



Mammalian diversity of Sunabeda Wildlife Sanctuary, Odisha, India

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ABSTRACT

A camera trap survey was conducted for terrestrial mammals in Sunabeda Wildlife Sanctuary from November to December 2018. Camera traps were deployed at 35 locations comprising of one pair camera trap which accumulated data over 875 camera trap-days. A total of 2650 photographs were captured out of which 632 photographs of mammals belonging to 12 families and 22 species were recorded. The leopard *Panthera pardus* was the most frequently captured species and had high relative abundance (RAI =7.31) among the other carnivore species and the Ruddy mongoose, *Herpestes smithii* (RAI =0.69) were represented by a relatively low abundance. Frequency of various anthropogenic activities related to movement of livestock, feral dogs and human traffic accounted for maximum photo capture and found to be negatively correlated with mammalian species. This result highlighted the fact that all mammalian species presence occurred in the sanctuary and were confirmed by the photographs captured, which resulted in knowing the distribution pattern of the species. In the study, assessing mammalian prey relative abundance and distribution are required to further manage the threatened and endangered species of the sanctuary.

Key words : Camera trap, livestock pressure, mammalian diversity, relative abundance index, Sunabeda

INTRODUCTION

Camera trap, which have been used widely in wildlife studies (Wemmer et al., 1996), are ideal for identifying the species in habiting a particular area, monitoring relative and absolute abundance of species and studying activity pattern (Karanth, 1995; Das et al., 2016). Camera traps have become an important tool for inventorying and estimating species diversity at a site (Cutler and Swann, 1999; Silveira et al., 2003; O'Connell et al., 2011). Camera trapping is a widely popular technique to study the presence and distribution of wildlife. While there are several types of camera traps, all models have the same basic principle: a photo (and / or video) camera protected by some sort of weather proof housing, coupled to a mechanism that allows the camera to be triggered automatically

when an animal moves in front of it. Since camera traps were first used to estimate the density of tiger *Panthera tigris* populations in India (Karanth, 1995). This methodology has been widely used to study a variety of species: leopards *Panthera pardus* (Henschel and Ray, 2003; Kostyria et al., 2003). Due to increasing anthropogenic pressure, half the world's known mammalian species have declined and almost one among five are clearly at the verge of extinction (Anon, 2016). Although the use of Relative Abundance Index (RAI) generated from camera trap encounter rates is controversial as it gets biased with animal body mass and study design (Sollmann et al., 2013), there are examples of a linear relationship between RAI with abundance, estimation, especially of cryptic species (Karantha and Nichols, 1998; Datta et al., 2008; Rovero and Marshall, 2008; Jenks et al., 2011; Gonthier and

Castañeda, 2013; Lahker, et al., 2018). In recent years, camera trapping is increasingly used for species inventories and population abundance and has been widely used in the state of Odisha as well (Debata et al., 2015; Palei et al., 2015; Kar et al., 2018; Debata and Swain, 2018; Mishra et al., 2018; Palei et al., 2018 a,b; Palei et al., 2019 a,b; Debata and Swain, 2020).

In the western part of Odisha state, large stretch of dry deciduous natural shrubs are contiguous with Chhattisgarh forest and it has been degraded due to open coal mining. Sunabeda used to have good numbers of endangered wild buffalo (*Bubalus arnee*) till 1960s. At present, they are found in Udanti Wildlife Sanctuary in Chhattisgarh, about 20 km away, but there is a Patdhara Reserve Forest of Sunabeda Wildlife Sanctuary (Kotwal, 1997). Hunting, cattle borne disease and habitat destruction led to extinction of Wild Buffalo in the region. Efforts should be made to improve the habitat so that the wild buffalo can come back to Sunabeda using this corridor.

In the present study, the camera trap survey was carried out in the tropical dry deciduous forest of Sunabeda Wildlife Sanctuary in the western parts of Odisha to estimate mammalian species and their relative abundance and occurrence of anthropogenic disturbance.

MATERIALS AND METHODS

The sanctuary is located in the Western Odisha adjacent to the interstate border of Odisha and Chhattisgarh and situated between Latitude 20° 24' N to 20° 44' N and Longitude 82° 20' E to 82° 34' E located in the Nuapada District of Odisha (Fig. 1). The entire sanctuary area comes under the administrative control of Sunabeda Wildlife Division with headquarters at Nuapada in Nuapada district. This Wildlife Division has three ranges, i.e. Nuapada, Komna, and Sunabeda having headquarters at Nuapada, Komna, and Sunabeda, respectively. It was declared as a Wildlife Sanctuary in 1983 with total geographical area of 600 sq. km. This sanctuary comes under

the Deccan Peninsular Zone of the Indian Biogeographical Zone and Eastern Plateau Province and Chhattisgarh -Dandakaranya Sub-Division. The mean daily temperatures of winter range from 6°C to 20°C and that of summers range from 28°C to 47°C. The average annual rainfall varies from 600 to 1400 mm. Most of the villages are outside the sanctuary and most of the people belong to tribal community. Their activities inside forest are grazing livestock and collection of forest products (e.g. fodder for livestock, non-timber). The forest division is dominated by northern dry mixed deciduous forest, dry peninsular Sal forest and dry Teak forest (Champion and Seth, 1968).

These types of forests are seen in all the forest blocks and constitute about 75% of the crop found over all types of geological formations. The top canopy is open and irregular frequented with numerous large gaps. Trees in this type of forests have relatively shorter boles and poor form. The trees under this type remain completely leafless for a period of about four months beginning from the month February to the middle of June. With the onset of monsoon, the forests change their appearance with green foliage with their crowns and moderately dense undergrowth. In these forests the top level consists of mainly the following species. Asan (*Terminalia tomentosa*), dhaura (*Anogeissus latifolia*), bija (*Pterocarpus marsupium*), haldu (*Adina cordifolia*), mundi (*Mitragyna parviflora*), kusum (*Schleichera oleosa*), pahadi sissoo (*Dalbergia latifolia*), harida (*Terminalia chebula*), bahada (*Terminalia bellirica*), moi (*Garuga pinnata*), teak (*Tectona grandis*), kendu (*Diospyros melanoxylon*), sidha (*Lagerstroemia parviflora*), simul (*Bombax ceiba*) and jamun (*Syzygium cumini*). The tree species in the middle canopy are *D. latifolia*, *Morinda tinctoria*, *Buchanania lanzan*, *Cleistanthus collinus*, *Bridelia retusa*, *Acacia arabica*. The ground flora contains *Indigofera pulchella*, *Phoenix acaulis*, *Woodfordia fruticosa*, and *Holorrhena antidysentrica*. *Butea superba*, *Ventilago calyculata*, *Smilax macrophylla*, *Millettia auriculata* and *Bauhinia vahlii* etc. are the dominant climbers found in this type of forest.

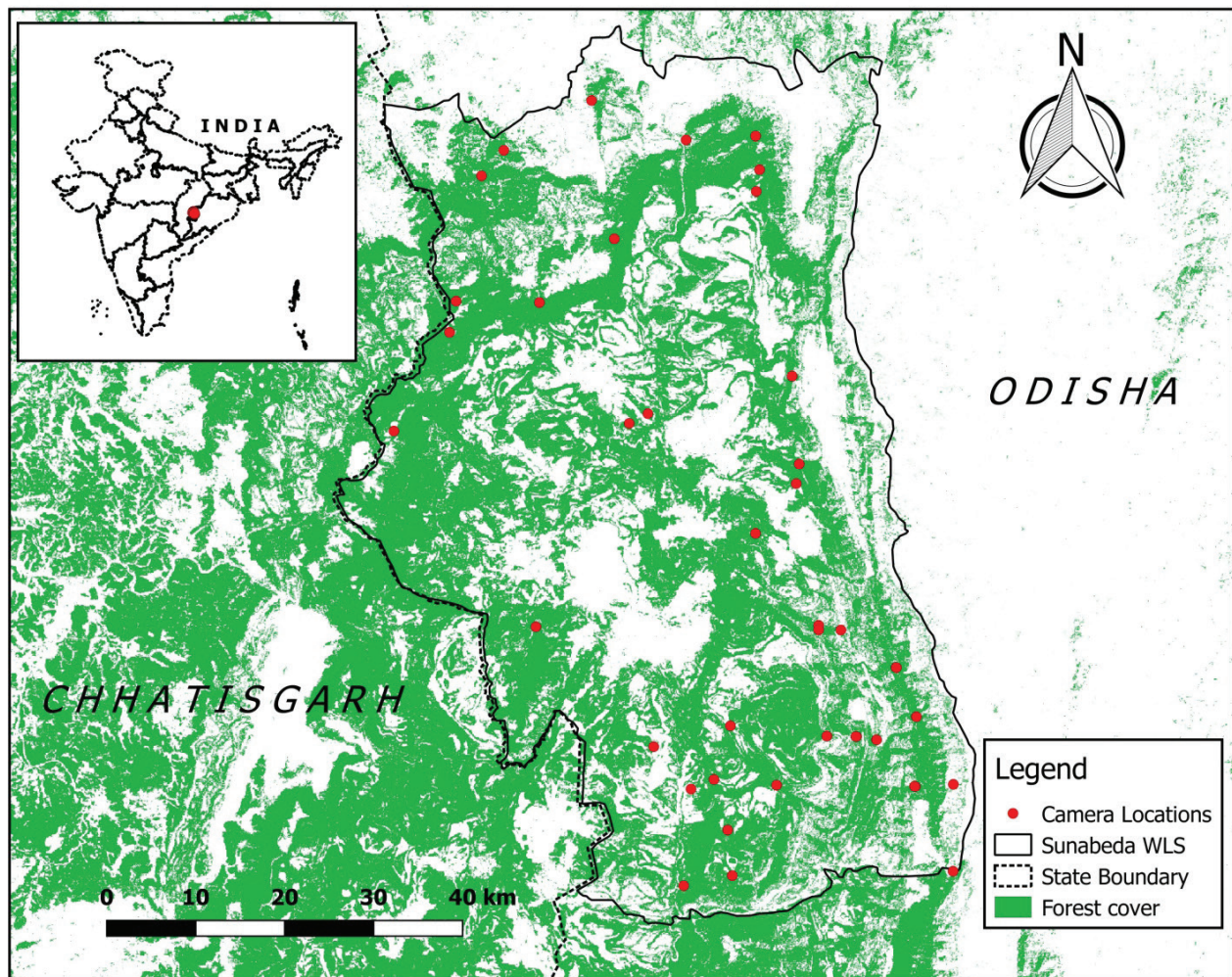


Fig. 1. Study area showing locations of camera traps in the Sunabeda Wildlife Sanctuary, Western Odisha.

An extensive reconnaissance survey was carried out in three wildlife forest ranges within Nuapada, Komna, and Sunabeda Range of Sunabeda Wildlife Sanctuary. During the survey, signs of carnivores, *viz.* scats, pug-marks, claw marks, scraps and scent marks, were recorded and geo-referenced using a geographical positioning system (GPS). To assess the status of carnivores and herbivores and their prey species in the study area, 70 numbers of motion sensor camera traps (Cuddeback Model C1) were used to carry out a mammal survey from 13th November 2018 to 7th December 2018 covering all the three ranges Sunabeda Wildlife Sanctuary. Camera traps were

predominantly set along forest roads, game trails and footpaths. All camera traps were strapped to trees approximately 45 cm above ground. At each location, a pair of traps on either side of the path facing each other was set up to photograph simultaneously both flanks of the animal passing between the cameras. Each location consists one pair camera trap and set to operate 24 hours with programmed to delay sequential photographs by 30 second delay time for capturing for 25 days, yielding a total of 875 trap nights. Each camera traps were checked at least once a week for battery level, positioning and to replace memory (SD) cards. Each and every photograph was manually checked

to identify the species. Total sampling effort was calculated as the sum of the effective days across all stations that each camera was functioning (Boitani and Powell, 2012). Photos separated by at least 30 minutes were considered as independent events (Ohashi et al., 2013; Guo et al., 2017). Data on large and medium sized mammals, bird, reptiles, birds, human traffic and livestock including date time, year and behavior were collated from camera trap photographs. Relative abundance was calculated as $RAI = A/N \times 100$

Where A is the total number of detections of a species by all cameras and N is the total number of camera trap days by all the cameras throughout the study area following Jenks et al. (2011). All photographs of animals captured in the camera traps were identified to the species level and the time and date of the capture (inbuilt in the camera) were noted. Consequently, each photo was rated as a dependent or independent event. All camera trap pictures were screened for the presence of animals and all data was entered in an Office Access 2010 database. Identification of the animals was done using the field guide (Menonn, 2016).

RESULTS AND DISCUSSION

A total of 35 camera trap locations with an effort of 875 trap nights with 2650 photographs were captured. Out of which 632 photographs were of mammals belonging to 22 mammalian species from 12 families. The mammals reported were from six carnivore species, nine herbivore species, three omnivore species, two primate species, two rodent species and four bird species. Table 2 shows all identified species (common and scientific names), the total number of pictures obtained, the RAI for each species as well as the total number of locations where each species was photographed. Out of the twenty two species of mammals, two species have been categorized as Endangered, two species as Vulnerable, and one species as Near Threatened sixteen species as Least Concern and 1 species as Lower risk as per the IUCN Red list of Threatened species (IUCN, 2017; Table 1). Out of all the photographs, majority of them were anthropogenic i.e. movement of livestock, feral

dog and human traffic (72%; n=1917), whereas the rest (24%; n=632) were wildlife, mostly herbivore mammals (13%; n=344) followed by carnivore mammals (7%; n=191), omnivore mammals (4%; n=97), birds (4%; n=101) (Fig. 3).

In Sunabeda Wildlife Sanctuary, during the camera trap survey we recorded the large and medium-sized mammalian species. The large carnivores, *Panthera pardus*, were detected in all locations in contiguous forest and represented high relative abundance (RAI = 7.31) among the carnivore while the Indian grey wolf (*Canis lupus*) was among the omnivores (RAI = 6.40) and the Hanuman Langur (*Presbytis entellus*) (RAI = 6.17). Besides that, camera traps also captured four bird species including the Jungle fowl (*Gallus gallus*) (RAI=5.37) followed by Indian peafowl (*Pavo cristatus*) (RAI=4.34) and Grey francolin (*Francolinus pondicerianus*) (RAI=1.37) and Painted spurfowl (*Galloperdix lunulate*) was the minimum photographed species (RAI=0.46) (Fig. 2). Ruddy mongoose (*Herpestes smithii*) (RAI=0.69) was the rarest species photo-captured followed by Nilgai (*Boselaphus tragocamelus*) (RAI=0.91) and striped hyaena (*Hyaena hyaena*) (RAI=0.91). Leopard, *Panthera pardus*, was distributed throughout the sanctuary with relatively higher concentration in the periphery of the core zone in moderately dense forests. However, few captures were also obtained towards the eastern side of the sanctuary in the buffer zone. Grey wolf (*Canis lupus*) showed patchy distribution within the sanctuary with higher concentration of photo-captures within the moderately dense forest and open forest within the buffer area. Jungle cat (*Felis chaus*) was photo captured at ten locations, mostly on the buffer area of the sanctuary. Sambar (*Rusa unicolor*) and cheetal (*Axis axis*) photo-captures was recorded within moderately dense forests and the open forests of the core zone. Apart from this, few captures were also found in the very dense forests. Sloth bear (*Melursus ursinus*) was distributed throughout the sanctuary with higher concentration of photo-captured in the central and eastern side of the sanctuary. Four-horned antelope (*Tetracerous quadricornis*) was

distributed throughout the sanctuary with higher concentration of photo-captures in the core zone of Sunabeda plateau. Golden jackal (*Canis aureus*) was distributed throughout the western part of the buffer zone in the sanctuary with relatively higher concentration of photo-captures on the Patadhara, Gatibeda and Manikagarh and the adjoining of Sunabeda plateau. Hanuman langur (*Presbytis entellus*) and rhesus macaque (*Macaca mulatta*) were distributed throughout the sanctuary with higher concentration of photo-captures towards the north and north-western boundary of the core and in moderately dense forests of the buffer zone. Grey mongoose (*Herpestes edwardsii*), ruddy mongoose (*Herpestes smithii*) common palm civet (*Paradoxurus hemaphroditus*), small Indian civet (*Viverricula indica*), honey badger (*Mellivora capensis*) and Indian hare (*Lepus nigricollis*), was photo captured at very few locations, mostly on the inside of the sanctuary.

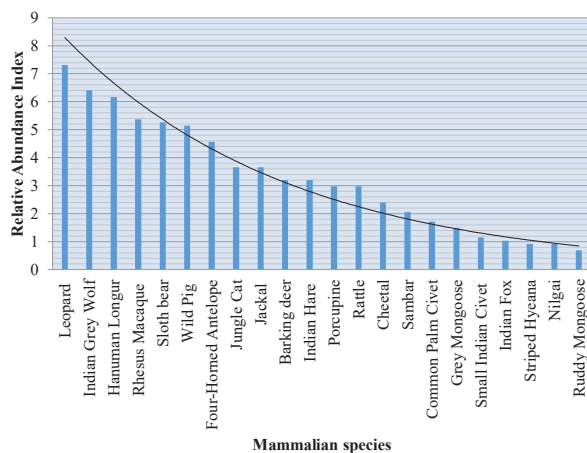


Fig. 2. Relative abundance index of different mammals in Sunabeda Wildlife Sanctuary from November to December 2018.

During the camera traps period various anthropogenic activity including human traffic and livestock photographs captured. As per activity cattle, goat, buffalo, camels, horses, sheep and donkeys was the maximum photograph activity (RAI=85.94) followed by private vehicle (RAI=40.69), villagers (RAI=37.14), department vehicle (RAI=20.80), forest department staff (RAI=16.00), feral dog (RAI=14.40) and poachers

(RAI=4.11). It is observed that detection rate and relative abundance index of livestock was higher than any other species photo-captured in Sunabeda Wildlife Sanctuary and is indicative of a high level of anthropogenic disturbances of the sanctuary. As per report of the Wildlife Management Plan of the sanctuary (Banchhur, 2007), wild buffalo (*Bubalus arnee*), Indian gaur (*Bos gaurus*), wild dog (*Cuon alpinus*), leopard cat (*Prionailurus bengalensis*), fishing cat (*Prionailurus rubiginosus*), pangolin (*Manis crassicaudata*) and mouse deer (*Moschiola indica*) are distributed all over the sanctuary, but there is no photo captured during the camera trap period and also there is no photographs captured of tiger (*Panthera tigris*). Since it is adjacent to Udanti-Sitanadi Tiger Reserve of Chhattisgarh State, it can be a potential site for tigers to breed in the wild. Steps to expedite the process of declaration of Sunabeda Wildlife Sanctuary to Sunabeda Tiger Reserve shall change the scenario in terms of management which will emerge the area as a potential tiger reserve. The sanctuary requires intensive management input in terms of habitat management and law enforcement for increasing the prey base. It is well connected to Udanti-Sitanadi Tiger Reserve in the west and has remote connectivity with the Indravati Tiger Reserve of Chhattisgarh. Better management interventions such as minimizing human disturbance and prey augmentation would be required for improving the wildlife conservation status for this area (Jhala et al., 2020). Hence, this landscape has been identified as a potential tiger meta-population landscape and requires intensive conservation efforts for better gene pool exchange. Connectivity between these sites should be protected for the future tiger and wildlife conservation. About 52 villages, with 11572 human population and 8303 cattle population fragment this sanctuary. The villagers subsist on forest products to a great extent, as they have land holdings with poor yield.

Since Sunabeda Wildlife Sanctuary is connected with Chhattisgarh state in the western side, the nomads from other adjacent states bring their livestock in form of camels, horses, goats sheep, donkeys, cows and buffaloes to graze in the

sanctuary causing a severe biotic pressure (Fig. 26). Also, the villagers in the plateau use the sanctuary as their grazing ground. This was clearly proved during the camera trap survey. Grazing has affected the regeneration of forest in the sanctuary which may lead to human-animal interface. In the current case the staff should be vigilant along the border to prevent any intrusion of livestock. This may lead to better connectivity with Udanti-Sitanadi Tiger Reserve and further to Indravati Tiger Reserve. Long term management and conservation efforts should be taken to overcome this issue. Livestock movement in the sanctuary may spread diseases from domestic to wild animals. Due to grazing in the sanctuary there may be shortage of food for herbivores which may directly affect the population of large cats. During grazing cattle lifting by large cats cannot be ruled out along with human causality.

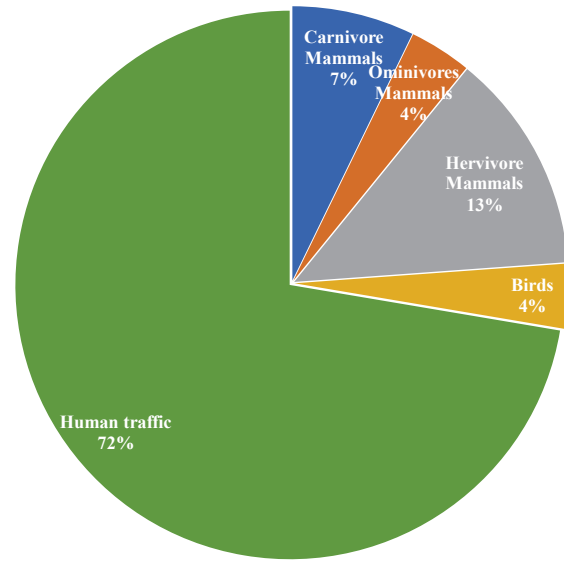


Fig. 3. Different wildlife species and others activities based on camera trap photographs captured in Sunabeda Wildlife Sanctuary



Fig. 4. Leopard, *Panthera pardus*



Fig. 5. Jungle cat, *Felis chaus*



Fig. 6. Indian grey wolf, *Canis lupus*



Fig. 7. Jackal, *Canis aureus*



Fig. 8. Hycana, *Hyaena hyaena*



Fig. 9. Indian fox, *Vulpes bengalensis*



Fig. 10. Sloth bear, *Melursus ursinus*



Fig. 11. Wild pig, *Sus scrofa*



Fig. 12. Porcupine, *Hystrix indica*



Fig. 13. Nilgai, *Boselaphus tragocamelus*



Fig. 14. Sambar, *Rusa unicolor*



Fig. 15. Cheetal, *Axis axis*



Fig. 16. Four horned antelope, *Tetracerus quadricornis*



Fig. 17. Barking deer, *Muntiacus muntjak*



Fig. 18. Honey badger, *Mellivora capensis*



Fig. 19. Indian hare, *Lepus nigricollis*



Fig. 20. Rhesus macaque, *Macaca mulatta*

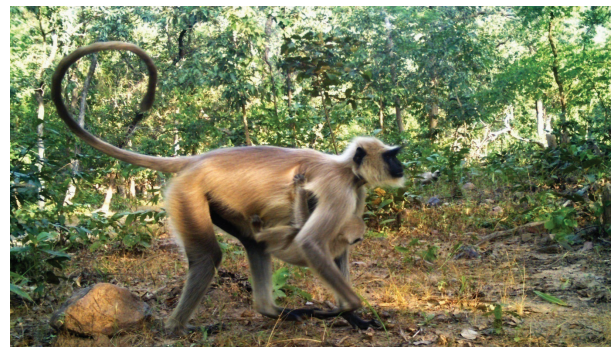


Fig. 21. Hanuman langur, *Presbytis entellus*



Fig. 22. Small Indian civet, *Viverricula indica*



Fig. 23. Common palm civet, *Paradoxurus hermaphroditus*



Fig. 24. Grey mongoose, *Herpestes edwardsi*



Fig. 25. Ruddy mongoose, *Herpestes smithii*



Fig. 26. Activities of livestock in Sunabeda Wildlife Sanctuary, Nuapada

Table 1. Comparative Relative Abundance Index (RAI) of different wildlife species and others based on camera trap photographs in Sunabeda Wildlife Sanctuary during the field-work with their current IUCN status and type of encounter

Sl.	Common Name	Families	Scientific Names	WPA Status	IUCN Status	N Camera trap stations with occurrence	%	Total Photo Captured	RAI
1	Leopard	Felidae	<i>Panthera pardus</i>	Schedule-I	VU	15	42.86	64	7.31
2	Jungle cat	Felidae	<i>Felis chaus</i>	Schedule-II	LR	10	28.57	32	3.66
3	Indian grey wolf	Canidae	<i>Canis lupus</i>	Schedule-I	LC	8	22.86	56	6.40
4	Jackal	Canidae	<i>Canis aureus</i>	Schedule-II	LC	5	14.29	32	3.66
5	Striped hyeana	Canidae	<i>Hyaena</i>	Schedule-III	NT	8	22.86	8	0.91
6	Indian fox	Canidae	<i>Vulpes bengalensis</i>	Schedule-II	LC	5	14.29	9	1.03
7	Sloth bear	Ursidae	<i>Melursus ursinus</i>	Schedule-I	EN	17	48.57	46	5.26
8	Wild pig	Suidae	<i>Sus scrofa</i>	Schedule-III	LC	20	57.14	45	5.14
9	Porcupine	Hystriidae	<i>Hystrix indica</i>	Schedule-IV	LC	7	20.00	26	2.97
10	Nilgai	Bovidae	<i>Boselaphus tragocamelus</i>	Schedule-III	LC	3	8.57	8	0.91
11	Four-horned antelope	Bovidae	<i>Tetracerus quadricornis</i>	Schedule-I	EN	30	85.71	40	4.57
12	Sambar	Cervidae	<i>Rusa unicolor</i>	Schedule-III	VU	7	20.00	18	2.06
13	Cheetal	Cervidae	<i>Axis axis</i>	Schedule-III	LC	2	5.71	21	2.40
14	Barking deer	Cervidae	<i>Muntiacus muntjak</i>	Schedule-III	LC	5	14.29	28	3.20
15	Honey badger	Mustelidae	<i>Mellivora capensis</i>	Schedule-I	LC	18	51.43	26	2.97
16	Rhesus macaque	Cercopithecidae	<i>Macaca mulatta</i>	Schedule-II	LC	12	34.29	47	5.37

17	Hanuman langur	Cercopithecidae	<i>Presbytis entellus</i>	Schedule-II	LC	9	25.71	54	6.17
18	Small indian civet	Viverridae	<i>Viverricula indica</i>	Schedule-II	LC	3	8.57	10	1.14
19	Common palm civet	Viverridae	<i>Paradoxurus hermaphroditus</i>	Schedule-II	LC	5	14.29	15	1.71
20	Grey mongoose	Herpestidae	<i>Herpestes edwardsii</i>	Schedule-II	LC	2	5.71	13	1.49
21	Ruddy mongoose	Herpestidae	<i>Herpestes smithii</i>	Schedule-II	LC	3	8.57	6	0.69
22	Indian hare	Leporidae	<i>Lepus nigricollis</i>	Schedule-IV	LC	5	14.29	28	3.20
Birds									
23	Indian pea fowl	Phasianidae	<i>Pavo cristatus</i>	Schedule-I	LC	15	42.86	38	4.34
24	Red jungle fowl	Phasianidae	<i>Gallus gallus</i>	Schedule-IV	LC	18	51.43	47	5.37
25	Painted spurfowl	Phasianidae	<i>Galloperdix lunulata</i>	Schedule-IV	LC	2	5.71	4	0.46
26	Grey francolin	Phasianidae	<i>Francolinus pondicerianus</i>	Schedule-IV	LC	5	14.29	12	1.37
Human traffic and livestock									
27	Forest department staff					25	33.78	140	16.00
28	Department vehicle					15	20.27	182	20.80
29	Private vehicle for villagers					26	35.14	356	40.69
30	Villagers					28	37.84	325	37.14
31	Poachers					12	16.22	36	4.11
32	Cattle, goat and buffalo					35	47.30	752	85.94
33	Feral dog					21	28.38	126	14.40

(EN-Endangered, NT-Near Threatened, VU- Vulnerable, LC- Least Concern, LR-Lower Risk, RAI- Relative Abundance Index, IUCN-International Union for Conservation of Nature, WPA-Wildlife Protection Acts)

In the present context for management of habitat and livestock, there is immediate need to strengthen the protection activities to control on livestock grazing by deployment of staff at the entry point in form of random patrolling. Awareness campaign along the forest fringe villages can be the way forward to the issue.

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