Diversity and activity pattern of wild cats in Way Kambas National Park, Sumatra, Indonesia

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Abstract. Camera trapping was applied for assess the diversity and activity pattern of wild cats in Way Kambas National Park on May 2013 to May 2014. Fifty-seven cameras were systematically set within 480 km2 area covering a total of 4,610 trap nights. Of 4,017 recorded videos, four wild cats species were capture and identified, those are sumateran tiger (Pathera tigris sumatrae), clouded leopard (Neofelis diardi), leopard cat (Pardofelis marmorata) and marbled cat (Prionailurus bengalensis). The highest capture rate (video per 100 trap nights) was sumatran tiger and leopard cat (0.87) followed by marbled cat (0.11) and clouded leopard (0.09). Sumatran tiger and marbled cat were cathemeral. Sumatran tiger was found active during both day (51.6 %) and night (48.4 %) with its highest activity was between 05.00 – 06.00 hours and 05.00 – 06.00 hours, whilst marbled cat was active during the day (41.2 %) and night (58.8 %) with it highest activity found between 12.00 to 02.00 hours and 05.00 – 06.00 hours. The other two cat species, leopard cat and marbled cat were mostly nocturnal with the highest activity recorded at 05.00 – 06.00 hours and 21.00 – 22.00 hours for clouded leopard and 05.00 – 06.00 hours for leopard cat. Our study demonstrates that the Way Kambas National Park is an important habitat for wild cats in Sumatra, although the presence of other rarer cat species in the park, such as golden cat and flat-headed cat still needs to be confirmed by further long-term monitoring study.

Keywords: Clouded leopard, camera trapping, cathemeral, leopard cat, marbled cat, mostly nocturnal, tiger

1. Introduction

Sumatra is a home for seven wild cats species, those are sumatran tiger (Pathera tigris sumatrae), clouded leopard (Neofelis diardi), golden cat (Pardofelis temincki), fishing cat (Prionailurus...
viverrinus), leopard cat (Paradoxelis marmorata), marbled cat (Prionailurus bengalensis), and flat-headed cat (Prionailurus planiceps) [1, 2]. Of seven species, only leopard cat is considered to have a low extinction risk [3]. In addition to habitat loss and fragmentation, poaching and hunting are the main threats for the wild cats in Sumatra [1, 2].

All wild cats species are protected by Indonesian law through the Government Regulation No. 7 1999 on the preservation of animal and plant species. Except for the sumatran tiger, conservation efforts and initiatives for the other wild cats species are very limited [4]. Most wild cats researches were done in Borneo especially in Sabah and Sarawak [5-8] and Thailand [9-13]. In Sumatra, ecological researches on wild cats were conducted recently [4, 14, 15]. Given the growing threats for those species, more studies on the biology and ecology of the wild cats are clearly needed as a basis to develop their comprehensive conservation and management plan [16].

Way Kambas National Park (WKNP) is one of key protected area for in-situ wild cats conservation in Sumatra [17, 18]. The 125,621.3 ha park is reported to harbor six of seven wild cats species living in Sumatra. Except sumatran tiger, there is little information on the ecology of other wild cats whilst long term monitoring is a must for the development of effective conservation strategy. This study represents the first intensive attempt to collect baseline information on the distribution and behavior patterns of wild cats species in WKNP.

Mammalian observation in tropical area is difficult as most of the species are secretive, elusive and nocturnal, with the great tendency to avoid human direct contact [19]. For the last ten years, camera trap has become the most used technique to study species diversity and to detection the presence of secretive and low density mammalian species [20]. For the wild cats, the following studies have been done to look into various aspect of these species biology using camera trap methods: population estimation [18], ecological characteristics and inter species interaction [15], overlap activity pattern [21, 22], inter species association [12], activity pattern and interaction [13] and habitat use [23]. This is the first systematic and comprehensive use of camera traps to study the diversity of wild cats and their activity pattern in WKNP.

2. Materials and method

2.1. Study area

This study was done in Way Kambas National Park (4°37' to 5°16'S and 105°55' to 105°54'E) from May 2013 until May 2014, in collaboration with Sumatran Tiger Conservation Program (STCP). The 125,621.3 ha park bordered by Sumatran coastlines on the east, Way Penet river on the southeast, Way Sukadana river on the west, Way Pegadungan river on the southwest and Way Seputh river on the north. Between Way Penet and Way Rincan rivers, as well as Way Sukadana and Way Tulung Braja rivers, there is 28.5 km man made river bank blocking. Geologically, most of its area is flat and approximately 30 m above sea level, with the highest point at 52 m above sea level in the southeast and east part. Soil type consists of association between brown-yellow podzolic and red-yellow podzolic, association aluvial-hydromorph and lacustrine glei humus, marine aluvial hydromorph, river aluvial hydromorph and dark brown sand regosol. The main soil includes acidic tuva, lacustrine, river, marine and sand sediments. According Smith and Ferguson, Way Kambas National Park has B climate type with average annual rainfall 2,500–3,000.

Way Kambas National Park vegetation consists of mangrove forest, Dipterocarp low land forest, fresh water swamp forest, riparian, grassland swamp, and alang-alang grassland (Imperata cylindrica). Tree species were dominated stratum A consist of Shorea ovalis, S. leprolusa, Dipterocarpus gracilis, Canarium littorale, C. denticulatum, Horsfieldia glabra and Albizia lebbeckioies, while in stratum B were Mallothus subpelatatus, Eurycoma longifolia, Baccaurea racemosa and Antidesma spp. Swamp vegetation was dominated include Melaleuca leucadendron, Pandanus tectorius, Oncosperma tigilaria and Gluta renghas. This park is also considered to be the largest non-peat fresh water swamp
Figure 1. Research and camera trap setting locations in Way Kambas National Park.

conservation area in Sumatra [24]. Historically, the park was declared in 1937 as a wildlife preservation, then changed into commercially exploited forest between year 1954 to 1974. In 1978 was proposed to be a national park, then finally declared as national park in 1989 [25], but officially become national park in 1997.

2.2. Methods
Wild cat video was collected using systematic camera traps, following the research carried out by [15] in three 10 km x 16 km sampling blocks. Each block was layered with 2 km x 2 km grid. Of the total 40 grid cells, 20 cells were selected on every other adjacent cell (figure 1). Camera traps were setup at the best location of each selected cell. Each camera was set in one block for three months ($\bar{X} = 112.3$ days) and sequentially moved to next block. At every station one camera trap was set up for 24 hours per day. Data was collected monthly, at the same time we did several treatments for camera included battery changing, lens cleaning, and lost/broken camera replacement.

The best locations to set up the camera are animal active track, patrol trail and old logging trail. Camera was setup on tree or poll of 30–40 cm height, 3m away from potential animal trail. Coordinates, elevation, wild cat indirect signs (foot prints, scraps, scats) and disturbing types (illegal logging, poaching or other illegal activities) were recorded. Total active day on each location was counted started from camera setup to checking time or the last recorded date. Activity patterns were deduced using the collected data in combination with 2007-2014 Sumatran Tiger Conservation Program (STCP) data. Photos and videos obtained in this study and the accumulation of data from a camera trap installed by STCP since 2007 used in the analysis of activity patterns of wild cats. Videos and photos independently verified before inclusion in the dataset.
2.3. Data analysis

Videos and photos were stored in the computer database, then managed using Automatic Storage and Analysis of Camera Trap Data software developed by Harris et al. [26] and Sanderson et al. [27]. Identification of wild cats caught in camera traps used field manuals for mammals [1-3]. Capture rate success (CR) was calculated as \( CR = \frac{n_i}{\sum t_n} \times 100 \) where \( n_i \) is total independent video of \( i \) species and \( \sum t_n \) is total trap nights [28]. Video of the same species from the same station considered independent if they were recorded at least with 30 minutes apart [28]. Time needed to get the wild cat video was based on species accumulation. It was based on total species recorded during the sampling period.

Activity pattern estimation used Kernel Density Estimation (KDE) on circular data developed by Ridout and Linkie [21] using R program [29] and overlap package [30]. Activity pattern is defined as photograph/video caught during the day (06.01 – 17.59 hours) and the night (18.00 – 06.00 hours) [5]. There are four different types of wild cat activity patterns [18] i.e. strongly nocturnal (if \( \geq 85 \% \) its activity is recorded between 18.00 – 06.00 hours), mostly nocturnal (if 61–84 \% its activity is between 18.00 – 06.00 hours), cathemeral (if 40–60 \% its activity is during the day or night), mostly diurnal (if 61–84 \% its activity is during the day, between 06.00 – 18.00 hours) and strongly diurnal (if \( \geq 85 \% \) its activity is between 06.00 – 18.00 hours).

3. Results and discussion

3.1. Results

3.1.1. Wild cat diversity. Total 57 camera traps were set up in three sampling blocks on effective survey area of 612.37 km\(^2\) (48.89 \% of WKNP total area). The camera traps in all blocks were set up in 380 days with 4,610 trap nights. Of 6,744 independent videos, there are 4,017 animal videos (59.56 \%), 2,533 forest vegetation videos (37.56 \%), 191 human videos (2.83 \%), and three unidentified or unable to be opened videos (0.04 \%). Forty-two identified animal species include mammals (16 families, 34 species), birds (3 families, 7 species), reptile (1 family, 1 species) and insects (unidentified in family and species strata).

Based on their habitat types the wild cat species were found in secondary forest (three species), shrubs (two species) and imperata reeds (one species). The leopard cat was found in three habitat types (secondary forests, shrubs and reeds), tigers and marbled cats was found in two habitat types (secondary forests and shrubs), while clouded leopard was found only in single habitat type (secondary forest).

Four wild cat species (figure 2) were caught on 29 (50.9 \%) of 57 camera trap stations. Total independent videos of wild cats were 89, consisted of sumatran tiger (\( n = 40 \)), clouded leopard (\( n = 4 \)), leopard cat (\( n = 40 \)) and marbled cat (\( n = 5 \)). It is 1.32 \% of total animal videos caught. Golden cat (\( Pardofelis temincki \)) and flat-headed cat (\( Prionailurus planiceps \)) were not recorded. Based on capture rate success, sumatran tiger and leopard cat (0.87 per 100 trap nights) were the most frequent, followed by marbled cat (0.11) and clouded leopard (0.09). Forty two active trapping days (12 callendar days) were needed to catch the first wild cat (leopard cat), 48 days for clouded leopard, 155 days for sumatran tiger and 202 days for marbled cat (figure 3). Leopard cat, clouded leopard, sumatran tiger, and marbled cat were 7\(^{th} \), 9\(^{th} \), 17\(^{th} \), and 19\(^{th} \) species respectively of 42 caught by camera. Potential wild cat prey caught include sambar deer (\( Cervus unicolor \)), wild pig (\( Sus scrofa \)), barking deer (\( Muntiacus muntjak \)), napu (\( Tragulus napu \)), mouse deer (\( Tragulus javanicus \)), long-tailed macaque (\( Macaca fascicularis \)), pig-tailed macaque (\( Macaca nemestrina \)), crested fireback (\( Lophura ignita \)), jungle fowl (\( Gallus gallus \)), common emerald dove (\( Chalcophaps indica \)), crested partridge (\( Rollulus rouloul \)), island collared dove (\( Streptopelia bitorquata \)), some species of Muridae and Sciuridae.

3.1.2. Activity pattern. Four hundred eighty-nine independent photographs and videos for analyzing wild cat activity pattern were from collected in the field and 2007 – 2014 STCP data (table 1). Two pairs of wild cats have similar activity patterns, sumatran tiger and marbled cat, and clouded leopard and...
leopard cat. Sumatran tiger and marbled cat were active both day and night (cathemeral). Sumatran tiger (n = 271) showed night activity (51.6 %) and day (48.4 %), marbled cat 41.2 % and 58.8 % (n = 17) respectively (figure 4). Sumatran tiger was most active in the morning, 05.00 – 06.00 hours and in the afternoon, 17.00 – 18.00 hours while marbled cat at 05.00 – 06.00 hours in the morning and 12.00 – 14.00 hours in the afternoon. Leopard cat (82 %, n = 189) and clouded leopard (66.7 %, n = 12) were more active during the night (mostly nocturnal). The leopard cat highest activity was on 05.00 and 18.00 hours, and clouded leopard was 05.00 – 06.00 hours and 21.00 – 22.00 hours (figure 5).

Figure 2. Wild cats species in WKNP based on camera trap: (a) sumatran tiger (b) clouded leopard, (c) leopard cat and (d) marbled cat.

Figure 3. Cumulative number of wild cats species captured in camera trap nights from May 2013 to May 2014 at Way Kambas National Park.
Table 1. Number of photographs and videos of wild cats with time/date stamp data from this study and STCP study [31].

| Year | Camera site | Trap night | Sumatran tiger | Leopard cat | Marbled cat | Clouded leopard | Total |
|------|-------------|------------|----------------|--------------|-------------|----------------|-------|
| 2007 | 11          | 1009       | 10             | 0            | 0           | 0              | 11    |
| 2008 | 12          | 3760       | 32             | 1            | 0           | 0              | 33    |
| 2009 | 18          | 4863       | 11             | 0            | 0           | 0              | 11    |
| 2010 | 32          | 6535       | 40             | 13           | 1           | 0              | 54    |
| 2011 | 29          | 7591       | 2              | 0            | 1           | 0              | 3     |
| 2012 | 22          | 7045       | 19             | 51           | 1           | 0              | 71    |
| 2013 | 31          | 7965       | 46             | 67           | 5           | 1              | 119   |
| 2014 | 39          | 4565       | 71             | 16           | 4           | 7              | 98    |
| 2013 | 41          | 3345       | 40             | 35           | 1           | 4              | 80    |
| 2014 | 16          | 1265       | 0              | 5            | 4           | 0              | 9     |
| Total| 125         | 47,943     | 271            | 189          | 17          | 12             | 489   |

1) STCP  
2) Our data

Figure 4. Wild cats activity percentage of day and night.

3.2. Discussion

3.2.1. Wild cat diversity. Four wild cat species, sumatran tiger, clouded leopard, marbled cat, and leopard cat were caught by cameras. Time needed to catch these species is relatively shorter than in Kalimantan [7] with total 231 trapping active days (21 calendar days) to have the first wild cat picture (leopard cat). Way Kambas National Park is relatively dryer in rainy season and high number of patrol lanes, tracks, ease the wild cat mobility. Therefore, the probability to catch the animals is higher. Wet condition such as in Kerumutan [15] or Sebangau National Park [7] limits the wild cat mobility due to swamp and water barrier as well as camera setting accessibility. In comparison to other areas in Sumatera, wild cat diversity in WKNP is low, only four out of six. While in other parks have five species.
Figure 5. Estimated activity patterns for four wild cats species in WKNP with smoothing parameter $c = 1$. Solid lines are kernel-density estimates. The short vertical lines above the $x$-axis indicate the times of day at which the species were photographed.

such as Sunarto et al. [15] in Central Sumatra, McCarthy et al. [4] in Bukit Barisan Selatan National Park (BBSNP), Pusparini et al. [14] in Gunung Leuser National Park (GLNP) and STCP [31] in Bukit Tigapuluh National Park (BTNP). Golden cat was not caught in WKNP, but flat headed cat was not found in other areas either (table 2).

Bastoni and Apriawan [17] found two other species, golden cat and flat-headed cat in WKNP. It cannot be concluded that those two species is locally extinct in WKNP. Factors affected its absence from camera trapping include sampling effort, species habitat preference [32], low species density and human active trail avoidance [15] or camera trap limitation for arboreal species, such as for marble cat and clouded leopard [5, 23].

Most wild cats were found in secondary forest habitats, the other were found in shrubs and reeds. The secondary forests provide abundant resources for the survival of wild cats, including prey availability, shelter, and a safe place for reproduction. The abundance of prey species such as wild boar ($Sus scrofa$), deer ($Muntiacus muntjak$), squirrels, rats and birds are high in secondary forests. The forest has the highest potential trap rate for all prey. The growing densely tree and pole vegetation is also a good protection site for wild cat species, especially arboreal species (clouded leopard and marbled cat).

Park rangers and local people informed that golden cat and flat-headed cat have been seen in WKNP. Further scientific investigaton is needed to confirm those claims. Park ranger and field guide reported direct contact with golden cat in Way Kanan river and Suaka Rhino Sumatra (SRS) (Pers. Comm.). The same information for flat-headed cat come from Braja Yekti (Wayan Sadi 2015; Pers. Comm).
Table 2. Wild cat species diversity and capture rate success comparison (photograph/video per 100 trap nights) in Sumatera conservation area.

| Location | Trap night | Sumatran tiger | Clouded leopard | Golden cat | Leopard cat | Marbled cat | Flat-headed cat |
|----------|------------|----------------|-----------------|------------|-------------|--------------|-----------------|
| WKNP\(^1\) | 3,507      | √              | √               | √          | √           | √            | √               |
| WKNP\(^2\) | 4,610      | 0.87           | 0.09            | nd         | 0.87        | 0.11         | nd              |
| BBSNP\(^3\) | 34,166     | 0.16           | 0.15            | 0.30       | 0.08        | 0.10         | nd              |
| GLNP\(^4\) | 3,452      | *              | 0.41            | 0.72       | 0.20        | 0.23         | nd              |
| Central Sumatra\(^5\) | [7,513] |                |                 |            |             |              |                 |
| Kampar     | 1,132      | td             | 0.60            | td         | 0.60        | td           | nd              |
| Kerumutan  | 1,868      | 0.70           | 0.10            | td         | 0.10        | 0.20         | nd              |
| Teso Nilo  | 1,618      | 1.60           | 0.25            | td         | 3.10        | 0.15         | nd              |
| Peranap    | 1,321      | td             | 0.70            | 0.20       | 0.75        | 0.49         | nd              |
| R. Baling  | 1,574      | 0.45           | 1.80            | 0.30       | 2.20        | 0.60         | nd              |
| BTNP\(^6\) | 19,076     | 1.82           | 1.24            | 0.32       | 2.16        | 0.37         | nd              |

\(^1\) Way Kambas National Park [17], photograph documents, no independent numbers, \(^2\) Way Kambas National Park (current data), \(^3\) Bukit Barisan National Park [4]; \(^4\) Gunung Leuser National Park [14]; \(^5\) Sunarto et al. [15]; \(^6\) Bukit Tiga Puluh National Park [31], unpublished data; *: restricted access data; nd: not detected.

Rawa Betik local people (Komarudin 2015; Pers. Comm). Based on morphological characteristics before showing the photograph, flat-headed cat was seen at the padie field and river sides next to the national park during the dry season. Komarudin’s sighting point was similar to Hearns et al. [33] in Sabah, Malaysia. Hearns et al. [8] reported direct contact with flat-headed cat at Kinabatangan river side, Sabah Malaysia.

Flat-headed cat is the threatened species [8], is the smallest cat in Sumatera, which is approximately 44.6–52.1 cm body length, and 1.5-2.2 kg body weight. It is least known, with its distribution only in lowland tropical forest in Thailand, Malaysia Peninsula, Borneo and Sumatera [6]. Pusparini et al. [14], Sunarto et al. [15], McCarthy et al. [4] and STCP [31] have not seen it in Sumatera. Cheyne and Macdonald [7] saw flat-headed cat in Sebangau National Park, Central Kalimantan after 3,498 trap nights. In Indonesia, flat-headed cat presence has been seen more in Kalimantan than other islands [6]. There are 12 informations on its presence in Kalimantan [34]. Its small body size, aquatic habitat preference and low density may affect its low camera trap success. Camera set up that is not focus on one species with highly specific habitat contribute to its success. Azlan and Sharma [5] stated that flat-headed cat may not use the open trail used by big mammals, where the camera being set up. It is possible this species passed the camera set point but it didn’t trigger the sensor for recording. Wadey et al. [35] had two photographs of flat-headed cat during the day, far from water resources but next to palm oil plantation during the dry season. But Bezuuien [36], Bezuuien [37], Nowel and Jackson [1] and Wilting et al. [6] stated that flat-headed cat prefers to aquatic habitat, active during the night and avoiding direct human contact. Wadey et al. [35] suggested that to increase the detection chance and decrease sampling biased for flat-headed cat, research has to be focused on their habitat preference. Camera has to be lowered closed to soil surface level (±10 cm), on small wildlife trail, not on logging or patrol trails.

Golden cat caught in WKNP only in the year 1996 [17], so did several studies in Sumatera hill areas [4, 14, 15, 31]. Sunarto et al. [15] reported golden cat in Peranap and Rimbang Baling, 200–300 m above the sea level, (average 245.8 m above sea level), but not in lower areas (Kampar, Kerumutan and Teso Nilo). In GLNP it is caught in mountainous forest and low mountainous area [14]. In BBSNP it is found in lower areas [4]. Golden cat is commonly found in low land forest to high land, in Sumatera, it is commonly caught in hilly area of 200–300 m above sea level [5, 14, 15, 31]. Way Kambas National
Park which 0–60 m above sea level (the highest point is ±60 m above sea level), may not be suitable habitat for golden cat.

Based on capture rate success, sumatran tiger and leopard cat have the highest success (0.87), followed by marbled cat (0.11) and clouded leopard (0.09). It has the same results as Sunarto et al. [15] and STCP [31], but it has different from McCarthy et al. [4] and Pusparini et al. [14] (table 2). In Central Kalimantan and Malaysia Peninsula, leopard cat has the second success rate after clouded leopard [7] and tiger [5]. In Thailand, at the second place after leopard (*Panthera pardus*), followed by tiger [13]. In WKNP, these two wild cats were found in 26 of 57 (60.5 % ) and occupied 11 % of camera stations.

Leopard cat is the commonest cat species and widely spread [3], can live in different habitat types and more tolerant against disturbance areas even in palm oil plantation [1, 2]. In disturbed area such as oil palm plantation and secondary forest, they will easily find prey species especially rats. Its high adaptation ability makes leopard cat widely spread inside national park and frequently caught. Even though Sumatran tiger is critically endangered, the camera trapping rate is higher than other wild cat. Due to the nature of dominance, pre-species diversity, living in different habitat types, and its preference to permanent trail, trapping success for tiger catch is higher. In Southeast Asia, tiger is a dominant wild cat. Smaller wild cat with similar diet as tiger, e.g. clouded leopard, will be in different niche by living in different latitude or active time [15]. Sumatran tiger has wider home range than other smaller wild cats, using permanent and wide forest trail, may reach 52 km² for male, and 27 km² for female tigers [18]. Ngoprasert et al. [12] stated wild cat distribution was affected by prey availability and potential competitors.

Our clouded leopard capture rate success is lower than other studies in Sumatra and in Borneo [5, 7]. The low capture rate on clouded leopard in WKNP is due to its competition and being sub-ordinate predator toward sumatran tiger, and therefore; it has temporal and spatial avoiding behavior towards tiger. As Sunarto et al. [15] showed the lowest overlapped temporal activity between sumatran tiger and clouded leopard. Spatially, clouded leopard distribution is in medium latitude of 150-200 m above the sea level, whilst sumatran tiger below 100 m above the sea level. In Asia, clouded leopard high density is when there is no or low big cat density [11, 13]. On the other hand, when big cats are in the same habitat as clouded leopard, its density is low [11, 13]. Except in Rimbang Baling [15], in Sumatra [5, 14, 15, 31] and in Borneo [5, 7] has the same pattern. In Thailand, clouded leopard movement and distribution were influenced by the low density of tiger and leopard [11]. Clouded leopard avoided confrontation with dominant predator. According to Grassman et al. [11], spatial pattern of medium size cat and its coexistence with tiger and leopard may due to social dominance, prey diversity and vegetation density.

Our marbled cat's capture rate success is lower (0.11 per 100 trap nights) than trapping by Sunarto et al. [15] and Cheyne and Macdonald [7]. In Kalimantan and Sumatera marbled cat rarely found [1], it preferred hilly forest [11]. In Central Sumatera and BBSNP marbled cat is commonly found in 100 m above sea level areas. It is associated with wet and tropical rain forest [2], prefer hilly forest [11]. It is also arboreal cat, its activities cannot be caught by camera. It has high climbing ability [5]. This ability increases its ecological separation from other cats which active terrestrial.

3.2.2. Activity pattern. Activity pattern of sumatran tiger is cathemeral (1, 20, 30, 31). Sumatran tiger activity pattern may follow its main prey such as wild pig, barking deer, sambar deer, long-tailed and pig-tailed macaques those are nocturnal and diurnal. Tiger scat analysis (n = 64) showed that its main prey include wild pig (33.3 %), macaque (27.5 %), sambar (19.7 %) and barking deer (17 %) [38]. Wild pig, sambar, barking deer, and sun bear are cathemeral and macaques are diurnal [39]. As Southeast Asia dominant predator, tiger activity is not influenced by competition with other cats. It is more affected by prey density, distribution and daily activity. Linkie and Ridout [22] showed that varied prey species and activity patterns affected sumatran tiger activity pattern in Kerinci Seblat National Park.

Our marbled cat study also showed that this species is cathemeral and tend to be diurnal (58.8 %) as supported by other studies in Sumatra [4, 14, 15], Borneo [5] and Thailand [13]. Different studies showed primarily nocturnal [1, 2]. It suggested marbled cat activity is related to prey choice and
competition with other wild cat. Based on body size and prey, its main competitor is leopard cat. Marbled cat tends to be diurnal to reduce its competition with leopard cat, which tends to be nocturnal, and main prey is murids. There are nine marbled cat’s prey, i.e. terrestrial and arboreal mammals such as hog deer, slow loris, bush-tailed porcupine, malayan pangolin and indochinese ground squirrel. Marbled cat’s temporal avoidance toward leopard cat and clouded leopard was supported by Lynam et al. [13] and Sunarto et al. [15] by low temporal overlapped coefficient. Vertically marbled cat has an ability to avoid competition with leopard cat by being arboreally active.

In our study, leopard cat is mostly nocturnal (82 %, n = 189), supported by several studies [1, 2], as well as in Sumatera [4, 14, 15], Malaysia peninsula [5] and Borneo [7]. Grassman et al. [9] stated it is arrhythmic. Its higher activity during the night is correlated with nocturnal murids prey choice [4]. It is not ecological niche separation mechanism with other wild cats [4]. Being nocturnal may also play avoidance mechanism towards human activity, as it occupied areas with high human presence [4]. In Thailand, Grassman [9] showed eventhough leopard cat is crepuscular, it also active during the day. It is supported with its unspecific prey which consist of species those active during the day and night.

In our study, clouded leopard activity pattern is mostly nocturnal (66.7 %, n = 12), as commonly found in Sumatera [15, 21], Borneo [5, 7, 8] and Thailand [13]. Other studies found clouded leopard is crepuscular [4, 14], diurnal and arrhythmic [11]. Due to illegal activity and sumatran tiger as its main competitor, clouded leopard was more active during the night and hunting its prey during the day arboreally, to reduce the competition and void human disturbance. According to Sunquist and Sunquist [2], wild cat activity time depends on its prey activity and disturbance level of human activity. Clouded leopard’s higher night activity in Borneo may due to the absence of big cats (tiger and leopard, its main competitors) [1]. Hearn et al. [8] stated intra-guild predation and competition will not influence clouded leopard activity pattern, as comparing with all sympatric predators in Borneo, it is the biggest predator (11-23 kg). Its activity is affected by main prey activity cycle, as showed by other Pantherine. Or it reflects mechanism to maximize hunting success. On the other hand, in Sumatera, clouded leopard and sumatran tiger are sympatic species. By its smallest body size, clouded leopard may become subordinate for sumatran tiger, and therefore; it minimizes spatial and temporal overlap [8]. Clouded leopard hunts its prey terrestrially, due to big predator like tiger, it may hunt arboreally [2].

4. Conclusion
The diversity of wild cat species in the Way Kambas National Park in this study is lower than the results of previous surveys. Four wild cat species found in this study were sumatran tigers, clouded leopards, marbled cats and leopard cats. The pattern activities of the sumatran tiger and the marbled cat is cathemeral (active during the day and night), while clouded leopards and leopard cats are active at night (mostly nocturnal). Although the presence of other rarer cat species in the park, such as golden cat and flat-headed cat still needs to be confirmed by further long-term monitoring study, this study demonstrates that the Way Kambas National Park is an important habitat for wild cats in Sumatra.

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