Journal of Animal Diversity

Online ISSN 2676-685X

Volume 4, Issue 3 (2022)

Research Article

http://dx.doi.org/10.52547/JAD.2022.4.3.7

A preliminary study on relative abundance of wild mammals based on camera trap in Balaram-Ambaji Wildlife Sanctuary, Gujarat State, India

Vasantkumar M. Rabari[1*], Arzoo Malik[1,2] and Nishith Dharaiya[1]

[1]*Wildlife and Conservation Biology Research Lab, Department of Life Sciences, Hemchandracharya North Gujarat University, Patan–384265, Gujarat State, India*
[2]*Department of Environmental Studies, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara (Gujarat)–390002, Gujarat State, India*
[*]*Corresponding author*: *rabarivasant016@gmail.com*

Citation: Rabari, V. M., Malik, A. and Dharaiya, N. (2022). A preliminary study on relative abundance of wild mammals based on camera trap in Balaram-Ambaji Wildlife Sanctuary, Gujarat State, India. *Journal of Animal Diversity*, 4 (3): 53–61. http://dx.doi.org/10.52547/JAD.2022.4.3.7

Received: 13 April 2022
Accepted: 9 August 2022
Published online: 30 September 2022

Abstract

Knowledge of the occurrence and distribution of terrestrial mammals is imperative in the design of conservation strategies in protected areas. There is a lack of information available on the occurrence and abundance of wild mammals in the Balaram-Ambaji Wildlife Sanctuary, Gujarat of India. Thus, the present study was carried out to understand the relative abundance of the wild mammalian species in the Balaram-Ambaji Wildlife Sanctuary via camera trapping. We used day/night camera traps to record the presence of diurnal and nocturnal mammals in the Balaram-Ambaji Wildlife Sanctuary. We plotted 11 cameras near water bodies for 20 days from 6 January 2020 to 26 January 2020. A total of 268 photographs of wild animals were captured. Among the photos 13 wild mammalian species were identified, including the Rusty-spotted cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire), which is reported for the first time in this area. The Relative Abundance Index (RAI) of each identified species was calculated to understand the species richness, providing baseline data for species occupancy.

Key words: Arawali Mountain Range, mammalian diversity, North Gujarat, Relative Abundance Index (RAI)

Introduction

Research on mammals in India was initiated in the late nineteenth century by William Thomas Blandford and he published the first edition of the *Fauna of British India - Mammalia* in two parts in 1888 and 1891 (Harshey and Chandra, 2001). Later on, the first updated e-version of the checklist of mammals of India was published by the Zoological Survey of India (ZSI) in 2013 and an updated 3rd version of the checklist was published recently in 2015 with records of 427 species belonging to 197 genera, 48 families and 14 orders (Sharma et al., 2015). Gujarat State is located in the western part of India, stretching between the Arawali Mountain Range in north and the Satpura Range in the south with records of 103 species of mammals (Singh, 2001). This was followed by the recording of 28 wild mammalian species from the North Gujarat region (Gajera and Dharaiya, 2011). A total of 25 wild mammalian species belonging to 9 orders, 16 families and 22 genera were reported from the Taranga Hill Forest, Gujarat (Patel and Patel, 2011). Similarly, 26 species of mammals were recorded from Little Rann of Kachchh, Gujarat (Joshi et al., 2018). A number of standard protocols have been developed for the study of large mammals (Wood et al., 2005; McCafferty, 2007; Farsi et al., 2018), while for the small mammals detecting their presence and location in order to derive a meaningful estimation of their abundance is difficult because of their shy and secretive nature (Webbon et al., 2007). There have been a few studies that estimated the abundances of nocturnal small mammals using camera traps in India

(Chetana and Ganesh, 2007; Mudappa et al., 2007; Debata and Swain, 2018), however, none of them are from the fragmented habitats of Gujarat State. A camera trap is a widely used device in the research and management of wildlife through the detection of rare, secretive and elusive wildlife species (Swann and Perkins, 2014). Camera traps have been used for studying community structure, occupancy, activity pattern, diversity and relative abundance of rare and nocturnal mammals (Chetana and Ganesh, 2007; Ahumada et al., 2011; Debata and Swain, 2018). Camera traps are motion-sensitive and are able to record a series of images/videos of an animal with time, date and location information, which gives an idea of the species presence at that time and place (Yadav et al., 2021). Camera traps have been used to analyze 1) presence of wild mammals, 2) identification of species, 3) species diversity, 4) species abundance and 5) animal activity pattern in the particular area of interest (Liu et al., 2013). Yadav et al. (2021) and Norbu et al. (2022) used camera trap to record the rare wild mammal Rusty-spotted cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hillaire) from the Western Terai Arc Landscape, Nepal, and Spotted linsang *Prionodon pardicolor* Hodgson from the Tashigang Forest Division, Eastern Bhutan, respectively. Timilsina et al. (2021) also worked with camera traps to understand the status, current distribution and threats to the Fishing cat *Prionailurus viverrinus* (Bennett) in Nepal. Similarly, camera traps were used to draw possible linkage between two tiger population clusters in the Terai Arc Landscape of Nepal (Subedi et al., 2021). Moreover, resource selection of the Indian leopard *Panthera pardus fusca* (Meyer) was investigated at Sariska Tiger Reserve, Western India (Mondal et al., 2022). Hence, the present study was aimed to understand 1) presence of wild mammals, 2) diversity of wild mammals, and 3) relative abundance of wild mammals using camera traps in the Balaram-Ambaji Wildlife Sanctuary, Gujarat State, India.

Historical records of wildlife research in North Gujarat show the presence of rich forests with a diversity of wild mammals including the Tiger *Panthera tigris* (Linnaeus), Sambar *Rusa unicolor* (Kerr), Chital *Axis axis* (Erxleben) in the past but were hunted or exterminated due to high anthropogenic pressures and habitat loss (Singh, 2001; Gajera and Dharaiya, 2011). Agriculture practices are one of the large contributors to biodiversity loss in this region (Vyas and Dharaiya, 2021). Still, there are sizable populations of Sloth bear *Melursus ursinus* (Shaw) (Garshelis et al., 1999) and Indian leopard *Panthera pardus fusca* (Meyer), as well as many other wildlife (Mewada et al., 2019). However, there is a dearth of literature available based on camera trap study in the Balaram-Ambaji Wildlife Sanctuary, Gujarat. Hence, the present research was proposed to understand the relative abundance of wild mammals in the Balaram-Ambaji Wildlife Sanctuary. The present study was the part of on-going research that involves the monitoring of mammals around the water point to understand the movement of mammals during different seasons. Through the exploration of the Relative Abundance Index (RAI) of wild mammals, we hope to provide new information on wild mammal diversity and the estimated relative wild mammal abundance in this sanctuary.

Material and Methods

Study area

The study was carried out in the Balaram-Ambaji Wildlife Sanctuary, Banaskantha District, Gujarat State, India from 6 January 2020 to 26 January 2020 during winter. The forest of Balaram-Ambaji was declared as a wildlife sanctuary by the Government of India on 7 August 1989 in order to protect the pristine forest of the Aravalli Mountain system and to encourage the propagation of wildlife. Geographically, the sanctuary is located between 24º10'15" to 24º21'30" N latitude and 72º38'28" to 73º00' E longitude (Mewada et al., 2019). The area falls within Biogeographic Zone 4; the semiarid area and can be classified as ravine thorn forest: 6B/C2 (Champion and Seth, 1968; Chaudhary et al., 2022). The topography of the Balaram-Ambaji Wildlife Sanctuary varies from plains with an elevation gradient of 10 m to 600 m above mean sea level (amsl) (Mewada et al., 2019). Balaram-Ambaji Wildlife Sanctuary is a part of the Aravalli Mountain Range, composed of a contiguous and vital patch of forest for a variety of wildlife and floral diversity where *Melursus ursinus* (Shaw) is a flagship species (Sukhadiya et al., 2013). Balaram-Ambaji Wildlife Sanctuary covers an approximate area of 542 km^2 and falls into the catchment zone of the Banas and Sabarmati Rivers, which helps in preserving the ecological balance in its forests and is important for water conservation (Mewada et al., 2019). The temperature of the sanctuary is recorded from 5 ºC in winter to 46 ºC in summer and an average rainfall of 765 mm has been recorded during the monsoon season (Mewada et al., 2019). There are more than 483 plants, including more than 107 tree species, more than 219 herb species, more than 58 shrub species, nearly 50 climber species, 40 grass species and about 10 species of lower plants which have been recorded in the sanctuary (Patel and Varshney, 2018; Mewada et al., 2019) (Fig. 2). As a flagship species, the Balaram-Ambaji Wildlife Sanctuary is popularly known as the home of *Melursus ursinus* (Shaw). Some of the other mammalian fauna including Indian leopard *Panthera pardus fusca* (Meyer), Striped hyaena *Hyaena hyaena* (Linnaeus), Honey badger *Mellivora capensis* (Schreber), Jackal *Canis aureus* Linnaeus, Jungle cat *Felis chaus* Schreber, Indian civet *Viverricula indica* (É. Geoffroy Saint-Hilaire), Porcupine *Hystrix indica* Kerr, Wild boar *Sus scrofa* Linnaeus, Nilgai *Boselaphus tragocamelus* (Pallas) and Indian langur *Semnopithecus entellus* (Dufresne), etc., were also recorded from this area by Gajera and Dharaiya (2011). At present, Balaram-Ambaji Wildlife Sanctuary is considered the sanctuary with the highest number of human settlements among all the sanctuaries in Gujarat, as the total human population living within the sanctuary is around 1,18,608 in 91 villages (Human Census, 2011).

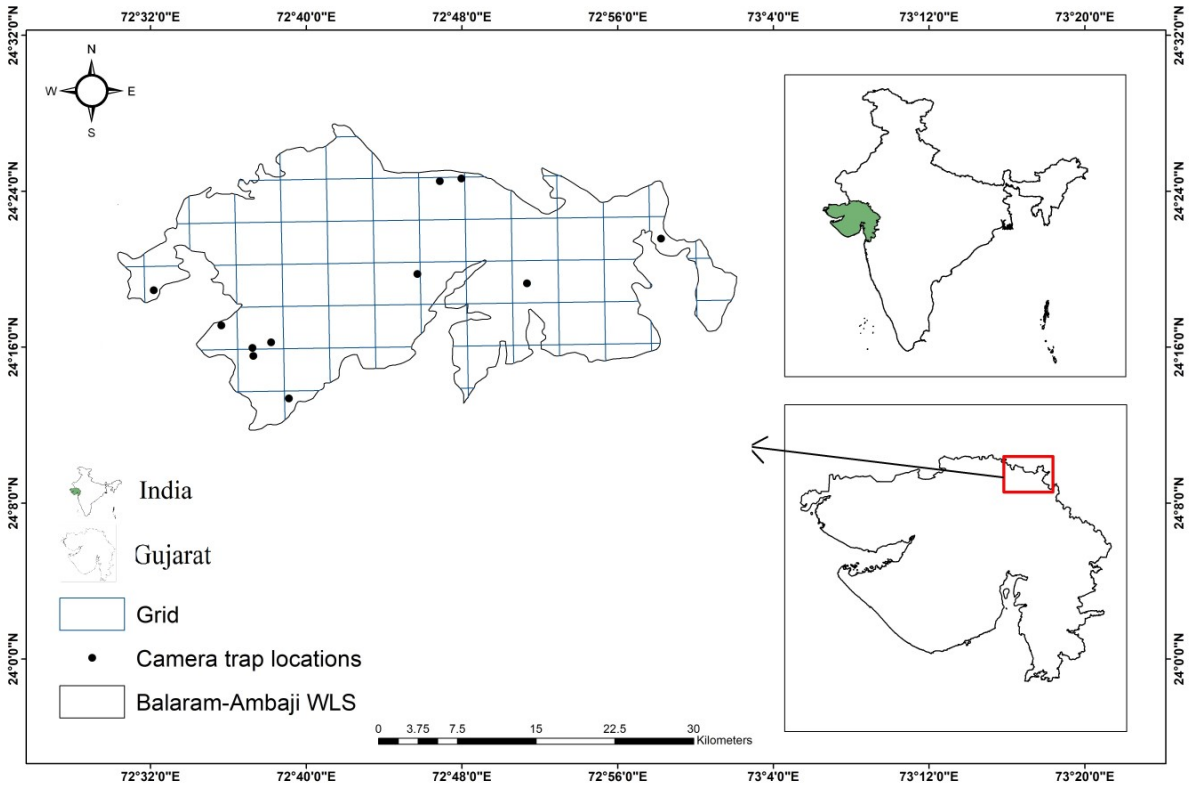

Figure 1: Balaram-Ambaji Wildlife Sanctuary, Gujarat State, India showing camera trap locations.

Figure 2: Landscape of Balaram-Ambaji Wildlife Sanctuary, Gujarat State, India.

Methodology

Information on water points was gathered from locals inhabitants, grazers and the forest field staff of the Forest Department of Gujarat State. The map of the sanctuary (Fig. 1) was prepared using QGIS software with a WGS 84 Projection system. Prior to the selection of water points, a sign survey was conducted to know the movement of wildlife around a water point by conducting a strip transect of 100 m in each direction. A total of 11 water points were identified for placing camera traps (Table 1). A total of 11 cameras (model E, a1/4 second trigger speed, 20 megapixel (MP) resolution, Cuddeback Digital, De Pere, WI, USA) were placed over a period of 20 days from 6 January 2020 to 26 January 2020, helping us to understand the presence of wild mammals (Fig. 1). The cameras were deployed approximately 50 cm above the ground near a water body, either on trees or on wooden stalks, so that it was possible for the cameras to cover the maximum area as part of the field of view to capture as many movements as possible (Debata and Swain, 2018). In order to achieve a balance between detection probability and battery power conservation, the trigger speed was set to 2 frames in day and 5 frames at night; there was higher probability of wild animal capture at night because of their nocturnal behavior. To decrease the possibility of double-counting, a time-lapse of 20 minutes was set between object captures. Near each water body a single camera was fixed after cleaning of vegetation from the shuttle way.

After retrieving all the camera trap pictures, an inventory of photographs based on the locations (Table 3) was created and each photograph was carefully examined to facilitate species identification. The photo-captures of the animals were identified to species level using *The Book of Indian Animals* by Prater (2005) and *Mammals of South Asia* by Johnsingh and Manjrekar (2013). In addition to the photographs of wild mammals (n= 268), photographs of humans (tourists and local villagers (n= 89)) and domestic animals (cattle and dogs (n= 60)) were also counted. The identified wild mammals were categorized according to their IUCN status (2022) and schedule under the Wildlife Protection Act (Government of India, 1972). The RAI (Relative abundance index) based on the number of individuals of each species was calculated using the following formula

$$RAI = \frac{A}{N} \times 100$$

where, A is the total number of detections of a species by all cameras and N is the total number of camera trap days for all cameras throughout the study area (*sensu* Jenks et al., 2011; Debata and Swain, 2018).

Results

Visual data from camera traps is beneficial for confirming the presence of species in order to study species richness and habitat use (Tanwar et al., 2021). In our study, we identified 13 mammalian species through captured images (Table 2). In total, 268 photographs of wild mammals and 89 photographs showing human presence were captured at nine different sites in 20 trap days. Data was not collected from two of the original eleven cameras; one camera was stolen from the Chip Pani station and the one at Panchha had a technical issue. The estimated relative abundance of mammalian diversity varied from small to big mammals; the RAI of the Ruddy mongoose *Urva smithii* (Gray) (RAI= 47.22) was found to be very high followed by the Common palm civet *Paradoxurus hermaphroditus* (Pallas) (RAI= 38.88) (Fig. 3).

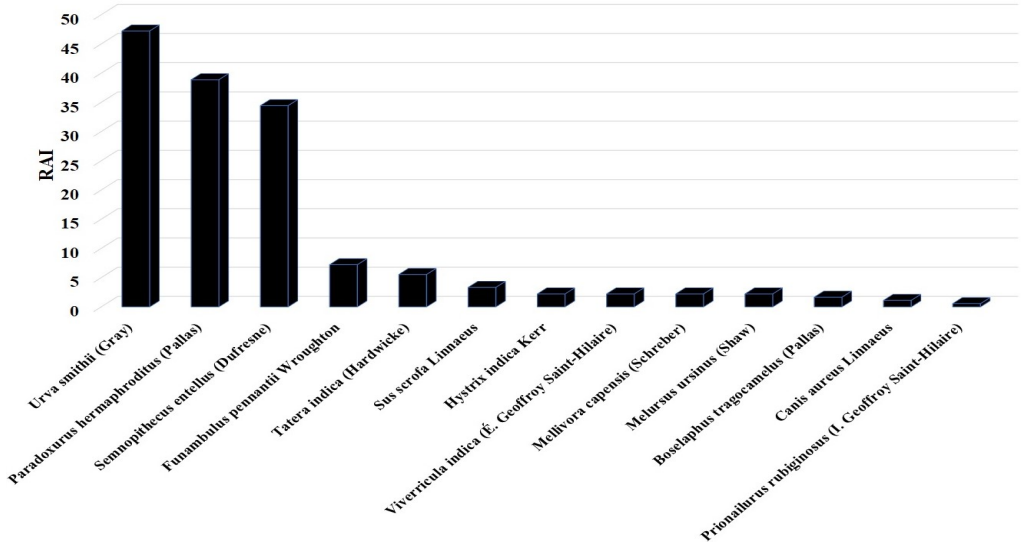

Figure 3: The Relative Abundance Index (RAI) of mammalian species based on camera trap photographs in the Balaram-Ambaji Wildlife Sanctuary, Gujarat State, India.

Table 1: Details of locality and trapping days of camera traps in Balaram-Ambaji Wildlife Sanctuary.

Serial Number	Water point Name	Latitude	Longitude	Number of trapping days
1	Kochhadi	24.265087	72.528427	20
2	Andhariya	24.215811	72.612946	20
3	Moti Pastani	24.208878	72.61377	20
4	Kotha	24.234972	72.586338	20
5	Sipnu	24.22044	72.629051	20
6	Paniyari	24.172461	72.644165	20
7	Sembalpani	24.358393	72.77346	20
8	Bedapani	24.360567	72.792015	20
9	Panccha	24.271015	72.848198	20 (Technical malfunction)
10	Ranpur	24.309187	72.962921	20
11	Chip Pani	24.278967	72.754211	20 (Stolen)

Table 2: List of mammalian species photo-captured by camera traps during the study period.

S.N	Order	Family	Scientific name	Common name	IUCN status	Schedule	Activity
1	Primates	*Cercopithecidae*	*Semnopithecus entellus* (Dufresne)	Common langur	LC	II (Part I)	Diurnal
2	Carnivora	Felidae	*Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire)	Rusty-spotted cat	NT	II (Part II)	Diurnal
3	Carnivora	Canidae	*Canis aureus* Linnaeus	Jackal	LC	II (Part I)	Diurnal
4	Carnivora	Viverridae	*Paradoxurus hermaphroditus* (Pallas)	Common palm civet	LC	II (Part II)	Nocturnal
5	Carnivora	Viverridae	*Viverricula indica* (É. Geoffroy Saint-Hilaire)	Small Indian civet	LC	II (Part II)	Nocturnal
6	Carnivora	Herpestidae	*Urva smithii* (Gray)	Ruddy mongoose	LC	II (Part II)	Diurnal
7	Carnivora	Mustelidae	*Mellivora capensis* (Schreber)	Honey badger	LC	I (Part I)	Nocturnal
8	Carnivora	Ursidae	*Melursus ursinus* (Shaw)	Sloth bear	VU	I (Part I)	Nocturnal
9	Cetartiodactyla	Bovidae	*Boselaphus tragocamelus* (Pallas)	Blue bull/Nilgai	LC	III	Crepuscular
10	Cetartiodactyla	Suidae	*Sus scrofa* Linnaeus	Wild boar	LC	III	Crepuscular to Nocturnal
11	Rodentia	Hystricidae	*Hystrix indica* Kerr	Porcupine	LC	IV	Nocturnal
12	Rodentia	Sciuridae	*Funambulus pennantii* Wroughton	Five-striped palm squirrel	LC	IV	NA
13	Rodentia	Muridae	*Tatera indica* (Hardwicke)	Indian gerbil	LC	V	Nocturnal

Discussion

This paper gathers a preliminary record of the terrestrial mammals in the North Gujarat region of India. There were 28 species of mammals recorded in the North Gujarat by Gajera and Dharaiya (2011) by carrying out direct encounters and sign survey on the transects. Among these previously recorded mammals, the present study recorded 13 species using the camera traps in Balaram-Ambaji Wildlife Sanctuary. The photo-captured mammalian species in the present study include *Semnopithecus entellus* (Dufresne), *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire), *Canis aureus* Linnaeus, *Paradoxurus hermaphroditus* (Pallas), *Viverricula indica* (É. Geoffroy Saint-Hilaire), *Urva smithii* (Gray), *Mellivora capensis* (Schreber), *Melursus ursinus* (Shaw), *Boselaphus tragocamelus* (Pallas), *Sus scrofa* Linnaeus, *Hystrix indica* Kerr, *Funambulus pennantii* Wroughton and *Tatera indica* (Hardwicke) (Fig. 4). The distribution of *Urva smithii* (Gray), *Paradoxurus hermaphroditus* (Pallas) and *Semnopithecus entellus* (Dufresne) was wide as they were found frequently in all cameras placed, while *Mellivora capensis* (Schreber), *Melursus ursinus* (Shaw), *Canis aureus* Linnaeus and *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire) were restricted in the sanctuary. Therefore, the need emerges to study further and more precisely identify their distribution within the sanctuary (Table 3). The presence of a *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire) is recorded for the first time in this sanctuary from the Bedapani camera trap station. We found two arboreal mammals, *Funambulus pennantii* Wroughton and *Semnopithecus entellus* (Dufresne). Some species, namely *Tatera indica* (Hardwicke), *Hystrix indica* Kerr, *Paradoxurus hermaphroditus* (Pallas), *Viverricula indica* (É. Geoffroy Saint-Hilaire), *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire), *Mellivora capensis* (Schreber) and *Melursus ursinus* (Shaw) were captured at nighttime showing their nocturnal activity pattern, while only two species (*Sus scrofa* Linnaeus and *Boselaphus tragocamelus* (Pallas)) were recorded with crepuscular activity. Although there is a substantial population of *Panthera pardus fusca* (Meyer) in this sanctuary (Mewada et al., 2019), this species was not photo-captured during the study period.

Figure 4: Photographs of wild mammalian species photo-captured from the Balaram-Ambaji Wildlife Sanctuary.

11

12

13

Figure 4: (Continued).

Table 3: Presence–absence of captured wild mammals in selected water points/camera trap stations.

S.N	Captured wild mammals	Name of water points/Camera stations										
		Kochhadi	Andhariya	Moti pastani	Kotha	Sipnu	Paniyari	Sembalpani	Bedapani	Panccha	Ranpur	Chip pani
1	*Semnopithecus entellus* (Dufresne)	+	0	0	+	0	+	0	+	0	+	0
2	*Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire)	0	0	0	0	0	0	+	+	0	0	0
3	*Canis aureus* Linnaeus	0	0	0	0	0	0	+	0	0	0	0
4	*Paradoxurus hermaphroditus* (Pallas)	0	0	0	+	0	0	0	0	0	0	0
5	*Viverricula indica* (É. Geoffroy Saint-Hilaire)	+	+	+	+	0	+	+	+	0	0	0
6	*Urva smithii* (Gray)	0	0	0	0	0	+	0	0	0	0	0
7	*Mellivora capensis* (Schreber)	+	+	+	+	+	+	+	+	0	0	0
8	*Melursus ursinus* (Shaw)	+	0	0	0	0	+	0	0	0	0	0
9	*Boselaphus tragocamelus* (Pallas)	+	0	0	0	0	+	0	0	0	0	0
10	*Sus scrofa* Linnaeus	0	0	0	+	0	0	0	0	0	0	0
11	*Hystrix indica* Kerr	+	0	0	0	0	+	0	0	0	0	0
12	*Funambulus pennantii* Wroughton	+	0	0	0	0	+	0	0	0	0	0
13	*Tatera indica* (Hardwicke)	+	+	0	0	+	0	0	0	0	0	0

Camera traps are an efficient and useful tool to provide adequate data for wildlife monitoring (Marsh and Trenham, 2008). Although, the present study was conducted for a small number of days as a preliminary study, it represents the first attempt to understand the mammalian diversity in Balaram-Ambaji Wildlife Sanctuary using the camera trap method. A similar study involving a longer period of time and covering multiple seasons will give a clearer picture of the faunal diversity and abundance in the protected area. The study can be used as a pilot study for designing further wildlife monitoring protocols by forest management departments and for habitat management practices and policy making related to wildlife conservation.

Acknowledgments

The authors are thankful to the Gujarat Forest Department for granting the necessary permission and for logistic support. We would like to thank the Wildlife and Conservation Biology Research Lab for technical support during the research work. We would also like to thank the anonymous reviewers and Editor for their comments to make this manuscript very effective. The study did not receive any grants from the public, commercial or not-for-profit sectors to carry out this work.

Conflict of interest

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

References

Ahumada, J. A., Silva, C., Gajapersad, K., Hallam, C., Hurtado, J., Martin, E. and Andelman, S. J. (2011). Community structure and diversity of tropical forest mammals: Data from a global camera trap network. 2703–2711. https://doi.org/10.1098/rstb.2011.0115

Champion, H. G. and Seth, S. K. (1968). *Revised Forest types of India*. Govt. of India Publications, New Delhi, India. 404 pp.

Chaudhary S. V., Desai P. G. and Dharaiya N. A. (2022). An annotated checklist of bird diversity of Kheralu, Mehsana, Gujarat. *Species*, 23: 74–85.

Chetana, H. C. and Ganesh, T. (2007). Survey and activity patterns of nocturnal mammals in a fragmented dry deciduous forest of Karnataka. *Zoos' Print Journal*, 22 (4): 2644–2647. https://doi.org/10.11609/jott.zpj.1576.2644-7

Debata, S. and Swain, K. K. (2018). Estimating mammalian diversity and relative abundance using camera traps in a tropical deciduous forest of Kuldiha Wildlife Sanctuary, Eastern India. *Mammal Study*, 43 (1): 1–9. https://doi.org/10.3106/ms2017-0078

Farsi, H., Harti, D., Achaâban, M. R., Piro, M., Ouassat, M., Challet, E., Pevet, P. and El Allali, K. (2018). Validation of locomotion scoring as a new and inexpensive technique to record circadian locomotor activity in large mammals. Heliyon, 4 (12), e00980. https://doi.org/10.1016/j.heliyon.2018.e00980

Gajera, N. and Dharaiya, N. (2011). Status, occurrence, distribution of some mammals of North Gujarat, India. *In: Proceedings of the Zoological Society*, 64 (1): 46–53. https://doi.org/10.2139/ssrn.2118323

Garshelis, D. L., Joshi, A. R., Smith, J. L. and Rice, C. G. (1999). Sloth Bear Conservation Action Plan, *In:* Servheen, C., Herrero, S. and Peyton, B. (Compilers)., *Bears. Status survey and conservation action plan*. IUCN/ SSC bear and polar bear specialist groups (pp. x + 309). IUCN.

Harshey, D. K. and Chandra, K. (2001). Mammals of Madhya Pradesh and Chhattisgarh. *Zoos' Print Journal*, 16 (12): 659–668. https://doi.org/10.11609/JoTT.ZPJ.16.12.659-68

Human census (2011). Office of the Registrar General and Census Commissioner, India. Ministry of Home Affairs, Government of India. Available: https://censusindia.gov.in

IUCN 2022. The IUCN Red List of Threatened Species. Version 2022-1. Accessed on 18 November, 2022. Available: https://www.iucnredlist.org.

Jenks, K. E., Chanteap, P., Kanda, D., Peter, C., Cutter, P., Redford, T., Antony, L., Howard, J. and Leimgruber, P. (2011). Using relative abundance indices from camera-trapping to test wildlife conservation hypotheses–an example from Khao Yai National Park, Thailand. *Tropical Conservation Science*, 4 (2): 113–131. https://doi.org/10.1177/194008291100400203

Johnsingh, A. and Manjrekar, N. (2013). *Mammals of South Asia*. University Press (India) Private Limited, Himayatnagar, Hyderabad, India. 614 pp.

Joshi, J. D., Tatu, K., Joshi, D. and Kamboj, R. D. (2018). Faunal Diversity of the Little Rann of Kachchh (LRK), Gujarat, India. *International Journal of Scientific Research in Biological Sciences*, 5 (5): 117–123. https://doi.org/10.26438/ijsrbs/v5i5.117123

Liu, X., Wu, P., Songer, M., Cai, Q., He, X., Zhu, Y. and Shao, X. (2013). Monitoring wildlife abundance and diversity with infra-red camera traps in Guanyinshan Nature Reserve of Shaanxi Province, China. *Ecological Indicators*, 33: 121–128.

Marsh, D. M. and Trenham, P. C. (2008). Current trends in plant and animal population monitoring. *Conservation Biology*, 22 (3): 647–655. https://doi.org/10.1111/j.1523-1739.2008.00927.x

McCafferty, D. J. (2007). The value of infrared thermography for research on mammals: previous applications and future directions. *Mammal Review*, 37 (3): 207–223. https://doi.org/10.1111/j.1365-2907.2007.00111.x

Mewada, T. P., Tiwari, U. L. and Kotia, A. (2019). Fruiting species influence the seasonal use of the habitat by sloth bear in and around Balaram Ambaji Wildlife Sanctuary, Gujarat, India. *Notulae Scientia Biologicae*, 11 (2): 183–190. https://doi.org/10.15835/nsb11210391

Mondal, K., Chourasia, P., Gupta, S., Sankar, K. and Qureshi, Q. (2022). Investigating resource selection of the Indian leopard *Panthera pardus* fusca (Meyer, 1794) in a tropical dry deciduous forest. *Journal of Animal Diversity*, 4 (2): 97–109. http://dx.doi.org/10.52547/JAD.2022.4.2.5

Mudappa, D., Noon, B. R., Kumar, A. and Chellam, R. (2007). Responses of small carnivores to rainforest fragmentation in the southern Western Ghats, India. *Small Carnivore Conservation*, 36: 18–26.

Norbu, L., Thinley, P., Dechen, U., Koirala, B. K., Dorji, T., Tshering, D., Dorji, P. and Tobgay, S. (2022). Photographic evidence of the Spotted linsang *Prionodon pardicolor* (Mammalia: Carnivora: Prionodontidae) from the Tashigang Forest Division, Eastern Bhutan. *Journal of Animal Diversity*, 4 (2): 115–120. http://dx.doi.org/10.52547/JAD.2022.4.2.7

Patel, C. D. and Patel, M. I. (2011). Checklist of mammals in Taranga Hill Forest, Gujarat, India. *Zoos' Print*, 26 (5): 30–32.

Patel, R. H. and Varshney, A. V. (2018). Floristic diversity of forest of Balaram Ambaji Wildlife Sanctuary, Banaskantha District, Gujarat. *Journal of Agroecology and Natural Resource Management*, 5 (3): 132–134.

Prater, S. H. (2005). *The Book of Indian Animals*. Twelfth reprint. Oxford University Press, UK. 324 pp.

Sharma, G., Kamalakannan, M. and Venkataraman, K. (2015). A Checklist of mammals of India with their distribution and conservation status. 107 pp.

Singh, H. S. (2001). *Natural heritage of Gujarat*. Gujarat Ecological Education and Research Foundation, Gandhinagar, India. GEER Press. 261 pp.

Subedi, N., Lamichhane, B. R., Dahal, Y. N., Kandel, R. C., Karki Thapa, M., Regmi, R. and Shrestha, B. (2021). Tigers in the Himalayan foothills: Possible linkage between two tiger population clusters in Terai Arc Landscape, Nepal. *Journal of Animal Diversity*, 3 (2), 69–75. http://dx.doi.org/10.52547/JAD.2021.3.2.7

Sukhadiya, D., Joshi, J. U. and Dharaiya, N. (2013). Feeding ecology and habitat use of sloth bear (*Melursus ursinus*) in Jassore Wildlife Sanctuary, Gujarat, India. *Indian Journal of Ecology*, 40 (1): 14–18.

Swann, D. E. and Perkins, N. (2014). Camera trapping for animal monitoring and management: A review of applications, *In:* Meek, P. and Fleming, P. (Eds.), *Camera trapping: Wildlife management and research*. Collingwood, Australia: CSIRO Publishing. pp. 3–11.

Tanwar, K. S., Sadhu, A. and Jhala, Y. V. (2021). Camera trap placement for evaluating species richness, abundance, and activity. *Scientific Reports*, 11 (1): 1–11. http://dx.doi.org/10.1038/s41598-021-02459-w

Timilsina, S., Mishra, R., Adhikari, A., Gautam, S. and Neupane, B. (2021). Status, current distribution and threats to the Fishing cat *Prionailurus viverrinus* (Bennett, 1833) in Nepal. *Journal of Animal Diversity*, 3 (2): 18–25. http://dx.doi.org/10.52547/JAD.2021.3.2.3

Vyas, S. and Dharaiya, N. (2021). Assessment of wildlife habitat in Taranga hill forest with reference to change in land use and land cover. *eJournal of Applied Forest Ecology*, 9 (1): 22–28.

Webbon, C. C., Baker, P. J. and Harris, S. (2007). Faecal density counts for monitoring changes in red fox numbers in rural Britain. *Journal of Applied Ecology*, 41 (4): 768–779. http://dx.doi.org/10.1111/j.0021-8901.2004.00930.x

Wood, J. D., O'Connell-Rodwell, C. E. and Klemperer, S. L. (2005). Using seismic sensors to detect elephants and other large mammals: a potential census technique. *Journal of Applied Ecology*, 42 (3): 587–594.

Yadav, S. K., Lamichhane, B. R., Subedi, N., Acharya, H. B., Macdonald, D. W. and Fitzmaurice, A. (2021). Rusty-spotted cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hillaire) camera trapped in the Bardia-Banke complex of Western Terai Arc Landscape, Nepal. *Journal of Animal Diversity*, 3 (4): 49–55. http://dx.doi.org/10.52547/JAD.2021.3.4.7