OKUPANSI KIJANG (*Muntiacus muntjak*) DI KAWASAN HUTAN DENGAN TUJUAN KHUSUS (KHDTK) UGM GETAS NGANDONG

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INTISARI

Kijang (*Muntiacus muntjak*) mengalami penurunan populasi karena hutan yang terfragmentasi dan terdegradasi. Habitat di KHDTK UGM Getas Ngandong masih menyediakan ruang hunian, tetapi juga merepresentasikan penyebab penurunan tersebut. Oleh karena itu, penelitian ini bertujuan untuk menaksir okupansi kijang dan faktor lingkungan yang berpengaruh terhadap okupansi kijang di KHDTK UGM Getas Ngandong.

Penelitian ini menggunakan *camera trap* untuk mengetahui kehadiran kijang. Penempatannya dilakukan secara *systematic* pada grid berukuran 1 x 1 km. Grid penelitian ditentukan berdasarkan hutan dan non hutan (stratifikasi). Kovariat/ faktor lingkungan diperoleh menggunakan *protocol sampling* dan Peta RBI melalui ArcGIS. Analisis model okupansi menggunakan *unmarked package* dengan *software* RStudio.

Berdasarkan hasil penelitian, kehadiran kijang terdeteksi pada 7 grid dari total 20 grid penelitian. Kijang menempati 35% dari luas yang disurvei di KHDTK UGM Getas Ngandong dan kelerengan merupakan kovariat/faktor lingkungan yang memiliki pengaruh terbesar terhadap okupansi kijang dibandingkan kovariat lainnya. Selain itu, nilai β *co-efficients* (6,07±3,35) menunjukkan hubungan positif antara probabilitas okupansi dan kelerengan berdasarkan interval kepercayaan 85% (CI). Probabilitas okupansi kijang terkonsentrasi di bagian timur laut KHDTK UGM Getas Ngandong yang diduga vegetasinya lebih beragam dibandingkan area (bagian) lain. Pada lokasi tersebut, kelerengan rendah hingga sedang (22˚-29˚) berkaitan dengan tutupan hutan yang lebih rapat dibandingkan area dengan kelerengan yang lebih landai.

Kata Kunci: *okupansi*, *kijang*, *KHDTK UGM Getas Ngandong*, *model okupansi*

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BARKING DEER (*Muntiacus muntjak*) OCCUPANCY IN KHDTK UGM GETAS NGANDONG

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ABSTRACT

The barking deer (*Muntiacus muntjak*) is experiencing a population decline due to fragmented and degraded forests. Habitat in the KHDTK UGM Getas Ngandong still provides occupied space, but also represents the cause of the decline. Therefore, this study aims to estimate the occupancy of the barking deer and the environmental factors influencing its occupancy in KHDTK UGM Getas Ngandong.

This research used camera traps to detect the presence of barking deer, with cameras placed systematically within 1 x 1 km grid cells in forested and non-forested areas (stratified). Environmental covariates were collected through sampling protocols and RBI maps using ArcGIS. Occupancy model analysis was conducted using the unmarked package in RStudio.

The presence of barking deer was detected in 7 of the 20 research grids. Deer occupied 35% of the surveyed area in the KHDTK UGM Getas Ngandong and slope was the covariate that had the greatest influence on deer occupancy compared to other covariates. In addition, the β co-efficients (6.07±3.35) indicates a positive relationship between occupancy probability and slope based on 85% confidence interval (CI). The probability of deer occupancy is concentrated in the northeastern part of the KHDTK UGM Getas Ngandong, which is suspected to have more diverse vegetation than other areas (parts). In these locations, low to moderate slopes (22˚-29˚) associated to denser forest cover than areas with more gentle slopes.

Keywords: *occupancy, barking deer, KHDTK UGM Getas Ngandong, occupancy modelling*

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SUMMARY

BARKING DEER OCCUPANCY IN KHDTK UGM GETAS NGANDONG

INTRODUCTION

Barking Deer (*Muntiacus muntjak*) populations are declining across its range due to habitat loss and poaching (Timmins et al., 2016). Consequently, the Indonesian government has classified the deer as a protected species (Pemerintah Republik Indonesia, 1999). Recently, a population of deer inhabits KHDTK UGM Getas Ngandong (hereafter KHDTK Getas) located between Central Java and East Java. Java Island is known as the most populated island in the world. Within a degraded and fragmented forest landscape, such as the KHDTK Getas (Imron et al., 2023), the availability of essential resources (food plants, water, and forest cover) would be crucial (Morrison, 2013; Morrison et al., 2006) for the occurrence of barking deer (Mackenzie et al., 2018). Resources may support the ability to survive in the long term in such a poor habitat. The small size of the area (<100 km^2), fragmented forests (Imron et al., 2023), and increased human activity in surrounding settlements (Rijneveld, 2019) may have an impact on deer habitat conditions, so the status of the deer population in the KHDTK Getas needs to be investigated. Therefore, this study aims to estimate the occupancy probability of muntjacs in relation to habitat factors in KHDTK Getas.

METHODOLOGY

This study used camera traps to detect muntjacs. Camera traps were set up systematically with one camera installed in a 1 km^{-1} grid, corresponding to the barking deer's seasonal home range (Wegge & Mosand, 2015). Using a land use map, fifty grids were selected based on 50% or more forest coverage, considering that mammals tend to favor habitats with greater forest cover (Regmi et al., 2023). After ground checking, 30 of the 50 grids were deemed unsuitable, consisting mainly of plantations (corn, sugarcane, teak) with no forest covers. Hence, cameras were only installed in the 20 grids (Figure 1) during a 4-month period (between 10/03/2024 and 28/07/2024). Furthermore, environmental covariates, representing the surveyed grids, in the form of micro- (Capen, 1981) and macro habitats were obtained based on field measurements and using a GIS system (Table 1). A multicollinearity test was conducted to minimize the presence of highly correlated pairs of covariates (Alin, 2010). Covariates were tested in the occupancy models using the unmarked package in R-studio (Chandler et al., 2024; Fiske & Chandler, 2011). Model uncertainty (>1 subset models with ΔAIC $\leq$ 2.00) was addressed by performing model averaging (Barton & Barton, 2024; Symonds & Moussalli, 2011). Effects of covariates on the occupancy probability of barking deer were determined based on whether its 85% confidence interval overlaps zero (Arnold, 2010).

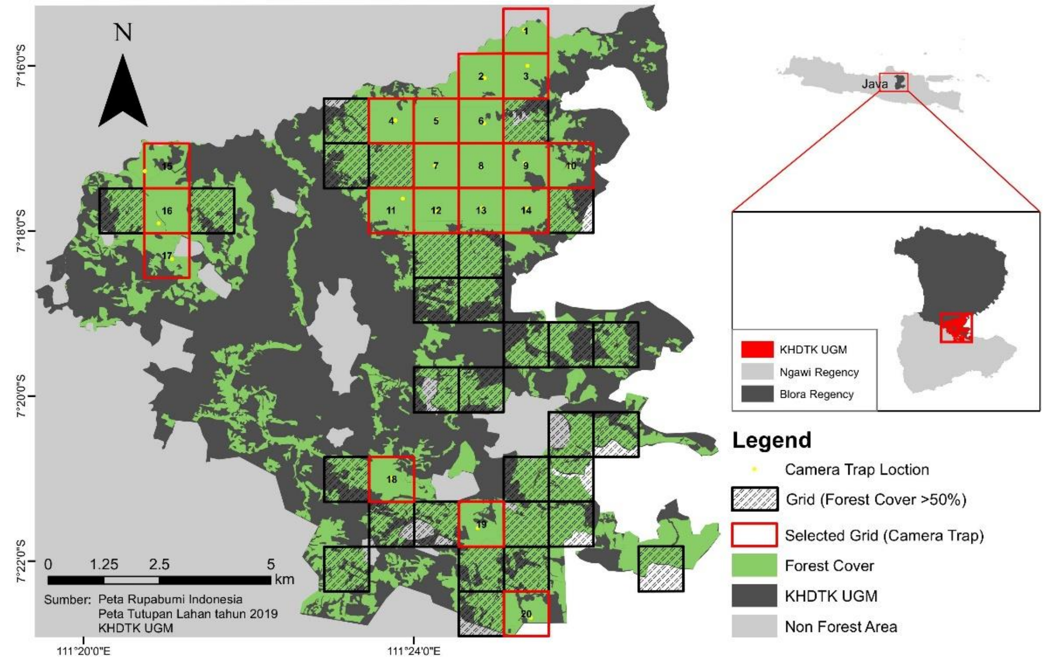

Figure 1. Study Area at KHDTK UGM Getas Ngandong showing the original 50 grids selected based on percent of forest cover (≥ 50%). The surveyed grids (red rectangle, n=20) were selected for camera trapping after field validation which resulted in discarding 30 grids based on current land use practices (all were plantations; corn, sugar cane and teak). Camera traps were installed during the study period of four months between 10/03/2024 and 28/07/2024.

Table 1. Habitat covariates used in the analysis. Data are presented as mean ± standard deviation and ranges (minimum to maximum)

Variable code	Data source	Description	Summary statistics
Slope (slo) [%]	Field Measurments	Observation point using a clinometer	30.8 ± 16.30 (9 - 55)
Low ground (lg) [%]	Field Measurments	Counting the number of boxes (≥ 50%) on the density board. Calculations were made at each altitude interval and in each cardinal direction	62.88 ± 24.20 (15.83 - 96.67)
High ground (hg) [%]	Field Measurments		39.09 ± 30.19 (0 - 88.57)
Low shrub (ls) [%]	Field Measurments		36.60 ± 29.73 (0 - 80.50)
High shrub (hs) [%]	Field Measurments		40.25 ± 34.46 (0 - 91)
Canopy cover (cc) [%]	Field Measurments	Walking along the transect lines (10 points per transect) in the four cardinal directions. Readings of (+) and (-) indicate the presence or absence of green vegetation at the point of intersection of the lines	87 ± 13.12 (50 - 100)
Ground cover (gc) [%]	Field Measurments	Walking along the transect lines (10 points per transect) in the four cardinal directions. Readings of (+) and (-) indicate the presence or absence of green vegetation at the point of intersection of the lines.	62.25 ± 26.63 (5 - 100)
Human presence (hm) [%]	Field Measurments	Each grid was calculated by totaling the number of days human was presence and divided by the total survey days of the grid	1.77 ± 1.65 (0 - 5.67)
Distance to water course (dw) [meter]	Rupa Bumi Indonesia Map	Nearest distance from camera trap to water course	57.27 ± 65.9 (0.2 - 250.07)
Distance to road (dr) [meter]	Rupa Bumi Indonesia Map	Nearest distance from camera trap to road	104.97 ± 74.88 (8.05 - 291.2)
Distance to village (dv) [meter]	WorldPop (Resolution 100x100 m)	Nearest distance from camera trap to village (distribution of population data)	1620 ± 900.35 (102.92 - 3615.13)

RESULTS

Barking deer were detected in 7 out of 20 grids, resulting in an unadjusted occupancy estimate of 35%. The camera trap survey also revealed the presence of other large mammals, such as wild boars (*Sus scrofa*), which were detected in higher proportions (10 out of 20 grids). The top-ranking models (subset models with ΔAIC ≤ 2.00) included combinations of slope, distance from the village, distance from water sources, and distance from roads on the occupancy probability (Table 2). Model averaging of covariate effects showed a positive relationship between barking deer occupancy probability and slope, based on its 85% confidence interval (CI) (Table 3 and Figure 2). No clear relationships were found for other covariates, as their 85% confidence intervals overlap zero (Table 3). The model average prediction of occupancy probability (0.35; 95% CI 0.14 – 0.69) (averaged across the subset models with ΔAIC ≤ 2.00) is like the constant model, suggesting minimal effects from habitat covariates used in this analysis. This is probably due to the absence of supposedly important covariates, such as forest cover, as there is no updated and reliable dataset for this variable available at the time of the analysis.

Table 2. Model selection of barking deer's occupancy probability showing only top-ranking models (subset models with ΔAIC ≤ 2.00). K – number of parameters estimated from the model; AIC – Akaike Information Criteria; ΔAIC – difference in AIC; w_i – model weight; Cum w_i – cumulative weight

Model	***K***	**AIC**	**ΔAIC**	w_i	**Cum** w_i
ψ (slo) + *p*(.)	3	370.41	0	0.21	0.21
ψ (slo + dv) + *p*(.)	4	370.89	0.48	0.16	0.37
ψ (dw) + *p*(.)	3	372.07	1.67	0.09	0.46
ψ (slo + dw) + *p*(.)	4	372.29	1.89	0.08	0.54
ψ (slo + dr) + *p*(.)	4	372.35	1.94	0.08	0.61

Table 3. Estimated parameters based on model averaging (β – beta coefficient; SE – standard error; 85% lci – lower confidence interval; 85% uci – upper confidence interval). Bold fonts represent covariate which has effect as its 85% CI do not overlap zero.

	β	**SE**	**85% lci**	**85% uci**
ψ (Int)	-3.91	2.71	-1.28	0.07
ψ (slo)	**6.67**	**3.93**	**1.26**	**10.89**
p(Int)	-2.79	0.16	-3.01	-2.56
ψ (dv)	-0.85	0.75	-0.59	0.79
ψ (dw)	-0.86	1.03	-2.42	0.19
ψ (dr)	0.13	0.57	-0.82	0.59

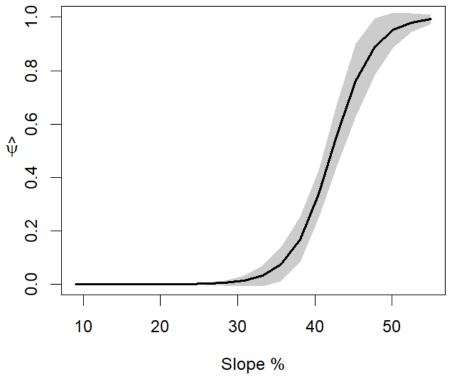

Figure 2. Model averaging effect of percent slope on the occupancy probability of barking deer in Getas

DISCUSSION

Barking deer has occupied 35% (approximately 20 km^2) of the area surveyed in KHDTK Getas. The highest occupancy probability is concentrated in the northeastern part, where diverse vegetation remains. These areas have low to moderate slopes (22˚-29˚), which are associated with denser forest cover than areas with more gentle slopes in Getas (Figure 3). As the landscape at the KHDTK Getas is comprised mainly of small fragmented and isolated forest patches, the quality and availability of habitats for barking deer are likely to be reduced. Barking deer may be forced to use such available habitats regardless of their conditions. Thus, the remaining habitats where their occupancy probability is high need to be protected and maintained to ensure the long-term survival of barking deer as they are experiencing population declines (Timmins et al., 2016) and are protected by Indonesian law (Pemerintah Republik Indonesia, 1999). The forest's conservation planning should prioritize preventing illegal activities such as logging and hunting. While there is no direct evidence of human activity effects on barking deer, it is possible that these activities observed during the study, such as illegal logging or sightings of people carrying a gun (indicating active hunting), could negatively impact the occupancy of barking deer. Although barking deer can use various habitat types, including fragmented forests, human-dominated landscapes, or agriculture (Paudel & Kindlmann, 2012; Habiba et al. 2021), habitat management and restoration should focus on improving habitat quality, especially in areas with high occupancy probabilities (Figure 3). For instance, as the muntjac consume varieties of trees, shrubs, and forbs (Habiba et al., 2021; Ilyas & Khan, 2003), these plant species can be incorporated into the current rehabilitation effort carried out by Pertamina to enhance habitat quality for muntjacs.

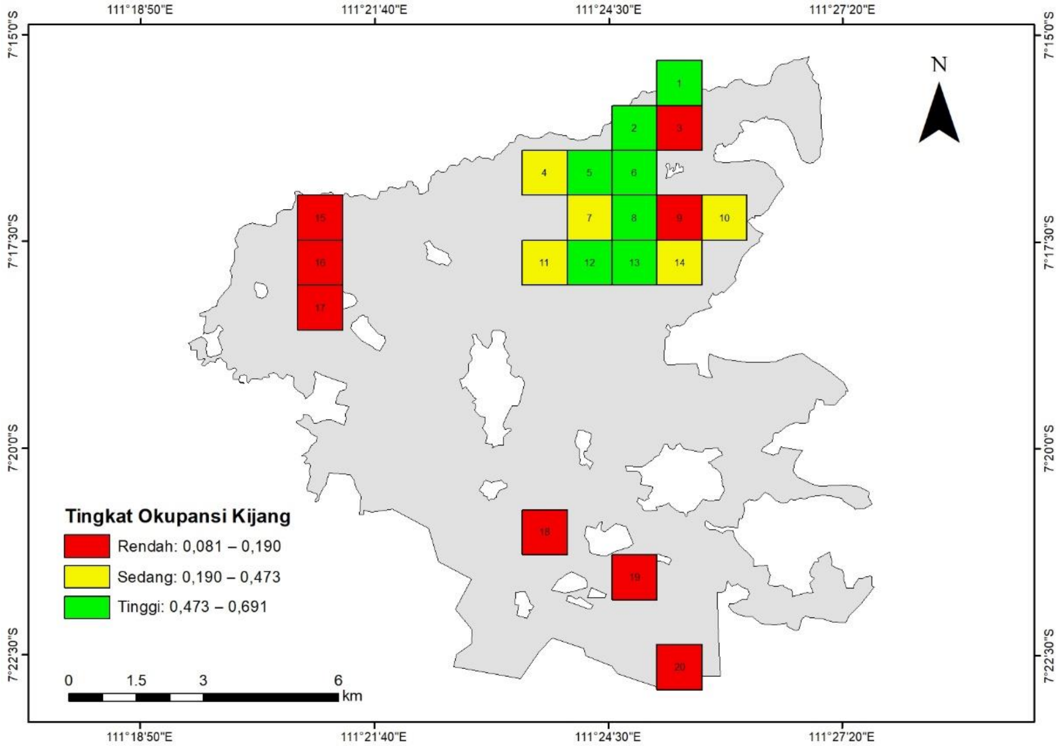

Figure 3. Prediction map of barking deer's (*Muntiacus muntak*) occupancy probability presented in three categories; red, low occupancy probability (0.081 - 0.190); yellow, medium occupancy probability (0.190 - 0.473); and green, high occupancy probability (0.473 - 0.691).

CONCLUSION

This study shows that forest cover with diverse vegetation (not dominated by teak) found in low to moderate-slope areas are the remaining habitats of muntjac in Getas. Although muntjac may be able to use various habitat types (including agriculture), habitat protection and restoration should be prioritized to ensure the survival of the extant population, thus increasing the chance of expansion in occupancy. Occupancy-habitat relationships offer important information on barking deer populations and habitat management. Furthermore, the number of samples needs to be increased –placing camera traps in 40-60 locations– to obtain more representative occupancy estimates and reduce bias, supported by updated Getas land cover (forest) data to support barking deer habitat management.

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