

Rusty-spotted cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hillaire) camera trapped in the Bardia-Banke complex of Western Terai Arc Landscape, Nepal

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Abstract

The Rusty-spotted Cat *Prionailurus rubiginosus* is a ‘Near Threatened’ small felid native to South Asia. It was believed to occur only in India and Sri Lanka, but recent studies confirmed its presence in the Bardia National Park (BNP) and Shuklaphanta National Park, Nepal. Here we add evidence of the species in the Banke National Park (BaNP) in 2013 and Bardia National Park (BNP) in 2017. A pair of motion sensor cameras was installed either side of the game trail, forest road or stream bed, maximizing the possibility of tiger capture. Cameras were active for a minimum of 15 days in each sampling location. Camera trap photos were systematically sorted species-wise. A photograph of a single individual rusty-spotted cat was obtained in BaNP in the hot dry season (April-May) of 2013. The camera trap location in BaNP lies in dry-deciduous Sal *Shorea robusta* forest at a distance of approximately 4.3 km from the nearest settlements. Additional photographs of rusty-spotted cat were obtained in BNP during the camera trap survey conducted in the dry season (January-April) of 2017. Importantly, the BNP detections confirm the presence of rusty-spotted cats in community forests outside protected areas. These findings reinforce mounting evidence of the value of observations of elusive species made as by-catch from camera-trapping studies focused on tigers or other large charismatic fauna, especially in the context of extending information on poorly known geographical ranges.

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Introduction

Forty species of wild felids are extant globally; 12 of them occur in Nepal (Amin et al., 2018). In the southern lowlands of Terai, nine species are known to exist, including iconic flagship species such as Bengal tiger (*Panthera tigris tigris*), common leopard (*Panthera pardus fusca*) and clouded leopard (*Neofelis nebulosa*) (Lamichhane et al., 2016).

Another iconic species could arguably be the smallest cat in the world, the rusty-spotted cat, only found in India, Nepal and Sri Lanka (Mukherjee et al., 2016). The rusty-spotted cat is listed as ‘Near Threatened’ in the global IUCN Red List (Mukherjee et al., 2016).

Rusty-spotted cats (RSC) are mostly recorded in the southern part of India but occasionally also as far north as the Terai Arc landscape of Nepal and India

(Mukherjee et al., 2014, Lamichhane et al., 2016). The rusty-spotted cat has been recorded in India from the Gir Wildlife Sanctuary and National Park (Pathak, 1990) in the South to Jammu Kashmir in the North-West, with a discontinuous distribution in between. Sightings in the Pilibhit Tiger Reserve in the Indian part of the Nepal-India transboundary Terai region were once thought to represent the northernmost extent of its range (Anwar et al., 2010), but more recently camera traps have detected the species' presence in the Corbett Tiger Reserve in Uttarakhand. Additionally, sightings in the states of Jammu and Kashmir have been recorded (Prater, 1998; Sunquist and Sunquist, 2002), indicating that the species' distribution extends even farther north than formerly suspected. However, the contiguity of its distribution remains unknown due to the scant information on its habitat preferences (Nowell and Jackson, 1996).

Rusty-spotted cats are believed to prefer forested habitats but can be found in wet or dry deciduous forests as well as scrubby grasslands (Vyas and Upadhyay, 2014; Sunquist and Sunquist, 2002). Little is known about this species in Nepal, where it has only recently been reported from Suklaphanta (Lamichhane et al., 2016; Adhikari et al., 2019) and Bardia National Park (BNP) in 2012 (Lamichhane et al., 2016). The main threats to the species are considered to be habitat loss and fragmentation (Mukherjee et al., 2014). In addition, rusty-spotted cats are hunted for the fur trade, as livestock pests and occasionally for consumption (Van Gruisen and Sinclair, 1992). Additionally, a road kill record of a rusty-spotted cat was found near Arjuni Phanta in Shuklaphanta National Park, Nepal on 19 March 2018 (Adhikari et al., 2019). Here, we present an opportunistic camera trap record of the rusty-spotted cat, recorded for the first time in Banke National Park (BaNP) in 2013 and their re-discovery in Bardia National Park (BNP) in 2017. The main aim of the research was to describe the recent evidence and new record of the little known species rusty-spotted cat, in BNP and Banke NP respectively.

Material and Methods

Survey Area

The study was conducted in Banke-Bardia complex which is a part of the transboundary (Nepal-India) Terai Arc Landscape located in southwestern part of Nepal. BaNP was established in 2010 and covers a 550 km² area, with a buffer zone of 343 km² surrounding the park DNPWC and DFSC, (2018). BNP was gazetted in 1988 covering 968 km², with a buffer-zone of 507 km² (Thapa and Chapman, 2010). Both national parks contain an array of vegetation types such as Sal (*Shorea robusta*) forest, deciduous Riverine forest, savannahs and grasslands, mixed hardwood forest, flood plain community, Bhabar and Chure Hill range. Nearly half of the study area lies in relatively low-lying flat terrain of the Terai consisting of fine alluvial soil and loam, whereas, the other half consists of the Churia hills, the Himalayan foothills. The climate is sub-tropical with three main seasons, namely winter

(November-February), hot dry (March-June) and monsoon (July-October) (Dinerstein, 1979). The temperature is minimum 5 °C during winter and maximum 45 °C during the monsoon (Bhattarai, 1993). Most of the annual precipitation occurs during four months of the year (late June-September).

The Bardia-Banke complex contains at least 56 mammal species, 438 bird species, 25 reptile and amphibian species and 121 fish species (RBNP, 2005; Upadhyay, 2005). The major predators of the area are Bengal tiger, leopard, striped hyaena (*Hyaena hyaena*), and leopard cat (*Prionailurus bengalensis*). Prey species such as chital (*Axis axis*), hog deer (*Axis porcinus*), wild boar (*Sus scrofa*), barking deer (*Muntiacus vaginalis*), swamp deer (*Cervus duvauceli*), four-horned antelope (*Tetracerus quadricornis*) and nilgai (*Boselaphus tragocamelus*) also occur in the park (Wegge et al., 2009). Other carnivores such as sloth bear (*Melursus ursinus*), golden jackal (*Canis aureus*) and dhole (*Cuon alpinus*) are also present, but in low numbers (Støen and Wegge, 1996; Yadav et al., 2019). Mega herbivores like one horned Rhinoceros (*Rhinoceros unicornis*) and Asian elephant (*Elephas maximus*) are also present in the area. Agricultural land and community forests make up the mosaic landscape of the buffer zones. An estimated 120,000 people, including indigenous Tharu people and migrants from the hill areas (Pahade), reside in the buffer zone of BNP (Thapa and Chapman, 2010). Similarly, ca. 35,000 people (~5000 households) live in the buffer zone of BaNP (BaNP, 2018).

Camera trap surveys

Camera trapping surveys were conducted in two different sessions in Bardia-Banke Complex. The survey in BaNP was a part of the national tiger survey (DNPWC and DFSC, 2018). Systematic grid cells (n= 150) of 2 x 2 km² were superimposed in BaNP. The field survey was conducted in 3 blocks successively during May-June 2013. In BNP, the survey was conducted between January-April 2017 and 2018 as part of the Living with Tigers Project, using the same grid system (<https://www.wildcru.org/research/living-with-tigers-project/>). The camera trap location within each grid cell was selected following an extensive survey of tiger signs. In each sampling point a pair of motion sensor camera traps (Cuddeback Color Model C1, Cuddeback Attack, Reconyx 500 and Reconyx 550) was installed at 45–60 cm above ground on either side of the game trail, forest road or stream bed, maximizing the possibility of tiger capture. GPS location and other details of the site were recorded in the standard data format (Karki et al., 2009). In BaNP, camera traps were checked twice a week to observe the capture of tiger and other species during the previous night. In BNP, cameras were not checked between set up and collection to reduce additional human disturbance at the cameras. Cameras were active for a minimum of 15 days in each grid cell. Camera trap photos were given unique identification names and sorted species-wise in separate folders. As the primary target species of the study was tiger, site selection, distance between paired cameras and camera height was not optimized for capture of the rusty-spotted cat.

Data analysis

For BaNP, the photographic data were downloaded, given unique identification names using ReNamer package and sorted by species. Individuals were identified whenever possible. Photo capture of a species within a 30-minute interval was termed as an 'independent event' (Karki et al., 2009). For BNP, the photographic data were downloaded and stored in camera folders per station. A photo capture of a species within a 15-minute interval was termed as an 'independent' event. All photos were tagged using Digikam and CamTrapR package (Niedballa et al., 2020) was used to extract the photo metadata into Excel. Data was subsetted in R for the focus species. Capture rate (number of independent events per 100 trap nights) was calculated as an abundance index of Rusty-spotted cat (Thapa et al., 2013). Spatial calculations were done using ArcGIS 10.0. We analyzed the raw data in R software (R Development Core Team, 2015), using packages 'activity' (Rowcliffe et al., 2014) for activity patterns and 'overlap' (Ridout and Linkie, 2009) for estimating the coefficient of overlapping activity between the rusty-spotted cat and all other species detected at the camera traps. We compared the photos with 'Rusty Spotted Cat' photos on The IUCN Red List of Threatened Species (Mukherjee et al., 2016) and 'Rusty-spotted cat: 12th cat species discovered in Western Terai of Nepal' (Lamichhane et al., 2016) to confirm the identification.

Results

A total effort of 2,250 trap nights from 150 camera trap grids in BaNP recorded 24 mammal species including the rusty-spotted cat. Three photographs of a single individual were obtained on 2nd May 2013 inside BaNP, approximately 4.3 km from the nearest settlement (Fig. 2). Similarly, a total survey effort of 2,395 trap nights resulted 31 mammal species in BNP in 2017 including four photographs of probably three different individuals of the rusty-spotted cat. Importantly, this is the first record of the rusty-spotted cat occurring outside the core Protected Area in the Sainawar buffer zone community forest of Nepal (Fig. 1; Appendix 1).

The encounter rate of rusty-spotted cat was 0.13/100 and 0.88/100 trap nights within BaNP and BNP respectively. All the photographs were obtained in the night between 20:04:00 hrs and 5:44:00 hrs. Seven carnivore species including two felids (Bengal tiger and jungle cat) were also photographed at camera stations where rusty-spotted cats were photographed in BaNP and BNP (Table 1). Comparison of activity patterns of the rusty-spotted cat and other carnivore species suggests some temporal partitioning, although with so few records of the rusty-spotted cat, this analysis is limited.

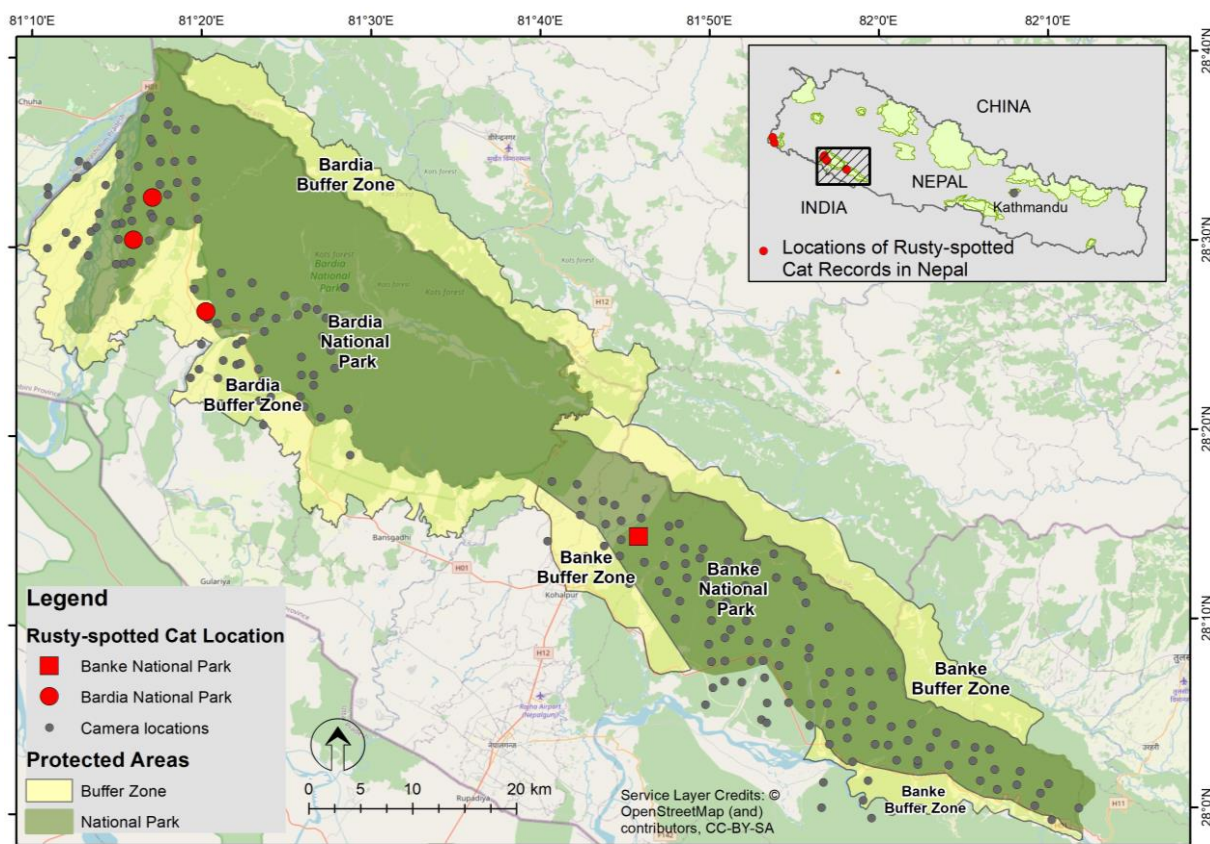


Figure 1: Rusty-spotted cat detection locations during camera trap survey (2013) in Banke National Park Nepal (red square) and detections in Bardia National Park and buffer zone in 2017 (red circles). (Map prepared by Babu Ram Lamichhane with Arc GIS 10.4)



Figure 2: Camera trap images of the rusty-spotted cat (*Prionailurus rubiginosus*) from Banke National Park (A) and Bardia National Park (B).

Table 1: Species detected at camera stations where rusty-spotted cat was detected in BaNP in 2013 and BNP in 2017.

Taxa	Camera station			
	BNP 45	BNP 57	BNP C7	BaNP 20
Felidae				
Bengal tiger <i>Panthera tigris tigris</i> (Linnaeus)	Yes	No	No	No
Jungle cat <i>Felis chaus</i> Schreber	Yes	Yes	Yes	Yes
Canidae				
Golden jackal <i>Canis aureus</i> Linnaeus	Yes	Yes	Yes	No
Striped hyaena <i>Hyena hyena</i> (Linnaeus)	No	No	No	Yes
Viverridae				
Small Indian civet <i>Viverricula indica</i> (É. Geoffroy Saint-Hilaire)	No	Yes	Yes	Yes
Common palm civet <i>Paradoxurus hermaphrodites</i> (Pallas)	Yes	No	No	No
Herpestidae				
Ruddy mongoose <i>Urva smithii</i> (Gray)	No	Yes	No	No
Hystricidae				
<i>Hystrix</i> sp.	Yes	No	No	No
Leporidae				
Indian hare <i>Lepus nigricollis</i> (F. Cuvier)	No	Yes	No	Yes
Ungulates				
Barking deer <i>Muntiacus vaginalis</i> (Boddaert)	Yes	No	Yes	No
Hog deer <i>Axis porcinus</i> (Zimmermann)	No	No	Yes	No
Chital <i>Axis axis</i> (Erxleben)	No	Yes	Yes	No
Four-horned antelope <i>Tetracerus quadricornis</i> (de Blainville)	Yes	No	No	Yes
Wild boar <i>Sus scrofa</i> Linnaeus	No	No	Yes	Yes
Primates				
Rhesus macaque <i>Macaca mulatta</i> (Zimmermann)	Yes	Yes	Yes	No
Terai langur <i>Semnopithecus hector</i> (Pocock)	No	No	Yes	No
People <i>Homo sapiens sapiens</i>	Yes	Yes	Yes	No

Note: At camera stations 45, 57, C7 and 20 are the grid cell numbers where the camera traps were placed.

Discussion

We present the first conclusive record of the rusty-spotted cat in BaNP and the second record from BNP, Nepal. In the context of other small felids in Nepal, two species *i.e.* Marbled cat *Pardofelis marmorata* (Martin) (for which no photographic evidence has been reported in recent years) and Asiatic golden cat *Catopuma temminckii* (Vigors and Horsfield) are listed as Data Deficient (Jnawali et al., 2011). Rusty-spotted cat and Pallas's cat were discovered respectively in 2012/2016 from Western Terai (Bardia and Shuklaphanta) and in 2012 from Annapurna Conservation Area (Amin et al., 2018) for the first time in Nepal. With this record, the BaNP has evidence of 34 mammalian species (BaNP/NTNC-BCP, 2019).

Similarly, four images of rusty-spotted cat were obtained at three locations in BNP in 2017. One location yielded photographs of the rusty-spotted cat on two different nights. Rusty-spotted cat had not previously been photographed by camera traps in BNP but had been photographed by a tourist on safari (Lamichhane et al., 2016). The record from Sainawar buffer zone community forest of BNP is the first from the region in a human-dominated area. Lamichhane et al. (2016) also reported a sighting of a rusty-spotted cat in proximity of the settlements in Shuklaphanta NP (SNP). The availability of food (chicken, duck and other domestic poultry) close to the settlements may have attracted the rusty-spotted cat in the human-dominated areas.

The encounter rate (0.13/100 trap nights) of rusty-spotted cat within the core area of BaNP was lower than in BNP (0.88/100 trap nights) and SNP (0.46/100 trap nights) (Lamichhane et al., 2016). Lower encounter rate indicates that rusty-spotted cat is relatively rare in BaNP due to relatively dry habitat with lower density of prey base compared to BNP and SNP (Dhakal et al., 2014). We found that rusty-spotted cat co-exists in the Bardia-Banke Complex with sympatric carnivores such as striped hyaena, jungle cat, fishing cat, leopard cat, small Indian civet, Bengal tiger, and common palm civet. Further intensive studies focused on rusty-spotted cats are suggested at a finer spatial scale.

Rusty-spotted cat has been previously recorded in Katarniaghat Wildlife Sanctuary, Uttar Pradesh State, India (Anwar et al., 2012). Although the BaNP record raises the possibility of rusty-spotted cat occurrence in other parts of the Banke–Bardia–Katarniaghat–Suhelwa Complex, the few detections of this species suggest its low density. Our opportunistic record does not represent the optimum capture of the rusty-spotted cat as camera trapping technique (*i.e.* camera height and spacing) was biased towards tigers. However, such information on species with very few published records will positively contribute towards conservation and updated assessment of IUCN Red List status. Further camera trapping efforts would be informative in forested habitats of the protected areas and their buffer zones in Nepal.

The majority of the location results have recorded humans because of tourism activity in core area of the park. Moreover, local people are allowed to collect grass and fuel wood from the buffer zone.

Conclusion

This study presents the conclusive record for the presence of the rusty-spotted cat in Banke and Bardia National Parks. With this record, 35 species have now been recorded in BaNP. Similarly, the second photographic evidence of this species in BNP highlights the importance of this habitat. Targeted studies on status, distribution and ecology for rusty-spotted cat is necessary in Nepal for conservation in the Bardia–Banke complex and beyond.

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Conflict of interest

All authors declare that there are no conflicting issues related to this research article.

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Appendix 1: Details of the record of rusty-spotted cat in Banke National Park 2013 and Bardia NP 2017, Nepal.

Particulars	Elevation in meter	No. of photo (Video)	No. of individuals	Duration of Camera Trap	Photo Captured date and time	Terrain	Habitat type	Nearest distance to village (km)	Distance to nearest tiger captured locations (km)
CT 20 (BaNP)	140	3	1	5/1/2013	2013-05-16 (20:04:55 to 20:04:57)	Flat	Mixed Forest composed of Sal <i>Shorea robusta</i> , Saj <i>Terminalia tomentosa</i> , Bot dhairo <i>Lagerstroemia parviflora</i> , Bans, Bhorla <i>Bauhinia vahlii</i> and <i>Bauhinia</i> spp.	4.3	6.2
BNP 2017 Camera Grid Number 57	NA	1	1	2/21/2017	2:38:46	Flat	Mixed Forest composed of Sal forest	NA	2
BNP 2017 Camera Grid Number 45	NA	1	1	2/20/2017	23:53:05	Flat	Mixed Forest composed of Sal forest	NA	0
BNP 2017 Camera Grid Number C7	NA	2	1	2017-03-16, 2017-03-17	05:44:10, 03:33:03	Flat	Mixed Forest composed of Sal forest and grassland	0.5	2