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

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ABSTRACT

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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 species protected by the mammal 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	PWS, RMNP, Sarpang	Wangchuk et al., 2004; PWS,
	Asiatic Brush-tailed porcupine		2019.
2	Hysterix bracyhura, Linnaeus, 1758	JKSNR, JWS, PWS and	Koirala and Jamtsho 2019; PWS,
	Himalayan crestless porcupine	Sarpang	2019; JKSNR, 2020.
	Order Carnivora		
	Family: Felidae		
3	Catopuma temmincki, Vigors and	RMNP, JSWNP, JKSNR,	Tempa et al., 2011; Dorji et el.,
	Horsfield, 1827	PWS, Sarpang and Gedu	2017;
	Asiatic golden cat	(Chukha)	Koirala and Jamtsho, 2019; PWS,
			2019; Tenzin <i>et al.</i> , 2019;
			JKSNR, 2020.
4	Neofelis nebulosa, Griffith 1821	JSWNP, JKSNR,	Tempa <i>et al.</i> , 2011; Koirala and
	Clouded leopard	Gedu(Chukha), RMNP and	Jamtsho, 2019. Penjor <i>et al.</i> ,
		Sarpang	2019, PWS, 2019; Tenzin <i>et al.</i> ,
			2019;
5	Panthera pardus, Linnaeus, 1758	JSWNP, JKSNR, PNP,	Tempa <i>et al.</i> , 2011; Koırala and
	Common leopard	RMNP also from Sarpang	Jamtsho 2019; Tenzin <i>et al.,</i>
		DUIG IGUAID HZOND	2019; JKSNR, 2020.
6	Prionailurus bengalensis, Kerr 1/92	BWS, JSWNP, JKSNR,	Tempa <i>et al.</i> , 2011; Koirala and
	Leopard cat	RMNP and also from	Jamtsho 2019; Tenzin <i>et al.</i> ,
7	D (1: 1027	Sarpang.	2019; JKSNR, 2020.
/	Parofelis marmorata, Martim 1837	KMNP, Lamaigonpa	Tempa <i>et al.</i> , 2011; Koirala and
	Marbled cat	(Bumthang), JDNP, PWS,	Jamtsno, 2019; Tenzin <i>et al.,</i>
		JKSNR also from Sarpang.	2019; Dhendup and Tenzin,
0	Dauthaug tiquig Linnagua 1750	Samana 7hamaana Casa	2020; JKSNK, 2020.
0	<i>Faninera ligris</i> , Linnaeus, 1738	Sarpang, Zhenigang, Gasa,	Wangenuk <i>et al.</i> , 2004; DOFPS,
	liger	Trongsa, Bunnung,	2015; Kolfala and Jamisho, 2019; Tampin at $al = 2010$; IKSND
		I Tashigang and JKSINK,	2020
	Order: Carnivora		2020.
	Family: Canidae		
9	Cuon alpinus primaevus Pallas 181	IDNP IKSNR ISWNP	Wangchuk <i>et al</i> 2004: IWS
	Wild dog	JWS, PWS, RMNP and	2018: PWS, 2019: Koirala and
		Sarpang	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 &	2018; Koirala and Jamtsho, 2019;
		Sarpang	PWS, 2019; JKSNR, 2020.
	Order Proboscidea		
	Family: Elephantidae		
11	Elephas maximus, Linnaeus, 1756	Samtse, Sarpang, Samdrup	Wangchuk et al., 2004; Nature
	Asian elephant	Jongkhar, Lhamoizhingkha	Conservation Division [NCD],
		(Dagana), JWS, PWS,	2018; PWS, 2019.
		RMNP.	
	Order Artiodactyla		
10	Family: Cervidae		
12	Muntiacus mutjak, Zimmermann,	Distribution recorded across	Wangchuk <i>et al.</i> , 2004; JWS,
	1/80 Barking deer	Bhutan	2018; Kolfala and Jamisho, 2019 ;
13	Bos agurus C H Smith 1827	PMND IWS DWS	Wangchuk <i>et al.</i> 2004: IWS
15	Guar	IKSNR Banatar (Samdrup	2018: Koirala and Jamtsho 2010:
	Guai	JASIAR, Bangtar (Samurup	IKSNR 2020
		(Pemagatshel) Sarnang	JK51(K, 2020.
14	Nemorhaedus goral Hardwicke, 1825	IDNP. JWS. PWS. RMNP.	Wangchuk <i>et al</i> 2004: Koirala
	Himalayan goral	Rimchu (Gasa). Sarpang	and Jamtsho. 2019: PWS. 2019:
			JKSNR, 2020.
15	Capricornis sumatraensis, Hodgson,	Deothang (Samdrup	Wangchuk et al., 2004; JWS,
	1831	Jongkhar), RMNP,	2018; Koirala and Jamtsho, 2019;
	Himalayan serow	Khebethang(Wangdue),	JKSNR, 2020.
		Sakteng (Tashigang),	
		Barshong (Tsirang),	
		Lingzhi, JDNP, PWS,	
		JWS& Sarpang.	
16	Cervus unicolor, Kerr, 1792	RMNP, JSWNP, JWS,	Wangchuk et al., 2004; JWS,
	Sambar	SWS, JDNP, PNP	2018; Koirala and Jamtsho,
15		&Sarpang	2019; JKSNR, 2020.
17	Axis porcinus, Zimmermann, 1/80	RMNP, PWS JWS, Singye,	Wangchuk <i>et al.</i> , 2004
	Hog deer	(Sarnang)	
	Order Artiodactyla	(Salpang).	
	Family: Suidae		
18	Sus scrofa. Linnaeus, 1758	Distribution recorded across	Wangchuk <i>et al.</i> , 2004: Koirala
_	wild pig	Bhutan including Sarpang.	and Jamtsho, 2019; JWS, 2018;
			PWS, 2019; JKSNR, 2020.
	Order Rodentia		
	Family: Sciuridae		
19	Ratufa bicolor, Sparrman, 1778	JKSNR, JDNP, JWS and	JWS, 2018; Koirala and Jamtsho,
	Malayan giant squirrel	Sarpang	2019; JKSNR, 2020.
20			
	Dremomys lokriah, Hodgson, 1836	JDNP, JKSNR and	Koirala and Jamtsho, 2019;
	Dremomys lokriah, Hodgson, 1836 Orange-bellied squirrel	JDNP, JKSNR and Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020.
21	Dremomys lokriah, Hodgson, 1836 Orange-bellied squirrel Callosciurus pygerythrus, Geoffroy	JDNP, JKSNR and Sarpang Distribution recorded from	Koirala and Jamtsho, 2019; JKSNR, 2020.
21	Dremomys lokriah, Hodgson, 1836 Orange-bellied squirrel Callosciurus pygerythrus, Geoffroy Saint-Hilaire, 1831	JDNP, JKSNR and Sarpang Distribution recorded from Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020.
21	Dremomys lokriah, Hodgson, 1836 Orange-bellied squirrel Callosciurus pygerythrus, Geoffroy Saint-Hilaire, 1831 Hoary-bellied squirrel Callosciurus anythragus Pallos 1700	JDNP, JKSNR and Sarpang Distribution recorded from Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020.
21	Dremomys lokriah, Hodgson, 1836 Orange-bellied squirrel Callosciurus pygerythrus, Geoffroy Saint-Hilaire, 1831 Hoary-bellied squirrel Callosciurus erythraeus, Pallas, 1799 Pallas squirrel	JDNP, JKSNR and Sarpang Distribution recorded from Sarpang JDNP, JKSNR and Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020. Koirala and Jamtsho, 2019; IKSNR, 2020
21	Dremomys lokriah, Hodgson, 1836Orange-bellied squirrelCallosciurus pygerythrus, GeoffroySaint-Hilaire, 1831Hoary-bellied squirrelCallosciurus erythraeus, Pallas, 1799Pallas squirrelOrder Primates	JDNP, JKSNR and Sarpang Distribution recorded from Sarpang JDNP, JKSNR and Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020. Koirala and Jamtsho, 2019; JKSNR, 2020.
21	Dremomys lokriah, Hodgson, 1836Orange-bellied squirrelCallosciurus pygerythrus, GeoffroySaint-Hilaire, 1831Hoary-bellied squirrelCallosciurus erythraeus, Pallas, 1799Pallas squirrelOrder PrimatesFamily: Cerconithecoidea	JDNP, JKSNR and Sarpang Distribution recorded from Sarpang JDNP, JKSNR and Sarpang	Koirala and Jamtsho, 2019; JKSNR, 2020. Koirala and Jamtsho, 2019; JKSNR, 2020.
21	Dremomys lokriah, Hodgson, 1836Orange-bellied squirrelCallosciurus pygerythrus, GeoffroySaint-Hilaire, 1831Hoary-bellied squirrelCallosciurus erythraeus, Pallas, 1799Pallas squirrelOrder PrimatesFamily: CercopithecoideaMacaca assamensis M'clelland, 1840	JDNP, JKSNR and Sarpang Distribution recorded from Sarpang JDNP, JKSNR and Sarpang Distribution recorded in	Koirala and Jamtsho, 2019; JKSNR, 2020. Koirala and Jamtsho, 2019; JKSNR, 2020. Wangchuk <i>et al.</i> , 2004: Koirala

		Phuntsholing, Punakha,	JKSNR, 2020.
		Trongsa, Zhemgang,	
		Trashigang, JDNP, JKSNR,	
		PWS, and Sarpang	
24	Macaca mulatta, Zimmermann, 1780	RMNP and PWS and	Wangchuk et al., 2004; JWS,
	Rhesus macaque	Sarpang.	2018; PWS, 2019.
25	Trachypithecus geei, Khajuria, 1956	Trongsa, Zhemgang,	Wangchuk et al., 2004; Thinley
	Golden langur	Gelephu(Sarpang), RMNP,	et al., 2019; PWS, 2019.
	C C	PWS and Tsirang	
	Order Primates		
	Family: Lorissidae		
26	Nycticebus bengalensis, Lacepede,	RMNP, Jigmeling, Dekiling	Wangchuk et al., 2004; Thinley
	1800	and Samtenling (Sarpang)	<i>et al.</i> , 2019.
	Bengal slow glories		
	Order Carnivora		
	Family: Mustelidae		
27	Martes flavigula. Bodaert. 1785	Distribution recorded	Wangchuk et al., 2004: Koirala
	Yellow-throated marten	throughout Bhutan	and Jamtsho. 2019:PWS. 2019:
		including Sarpang	JKSNR. 2020.
	Order Carnivora		51101(11, 2020)
	Family: Viverridae		
28	Paguma larvata C.E.H.Smith, 1827	Namling(Mongar), JDNP.	Wangchuk <i>et al</i> 2004
20	Himalayan palm civet	and hilly area of Sarpang	Wangenan et al., 2001
29	Viverra zibetha Linnaeus 1758	Langthel (Trongsa)	Wangchuk et al 2004: PWS
2)	Large Indian civet	IKSNR IDNP PWS and	2019: Koirala and Jamtsho
		Sarpang	2019, itomata and samsio, 2019 it SNR 2020
30	Viverricula indica	RMNP and PWS and	Wangchuck <i>et al</i> 2004
50	Geoffroy Saint-Hilaire 1803	Sarpang	Wangendek er un, 2004
	Small Indian civet	Surpang.	
	Order Carnivora		
	Family: Hernestidae		
31	Hernestes urva Hodgson 1836	RMNP PWS IDNP and	Wangchuk et al. 2004: Koirala
51	Crab eating mongoose	IKSNR and Sarnang	and Jamtsho 2019: PWS 2019:
	Crub curing mongoose	sites with and surpung	IKSNR 2020
	Order Rodentia		51151(11, 2020)
	Family: Muridae		
32	Mus musculus Linnaeus 1758	Distribution recorded from	
	House mouse	Sarpang	
33	Mus Pahari, Thomas, 1916	Distribution recorded from	
	Sikkim mouse	Sarpang	
	Order Carnivora	~	
	Family: Mustelidae		
34	Arctonyx collaris Cuvier, 1825	RMNP including Sarpang	Wangchuk <i>et al</i> 2004
	Hog badger	5	o
	Order Legomorpha		
	Family: Leporidae		
35	Lepus nigricollis. F.Cuvier. 1823	Distribution recorded from	Wangchuk et al., 2004
	Indian hare	southern foothills including	o
		Sarpang	
	Order Pholidota		
	Family: Manidae		
36	Manis pentadactyla. Linnaeus, 1758	RMNP and Samdrup	Wangchuk et al., 2004
	Chinese pangolin	Jongkhar, Pelrithang jail	

	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 biggersized 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 lesserknown 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

summary, management of mammal In diversity has become of utmost importance in light of rampant declining global mammal biodiversity due to anthropogenic activities, data deficiency, and effects. Nevertheless, climate change the availability of a structured mammal checklist in the PAs and NPA in Bhutan is the only solution to develop pragmatic conservation & management which effective plans can ensure 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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