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The first description of population density and habitat use of the mainland clouded leopard *Neofelis nebulosa* within a logged-primary forest in South East Asia

Shariff Wan Mohamad[1] · D. Mark Rayan[1] · Wong Chai Thiam Christopher[1] · Muhamad Hamirul[1] · Azlan Mohamed[1] · Ching Fong Lau[1] · Elangkumaran Sagtia Siwan[1]

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Abstract The mainland clouded leopard (*Neofelis nebulosa*) is classified as vulnerable under the IUCN Red List, meaning that it faces a high risk of extinction in the wild. However, hardly any ecological research has been published on this species apart from several radiotelemetry studies in Thailand and Nepal, and one camera-trapping study in India. Here we present findings on the clouded leopard from a camera-trapping study conducted in Temengor forest reserve (a logged-over forest) and Royal Belum State Park (a primary forest) within Peninsular Malaysia. Using the spatially-explicit capture-recapture method, the density from Temengor forest reserve and Royal Belum State Park was estimated at 3.46 ± SE 1.00 and 1.83 ± SE 0.61, respectively. Clouded leopard habitat use was found to be highly influenced by the availability of small and medium prey species and therefore intrinsically highlights the potential conservation importance of species such as pig-tailed macaques, porcupine, mouse deer and small carnivores. These findings provide the first estimates of density and habitat use of this species in a logged-primary forest from both Peninsular Malaysia and South East Asia. Our study provides important baseline information on clouded leopards and contributes to filling up the knowledge gap that exists in understanding the population ecology of this species, not only within Peninsular Malaysia, but also on a regional level.

✉ D. Mark Rayan
mdarmaraj@wwf.org.my

1 WWF-Malaysia, 1 Jalan PJS 5/28A, Petaling Jaya Commercial Centre (PJCC), 46150 Petaling Jaya, Selangor, Malaysia

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Introduction

The clouded leopard (*Neofelis* spp.) is a medium-sized felid (approximately 11–23 kg), reaching up to about one metre in head-body length (Hearn et al. 2013). It is a charismatic species, in which its name is derived from the cloud-like patterns on its pelage. The clouded leopard is classified as Vulnerable under the IUCN Red List (Sanderson et al. 2008), meaning that it faces a high risk of extinction in the wild. The main threats to this species are deforestation and hunting for the illegal wildlife trade (Sanderson et al. 2008). The clouded leopard ranges from central Nepal and southern China all the way south to Peninsular Malaysia, in addition to the islands of Sumatra and Borneo (Austin et al. 2007). It was recently classified as two separate species, whereby the population in Sumatra and Borneo was recognised as the Sunda clouded leopard (*Neofelis diardi*) based on DNA and morphological analysis, separating it from the mainland clouded leopard (*Neofelis nebulosa*) (Buckley-Beason et al. 2006; Kitchener et al. 2006; Wilting et al. 2007, 2011).

Although clouded leopards are adapted for climbing, it is likely that they move primarily on the ground (Rabinowitz et al. 1987; Grassman et al. 2005) and use trees only for resting or occasional hunting (Nowell and Jackson 1996). The clouded leopard has unique morphological features such as having the longest canines proportionate to its body compared to all other living felid species (Guggisberg 1975); however, little is known about its prey preference. Current knowledge of its diet is mostly based on opportunistic records and a couple of scat samples from trapped animals (Grassman et al. 2005; Gordon and Stewart 2007; Matsuda et al. 2008; Mohamed et al. 2009; Morino 2010; Lam et al. 2014). This dearth of information most likely stems from the difficulty in attributing carnivore scat to a specific species using morphological keys due to overlapping diameter sizes of scats with other sympatric carnivore species (Davison et al. 2002; Grassman et al. 2005). This constraint however, has been addressed with the advent of molecular scatology that has been used in other carnivore studies (e.g., Farrell et al. 2000). Nevertheless, the natural high humidity conditions in tropical rainforests can result in rapid scat degradation, making scat collection less feasible (Sunquist 2010).

To date there have only been a handful of published ecological studies on the mainland clouded leopard, namely from radio-collared individuals in Thailand and Nepal (Dinerstein and Mehta 1989; Grassman et al. 2005; Austin et al. 2007), and more recently from India via camera-trapping (Borah et al. 2014). More camera-trapping studies have been conducted on the Sunda clouded leopard, although mainly concentrated in Sabah (Wilting et al. 2006; Brodie and Giordano 2012; Wilting et al. 2012; Hearn et al. 2013), in addition to Sumatra (Hutajulu et al. 2007; Sollmann et al. 2014) and Kalimantan (Cheyne et al. 2013). Two of these studies (Hutajulu et al. 2007; Cheyne et al. 2013) used a conventional capture-recapture analysis approach to estimate clouded leopard density, which has a tendency to overestimate population density (Obbard et al. 2010; Noss et al. 2012); whereas two density estimates from Sabah (Brodie and Giordano 2012; Wilting et al. 2012) and one from Sumatra (Sollmann et al. 2014) were derived using the more recent spatially explicit capture recapture (SECR) analysis.

Although the clouded leopard is “totally protected” under Peninsular Malaysia’s Wildlife Conservation Act 2010, and classified as “near threatened” under Peninsular Malaysia’s Red List, population ecology information for this species is severely lacking. With an increasing number of researchers utilizing remote monitoring methods such as camera-traps (Brodie and Giordano 2012; Wilting et al. 2012; Borah et al. 2014) and telemetry (Hearn et al. 2013), there is much potential to gain further insights into the population ecology of this vulnerable animal especially since such science-based information can be used to guide conservation managers.

From 2009 to 2011, we carried out camera-trapping in the Belum–Temengor Forest Complex which has been identified as one of the priority areas for tigers (*Panthera tigris*) under the National Tiger Action Plan for Malaysia (Department of Wildlife and National Parks (DWNP) 2008), primarily to obtain density estimates of tigers and occupancy of their prey species (Darmaraj 2012). A considerable amount of data on clouded leopards was obtained, and so we decided to investigate some population ecology parameters of this individually-identifiable species in order to increase the knowledge of the species with the ultimate goal of providing timely conservation recommendations. In this paper, we present density estimates using a maximum likelihood SECR approach (Efford 2011) and habitat use using occupancy models (Hines 2006) for clouded leopards from (1) a forest reserve which has been designated for logging and (2) a state park consisting of primary forest. Our paper therefore provides novel and much needed information on clouded leopard not just from Peninsular Malaysia but also mainland South East Asia.

Methods

Study area

The study was carried out in Temengor forest reserve and Royal Belum State Park (hereafter referred to as Temengor and Belum, respectively), which are situated in the northern reaches of Peninsular Malaysia, within the state of Perak. Both areas are contiguous but bisected by a seven metre wide highway (Fig. 1). Collectively these forests cover an area of about 3000 km^2, and are connected to the greater main range. This forest complex is home to a number of indigenous communities, many of whom depend on non-timber forest produce, hunting, fishing and small scale farming in sustaining their livelihoods (Department of Orang Asli Affairs, unpublished data).

Temengor is the second largest forest reserve in Peninsular Malaysia, covering 1489 km^2. Its elevational range extends from 260 to 2160 m a.s.l. As Temengor is classified as a production forest, selective logging is currently ongoing and has been carried out in various logging compartments since the 1970s. Belum is the second largest protected area in Peninsular Malaysia after Taman Negara National Park, covering an area of 1175 km^2. Its elevational range extends from 260 to 1533 m a.s.l.

Much of the lowland forest has been inundated by a man-made lake, so the forest complex predominantly consists of hill-upper dipterocarp forest, as well as montane forest (Darmaraj 2012). More than 100 species of mammal have been recorded from the Belum–Temengor forest complex, and it also contains all the large mammal species found in northern Peninsular Malaysia, excluding the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) (Darmaraj 2012). The annual rainfall averages 2160–2250 mm, whilst day-time temperatures are typically above 30 °C (MNS 2005).

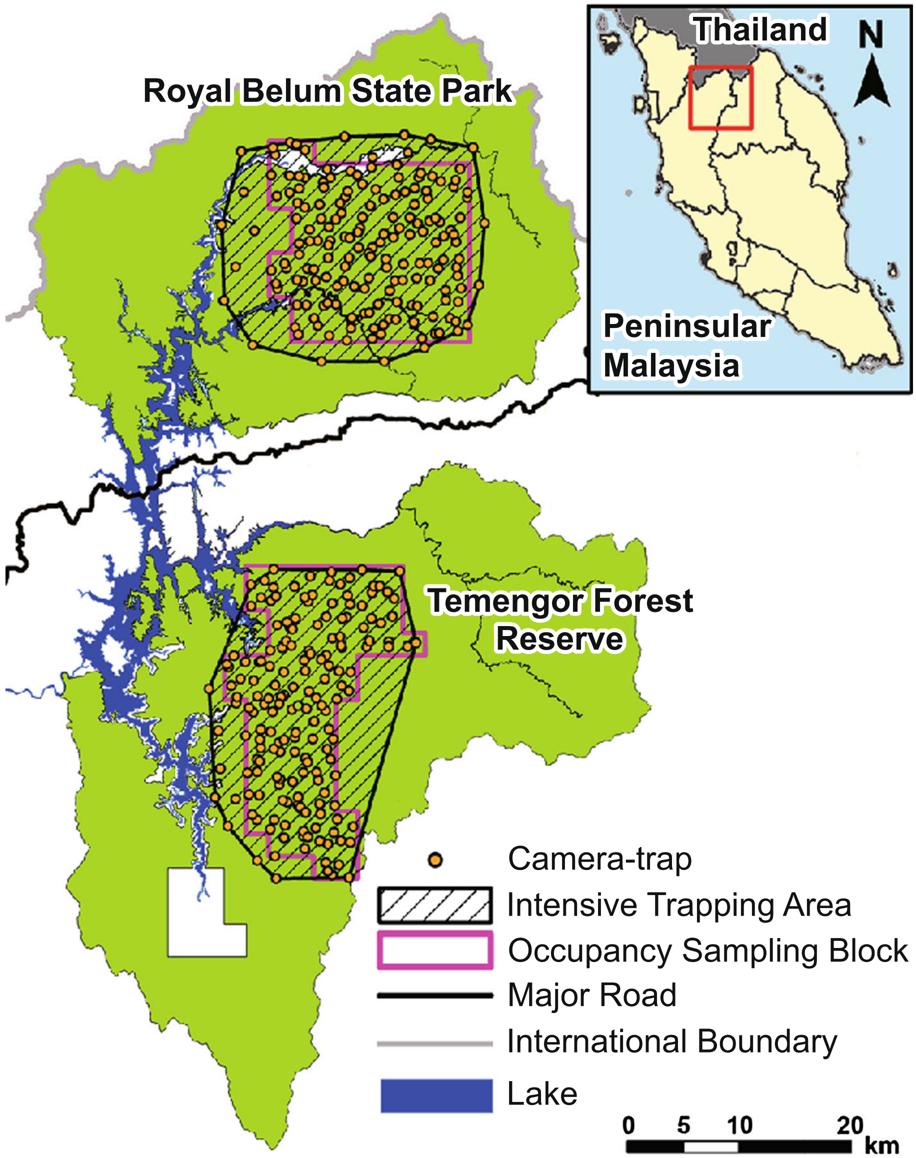

Fig. 1 Map showing the camera-trap placements, intensive trapping area and occupancy sampling blocks in Royal Belum State Park and Temengor forest reserve

Field methods

Camera-trapping was conducted in both Temengor and Belum to estimate the density of tigers and prey occupancy in this landscape, where camera-traps were set along trails expected to be used by tigers and other large mammal species, such as ridges, old logging roads, and wildlife trails (e.g., Rayan et al. 2012).

A total of 175 camera stations were set in an area of about 400 km^2 in Temengor from October 2009–May 2010. This was subsequently replicated at the same scale in Belum from August 2010–April 2011 (Fig. 1). Of this, 35 camera stations (with cameras in pair at each station) were fixed throughout the sampling period in each study area and the remaining 140 camera stations were set in a 280 km^2 prey occupancy sampling grid cell (2 × 2 km) that was stratified according to the elevational classes. Within this occupancy grid, 70 single camera stations were set and subsequently moved to another location within the same 4 km^2 cell to increase spatial and detection coverage. Thus, two camera stations were set within each cell.

For this study, custom-built passive digital camera-trap units (Sony P41 white flash digital cameras housed in waterproof Pelican cases) were used. Camera-traps were operational for 24 h a day with no break in monitoring, except during events of malfunction or damage. Camera stations were marked on a map using a handheld Global Positioning System unit (Garmin GPSMAP® 60CSx) and data retrieval was conducted every 2–3 months.

Data analysis

All the statistical analyses were conducted in the R software environment v3.0.2 (R Development Core Team 2013), unless explicitly stated. Using a spatially-explicit capture-recapture (SECR) framework, clouded leopard density was derived using the "secr" package (Efford 2011). Given that the social system of clouded leopards are likely to be similar to that of other territorial carnivores, the use of a Poisson distribution of home range centres in the SECR analysis is considered to be a reasonable justification (Darmaraj 2012). Clouded leopards were distinguished by their unique coat patterns, which enables identification of individual animals. Data from all 175 camera stations within each study area were utilised in the density analysis. In order to respect the population closure assumption, a 3-month sampling period was used in accordance to what has been suggested for other large cat studies (Silver et al. 2004; Foster and Harmsen 2011). The onset of the 3-month sampling period was based on when all double-sided camera-traps were set up, and detection histories were constructed in a standard X matrix format (Otis et al. 1978), according to a 24-h period. Camera stations were treated as "proximity detectors" that allowed the animal to be detected at multiple traps for any occasion.

To approximate a buffer width, the root pooled spatial variance (RPSV) value was multiplied by a factor of four, as an animal outside such a buffer width has a negligible probability (<0.001) to get caught in any trap and is unlikely to affect density estimates (Efford 2004). Using the Hawths tools extension in ArcGIS, a grid mesh of 580 m × 580 m cells following Royle et al. (2009) was superimposed over the buffered area and the geographical coordinates of the centroid points for each cell containing suitable habitat were extracted for a habitat mask input file. Non-forest habitat cells (lake and large human settlements) were excluded from buffered area. A closure test (Otis et al. 1978) was conducted within the same "secr" package (Efford 2011) to evaluate whether the 'closed population' assumption was violated. Clouded leopard density was estimated using conditional likelihood SECR with a half-normal detection function using a Poisson distribution, with the constant default models; magnitude of the detection function (g0[.]) and spatial scale parameter (sigma[.]). Differences in density estimates between study areas were assessed using a Wald test (Morgan 2008), whereby z values larger than 1.96 (critical value at $\alpha = 0.05$) were considered significant. SECR-based density estimates, 95 % confidence intervals and population size (N) were calculated for each study area.

Clouded leopard habitat use (ψ) was defined as the probability of a clouded leopard using a sampling unit (camera station), within a likelihood-based sampling approach (Mackenzie et al. 2005). Only single camera-trap data were used for the analysis in order to standardise the effort, which incorporated the protocol of moving camera-traps within each 4 km^2 cell. Clouded leopard detection histories were constructed in a two dimensional matrix format (MacKenzie et al. 2006) for each camera station, according to ten sampling occasions spanning 4 weeks each. The sampling units (camera stations) for the two study areas were combined ($n = 280$). A dataset consisting of three covariates reflecting an ecological factor [large prey species relative abundances (LP) and small/medium prey species relative abundances (SP)] and human disturbance factor [nearest distance to settlements (set; proxy for human disturbance)] were used to model clouded leopard habitat use within the occupancy framework.

To quantify the relative abundances of prey, the photo capture rates of prey species (number of photos/100 trap nights) were used to produce a relative abundance index (following O'Brien et al. 2003) for each camera station, which is assumed to reflect the availability of prey at that particular sampling unit (Harihar and Pandav 2012). To produce mean relative abundances and standard errors for clouded leopards, photo capture rates were averaged across all camera placements within each study area. Only independent photographic events (detections) were taken into account to calculate the photo capture rates, namely photographs taken >30 min apart at the same camera-trap station (O'Brien et al. 2003). Although acknowledging the limitations of using relative abundance indices due to not accounting for imperfect and variable detection (Sollmann et al. 2013), in this case it was judged to be the most suitable method to assess the potential influence of prey on the presence of clouded leopards. Based on the energetic constraints of carnivores (Carbone et al. 1999), adult clouded leopards would be expected to primarily prey on species less than 10 kg in body weight (<45 % of their body mass), hence prey species were clustered into two classes: small/medium prey species (1–10 kg) and large prey species (>10 kg) to test the association between clouded leopard presence and prey relative abundance of a certain size class. The large prey species were limited to barking deer (*Muntiacus muntjak*) and wild boar (*Sus scrofa*), as we do not expect clouded leopards to prey on large ungulates such as serow (*Capricornis sumatraensis*), sambar deer (*Rusa unicolor*) and gaur (*Bos gaurus*) which exceed 100 kg in weight. The small/medium prey species primarily consisted of pig-tailed macaque (*Macaca nemestrina*), porcupine (*Hystrix brachyura* and *Atherurus macrourus*), mouse deer (*Tragulus* spp.), and small carnivores (binturong *Arctictis binturong*, large Indian civet *Viverra zibetha*, masked palm civet *Paguma larvata*, common palm civet *Paradoxurus hermaphroditus*, banded civet *Hemigalus derbyanus*, yellow-throated marten *Martes* *flavigula* and crab-eating mongoose *Herpestes urva*). Other smaller felids were not considered to be potential prey species. We also did not include mammals <1 kg and arboreal mammals in our analysis (following Tobler et al. 2008) as the camera-trapping rates would not reflect their actual abundance due to their low detection probability (Ancrenaz et al. 2012).

All continuous covariates were tested for collinearity using a Spearman's rank correlation. Covariates were considered to be highly correlated if their corresponding coefficients were >0.6 (Gaveau et al. 2009). To explicitly account for variation in detection probability (p), two covariates were modelled: (1) number of trap-nights a camera station was operational; and, (2) a binary study area covariate. Continuous covariates were transformed into standardised z scores prior to performing the data analysis.

The combination of covariates that best explained clouded leopard habitat use and detection probability were investigated using PRESENCE v4.0 software (Hines 2006) under the single-species, single-season framework. A two-step approach was used to model parameters of interest (Harihar and Pandav 2012). First, detection probability (p) was modelled where the parameter was either assumed constant or allowed to vary with individual or additively combined covariates. For each model, a global model (the most complex model with the greatest number of parameters) for the probability of habitat use (ψ) was maintained (MacKenzie 2006). Subsequently, the influence of covariates on habitat use was modeled where the parameter was either assumed constant or allowed to vary with individual or additively combined covariates, whilst maintaining the top ranked model structure for detection probability as derived from the first step.

Models were ranked using the small-sample correction to Akaike's information criterion (AIC_c; Burnham and Anderson 2002). Model fit was evaluated by comparing the observed Pearson Chi-square statistic ($\hat{c}$) from the global model with Chi-square statistics from 10,000 simulated parametric bootstrap datasets (MacKenzie and Bailey 2004). Covariates that were likely to affect detection probability and habitat use probabilities were identified based on the covariates that were contained in the top ranked model and relative summed Akaike weights ($\sum w_i$) of models or summed model weights (SMW) that contained a particular covariate; where SMW >0.50 were considered indicative of a strong habitat use response to a covariate (Barbieri and Berger 2004; Kalies et al. 2012).

Results

Density

In total, 243 independent records of clouded leopard were obtained from Temengor and Belum throughout the entire camera-trapping period spanning 33,727 trap nights, from which 39 individuals were positively identified (Table 1). Within the 3-month sampling period, 16 and 11 individual

Table 1 Sampling information and general clouded leopard findings from the camera-trapping study

	Temengor	Belum
Sampling information		
Camera-trapping period	October 2009–May 2010	August 2010–April 2011
Intensive trapping area	397 km^2	418 km^2
Trap nights	15,969	17,758
Camera-trap elevational range	262–1784 m	277–1190 m
Average inter-trap distance	0.86 km	0.97 km
Clouded leopard information		
Independent detections	124	119
Relative abundance	0.75 ± 0.11	0.64 ± 0.11
Percentage of locations which detected clouded leopard	36.2 %	27.7 %
Number of individuals	22	17
Average number of detections per individual	3.6 (1–16)	5.8 (1–24)
Average number of detections per station	0.7 (0–6)	0.7 (0–13)
Sex composition	15 ♂, 7 unknown	9 ♂, 5 ♀, 3 unknown
Three month sampling information used for density analysis		
Number of detections of identified individuals	35	35
Number of individuals	16	11
Average number of detections per individual	2.2 (1–5)	3.2 (1–7)
Sex composition	13 ♂, 3 unknown	7 ♂, 2 ♀, 2 unknown

clouded leopards were recorded in Temengor and Belum respectively. These 27 individuals were detected an average of 2.6 times, whilst individuals detected more than once were recorded at an average of 3.4 different locations. The root pooled square variance (RPSV) was similar for both areas: 3.79 km for Temengor and 3.75 km for Belum, hence a buffer width of 15 km (four times the RPSV value) was used for the analysis (Efford 2004). SECR's closure test supported the assumption that the population was closed during the 91 day sampling period (Temengor: $z = -0.15$, $p = 0.44$; Belum: $z = -0.38$, $p = 0.35$). It was not possible to model for sex-specific detection parameters due to the sparse data on female individuals (Sollmann et al. 2014). The density of clouded leopards in Temengor was about two-folds higher compared to Belum (Table 2) but these estimates were not significantly different based on the Wald test (critical value at $\alpha = 0.05$). Extrapolating the density estimates and corresponding 95 % CIs to the larger area, Temengor is estimated to hold 52 clouded leopards [95 % CI (29, 90)], whilst the estimate for Belum is 22 [95 % CI (11, 41)].

Table 2 Clouded leopard density estimates, 95 % confidence intervals and corresponding magnitude of the detection function (g0) and spatial scale parameter (sigma)

	Temengor	Belum
$\hat{D} \pm$ SE (per 100 km^2)	3.46 ± 1.00	1.83 ± 0.61
95 % CI	(1.98, 6.04)	(0.97, 3.48)
g0	0.003	0.003
Sigma	3.12 km	3.18 km

Table 3 Clouded leopard detection probability (p) models with ψ (set + LP + SP + study area) in Temengor and Belum

Model	AIC$_c$	ΔAIC	w_i	K	−2 log likelihood
p (TN)	628.72	0.00	0.75	7	613.87
p (study area + TN)	630.97	2.25	0.25	8	613.87
p (.)	673.32	44.60	0.00	6	660.69
p (study area)	675.51	46.79	0.00	7	660.66

AIC$_c$ akaike's information criterion adjusted for small sample sizes, *ΔAIC* relative difference in AIC values compared with the top ranked model, w_i weight, K number of parameters, *LP* large prey index, *SP* small/medium prey index, *study area* binary base covariate on whether in Temengor (1) or Belum (0), *set* distance to settlements, *TN* trap nights

Habitat use

None of the three continuous covariates were found to be highly correlated (maximum $r = 0.33$) and there was no indication of a poor model fit due to over-dispersion of the data $\hat{c}$ (0.99). The constant p(.) model performed poorly (ΔAIC$_c$ = 44.6) and was less likely to explain variation in the observed data than models that incorporated covariates for detection probability particularly camera-trapping effort (trap-nights) as the SMW for this covariate was 100 % (Table 3). The analysis showed that intensity of habitat use by clouded leopards was highly influenced by the availability of small/medium prey species $\hat{\beta}$ (2.04 ± 0.67), as this covariate had a SMW of 100 percent (Table 4). The SMW for other covariates such as study area $\hat{\beta}$ (0.37 ± 0.34; SMW = 41.5 %), large prey $\hat{\beta}$ (0.19 ± 0.18; SMW = 39.2 %) and distance to settlements $\hat{\beta}$ (−0.26 ± 0.18; SMW = 29.2 %) were less than 50 % and therefore deemed less likely to heavily influence clouded leopard habitat use.

Discussion

Our study provides the first density estimates of the mainland clouded leopard from Peninsular Malaysia and within South East Asia. A recent camera-trapping study in Manas National Park, India, however, was the first to

Table 4 Clouded leopard habitat use (ψ) models ($w_i > 0$) with p(TN), in Temengor and Belum

Model	AIC$_c$	ΔAIC	w_i	K	−2 log likelihood
ψ (SP)	625.35	0.00	0.28	4	617.05
ψ (SP + study area)	626.46	1.11	0.16	5	616.01
ψ (LP + SP + study area)	626.52	1.17	0.15	6	613.89
ψ (LP + SP)	626.96	1.61	0.12	5	616.51
ψ (set + SP)	626.98	1.63	0.12	5	616.53
ψ (set + LP + SP)	628.22	2.87	0.07	6	615.59
ψ (set + SP + study area)	628.61	3.26	0.05	6	615.98
ψ (set + LP + SP + study area)	628.72	3.37	0.05	7	613.87

AIC$_c$ akaike's information criterion adjusted for small sample sizes, *ΔAIC* relative difference in AIC values compared with the top ranked model, w_i weight, K number of parameters, *LP* large prey index, *SP* small/medium prey index, *study area* binary base covariate on whether in Temengor (1) or Belum (0), *set* distance to settlements, *TN* trap nights derive a density of this species, which was estimated at 4.73 individuals per 100 km^2 using the SECR method (Borah et al. 2014). Aside from that there have been only three publications on the density of Sunda clouded leopards using the SECR method, ranging from 0.4 to 1.3 per 100 km^2, from logged-protected forests (Brodie and Giordano 2012; Wilting et al. 2012; Sollmann et al. 2014). Although our density estimate for Temengor, a logged forest, was almost twice higher than that of Belum, a primary forest, the differences were not significant. This suggests that logged-over forest and primary forest are both important habitat types for clouded leopards within this landscape.

Our habitat use analysis shows that the relative abundances of small/medium prey species are highly influential in predicting clouded leopard occurrence. A recent study in Sumatra found that clouded leopards in Sumatra prefer higher elevations (Haidir et al. 2013), but we did not include this as a covariate because elevation is not a proximal factor, but a distal factor that likely influences prey availability which we had incorporated in the analysis with the use of prey photo capture rates. The study in Sumatra also showed that clouded leopards tended to avoid forest edge, but we did not account for this factor as our study sites were not bordering non-forested areas.

Our study infers that clouded leopard prefer prey <10 kg in body mass as opposed to medium-sized ungulates such as wild boar and barking deer; at least in the Belum–Temengor landscape. A recent study covering 13 Protected Areas in Thailand has shown that clouded leopards there are associated with the presence of wild boar and barking deer (Ngoprasert et al. 2012). However, that study did not test for the effect of smaller potential prey species. It is also acknowledged that primates could take up a portion of clouded leopard diets, of which we were unable to measure the prey index using camera-traps except for the pig-tailed macaque, which is predominantly terrestrial (Richardson et al. 2008). Thus, it seems likely that conservation of small/medium mammal species such as pig-tailed macaques, porcupines, mouse deer and small carnivores is important to enable clouded leopards to viably persist. However, further dietary studies are needed to confirm that these species indeed form a significant part of the clouded leopards' diet.

This study has provided baseline information and new insights into clouded leopard ecology from within Peninsular Malaysia. Although previous literature has inferred that clouded leopards prefer primary forest (Nowell and Jackson 1996; Austin et al. 2007; Brodie and Giordano 2012), the results of this study show that clouded leopards in Malaysia can be resilient towards logged forests, as has been shown by other species such as tigers (Rayan and Mohamad 2009), Asian tapirs *Tapirus indicus* (Rayan et al. 2012) and leopard cats *Prionailurus bengalensis* (Mohamed et al. 2013). Hence, selectively logged forests should not be considered as 'degraded' habitat as an excuse for it to be converted to crops or plantations (Edwards et al. 2010). An emerging threat is that due to a policy loophole, permanent reserved forests in Peninsular Malaysia can be converted to monocultures such as latex-timber clone plantations due to ambiguity in the definition of 'forest' (Aziz et al. 2010). The National Tiger Action Plan for Malaysia (Department of Wildlife and National Parks (DWNP) 2008) has identified the Belum–Temengor landscape as a priority area for tigers, and our study shows that it likely holds a viable population of clouded leopards as well. Thus, we urge against the establishment of monoculture plantations in permanent reserved forests within this landscape and in other forest reserves within Peninsular Malaysia. This is especially important since the status of clouded leopards and other rare or endangered species remains largely unknown, for which these areas could provide potential refuge sites.

As the findings of this study were obtained from a study to estimate tiger density, it also serves to reinforce the usefulness of using ancillary data from camera-trapping studies to gain information on non-target species (Rayan et al. 2012; Sollmann et al. 2014). In fact, the secondary information obtained during this camera-trapping study is the largest data set ever published for clouded leopards. This is most likely due to the intensive camera-trapping survey over a relatively large area which also targeted tiger prey species, which resulted in a denser camera-trap network than typically used for studies to estimate tiger densities. There is much potential to use the recently-developed SECR framework to obtain density estimates of other individually-identifiable species, which might not be part of the original study objectives. However, it is also important to note that densities derived from such studies (including this one) are likely to be conservative estimates, due to the possibility of reduced capture probabilities biased by the placement of camera stations which were optimised for other species in terms of trail usage, camera-trap density and camera-trap height (Harmsen et al. 2010), and in this case, also due to clouded leopards being partly arboreal. Nevertheless, we urge more researchers to compile, analyse and publish such findings in order to better understand the conservation needs of species which are not well studied.

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