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Original Research Article

Mammalian diversity, distribution, and ecological threats in Swabi, Pakistan: implications for biodiversity conservation

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Abstract: This study investigated the diversity, distribution, and abundance of large and small mammals in District Swabi, Khyber Pakhtunkhwa, Pakistan, from September 2017 to September 2018. A total of 7,801 individual mammals representing 16 species were recorded across six survey sites. The large-mammal survey documented 2,552 individuals belonging to six species, three orders, and five families, including the Himalayan goral (Naemorhedus goral), markhor (Capra falconeri), wild boar (Sus scrofa), golden jackal (Canis aureus), red fox (Vulpes vulpes), and rhesus macaque (Macaca mulatta). Utla recorded the highest numbers of Himalayan goral and markhor, while golden jackals, red foxes, and rhesus macaques showed variations in their distribution across the surveyed sites. The small-mammal survey recorded 5,249 individuals representing ten species, six orders, and seven families. These included rodents, insectivores, carnivores, bats, and hares. Gandaf supported a diverse assemblage, particularly hedgehogs and palm squirrels, whereas house rats and mole rats were frequently recorded in Jhangera. Guluderi recorded the highest numbers of house rats and house mice. Mammalian diversity was assessed using the Shannon–Wiener, Simpson, species richness, evenness, and dominance indices. The findings revealed variations in species composition, distribution, and recorded abundance among the surveyed habitats. Habitat degradation, deforestation, agricultural expansion, hunting, and anthropogenic disturbances pose significant threats to regional mammalian biodiversity. This study provides baseline information for understanding mammalian diversity in District Swabi and emphasizes the need for habitat protection, systematic wildlife monitoring, conservation awareness, and effective management strategies.

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1. Introduction

District Swabi is located in the northeastern part of Khyber Pakhtunkhwa Province, Pakistan, at approximately 34°07′ N latitude and 72°28′ E longitude, about 150 km southwest of Islamabad. The district encompasses a range of geographical features, vegetation types, and habitats that support diverse wildlife communities. It experiences a warm, temperate climate, characterized by relatively greater rainfall during summer than winter. The mean annual temperature is approximately 22.2°C, with an average annual precipitation of around 639 mm. These geographical and climatic characteristics, together with the district's natural vegetation and mountainous terrain, provide important ecological conditions for the occurrence and distribution of mammalian fauna.

Mammals constitute an essential component of terrestrial ecosystems and contribute to ecological processes through herbivory, predation, seed dispersal, insect regulation, and the maintenance of food-web interactions. Their presence, abundance, and distribution can also provide valuable information about habitat conditions and broader ecosystem changes. Nevertheless, mammalian biodiversity is increasingly threatened by anthropogenic activities, including habitat destruction and fragmentation, deforestation, agricultural expansion, infrastructure development, hunting, and other forms of human disturbance. Such pressures can alter habitat structure, reduce the availability of food and shelter, restrict animal movement, and isolate wildlife populations. Small mammals are particularly influenced by changes in vegetation cover, land-use patterns, and the availability of suitable nesting and foraging habitats. Consequently, systematic assessments of mammalian diversity and distribution are essential for establishing baseline biodiversity information, identifying potential conservation concerns, and supporting effective wildlife-management strategies (Ali, 2017, 2021; Khan, et al, 2025 a, b; Ali et al., 2018; Rehman et al., 2021; Faiz-ur-Rahman et al., 2023; Jaeger, et al., 2025).

Previous investigations in Khyber Pakhtunkhwa have documented considerable mammalian diversity across different ecological landscapes and highlighted the conservation challenges affecting regional wildlife. Akhtar et al. (2018) documented 10 mammalian species belonging to nine families, five orders, and 10 genera in Mahaban and Malka valleys, District Buner. Jackals and foxes were among the frequently recorded species, while the Himalayan goral (*Naemorhedus goral*) was identified as vulnerable to hunting pressure and habitat disturbance. These findings demonstrate the ecological importance of mountainous habitats in supporting mammalian communities and the need to address pressures affecting their persistence.

Similarly, Khattak et al. (2022) recorded 21 mammalian species representing 18 genera, 12 families, and six orders in District Nowshera. Artiodactyla was the most species-rich order, comprising seven species, while the wild boar (*Sus scrofa*) was frequently recorded. Their findings provide important information on the composition of mammalian communities in the region and emphasize the importance of wildlife conservation and habitat management.

In another regional investigation, Saeed et al. (2021) documented 12 mammalian species in Elum Valley, District Buner. The recorded fauna included the Himalayan goral (*Naemorhedus goral*), Indian hare (*Lepus nigricollis*), rhesus macaque (*Macaca mulatta*), golden jackal (*Canis aureus*), mouse-eared bat (*Myotis myotis*), Indian crested porcupine (*Hystrix indica*), wild boar (*Sus scrofa*), dwarf mongoose (*Helogale parvula*), grey mongoose (*Herpestes edwardsii*), palm squirrel (*Funambulus* sp.), and Sunda pangolin (*Manis javanica*). This study further illustrates

the diversity of mammalian fauna associated with the mountainous landscapes of Khyber Pakhtunkhwa and provides a regional basis for comparative assessments of species occurrence and distribution.

In addition to documenting mammalian diversity, previous studies have identified several anthropogenic activities that threaten wildlife habitats across the province. Akhtar et al. (2014), in a survey of District Buner, recorded eight mammalian species and identified deforestation, increasing human pressure, and excessive hunting as important conservation concerns. Similarly, Rehman et al. (2021) reported that mining activities, blasting, pollution, hunting, deforestation, and habitat degradation exert considerable pressure on local fauna in District Mardan and District Mohmand. Research conducted in northern Khyber Pakhtunkhwa has also highlighted habitat loss and hunting pressure as major concerns for wildlife conservation (Faiz-ur-Rahman et al., 2023). Furthermore, the provincial review by Ali et al. (2018) emphasised the ecological significance of wildlife habitats and the vulnerability of mammalian fauna to habitat degradation and poaching. Collectively, these studies indicate that increasing anthropogenic disturbance and landscape modification represent important challenges for maintaining mammalian biodiversity in Khyber Pakhtunkhwa.

Despite these regional investigations, information on the diversity, distribution, and relative abundance of large and small mammals across different habitats of District Swabi remains limited. The district comprises mountainous, semi-natural, agricultural, and human-modified landscapes that may support different mammalian assemblages. Variations in vegetation structure, habitat characteristics, land-use patterns, and human disturbance may influence the occurrence and distribution of mammalian species across these environments. Documenting such variation is therefore important for understanding local biodiversity patterns and establishing a baseline for future ecological monitoring and conservation planning.

The present study aims and objectives to assess the diversity, distribution, and recorded abundance of large and small mammals across selected habitats of District Swabi, Khyber Pakhtunkhwa, Pakistan, second, Examine potential ecological and anthropogenic threats to mammalian habitats and identify conservation priorities to support wildlife monitoring, habitat management, and biodiversity conservation in the region, third, Evaluate differences in species occurrence, recorded abundance, and diversity patterns among the surveyed locations using species richness, Shannon–Wiener, Simpson, evenness, and dominance indices

Briefly speaking, this study investigated the diversity and distribution of large and small mammals in District Swabi, Khyber Pakhtunkhwa, Pakistan, from September 2017 to September 2018. A total of 17 mammalian species were recorded, comprising six large mammal species and ten small mammal species. The large mammals, representing three orders and five families, included the Himalayan goral (*Naemorhedus goral*), markhor (*Capra falconeri*), wild boar (*Sus scrofa*), golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), and rhesus macaque (*Macaca mulatta*). Across the large-mammal survey sites of Utla, Tarbela Dam, and Jhanda, 2,552 individuals were recorded. Utla supported the highest recorded numbers of Himalayan goral and markhor, and was the only site where recorded. Golden jackals and red foxes were comparatively more frequently recorded at Utla and Tarbela Dam, whereas rhesus macaques were predominantly recorded in Utla.

The small-mammal survey, conducted at Guluderi, Jhangera, and Gandaf, documented 5,249 individuals representing ten species, six orders, and seven families. These included the long-

eared desert hedgehog (*Hemiechinus* sp.), northern palm squirrel (*Funambulus pennantii*), house rat (*Rattus rattus*), house mouse (*Mus musculus*), short-tailed mole rat (*Nesokia indica*), small Indian mongoose (*Herpestes javanicus*), Indian grey mongoose (*Herpestes edwardsii*), house shrew (*Suncus murinus*), bat (*Myotis myotis*), and hare (*Lepus nigricollis*). Gandaf supported a diverse small-mammal assemblage, particularly hedgehogs and palm squirrels, whereas house rats and mole rats were frequently recorded in Jhangera. Guluderi had the highest recorded numbers of house rats and house mice. Overall, 7,801 individual mammals were recorded during the study. Species diversity was further assessed using the Shannon–Wiener, Simpson, species richness, evenness, and dominance indices.

The findings demonstrate variation in mammalian distribution and recorded abundance among the surveyed habitats. Habitat degradation, deforestation, agricultural expansion, hunting, and increasing anthropogenic disturbance are important conservation concerns in the region. The study provides baseline information on mammalian diversity in District Swabi and highlights the need for habitat protection, regular wildlife monitoring, conservation awareness, and effective management strategies to maintain regional mammalian biodiversity.

2. Materials and Methods

During study direct and indirect methods were used to explore the mammalian diversity. Binoculars (32x50) were used to examine animals and filed guides were consulted to correctly identify the species (Altaf et al., 2014). During present study telescope, mobile camera, GPS were used. Where mammals were physically sighted or its indirect evidence was collected. Point surveys were conducted at strategic locations, with 15–60 minutes of observation per site. Roadside counts were conducted at dawn and night using searchlights to locate nocturnal species. Track counts after rainfall provided insights into species movement, while pellet counts were used to estimate population density. Local interviews were conducted to gather traditional knowledge on mammal distribution.

Table.1 Data Collection Methods for Mammals

Data Collection Method	Large Mammals	Small Mammals
Point Surveys	Yes	No
Roadside Counts	Yes	No
Track Counts	Yes	No
Pellet Counts	Yes	No
Interviews with Locals	Yes	Yes
Active Searching	No	Yes
Baiting Method	No	Yes

3. Results

3.1. Diversity and distribution of large mammals

The survey recorded six large mammal species across the study localities: Himalayan goral (*Naemorhedus goral*), markhor (*Capra falconeri*), wild boar (*Sus scrofa*), golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), and rhesus macaque (*Macaca mulatta*). Their occurrence and abundance varied among Utla, Tarbela Dam, and Jhanda (Table X).

Utla recorded the highest numbers of Himalayan goral and markhor, whereas comparatively fewer individuals of both species were recorded around Tarbela Dam. Jhanda exhibited the lowest recorded abundance of these two ungulates. In contrast, golden jackals and red foxes were recorded more frequently in Tarbela Dam and Utla than in Jhanda. while rhesus macaques were predominantly recorded in the same locality, with very few or no individuals recorded in Tarbela Dam and Jhanda.

Wild boar was also recorded during the survey, although its relative abundance varied among the study localities. Overall, Utla supported a greater representation of several large mammal species, particularly mountain-associated ungulates, and rhesus macaque, compared with the other surveyed localities.

3.2. Diversity and distribution of small mammals

A total of ten small mammal species were recorded from Guluderi, Jhangera and Gandaf. These included the long-eared desert hedgehog, northern palm squirrel, house rat, house mouse, short-tailed mole rat, small Indian mongoose, mongoose, house shrew, bats, and hare (Table 2).

The distribution of small mammals differed among the three localities. Gandaf, a mountainous area characterized by relatively abundant shrub vegetation, supported a diverse assemblage of small mammals, with comparatively greater representation of hedgehogs and northern palm squirrels. Jhangera, a semi-urbanized locality, recorded relatively high numbers of house rats and mole rats. Guluderi, characterized by greater human population density and land-use modification, recorded the highest numbers of house rats and house mice, while comparatively fewer individuals of other small mammal species were recorded.

Table 2. Taxonomic classification of large and small mammals recorded in District Swabi, Pakistan

Order	**Family**	**Common name**	**Scientific name**
Artiodactyla	Bovidae	Himalayan goral	*Naemorhedus goral*
Artiodactyla	Bovidae	Markhor	*Capra falconeri*
Artiodactyla	Suidae	Wild boar	*Sus scrofa*
Carnivora	Canidae	Golden jackal	*Canis aureus*
Carnivora	Canidae	Red fox	*Vulpes vulpes*
Primates	Cercopithecidae	Rhesus macaque	*Macaca mulatta*
Eulipotyphla	Erinaceidae	Long-eared desert hedgehog	*Hemiechinus* sp.
Rodentia	Sciuridae	Northern palm squirrel	*Funambulus pennantii*
Rodentia	Muridae	House rat	*Rattus rattus*
Rodentia	Muridae	House mouse	*Mus musculus*
Rodentia	Spalacidae	Short-tailed mole rat	*Nesokia indica*
Carnivora	Herpestidae	Small Indian mongoose	*Herpestes javanicus*
Carnivora	Herpestidae	Indian grey mongoose	*Herpestes edwardsii*
Eulipotyphla	Soricidae	Asian house shrew	*Suncus murinus*
Chiroptera	Vespertilionidae	Mouse-eared bat	*Myotis myotis*
Lagomorpha	Leporidae	Indian hare	*Lepus nigricollis*

These observations revealed differences in the composition and relative abundance of small mammal communities across the three surveyed localities, with vegetation-associated species

more prominently represented in Gandaf and commensal rodents more abundant in the human-influenced localities.

Table 3: Mammalian species observed in district Swabi along with their IUCN status

Order/ family	Common name	Scientific name	Species observed	Status
Bovidae	Goral	*Goral naemorhedus*	180	NT
Bovidae	Markhor	*Capra falconeri*	76	NT
Suidae	Wild boar	*Sus scrofa*	833	LC
Canidae	Golden Jackal	*Canis aureus*	454	LC
Canidae	Fox	*Vulpes vulpes*	313	LC
Hyaenidae	Striped Hyena	*Hyaena hyaena*	121	NT
Erinaceidae	Long eared hedgehog	*Hemiechinus collaris*	80	LC
Sciuridae	Northern palm squirrel	*Funambulus pennantii*	100	LC
Muridae	House rat	*Rattus rattus*	900	LC
Muridae	House mouse	*Mus musculus*	700	LC
Muridae	Short tailed mole rat	*Nesokia indica*	306	LC
Herpestidae	Indian mongoose	*Urva auropunctata*	300	LC
Herpestidae	Mongoose	*Urva edwardsi*	400	LC
Soricidae	House shrew	*Suncus murinus*	217	LC
Vespertilionidae	Bat	*Myotis myotis*	800	LC
Leporidae	Hare	*Lepus nigricollis*	293	LC

3.3. Species diversity indices

Species diversity and community structure were assessed using the Shannon–Wiener diversity index (H′), Simpson's index (D), species richness (S), evenness (E) and dominance (D′) for the three mammalian communities (A, B and C). These indices were used to compare species richness, diversity, the distribution of individuals among species and dominance patterns across the surveyed communities.

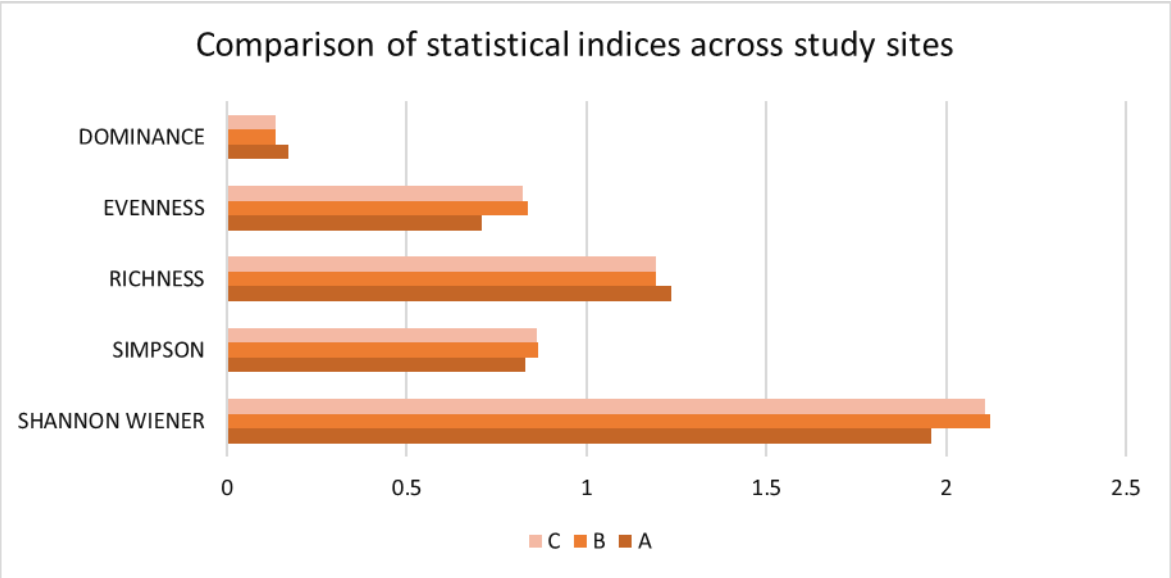

Figure 1. Species diversity indices in four habitats of District Swabi

The comparative values of the diversity indices are presented in Figure 1. The indices provide a quantitative assessment of differences in mammalian community structure among the three groups. Species richness represents the number of species recorded, while the Shannon–Wiener and Simpson indices describe aspects of species diversity and relative abundance. Evenness indicates the distribution of individuals among species, whereas dominance reflects the extent to which particular species predominate within a community.

4. Discussion

The present study, conducted from September 2017 to September 2018, documented a total of 7,801 individual mammals across the surveyed sites in District Swabi, comprising 2,552 individuals belonging to six large mammal species and 5,249 individuals representing ten small mammal species. These findings provide baseline information on the composition, occurrence and relative representation of mammalian fauna in the study area. The greater number of recorded small mammal individuals may reflect differences in population density, habitat use, reproductive potential, detectability and sampling methods. However, comparisons of abundance between large and small mammals should be interpreted cautiously because differences in body size, behaviour and survey techniques can influence detection rates.

Comparison with previous regional studies revealed considerable similarities in mammalian species composition across the neighbouring districts of Khyber Pakhtunkhwa. Saeed et al. (2021), in their survey of Elum Valley, District Buner, documented 12 mammalian species, including *Naemorhedus goral*, *Panthera pardus*, *Lepus nigricollis*, *Macaca mulatta*, *Canis aureus*, *Myotis myotis*, *Hystrix indica*, *Sus scrofa*, *Helogale parvula*, *Herpestes edwardsii*, *Funambulus* sp. and *Manis javanica*. Eleven of these species were also reported in the present study, indicating substantial similarity in species composition between the two geographically adjacent areas. The occurrence of shared species, particularly those associated with woodland, scrubland, agricultural landscapes and mountainous habitats, suggests that these regions support comparable mammalian communities. Such similarities may be associated with geographical proximity, habitat continuity and comparable ecological conditions. Nevertheless, differences in habitat structure, altitude, human disturbance and survey methods may account for variations in species occurrence and abundance.

Khattak et al. (2022) recorded 21 mammalian species belonging to 18 genera, 12 families and six orders in District Nowshera. Artiodactyla was the most species-rich order, with seven recorded species. Wild boar (*Sus scrofa*) was among the frequently recorded mammals. The presence of several mammalian species shared between Nowshera and Swabi further indicates similarities in regional mammalian composition. However, the greater species richness documented in Nowshera may be related to differences in habitat diversity, geographical coverage, sampling effort and survey methodology. Altaf (2014) also reported 15 mammalian species in District Nowshera, providing additional evidence of the region's mammalian diversity. Differences between these inventories should be interpreted in relation to their respective survey periods, locations and sampling methods rather than being attributed exclusively to ecological differences.

Akhtar et al. (2020), in their study of Mardan Khel Dam, Teri, District Karak, reported eight mammalian taxa, including *Felis catus*, *Equus asinus*, *Vulpes cana*, *Canis lupus*, *Capra hircus*, *Ovis aries*, *Oryctolagus cuniculus* and *Dipus sibiricus*. The recorded taxa represented Carnivora, Artiodactyla, Rodentia, Lagomorpha and Perissodactyla. Some of these taxa are

also represented in the broader mammalian records of the present study, suggesting similarities in the regional occurrence of mammals. However, this comparison requires caution because the Mardan Khel inventory includes domestic animals, such as cats, donkeys, goats and sheep, which should be distinguished from naturally occurring wild mammalian populations when assessing wild species richness and conservation status.

Earlier studies from Pakistan have also documented considerable mammalian diversity across different habitats. Roberts (1997) reported 23 mammalian species along the Chenab River, whereas Abida (2013) recorded 24 species representing five orders and ten families. The repeated occurrence of mammals such as jackals, hares, foxes and palm squirrels across different geographical areas suggests that several species are widely distributed and capable of occupying a range of habitats. Their persistence across agricultural, scrubland and other modified landscapes may reflect ecological flexibility and adaptability to changing environmental conditions. Nevertheless, the occurrence of common and adaptable species does not necessarily indicate that the overall ecological condition of these habitats is satisfactory.

Small mammals constituted a substantial component of the recorded fauna in District Swabi. Rodents, particularly house rats, were among the dominant small mammals in the study area. This pattern is consistent with previous studies reporting the widespread occurrence and abundance of rodents in human-modified and agricultural environments (Prakash et al., 1971; Roberts, 1997; Ghalib et al., 2008; Rafique et al., 2010). Rodent dominance may be associated with their high reproductive capacity, flexible feeding behaviour and ability to exploit food and shelter resources around human settlements and cultivated areas. However, the dominance of commensal rodents should not be interpreted as evidence of high overall small-mammal diversity or good habitat quality. Changes in land use and vegetation structure may favour adaptable species while reducing the availability of suitable habitats for less tolerant mammals.

The findings also highlight substantial conservation concerns associated with habitat degradation and increasing anthropogenic pressure across the study area. Deforestation, agricultural expansion, infrastructure development and human encroachment can reduce the availability and quality of natural habitats, disrupt ecological connectivity and restrict the movement of mammalian populations. These pressures are particularly relevant to large mammals, which often require extensive and connected habitats to maintain viable populations. Small mammals may also be affected through the removal of vegetation cover, loss of nesting and shelter sites, and changes in food availability. Previous studies in Khyber Pakhtunkhwa have similarly identified deforestation, hunting, mining, pollution and habitat disturbance as important pressures on wildlife populations (Akhtar et al., 2014; Ali et al., 2018; Rehman et al., 2021; Faiz-ur-Rahman et al., 2023).

Within District Swabi, the surveyed areas around Tarbela Dam, Jhanda and Guluderi experience different forms of land-use pressure. Habitat degradation and infrastructure development around Tarbela Dam may alter natural habitats and contribute to fragmentation, while agricultural expansion in Jhanda and Guluderi may result in the conversion of natural vegetation into cultivated land. Such changes can reduce habitat availability, increase disturbance and potentially displace native mammalian populations. The extent to which these activities affect individual species, however, requires further investigation through systematic habitat assessment, population monitoring and land-use analysis. These local observations are consistent with wider regional concerns regarding habitat degradation and human-induced disturbance reported in other parts of Khyber Pakhtunkhwa.

In addition to habitat loss, hunting pressure, weak enforcement of wildlife-protection regulations and limited public awareness can further intensify conservation challenges. Previous research has identified hunting and trapping as significant threats to species such as the Himalayan goral, while provincial assessments have emphasised the importance of effective wildlife protection and community participation in conservation (Perveen et al., 2013; Ali et al., 2018; Kakakhel, 2020). Therefore, conservation strategies in District Swabi should prioritise the protection of remaining natural habitats, restoration of degraded vegetation, maintenance of habitat connectivity, regulation of hunting and sustainable land-use planning. Community awareness programmes and stronger implementation of wildlife legislation are also essential for reducing human-induced pressures.

Overall, the present study demonstrates that District Swabi supports a diverse mammalian assemblage comprising both large and small mammals. The similarities between the recorded fauna and those reported from neighbouring districts indicate the ecological importance of the wider regional landscape for mammalian distribution and persistence. At the same time, habitat degradation, deforestation, agricultural expansion and infrastructure development represent important conservation concerns. The baseline information generated by this study can support future wildlife surveys, long-term population monitoring, habitat restoration initiatives and evidence-based conservation planning in District Swabi.

5. Conclusion

The study provides baseline information on the diversity, distribution, and recorded abundance of large and small mammals in District Swabi, Khyber Pakhtunkhwa, Pakistan. A total of 16 mammalian species, comprising six large and ten small mammal species, were documented during the survey period (September 2017–September 2018), with 7,801 individuals recorded across the selected study sites. The findings revealed variations in species occurrence and recorded abundance among locations, reflecting the ecological heterogeneity of the district's mountainous, semi-natural, agricultural, and human-modified habitats. Utla supported comparatively higher recorded numbers of Himalayan goral and markhor. Differences in small-mammal assemblages were also evident, with Gandaf supporting notable occurrences of hedgehogs and palm squirrels, Jhangera showing relatively frequent records of house rats and mole rats, and Guluderi having higher recorded numbers of house rats and house mice. These patterns highlight the importance of habitat characteristics and landscape conditions in supporting mammalian communities. However, habitat degradation, deforestation, agricultural expansion, hunting, infrastructure development, and other anthropogenic disturbances represent important potential threats to regional wildlife habitats and biodiversity. Although this study did not quantify the individual effects of these pressures or establish long-term population trends, its findings provide a foundation for identifying conservation concerns and guiding future ecological investigations. Effective conservation of mammalian biodiversity in District Swabi requires the protection of remaining natural vegetation, restoration of degraded habitats, regulation of hunting, increased public awareness, and regular wildlife monitoring. Long-term biodiversity assessments and systematic evaluations of habitat conditions are also recommended to identify changes in species distribution and abundance. Overall, this study establishes an important baseline for future mammalian research and supports evidence-based wildlife conservation, ecosystem management, and biodiversity protection in District Swabi and the wider region of Khyber Pakhtunkhwa, Pakistan.

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