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Annotated Checklist and Conservation Status of Mammal Species in Sarpang District, Bhutan

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ABSTRACT

Bhutan has a total geographical area of 38,394 Km² located in between the Indo-Malayan and Palearctic region, out of which 51.44% (19750.75 km²) of its total geographical area has been designated as the protected area. However, none of the districts have a structured baseline checklist of mammal species documented till date. Therefore, Sarpang Forest Division under the Department of Forests and Park Services had carried out five rigorous camera trap surveys including a nationwide tiger survey that covers representable areas of the district from 2014 till 2020. The survey shows that district has 36 mammal species that belong to 18 families under seven orders. Felidae and Cervidae families has the highest species abundance (n = 17%), while, Canidae, Herpestidae, Leporidae, Manidae, Melinae, Muridae, Mustelidae, Tupaiidae, Proboscidae, Pteromyidae, Suidae and Ursidae were the lowest (n = 3%). Above all, Sarpang homed 29.90% of total mammal species of Bhutan, out of which 3% of mammal species were categorized under Critically Endangered, 14% Endangered, 14% Vulnerable, 22% Near Threatened, and 47% Least Concern as per IUCN Red List. However, only 20 mammal species are listed under CITES and nine in Schedule I of Forest and Nature Conservation Act of Bhutan, 1995. Therefore, landscape-based planning such as the Division-based Conservation & Management plan; periodic monitoring of wildlife species using camera traps, and validation of Schedule I species are suggested for long-term conservation and management of globally threatened species inside the landscape of Sarpang district in Bhutan.

INTRODUCTION

Bhutan has a total geographical area of 38,394 Km² located in between the two ecological regions: The Indo-Malayan region and Palearctic region (Wangchuck *et al.,* 2004; Tenzin *et al.,* 2019). Due to this landscape's convergence and persistence guidance from a farsighted monarch, has leads to designate 51.44% of total geographical areas into the protected area (PA) that harbors more than 200 mammal species protected by the sound conservation policies (Wangchuk *et al.,* 2004; Dhendup and Dorji, 2018). Thus, Bhutan is included within the landscape of Himalayan biodiversity hotspots (Myers *et al.,* 2000) and Global 200 ecoregions (Olsen and Dinerstein, 2002; Mitermeier *et al.,* 2004).

Ecologically, mammal plays an important role in ecosystems which provides numerous essential ecosystem services such as seed dispersal, pollination and regulating insect populations, and reducing disease transmissions (Keesing *et al*., 2010; Kunz *et al*., 2011) and some also evidence as an indicator of ecosystem health (Jones *et al*., 2009). However, rapid declines in mammalian biodiversity (Schipper, 2008; Penjor *et al.,* 2021) were induced by the monopolization of ecosystems and natural resources by anthropogenic activities (Mace *et al*., 2005; Butchart *et al.,* 2011; Penjor *et al.,* 2021). On other hand, the lack of data and climate change effects (high temperature and evapotranspiration in tropical areas) also exacerbate the species decline across the globe (Jones and Safi, 2011; Jones and Safi, 2011; Penjor *et al.,* 2021). Further, the studies had also predicted that by 2070, the impact of land-use change is predicted to globally endanger ~1700 species of amphibians,

birds and mammals, including species of high conservation value and functional importance, due to habitat contraction (Barlow *et al*., 2016; Powers and Jetz, 2019; Penjor *et al*., 2021).

The latest nationwide on-site camera traps survey has recorded only 129 mammal species listed in the Biodiversity Statistics of Bhutan (NBC, 2017; NCD, 2020). On other hand, entire national parks and wildlife sanctuaries under the Department of Forests and Park Services (DoFPS) have their own mammal checklists attached with their Conservation Management Plans. While some have separate printed checklist books as well as published scientific papers. For instance, Jomotsangkha Wildlife Sanctuary [JWS], Phibsoo Wildlife Sanctuary [PWS], Jigme Dorji National Park [JDNP], and Jigme Khesar Strict Nature Reserve [JKSNR] have a separate printed checklist of mammal's books that has recorded 34, 36, 33 & 41 species of mammals respectively (JWS, 2018; PWS, 2019; Koirala and Jamtsho, 2019; JKSNR, 2020). Thus, the existence of a structured mammal checklist in the protected areas (PAs) has not only helped in developing pragmatic management plans but also ensures in developing effective conservation policies (Esmaeili *et al.*, 2017).

However, none of the Non-Protected Areas (NPAs) managed by 14 Divisional Forests Offices (DFOs) under DoFPS and districts have structured checklist of mammal species published till date. The DFOs were established long before 1957 which is before the inception of the Protected Areas management system in Bhutan (Forest Resource Management Division [FRMD], 2019). Nationwide Tiger survey of 1989 was the first-ever scientific study in Bhutan, that covers both PAs and NPAs including Sarpang district (Dorji and Santiapillai, 1989), followed by second (McDougal and Tshering, 1998)& third nationwide tiger survey in 2014-2015 (DoFPS, 2015). Later, nationwide elephant's survey in 2016; selective tiger monitoring survey in 2018, and rapid biodiversity assessment [RBA]inside & outside Biological Corridor-03 [BC-03] in 2019 have covered representable areas of Sarpang district (Tenzin *et al.,* 2021). However, the district still lacks comprehensive inventories of mammal species except for a few scanty studies on felid species by Tenzin *et al*. (2019) and Tenzin *et al*. (2021) in the light of rapidly changing ecosystems in Bhutan (Dhendup and Dorji 2018; Penjor *et al.,* 2018). Therefore, the paper aims to document first-ever checklists, determine relative species abundance, and conservation status of mammal species through consolidation of past camera traps data (2014-2020) to facilitate periodic monitoring and management of wildlife species under the jurisdiction of Sarpang district in Bhutan.

MATERIALS AND METHODS

Study area

Sarpang district has a total geographical area of 1,655.37 Km² located in between 26°52' North and 90°16' East (Ministry of Work & Human Settlement [MoWHS], 2019) in the southern central part of Bhutan (Figure 1). The district falls within the convergences of three ecologically-diverse protected areas (RMNP, JSWNP, and PWS) of Bhutan, connected to each other by BC-03 (Tenzin *et al*., 2021). The district shares the southern border with the Northeast state of Assam, India which has further connected their landscapes with the Royal Manas National Park [RMNP] and Indian Manas National Park [MNP] towards the east. While PWS in the west connects with Buxa Tiger Reserve [BTR] in West Bengal. Thus, the entire integration of RMNP, MNP, PWS, and BTR landscapes has holistically formed one of the biggest tiger conservation landscapes called, "Northern Forest Complex-Namdhapha-Royal Manas (NFC-N-RM)" in Eastern Himalayas (Tempa, 2017; Tempa *et al.,* 2019; Tenzin *et al.,* 2021).

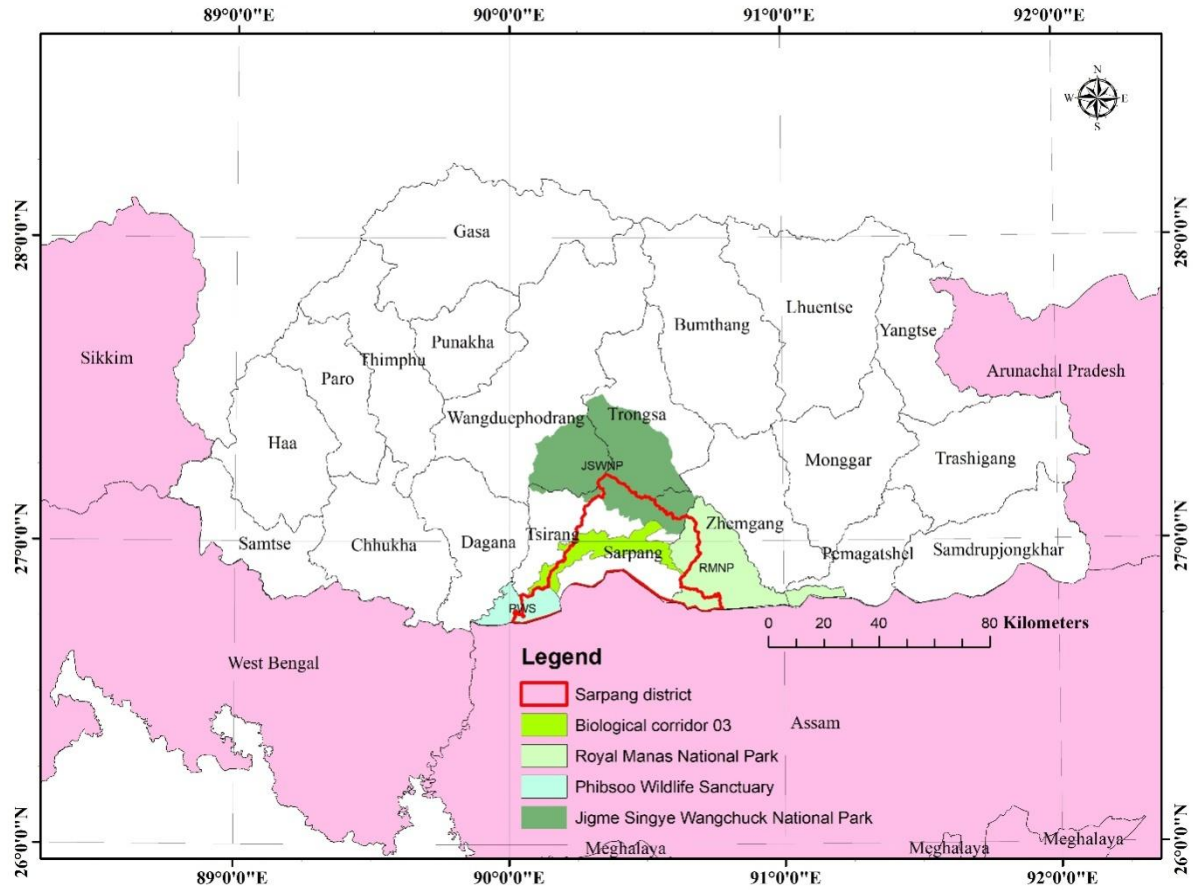

Figure 1. Bhutan map showing the location of Sarpang district (red outline) in between the three ecologically diverse protected connected each other by Biological corridor-03 in the south-central part of Bhutan.

Elevation ranges from 153 to 3,506 masl (Tenzin *et al*., 2018) with annual precipitation of 3,500 – 5,500 mm (DOA, 2012). The district has a diverse forest type: sub-tropical broadleaved (153-1000), warm broad forest (1000-2500), and cool broadleaved forest (2500-3000) (Oshawa, 1987). Sarpang district alone has a total population of 46,004 that lives in 10,369 households across the 12 blocks (NSB, 2018).

Data collection

Camera Traps

Data were collected using a camera trap of Nationwide Tiger Survey [NTS] (2014-2015); National Elephants survey (2016); selective tiger monitoring camera trap survey (2018), RBA inside BC-03 (2019), and Rapid assessment of tiger and prey habitats (2020), which together had covered representable area of the Sarpang district. A total of 70 camera traps were stationed inside 35 grids (grid sizes of 5 x 5 km) under Sarpang during NTS (2014-2015). While, 11 camera traps were selectively stationed inside NTS grids in 2018 and another 37 camera traps (grid sizes of 4 x 4 km) during the recent RBA and Conservation Assured Tiger Standards [CA|TS] survey (Tenzin *et al.,* 2019; Tenzin *et al.,* 2021). In the case of NTS, two cameras/grid were stationed along trails for the periods of seven months (DoFPS, 2015), while, one camera traps/grid were used during RBA, selective tiger monitoring, and CA|TS survey respectively for the period of three months due to limited camera traps and budgets. Meanwhile, cameras like Reconyx, Cuddle back, U-way, and Scout guard were used and stationed 45–50 cm above the ground.

Field Observation

On-site photographs of mammal species captured from the jurisdiction of Sarpang Forest Division were also included in this mammal checklists. Species were identified using mammals of Bhutan (Wangchuck *et al*., 2004) and Mammals of the Indian sub-continent (Menon, 2012). Relative

species abundance and conservation status of each species as per International Union for Conservation of Nature [IUCN], Convention on International Trade in Endangered Species of Wild Fauna and Flora [CITES] and Forest and Nature Conservation Act of Bhutan [FNCAB] (1995) were also been provided for better information.

Data analysis

Data of entire camera traps images were sorted, segregated, and analyzed using Renamer software (Sanderson and Harris, 2012) and generated the mammal checklists. While the determination of relative species abundance and updation of conservation status were carried out using the Pivot table of MS excel 2016.

RESULTS AND DISCUSSION

Sarpang Forest Division (SFD) had carried out five extensive division-wide camera traps survey which had recorded a total of 36 mammal species that belong to 18 families under seven orders (Table 1 & 2).

Table 1. Lists of mammal species and its distribution range in Bhutan.

Sl.#	Scientific Name	Distribution Range	Source
	Order Rodent **Family: Hystricidae**		
1	*Atherurus macrourus,* Linnaeus, 1758 Asiatic Brush-tailed porcupine	PWS, RMNP, Sarpang	Wangchuk *et al.,* 2004; PWS, 2019.
2	*Hysterix bracyhura,* Linnaeus, 1758 Himalayan crestless porcupine	JKSNR, JWS, PWS and Sarpang	Koirala and Jamtsho 2019; PWS, 2019; JKSNR, 2020.
	Order Carnivora **Family: Felidae**		
3	*Catopuma temmincki,* Vigors and Horsfield, 1827 Asiatic golden cat	RMNP, JSWNP, JKSNR, PWS, Sarpang and Gedu (Chukha)	Tempa *et al.,* 2011; Dorji *et el.,* 2017; Koirala and Jamtsho, 2019; PWS, 2019; Tenzin *et al.,* 2019; JKSNR, 2020.
4	*Neofelis nebulosa,* Griffith 1821 Clouded leopard	JSWNP, JKSNR, Gedu(Chukha), RMNP and Sarpang	Tempa *et al.,* 2011; Koirala and Jamtsho, 2019. Penjor *et al.,* 2019, PWS, 2019; Tenzin *et al.,* 2019;
5	*Panthera pardus,* Linnaeus, 1758 Common leopard	JSWNP, JKSNR, PNP, RMNP also from Sarpang	Tempa *et al.,* 2011; Koirala and Jamtsho 2019; Tenzin *et al.,* 2019; JKSNR, 2020.
6	*Prionailurus bengalensis,* Kerr 1792 Leopard cat	BWS, JSWNP, JKSNR, RMNP and also from Sarpang.	Tempa *et al.,* 2011; Koirala and Jamtsho 2019; Tenzin *et al.,* 2019; JKSNR, 2020.
7	*Parofelis marmorata,* Martim 1837 Marbled cat	RMNP, Lamaigonpa (Bumthang), JDNP, PWS, JKSNR also from Sarpang.	Tempa *et al.,* 2011; Koirala and Jamtsho, 2019; Tenzin *et al.,* 2019; Dhendup and Tenzin, 2020; JKSNR, 2020.
8	*Panthera tigris,* Linnaeus, 1758 Tiger	Sarpang, Zhemgang, Gasa, Trongsa, Bumthang, Trashigang and JKSNR, JDNP and PWS	Wangchuk *et al.,* 2004; DoFPS, 2015; Koirala and Jamtsho, 2019; Tenzin *et al.,* 2019; JKSNR, 2020.
	Order: Carnivora **Family: Canidae**		
9	*Cuon alpinus primaevus* Pallas, 181 Wild dog	JDNP, JKSNR, JSWNP, JWS, PWS, RMNP and Sarpang	Wangchuk *et al.,* 2004; JWS, 2018; PWS, 2019; Koirala and Jamtsho, 2019; JKSNR, 2020.
	Order Carnivora **Family: Ursidae**		
10	*Ursus thibetanus laniger,* Cuvier 1823	JDNP, JKSNR, PWS, JWS,	Wangchuk *et al.,* 2004; JWS,

	Himalayan black bear	Thimphu and Paro & Sarpang	2018; Koirala and Jamtsho, 2019; PWS, 2019; JKSNR, 2020.
	Order Proboscidea **Family: Elephantidae**		
11	*Elephas maximus,* Linnaeus, 1756 Asian elephant	Samtse, Sarpang, Samdrup Jongkhar, Lhamoizhingkha (Dagana), JWS, PWS, RMNP.	Wangchuk *et al.,* 2004; Nature Conservation Division [NCD], 2018; PWS, 2019.
	Order Artiodactyla **Family: Cervidae**		
12	*Muntiacus mutjak,* Zimmermann, 1780 Barking deer	Distribution recorded across Bhutan	Wangchuk *et al.,* 2004; JWS, 2018; Koirala and Jamtsho, 2019; PWS, 2019; JKSNR, 2020.
13	*Bos gaurus,* C.H. Smith, 1827 Guar	RMNP, JWS, PWS, JKSNR, Bangtar (Samdrup Jongkhar), Nganglam (Pemagatshel), Sarpang.	Wangchuk *et al.,* 2004; JWS, 2018; Koirala and Jamtsho, 2019; JKSNR, 2020.
14	*Nemorhaedus goral,* Hardwicke, 1825 Himalayan goral	JDNP, JWS, PWS, RMNP, Rimchu (Gasa), Sarpang	Wangchuk *et al.,* 2004; Koirala and Jamtsho, 2019; PWS, 2019; JKSNR, 2020.
15	*Capricornis sumatraensis,* Hodgson, 1831 Himalayan serow	Deothang (Samdrup Jongkhar), RMNP, Khebethang(Wangdue), Sakteng (Tashigang), Barshong (Tsirang), Lingzhi, JDNP, PWS, JWS& Sarpang.	Wangchuk *et al.,* 2004; JWS, 2018; Koirala and Jamtsho, 2019; JKSNR, 2020.
16	*Cervus unicolor,* Kerr, 1792 Sambar	RMNP, JSWNP, JWS, SWS, JDNP, PNP &Sarpang	Wangchuk *et al.,* 2004; JWS, 2018; Koirala and Jamtsho, 2019; JKSNR, 2020.
17	*Axis porcinus,* Zimmermann, 1780 Hog deer	RMNP, PWS JWS, Singye, Serzhong, and Gelephu (Sarpang).	Wangchuk *et al.,* 2004
	Order Artiodactyla **Family: Suidae**		
18	*Sus scrofa,* Linnaeus, 1758 wild pig	Distribution recorded across Bhutan including Sarpang.	Wangchuk *et al.,* 2004; Koirala and Jamtsho, 2019; JWS, 2018; PWS, 2019; JKSNR, 2020.
	Order Rodentia **Family: Sciuridae**		
19	*Ratufa bicolor,*Sparrman, 1778 Malayan giant squirrel	JKSNR, JDNP, JWS and Sarpang	JWS, 2018; Koirala and Jamtsho, 2019; JKSNR, 2020.
20	*Dremomys lokriah,* Hodgson, 1836 Orange-bellied squirrel	JDNP, JKSNR and Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020.
21	*Callosciurus pygerythrus,* Geoffroy Saint-Hilaire, 1831 Hoary-bellied squirrel	Distribution recorded from Sarpang	
22	*Callosciurus erythraeus*, Pallas, 1799 Pallas squirrel	JDNP, JKSNR and Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020.
	Order Primates **Family: Cercopithecoidea**		
23	*Macaca assamensis,* M'clelland, 1840 Assamese macaque	Distribution recorded in between Thimphu-	Wangchuk *et al.,* 2004; Koirala and Jamtsho, 2019; PWS, 2019;

		Phuntsholing, Punakha, Trongsa, Zhemgang, Trashigang, JDNP, JKSNR, PWS, and Sarpang	JKSNR, 2020.
24	*Macaca mulatta,* Zimmermann, 1780 Rhesus macaque	RMNP and PWS and Sarpang.	Wangchuk *et al.,* 2004; JWS, 2018; PWS, 2019.
25	*Trachypithecus geei,* Khajuria, 1956 Golden langur	Trongsa, Zhemgang, Gelephu(Sarpang), RMNP, PWS and Tsirang	Wangchuk *et al.,* 2004; Thinley *et al.,* 2019; PWS, 2019.
	Order Primates **Family: Lorissidae**		
26	*Nycticebus bengalensis,* Lacepede, 1800 Bengal slow glories	RMNP, Jigmeling, Dekiling and Samtenling (Sarpang)	Wangchuk *et al.,* 2004; Thinley *et al.,* 2019.
	Order Carnivora **Family: Mustelidae**		
27	*Martes flavigula,* Bodaert, 1785 Yellow-throated marten	Distribution recorded throughout Bhutan including Sarpang	Wangchuk *et al.,* 2004; Koirala and Jamtsho, 2019;PWS, 2019; JKSNR, 2020.
	Order Carnivora **Family: Viverridae**		
28	*Paguma larvata,* C.E.H.Smith, 1827 Himalayan palm civet	Namling(Mongar), JDNP, and hilly area of Sarpang	Wangchuk *et al.,* 2004
29	*Viverra zibetha,* Linnaeus, 1758 Large Indian civet	Langthel (Trongsa), JKSNR, JDNP, PWS and Sarpang	Wangchuk *et al.,* 2004; PWS, 2019; Koirala and Jamtsho, 2019; JKSNR, 2020.
30	*Viverricula indica,* Geoffroy Saint-Hilaire, 1803 Small Indian civet	RMNP and PWS and Sarpang.	Wangchuck *et al.,* 2004
	Order *Carnivora* **Family: Herpestidae**		
31	*Herpestes urva,* Hodgson, 1836 Crab eating mongoose	RMNP, PWS, JDNP and JKSNR and Sarpang	Wangchuk *et al.,* 2004; Koirala and Jamtsho, 2019; PWS, 2019; JKSNR, 2020.
	Order Rodentia **Family: Muridae**		
32	*Mus musculus,* Linnaeus, 1758 House mouse	Distribution recorded from Sarpang	
33	*Mus Pahari,* Thomas, 1916 Sikkim mouse	Distribution recorded from Sarpang	
	Order Carnivora **Family: Mustelidae**		
34	*Arctonyx collaris,* Cuvier, 1825 Hog badger	RMNP including Sarpang	Wangchuk *et al.,* 2004
	Order Legomorpha **Family: Leporidae**		
35	*Lepus nigricollis,* F.Cuvier, 1823 Indian hare	Distribution recorded from southern foothills including Sarpang	Wangchuk *et al.,* 2004
	Order Pholidota **Family: Manidae**		
36	*Manis pentadactyla,* Linnaeus, 1758 Chinese pangolin	RMNP and Samdrup Jongkhar, Pelrithang jail	Wangchuk *et al.,* 2004

		area, and Gelephu (Sarpang)	

Note: JDNP: Jigme Dorji National Park; RMNP: Royal Manas National Park; JSWNP: Jigme Singye Wangchuck National Park; PNP: Phrumsengla National Park; PWS: Phibsoo Wildlife Sanctuary; JWS: Jomotsangkha Wildlife Sanctuary.

Relative Species Abundances

Relative species abundance is a measure of how common or rare a species is relative to other species in a defined location or community (McGill *et al.,* 2007). Analysis revealed that the relative species abundance under Felidae and Cervidae family has the highest individual (*n* = 17%) among 36 mammal species, followed by Sciuridae, Cercopithecoidae and Viverridae (*n* = 9%) and Hystricidae (*n* = 6%) respectively. While, Canidae, Herpestidae, Leporidae, Manidae, Melinae, Muridae, Mustelidae, Tupaiidae, Proboscidae, Pteromyidae, Suidae and Ursidae had lowest abundance in the study area (*n* = 3%) (Figure 2).

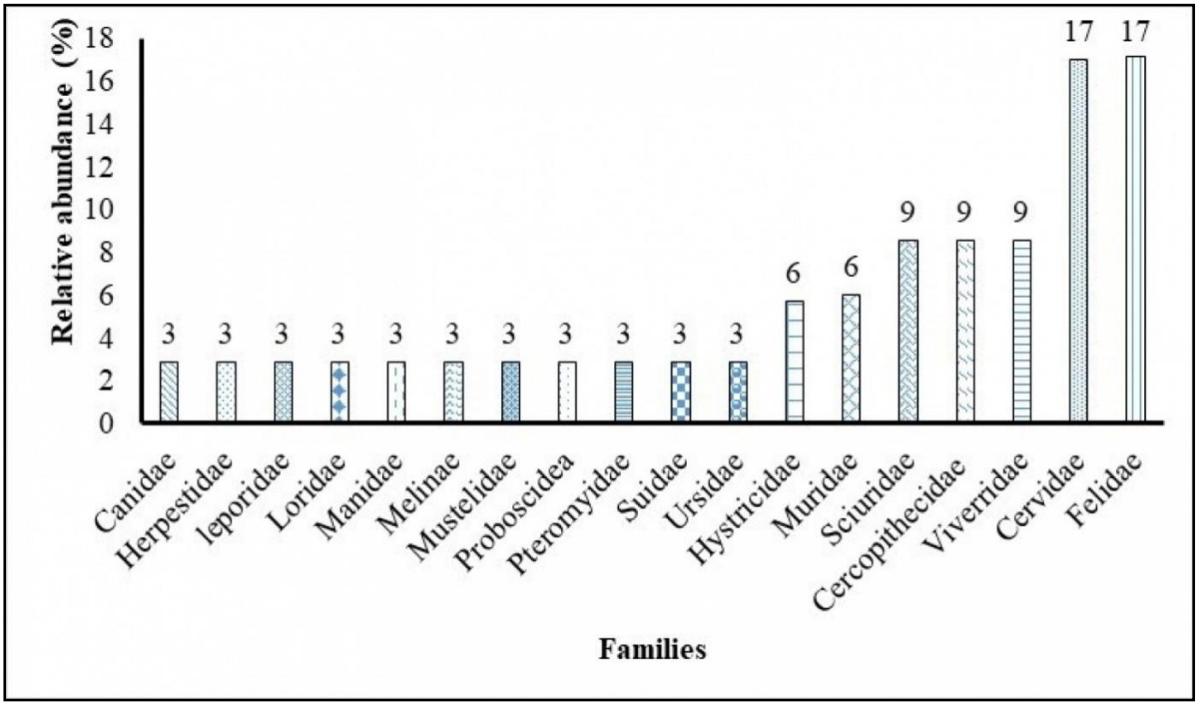

Figure 2. Relative species abundance of wildlife species (Families) under Sarpang district.

The highest records of felid species under Felidae in Sarpang could be due to the intact landscape connectivity with other ecologically riched protected areas of Bhutan such as RMNP, JSWNP, and PWS (Tenzin *et al.,* 2019; Tenzin *et al.,* 2021). Further, intact landscape connectivity and habitat contiguity also contributed to reporting six felid species from the southern central region of Sarpang (Tenzin *et al.* (2019) which is second to RMNP that had recorded eight felid species and declared as a Felid hotspot of Bhutan (Tempa *et al.,*2013; Tempa *et al.*, 2019). However, felid abundance, density, and distribution from Sarpang district is still remain understudied, that requires separate study in the future.

The wide distribution of ungulates under the Cervidae family indicates that Sarpang district landscape can support more Felid species. Tempa (2017) and Thinley *et al.* (2018) had suggested that the widespread presence of wild ungulates indicates a healthy ecosystem that can support more Felid population, especially tigers and other wild cats' species in the ecosystem. The studies of Tempa (2017) and Tempa *et al.* (2019) had also substantiated that abundant availability of bigger-sized ungulates such as gaur (*Bos gaurus* Smith 1827) and sambar (*Rusa unicolor* Kerr, 1792) also shows strong determinant to tiger occupancy especially in the central part of Bhutan. However, a concern of depleting prey species has been raised, due to poaching which contributes to the declining predator population in the wild (Karanth and Gopal, 2005; Seidensticker, 2010; Ripple *et al.,* 2014). Therefore, Divisional Forest Office at the district

level must step-up patrolling efforts and surveillances using Spatial Monitoring and Reporting Tools (SMART) Conservation software, across the landscapes to protect ungulates which in return will protect both bigger-sized & small Felid species that will help in maintaining the vibrant ecosystem in the southern landscapes of Bhutan.

Meanwhile, the district has relatively captured less mammal species that belong to Canidae, Herpestidae, Leporidae, Manidae, Melinae, Muridae, Mustelidae, Tupaiidae, Proboscidae, Pteromyidae, Suidae, and Ursidae family. This indicates that species of these families have a less species diversity, unlike Felid and Cervidae. Nevertheless, most of the past camera traps survey was targeted only at large-sized carnivores (Tiger) and ungulates (elephants) with bigger grid sizes due to larger home ranges. Thus, most of the lesser-known species were under-represented (Dhendup and Dorji, 2018). Therefore, a separate study on small-sized mammal species with smaller grid sizes is suggested to capture more lesser-known species in future studies.

Conservation Status of mammal species as per IUCN Redlist, CITES & FNCAB (1995)

The conservation status of mammal species present under Sarpang district were updated as per IUCN Red List for Threatened species (2019), CITES, and FNCAB (1995) for conservation purposes. Among 36 mammal species, 47% (*n*=17) of the species were categorized under LC, 22% NT (*n*=8) and 14% VU (*n*=5) and EN (*n*=5) respectively, while, 3% (*n*=1) are categorized under CR (Figure 3 & Table No. 3).

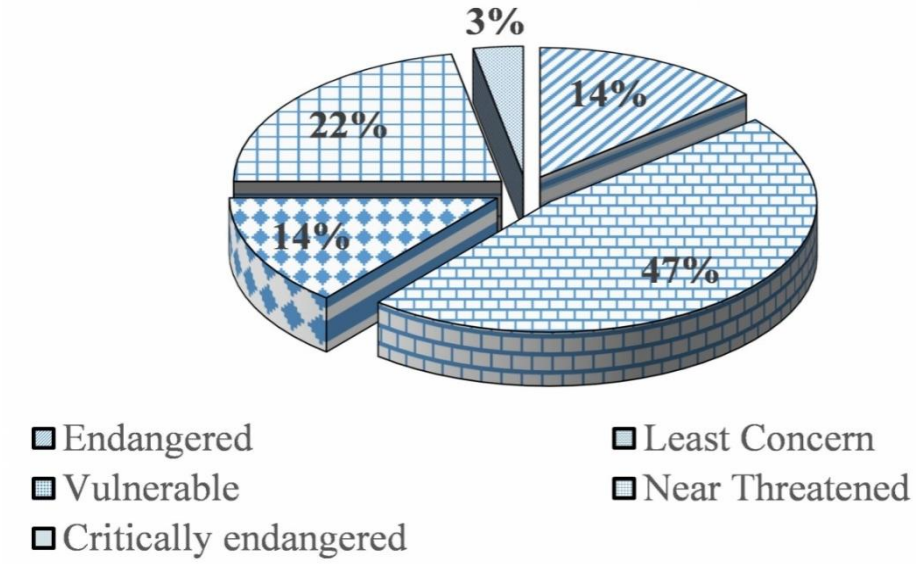

Figure 3. IUCN Conservation status of mammal species (%) found in Sarpang district.

Among 36 mammal species, only 11 mammal species were appended under CITES Appendix I, seven in appendix II, and two in Appendix III respectively (Figure 4). Therefore, any international trades of CITES listed mammal species (appendix I, II & III) must follow the specific legal obligation or international protocols before trading the mammal parts and derivatives to other countries (CITES, 1973). Likewise, only nine, among 23 mammal species were categorized under Schedule I which is legally protected under the FNCAB (1995) in Bhutan (Royal Government of Bhutan [RGoB], 1995).

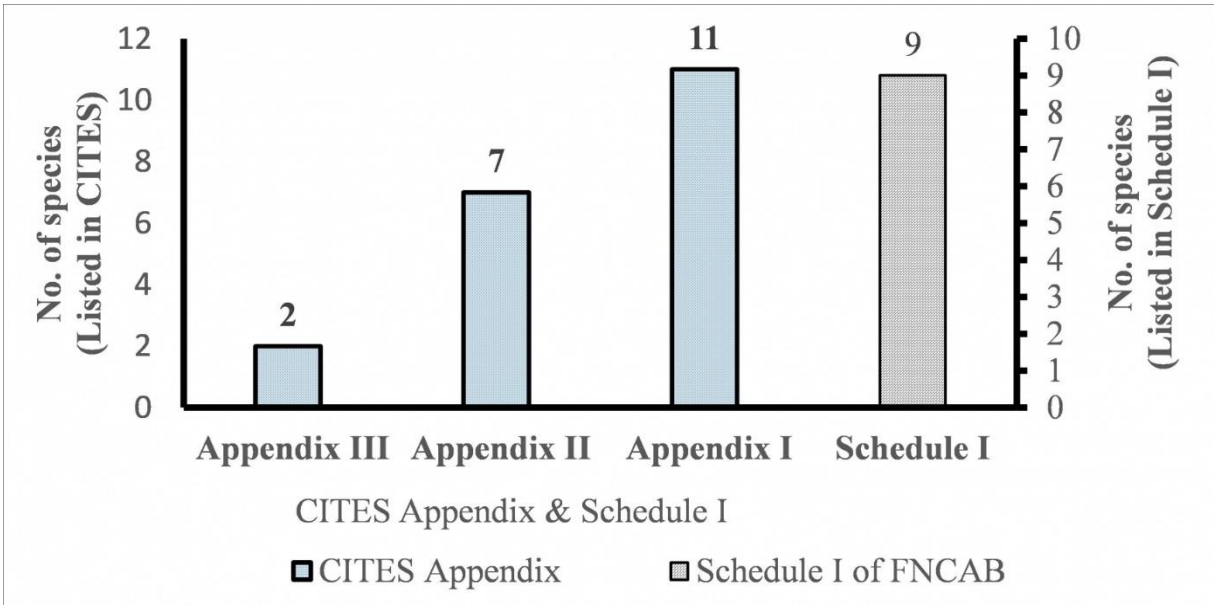

Figure 4. Mammal species are listed in CITES Appendix and Schedule I of Forests and Nature Conservation Act of Bhutan (1995).

With regards to conservation status, more than 50% (n =19) of checklist species were globally threatened which requires high conservation priority, especially under Sarpang district. However, since the district being outside the protected areas (Non-Protected Area), protection and conservation of those threatened species will be challenging, solely due to the lack of a structured Division-based Conservation plan, unlike the protected areas which leads to haphazard allocation of timber resources (rural as well as commercials purposes) from the core wildlife habitats. Further, Dhendup and Dorji (2018) and Tenzin *et al.* (2019) also reported that although regulations exist in the Non-protected areas, wildlife species might be threatened, since Divisional Forest Offices (DFOs) does a lot of forest management, resource allocation (subsidized/ commercials), and other forestry-related public service deliveries. Thus, the recent DoFPS initiative in preparing Division Management Plans for 14 Divisional Forest Offices under International Climate Initiative [IKI] project (WWF Bhutan) and Biological Corridor Management plan (funded by Bhutan for Life Secretariat [BFL) will address the above issues & secure the wildlife species under this landscapes in future.

On other hand, Bhutan has recorded more than 200 mammal species (Wangchuk *et al.,* 2004), only 23 mammal species (10%) are legally protected under Schedule I of FNCAB, 1995 (RGoB, 1995). Likewise, in the case of Sarpang district, only nine mammal species which includes Tiger (*Panthera trigris*), Common leopard (*Panthera pardus*), Clouded leopard (*Neofelis nebulosa*), Leopard cat (*Prionailurus bengalensis*), Golden langur (*Trachypithecus geei*), Asian elephant (*Elephas maxmus*), Himalayan black bear (*Ursus thibetanus laniger*), Guar (*Bos gaurus*) and Himalayan serow (*Capricornis sumatraensis*) were legally protected under Schedule I of FNCAB (1995) irrespective of their conservation status in IUCN and CITES. However, most of the mammal listed in schedule I of FNCAB (1995) requires critical review and species validation especially the occurrence of Rhinoceros (*Rhinoceros unicornis*), Pigmy hog (*Sus sylvanicus*), and Hapid hare (*Caprolagus hispidus*) in Bhutan. Because there is no valid scientific evidence supporting the presence of those species except a few scanty anecdote reports existed before the 1990s. Further, both common name and scientific names for pangolin and leopard listed in schedule I were vague and inconsistent (i.e. need to specify which species of pangolin and leopard species is it?) that requires immediate updation by the DoFPS. Therefore, species listed in schedule I require immediate review and validation by the DoFPS to make a consistent name (common and scientific name) and accordingly update the lists of Schedule I species in revised FNCAB (2022) in the future.

CONCLUSION

In summary, management of mammal diversity has become of utmost importance in light of rampant declining global mammal biodiversity due to anthropogenic activities, data deficiency, and climate change effects. Nevertheless, the availability of a structured mammal checklist in the PAs and NPA in Bhutan is the only solution to develop pragmatic conservation & management plans which can ensure effective future conservation policies. Therefore, the urgent requirement of landscape-based species conservation plans (i.e. Division or district-based conservation and management plan) for 14 DFOs and BC-03; periodic monitoring of existing keystone and other lesser-known species using camera traps and urgent validation of name of Schedule I species were suggested for long-term conservation and management of wildlife species under the jurisdiction of Sarpang district in future.

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