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Research Paper

Diversity and Conservation Status of Large Mammals in Ghamot National Park, Azad Jammu and Kashmir, Pakistan

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Abstract

We evaluated the abundance and diversity of the large mammals in Ghamot National Park (GNP), Neelum Valley, Azad Jammu and Kashmir, Pakistan, and compared these parameters across four different habitat types (forest, riparian, scrub, and wetland) and seasons during 2020-2021. A total of 66 line transect surveys (with 53 km total length) were carried out across all study sites. In terms of sampling yield, indirect observations had the highest sitting at (n=131; 76.60%) while the least was from direct observations (n=40; 23.39%). Fecal droppings were the most common type of indirect evidence (n=73; 55.72%), followed by footprints (n=29; 9.94%), and dens/latrines (n=19; 14.50%). Using direct and indirect field evidence, we identified 14 species of mammals from 6 families. Four species (28.57%) were directly observed, including *Canis aureus, Vulpes vulpes, Macaca mulatta*, and *Semnopithecus ajax*, whereas the remaining ten (71.42%) were observed indirectly. In terms of global (IUCN) conservation status, two species were Endangered, three were vulnerable and other three were near threatened. Species richness varied greatly across the seasons among the four habitat types. Irrespective of summer-winter seasons diversity indices were recorded highest in riparian zones (H=3.14) followed by forests (H=2.88), and agriculture lands (H=2.73). The forest and riparian zones had the highest similarity in species composition, both between and among seasons. The findings of this study provide a baseline for park management to make effective conservation decisions, as well as for researchers conducting similar ecological studies.

Introduction

Protected areas are geographic regions designated and managed to safeguard biodiversity, preserve ecosystems, and protect endangered species from anthropogenic pressures. According to Bernard et al. (2014) and Locke and Dearden (2005), the primary strategy for biodiversity conservation and climate change adaptation or mitigation is to create protected places, such as national parks. Accordingly, the size and number of protected areas is increasing globally (Bernard et al., 2014). Although protected areas are heavily relied upon as a conservation approach and despite rising trends, many protected areas run the risk of failing to meet the precise conservation objectives for which they were initially established (Bernard et al., 2014; Struhsaker et al., 2005). The main obstacles to achieving the conservation objectives for protected areas are increased anthropogenic risks, inadequate management systems, and scarce resources. Failure of protected areas management not only cause the extinction of species but also the disturbance of ecosystem processes and the loss of ecosystem services and benefits that human rely on (Bruner et al., 2001; Bernard et al., 2014).

Several studies have highlighted that the anthropogenic disturbances have the greatest impact on different regions, particularly the Southeast Asia (Barlow et al., 2016; Hughes, 2017; Tilker et al. (2019). A serious threat to the wildlife population of these regions has been the rise in demand for wildlife and wildlife related goods in recent past (Peres, 2010; Alroy, 2017; Symes et al., 2018). Particularly the large mammals need vast home ranges to locate appropriate food, and because they frequently engage in conflict with humans, which make them more vulnerable to environmental disturbance (Ripple et al., 2016, 2017).

Owing to their need for extensive home ranges, mammals serve as umbrella species in terrestrial ecosystems and aid in the preservation of other species. Large (weighing more than 7 kg) and medium-sized mammals (between 2 and 7 kg) play crucial roles in the ecosystem. Mammals play important roles in grazing, predation, and seed distribution in many ecosystems worldwide (Geleta & Bekele, 2016). In addition, they offer crucial human advantages, including food, entertainment, and revenue (MEA, 2005).

Threats to medium- and large-sized animals are widespread (Kasso & Bekele, 2014). The two greatest risks to mammals are habitat loss by deforestation and harvesting (hunting and gathering for food, medicine, fuel, and materials) (Ripple et al., 2016; Tabor et al., 2020). The number of species categorized as Critically Endangered (169–203 species) and Endangered (315–

506 species) between 1996 and 2020 indicates that threats to the world's mammal biodiversity are intensifying (IUCN, 2020). A disproportionate number of vulnerable mammals reside in tropical Asia, and under the status quo, between 9% and 36% of the mammals living in the lowland forests of tropical Southeast Asia are predicted to become extinct by the year 2100 (Wilcove et al., 2013).

The majority of protected areas in developing countries are not properly managed, and most nations in this region, which are rich in biodiversity and are rapidly developing, have insufficient political commitment to bridge the gap in biodiversity protection (Watson et al., 2014). The future of biological diversity in such protected regions, especially those of developing tropical and subtropical nations such as Pakistan, is therefore in doubt unless adequate conservation measures are put in place. Basic knowledge of biodiversity in terms of species checklists of fauna and flora, as well as the distribution and habitat usage of wildlife species in these protected areas is crucial for developing effective conservation strategies. These data help conservation organizations and decision-makers to manage the protected areas accordingly and precisely through successful conservation measures (Bernard et al., 2014; Thomas & Middleton, 2003).

Pakistan is not a biogeographically isolated region, because it is mostly surrounded by artificial borders. Thus, Pakistan has comparatively low rates of endemism for some species. There are 174 known mammalian species with at least three indigenous species found in Pakistan (Baig & Al-Subaiee, 2009). The protected areas in Pakistan and Azad Jammu and Kashmir State (AJ&K) include national parks, wildlife sanctuaries, and game reserves. The laws governing wildlife management are either insufficient or not implemented properly. The regulations provide provincial wildlife department authorities with the ability to manage protected areas, but due to unavailability of required resources proper management is scarce in most of the protected areas (Khan, 2004; Manzoor et al., 2013; GoAJK, 2018).

The state of AJ&K has established 18 protected areas, comprising eight national parks (with 99,191 ha area) and 12 game reserves (14,164 ha), totaling 113,355 ha covered area, which comprises about 8.5 percent of the state's area (Marwat, 2011; GoAJK, 2018). However, very limited scientific data is available about the biodiversity of most of these protected areas. The current study evaluated the abundance, diversity, and community structure of the large mammals in Ghamot National Park (GNP), Neelum Valley, AJ&K, Pakistan, and compared these parameters across four different habitat types (forest, riparian, scrub, and wetland) and seasons. This study aimed to establish a baseline data for park management to make effective conservation decisions, as well as for researchers conducting similar ecological studies (Li & Quan, 2017). The study focused on larger mammals, considering that they are often more threatened with extinction than small mammals (Liow et al., 2008).

Materials and methods

Study Area

The Ghamot National Park (GNP) is located in the upper Neelum Valley, an area of the inner Himalayas, 170 km north to Muzaffarabad, the capital of AJ&K State. The study area is located between 2439 and 4949 meters above the sea level, within longitude 73°57 E and latitude 35°24 N (Figure 1). Khyber Pakhtunkhwa's Kaghan Valley is located on its western side, while Indian-the Indian occupied Jammu & Kashmir borders it on the eastern side (Jahangeer et al., 2023; 2024). The study area features steep, uneven topography with deep valleys and high peaks, characterized by hilly terrain (Qamar et al., 2005; GoAJK, 2018).

The Neelum Valley is located in the subtropical and temperate highland climatic zone. Although the climate changes with elevation, the forest areas can be classified as alpine pastures, subalpine scrubs, moist temperate woods, or dry temperate forests. Summers are mild and pleasant, while winters are bitterly cold with a lot of snow. At high altitudes, snow may linger until June or even later (glaciers). The Pakistan Meteorological Department does not have the meteorological data record for the Neelum Valley (Qamar et al., 2005; Qamar et al., 2008; Jahangeer et al., 2023; 2024).

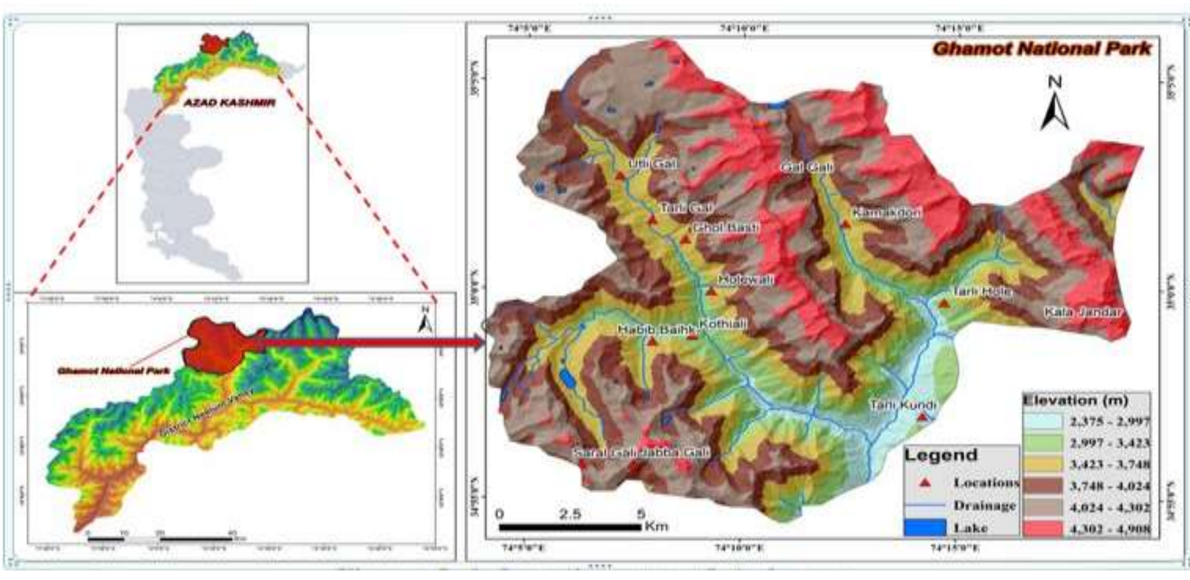

Figure 1: Location map of the study area (Ghamot National Park)

The study area is situated close to the junction of the Hindu Kush, Karakorum, and Himalayan Mountain systems which result in a rich floral and faunal diversification in this part of the globe. The study area is home to several rare and globally threatened wildlife species, such as the Snow leopard (*Uncia uncia*), Himalayan ibex (*Capra ibex*), Common leopard (*Panthera pardus*), Musk deer (*Moschus chrysogaster*), Black Bear (*Ursus thibetanus*), Grey Wolf (*Canis lupus*), Brown Bear (*Ursus arctos*) and Monal pheasant (*Lophophorus impejanus*). The study area also provide habitat to hundreds of economically and medically important plant species including *Cedrus deodara, Abies pindrow, Pinus willichiana, Aesculus indica, Picea smithiana, Sassurea lappa, Viburnum nervosum,* and *Pyrus pashia*. (Qamar et al., 2008; Khan et al., 2010; Baig, 2012; Khan et al., 2005 (Qamar et al., 2005; Qamar et al., 2008; Khan et al., 2010; Baig, 2012; Khan et al., 2012; Abbas et al., 2014; Ali et al., 2018; Jahangeer et al., 2023; 2024).

Data collection

The study area was divided into various zones. The topography, vegetation, aspect, elevation, and slope of the area were taken into consideration for this purpose. Five zones were identified within the study area: riparian zone (RZ, 2400-3600m), high alpine pasture zone (APZ, 3400-4400m), scrubland zone (SLZ, 2800-3200m), forest zone (FZ, height varying from 2400-3300m), and agricultural cropland zone (ACZ, 2300-2700m). Twenty distinct localities were identified by further subdividing these five zones. The vegetation characteristics in different localities in each zone was similar, however, there were differences in terms of aspect, slope, and elevation. Five localities (FZL1-FZL5; forest zone "FZ," locality "L," number "1-5") made up the forest zone. Similarly, three localities (SLZL1-SLL3; scrubland "SL," zone "Z," locality "L," and "number" 1-3") were identified within the scrubland zone. There were four localities in the alpine pasture zone (APZL1-APZL4; alpine pasture "AP"). The riparian area was divided into five localities (RZL1-RZL5; riparian zone "RZ"). Lastly, the agricultural zone was divided into three localities (ACZ1-ACZ3; agricultural crop zone "ACZ") (Table 1, Figure 2). The zonation of the study area was performed using Arc Globe 10.4.1 a paid GIS software available to the Geology Department of the University of Azad Jammu and Kashmir and Planning and Development Department AJ&K. Previous studies and contour maps present in the AJ&K Forest Department were also used (Figure 3).

Figure 2: Large mammals survey riparian and forest zones (A, C), direct observation cannon binocular (B) and line transect searching a den (D)

For the large mammal survey, six locations that were typical of each habitat category were chosen. Using the fixed-width line transect survey approach, large mammals were sampled, including direct and indirect observations following Sutherland (2006). Throughout, 66 line transects totaling 41.5 km of significant habitat categories were created. Depending on the extent of the habitat, different numbers and lengths of line transects were laid: 8 in wetland habitats, 12 in scrublands, 17 in alpine pastures, and 29 in riparian and forest habitats (Girma et al., 2012).

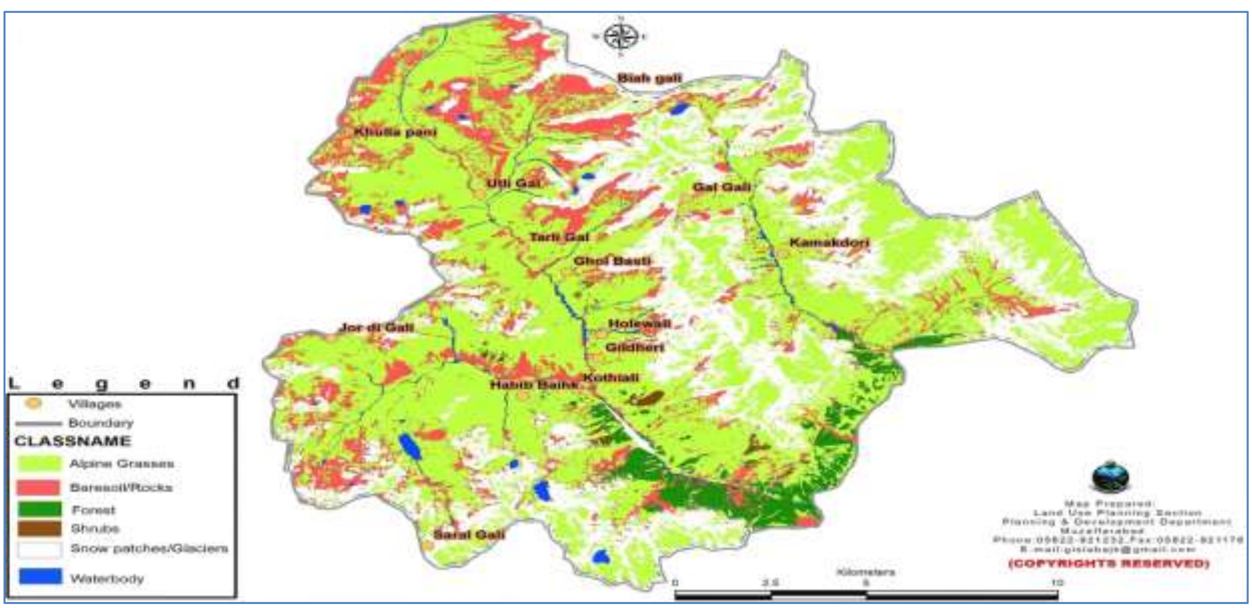

Figure 3: Land cover map of study area used as stratification of different zones

The average length of line transect survey was 500 meters, and fixed-sighting distances of 200 meters on both sides of transects were utilized in scrublands, wetlands, and alpine environments (Krebs, 2006). However, the riparian forest's viewing distance was limited to 100 m due to the thicker foliage, which made it difficult to accurately observe and identify creatures beyond 100 m from the transect lines (Alves et al., 2014; Gonfa et al., 2015). Large carnivore spatial distributions were assessed by landscape-scale sign surveys, which can also clarify the variables influencing their local presence and ecological processes (Karanth et al. 2004). Fecal droppings, feed tracks, footprints, dens, territorial markings, spines, calls, and other indirect evidence were also noted in addition to direct observations (Sutherland, 2006).

The large mammal sample survey was carried out during August 2020 to June 2021. Given that animals are believed to be more active during morning hours, surveys were conducted between 05:00 am and 12:00 pm, and in the late afternoon (16:00-18:30). Data collected from repeated visits of all transects in two seasons were used for analysis (Mengesha & Bekele, 2008; Girma et al., 2012). While moving smoothly along each transect, direct (added cannon binocular, 750 mm, and 840 mm) and indirect data collection were performed. Time, date, habitat, special traits (behavior, coloration, body size), number of individuals, location, and elevation were recorded using GPS (eTrax 10 Garmin).

Conservation Status

The local conservation status (LCS) of recorded large mammalian species was determined based on abundance (based on total individuals count= specimens collected, number of direct observations, collected indirect evidence) in the study area. The formula used to calculate the LCS was "LCS=∑ns /∑NS x100," where "∑" sum, "ns" individual of same species in all localities, and "NS" number of individuals of all species in all localities. The definition of abundance was percentage abundance, or "AP." Following Jahangeer et al. (2023), LCS was divided into four classes: abundant (A), common (C), becoming rarer (BR), and rare (R).

Data analysis

Direct and indirect evidences were used to identify large mammalian species following Z.B Mirza (1998). Following Abie et al. (2021), the Shannon-Weiner Species Diversity Index was calculated using formula: $H' = -\sum Pi * \ln(Pi)$. Where Pi is the proportion of ith species. This index

Table 1: Zonation, localities elevations, coordinates; transect number and length, total covered area, and number of direct and indirect evidences in the study area.

Zones	Locality	Code	Elevation	Coordinates		#Transect and length (m)		Total area covered (km)	#Sample							
				N	E	500	1000		#Direct		#Indirect evidences					
											Fecal		Foot print		Dens/latrine	
									S	W	S	W	S	W	S	W
Forest Zone 2400-3500m	Samgam Mali	FZL1	2615	34.9007	74.1959	2	2	3	2	2	1		1			
	Ghamot	FZl2	2680	34.9465	74.2144	1	3	3.5			2	3		2		
	Rata Chang	FZL3	2780	34.9680	74.2253	1	1	1.5	1	2		4	3		4	
	Sora	FZL4	3310	35.0009	74.2200	2	3	4	2	2	2			2	3	
	Alihol	FZl5	3000	34.9971	74.2390	1	2	2.5							2	
Scrub Land Zone 2300-2800m	Alif Rakh	SLZL1	2510	34.9486	74.2240	2	3	4	1	3	4	3	3	1	1	
	Saral	SLZL2	2500	34.9393	74.2169	2	2	3	2	1	3	1	7		3	
	Surgan Nalah	SLZL3	2480	34.9328	74.2174	1	2	2.5	1		5	4		2		
Alpine pasture zone 3400-4400m	Habib Bhaik	APZL1	3420	34.9736	74.1309	1	2	2.5	2		6	1		2		
	Saral Sar	APZL2	4030	34.9882	74.0718	1	2	2.5			2		3			
	Kamakhodari Sar	APZL3	4120	35.0739	74.1799	1	2	2.5				2				
	Alihol Bek	APZL4	3780	35.0067	74.2419	1	2	2.5	2	2						
Riparian Zone 2300-300m	Samgam	RZL1	2460	34.9041	74.2004	1	1	1.5			2		1		2	2
	Saral	RZL2	2590	34.9455	74.2083	1	2	2.5	1	4	1	3		2		2
	Kamakhodari	RZL3	2980	34.9964	74.2333	2	2	3			1	1	1	3		
	Alihol	RZL4	2980	34.9962	74.2381	1	1	1.5								
	Kaley Janderan	RZL5	2750	34.9816	74.2423	1	2	2.5	2							
Agricultural zone 2400-2800m	Surgan Nalah	ACZL1	2500	34.9466	74.2214	1	2	2.5	3	1	6	4	2	1		
	Ghamot	ACZL2	2450	34.9439	74.2187	1	2	2.5	2	1	2	5		2		
	Kundi	ACZL3	2570	34.9563	74.2275	2	2	3	1		2	3	1	1		
						26	**40**	**53**	**22**	**18**	**39**	**34**	**21**	**18**	**15**	**4**

Key: Summer “S”, winter “W”

Results

Across all the localities with 66 line-transect surveys (53km), indirect observation was represented by maximum evidences (n=131; 76.60%) and least was represented by direct observation (n=40; 23.39%). Among indirect evidence, fecal dropping was most numerous (n=73; 55.72%) as compared with footprint (n=39; 29.80%) and dens/latrine (n=19; 14.50%). Among all the zones, the highest indirect evidences were (n=37) recorded in SLZ (elevation ranges between 2600-3600m). The second highest (n=28) number of evidences were recorded in the forest zone (elevation ranges between 2700-3450m) following AZ (n=28), RZ (n=21), and least in APZ (n=16) (elevation 4000-4400m; habitat type high alpine pastures) (Figure 4).

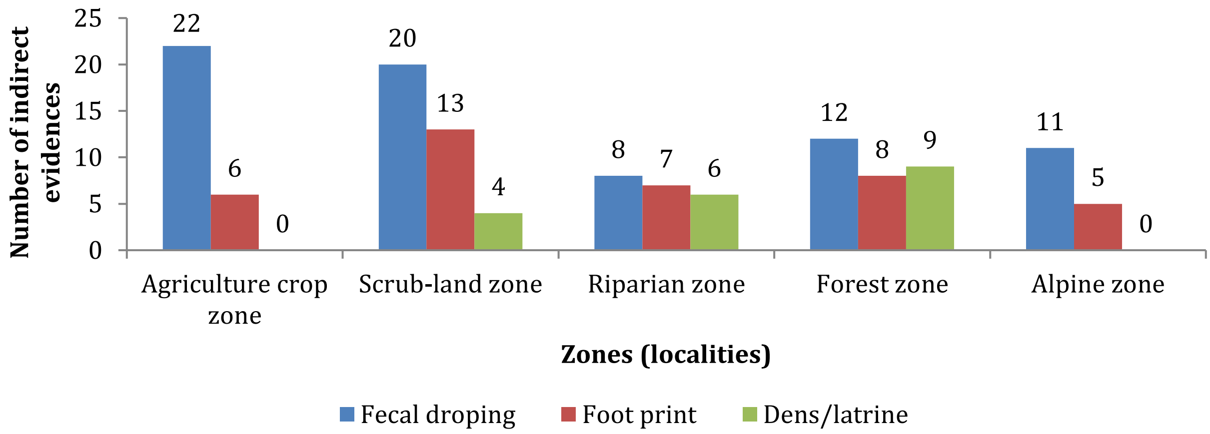

Figure 4: Large mammal's indirect evidences in the study area

Overall, a total of fourteen species belonging to six families were identified by direct and indirect field evidences. Unfortunately, in the present study directly encountered rate of species was recorded minimum and only four species (28.57%) were directly observed; including *Canis aureus, Vulpes vulpes, Macaca mulatta, and Semnopithecus ajax,* whereas the remaining ten species (71.42%) were indirectly observed. Direct and indirect observation was recorded maximum in winter (n=87; 50.88%) as compared with summer season (n=84; 49.12%).

Species richness varied among families. Canidae (n=3; 21.42%) and Felidae (n=3; 21.24%) families were represented by the highest number of species (three each). Ursidae, Bovidae, Moschidae, and Cercopithecidae were represented by two species (each), and the Viverridae family was represented by a single species. In terms of global (IUCN) conservation status, two species were Endangered, three were vulnerable and near threatened each. Similarly, based on local status, 9 species were Rare or becoming Rare, while others were abundant or common (Table 2).

Table 2. Large mammal abundance, richness, and conservation status in the GNP during 2020-21

Family	Species	Common Name	ACZ		SLZ		RZ		FZ				AZ		AP (%)	Status	
			L 1,2	L 1,2	L1,2,3	L1,2,3	L1,2,3,4	L1,2,3,4	L 1,2	L 1,2	L 3,4	L 3,4	L 1,2	L 1,2		LCS	IUCN
			S	W	S	W	S	W	S	W	S	W	S	W			
Felidae	*Uncia uncia*	Snow Leopard	0	0	0	0	0	0	0	0	0	0	2	1	1.75	R	VU
	Panthera pardus	Common Leopard	4	2	1	0	2	1	2	1	0	0	0	0	7.60	C	VU
	Prionailurus bengalensis	Leopard cat	2	2	1	4	0	2	0	0	0	0	0	0	6.43	BR	LC
	Lynx lynx	Eurasian lynx	0	0	0	0	0	0	0	0	0	3	2	1	3.51	R	NT
Ursidae	*Ursus thibetanus*	Himalayan Black Bear	2	1	0	2	1	1	1	0	0	0	0	0	4.68	R	VU
	Ursus arctos	Brown Bear	0	0	0	0	1	0	0	0	0	0	1	2	2.34	R	LC
Canidae	*Canis aureus*	Asiatic Jackal	10	11	2	3	0	4	0	0	0	0	0	0	17.54	A	LC
	Canis lupus	Indian Wolf	0	0	0	0	1	2	0	1	2	0	0	0	3.51	R	LC
	Vulpes vulpes	Common Red Fox	0	0	7	9	4	3	2	1	0	0	0	0	15.20	A	LC
Bovidae	*Capra sibirica*	Himalayan Ibex	0	0	0	0	0	0	0	0	0	0	2	0	1.17	R	NT
	Naemorhedus goral	Grey Goral	0	0	0	0	0	0	2	3	4	5	2	3	11.11	A	NT
Moschidae	*Moschus chrysogaster*	Himalayan Musk Deer	0	0	0	0	0	2	1	0	3	0	1	2	5.26	BR	EN
Cercopithecidae	*Macaca mulatta*	Rhesus Macaque	6	3	2	2	0	1	2	3	0	0	0	0	11.11	A	LC
	Semnopithecus ajax	Kashmir Grey Langur	5	4	1	2	3	0	0	0	0	0	0	0	8.77	C	EN

Key: agricultural lands "ACZ", scrublands "SLZ", riparian "RZ", forests "FZ", alpine "APZ", localities "L" number "1-4", summer "S", winter "W. local conservation status "LCS"; Abundant "A", Common "C", Becoming rare "BR" rare "R", not elevated "NE", least concern "LC", near threatened "NT" endangered "EN" vulnerable "VU" critically endangered "CR.

In terms of abundance, individuals varied among families and species. The abundant families by the number of observations were recorded as Canidae (n=62; 36.25%), whereas the least was Ursidae (7.01%) which included only 12 individuals. *Canis aureus* (n=30; 17.54%) and *Vulpes vulpes* (n=26; 15.20%) were the most abundant species in terms of the number of individuals recorded in all localities followed by *Macaca mulatta* (n=19; 11.11%), *Semnopithecus ajax* (n=15; 8.77%), *Panthera pardus* (n=13; 7.60%) whereas *Uncia uncia* (n=3;1.75%) and *Capra sibirica* (n=2;1.16%) were represented by least number of individual (Figure 5).

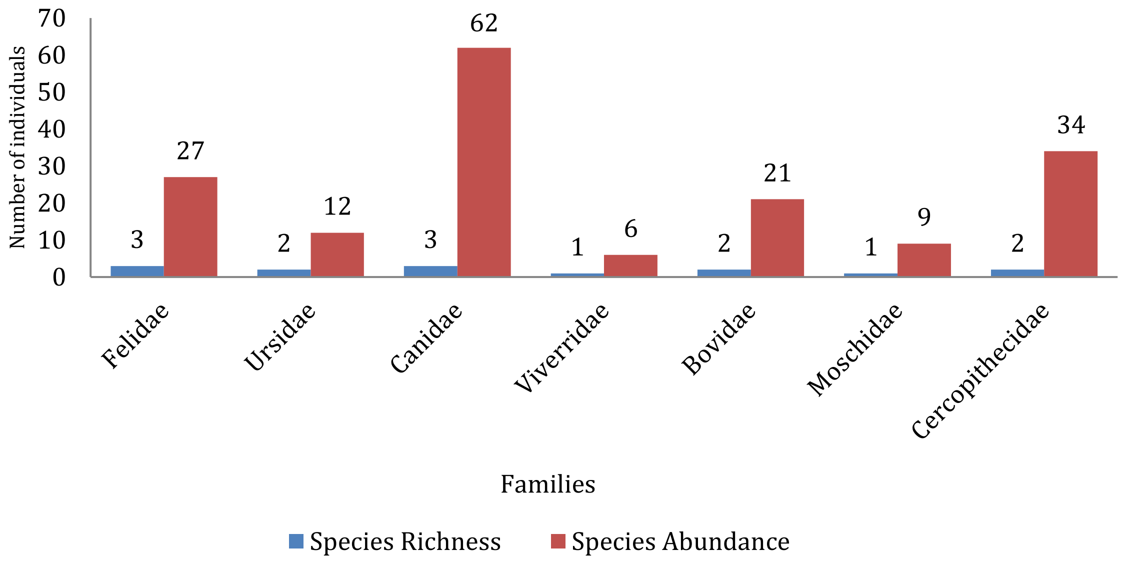

Figure 5: Large mammal's family's composition in the study area during study 2020-21

Across the localities and elevation species richness and abundance varied. Maximum richness (n=9) and abundance (n=57) were recorded at the lowest elevation (2450-3400m) in ACZ, whereas minimum richness (n=4) and abundance (n=14) was recorded at the highest elevation (4200m) in APZ (Figure 6).

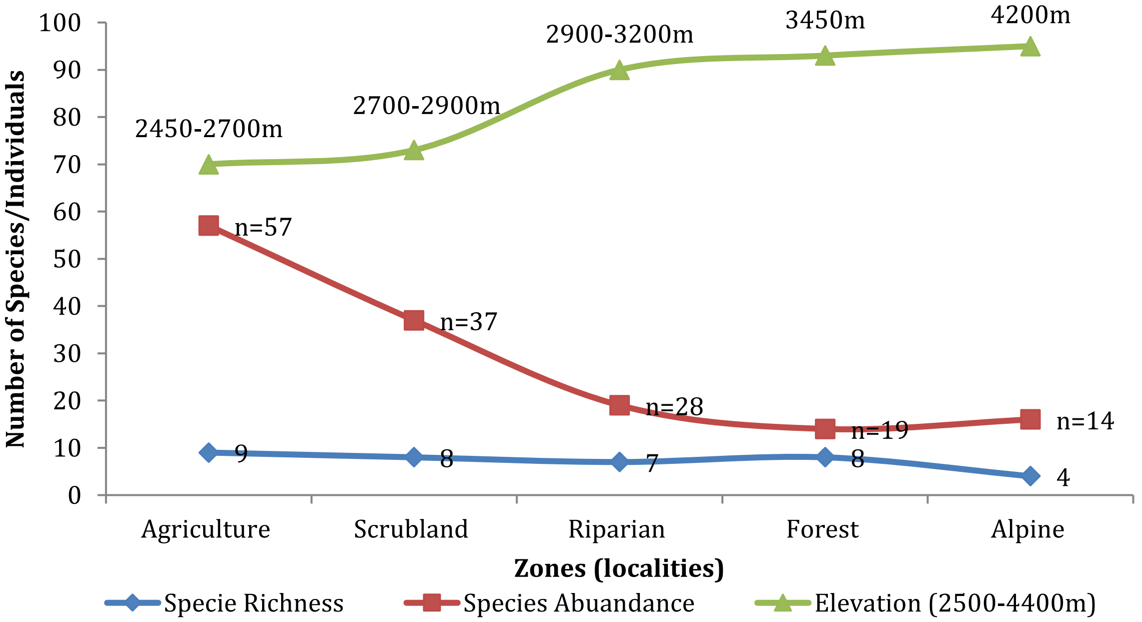

Figure 6: Large mammals' richness and abundance at different elevations in the study area

Apart from habitat type, recorded diversity indices were similar during the summer and winter seasons. Irrespective of summer-winter seasons diversity indices were recorded highest in riparian zones (H=3.14) followed by forests (H=2.88), and agriculture lands (H=2.73). Higher diversity was recorded in riparian, scrubland, and forest within the habitat type during the summer as compared with the winter season. Evenness was recorded as almost similar for summer and winter however evenness greatly varied between localities and habitat type. The equitability (J) trend was recorded as nearly similar for both seasons and among the localities. Overall locality 5 showed the highest dominance and lowest value of Shannon, and equitability in winter as compared with summer and other localities (Table 3).

Table 3: Comparison of diversity of large mammals in Ghamot National Park

Diversity Indices	**ACZ**		**SLZ**		**RZ**		**FZ**		**AZ**			
	L1,2		**L1,2**		**L,1,2,3**		**L,1,2,3**		**L,1,2,3,4**		**L,1,2,3,4**	
	S	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**
Number of species	7	7	7	6	6	8	6	5	3	1	5	4
Individuals	32	25	15	22	12	16	10	9	9	5	8	8
Shannon index (H)	2.73	2.55	2.62	2.47	2.66	3.14	2.88	2.43	1.69	0.00	2.61	2.18
Evenness (J)	0.97	0.91	0.93	0.96	1.03	1.05	1.12	1.05	1.07	1.07	1.12	1.09

Key: agricultural lands “ACZ”, scrublands “SLZ”, riparian zone “RZ”, forests “FZ”, alpine pastures “APZ”, localities “L” number “1-4”, summer “S”, winter “W.

Discussion

The current study found 14 large mammals in GNP, including 7 globally threatened species, 4 large predator species (*Uncia uncia, Panthera pardus, Ursus arctos, Ursus thibetanus*, and three ungulates *Capra sibirica, Naemorhedus goral,* and *Moschus chrysogaster*) (IUCN, 2020). All of these globally threatened species were also protected at the national level. According to Bruner et al. (2001) and Bernard et al. (2014), the presence of all of these major endangered predators and ungulate species in the protected region may be attributed to the efficiency of wildlife conservation efforts.

The current study found that seasonal fluctuations (summer-winter) had minimal effect on species abundance, richness, and diversity, however, habitat type has a substantial impact. Except for Uncia uncia, Ursus arctos, and Capra sibirica, all of the described species are from woodland habitats. The current findings indicated that the study area is vital for the large mammal conservation; in particular, the presence of Uncia uncia and Ursus arctos in the study area is particularly noteworthy, due to their low global population, larger home ranges, scarcity of diet, and disturbance from local communities throughout their range (Diriba et al., 2020). The variety of large animals in the western Himalayas is significant in comparison to other parts of the country, but most of these species are either vulnerable or endangered (Baig &

Ahmed, 2007). In this region, Qamar et al. (2005) have already recorded 10 large mammals, 2 small mammals, and 35 bird species.

The abundance of large mammals reported in the summer (n=84) was not much different from the number reported in the winter (n=87). Less variation in different seasons may be attributed to a variety of causes, including a lack of appropriate habitat in the surrounding region, a lack of connection and routes between nearby areas with comparable habitat if exist (Illius & O'Connor, 2000; Alvarenga et al., 2018). However, during the summer, human and cattle encroachment on the study area was significantly higher. Several studies suggested that such disruptions affect mammals through numerous processes, such as causing animals to hide or move to other locations, reducing the likelihood of animals being spotted (Dinakaran & Anbalagan, 2007); Hassani et al., 2008; Stankowich, 2008). In addition, restoration of woody vegetation and proliferation of ground vegetation throughout the summer season may have endowed the animals with a thick coat, making their sighting difficult (Girma et al., 2012).

Riparian woodland and forest habitats had a higher Shannon diversity index in the current study. These findings are not surprising given that these well-established habitats with a larger area tends to hold more species than a destructed habitat with a smaller area (Bantihun & Bekele, 2015; Girma et al., 2012). The current study found a high number of herbivores in riparian forests and scrublands, which may have attracted a high number of carnivore species, resulting in a greater variety (Alvarenga et al., 2018).

According to the findings, the highest abundance of mammalian species was observed in agriculture lands and scrubland. As compared to high alpine pasture environments, these habitats had the lowest seasonal fluctuation in Shannon diversity and the maximum homogeneity in species composition. These findings may imply that agriculture areas, riparian woodland and scrubland habitats are more adaptable to seasonal resources than other habitats such as high alpine pastures and wetlands. Because of its high flexibility, these habitats may have retained its habitat quality and quantity throughout the year, resulting in its species composition.

The most abundant species recorded in five sites were *Canis aureus* (17.54%) and *Vulpes vulpes* (15.20%). The *Uncia uncia* (1.75%) and *Capra sibirica* (1.16%) were restricted to high alpine pastures (two localities) and had the lowest number of representatives. The relative abundances of these two species were also reflected in the results of similarity analysis, which revealed that high alpine pasture habitat animals had a poorer similarity to the other four habitat types. The current study found that, although having the fewest species, high alpine pastures support species that are unique to the habitat type. As a result, it is possible to conclude that high alpine pastures in the research area have a commensurate role in enhancing mammal diversity and that despite the limited number of high alpine pasture habitats; it should not be ignored during conservation planning.

Species richness and abundance vary among localities and elevations. The lowest elevation (2980m) had the highest richness (85.17%) and abundance (33.33%), whereas the highest elevation (4210m) had the lowest richness (n=4) and abundance (n=14). According to McCain (2009) and Rahbek (2005), the substantially higher mammal species richness and abundance in lower elevations than in higher elevations could be owing to the varied character of ecosystems in lower elevations, which provides better foraging opportunities and food diversity. The association of mammal diversity and elevation patterns are temperature, rainfall, habitat heterogeneousness, species interactions, and evolutionary processes such as endemism, niche conservatism, isolation and speciation (Hawkins et al., 2012; Machac et al., 2011). The decline in species abundance and richness with elevation could be due to a decrease in habitat variability, a lack of enough canopy cover, and a higher danger of predation in the open region compared to the dense forest, which provides enough space to hide and move. Elevation, slope, and aspect all affect microclimate conditions thereby affecting the mammal distribution and abundance. Slope may be another major input for microclimatic variables impacting vegetation development and dispersal. Slope influences the amount of solar radiation available to vegetation, soil moisture, and microclimatic factors which in turn influences the abundance and distribution of mammals (Bennie et al., 2008).

In conclusion, the findings of the study reveal that GNP harbors a variety of large mammalian species, some of which are globally threatened. *Canis aureus* (17.54%) and *Vulpes vulpes* were the common species, while *Uncia uncia* (1.75%) and *Capra sibirica* (1.16%) were the rarest and restricted to high alpine pastures. However, very slight seasonal variation was recorded in the abundance and diversity of species in the study area. This study provides the first ecological data on mammal diversity in GNP, which will be valuable for park management to make effective conservation interventions, as well as for researchers conducting related studies. To aid in the development of management plans, it is necessary to not only strengthen law enforcement to check the human and their livestock encroachment in the park but also conduct further detailed studies on population structure, spatiotemporal habitat use, and the impacts of human-induced actions on biodiversity of the park.

References

Abbas, Q., Khan, S. W., Khatoon, S., Hussain, S. A., Hassan, S. N., Hussain, A., ... & Hussain, I. (2014). Floristic biodiversity and traditional uses of medicinal plants of Haramosh valley, Central Karakoram National Park of Gilgit district, Gilgit-Baltistan. *Pakistan Journal of Bio-Environmental Sciences*, 5, 75-86.

Abie, K., Tilahun, B., Feyisa, A., Kumssa, T., & Amare, A. (2021). Diversity and habitat association of medium and large mammals in Gibe Sheleko National Park, Southern Ethiopia. *Ecology and Evolution,* 11(18), 12251-12258.

Ali, U., Iftikhar, N., Shafi, N., Ahmad, K. B., Awan, M. S., Minhas, R. A., & Khan, L. A. (2018). Population status and distribution of Himalayan brown bear (*Ursus arctos isabellinus*) in Musk Deer National Park, Neelum, Azad Jammu and Kashmir (Pakistan): Himalayan Brown Bear Population Study. *Biological Sciences - PJSIR,* 61(3), 158–164. https://doi.org/10.52763/PJSIR.BIOL.SCI.61.3.2018.158.164

Alroy, J. (2017). Effects of habitat disturbance on tropical forest biodiversity. *Proceedings of the National Academy of Sciences*, 114(23), 6056-6061.

Alvarenga, G. C., Ramalho, E. E., Baccaro, F. B., da Rocha, D. G., Ferreira-Ferreira, J., & Bobrowiec, P. E. D. (2018). Spatial patterns of medium and large-sized mammal assemblages in várzea and terra firme forests, Central Amazonia, Brazil. *PLoS One,* 13(5), e0198120. https://doi.org/10.1371/journal.pone.0198120

Alves, B. G., Junior, M. O., & Brites, V. C. (2014). Medium and large-sized mammals of a fragment of Cerrado in the Triangulo Mineiro region, Southeastern Brazil. *Bioscience Journal of Uberlandia*, 30(3), 863–873.

Baig, M. B. (2012). Wildlife of Pakistan. Journal of Pure and Applied Sciences, 1(1), 62.

Baig, M. B., & Ahmed, M. (2007). Biodiversity in Pakistan: Status, challenges, and strategies for its conservation. *International Journal of Biology and Biotechnology*, 4(4), 283-292.

Baig, M. B., & Al-Subaiee, F. S. (2009). Biodiversity in Pakistan. *Biodiversity,* 10(4), 20-29.

Barlow, J., Lennox, G. D., Ferreira, J., Berenguer, E., Lees, A. C., Nally, R. M., Thomson, J. R., Ferraz, S. F., Louzada, J., Oliveira, V. H., & Parry, L. (2016). Anthropogenic disturbance in tropical forests can double biodiversity loss from deforestation. *Nature,* 535(7610), 144-147.

Bennie, J., Huntley, B., Wiltshire, A., Hill, M. O., & Baxter, R. (2008). Slope, aspect and climate: spatially explicit and implicit models of topographic microclimate in chalk grassland. *Ecological Modelling*, 216(1), 47-59.

Bernard, E., Penna, L. A., & Araújo, E. (2014). Downgrading, downsizing, degazettement, and reclassification of protected areas in Brazil. *Conservation Biology*, 28(4), 939-950.

Bruner, A. G., Gullison, R. E., Rice, R. E., & Da Fonseca, G. A. (2001). Effectiveness of parks in protecting tropical biodiversity. *Science*, 291(5501), 125-128.

Dinakaran, S., & Anbalagan, S. (2007). Effects of riparian vegetation on the functional organization of stream communities in southern Western Ghats. *Journal of Aquatic Biology*, 22(1), 25-31.

Diriba, G., Tamene, S., Mengesha, G., & Asefa, A. (2020). Diversity of medium and large mammals in the Loka Abaya National Park, southern Ethiopia. *Ecology and Evolution*, 10(18), 9896-9905.

Geleta, M., & Bekele, A. (2016). Survey of medium and large-sized mammals in Wacha Protected Forest, Western Ethiopia. *Journal of Agricultural Science*, 6(3), 71-79.

Girma, Z., Mamo, Y., & Ersado, M. (2012). Species composition, distribution and relative abundance of large mammals in and around Wondo Genet Forest Patch, Southern Ethiopia. *Asian Journal of Applied Sciences*, 5(8), 538-551.

Gonfa, R., Gadisa, T., & Habtamu, T. (2015). The diversity, abundance, and habitat associations of medium and large-sized mammals in Dati Wolel National Park, western Ethiopia. *International Journal of Biodiversity and Conservation*, 7, 112–118.

GoAJK (2018). Azad Jammu & Kashmir Interim Constitution (Twelfth Amendment) Act. *Law, Justice, Parliamentary Affairs, and Human Rights Department, Muzaffarabad*. Retrieved from AJK Supreme Courtp://ajksupremecourt.gok.pk/wp-content/uploads/2014/04/2019-02-14-5c647c81b020b1550089345.pdf).

Hassani, N., Asghari, R., Frid, S., & Nurberdief, M. (2008). Impacts of overgrazing in long-term traditional grazing systems on vegetation around watering points in semi-arid rangeland, North-Eastern Iran. *Pacific Journal of Biological Science*, 11, 1733–1737.

Hawkins, B. A., McCain, C. M., Davies, T. J., Buckley, L. B., Anacker, B. L., Cornell, H. V., Damschen, E. I., Grytnes, J. A., Harrison, S., Holt, R. D., & Kraft, N. J. (2012). Different evolutionary histories underlie congruent species richness gradients of birds and mammals. *Journal of Biogeography*, 39(5), 825-841.

Hughes, T. P., Kerry, J. T., Álvarez-Noriega, M., Álvarez-Romero, J. G., Anderson, K. D., Baird, A. H., Babcock, R. C., Beger, M., Bellwood, D. R., Berkelmans, R., & Bridge,

T. C. (2017). Global warming and recurrent mass bleaching of corals. *Nature,* 543(7645), 373-377.

Illius, A. W., & O'connor, T. G. (2000). Resource heterogeneity and ungulate population dynamics. *Oikos,* 89(2), 283-294.

IUCN, (2020). International Union for Conservation of Nature Primate Specialist Group. Regional action plan for the conservation of western chimpanzees (Pan troglodytes verus) (2020–2030).

Jahangeer, M., Awan, M. S., Altaf, M., Minhas, R. A., & Ali, U. (2023). Study of bird diversity in Ghamot National Park Azad Jammu and Kashmir, Pakistan. *Pakistan Journal of Zoology*, 1-11. https://dx.doi.org/10.17582/journal.pjz/202212070512

Jahangeer, M., Awan, M. S., Shakeel, A., Minhas, R. A., Saleem, M. M., Ali, U., & Sudhzoi, A. (2024). Ethnoveterinary utilization of medicinal plants in Ghamot National Park, Western Himalayas of Azad Jammu and Kashmir, Pakistan. *Ethnobotany Research and Applications*, 28, 1–17. https://ethnobotanyjournal.org/index.php/era/article/view/5587

Karanth, K. U., Chundawat, R. S., Nichols, J. D., & Kumar, N. S. (2004). Estimation of tiger densities in the tropical dry forests of Panna, Central India, using photographic capture–recapture sampling. *Animal Conservation Forum*, 7(3), 285-290.

Kasso, M., & Bekele, A. (2014). Threats to mammals on fragmented habitats around Asella Town, central Ethiopia. *International Journal of Biodiversity*, 2014, 1-7.

Khan, M. B., Khawaja, B. A., Awan, M. S., Usman, A., Minhas, R. A., & Choudary, S. A. (2012). Distribution, population status, and habitat utilization of the common otter (Lutra lutra) in Neelum Valley, Azad Jammu and Kashmir. *Pakistan Journal of Zoology*, 44(1).

Khan, M. S. (2004). Annotated checklist of amphibians and reptiles of Pakistan. *Asiatic Herpetological Research*, 10(1), 191-201.

Khan, M. Z., Zehra, A., Ghalib, S. A., Siddiqui, S., & Hussain, B. (2010). Vertebrate biodiversity and key mammalian species status of Hingol National Park. *Canadian Journal of Pure and Applied Sciences*, 1151.

Krebs, R. E. (2006). The history and use of our earth's chemical elements: A reference guide. Greenwood Publishing Group.

Li, S.Q., & Quan, R.C. (2017). Taxonomy is the cornerstone of biodiversity conservation—SEABRI reports on biological surveys in Southeast Asia. *Zoological Research*, 38(5), 213–214. https://doi.org/10.24272/j.issn.2095-8137.2017.061

Liow, L. H., Fortelius, M., Bingham, E., Lintulaakso, K., Mannila, H., Flynn, L., & Stenseth, N. C. (2008). Higher origination and extinction rates in larger mammals. *Proceedings of the National Academy of Sciences*, 105(16), 6097-6102.

Locke, H., & Dearden, P. (2005). Rethinking protected area categories and the new paradigm. *Environmental Conservation*, 32(1), 1-10.

Machac, A., Janda, M., Dunn, R. R., & Sanders, N. J. (2011). Elevational gradients in phylogenetic structure of ant communities reveal the interplay of biotic and abiotic constraints on diversity. *Ecography*, 34(3), 364-371.

Manzoor, M., Riaz A., Iqbal Z., Mian, A. (2013). Biodiversity of Pir Lasura National Park, Azad Jammu and Kashmir, Pakistan. *Science, Technology and Development*, 32 (2): 182-196

Marwat, S. K., Usman, K., Rashid, A. B., & Ghulam, S. A. (2011). Biodiversity of grassy weeds and their ethnobotanical importance in Dera Ismail Khan District (DI Khan), KPK, Pakistan. *Pakistan Journal of Botany*, 43(4), 1731-1739.

McCain, C. M. (2009). Global analysis of bird elevational diversity. *Global Ecology and Biogeography*, 18(2), 163-174.

Mengesha, G., & Bekele, A. (2008). Diversity, distribution and habitat association of large mammals of Alatish, north Gonder, Ethiopia. *Acta Zoologica Sinica*, 54(1), 20-29.

Millennium Ecosystem Assessment (MEA). (2005). *Ecosystems and human well-being*. Washington, DC: Island Press.

Mirza, Z. B. (1998). *Illustrated handbook of animal biodiversity of Pakistan*. Centre for Environmental Research and Conservation.

Peres, C. A., Gardner, T. A., Barlow, J., Zuanon, J., Michalski, F., Lees, A. C., Vieira, I. C., Moreira, F. M., & Feeley, K. J. (2010). Biodiversity conservation in human-modified Amazonian Forest landscapes. *Biological Conservation*, 143(10), 2314-2327.

Qamar, Q. Z., Anwar, M., & Minhas, R. A. (2008). Distribution and population status of Himalayan musk deer (Moschus chrysogaster) in the Machiara National Park, AJ&K. *Pakistan Journal of Zoology*, 40, 159–163.

Qamar, Z. Q., Awan, M. S., Maqsood, A., & Shahid, M. (2005). Status of wild species and their management in Ghomat Game Reserve, District Muzaffarabad. *Journal of Natural Science*, 3(4), 100-108.

Rahbek, C. (2005). The mid-domain effect applied to elevational gradients: Species richness of small mammals in Costa Rica. *Journal of Biogeography*, 31(1), 19–31.

Ripple, W. J., Abernethy, K., Betts, M. G., Chapron, G., Dirzo, R., Galetti, M., Levi, T., Lindsey, P. A., Macdonald, D. W., Machovina, B., & Newsome, T. M. (2016). Bushmeat hunting and extinction risk to the world's mammals. *Royal Society Open Science*, 3(10), 160498.

Ripple, W. J., Chapron, G., López-Bao, J. V., Durant, S. M., Macdonald, D. W., Lindsey, P. A., Bennett, E. L., Beschta, R. L., Bruskotter, J. T., Campos-Arceiz, A., & Corlett, R. T. (2017). Conserving the world's megafauna and biodiversity: The fierce urgency of now. *Bioscience*, 67(3), 197-200.

Stankowich, T. (2008). Ungulate flight responses to human disturbance: A review and meta-analysis. *Biological Conservation*, 141(9), 2159-2173.

Struhsaker, T. T., Struhsaker, P. J., & Siex, K. S. (2005). Conserving Africa’s rain forests: Problems in protected areas and possible solutions. *Biological Conservation*, 123(1), 45-54.

Sutherland, W. J. (2006). Ecological census techniques: A handbook. Cambridge University Press.

Symes, W. S., Edwards, D. P., Miettinen, J., Rheindt, F. E., & Carrasco, L. R. (2018). Combined impacts of deforestation and wildlife trade on tropical biodiversity are severely underestimated. *Nature Communications*, 9(1), 1-9.

Tabor, C., Otto-Bliesner, B., & Liu, Z. (2020). Speleothems of South American and Asian monsoons influenced by a Green Sahara. *Geophysical Research Letters*, 47(22), e2020GL089695.

Thomas, L., & Middleton, J. (2003). *Guidelines for management planning of protected areas*. Gland, Switzerland/Cambridge, England.

Tilker, A., Abrams, J. F., Mohamed, A., Nguyen, A., Wong, S. T., Sollmann, R., Niedballa, J., Bhagwat, T., Gray, T. N., Rawson, B. M., & Guegan, F. (2019). Habitat degradation and indiscriminate hunting differentially impact faunal communities in the Southeast Asian tropical biodiversity hotspot. *Communications Biology*, 2(1), 1-11.

Watson, J. E., Dudley, N., Segan, D. B., & Hockings, M. (2014). The performance and potential of protected areas. *Nature*, 515(7525), 67-73.

Wilcove, D. S., Giam, X., Edwards, D. P., Fisher, B., & Koh, L. P. (2013). Navjot's nightmare revisited: Logging, agriculture, and biodiversity in Southeast Asia. *Trends in Ecology & Evolution*, 28(9), 531-540.