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Diversity distribution, land used type of small and meso-mammals in Ghamot national park the state biosphere reserve-Neelum, Pakistan

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ABSTRACT

This research aimed to examine the impact of diversity distributions, seasonal variations, and land use types on the richness and diversity of native small and mesomammals communities in Ghamot National Park.The study employed various methods, including Barn Owl Pellets (Tyto alba), Sherman live traps and Genet scat methods, to sample small and mesomammals during both summer and winter seasons. The findings were based on data from three sampling methods, which resulted in a total of 534 specimens representing 14 species from 8 families. The family Muridae stood out as dominant, with 4 species (28.57%) of rodents. During the summer, the highest number of individuals was observed in the forest zone (n = 171), whereas during the winter season, the highest abundance was recorded in the riparian zone (n = 128). In terms of species richness, the riparian zone (n = 9) and agricultural crop zone (n = 9) had the highest values during the summer season. The highest Shannon diversity values (3.48) were found in riparian and forest habitats, scrubland, and dense vegetation, while the lowest biodiversity (H = 0.77) was observed in high alpine pastures and wetland habitats. Notably, no significant differences were observed between the two seasons (summer and winter) in terms of species richness and abundance. Further analysis using a one-way-ANOSIM test via the Bray-Curtis methods indicated a significant difference (R = 0.02144; p = 0.2873) among various survey locations and land types. Specifically, four habitat types dense forest, riparian zone, scrubland, and dense vegetation displayed significant correlations with each other ($p < 0.05$). Our study highlighted that changes in elevation, seasonal variations, and differences in land use significantly impact the composition of small mammal communities, leading to fluctuations in population numbers and spatial-temporal variations in species diversity. It is crucial to carefully regulate and monitor the frequency and intensity of human-induced disturbances to enable native populations to recover and maintain stability following such events, ensuring their long-term persistence. By considering the unique ecology, behavior, and physiology of various species, stakeholder can implement thoughtful land-use management strategies that mitigate the homogenization of natural environments, potentially slowing the loss of species in protected areas that have been influenced by human activitie.

Keywords: Diversity, distribution, ghamot, richness, small mammals, Neelum valley.

INTRODUCTION: Anthropogenic impacts on small mammals, which include a diverse variety of species such as rats, shrews, and bats (Balestrieri *et al.*, 2019), have alarming in recent era. Human activities such as habitat destruction, pollution, climate change, and invasive species introduction have substantially affected the ecosystems in which these creatures flourish. These disruptions frequently result in habitat fragmentation, decreased food availability (Iqbal *et al.*, 2022), and increased pollution exposure, all of which can have a negative impact on small animal populations (Goudie, 2018). Small animals also serve important roles in ecosystems as seed dispersers, pollinators, and prey for larger predators (Altaf, 2016). The diversity of species in an area, including their abundance, is known as diversity, and it serves as a reliable indicator of the overall health of an ecosystem. Monitoring diversity over time is crucial, as it reveals the impact of human activities on natural environments (Christie *et al.*, 2019). A decrease in community evenness can signify a reduction in both species and diversity, resulting in the uniformity of once-varied landscapes and the extinction of local species (Magurran, 2004). Small mammals heavily rely on the resources and shelter in their habitats, making it essential to monitor external factors that can influence these environments. One such factor is seasonal variation, which can have immediate and delayed effects on natural landscapes. In the short term, wet-season climates can lead to physical changes like softer soil, whereas dry-season climates can result in soil hardening (Ramahlo *et al.*, 2022). Conversely, during the dry season, resources like food and cover may become scarce, leading to competition among species for these necessities (McKee *et al.*, 2004). The study of animals that display population fluctuations in reaction to changes in their habitat is critical, as these organisms are particularly at risk to a variety of environmental and human-caused risks (Ndlovu *et al.*, 2023).

OBJECTIVES: The objective of this study was to investigate how land modification and seasonal variations impact the biodiversity of small mammals in Ghamot National Park. We assessed factors like species richness, community diversity, evenness, and similarity. Our hypotheses were that increasing elevation and landscape disturbance would be inversely related to population health and community diversity. We also anticipated that seasonal variations would decrease community diversity during winter while increasing population abundance during the summer season.

MATERIAL AND METHODS: **Study area:** The study area was divided into five zones based on vegetation and elevation. These zones were the forest zone, scrubland zone, high alpine pasture zone, riparian zone, and agricultural crop land zone. Each of these zones was further divided into twenty distinct localities, sharing similar vegetation characteristics but varying in terms of elevation, slope, and aspect. For instance, the forest zone was divided into five localities (FZL1-FZL5), the scrubland zone into three localities (SLZL1-SLL3), the alpine pasture zone into four localities (APZL1-APZL4), the riparian zone into five localities (RZL1-RZL5), and the agricultural crop zone into three localities (ACZ1-ACZ3) (figure 2).

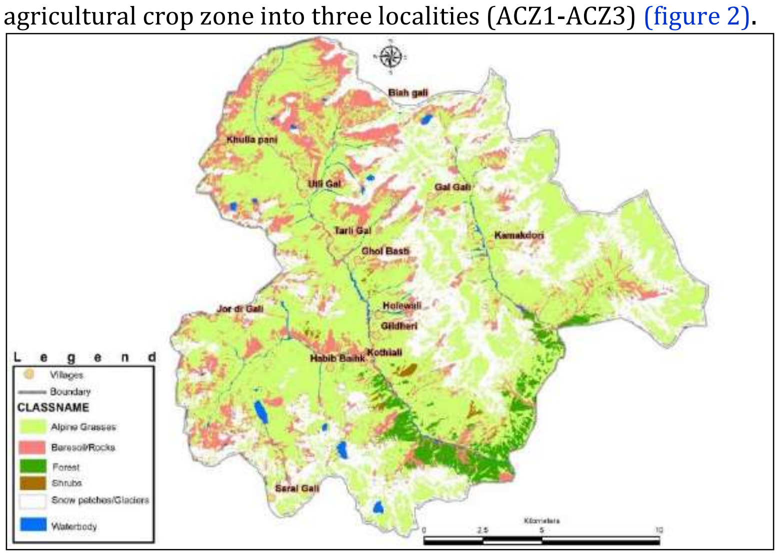

Figure 2: Illustrates the zones and specific locations where surveys were conducted and Sherman live traps were deployed.

Ghamot National Park (GNP) is positioned in the upper Neelum Valley, an area within the inner Himalayas, situated approximately 170 kilometers to the north of Muzaffarabad, the capital of Azad Jammu and Kashmir. The study area's geographical coordinates are within latitude 35° 24 N and longitude 73° 57 E, with elevations ranging from 2439 to 4949 meters above sea level. The area of Sharda Range, Sharda Forest division Surgan block compartment no. 16 and 17 with a total area of 27,271 ha (67388 acres) were declared as Game Reserve on 28 July 1982, under the AJK Wildlife Act 1975, and later notified and upgraded to National Park (GNP) under a government notification no SJ-F-O-02(14)/08-1212/2004 dated April 15, 2004, to ensure the sustainable conservation and management of natural resources of the area by the active participation of local communities.The park is situated adjacent to Surgan Nullah, roughly 25 kilometers away from Sharda Union Council. To reach Ghamot National Park from Sharda Union Council, one must travel along a seven-kilometer paved road leading to

Surgan, a small town at the entrance of the Surgan Valley. Subsequently, there is an additional 16 to 18-kilometer stretch of roads suitable for Jeeps, which takes you from Surgan village to Ghamot village—a small settlement located at the park's boundary (Jahangeer *et al.*, 2023) (figure 1).

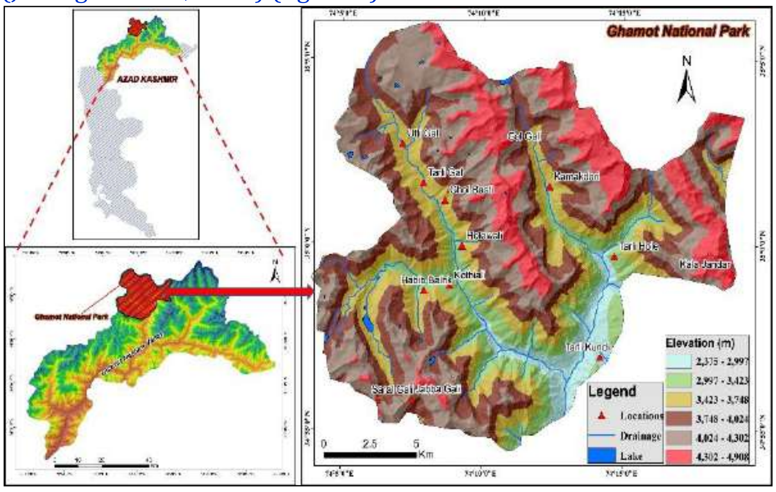

Figure 1: A map depicting the location of the study area

The research area is characterized by rugged, mountainous terrain with steep slopes, uneven topography, and an unstable geology. The region is prone to frequent landslides and glacier slides, often leading to road blockades due to loose rocks, steep inclines, inadequate land management, sparse vegetation, and heavy rainfall (Qamar *et al.*, 2012). Located within the subtropical highlands climate zone, the Neelum valley experiences varying climatic conditions dictated by altitude. The forested regions in the study area are typically classified as moist temperate forest, dry temperate forest, sub-alpine scrub, and alpine meadows. Winters are characterized by intense cold and substantial snowfall, while summers are generally mild and pleasant. High peaks remain snow-covered well into June or even later, with minimal rainfall during the summer months and the bulk of precipitation occurring as snowfall during winter.The research area itself does not support any permanent human habitation. However, the surrounding dependent villages rely heavily on the natural resources of the study area. These villages collectively accommodate around 61, 31, and 734 families, with an average household size of 8.13 individuals, as indicated in the 2017 District Census Report. The male-to-female ratio stands at 49:51, and the entire population adheres to the Islamic faith, with a general literacy rate of 17%. The dependent population comprises diverse ethnic groups, including Butt, Loan, Sayyed, Mir, Khawaja, Mughal, Minhas, Chaudhry, Swati, Raja, and Kayani. Due to the challenging climatic conditions, these villages are strategically located in forested areas, facilitating easy access to grazing grounds and forest resources within the study region (Jahangeer *et al.*, 2023).

Barn owl pellets (Tyto alba): In this study, following Torre *et al.* (2004), we employed barn owl pellets (Tyto alba) methodologies, the utilization of barn owl pellets (Tyto alba) serves as an effective and non-invasive method for studying the diversity distribution and ecological interactions of small and mesomammals within an ecosystem. As a natural predator, the barn owl preys on small mammals and subsequently regurgitates indigestible components, such as bones, fur, and feathers, in the form of pellets. These pellets were collected from owl roosting sites and other locations where the owls frequently feed. For analysis of mesomammals diversity we dissected collected pellets in a controlled laboratory setting. The process involved carefully unraveling the pellet contents and identifying the various components, including the skeletal remains of small mammals, which provide valuable insights into the species composition, relative abundance, and diversity of the small mammal population in the study area. By examining the undigested fragments, we determined the types of small mammals consumed by the barn owls, thereby gaining a deeper understanding of the diversity and distribution of these small mammals within different habitat in study area.

Sherman live-trapping: Following Torre *et al.* (2004), we designed Sherman live traps, allowing us to study various aspects of small and mesomammal populations, including species diversity, abundance, and distribution. The Sherman live-trapping method was involved setting up small, sturdy, and easily deployable traps that are baited to attract small and mesomammals. We designed these traps that once the animal enters the trap, a mechanism triggers the door to close, and safely containing the animal until it was retrieved for examination and data collection was done. This method was particularly useful in studying the behavior, ecology, and population dynamics of small and mesomammal species in different habitats and season in study area. The data collected from Sherman live-trapping studies contributed significantly to our understanding of the roles that these animals play within their ecosystems and their responses to environmental changes over time. Overall, we established a total of 59 line transects, covering an area of 30.25 square kilometers across all selected localities (table 1).

Zones	**Locality**	**Code**	**Elevation**	**Coordinates**		**Line transect**	**Grids**	**Traps**	**Specimens collected**		
				N	E				Live trapping	Indirect evidences	
										Scats	barn owl pellets
Forest Zone	Samgam Mali forest	FZL1	2615	34°54'2.69	74°11'45.28	3	1	3		31	29
2400-	Ghamot forest	FZl2	2680	34°56'47.32	74°12'51.68	3	1	3		19	13
3500m	Rata chang forest	FZL3	2780	34°58'4.77	74°13'31.21	2	1	3		13	
	Sora forest	FZL4	33010	35° 0'3.40	74°13'11.95	2	1	3		24	18
	Alihol forest	FZl5	3000	34°59'49.73	74°14'20.39	4	1	3		14	12
Scrub Land	Alif rakh	SLZL1	2510	34°56'55.11	74°13'26.36	3	2	6	11	23	18
Zone	Saral	SLZL2	2500	34°56'21.63	74°13'0.96	3	2	6	9	11	19
2300-2800m	Surgan stream	SLZL3	2480	34°55'57.99	74°13'2.65	2	1	3	1	22	
Alpine	Habib Bhaik	APZL1	3420	34°58'25.13	74° 7'51.06	4	1	3		18	
pasture	Saral lake	APZL2	4030	34°59'17.47	74° 4'18.63	3	1	3		8	
zone	Kamakhodari lake	APZL3	4120	35° 4'25.99	74°10'47.70	3	1	3		24	
3400-4400m	Alihol pasture	APZL4	3780	35° 0'24.15	74°14'30.98	3	2	6		12	27
Riparian	Samgam Nar	RZL1	2460	34°54'14.61	74°12'1.61	3	1	3	6	13	8
Zone	Saral Nar	RZL2	2590	34°56'43.68	74°12'29.75	3	1	3	7	12	16
2300-300m	Kamakhodari nar	RZL3	2980	34°59'47.15	74°13'59.81	3	1	3	4	25	
	Alihol Nar	RZL4	2980	34°59'46.22	74°14'17.27	2	1	3	5		16
	Kaley jender nar	RZL5	2750	34°58'53.84	74°14'32.29	3	1	3	4		
Agricultural	Surgan stream	ACZL1	2500	34°56'47.84	74°13'16.93	3	1	3	1	5	
zone	Ghamot	ACZL2	2450	34°56'38.06	74°13'7.34	4	2	6	5	13	2
2400-2800m	Kundi	ACZL3	2570	34°57'22.85	74°13'38.98	3	2	6	2	5	9
						59	25	75	55	292	187

Table 1: Zonation and methods in study area.

We placed a total of 75 live traps in 25 grids spanning all five zones (figure 2). In the forest zone (FZ), which ranged in elevation from 2500 to 3000 meters, we set up four trapping stations along a 14-transect area. Specifically, the forest zone was sampled using five independent trapping grids, each equipped with 15 live traps (Sherman folding small animal traps) spaced 10 meters apart, which remained operational both day and night during two seasons: summer (S) and winter (W) from April 2021 to March 2022, ensuring the capture of diurnal and nocturnal species as described by Torre *et al.* (2004). All traps were checked in the morning from 05:30 to 10:00 and again from 15:00 to 17:00 daily during the summer season, while in the winter season, they were checked from 7:30 to 11:00 and again from 14:00 to 16:00, following the protocol by Ramahlo *et al.* (2019). We identified and, where possible, sexed all captured animals. Each trap was baited with a mixture of oats and peanut butter, following the standard procedures outlined by

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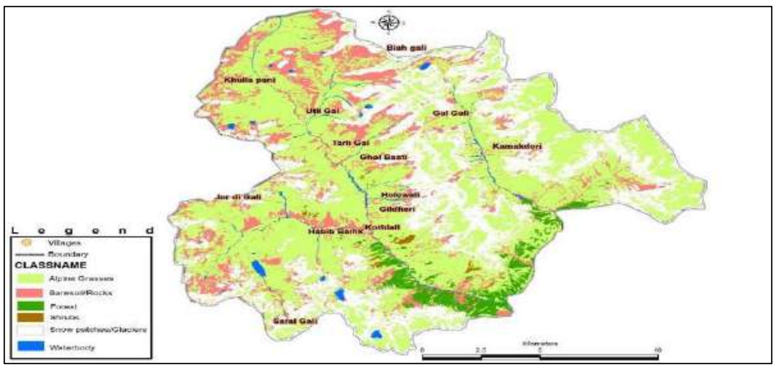

Figure 2: Illustrates the zones and specific locations where surveys were conducted and Sherman live traps were deployed.

Ramahlo *et al.* (2019). The remaining four zones (RZ, SLZ, APZ, and ACZ) were sampled using similar trapping efforts as in the forest zone but at different elevation ranges, namely 3000–3500 and 3500–4400 meters. The number of transects in these zones was 11, 13, 10, and 11, respectively. We recorded varying habitat characteristics for each sampling locality to maximize the likelihood of capturing different species, as recommended by Torre *et al.* (2004). Small and mesomammals were identified using a field guide on small mammals of Pakistan by Roberts and Bernhard (1977). We utilized direct i.e. physical count and voices and indirect evidence i.e. body parts, fecal pellet, caracases, footprints and remainings to identify small mammals at the family and species levels by applying taxonomic characteristics listed in the Kingdom Field Guide to African Mammals (Kingdom, 2003) and a handbook on the animal biodiversity of Pakistan by Mirza (1998).

Genet scat methods: The analysis of genet scat (feces) is a widely utilized method in ecological research for studying the small mammals. We collected genet scat samples from the field, often in specific habitats and locations where genets were known to frequent. These scat samples were then carefully examined in a laboratory setting to identify and analyze the remains of prey items, plant matter, and other materials present in the scat. This method contributed to a comprehensive understanding of the small mammals diversity and distribution in study area.

Statistical analysis: We employed a one-way analysis of similarity (ANOSIM) using the Bray-Curtis method and the Jacquard similarity index to assess the degree of similarity between two distinct sampling sites. We treated data collected in the morning and evening as replicates. Prior to analysis, the data was log-transformed in MS Excel. To calculate the Shannon-Weiner diversity indices and perform the one-way ANOSIM analysis with the Bray-Curtis method and Jacquard similarity index, we utilized the Paleontology Association software (Past 2004; version 4.9).

RESULTS: Direct and Indirect evidences: Out of a total of 534 specimens, scats accounted for the highest number (n = 292; 54.68%), followed by barn owl pellets (n = 187; 35%), with live traps being the least (n = 55; 10.29%) utilized method. Across all zones, scats were most abundant in the forest zone (n = 101) and least in the agriculture zone (n = 23). Barn owl pellets were most prevalent in the forest zone (n = 72) and least in the agriculture zone (n = 11). Live traps were most numerous in the riparian zone (n = 26), followed by the scrubland zone (n = 21), while the agriculture zone had the fewest live traps (n = 8) (figure 3).

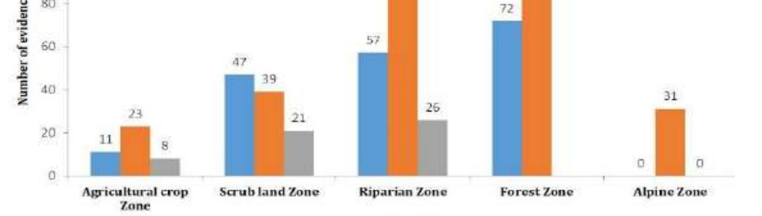

Figure 3: Small and mesomammals indirect (barn owl pellets, scats) and direct evidences (live traps) in study area.

Diversity distributions: Three different sampling methods were employed, resulting in a total of 534 specimens representing 14 species from 8 families. The dominant family was Muridae, comprising 4 species (28.57%) of rodents. Three families, Mustelidae, Sciuridae (n = 2, 14.28% each), and Soricidae (n = 2, 14.28% each), were represented by two species each. Four families, Hystricidae, Felidae, Ochotonidae, and Cricetidae, were represented by a single species. Local sightings were most frequent (n = 253, 48.84%) for all species in the Muridae family and were abundant in the study area. The remaining 7 families (11 species) were rarely sighted, categorized as either becoming rare (BR) or rare (R) in the study area. Notably, *Suncus murinus* was the least observed species in the area during the study period (table 2 and figure 4).

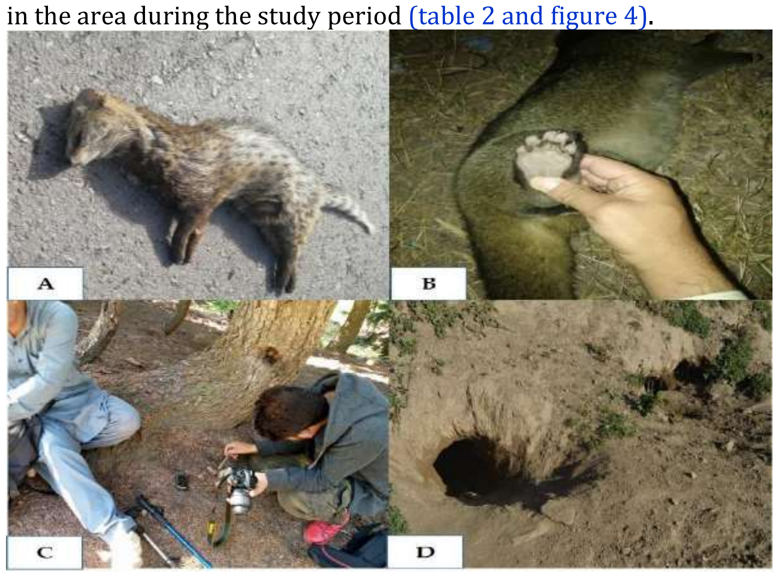

Figure 4: Small and mesomammal's diversity *Paguma larvata* (A), *Paradoxurus hermaphrodites* (B), barn owl pallet (C), *Marmota caudate* dens (D), in study area.

Shannon diversity indices revealed the highest values (3.48) in riparian and forest habitats, as well as scrubland and dense vegetation, while the lowest biodiversity (H = 0.77) was observed in high alpine pastures and wetland habitats. Furthermore, the highest evenness (1.52) was recorded in forests and dense vegetation habitats, while the lowest evenness value (0.77) was found in the Alpine zone (table 3).

Seasonal and Land variations: In the summer season, the highest number of individuals was observed in the forest zone (n = 171), followed by the scrubland zone (n = 114), riparian zone (n = 114), agricultural zone (n = 72), and agricultural crop zone (n = 43). During the winter season, the maximum abundance was recorded in the riparian zone (n = 128), while the lowest was in the agricultural crop zone (n = 29). In terms of species richness, the summer season saw the most diverse in the riparian zone (n = 9) and agricultural crop zone (n = 9), followed by the forest zone (n = 8) and scrubland zone (n = 8), with the fewest in the agricultural zone (n = 5). Conversely, during the winter season, the riparian zone had the highest number of species (n = 8), while the agricultural zone had the fewest (n = 3) (figure 5). There was no significant difference in richness and abundance between the two seasons (summer and winter), one-way ANOSIM tests using the Bray-Curtis method indicated a significant difference (R = 0.02144; p = 0.2873) across various survey locations and land types. Specifically, four habitat types—dense forest, riparian zone, scrubland, and dense vegetation displayed significant correlations with each other ($p < 0.05$) (table 4)."

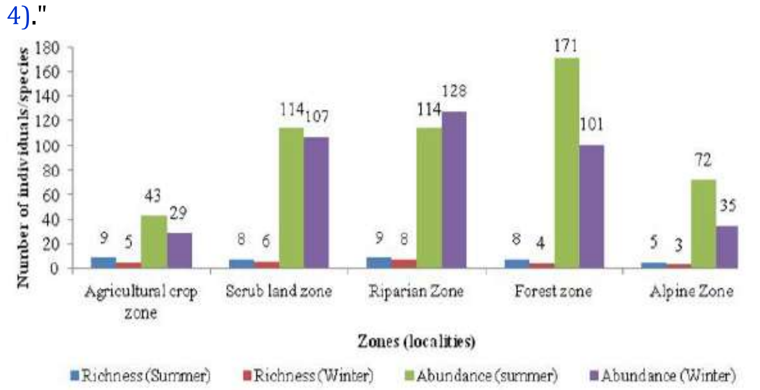

Figure 5: Small and mesomammal's abundance, richness in summer and winter in study area during 2020-21.

DISCUSSIONS: A survey of small and mesomammals identified a total of 14 species. Among these species, Rattus rattus was the most abundant (14.48%) in the study area in terms of population. The research findings indicated that the distribution of small and mesomammals varied with changes in elevation. Lower elevation zones exhibited higher abundance but lower evenness, whereas localities at higher elevations had fewer individuals and species richness compared to localities at lower elevations. This disparity in diversity could be attributed to factors like low temperatures, land cover types, and homogeneous habitats, which tend to limit species diversity. The results of this study align with previous research by

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Gebrezgiher *et al.* (2022), which reported reduced diversity at higher altitudes in Mount Meru, Tanzania. According Gebrezgiher *et al.* (2022), intermediate zones with moderate elevations tend to support a greater number of species due to species range overlap, habitat heterogeneity, milder environmental conditions, and the availability of food and shelter. The study also highlighted the influence of habitat type and seasonal variations on the richness and abundance of small and mesomammals. Notably, some localities exhibited relatively low abundance during the summer season. Factors contributing to this lower abundance could include human activities such as livestock grazing and forest fire, which directly impact small mammal populations. Additionally, the presence of humans in certain areas may also affect the number of small and mesomammals (Ramahlo *et al.*, 2022). The study did not find significant differences across localities within the study area, although species richness remained consistent across seasons and localities. The highest species richness was observed in intermediate localities. Intermediate zones are typically associated with increased species richness, as they provide suitable conditions for multiple species to coexist and thrive. The variation in land-use types was found to influence small and mesomammal richness, leading to differences in small and mesomammal composition (Umetsu and Pardini, 2007). For example, the presence of Bandicota bengalensis was primarily observed in agricultural fields, a finding supported by Ramahlo *et al.* (2022), who reported a high abundance of this species in such areas. The relatively low significant variations in richness across habitats and seasonal changes in this study corroborate the findings of Ramahlo *et al.* (2022). Collectively, the results obtained for community assemblage diversity, evenness, and similarity underscore the importance of adopting comprehensive approaches in biodiversity research.

Family	Species	Common Name	Local Name	ACZ		SLZ				RZ				FZ						APZ				AP (%)	LCS
				L(1, 2)		L(1,2)		L(3)		L(1,2,3		L(4,5)		L(1,2)		L(3)		L(4)		L(1)		L(1,2)			
				S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W		
Mustelidae	*Martes flavigula*	Yellow throated Marten	Ban trukla	0	0	1	1	1	0	0	0	1	1	1	0	2	0	0	6	10	0	4	0	7.53	BR
	Mustela altaica	Alpine Weasel	--	0	0	0	0	0	0	0	0	2	0	1	1	2	1	4	4	4	5	5	3	6.37	BR
Hystricidae	*Hystrix indica*	Indian Crested porcupine	Seh	3	0	8	7	11	3	7	6	0	0	0	0	0	0	0	0	0	0	0	0	9.85	BR
Sciuridae	*Marmota caudata*	Long-tailed Kashmir Marmot	Khunn chooha	0	0	0	0	0	1	0	2	0	2	0	1	4	0	2	8	5	0	8	2	6.95	BR
	Hylopetes fimbriatus	Small Kashmir Flying Squirrel	Choti uran gulehri	1	1	0	2	2	0	4	0	1	2	0	1	0	0	0	0	0	0	0	0	5.21	BR
Muridae	Rattus rattus	Common Rat	Chooha	18	12	12	5	9	6	11	12	4	3	2	0	3	10	8	0	0	0	0	0	14.48	A
	Bandicota bengalensis	Indian Mole Rat	Fusli chooha	9	5	6	11	8	8	8	9	2	4	0	0	1	0	0	0	0	0	0	0	13.71	A
	Mus musculus	Common House mouse	Choohai	12	9	8	12	8	11	7	9	4	1	2	1	0	0	1	0	0	0	0	0	15.06	A
	Apodemus rusiges	Kashmir Field Mouse	Jungli chooha	2	0	5	0	0	1	4	0	2	0	1	0	4	0	1	0	2	0	0	0	5.41	BR
Soricidae	*Crocidura pullata*	Kashmir White-toothed Shrew	Throoee	0	0	0	0	0	0	0	0	2	0	1	1	0	1	4	0	5	0	5	2	4.25	R
	Suncus murinus	Indian Musk Shrew	Chchundar	0	0	0	1	0	0	1	0		0	0	0	1	0	0	0	0	0	0	0	0.97	R
Viverridae	*Paguma larvata*	Himalayan Masked Palm Civet	Mushki Billi	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	1	0	1	0	0	1.16	R
Ochotonidae	*Ochotona roylei*	Royle's Pika or Indian Pika	Lunda chooha	0	0	1	1	1	1	1	0	2	2		0	1	0	1	0	1	0	0	0	4.44	R
Cricetidae	*Alticola roylei*	Royle's high mountain Vole	Unna chooha	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**1**	**2**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	4.44	**R**

Table 2: Checklist of small and medium sized mammals in study area.
Key: agricultural crop zone "ACZ", scrubland zone "SLZ", riparian zone "RZ", forest zone "FZ", alpine zone "APZ", localities "L" number "1-5", summer "S", winter "W", abundance percentage "AP", Local conservation status "LCS"; Abundant "A", common "C", becoming rare "BR", rare "R".

Diversity indices	ACZ		SLZ				RZ				FZ						AZ			
	L(1, 2)		L(1,2)		L(3)		L(1,2,3)		L(4,5)		L(1,2)		L(3)		L(4)		L(1)		L(1,2)	
	S	W	S	W	S	S	W	S	W	S	S	W	S	W	S	S	W	S	W	S
Number of species	6	4	7	9	7	8	9	7	10	8	7	6	10	4	7	4	6	2	4	3
Individuals	45	27	41	41	40	32	45	40	22	16	9	6	20	13	21	19	27	6	22	7
Simpson	0.74	0.68	0.82	0.81	0.81	0.80	0.86	0.80	0.92	0.90	0.94	1.00	0.91	0.42	0.80	0.71	0.79	0.33	0.77	0.76
Shannon	2.16	1.76	2.58	2.71	2.52	2.59	2.97	2.49	3.48	3.14	3.21	3.19	3.41	1.31	2.60	1.86	2.43	0.77	2.05	1.76
Evenness	0.84	0.88	0.92	0.85	0.90	0.86	0.94	0.89	1.05	1.05	1.14	1.23	1.03	0.66	0.93	0.93	0.94	0.77	1.02	1.11

Table 3: Comparison of diversity of small mammal's in different seasons in study area during study period 2020-21.
Key: agricultural crop zone "ACZ", scrubland zone "SLZ", riparian zone "RZ", forest zone "FZ", alpine zone "APZ", localities "L" number "1-5", summer "S", winter "W.

	ACZ		SLZ				RZ				FZ						AZ			
	L(1, 2)		L(1,2)		L(3)		L(1,2,3)		L(4,5)		L(1,2)		L(3)		L(4)		L(1)		L(1,2)	
	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
N	14	12	14	14	14	14	14	14	14	14	14	14	14	14	14	8	14	13	14	13
Max	18	12	12	12	11	11	11	12	4	4	2	1	4	10	8	8	10	5	8	3
Sum	45	27	41	41	40	32	45	40	22	16	9	6	20	13	21	19	27	6	22	7
Mean	3.2	2.3	2.9	2.9	2.9	2.3	3.2	2.9	1.6	1.1	0.6	0.4	1.4	0.9	1.5	2.4	1.9	0.5	1.6	0.5
Std. error	1.5	1.2	1.1	1.1	1.1	0.9	1.0	1.1	0.4	0.3	0.2	0.1	0.4	0.7	0.6	1.1	0.8	0.4	0.7	0.3
Variance	32.2	17.3	16.5	17.5	17.1	12.4	13.6	18.0	1.8	1.7	0.6	0.3	2.0	7.0	5.5	10.3	9.1	1.9	7.3	1.1
Stand. dev	5.7	4.2	4.1	4.2	4.1	3.5	3.7	4.2	1.3	1.3	0.7	0.5	1.4	2.6	2.3	3.2	3.0	1.4	2.7	1.1
Median	0	0	0.5	1	0.5	1	1.5	0.5	2	1	0.5	0	1	0	0.5	0.5	0	0	0	0
Coeff. var	176	185	139	143	145	154	115	148	85	113	116	120	98	285	156	135	157	301	172	195

Table 4: Data of small mammal's between two seasons in study area during (2020-21).
Key: agricultural crop zone "ACZ", scrubland zone "SLZ", riparian zone "RZ", forest zone "FZ", alpine zone "APZ", localities "L" number "1-5", summer "S", winter "W.

CONCLUSION: Our study highlighted that changes in elevation, differences in land use significantly impact the composition of small and mesomammals communities, leading to fluctuations in population numbers and spatial-temporal variations in species diversity. Our findings underscore the importance of maintaining healthy and diverse wildlife populations in an ever-changing environment, especially in natural and moderately disturbed landscapes. Nonetheless, there was no notable contrast in the richness and abundance observed between the two seasons.While preserving undisturbed landscapes is ideal, we can effectively manage altered landscapes to safeguard the region's species richness and community diversity. Therefore, it is crucial to carefully regulate and monitor the frequency and intensity of human-induced disturbances to enable native populations to recover and maintain stability following such events, ensuring their long-term persistence. By considering the unique ecology, behavior, and physiology of various species, stakholders can implement thoughtful land-use management strategies that mitigate the homogenization of natural environments, potentially slowing the loss of species in protected areas that have been influenced by human activities.

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REFERENCES: Altaf, M., 2016. Assessment of avian and mammalian diversity at selected sites along river chenab. University of veterinary and animal sciences, Lahore, Pakistan.

Balestrieri, A., A. Gazzola, G. Formenton and L. J. E. m. Canova, 2019. Long-term impact of agricultural practices on the diversity of small mammal communities: A case study based on owl pellets. Environmental monitoring assessment, 191: 1-14.

Christie, A. P., T. Amano, P. A. Martin, G. E. Shackelford, B. I. Simmons and W. J. Sutherland, 2019. Simple study designs in ecology produce inaccurate estimates of biodiversity responses. Journal of applied ecology, 56(12): 2742-2754.

Gebrezgiher, G. B., R. H. Makundi, Y. Meheretu, L. S. Mulungu and A. A. Katakweba, 2022. A decade-long change in the elevational distribution of non-volant small mammals on mount meru, tanzania. Diversity, 14(6): 454.

Goudie, A. S., 2018. Human impact on the natural environment. John wiley & sons.

Iqbal, K. J., M. S. Haider and S. Ashraf, 2022. Habitat preferences of wild mammalian species around river chenab in Sialkot, Gujrat and Gujranwala Districts, Punjab, Pakistan. Pakistan journal of zoology, Accepted: 1-7.

Jahangeer, M., M. S. Awan, M. Altaf, R. A. Minhas and U. Ali, 2023. Study of bird diversity in Ghamot national park Azad Jammu and KASHMIR, pakistan. Pakistan journal of zoology, Accepted.

Magurran, A. J. M. b. d. B. S., Malden, Massachusetts, 2004. Diversity in space (and time). USA: 162-184.

McKee, J. K., P. W. Sciulli, C. D. Fooce and T. A. Waite, 2004. Forecasting global biodiversity threats associated with human population growth. Biological conservation, 115(1): 161-164.

Mirza, Z., 1998. Illustrated handbook of animal biodiversity of pakistan. Centre for environmental reserach and conservation.

Ndlovu, M., G. Chiyangwa, N. Eisen and A. Chanyandura, 2023. Influence of mining on herbivore occurrence in mufurudzi safari area. Zimbabwe Journal of wildlife ecology, 7(3): 109-120.

Qamar, Q. Z., A. Usman, R. A. Minhas, N. I. Dar and M. Anwar, 2012. New distribution information on woolly flying squirrel (*Eupetaurus cinereus* thomas, 1888) in neelum valley of Azad Jammu and Kashmir, Pakistan. Pakistan journal of zoology, 44(5).

Ramahlo, M., C. Chimimba, C. Pirk and A. Ganswindt, 2019. Non-invasive monitoring of adrenocortical activity in free-ranging namaqua rock mice micaelamys namaquensis from south africa in response to anthropogenic land use and season. Wildlife biology, 2019(1): 1-6.

Ramahlo, M., M. J. Somers, D. W. Hart and A. Ganswindt, 2022. Small mammal diversity in response to land transformation and seasonal variation in south africa. Diversity, 14(2): 138.

Roberts, T. J. and Bernhard, 1977. The mammals of Pakistan. Cambridge University Press.

Torre, I., A. Arrizabalaga and C. Flaquer, 2004. Three methods for assessing richness and composition of small mammal communities. Journal of mammalogy, 85(3): 524-530.

Umetsu, F. and R. Pardini, 2007. Small mammals in a mosaic of forest remnants and anthropogenic habitats evaluating matrix quality in an atlantic forest landscape. Landscape ecology, 22: 517-530.