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Distribution Pattern and Activities of Felidae and Prey in Bukit Rimbang Bukit Baling Wildlife Reserve, Riau

Distribusi Spasial dan Waktu Aktif Felidae Serta Satwa Mangsa di Suaka Margasatwa Bukit Rimbang Bukit Baling, Riau

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ABSTRACT

The interaction between predators and prey has resulted in population dynamics and played a crucial role in maintaining species' populations within ecosystems. This research aimed to identify distribution and activity patterns to understand prey-predator interactions and the effect of environment and prey density on Felidae presence at Bukit Rimbang Bukit Baling Wildlife Reserve (BRBB WR), as an essential area for maintaining large mammal habitats in Sumatra. The camera traps were systematically placed in the Northeastern part of BRBB WR to collect presence data. The prey-predator interaction analysis used kernel density in RStudio. The effect of environment and prey density on Felidae presence was analyzed using a generalized linear model (GLM). The results indicated that Felidae and prey exhibited a dispersed distribution pattern, showing high activity at night and day, respectively. The Sumatran tiger, clouded leopard, leopard cat, and mouse deer had the highest overlap time (>0.50). However, the environmental and prey density had statistically non-significant effects on the presence of Felidae. Human activities in the area potentially disrupted wildlife community dynamics, although this aspect was beyond the scope of this research. This research suggested further investigation of the effects of human activities on wildlife communities in BRBB WR.

INTISARI

Dinamika populasi spesies merupakan hasil interaksi antara predator dengan mangsa yang berperan penting dalam mengatur populasi organisme di dalam ekosistem. Penelitian ini bertujuan untuk mengidentifikasi pola distribusi, pola aktivitas untuk mengetahui interaksi prey-predator, dan pengaruh kepadatan mangsa dan faktor lingkungan terhadap kehadiran Felidae di Suaka Margasatwa Bukit Rimbang Baling (SM BRBB). Data dikumpulkan dengan menggunakan camera trap yang secara sistematis diletakkan di wilayah timur laut SM BRBB. Analisis interaksi prey-predator menggunakan kernel density pada RStudio, dan identifikasi pengaruh faktor habitat dan kepadatan mangsa terhadap kehadiran Felidae menggunakan generalized linear model (GLM). Hasil penelitian menunjukkan bahwa Felidae dan satwa mangsa di SM BRBB memiliki pola distribusi merata. Felidae mempunyai pola aktivitas tinggi pada malam hari sedangkan sebagian besar spesies mangsa pada siang hari. Harimau sumatra, macan dahan, kucing hutan dan pelanduk kancil mempunyai nilai tumpang tindih waktu tertinggi (>0.50). Faktor kepadatan satwa mangsa dan lingkungan secara statistik tidak berpengaruh signifikan terhadap keberadaan Felidae. Keberadaan manusia di dalam kawasan berpeluang mengganggu dinamika komunitas satwa, namun faktor tersebut di luar cakupan penelitian ini. Penelitian ini menyarankan investigasi lebih lanjut mengenai aktivitas manusia dan pengaruhnya terhadap komunitas satwa liar di SM BRBB.

Introduction

Most carnivorous species in Asia belonging to the Felidae family are classified as endangered. The population status and ecological interactions are crucial for conservation management, specifically when species within the same niche have similar threat levels (Harihar et al. 2018). Felidae plays a crucial role in the ecosystem as a top predator, and this role has links to the spatial and temporal activity patterns of carnivorous species, influenced by habitat and dietary preferences, as well as interactions with dominant species (Rich et al. 2017). Meanwhile, Bukit Rimbang Bukit Baling Wildlife Reserve (BRBB WS) in Riau Province, Sumatra, is an essential area for Felidae habitat (Sunarto et al. 2015). BRBB WS can maintain the presence of the Sumatran tiger *(Panthera tigris sumatrae)*, threatened by habitat fragmentation, human conflicts, uncontrolled hunting of prey species, and deforestation (Wibisono et al. 2011).

BRBB WS is a habitat for the Sumatran tiger and hosts several other Felidae species occupying the same habitat. Some of the Felidae species include the clouded leopard *(Neofelis diardi)*, golden cat *(Catopuma temminckii)*, Sumatran leopard cat *(Prionailurus bengalensis sumatranus)*, and marbled cat *(Pardofelis marmorata)* (Sunarto 2015). The distance to the forest edge positively influences the habitat of the clouded leopard and Asiatic golden cat. Furthermore, research on Felidae by (Sunarto et al. 2015) in central Sumatra, including BRBB WS, Kerumutan Wildlife Sanctuary, Tesso Nilo National Park, and Bukit Tiga Puluh National Park, stated that knowledge of interspecific interactions can enhance the effectiveness of conservation management efforts for endangered wildcats.

The prey-predator relationship is a biological interaction that occurs in an ecosystem. Prey plays a role as a biomass source for the predator, enhancing their fitness and energy. Prey-predator interactions occur spatially, and several theoretical models, such as the Ideal Free Distribution (IFD), explain that the dispersed distribution of prey influences predator distribution and population stability. Prey species also play a vital role in the daily cycle of predator species as they adjust their hunting periods to facilitate more manageable and more effective energy acquisition (Karanth & Sunquist 2000).

Their daily activity durations could indicate their spatial utilization. Availability and distribution patterns of resources determine the spatial pattern and duration of species residing in a particular habitat. Availability and distribution patterns of resources in a particular habitat determine the spatial pattern and stay duration of species in a given habitat. This phenomenon has a direct link to the ecological niche occupied by a species, as it is contingent on the availability and distribution of its prey (Setiawan et al. 2018). According to (Ramesh et al. 2012), tigers and leopards can coexist without spatial or temporal differences. Felidae species are believed to be primarily active in hunting during the night (Haidir et al. 2018). The high overlap between predator and prey increases the risk for prey availability. Predators could have a higher chance of catching prey because prey often leaves their shelter searching for food in risky areas (Hernández & Laundré 2005). This research aims to understand the prey-predator relationship by examining spatial patterns and activities and the influence of prey density and environmental factors on the presence of Felidae in BRBB WS. The results could become inputs for formulating a conservation management strategy for endangered wildcat species in BRBB WS.

Methods

Research Location

BRBB WR as a conservation area was designated by the government as a Wildlife Reserve based on the Governor's Decree of Riau Province No. 149/V/1982 dated June 21, 1982, covering an area of 136,000 hectares, spanning Kampar Regency and Kuantan Singingi Regency in Riau Province. Furthermore, the forest areas surrounding the BRBB WR have become wildlife reserves and spring water sources. The Ministry of Forestry has designated the extension of the BRBB WR area through the Ministry of Forestry's Decree No. SK. 3977/ Menhut-VII/ KUH/ 2014, covering an area of 141,226.25 hectares (BBKSDA 2020).

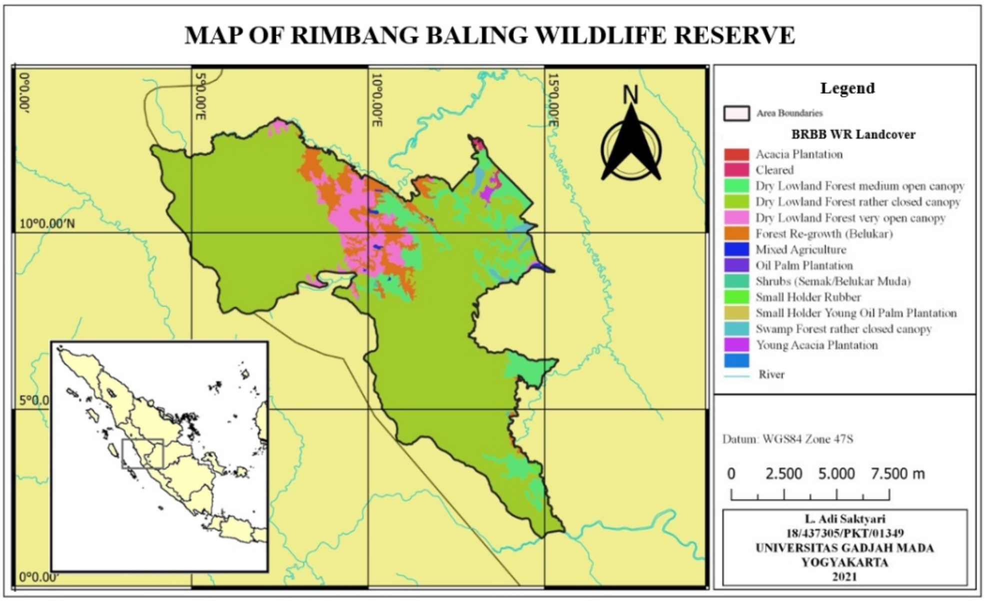

Figure 1. Map of research location in Bukit Rimbang Bukit Baling Wildlife Reserve

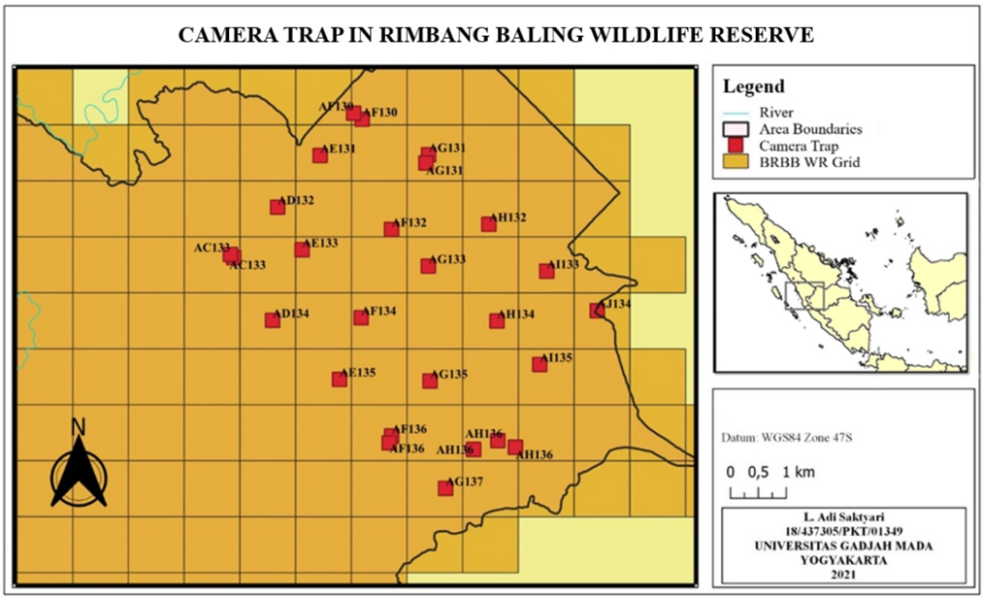

Figure 2. Camera trap design in Rimbang Baling was installed April-Juli 2006

Data Collection

The camera traps were installed in collaboration with the WWF Riau team to survey large mammals in BRBB WR from April to July 2006. The placement location of camera traps should consider the previously identified predicted wildlife corridors and habitats to ensure good photo results and facilitate the identification of captured Felidae. The installation of camera traps was in 2 x 2 km grids consisting of one to two camera traps, with a distance of approximately 3 km between camera traps. The data collection procedure for prey species was similar to Felidae, with the grid sizes determined by the home range of the Sumatran tiger. To understand the current field conditions and document the latest information about BRBB WR, the researchers visited the research location in November 2020.

Data Analysis

Spatial Distribution of Felidae and Prey Species

The coordinates of camera trap placements that captured photos of each Felidae and prey species became the spatial distribution data of Felidae and prey species. This research used the kernel density function in ArcGIS 10.3 software to generate spatial distribution maps of Felidae and prey species using the spatial distribution data. The resulting maps were then overlaid on the land cover map of BRBB WR, classified by WWF and the National Standardization Agency. The spatial distribution patterns were determined using Average Nearest Neighbor (ANN) analysis, a spatial analysis technique for detecting distribution patterns based on geographic data (Wilson & Din 2018). The z-score values resulting from the analysis determined the spatial distribution patterns. A z-score <1, =1, and >1 indicates clustered, random, and dispersed distributions.

Activity Patterns of Felidae and Prey Species

The activity patterns analysis of Felidae and their prey species was based on the time of capture for each species recorded by the camera traps over 24 hours. The analysis of activity patterns used kernel density and overlap packages in Rstudio (Ridout & Linkie 2009) to determine the overlap value between Felidae and their prey and its relation to competition and predation (Linkie & Ridout 2011; Ramesh et al. 2012; Azevedo et al. 2018). The overlap value could only analyze the overlap between two species. Its value (Δ) ranged from 0 to 1, with higher values indicating more significant overlap. According to Meredith & Ridout (2014), the scenario for analyzing overlap depends on the sample size. The (Δ_1) or (Δ_4) values were used when the sample size was less than 50 or exceeded 75.

Prey Species Density Values

The species density analysis used the Thierry Chambert Analysis software to estimate the density of wild animals through camera trap capture data using Space-To Event (STE) and Instantaneous Sampling (IS) (Moeller 2017). The prey species were assumed based on information from previous research, such as wild boars, deer, and antelope (Dinata & Sugardjito 2008), mouse deer, and small mammals (*Rodentia*) (Kawanishi & Sunquist 2008). The analysis utilized information such as camera deployment periods, prey species identities, and the time and location of each recorded prey species captured. The species density analysis required two types of data, namely "Deployments" and "Images" in CSV format. Each data set represents the analytical needs for estimating prey species density and contains information such as coordinates, camera trap grid names, species names, and camera trap deployment's start and end times.

Identification of Prey Species Density and Environmental Factors Influence on the Presence of Felidae

This research utilized the Generalized Linear Model (GLM) to identify the influence of prey species density and environmental factors on the presence of Felidae. GLM is an extension of the linear regression statistical model to predict the best relationship between dependent and independent variables. The selection and determination of dependent and independent variables impacted Felidae's presence employed logistic regression analysis using GLM and the brglm package in RStudio 4.0.2 software. The selection of independent variables was based on previous research on Felidae ecology, incorporating important habitat-use variables. Several variables used included the distance from roads, distance from rivers, the density value of prey species captured by the camera traps, distance from settlements, and elevation. The dependent variable consisted of presence-absence data for Felidae (Sunarto et al. 2015; Ariyanto 2015).

Results and Discussion

Encounters between Felidae and Prey Species

The number of Felidae and prey species captured by the camera traps placed in 22 grids at BRBB WR was calculated from April to July 2006 (Table 1). The Sumatran tiger, clouded leopard, leopard cat, golden cat, and marbled cat were five species of Felidae captured by the camera traps. The detected prey species included barking deer, mouse deer, macaque, and wild boar. All Felidae species encountered fell in the category of protected wildlife according to the Regulation of the Minister of Environment and Forestry of Indonesia number P.106/MENLHK/SETJEN/KUM.1/6/2018 regarding protected plant and animal species. According to the IUCN Red List, almost all Felidae species were critically endangered, near threatened, or vulnerable. Some prey mammal species were also protected.

Table 1. List of Felidae and prey captured by camera traps in BRBB WR between April and July 2006.

No.	Species name	Scientific Name	2006 Photo Count	Total Grid	Encounter Grids	Land Cover	Effective Trap Night	Trap Night
1	Sumatran tiger	*Panthera tigris sumatrae*	7	22	4	Low-dryland forest	2619	3445
2	Clouded leopard	*Neofelis diardi*	36		7	Low-dryland forest		
3	Marbled cat	*Pardofelis marmorata*	12		3	Low-dryland forest		
4	Golden cat	*Catopuma temminckii*	3		6	Low-dryland forest		
5	Leopard cat	*Prionailurus bengalensis*	37		8	Low-dryland forest Plantation forest		
6	Mouse deer	*Tragulus kanchil*	31		8	Low-dryland forest		
7	Barking deer	*Muntiacus muntjak*	73		12	Low-dryland forest		
8	Macaque	*Macaca nemestrina*	648		22	Plantation forest Mixed agriculture Low-dryland forest		
9	Wild boar	*Sus scrofa*	60		15	Low-dryland forest Plantation forest		
		Total	908					

The distribution maps indicated that Felidae and prey species encounters were higher in low-dryland forests (medium open canopy) than in plantation forests and mixed agriculture. Wild boar was found at 15 points in low-dryland forests (medium open canopy-rather open canopy) and plantation forests (two points). In comparison, macaque was found at 22 points in low-dryland forests (medium open canopy-rather open canopy), plantation forests (one point), and mixed agriculture (one point). Mouse and barking deers were recorded at eight and six points in low-dryland forests (medium open canopy-rather closed canopy), respectively. Sumatran tiger and clouded leopard were recorded at four and seven points in low-dryland forests (medium open canopy-rather closed canopy). The golden and marbled cats were detected at three and six points in low-dryland forests (medium open canopy-rather closed canopy) and lowland dryland forests (medium open canopy-rather closed canopy). In comparison, the leopard cat was detected at eight points in low-dryland forests (medium open canopy-rather closed canopy) and plantation forests (one point).

Felidae and Prey Distribution Patterns

Based on the Artificial Neural Network (ANN) and kernel density analyses, the distribution patterns of Felidae and prey species showed dispersed patterns (Table 2). Based on the presence-absence data, almost all camera trap stations captured macaques. Macaques are primates with good abilities to adapt their feeding activities, habitat use, and population control within groups. These abilities allow these species to survive in disturbed habitats and tolerate environmental changes (Hanya et al. 2003; Jaman & Huffman 2013).

Many of the population practiced mixed agriculture and oil palm production in BRBB WR areas. These types of land covers play a crucial role in influencing the dispersed distribution of macaques in BRBB WR, considering that oil palm plantations are one of the foraging sites frequently visited by animals (Linkie et al. 2007). The dispersed distribution pattern of macaques also resulted in the highest prey density value of 11.5 individuals/km². Most macaques occupied lowland forest habitats, and their semi-terrestrial nature led them to utilize human-made trails for movement. Furthermore, the density value of macaques in BRBB WR is consistent with the research conducted in the Kerinci Seblat National Park (TNKS), which also showed the highest density value in lowland forest habitats with a density of 1.7 groups/km² consisting of 10.5 macaque individuals (Yanuar et al. 2009).

Mouse and barking deer had dispersed distribution patterns and were captured in lowland forests (closed canopy-rather closed canopy). Mouse deer are commonly found in lowland forest habitats up to 600 meters above sea level (masl) while barking deer prefer to inhabit shrubs, agricultural lands, lowland and highland forests, and mountainous areas up to 2400 masl (Farida et al. 2006). Meanwhile, the characteris-

Table 2. Distribution pattern result of Felidae and Prey in BRBB WR

No	Species	Scientific Name	Distribution Pattern	*z-score* Value
1	Sumatran Tiger	*Panthera tigris sumatrae*	*Dispersed*	4.6759
2	Clouded Leopard	*Neofelis diardi*	*Dispersed*	4.0280
3	Golden Cat	*Catopuma temminckii*	*Dispersed*	8.2089
4	Leopard Cat	*Prionailurus bengalensis*	*Dispersed*	3.0226
5	Marbled Cat	*Pardofelis marmorata*	*Dispersed*	4.8425
6	Wild Boar	*Sus scrofa*	*Dispersed*	2.9542
7	Macaque	*Macaca nemestrina*	*Dispersed*	6.1227
8	Mouse Deer	*Tragulus kanchil*	*Dispersed*	4.4217
9	Barking deer	*Muntiacus muntjac*	*Dispersed*	6.7034

tics of the habitat as a resource provider play a crucial role in the social relationships of these herbivorous mammals. Research conducted by (Farida et al. 2006) in the Gunung Halimun Salak National Park (TNGHS) showed that mouse and barking deers consume 38 out of 44 identified plant species. The camera trap photo showed that both species visited the same five stations. Therefore, they could share the same resources in the location, which affects their distribution patterns.

This research found the mouse and barking deer in open and closed canopy areas. The encounter in these different habitats could be due to changes in vegetation structure, which is the main component providing resources for herbivorous mammals, differences in vegetation, distribution patterns of vegetation cover, and habitat openness as the influencing factors (Putman & Flueck 2011). Hunting activities by humans in BRBB WR were still high. Some residents engaged in logging using small trails within the forest. These activities could significantly influence wildlife distribution patterns. Wild animals naturally select safe locations and rely on vegetation composition as a shelter to avoid disturbance and hunting by humans, specifically the Mouse and barking deer, which were often hunted for their protein resources(Farida et al. 2006).

Wild boars exhibited a consistent distribution pattern, and according to the camera trap encounter data, they were absent from six stations. In diverse habitat types, wild boars showed the ability to utilize the vast array of plant species and vegetation available (Baskin & Danell 2003). The low-dryland forest and plantation areas became the habitats of wild boars in BRBB WR. Open habitats, shrubs, and areas near water sources are preferred habitats (Ballari et al. 2015; Morelle et al. 2015). The density values of wild boars vary across different habitat types. Considering the presence of predators, the density ranged from 0.7 individuals/km^2 and 0.3-1.2 individuals/km^2 in Ruhuna National and Wilpattu National Park, Sri Lanka. The density reached 27-32 individuals/km^2 in Peucang Island, Ujung Kulon National Park, without considering the presence of predators (Ickes 2001). Furthermore, wild boars in BRBB WR had a density of 0.81 individuals/km^2. This result is consistent with the presence of five Felidae species that serve as predators to control their population, depicting the distribution pattern as the main prey of Felidae.

The Felidae in BRBB WR had a dispersed distribution pattern. The two big cat species, Sumatran tigers and clouded leopards, were found in only four camera trap stations and lowland forests. Sumatran tigers and clouded leopards had similar social structures and hunting strategies (Pokheral & Wegge 2019). They visited three of the same camera trap stations, indicating that both species share resources, including space and prey, in their hunting strategies within the distributed species in the area. Species with similar ecological characteristics and close evolutionary relationships could indirectly compete for resources. They would adapt by differentiating or selecting resources, roaming areas, and activity patterns to coexist in the same habitat. Predators could also track the activity patterns of their prey choices (Ramesh et al. 2012; Justa et al. 2019). This research recorded prey species' presence, such as wild boars, barking deer, mouse deer, and macaques, in locations frequently visited by Sumatran tigers and clouded leopards.

Golden, marbled, and leopard cats had a uniform distribution pattern. This research recorded these three small cat species in lowland forest habitats at different points. Only leopard cats visited acacia plantations and swamp forest areas. These findings suggested that these three small cat species share space and avoid interspecific competition. The arboreal nature of marbled cats could enhance ecological separation from other species and provide the ability to select alternative resources to reduce competition. Furthermore, Grassman, (2005) indicated that leopard cats used spatial division to avoid golden cats, although larger cat species tend to dominate smaller ones.

Activity Patterns and Temporal Overlap of Felidae-Prey Interactions

The activity patterns and temporal overlap analyses showed varying results for each interaction between Felidae and their prey. Temporally, Sumatran tigers and their prey exhibit the highest overlap value (Δ1) with mouse deer (0.63). Regarding their activity patterns, Sumatran tigers were more active during the night (80%), while mouse deer were also active at night (75%). Tigers had diurnal activity, with 45% recorded in concession areas during the day (Lestari 2018), and were considered crepuscular, with the highest activity before dawn (Pusparini et al. 2018). The difference in activity patterns from previous research might be due to Sumatran tigers altering their activity patterns to avoid hunting threats from humans (Clinchy et al. 2016). Sumatran tigers had the lowest overlap value with macaques (0.26), followed by wild boars and barking deer, with overlap values (Δ1) of 0.41 and 0.37, respectively. The overlap values indicated prey preferences (Ridout & Linkie 2009) and the potential for high encounter rates between carnivores and their prey (Fortin et al., 2015). However, species with high abundance could be widely distributed throughout the landscape (Allen et al. 2021). Macaques had a uniform distribution and were captured by almost all camera trap stations, with a density of 11.1 individuals /km². Despite the low overlap value, macaques, mouse deer, and barking deer can be considered alternative prey for Sumatran tigers (Allen et al. 2021).

Clouded leopards had the highest overlap value with mouse deer at Δ1 0.56. This overlap value was the highest compared to the other three potential prey species, which were more active during the day, namely Δ1 0.45 (wild boars and barking deer) and Δ1 0.29 (macaques). Temporally, clouded leopards were active at night (nocturnal) (57%), and previous research showed similar results. Research in Malaysia (Rufino et al. 2009) reported high activity of clouded leopards during the night (58%), while in Basor Mountain, Kelantan, nocturnal activity accounted for 73% (Hamirul et al. 2019). In the concession area of Tigapuluh Hill, nocturnal activity accounted for 49% (Lestari 2018). The activity patterns of clouded leopards and Sumatran tigers in BRBB WR overlapped significantly due to high nocturnal activity, suggesting

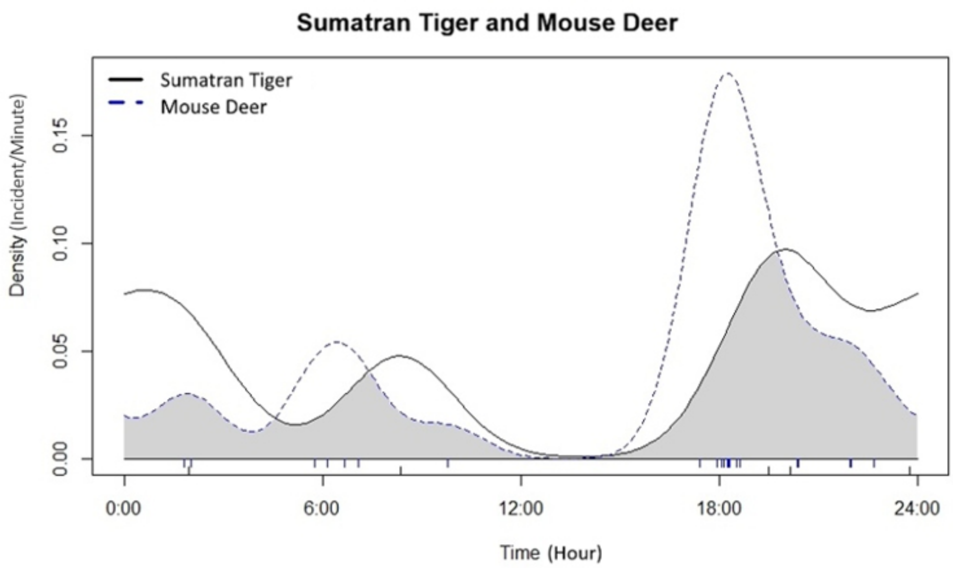

Figure 3. Overlap value between Sumatran tiger and mouse deer

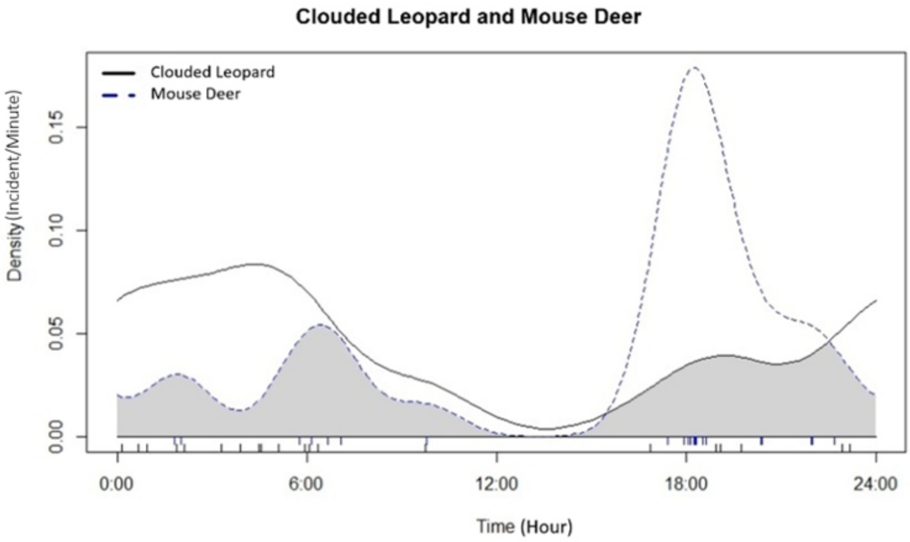

Figure 4. Overlap value between the clouded leopard and mouse deer

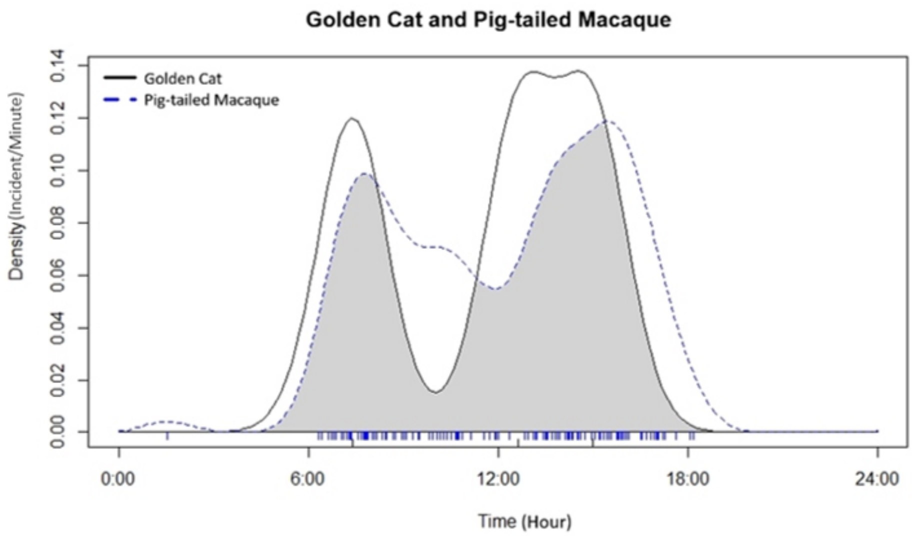

Figure 5. Overlap value between golden cat and pig-tailed macaque

interspecific competition between these species. The nocturnal activity was also related to their prey, mouse deer (Sunarto et al. 2015), which had high nocturnal activity (75%). Sumatran tigers were predators of large prey (Sunarto et al. 2015), but based on size comparison, they could also prey on smaller species. Similarly, clouded leopards were predators of small-medium prey (Sunarto et al. 2015; Kawanishi & E. Sunquist 2008). These findings suggested that clouded leopards and Sumatran tigers competed to prey on mouse deer (small prey) (Dinata & Sugardjito 2008).

The golden cat had the least captured frequently in BRBB WR, with only three recorded encounters. The golden cat was diurnal and active during the day. The temporal overlap examined with potential prey species showed that the golden cat and macaques had the highest overlap (Δ1) value of 0.74, followed by wild boars, barking deer, and mouse deer, with values of 0.63, 0.45, and 0.21. The overlap value indicates that the golden cat has a high encounter rate with macaques. The golden cat with 12-15 kg of weight (Francis 2008) had the potential to prey on macaques, which have a similar body weight (6-12 kg). Previous research reported golden cats preying on barking deer, mouse deer *(Tragulus spp.),* and Muridae (Grassman 2005). Research in Nam Et-Phou Louey, Laos, reported that the diet composition of golden cats consisted of 35% ungulates, 23% Muridae-rodents,

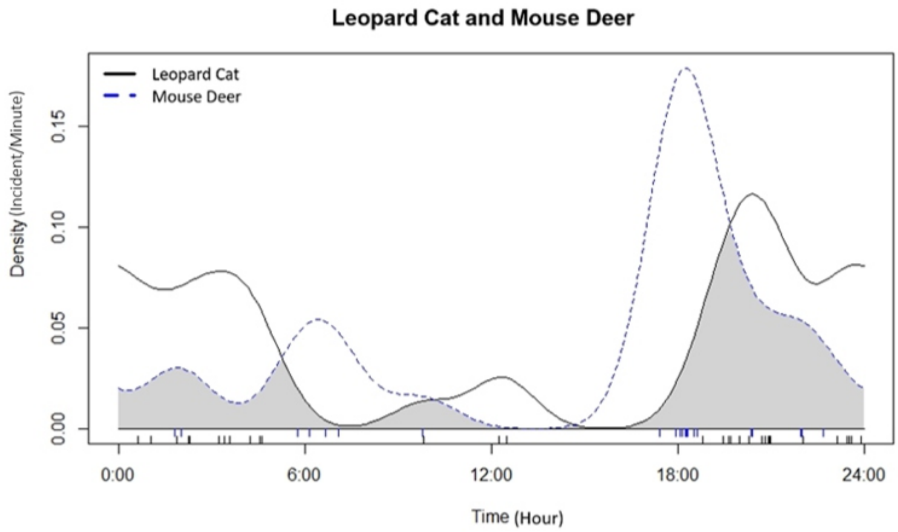

Figure 6. Overlap value between leopard cat and mouse deer

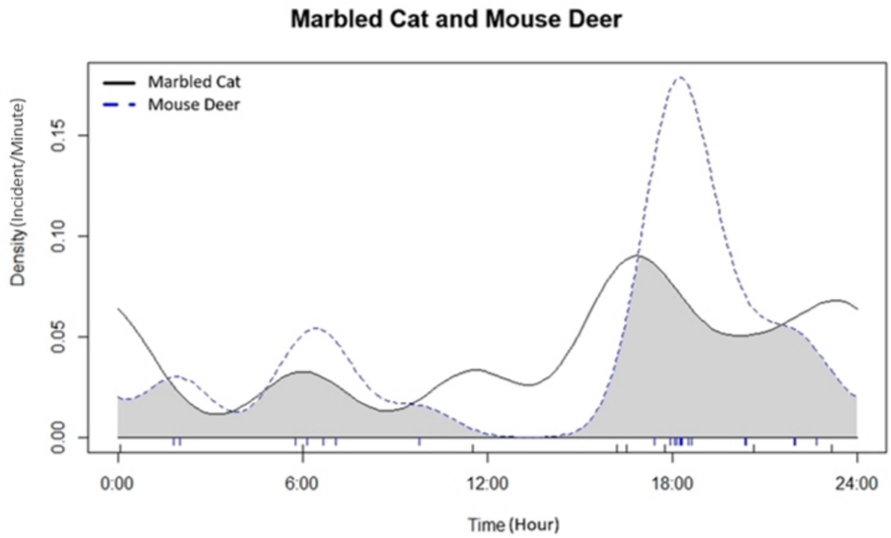

Figure 7. Overlap value between marbled cat and mouse deer

and 15% carnivores (Kamler et al. 2020). In Malaysia, golden cats prey on a dusky leaf monkey (*Trachy pithecus obscurus)* with a body weight of 6.5 kg (Grassman 2005).

Leopard cats in BRBB WR were primarily active at night (81%) and had the highest overlap (Δ1) value with mouse deer (0.50). However, leopard cats had a relatively low overlap (Δ1) value with wild boars (0.30), barking deer (0.25), and macaques (0.14), indicating distinct temporal activities. Leopard cats might share space with Sumatran tigers and clouded leopards, which exhibited high nocturnal activity. Based on body size and activity patterns, leopard cats had the potential to prey on mouse deer. However, the presence of Sumatran tigers and clouded leopards in the same location might result in interspecific competition. When the resources were sufficient, multiple species could coexist and inhabit the same ecological niche. However, competition among these species could result in the exclusion of one species from the niche, prompting the remaining to adapt and modify their niche (Rich et al. 2017). Leopard cats are small cats that use different mechanisms to coexist with larger ones (Kamler et al. 2020). For example, they might separate resource utilization, such as prey selection (Sunarto et al. 2015). Leopard cats could select between rodents and birds as prey (Dinata & Sugardjito 2008). Kamler et al. 2020 showed that Muridae-rodents accounted for 79% of the leopard cat's diet. Marbled cats needed to divide resources among competitors or select prey species to coexist with larger cats and avoid competition (Dröge et al. 2017).

In BRBB WR, marbled cats showed high activity during twilight (crepuscular) (38%) and nocturnal periods (38%). The highest overlap value (Δ_1) occurs with mouse deer (0.65), followed by barking deer (0.61), macaques (0.58), and wild boars (0.46). Marbled cats were nocturnal (Sunquist, 2002), but other examinations reported diurnal activity for marbled cats (Kamler et al. 2020; Sunarto et al. 2015). These cats had to divide resources among competitors or select prey species to coexist with larger cats (Dröge et al. 2017). Leopard and marbled cats had similar behaviors. However, they could share space and food resources due to differences in prey size and the arboreal nature of leopard cats. Mouse deer became a potential prey species for marbled cats based on body size comparison and overlapping active periods. However, Borries et al. (2014) reported that the marbled cats attacked subadult Phayre's leaf monkeys *(Trachypithecus phayrei)* in the morning. In this research, camera traps captured no other prey species of marbled cats. The reason might be that marbled cats were highly active in trees during the daytime, which camera traps may not capture.

The Influence of Prey Density and Environmental Factors on the Presence of Felidae

The analysis indicated that the environmental factors had no significant influence on the presence of Felidae di SM BRBB. The following explained selected variables in the GLM analysis to describe various responses. The Sumatran tiger required space to move, and the presence of roads also affected its movement activities (Rathore et al. 2012). According to Clark (2000), habitat components such as land cover, food, and water were essential for wildlife, specifically large mammals. In this research, elevation and rivers influenced the presence of Sumatran tigers. The Sumatran tigers occupied areas at the elevation of 75-450 masl. This wide range of elevation allowed for movement, tracking prey, and avoiding competition with clouded leopards and golden cats (Sunarto et al. 2015; Rathore et al. 2012). The presence of water was also an essential resource for tigers and their prey (Ariyanto 2015).

The elevation and rivers also influenced the presence of clouded leopards in BRBB WR. Previous research reported that the major river systems were the clouded leopards' home range. Elevation significantly influenced the presence of clouded leopards in BRBB WR. According to (Hearn et al. 2016), elevation became a factor affecting prey availability. This research recorded the presence of prey at the elevations of 75-450 masl. Additionally, clouded leopards use elevation to avoid competition with Sumatran tigers. Elevation negatively correlated with human activities (Sunarto et al. 2012), allowing clouded leopards to visit such places (Haidir et al. 2013). Hearn et al. (2016) stated that clouded leopards had the highest encounters along transects near rivers. The findings suggested that rivers played a crucial role in the presence of clouded leopards in BRBB WR. However, rivers also became a concentration of human activities and could hinder the presence of clouded leopards (Sunarto et al. 2012). Water sources or river streams in forests with minimal human activity could attract clouded leopards (Tan et al. 2017). This research did not record human activities during data collection through camera traps. Therefore, the influence of human activities on Felidae's presence was not in this research's scope.

Roads and prey density influenced the presence of golden cats. The golden cats tended to be in the same location as their prey species. Golden cats with a weight of around 12-15 kg (Francis 2008) had the potential to prey on macaques which have a similar body weight (6-12 kg), mouse deer *(Tragulus* spp*.),* and Muridae (Grassman 2005). Golden cats might use roads to track their prey's movements (Albihad 2019).

Furthermore, roads and elevation affected the presence of leopard cats. Roads or corridors could provide access to resources and migration. This research found leopard cats in plantation areas with the nearest road distance of 0.008 km. These cats might use roads to visit plantation areas to acquire other resources. Leopard cats occupied areas with elevations ranging from 75 to 275 masl to avoid competition with Sumatran tigers and clouded leopards by selecting resources in terms of space and elevation (Dröge et al. 2017).

Rivers and elevation influenced the presence of marbled cats. Rivers became essential resources, and the presence of rivers increased organism occupancy rates (Ariyanto 2015). However, Rich et al. (2017) suggested that the presence of water sources had no significant effect on the distribution of carnivores. This research recorded marbled cats in areas at an elevation of 450 masl. These cats preferred highland areas to respond to anthropogenic pressures on the lower lands. They used natural corridors for landscape-scale exploration and could roam up to elevations above 3000 masl (Thinley et al. 2016).

Conclusion

In conclusion, Felidae and prey species had a dispersed distribution pattern and a temporal overlap in BRBB WR. Sumatran tigers, clouded leopards, and leopard cats had similar activity patterns (nocturnal). Marbled and golden cats were crepuscular-active during night and daytime, respectively. The activity patterns of prey species, such as macaques, barking deer, and wild boars, were high during the daytime, except for mouse deer active at night. Prey density and environmental factors had no significant effect on the presence of Felidae. Longitudinal data covering a larger spatial scale was required to complete the uncaptured prey species in this research. The BRBB WR needs to protect lower-density prey species to stabilize their population and to meet the resource requirements for Felidae in BRBB WR.

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