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MAMMAL DIVERSITY IN A MONTANE FOREST IN CENTRAL BHUTAN

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MAMMAL DIVERSITY IN A MONTANE FOREST IN CENTRAL BHUTAN

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Abstract In Bhutan, knowledge of wildlife species richness in protected areas is increasing, particularly for mammals; however, the knowledge outside of protected areas typically remains poor. We conducted a camera trap survey from May 2016 to July 2017 in a montane forest outside of the protected areas network in central Bhutan and recorded 15 species of mammals (belonging to nine families and three orders), of which nearly half were listed as Endangered, Vulnerable, or Near Threatened. Our findings demonstrate that forested landscapes outside protected areas in Bhutan support a rich assemblage of wildlife species and are, therefore, deserving of comprehensive wildlife conservation plans and dedicated funding for ecological research and threat mitigation.

Keywords: Biodiversity, camera trap, Himalaya, protected areas, threatened species.

Bhutan has close to 200 species of mammals (Wangchuk et al. 2004; NEC 2011) and is a part of the Himalaya Biodiversity Hotspot (Mittermeier et al. 2004) and the Global 200 ecoregions (Olsen & Dinerstein 2002). Given the small geographical size of the country, the rich diversity of species can be attributed to its location at the junction of the Indo-malayan and the Palaearctic biogeographic realms. Apart from the protected areas which comprise more than 50% of the country, other regions lack dedicated species inventories. The lack of information deters comprehensive species conservation

initiatives in the light of rapid changes to Bhutan's rich and diverse ecosystem (Dhendup & Dorji 2018a; Penjor et al. 2018). Camera traps have emerged as a successful and most frequently used tool for terrestrial species monitoring in Bhutan and have provided critical information on a few keystone and endangered species such as the Bengal Tiger (Wang & Macdonald 2009; Tempa et al. 2013; DoFPS 2015; Thinley et al. 2015) and Snow Leopard (DoFPS 2016; WCNP & WWF 2016). Here we use camera traps to document the diversity and relative abundance of mammals in a montane forest in central Bhutan and also to provide baseline information to facilitate the preservation of such sites for the conservation of globally threatened species.

Materials and methods

We conducted the study in the Lamai Goempa Research Preserve in the Bumthang District of Bhutan (Figure 1). The preserve spans an area of 1,098ha and is also used by local communities as grazing ground for cattle, extraction of timber, collection of non-wood forest products, and hiking. The area receives an average annual rainfall of 1,404mm. The summer temperatures can go up to 23°C, and the winter temperature can drop to -6°C (Pearl et al. 2015). The vegetation comprises

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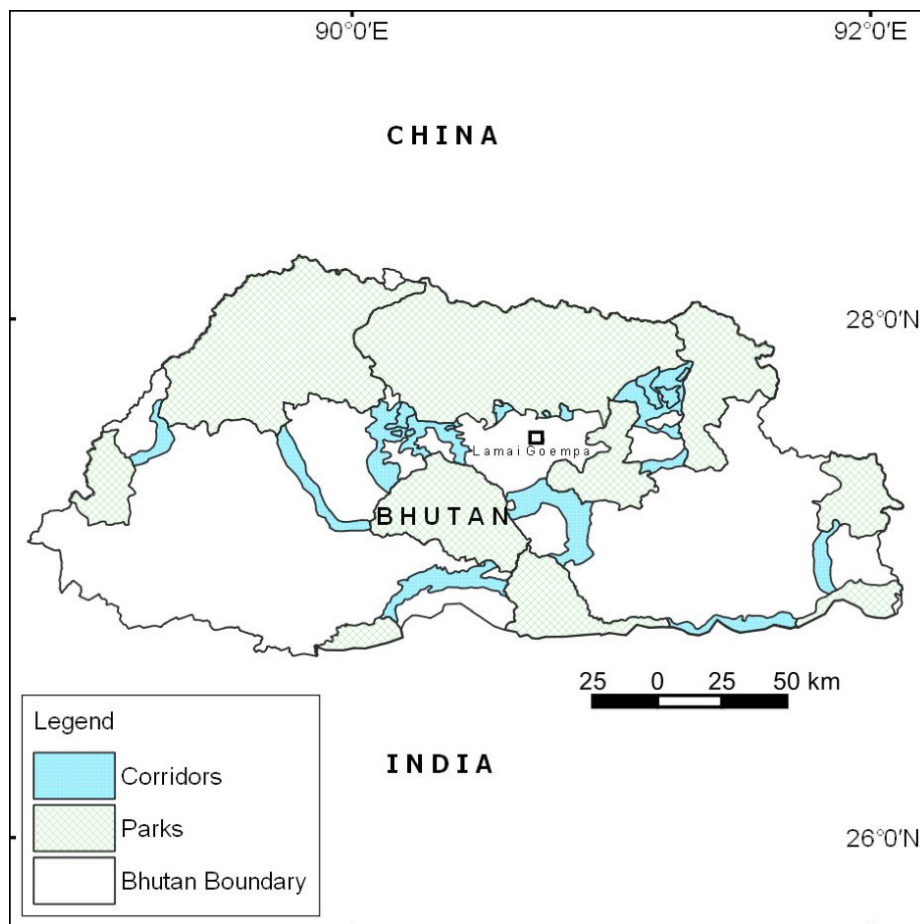


Figure 1. Study area in Bumthang against Bhutan's protected area network.

mixed conifer forest and alpine rhododendrons (Image 1 & 2).

We carried out the camera trapping survey from May 2016 to July 2017 using 25 camera stations established along footpaths, and game trails and the camera trapping array covered elevations from 2,892 to 4,120 m. We placed one passive infra-red Reconyx HC500 Hyperfire camera (RECONYX, Inc., Wisconsin, USA) at each station and was set to operate for 24h (Image 3). Cameras were at least 500m away from each other and were placed at the height of 45–50 cm above the ground. No bait/lure was used. For a series of images of the same species occurring at a camera trap location, we classified the captures as a notionally independent event only if they were taken at one-hour intervals (Sanderson & Harris 2013; Hodge & Arbogast 2016). Memory cards from two camera stations were lost. We calculated the relative abundance index (RAI), naïve occupancy, and the latency to initial detection for each species in the study area (Table 1).

Results and Discussion

The complete survey resulted in an effort of 4,501 trap nights and produced 34,237 photographs, of which 7,617 pictures were taken of 15 mammal species representing nine families and three orders (table 1) (Image 4–18). The species detected were Tiger *Panthera tigris*, Asiatic Golden Cat *Catopuma temminckii*, Marbled Cat *Pardofelis marmorata*, Leopard Cat *Prionailurus bengalensis*, Asiatic Wild Dog *Cuon alpinus*, Red Fox *Vulpes vulpes*, Himalayan Serow *Capricornis thar*, Barking Deer *Mutiacus muntjac*, Sambar *Rusa unicolor*, Wild Boar *Sus scrofa*, Yellow-throated Marten *Martes flavigula*, Asiatic Black Bear *Ursus thibetanus*, Himalayan Crestless Porcupine *Hysterix brachyura*, Orange-bellied Squirrel *Dremomys lokriah*, and Weasel *Mustela* sp. Two are listed as Endangered, three Vulnerable, two Near Threatened, and the rest as Least Concern on the IUCN Red List of Threatened Species. Although we did not record the Red Panda *Ailurus fulgens*, the River Otter *Lutra lutra* and other small mammals such as picas, rats and voles, these species are known to occur in the area and will require a species-specific survey protocol. Wild



Image 1. Typical weather in the study area during summer.



Image 2. Some parts of the study area has Blue Pine with bamboo understorey.



Image 3. Setting up a camera trap in the field.



Image 4. Himalayan Serow *Capricornis thar*.



Image 5. Tiger *Panthera tigris*.



Image 6. Asiatic Golden Cat *Catopuma temminckii*.

Table 1. Details of mammal species recorded in Lamai Goemba Research Preserve, Bumthang, Bhutan during 2016–2017 with camera trap records, total capture events, relative abundance index (RAI), naïve occupancy and latency to initial detection.

Species	Red List category ¹	Family	Camera trap records	Total capture events	RAI/Trap success ²	Naïve occupancy ³	Latency to the initial detection ³
Carnivora							
Tiger <i>Panthera tigris</i>	EN	Felidae	13	3	0.07	0.09	172
Asiatic Golden Cat <i>Catopuma temminckii</i>	NT	Felidae	258	54	1.20	0.59	72
Marbled Cat <i>Pardofelis marmorata</i>	VU	Felidae	469	48	1.07	0.18	185
Leopard Cat <i>Prionailurus bengalensis</i>	LC	Felidae	71	19	0.42	0.27	36
Asiatic Wild Dog <i>Cuon alpinus</i>	EN	Canidae	620	44	0.98	0.64	105
Red Fox <i>Vulpes vulpes</i>	LC	Canidae	161	53	1.18	0.32	32
Yellow-throated Marten <i>Martes flavigula</i>	LC	Mustelidae	46	14	0.31	0.32	87
Asiatic Black Bear <i>Ursus thibetanus</i>	VU	Ursidae	225	32	0.71	0.59	32
Weasel <i>Mustela</i> sp.	LC	Mustelidae	8	3	0.07	0.09	54
Cetartiodactyla							
Himalayan Serow <i>Capricornis thar</i>	NT	Bovidae	529	70	1.56	0.55	41
Barking Deer <i>Muntiacus muntjac</i>	LC	Cervidae	766	85	1.89	0.82	33
Sambar <i>Rusa unicolor</i>	VU	Cervidae	1363	44	0.98	0.50	33
Wild Boar <i>Sus scrofa</i>	LC	Suidae	2643	152	3.38	0.91	29
Rodentia							
Himalayan Crestless Porcupine <i>Hystrix brachyura</i>	LC	Hystricidae	402	81	1.80	0.41	29
Orange-bellied Squirrel <i>Dremomys lokriah</i>	LC	Sciuridae	43	15	0.33	0.09	105

¹ LC—Least Concern | NT—Near Threatened | VU—Vulnerable | EN—Endangered

² Relative Abundance Index (RAI) was calculated as the number of captures divided by the total sampling effort in days multiplied by 100 (O'Brien 2011; Hedwig et al. 2018).

³ Naïve occupancy was quantified as the number of camera trap locations at which we detected each species divided by the total number of camera trap locations (Jenks et al. 2011; Rovero et al. 2014; Hedwig et al. 2018).

⁴ Latency to initial detection was determined as the number of trap nights between the start of the survey and the first record of a species (Gompper et al. 1999).

Boars had the highest relative abundance index of 3.38 and also enjoyed the highest naïve occupancy among all the species. Among the carnivores, the Asiatic Golden Cat and the Red Fox were the most common. Tiger and weasel were the least common and were found in two camera stations each. People were observed in 21 of the total 23 camera stations indicating a prominent level of human presence in the study site.

The current study was one of the first systematic camera trapping for mammal inventory outside protected areas in Bhutan and has significant conservation implications for the country as most of the available information on fauna for management decisions come from protected areas. The rich assemblage of mammals, including globally threatened species such as the Tiger and Wild Dog, suggests that the preserve is a primary habitat for many species and hence, requires

protection and appropriate conservation interventions. The preserve is located near to two biodiversity-rich protected areas: Wangchuck Centennial National Park in the north and Phrumsengla National Park in the south. Given the rich diversity of mammals in the area, putting up appropriate conservation strategies could provide additional biodiversity gains. The area, however, is currently not fully gazetted as a research preserve and is under the jurisdiction of the Bumthang territorial division. As such, the area is used for selective logging, grazing, and other resource allocations for communities living nearby. Landscapes outside protected areas worldwide are facing an increase in human-induced land-use changes. This may affect species both outside and within nearby protected areas. The rich diversity of mammals in the area despite the strong human presence also demonstrates the possibility of human-

Image 7. Red Fox *Vulpus vulpus*Image 10. Himalayan Crestless Porcupine *Hystrix brachyura*Image 8. Leopard Cat *Prionailurus bengalensis*Image 11. Wild Boar *Sus scrofa*Image 9. Marbled Cat *Pardofelis marmorata*Image 12. Sambar *Rusa unicolor*

wildlife coexistence (Moo et al. 2017). Although the tiger and a few other species were detected only a few times, the region could be an important wildlife corridor and a part of their home range (Hodge & Arbogast 2016). Therefore, we strongly feel the need to convert the area into a research preserve and be used for long term research, outreach, teaching, among others.

Image 13. Asiatic Black Bear *Ursus thibetanus*Image 17. Orange-bellied Squirrel *Dremomys lokriah*Image 14. Yellow-throated Marten *Martes flavigula*Image 18. Weasel *Mustela* sp.Image 15. Asiatic Wild Dog *Cuon alpinus*Image 16. Barking Deer *Muntiacus muntjac*

The National Tiger Survey of 2015 recorded more tigers outside protected areas (DoFPS 2015) and also documented the presence of six species of felids and five species of small carnivores in a forest division in western Bhutan (Dhendup & Dorji 2018a,b). Unfortunately, these landscapes are highly vulnerable to habitat degradation and conversion and poaching. Therefore, as home to many threatened and endangered species, lands outside protected areas also require comprehensive conservation management plans and critical funding to ensure that these landscapes continue to sustain biodiversity in the future.

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