. SMN	PT. TBOT
1	Accipitridae	*Accipiter trivirgatus*	Crested goshawk	LC	II		-	-	√	-
2	Accipitridae	*Icthyophaga ichthyaetus*	Grey-headed Fish-eagle	NT	II	-	-	√	-	-
3	Accipitridae	*Nisaetus cirrhatus*	Changeable Hawk-eagle	LC	II	-	-	-	-	√
4	Accipitridae	*Spilornis cheela*	Crested Serpent-eagle	LC	II	-	-	-	√	√
5	Accipitridae	*Nisaetus nanus*	Wallace's Hawk-eagle	VU	II	-	1.3	-	√	-
6	Alcedinidae	*Halcyon smyrnensis*	White-breasted Kingfisher	LC	-	-	-	√	-	-
7	Bucerotidae	*Anorrhinus galeritus*	Bushy-crested Hornbill	LC	II	-	-	√	-	-
8	Cercopithecidae	*Macaca fascicularis*	Long-tailed macaque	LC	-	-	-	√	√	√
9	Cercopithecidae	*Macaca nemestrina*	Pig-tailed macaque	VU	II	-	1.3	√	√	√
10	Cercopithecidae	*Presbytis femoralis*	Banded Surili	NT	II	-	-	√	√	√
11	Ciconiidae	*Ciconia stormi*	Storm's Stork	EN	-	-	-	-	-	√
12	Columbidae	*Chalcophaps indica*	Grey-capped Emerald Dove	LC	-	-	-	-	√	-
13	Cuculidae	*Centropus chinensis*	Greater Coucal	LC	-	-	-	-	-	√
14	Cuculidae	*Centropus rectunguis*	Short-toed Coucal	VU	-	-	1.3	-	-	√
15	Cuculidae	*Centropus sp*	Coucal	-	-	-	-	√	√	-
16	Cuculidae	*Phaenicophaeus sumatranus*	Chestnut-bellied Malkoha	NT	-	-	-	-	√	-
17	Erinaceidae	*Echinosorex gymnura*	Moonrat	LC	-	-	-	√	√	√
18	Felidae	*Neofelis diardi*	Sunda clouded leopard	VU	I	P	1.3	√	√	√
19	Felidae	*Panthera tigris sumatrae*	Sumatran tiger	CR	I	P	1.2	√	√	√

20	Felidae	*Pardofelis marmorata*	Marbled cat	NT	I	P	1.3	√	√	√
21	Felidae	*Prionailurus bengalensis*	Leopard cat	LC	II	P	1.3	√	√	√
22	Felidae	*Prionailurus planiceps*	Flat-headed cat	EN	I	P	1.3	√	√	√
23	Geoemydidae	*Geoemydidae*	Turtle	-	-	-	-	√	-	-
24	Herpestidae	*Herpestes brachyurus*	Short-tailed mongoose	LC	-	-	-	√	√	√
25	Lorisidae	*Nycticebus coucang*	Greater Slow Loris	VU	I	P	1.3	-	-	√
26	Manidae	*Manis javanica*	Sunda pangolin	CR	II	P	1.2	-	√	√
27	Muridae	*Muridae*	Rats	-	-	-	-	√	√	√
28	Muscicapidae	*Luscinia cyane*	Siberian blue robin	LC	-	-	-	√	-	√
29	Muscicapidae	*Ficedula sp*	Flycatcher	-	-	-	-	-	√	-
30	Muscicapidae	*Trichixos pyrropygus*	Rufous-tailed Shama	NT	-	-	-	-	√	-
31	Mustelidae	*Martes flavigula*	Yellow-throated marten	LC	II	-	-	√	√	√
32	Phasianidae	*Lophura erythrophthalma*	Malay Crestless Fireback	VU	-	-	1.3	√	√	√
33	Phasianidae	*Melanoperdix nigra*	Black Partridge	VU	-	-	1.3	√	√	√
34	Phasianidae	*Rollulus rouloul*	Crested Partridge	NT	-	-	-	-	-	Y
35	Picidae	*Sasia abnormis*	Rufous Piculet	LC	-	-	-	-	√	-
36	Picidae	*Chrysocolaptes validus*	Orange-backed Woodpecker	LC	-	-	-	-	-	√
37	Pittidae	*Pitta granatina*	Garnet Pitta	NT	-	-	-	√	-	-
38	Pittidae	*Pitta megarhyncha*	Mangrove Pitta	NT	-	-	-	-	-	√
39	Pittidae	*Pitta sordida*	Hooded Pitta	LC	-	-	-	-	√	√
40	Prionodontidae	*Prionodon linsang*	Banded linsang	LC	II	P	-	-	√	√
41	Scincidae	*Eutropis multifasciata*	Golden skink	-	-	-	-	√	-	-
42	Sciuridae	*Callosciurus notatus*	Plantain squirrel	LC	-	-	-	√	√	√
43	Sciuridae	*Lariscus insignis*	Three-striped Ground Squirrel	LC	-	-	-	-	-	√
44	Sciuridae	*Sundasciurus lowii*	Low's Squirrel	LC	-	-	-	-	√	-
45	Sciuridae	*Sundasciurus sp*	Squirrel	-	-	-	-	-	√	-
46	Sciuridae	*Ratufa affinis*	Pale Giant Squirrel	NT	II	-	-	-	Y	-
47	Sciuridae	*Sciuridae*	Squirrel	-	-	-	-	√	√	√
48	Strigidae	*Ketupa ketupu*	Buffy Fish Owl	LC	II	-	-	-	-	√
49	Strigidae	*Strix leptogrammica*	Brown Wood-owl	LC	-	-	-	-	-	√
50	Suidae	*Sus barbatus*	Bearded pig	VU	-	-	1.3	√	√	√
51	Timaliidae	*Malacocincla abbotti*	Abbott's Babbler	LC	-	-	-	-	-	√
52	Timaliidae	*Malacocincla malaccensis*	Short-Tailed Babbler	NT	-	-	-	√	√	√

53	Timaliidae	*Malacopteron affine*	Sooty-capped Babbler	NT	-	-	-	-	-	√
54	Timaliidae	*Malacopteron magnirostre*	Moustached Babbler	LC	-	-	-	√	√	-
55	Timaliidae	*Pellorneum capistratum*	Black-capped Babbler	LC	-	-	-	√	√	√
56	Timaliidae	*Stachyris sp*	Babbler	-	-	-	-	-	√	-
57	Timaliidae	*Trichastoma bicolor*	Ferruginous Babbler	LC	-	-	-	√	√	-
58	Timaliidae	*Trichastoma rostratum*	White-chested Babble	NT	-	-	-	√	-	√
59	Tragulidae	*Tragulus sp*	mouse-deer	LC	-	P	-	√	√	√
60	Tupaiidae	*Tupaia glis*	Common Treeshrew	LC	-	-	-	-	√	√
61	Tupaiidae	*Tupaia sp*	Treeshrew	-	-	-	-	√	√	√
62	Tupaiidae	*Tupaia tana*	Large Treeshrew	LC	II	-	-	√	√	√
63	Tupaiidae	*Tupaidae*	Treeshrew	-	-	-	-	√	√	√
64	Ursidae	*Helarctos malayanus*	Sun bear	VU	I	P	1.3	√	√	√
65	Varanidae	*Varanus dumerilli*	Monitor lizard	NE	II	-	-	-	-	√
66	Varanidae	*Varanus rudicollis*	Rough-necked Tree Monitor	NE	II	-	-	-	-	√
67	Varanidae	*Varanus salvator*	Common Water Monitor	LC	II	-	-	√	-	-
68	Viperidae	*Trimeresurus*	Viper	-	-	-	-	-	√	-
69	Viverridae	*Arctictis binturong*	Binturong	VU	-	P	1.3	-	-	√
70	Viverridae	*Arctogalidia trivirgata*	Small-toothed palm civet	LC	-	-	-	√	-	√
71	Viverridae	*Hemigalus derbyanus*	Banded palm civet	VU	II	-	1.3	√	√	√
72	Viverridae	*Paradoxurus hermaphroditus*	Common palm civet	LC	-	-	-	-	√	√
73	Viverridae	*Viverra tangalunga*	Malay civet	LC	-	-	-	√	√	√

Appendix 2 Spatial overlap map of Felidae



Appendix 3 Temporal overlap degree of Felidae

Spesies	Sumatran tiger	Marbled cat	Leopard cat	Flat-headed cat
Clouded leopard	0.37	0.6	0.34	0.33
	(0.18-0.57)	(0.50-0.70)	(0.244-0.44)	(0.15-0.52)
Sumatran tiger		0.5	0.34	0.11
		(0.32-0.66)	(0.21-0.46)	(0.018-0.30)
Marbled cat			0.23	0.23
			(0.16-0.30)	(0.05-0.44)
Leopard cat				0.67
				(0.47-0.82)

Appendix 4 Categories of land cover based on SNI (Indonesia, 2010)

Land cover	Class	Argument
Sparse wetland forest	1	Wetland forest in peat swamp habitat and vegetation density 10%-40%
Dense wetland forest	2	Wetland forest in peat swamp habitat and vegetation density >70%
Medium wetland forest	3	Wetland forest in peat swamp habitat and vegetation density 41%-70%
Open land	4	Uncovered land use as well as natural, semi-natural, and artificial area
Plantation	5	Land use for agriculture and plantation
Settlement	6	Land use as a residential area or residential environment and the activities that support life
Bushes	7	Dry land region that has been overgrown with a variety of natural vegetation heterogeneous and homogeneous densities sparse to dense. The area is dominated by low vegetation (natural)
Water body	8	All the appearance of water, including the sea, reservoirs, coral reefs and sea grass beds

Appendix 5 Species captured

Clouded leopard
(*Neofelis diardi)*

Bearded pig
(*Sus barbatus)*

Malay crestless fireback
(*Lophura erythrophthalma)*

Storm`s stork
(*Ciconia stormi)*

Sun bear
(*Helarctros malayanus)*

Leopard cat
(*Prionailurus bengalensis)*

Binturong
(*Arctictis binturong*)

Marbled cat
(Pardofelis marmorata)

Flat-headed cat
(*Prionailurus planiceps*)

Malayan porcupine
(*Hystrix brachyura*)

Banded palm civet
(*Hemigalus derbyanus*)

Pig-tailed macaque
(*Macaca nemestrina)*