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Hotspot and distribution pattern of the estimated population of Markhor in Pakistan

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Abstract

Markhor is recognized as a wild goat and holds the status of Flagship species as the National Mammal of Pakistan. The study aims to estimate the population distribution with the identification of hotspot areas for the existence of this species within the distribution range in the country. 2024 individuals with population density of 0.875 per Km2, 214.65 individuals with population density of 1.1 animals per Km^2, 6343.2 animals with population density of 2.4 animals per Km^2, 3922.5 heads with population density of 0.75 animals per Km^2 are found in Gilgit Baltistan, Azad Jammu and Kashmir, Khyber Pakhtunkhwa and Baluchistan respectively through line transects or strip census method. Chitral in Khyber Pakhtunkhwa; Torgarh and Suleiman ranges in Baluchistan are the hotspot areas for the existence of this magnificent wild species. However, the cumulative impacts of the anthropogenic pressure and other factors underscore the urgent need for comprehensive conservation efforts to safeguard markhor in Pakistan.
Keywords: Distribution Pattern, Hotspot Areas, Markhor Population.

Introduction

Pakistan hosts exceptional biodiversity and diversity of mammals with over 190 species (Ali, 2008; Aslam et al., 2023; Iqbal & Khan, 2010). Markhor is recognized as a wild goat and categorized under the order Artiodactyla, a family of Bovidae (Roberts & Bernhard, 1977; Schaller, 1976, 1977). Generally, two subspecies have been identified in Pakistan based on the

size and shape of horns i.e., Flare horned Markhor and Straight horned Markhor. The Astor Markhor and Kashmir Markhor are identified as sub-species of flare-horned Markhor and Kabul and Suleiman Markhor are identified as sub-species of Straight horned Markhor. The Chiltan Markhor is known as a wild goat found in Chiltan Mountain of Pakistan (Ahmed, 2020; Ellerman & Morrison-Scott, 1951; Roberts, 1969; Schaller & Khan, 1975; Yasmeen et al., 2022). Morphological appearance defines the color reddish brown to grayish brown or dim with solid short legs and expansive hooves. The size of the adult male varies between 99-103 cm at the shoulder but the total body length varies from 132 -185 cm (Malik, 1987; Schaller, 1977). Moreover, this is a diurnal animal, and feeding habits and food priorities change seasonally and availability of food (Aleem, 1978; Roberts & Bernhard, 1977; Schaller, 1977). The rutting season spans from late October to early December. Whereas, the gestation period spans over 160-170 days after matting (Roberts & Bernhard, 1977; Yasmeen et al., 2022). It holds the status of Flagship species as the National Mammal of Pakistan (Ahmad et al., 2022; Haider et al., 2021; Kakakhel, 2020a; Khan et al., 2018). It is also considered the primary mammalian game species across the country. In accordance, the provincial wildlife department regulated a trophy hunting program annually for 12 animals in the residing areas (Ali, 2008; Jameel et al., 2019; Rehman & Khattak, 2020; Rosser et al., 2012). This sanctioned trophy hunting serves as a significant economic catalyst for local communities residing within the distribution range of this species in the country (Ali, 2008; Kakakhel, 2020b). Despite this, the species is declared as threatened by the International Union of Conservation of Nature.[1]

The comprehensive dataset about the population trends and distribution of the species across the country showcases a dynamic shift over the years under the location's unique circumstance (Ahmed et al., 2001).[2]

Hence, the objective of this study is to estimate the population along with the identification of the hotspot areas within the distribution range in Pakistan.

[1] (IUCN Red list Markhor (*Capra falconeri*) Supplementary Information)
[2] (IUCN Red list Markhor (*Capra falconeri*) Supplementary Information)

Material and methods

Study Area

Markhor is found in Afghanistan, China, India, Tajikistan, Turkmenistan, Uzbekistan and Pakistan.[3] In Pakistan, Flared horned Markhor is found in the deciduous and coniferous forest transitioning into alpine meadows at an elevation of about 1500 meters from sea level in Gilgit Baltistan and an elevation of 724 meters from sea level in alpine and subalpine forest and meadows of Azad Jammu and Kashmir (Abbas et al., 2019; Abbas et al., 2022; Abbas et al., 2017; Akbar et al., 2011; Alam et al., 2023; Amjad et al., 2014). Meanwhile, it is also found at an elevation around 1100 to 7000 meters from sea level in alpine and subalpine forests and meadows of the KPK (Afza et al., 2018; Ali et al., 2021; Ali et al., 2018; Arshad et al., 2013; Arshad et al., 2012; Badshah et al., 2016). On the contrary, strait horned Markhor is found at an elevation around 1700 to 3000 meters from sea level in coniferous forests and grasslands featuring xerophytic and halophytic vegetation in Baluchistan (Ahmad & Pieroni, 2016; Assadi & Runemark, 1983; Ghalib et al., 2019; Ismail et al., 2018; Roberts & Bernhard, 1977; Schaller, 1976). The study area is shown in Figure 1.

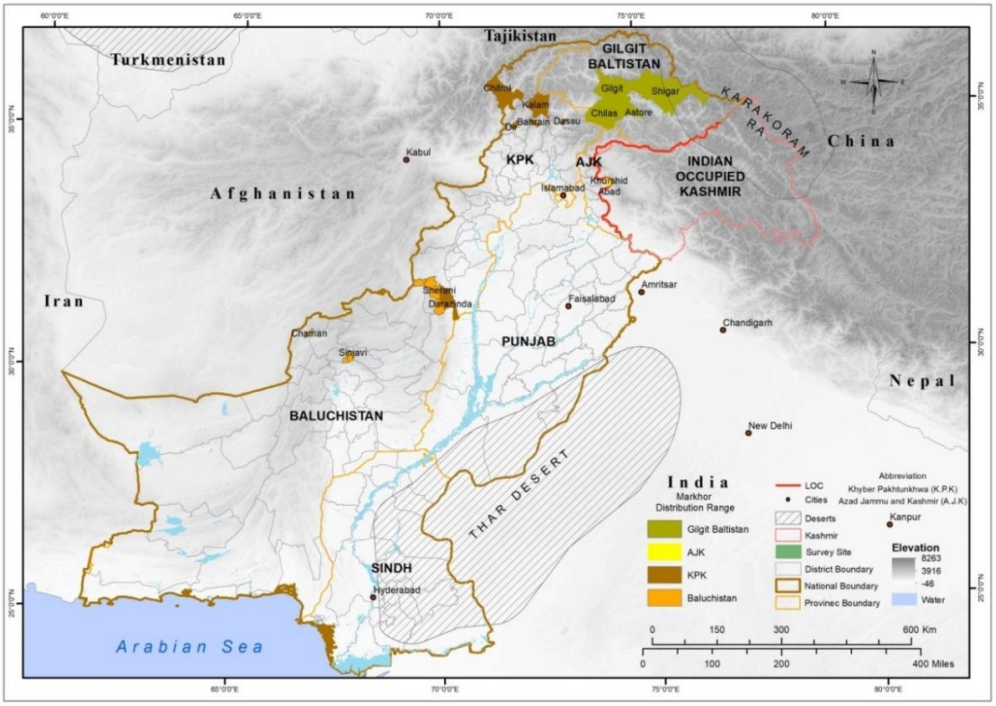

Figure 1: Distribution of Markhor in Pakistan

[3] (IUCN Red list Markhor (*Capra falconeri*) Supplementary Information)

Data Collection and Analysis

It is challenging to conduct field observation in the rugged terrains of Pakistan to study the Markhor in their natural habitat. A comprehensive approach for population estimates based on direct observation "Sample count (Line Transect or Strip Census)" was employed. (Ghalib et al., 2019). During the survey multifaceted approach was used for data collection. Wildlife staff and community volunteers helped to figure out the sites enriched in species. The presence of this species was confirmed through interviewing local people, hunters, and game watchers. Indication of the presence of this species is also confirmed through the presence signs like tracks, impressions of footprints, fecal pallets as well (Aslam et al., 2023). Anyhow, detail of the survey duration is discussed in the following. In Gilgit Baltistan, including Gilgit, Ghigar, Astor, and Chillas, a total of 20 days were dedicated to fieldwork, divided between December 2021 and January 2022. 7 days were spent in Azad Jammu and Kashmir in June 2022. The collected data set is presented in Table 1 and Table 2. The exploration of the wild regions of Khyber Pakhtunkhwa (KPK) involved 25 days (November and December 2022) in the field, covering the areas of Chitral (Golen Gol Conservancy, Toshi Shasha Conservancy, Garam Chashma, Chitral Gol National Park, Bumboret), Diamer, Dasu, Swat (Jaglot, Matiltan, and Gabral), Dir, Kohistan, Ragha Sar, ObastaTsukai, Darazinda. The data collected in this region is shown in Table 3. The study spanned approximately 20 days (May and June 2021) in the wild regions of Baluchistan, including Chiltan, Torghar Hills, Takht-e-Suleiman, Sherani, Dhana Sar, Taktu and Ziarat, with data collection periods in May and June 2021. The data collected from the field survey is shown in Table 4 (Aslam et al., 2023). Systematically collected data with geographic coordinates and then visualized in ArcMap to identify the hotspot area and distribution range of this species through hotspot analysis as shown in Figure 2.

Results

Population estimates of Markhor based on direct observation method

The population estimation of Markhor across the distribution range in Pakistan showcases 2024 individuals with population density of 0.875 animals per km^2 in Gilgit Baltistan (GB), 214.65 heads with population density of 1.1 animals per km^2 in Azad Jammu and Kashmir (AJK), 6343.2 heads with population density of 2.4 animals per km^2 in Khyber Pakhtunkhwa (KPK) and 3922.5 heads with population density of 0.75 animals per km^2 in Baluchistan. Despite this, the International Union for Conservation of Nature (IUCN) Red List marked the Markhor as a threatened species,

reflecting a critical conservation status. However, the following is the detail of the Markhor population estimation. To estimate the population of Markhor in Gilgit Baltistan, the total area searched using the distance sampling technique was calculated by adding the areas of four sites, each being 1 km², resulting in a combined area of 4 km². The total area of Gilgit Baltistan is 2314 km². The population (P) can be estimated using the formula P = (AZ) / (2 × Area Searched), where A is the total area of the study (2314 km²), Z is the number of animals flushed (7), and the Area Searched is 4 km². Plugging in the values, the population is calculated as follows: P = (2314 × 7) / (2 × 4) = 16198 / 8 = 2024 animals. The population density is then determined by dividing the number of animals by the total area of the study, resulting in a density of 0.875 animals per km². The sample fraction, which is the ratio of the area searched to the total area of the reserve, is 4 / 2314 = 0.001729 (Table 1). Additionally, the population estimation of Markhor in Azad Jammu and Kashmir (AJK) and Khyber Pakhtunkhwa (KPK) was calculated through the aforementioned technique.

A total of 5 sites had been searched, each being 1 km^2 and a combined area of 5 km^2. The total targeted area of AJK is 195.1387 km^2, and a total of 11 Animals were flushed during the field survey. However, these values are added as follows to estimate the population: P= (195.1387× 11) / (2 × 5) = 2146.525843 / 10 = 214.6526 animals, thus the population density is estimated by dividing the estimated population by the total area of AJK and it and the population density is 1.1 per km^2. While the sample fraction is the ratio of the area searched to the total area, which is 5 / 195. 1387 = 0.025623 (Table 2).

Similarly, 15 sites had been searched in this context each being 1 km2 and the combined area is 15 km^2. The total area in KPK is 2643 km^2 and a total of 72 animals were flushed during the field survey. To estimate the population; the values are added as follows: P = (2643 × 72) / (2 × 15) = 190296 / 30 = 6343.2 Animals. The density of population is estimated by dividing the total estimated number of animals by the total targeted area of KPK as follows: 1687.8 / 1746 = 2.4 per km^2. The sample fraction is calculated by dividing the search area by the total area of the reserve as follows: 15 / 2643 = 0.00567 (Table 3).

Markhor population and density are also estimated within the distribution range in Baluchistan using the distance sampling technique by adding the values of 6 survey sites, each being 1 $km^{2,}$ and combining an area of 6 $km^{2,}$ and a total of 9 animals are flushed during the field survey. The total targeted area of the Baluchistan is 5230 km^2. To estimate the population; the values are added

as follow: P = (5230× 9) / (2 x 6) = 47070 / 12 = 3922.5 Animals. The density of population is estimated by dividing the total estimated number of animals by the total targeted area of Baluchistan as follows: 3922.5 / 5230 = 0.75 animals/km^2. The sample fraction is calculated by dividing the search area by the total area of the reserve as follows: 6 / 5230 = 0.0011 (Ahmed et al., 2001)[4] (Table 4).

Table 1. Animals observed in Gilgit Baltistan, Pakistan

Sr.	Locality	Evidence		Animal			Observation
		Direct	Indirect	Male	Female	Yearling	
1	Gilgit	✓	✓		2		2
2	Astore	✓	✓	1			1
3	Shigar	✓	✓		2	1	3
4	Chillas	✓	✓		1		1
Total Animals Observed							**7**

Table 2. Animals observed in AJK, Pakistan

Sr.	Locality	Evidence		Animal			Observation
		Direct	Indirect	Male	Female	Yearling	
1	Guraiz Musk Deer NP	✓	✓		1	2	3
2	Mala Dari Dhok Tehsil Khurshid Abad	✓	✓	1	1		2
3	Chitti Watti, Bhedi Tehsil Haveli	✓	✓		1	1	2
4	Phalla Game Reserve Tehsil Khurshid Abad	✓	✓	1	2		3
5	Tao Bhatt	✓	✓	1			1
Total Animals Observed							**11**

[4] (IUCN Red list Markhor (*Capra falconeri*) Supplementary Information)

Table 3. Animal observed in Khyber Pakhtunkhwa, Pakistan

Sr.	Locality	Evidence		Animal			Observation
		Direct	Indirect	Male	Female	Yearling	
1	Awairat Gol (Chitral Gol NP)	✓	✓	2	3		5
2	Gok Shal (Chitral Gol NP)	✓	✓		4	2	6
3	Marine (Chitral Gol NP)	✓	✓	1	3	2	6
4	Toshi Shasha Conservancey	✓	✓	2	7	3	12
5	Gahirat Conservancy Chitral	✓	✓	1	4		5
6	Golen Gol Consarvency	✓	✓	1	5	2	8
7	Garam Chashma Chitral	✓	✓	1	3		4
8	Brumboret	✓	✓		3		3
9	Ragha Sar	✓	✓		2	1	3
10	Obasta Tsukai	✓	✓		3		3
11	Darazinda	✓	✓	2	3	1	6
12	Dasu	✓	✓	1	1		2
13	Jaklot	✓	✓		1	2	3
14	Matiltan	✓	✓	1	2		3
15	Gabral	✓	✓		3		3
Total Animals Observed							**72**

Table 4. Animals observed in Baluchistan, Pakistan

Sr.	Locality	Evidences		Animal			Observation
		Direct	Indirect	Male	Female	Yearling	
1	Chiltan	✓	✓		2		2
2	Takht-e-Sulaiman	✓	✓		1	1	2
3	Torgar Hills	✓	✓	1	1		2
4	Sherani	✓	✓		1		1
5	Dhna Sar	✓	✓	1			1
6	Ziarat	✓	✓	1			1
Total Animals Observed							**9**

Identification of Hotspot areas

Systematically collected data with geographic coordinates are visualized in ArcMap. The hotspot area within the distribution range of this species is identified through hotspot analysis. First of all, the geographic coordinates are integrated within 1 1-kilometer radius and then the ICount is calculated in ArcMap. Later on, the hotspot analysis is deployed.

The Hotspot analysis with a confidence level of 95% shows that the northwestern region of Khyber Pakhtunkhwa is highly populated with flared horned markhor with an estimated population of 6343.2 animals and a density of 2.4 animals per Km^2. The Torgarh and Suleiman Range in Baluchistan is highly populated with strait horned Markhor with an estimated population of 3922.5 heads and a density of 0.75 animals per Km^2. These are the hotspot areas for this magnificent wild species as shown in Figure 2.

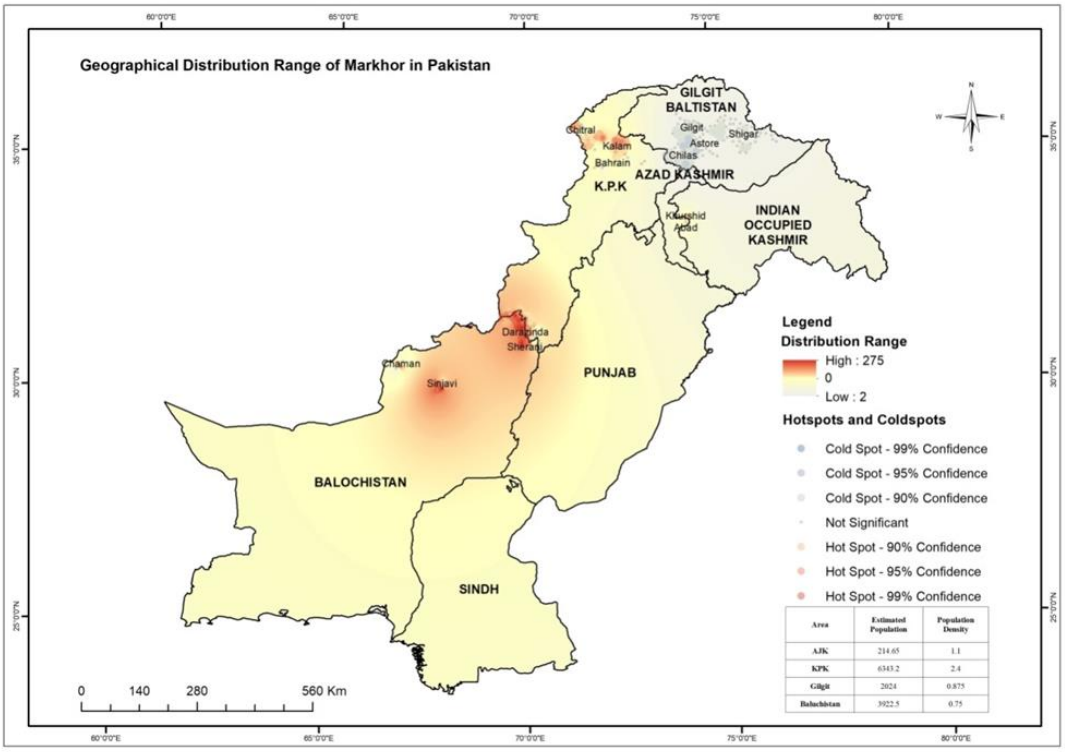

Figure 2. Spatial distribution and Hotspot areas of Markhor in Pakistan

Discussion

The biodiversity of Pakistan is characterized by its exceptional geographical features i.e. mountains, valleys, plain areas, grasslands, rivers, forests, and glaciers fostering an extraordinarily diverse ecosystem (Baig & Ahmed, 2007). This diversity hosts a variety of mammalian species, including the iconic Markhor, Pakistan's national animal (Aslam et al., 2023). It is estimated that 2024 individuals are found in Gilgit Baltistan with a population density of 0.875 per Km^2. Likewise, (Haider et al., 2021) conducted the census of Astor Markhor in Gilgit-Baltistan, Pakistan through the fixed point direct count method in 15 Community Controlled Hunting Areas (CCHAs). 1087 animals were counted in the CCHAs with a population density of 0.13 individuals/Km^2. The

Study revealed that the Kargah area is highly populated. The population of Markhor is estimated in Azad Jammu and Kashmir as well and 214.65 individuals with a population density of 1.1 animals per Km^2 are found. The highest population is estimated in Khyber Pakhtunkhwa (KPK). It is 6343.2 animals with a population density of 2.4 animals per Km^2. Similarly, (Kakakhel, 2020a) studied the population size of the Markhor in KPK. The findings of a four-year study revealed that the population of Markhor has enlarged to 5658 individuals in KPK. Meanwhile, 3922.5 heads are estimated in Baluchistan with a population density of 0.75 animals per Km^2 (Ahmed et al., 2001).

The study revealed that the Markhor's distribution is primarily confined to the Northern regions of Pakistan. However, the species faces significant challenges due to anthropogenic pressures, including human-wildlife conflicts and competition for resources. These pressures, combined with Markhor's already threatened status, highlight the urgent need for comprehensive conservation efforts to safeguard this iconic species in Pakistan.

Conclusion

Systematically collected geographical distribution data set and analysis revealed that Chitral in Khyber Pakhtunkhwa is highly populated with flared horned markhor and Torgarh and Suleiman range is highly populated with strait horned Markhor. These are the hotspot areas for this magnificent wild species. However, numerous threats persist like anthropogenic activities, habitat loss, overgrazing, competition for food, and disease transformation from livestock, which continue to threaten not only Markhor but also other wild species. (Ahmed, 2020; Ashraf et al., 2014). A multi-faceted approach is needed to address these challenges i.e., establishment of protected areas, strict regulations, community engagement, and raising awareness among local communities. Furthermore, the conservation of large carnivores is also important for maintaining ecosystem balance. By prioritizing wildlife conservation and fostering local support, Pakistan can safeguard its rich biodiversity for future generations while ensuring the ecological integrity of its diverse landscapes.

References

Abbas, Z., Alam, J., Khan, S. M., Hussain, M., & Abbasi, A. M. (2019). Diversity, ecological feature, and conservation of a high montane flora of the Shigar valley (Karakorum Range) Baltistan region, northern Pakistan. Pakistan Journal of Botany, 51(3), 985-1000.

Abbas, Z., Bussmann, R. W., Khan, S. M., & Abbasi, A. M. (2022). A review of current trends and future directions in the medical ethnobotany of Gilgit-Baltistan (Northern Pakistan). Ethnobotany Research and Applications, *24*, 1-16.

Abbas, Z., Khan, S., Alam, J., Ullah, Z., Khan, S. W., & Alam, N. (2017). Species, diversity and phyto-climatic gradient of a montane ecosystem in the Karakorum Range. Pakistan Journal of Botany, 45, 223-230.

Afza, R., Ahmad, H., Saqib, Z., Marwat, K. B., & Khan, J. (2018). Spatial analysis of vascular flora of Ayubia National Park, KPK, Pakistan: A classical example of moist temperate Himalaya. Pakistan Journal of Botany, 50(4), 1499-1508.

Ahmad, K., & Pieroni, A. (2016). Folk knowledge of wild food plants among the tribal communities of Thakht-e-Sulaiman Hills, North-West Pakistan. Journal of ethnobiology and ethnomedicine, 12, 1-15.

Ahmad, S., Rehman, E. U., Ali, H., Din, N., Haider, J., Din, J. U., & Nawaz, M. A. (2022). Density Pattern of Flare-Horned Markhor (Capra falconeri) in Northern Pakistan. Sustainability, 14(15), 9567.

Ahmed, J., Tareen, N., & Khan, P. (2001). Conservation of Sulaiman markhor and Afghan urial by local tribesmen in Torghar, Pakistan. International Union for the Conservation of Nature (IUCN).

Ahmed, S. (2020). Parasites of markhor, urial and Chiltan wild goat in Pakistan. Annals of Parasitology, 66(1).

Akbar, M., Ahmed, M., Hussain, A., Zafar, M. U., & Khan, M. (2011). Quantitative forests description from Skardu, Gilgit and Astore Districts of Gilgit-Baltistan, Pakistan. FUUAST Journal of Biology, 1(2 December), 149-160.

Alam, N. M., Shaheen, H., Manzoor, M., Tinghong, T., Arfan, M., & Idrees, M. (2023). Spatial Distribution and Population Structure of Himalayan Fir (Abies pindrow (Royle ex D. Don) Royle) in Moist Temperate Forests of the Kashmir Region. Forests, 14(3), 482.

Aleem, A. (1978). Markhor, population dynamics and food availability in Chitral gol game sanctuary. Pakistan Journal of Forestry, 28(3), 159-165.

Ali, A., Khan, M. A., Ashraf, M. I., & Goheer, M. A. (2021). Economic valuation of ecosystem services in alpine pastures of western Himalayas: a case study of Kaghan valley, Pakistan. Pakistan Journal of Botany, 53(5), 1801-1806.

Ali, A., Khan, T. A., & Ahmad, S. (2018). Analysis of climate data of Khyber Pakhtunkhwa, Pakistan. international research journal of engineering and technology, 5, 4266-4283.

Ali, S. (2008). Conservation and status of markhor (capra falconeri) in the northen parts of north west frontier province, Pakistan.

Amjad, M. S., Arshad, M., & Chaudhari, S. K. (2014). Structural diversity, its components and regenerating capacity of lesser Himalayan forests vegetation of Nikyal valley District Kotli (AK), Pakistan. Asian Pacific journal of tropical medicine, 7, S454-S460.

Arshad, M., Malik, R. N., & Saqib, Z. (2013). Assessing potential habitats of Kashmir Markhor in Chitral Gol National Park, Khyber Pakhtunkhwa, Pakistan. Pakistan Journal of Botany, 45(S1), 561-570.

Arshad, M., Qamer, F. M., Saleem, R., & Malik, R. N. (2012). Prediction of Kashmir markhor habitat suitability in Chitral Gol National Park, Pakistan. Biodiversity, 13(2), 78-87.

Ashraf, N., Anwar, M., Hussain, I., & Nawaz, M. A. (2014). Competition for food between the markhor and domestic goat in Chitral, Pakistan. Turkish Journal of Zoology, 38(2), 191-198.

Aslam, M., Essote, S. A., Taj, M. K., Ahmad, N., Ullah, A., Ahmed, S., & Kakar, D. M. (2023). Distribution and Conservation Status of the Mammalian Fauna of Takattu and Zarghoon Mountain Range of Quetta District. Pak-Euro Journal of Medical and Life Sciences, 6(3), 363-370.

Assadi, M., & Runemark, H. (1983). Notes on the flora and vegetation of S. Baluchistan, Iran. The Iranian Journal of Botany, 2(1), 69-78.

Badshah, L., Hussain, F., & Sher, Z. (2016). Floristic inventory, ecological characteristics and biological spectrum of plants of Parachinar, Kurram agency, Pakistan. Pakistan Journal of Botany, 48(4), 1547-1558.

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.

Ellerman, J. R., & Morrison-Scott, T. C. S. (1951). Checklist of Palaearctic and Indian mammals 1758 to 1946.

Ghalib, S. A., Khan, M. Z., Kanwal, R., Zehra, A., Siddiqui, S., Abbas, D.,…Khan, A. R. (2019). Recent observations on the distribution and status of wildlife of Baluchistan. Canadian Journal of Pure and Applied Sciences, 13(2), 4813-4846.

Haider, J., Rakha, B. A., Anwar, M., Khan, M. Z., & Ali, H. (2021). An updated population status of Astor Markhor (Capra falconeri falconeri) in Gilgit-Baltistan, Pakistan. Global Ecology and Conservation, 27, e01555.

Iqbal, M. M., & Khan, A. M. (2010). Climate change threats to biodiversity in Pakistan. Islamabad: World Environment *Day*.

Ismail, I., Sohail, M., Gilani, H., Ali, A., Hussain, K., Hussain, K.,…Ning, W. (2018). Forest inventory and analysis in Gilgit-Baltistan: A contribution towards developing a forest inventory for all Pakistan. International Journal of Climate Change Strategies and Management, 10(4), 616-631.

Jameel, M. A., Tabassum, S., Mehmood, S., Shah, T., Khan, M. F., Kabir, M., & Awan, M. N. (2019). Does Trophy Hunting of Kashmir Markhor Really Contributing in Its Conservation? International Journal of Conservation Science, 10(3), 525-532.

Kakakhel, S. F. B. (2020a). A review on Markhor (capra falconeri falconeri wagner 1839) population trends (2016-2019) and community-based conservation in Toshi Shasha, Gehrait Goleen, Kaigah Kohistan conservancies and Chitral Gol National Park, Khyber Pakhtunkhwa, Pakistan. American Journal of Natural Sciences, 3(1), 1-18.

Kakakhel, S. F. B. (2020b). Socioeconomic Impacts of Markhor (Capra falconeri falconeri) Trophy Hunting in Toshi Shasha Conservancy District Chitral Khyber Pakhtunkhwa, Pakistan. The International Journal of Science & Technoledge.

Khan, M., Siddiqui, P. A., Raza, A., & Zahler, P. (2018). Status of flare-horned markhor (Capra falconeri falconeri) in Jutial Conservancy, District Gilgit, Gilgit-Baltistan (previously northern areas), Pakistan. International Journal of Biology and Biotechnology, 15(2), 343-349.

Malik, M. M. (1987). Management plan for wild artiodactyls in North West Frontier Province, Pakistan.

Rehman, E., & Khattak, R. (2020). Trophy Hunting Impacts on Kashmir Markhor and Changing the Negative Perception of Local Communities about Wildlife in Chitral District, Pakistan. Zoo's Print Journal, 35, 12-14.

Roberts, T. (1969). A note on Capra falconeri (Wagner, 1839).

Roberts, T. J., & Bernhard. (1977). The mammals of Pakistan.

Rosser, A. M., Tareen, N., & Leader-Williams, N. (2012). The precautionary principle, uncertainty and trophy hunting: a review of the torghar population of central Asian markhor Capra falconeri. Biodiversity and the Precautionary Principle, 55-72.

Schaller, G. B. (1976). Mountain mammals in Pakistan. *Oryx*, *13*(4), 351-356.

Schaller, G. B. (1977). Mountain monarchs. *Wild sheep and goats of the Himalaya*.

Schaller, G. B., & Khan, S. A. (1975). Distribution and status of markhor (Capra falconeri. Biological Conservation, 7(3), 185-198.

Yasmeen, R., Hafeez, F., Qurashi, A. W., Mazhar, S., Ahmad, F., Arif, R.,…Ijaz, N. (2022). Conservation, Management and Threats to Markhor population in Pakistan: An Overview: Markhor Population in Pakistan. MARKHOR (The Journal of Zoology), 06-10.