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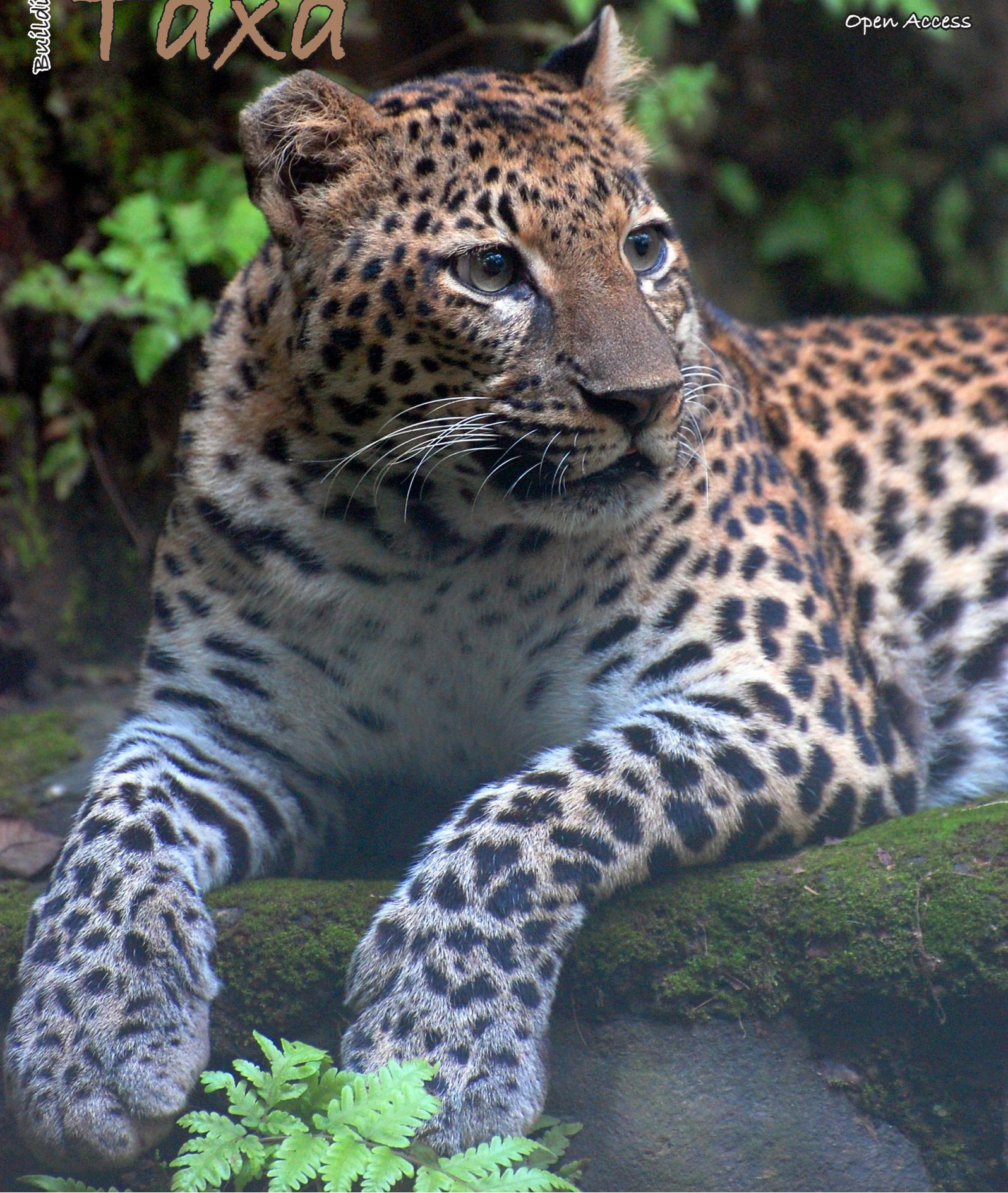
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No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,  
Coimbatore, Tamil Nadu 641035, India

Ph: +91 9385339863 | [www.threatenedtaxa.org](http://www.threatenedtaxa.org)

Email: [sanjay@threatenedtaxa.org](mailto:sanjay@threatenedtaxa.org)

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Cover: A female Javan Leopard *Panthera pardus melas* in rehabilitation phase at Cikananga Wildlife Center. © Yayasan Cikananga Konservasi Terpadu.



## First camera trap record of Striped Hyena *Hyaena hyaena* (Linnaeus, 1758) (Mammalia: Carnivora: Hyaenidae) in Parsa National Park, Nepal

Pramod Raj Regmi<sup>1</sup> , Madhu Chetri<sup>2</sup> , Haribhadra Acharya<sup>3</sup> , Prakash Sigdel<sup>4</sup> , Dipendra Adhikari<sup>5</sup> , Naresh Subedi<sup>6</sup> & Babu Ram Lamichhane<sup>7</sup>

<sup>1</sup> National Trust for Nature Conservation, P.O. Box.3712, Khumaltar, Lalitpur, Nepal.

<sup>2</sup> National Trust for Nature Conservation, P.O. Box.3712, Khumaltar, Lalitpur, Nepal, Faculty of Applied Ecology, Agricultural Sciences and Biotechnology, Inland Norway University of Applied Sciences, NO-2480 Koppang, Norway.

<sup>3</sup> Department of National Park and Wildlife Conservation, Babarmahal, Kathmandu, Nepal.

<sup>4</sup> Zoological Society of London Nepal Office, Kathmandu, Nepal.

<sup>5</sup> Nepal Conservation & Research Center, Chitwan, Nepal.

<sup>6</sup> National Trust for Nature Conservation, P.O. Box.3712, Khumaltar, Lalitpur, Nepal.

<sup>7</sup> National Trust for Nature Conservation, P.O. Box.3712, Khumaltar, Lalitpur, Nepal.

<sup>1</sup>regmiprr11@gmail.com (corresponding author), <sup>2</sup>mchetri@gmail.com, <sup>3</sup>hbacharya07@gmail.com, <sup>4</sup>sigdelprakash07@gmail.com, <sup>5</sup>dipenadk2005@gmail.com, <sup>6</sup>nareshsubedi@gmail.com, <sup>7</sup>baburaml@gmail.com

**Abstract:** The Striped Hyena occurs in the Tarai and midhill regions of Nepal, where limited information is available on species distribution. A camera trap survey was conducted in Parsa National Park in 2016 (Feb–May) and 2016–2017 (Nov–Feb) to monitor tigers at 158 locations for 21 days (6,615 trap efforts in total). This study successfully captured the 15 hyena images in 5 grids of eastern part (named as extension area) of national park. A total of 17 mammal species were captured simultaneously in hyena captured grid during the survey period. The presence of hyenas in Parsa National Park indicates the collective efforts of the government, conservation organizations and local communities in hyena conservation. A detailed ecological study of this species has been recommended for designing hyena conservation plan in the region.

**Keywords:** Camera trap survey, conservation, distribution, extension area, grid, hyenas, mammal.

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**Author details:** PRAMOD RAJ REGMI: Natural Resource Conservation Assistant, National Trust for Nature Conservation. MADHU CHETRI: Project Chief, National Trust for Nature Conservation-Gaurishankar Conservation Area Project. HARIBHADRA ACHARYA: Chief Conservation Officer, Department of National Parks & Wildlife Conservation-Chitwan National Park. PRAKASH SIGDEL: Wildlife Biologist, Zoological Society of London-Nepal Office. DIPENDRA ADHIKARI: Wildlife Biologist, Nepal Conservation & Research Center, Chitwan. NARESH SUBEDI: Department Head, Species Conservation, National Trust for Nature Conservation-Central Office. BABURAM LAMICHHANE: Office Incharge, National Trust for Nature Conservation-Biodiversity Conservation Center.

**Author contributions:** PRR, MC, HA, NS & BL: conceptualize the study; PRR, PS, DA: conducted field survey, PRR, PS, DA: compiled and cleaning the data; PRR, MC: finalized the manuscript; MC, HA, NS & BL: supervised the study.

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## INTRODUCTION

Striped Hyena *Hyaena hyaena* occupy a large geographic range that encompasses eastern Africa, central Asia, the Indian subcontinent, Turkey, and central Tanzania (Mills & Hofer 1998). Hyenas are solitary nocturnal scavengers, feeding on carcasses, dead remains, and waste produced by human communities (Yirga et al. 2014). They survive 10–12 years in the wild. Hyenas are recorded at up to 1,750 m in Nepal (Bhandari & Bhusal 2017) and 3,300 m in Pakistan (Alam et al. 2014). In Nepal, hyenas are distributed in the lowland areas (protected & outside of the protected areas) of the Tarai and midhill regions, and there are estimated to be fewer than 100 individuals in the wild (Jnawali et al. 2011).

Hyenas are a nationally protected priority species under the National Parks and Wildlife Conservation Act, 1973 and listed as Endangered in the National Red List Series (Jnawali et al. 2011). They are listed as the Near Threatened category in the IUCN Red List of Threatened Species, and believed to be fewer than 10,000 mature individuals worldwide (AbiSaid & Dloniak 2015). Their population is declining across its geographic range due to habitat alteration (Ripple et al. 2014) and facing various anthropogenic pressure, habitat loss & fragmentation, prey population depletion, poaching & illegal trade, retaliatory killing, and competition with other large carnivores species like tigers, and leopards (Inskip & Zimmermann 2009). Their historic and present range including their distribution, population, habitat, ecology, and diet preferences are little known due to limited study (Singh et al. 2010). Although, several national surveys for tigers and their prey base monitoring were conducted before 2015, there was no photographic evidence and scientific documentation of the presence of hyenas in the Parsa National Park (PNP). This article presents camera trap records of hyenas in PNP for the first time. Mammals associated with hyenas that were captured during the survey period are also discussed. It is hoped that this study will bring attention of the government and concerned conservation agencies to conduct further ecological studies of this important scavenger.

## MATERIALS AND METHODS

### Study Area

The study area in PNP (Figure 1) is located in the south-central lowland areas of the Tarai region (27.25–27.55 °N, 84.68–84.97 °E). It covers an area of 627.39

km<sup>2</sup> and is 188 km (south-west) from Kathmandu. The park covers three districts: Parsa (70%), Bara (18%), and Makwanpur (12%). Historically, Parsa served as a vacation and hunting site for the Rana Rulers of Nepal. It was established as a wildlife reserve in 1983 encompassing an area of 499 km<sup>2</sup> to protect the habitat of Asian Wild Elephants. In 2005, the Government of Nepal (GoN) declared the Buffer Zone area (285 km<sup>2</sup>) around the reserve and implemented community-based conservation programs. The GoN extended the reserve area by 128 km<sup>2</sup> in 2015 in the eastern part (named as the extension area), highlighting that this forest area serves as an important habitat for globally threatened animals including tigers and rhinos. There have been past records of tigers, their cubs and other animals in camera trap monitoring conducted in the extension area (PNP 2020). In 2017, the reserve was gazetted as a national park to preserve and improve the habitat of wildlife and support landscape-level conservation. The PNP provides an extended habitat for the spill-over population of megafauna as it adjoins to Balmiki Tiger Reserve of Bihar state of India in the south and Chitwan National Park in the west.

The PNP harbors diverse animals including Bengal Tiger *Panthera tigris tigris*, Common Leopard *Panthera pardus*, Striped Hyena *Hyaena hyaena*, Dhole *Cuon alpinus*, Golden Jackal *Canis aureus*, Indian Fox *Vulpes bengalensis*, and Honey Badger *Mellivora capensis*. Wild herbivore prey species include Gaur *Bos gaurus gaurus*, Sambar *Rusa unicolor*, and Nilgai *Boselaphus tragocamelus*, Spotted Deer *Axis axis*, Barking Deer *Muntiacus vaginalis*, and Wild Pig *Sus scrofa*. Non-human primates include langur *Semnopithecus* sp. and Rhesus Monkey *Macaca mulatta*. 37 mammal species, 31 butterflies, 13 reptiles, and 490 birds were recorded in the park (PNP 2018). The forests of PNP and its buffer zones consist of 70% vegetation which is dominated by Sal *Shorea robusta* forest, and the vegetation can best be described as a subtropical, dry, deciduous forest with colonizing wild sugarcane *Saccharum spontaneum*, and Cogon Grass *Imperata cylindrica* on the dry riverbeds and the floodplains, to a climax Sal forest on Bhabhar and hillsides. In the Churia hills, Chir Pine *Pinus roxburghii* grows, and along the streams and river sides, Khair *Acacia catechu*, Sissoo *Dalbergia sissoo*, and Silk Cotton Tree *Bombax ceiba* occur. Sabai grass *Enlaliopsis binata*, a commercially important grass, grows well on the southern face of the churia hills. The elevation of the park ranges between 100–950 m and lies in a humid subtropical climatic zone with a record of the mean minimum temperature of 7°C to mean maximum

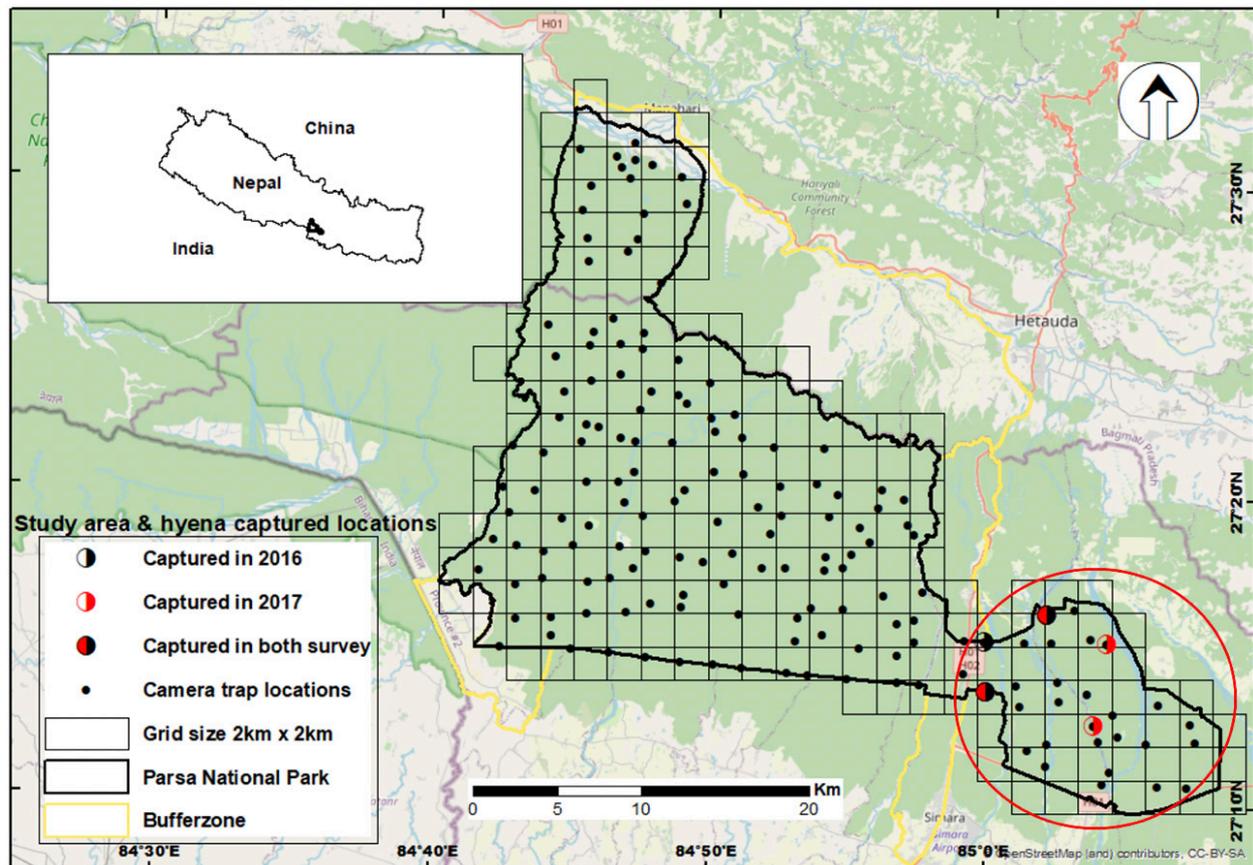


Figure 1. Survey grids with hyenas captured locations in multiple years in Parsa National Park, Nepal. The circle shown on the map is an extension area of the park.

temperature of 39°C; 83% of the total precipitation occurs mainly from June to September (PNP 2018).

### Camera trap survey

Two camera trap surveys were carried out in PNP. The first was in 2016 (Survey I) and the second survey in 2016–2017 (Survey II). Both surveys covered the whole area of the national park, which was divided into three blocks. The camera trapping survey was conducted in three deployment phases to manage the availability of skilled manpower, camera number, financial constraints, and surveyed all blocks. We overlaid a total of 167 systematic grids 2 x 2 km in area. A pair of camera traps was placed on each systematic grid cell, set 4–6 m apart, 45–60 cm above the ground surface for 21 days. Wegge et al. (2004) recommended that a trapping duration at each set of camera traps (i.e., sampling occasion) should be at least 15 days (nights), with a distance between neighboring traps not exceeding 2 km. The cameras were operational and functional 24 hours of a day, and were monitored every 1–3 days of deployment to check their performance, battery status and photo capture,

and to collect data of animal tracks and movements in the areas. Panthera V5 cameras were used in this study. The same method was used for both years. Images captured at an interval of 30 minutes were considered independent events (Silver et al. 2004; Thapa et al. 2014). The trapping rate was calculated by the number of independent images/total number of captured images per 100 trap nights (Karanth & Nichols 2002). We also examined associated species and discuss their presence.

### RESULTS

A total of 158 and 157 cameras were functional in Survey I & Survey II, respectively. The total trap efforts were 3,318 in the first survey and 3,297 in the second survey. We obtained 15 images of hyenas from five grids (Survey I–III grids: 8 images, Survey II– 4 grids: 7 images) and captured four independent hyena images in two consecutive surveys (Image 1A,B). We obtained images of a hyena from the camera traps installed at the eastern part of the national park at Mahendra

**Table 1. Hyena captured details in Parsa National Park, Nepal.**

	Parameters	Survey period	
		2016 (Feb–May)	2016–2017 (Nov–Feb)
1	Total survey area	627.39 km <sup>2</sup>	627.39 km <sup>2</sup>
2	Camera trap location	158	157
3	Sampling occasion	21	21
4	Trap efforts	3318	3297
5	Hyena captured grids	3	4
6	Independent capture events	4	4
7	Capture rate/100 traps	0.120	0.121

**Image 1. Striped Hyena captured on camera in Parsa National Park, Nepal: A—Right flank | B—Left flank.**

Highway (Amlekhgunj Pathlaiya Section) and the newly extended area (Figure 1). The capture rate of hyenas was calculated at 0.120 and 0.121 per 100 trap nights in Surveys I and II, respectively (Table 1). We captured hyenas in camera traps located 1 to 1.5 km away from the nearest human settlement and water sources of the extension area (Table 2). Altogether, 17 mammal species were recorded in hyena capture grids during the two

consecutive survey periods (Table 3).

## DISCUSSION

We recorded the first photographic evidence of a Striped Hyena in Parsa National Park, Nepal. A recent paper which was based on a literature review also mentioned the presence of hyena in PNP (Neupane et al. 2021) but lacks photographic evidence. Camera trap monitoring of tigers and their prey in PNP during surveys conducted in 2009, 2013, and 2014, did not detect the presence of hyenas. In 2016 and 2017, we captured hyena images in grid at the eastern part (extension area) of PNP near human settlements and water sources (Table 2), consistent with other reports (Hofer 1998) that hyenas frequently forage on garbage and carrion near human habitations (Tourani et al. 2012; Alam et al. 2014; AbiSaid & Dloniak 2015). Similarly, hyenas choose disturbed/fringe habitats due to the availability of easy food sources (Singh et al. 2014). Halkhoriya Daha (lake) is the major water source of the extension area of PNP and supports various species of wildlife. The availability of water sources might have attracted hyenas in the area.

In PNP, the park authorities are conducting habitat management activities (e.g., grassland management, patrolling, fireline maintenance, pond construction) and enabling law enforcement (DNPWC & DFSC 2018) which may provide adequate food for the hyena. Such activities in the park might help hyenas and their associated species in recolonizing the area. Also, the northern part of PNP is contiguous to the churia hills that encompass hilly terrain habitats and thus may provide optimal refuges and denning sites for hyenas. We recorded 17 mammal species in hyena image capture locations during two survey years (Table 3), with tiger and leopard being the major sympatric carnivores. Hyenas are directly or indirectly affected by decreasing natural food resources (Khorozyan et al. 2011), high competition, and increased anthropogenic pressure. The latest tiger monitoring reveals that the Tiger numbers in PNP are increasing (Lamichhane et al. 2018), which might push hyenas more into fringe areas in the future, although hyenas occur sympatrically with tigers in various parts of India (Harihar et al. 2010). Hyenas were not recorded in the camera traps deployed in the core areas of the western part of the national park. This might be due to inadequate water resources, preferred habitat and prey availability, and competition with carnivore species such as tigers and leopards. Hyenas are very susceptible to

**Table 2. Hyena captured location details of Parsa National Park, Nepal.**

Captured Grid ID	Captured year	Habitat type	Settlements distance (km)	Distance to water sources (km)
P16	2016	Sal forest	6.3 (Pathlaiya) 2.1(Amlekhgunj)	1
P17	2016 & 2016/2017	Sal forest	4.9 (Amlekhgunj) 3.6 (Pathlaiya)	0.5
R15	2016 & 2016/2017	Sal forest	3.6 (Dammarpur) 1.5 (Chakari )	0.5
S18	2016/17	Riverbed	4.93 (Piluwa) 4.76 (Ratanpuri)	0.1
T16	2016/17	Sal forest	2.6 (Dammarpur) 2.2 (Ratanpuri)	0.7

**Table 3. Associated mammalian species recorded in hyena captured grid cells during the survey period.**

	Species name	Scientific name	Survey period	
			2016 (Feb–May)	2016–2017 (Nov–Feb)
1	Four-horned Antelope	<i>Tetracerus quadricornis</i>	√	√
2	Barking Deer	<i>Muntiacus vaginalis</i>	√	√
3	Spotted Deer	<i>Axis axis</i>	√	√
4	Indian Hare	<i>Lepus nigricollis</i>	√	√
5	Wild Boar	<i>Sus scrofa</i>	√	√
6	Bengal Fox	<i>Vulpes bengalensis</i>	√	√
7	Golden Jackal	<i>Canis aureus</i>	X	√
8	Jungle Cat	<i>Felis chaus</i>	√	√
9	Leopard	<i>Panthera pardus</i>	√	√
10	Leopard Cat	<i>Prionailurus bengalensis</i>	√	√
11	Tiger	<i>Panthera tigris</i>	√	X
12	Indian Grey Mongoose	<i>Urva edwardsii</i>	X	√
13	Terai Langur	<i>Semnopithecus hector</i>		X
14	Rhesus Monkey	<i>Macaca mulatta</i>	√	√
15	Indian Crested Porcupine	<i>Hystrix indica</i>	X	√
16	Honey Badger	<i>Mellivora capensis</i>	X	√
17	Large Indian Civet	<i>Viverra zibetha</i>	√	√

√—presence | X—absence.

accidental or targeted poisoning (AbiSaid & Dloniak 2015). Recently, Adhikari et al. (2018) recorded a road kill of hyena outside the eastern part of PNP nearby Nijgadh City which is contiguous to the PNP boundary. Similarly, other top carnivore species predation to livestock accelerates the retaliatory killing which may directly or indirectly affect the hyena population.

The overall trapping rate of hyenas in our study was 0.120 and 0.121 in 2016 and 2017, respectively. The low trapping rate implies that the population is very low in the region. This may be due to the presence of a low prey population in the area. Also, the prey density estimates in PNP and its adjoining forests was 22 (SE 3.8)/ km<sup>2</sup>, which

is rather lower than the neighbouring Chitwan National Park (DNPWC & DFSC 2018). Similarly, the Government of Nepal conservation organization, and communities are carrying out conservation activities especially focusing on tigers and rhinos in lowland protected areas. This has limited the conservation and research priority to other important species (Katuwal et al. 2018) including hyenas. The extension area of PNP can be an ideal site for hyenas if the concerned authorities continue their efforts on habitat management activities and law enforcement. The awareness activities and conservation programs in the buffer zone area of the national park are solely needed for the long-term conservation of hyenas.

Furthermore, a detailed ecological study particularly focusing on hyenas is required for estimating their abundance, distribution, diet preferences, and assessing current conservation threats. This information will be crucial in future for designing hyena conservation plans in the region.

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