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Abundance and Distribution of Asiatic Golden Cat (*Catopuma teminckii* Vigors and Horsfield) and Clouded Leopard (*Neofelis nebulosa* Griffith) in Jomotsangkha Wildlife Sanctuary, Bhutan

Pema Yongdrup¹, Karma Sherub^{1,*}, UgyenTshering², Lekey Chaida², Chaten²

Abstract

Little is known regarding the biology and status of Near Threatened Asiatic golden cat, *Catopuma teminckii* Vigors and Horsfield and Vulnerable Clouded leopard, *Neofelis nebulosa* Griffith, in Bhutan. A systematic camera trap survey was conducted in Jomotsangkha Wildlife Sanctuary from December 2018 to February 2019 to assess the abundance, activity patterns and conservation threats of these species. Distributions of both the species were recorded in the elevation range of 216-1690 m asl. Asiatic golden cat was nocturnal (66.60% of the pictures; $n = 2$) and least abundant (RAI = 0.17) whereas the Clouded leopard was diurnal (75.00%; $n = 8$) and second least abundant (RAI = 0.68) among its sympatric species. Daily activities of these species showed an overlapping pattern with its sympatric species in which high degree of overlap was seen between Clouded leopard and Marbled cat ($\Delta = 0.77$). The habitat under study was moderately disturbed by deforestation (46.45%). Thus, these findings call for regular monitoring of their threatened habitats.

Keywords: Activity patterns, camera trap survey, Near Threatened, sympatric species, Vulnerable

Introduction

Currently, Bhutan has over 71% of its total land area under forest cover (DOFPS, 2018) harbouring nine confirmed wild cat species viz.; Tiger (*Panthera tigris* Linnaeus), Clouded leopard

(*Neofelis nebulosa* Griffith), Marbled cat (*Felis marmorta* Martin), Snow leopard (*Panthera unica* Schreber), Asiatic golden cat (*Catopuma teminckii* Vigors and Horsfield), Leopard cat (*Felis bengalensis* Horsfield and Vigors), Pallas's cat (*Octocolobus manul* Pallas), Common leopard (*Panthera pardus* Linnaeus) and Jungle cat (*Felis chaus* Schreber) (Dhendup and Dorji, 2018). Among these, Asiatic golden cat and Clouded leopard are least studied in the tropical Asia; and currently Bhutan has very few pictures of its presence recorded by camera traps in Jigme Dorji National Park, Jigme Singye Wangchuck National Park, Royal Manas National Park and Jomotsangkha Wildlife Sanctu-

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ary (Wangchuk *et al.*, 2004; Jigme, 2011; Tempa *et al.*, 2011; Vernes *et al.*, 2015; Wang, 2017). Globally, they are found in Tibet, Nepal, Bhutan, India, Bangladesh, Myanmar, Thailand, Cambodia and Vietnam (Grassman *et al.*, 2005; Tempa *et al.*, 2013). However, very little is known about their distribution, abundance, habitat use and ecology in Bhutan (Penjor, 2018).

The global population of Clouded leopard is suspected to be fewer than 10,000 mature individuals with a decreasing population trend and the Asiatic golden cat's population is thought to be even less with rare sightings (Grassman *et al.*, 2005). Moreover, their survival is threatened by poaching (Nowell and Jackson, 1996) and habitat fragmentation (Choudhury, 1993). Currently, both the species are listed in Appendix I of CITES (Grassman *et al.*, 2016) and Schedule I of the Forest and Nature Conservation Act of Bhutan, 1995 (FNCA, 1995). Besides strict regulations and monitoring, the intensity of poaching and current trend of habitat destruction in and around Jomotsangkha Wildlife Sanctuary (JWS) persist. Moreover, most studies in the sanctuary are focused on flagship species such as tigers and snow leopards (Dhendup *et al.*, 2016), and no systematic studies on Asiatic golden cat and Clouded leopard are conducted. Thus, this study was designed to assess the distribution, relative abundance, activity patterns and conservation threats of Asiatic golden cat and Clouded leopard in JWS.

Materials and Method

Study area

Jomotsangkha Wildlife Sanctuary is the smallest protected area of Bhutan covering 334.73 km² and is situated in the south-eastern most corner of the country. It is located in between 26°48' N and 26°60' N, 91°42' E and 92°08' E in Samdrup Jongkhar district (Figure 1). The elevation ranges from 184 m to 3000 m asl. Based on elevation, the sanctuary is divided into three eco-floristic zones, namely sub-

tropical forest, cool broadleaved forest, warm broadleaved forest, and patches of grasslands along the southern fringes (Ahmed *et al.*, 2019).

The sanctuary harbours a wide array of important wildlife species such as Asiatic elephant (*Elephas maximus* Linnaeus), Himalayan Black bear (*Ursus thibetanus laniger* Pocock), Bengal tiger (*Panthera tigris* Linnaeus), Guar (*Bos gaurus* Smith), Great Hornbill (*Buceros bicornis* Linnaeus) and Rufous-necked hornbill (*Aceros nipalensis* Hodgson). Ahmed *et al.* (2019) reported that the Sanctuary is said to be the only habitat for the rare and endangered Pygmy hog (*Porcula salvania* Hodgson) and the Hispid hare (*Caprolagus hispidus* Pearson). In this study, the camera trapping were set up in three administrative blocks of the district; Samrang, Langchenphu, and Serthi.

Field sampling

The camera trap survey was carried out in Jomotsangkha Wildlife Sanctuary from 28 December, 2018 to 28 February, 2019. The study area was divided into 2 x 2 km grids covering three administrative blocks to increase detection probability. A total of 25 remotely triggered infrared cameras (Panthera V4 and CUDEBACK) were employed in 25 grids, selected based on the presence of felids sign such as foot print, scrap and scats were found to ensure maximum chances of photographing. A distance of 2-3 km was maintained between the camera stations. All camera traps were operational for 24 hours per day except for two. Thus, the research has generated the data of 1,171 traps days from 23 camera trap over 2 months.

Estimation of relative abundance and activity patterns

In order to avoid pseudo-replication, the images were sorted to rate as independent event as per Tobler *et al.* (2013). Day time was defined from 0600-1800 hours and night time from 1800-0600 hours. The relative abundance was

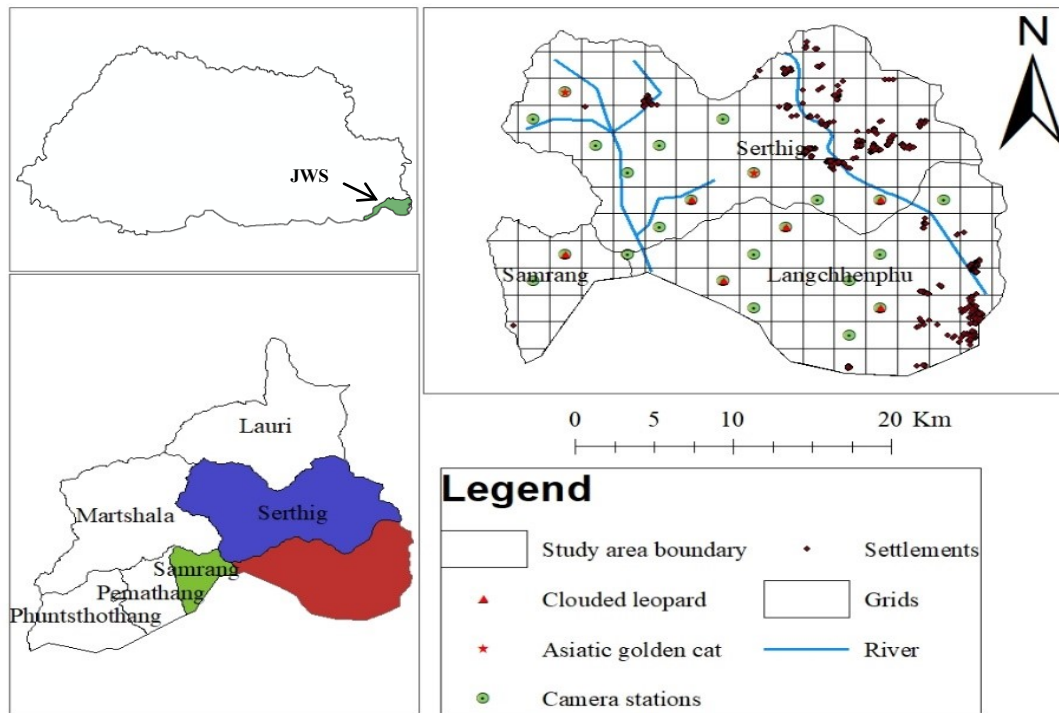


Figure 1: Map of study area showing camera trap sites where Asiatic golden cat and Clouded leopard were captured

calculated as the number of single images of felid species captured per 100 trap days. Using package overlap, the probability density function of two focal species was generated and referred as the activity pattern (Ridout and Linkie, 2009; Linkie and Ridout, 2011). Overlap estimated probability density function was computed using Kernel density (e.g., Asiatic golden cat – Common leopard) to understand how overlapping of temporal activity patterns of focal species with other felids occurred. Ridout and Linkie (2009) favoured the coefficient of overlapping, “ Δ ”, which is defined as the area under the curve that is formed by taking the minimum of the two density functions at each time point.

Threats assessment

Threats of Asiatic golden cat and Clouded leopard were assessed based on the presence of anthropogenic activities. During the course of camera trap installation, signs of anthropogenic activities were recorded in every camera station within 20 m radius circular plot. Recorded threats were rated 0-3 based on the scale of

threats signs; 0 = disturbances absent, 1 = low (1-20%), 2 = moderate (30-40%), and 3 = high (>50%).

Data analysis

After retrieving all the camera traps, the photographs were downloaded and catalogued using Camera Trap File Manager software (CTFM) (Version 2.1.8) which is specifically developed for cat image sorting. During the cataloging process, images were carefully observed and the species identified. The images of all the felid species were sorted by survey sites and station grid numbers. A capture history of Asiatic golden cat and Clouded leopard were built using CTFM.

Results and Discussion

Sampling efforts and sampling success

Only 23 among 25 cameras employed remained operational, and the two other cameras malfunctioned. In the 1,171 traps days, a total of 2,497 photographs were captured of which 68.84% ($n = 1,719$) were wildlife photos and

29.64% ($n = 740$) were either anthropogenic activities such as the movement of livestock, people or false triggers. In 1.03% ($n = 38$) cases, species could not be determined due to poor focus, lighting or angles. Only 6.73% ($n = 168$) were felids species, equivalent to 7.30 photographs per camera deployed.

Distribution of Asiatic golden cat and Clouded leopard

Asiatic golden cat was captured from two locations (Minjiwoong top and Pelrithang top) in the cool broadleaved forest between 216-1276 m elevations (Figure 1). The Clouded leopard was captured at six different locations from various forest types and elevation gradients (708-1690 m). Previous finding show that the Asiatic golden cat occurs within the elevation range of 1500 m to 4000 m (Jigme, 2011) and the Clouded leopard from the lowlands to 3000 m (Jaimo, 2016) in Bhutan. Bashir *et al.* (2011) showed that the Asiatic golden cat occurs at altitude range of 1980–3960 m in Sikkim. These studies indicate that the current study area is a potential habitat for Asiatic golden cat and Clouded leopard.

Relative abundance of Asiatic golden cat and Clouded leopard

Camera traps recorded five felid species (Table 1). The photographic encounter rate of Asiatic golden cat was the lowest (RAI = 0.17). The number of days required for one capture event for Asiatic golden cat was 585.50 days. Azlan

and Sharma (2006) also showed that the detection rate of the Asiatic golden cat compared with other felids is the lowest. The photographic rate calculated for Clouded leopard was higher (RAI = 0.68) indicating that the Clouded leopard was relatively abundant than Asiatic golden cat. The number of days required for one capture event of Clouded leopard was 146.38 days. A study by Jaimo (2016) in the Royal Manas National Park showed the lowest abundance rate for Clouded leopard (RAI = 0.02) compared to its sympatric species.

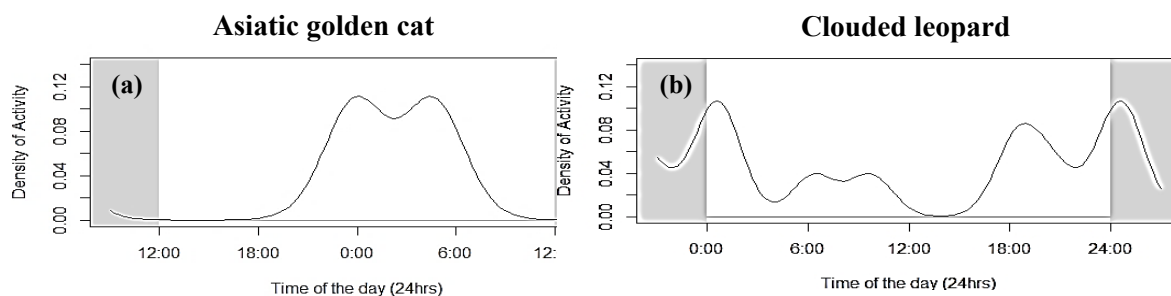
Temporal activity patterns of Asiatic golden cat and Clouded leopard

Asiatic golden cat exhibited at least two peak activity patterns, predominantly at dusk (66.60% of pictures; $n = 2$) between 0400–0600 hours, whereas 33.40% ($n = 1$) of the activities were at 2300-2400 hours exhibiting nocturnal behaviour (Figure 2 a). Similar findings of Asiatic golden cat activities were reported by Azlan and Sharma (2006), where 52.00% of the Asiatic golden cat photos were captured between the periods of 1900-0500 hours in an unprotected secondary Dipterocarp forest. Kawanishi and Sunquist (2008) also reported that the Asiatic golden cats are largely nocturnal with 69.00% of the photos ($n = 32$) captured between 1900-0700 hours in a primary rainforest of Peninsular Malaysia. However, Clouded leopard in current study sites showed highly diurnal activity pattern with 75.00% peak activity in 0600-0900 hours, whereas 25.00% of activities were at night (Figure 2 b).

Table 1: Relative abundance of felids in JWS

Species name	Red list category	Number of IE	Total trap nights	RAI	No. of days required for 1 event
<i>Catopuma temminckii</i>	NT	2	1171	0.17	585.5
<i>Felis bengalensis</i>	LC	41	1171	3.50	28.56
<i>Felis marmorata</i>	VU	32	1171	2.73	36.59
<i>Neofelis nebulosa</i>	VU	8	1171	0.68	146.38
<i>Panthera pardus</i>	NT	33	1171	2.82	35.48

* IE = Independent Events, RAI = Relative Abundance Indices for felid species recorded in camera traps in JWS



* Activity overlap of Asiatic golden cat and Clouded leopard with its sympatric species

Figure 2: Temporal activity of Asiatic golden cat (a) and Clouded leopard (b) based on single season

In Jomotsangkha Wildlife Sanctuary (JWS), Asiatic golden cat had higher degree of daily activity overlap with Clouded leopard and Leopard cat ($\Delta = 0.57$). The Clouded leopard had a high degree of daily activity overlap with Marbled cat ($\Delta = 0.77$) and Leopard cat ($\Delta = 0.72$) with relatively a lower overlap with Common leopard ($\Delta = 0.65$). Overall, the maximum

overlap was seen between Clouded leopard and Marbled cat ($\Delta = 0.77$) (Table 2; Figure 3). Similar findings were reported by Lyam and Jenks (2013) where Asiatic golden cat had higher activity overlap with Clouded leopard ($\Delta = 0.90$) followed by Leopard cat ($\Delta = 0.63$).

Table 2: Estimates of activity pattern overlap (Δ) between felid species with approximate 95% Confidence Interval in parentheses

	Clouded leopard	Marbled cat	Leopard cat	Common leopard
Asiatic golden cat	$\Delta = 0.57$ (0.25-0.95)	$\Delta = 0.44$ (0.20-0.75)	$\Delta = 0.57$ (0.27-0.94)	$\Delta = 0.34$ (0.13-0.66)
Clouded leopard		$\Delta = 0.77$ (0.25-0.95)	$\Delta = 0.72$ (0.54-0.96)	$\Delta = 0.65$ (0.38-0.86)

Table 3: Association between threats intensity and anthropogenic factors

Threat Intensity	Factors of anthropogenic threats (%)				
	TL	DF	P	LA	Total (%)
Low (10-20%)	18.18	0.00	9.09	0.00	27.27
Moderate (30-40%)	0.00	0.00	0.00	27.27	27.27
High (>50%)	0.00	45.46	0.00	0.00	45.46
Total (%)	18.18	45.46	9.09	27.27	100.0

*TL = transmission line, DF = deforestation, P = poaching, LA = logging activities

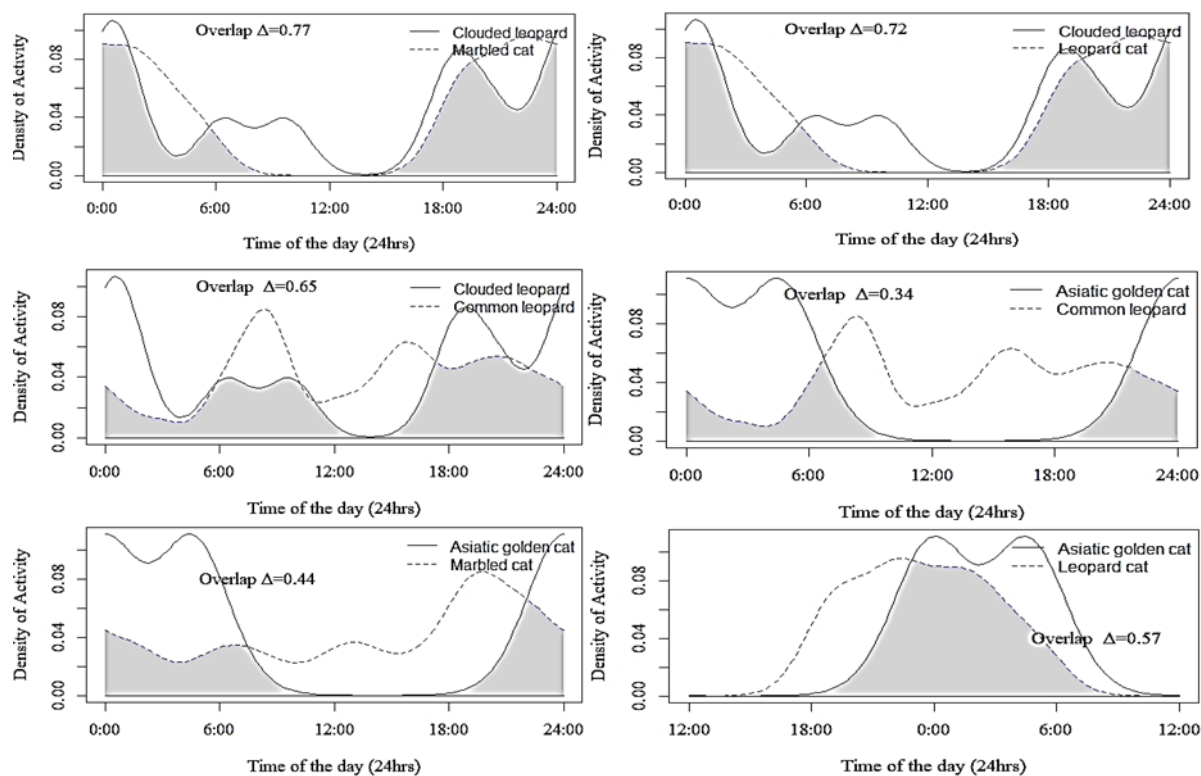


Figure 3: Daily activity overlap of Asiatic golden cat and Clouded leopard with its sympatric species.

Conservation threats of Asiatic golden cat and Clouded leopard

Anthropogenic threats were recorded from 10 sample plots and absent in 13 plots. The study could identify only four activities in the study sites that had direct influence on the wild cat species survival such as construction of transmission line, deforestation (agricultural land extension, firewood collection, etc.), poaching and logging activities. Among these threats, deforestation incidences were the highest (45.46%) and poaching or hunting the least (9.09%) (Table 3). Interaction with park staff indicated that most of the illegal logging activities are leading to habitat loss which is considered as a key conservation challenge in Jomotsangkha Wildlife Sanctuary. Hedwig *et al.* (2018) also reported that the habitat loss or degradation have affected the density of Asiatic golden cat and Clouded leopard in Bateke Plateau National Park of Gabon.

Conclusions

Bhutan is home to nine confirmed wild cat species of which Jomotsangkha Wildlife Sanctuary harbours five species such as Leopard cat, Marbled cat, Common leopard, Clouded leopard and Asiatic golden cat. The current research focused on the study of Asiatic golden cat and Clouded leopard as they are least studied in the tropical Asia and in the sanctuary. In the sanctuary the species are distributed in the elevation range of 216-1690 m. Among their sympatric species, the photographic encounter rate of Asiatic golden cat was the lowest (RAI = 0.17) with better record for Clouded leopard (RAI = 0.68).

The activity pattern of Asiatic golden cat was predominant at dusk (66.60% of pictures; $n = 2$ from 0400-0600 hours), whereas the Clouded leopard was highly diurnal with 75.00% peak activity in between 0600-0900 hours. Of all the felids recorded, high degree of overlap was seen between Clouded leopard and Marbled cat ($\Delta = 0.77$). Since there was moderate effect

of deforestation on the habitat (45.46%), as the study was mostly around human settlement, the study needs to expand to other parts of the sanctuary as well. Moreover, there is a need to evaluate the prey base species and document poaching intensity to help conservationist and planners to develop effective management plans.

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