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**Research Article****An estimation of population density of Punjab urial (*Ovis vignei punjabiensis*) at Kalabagh game reserve in district Mianwali, Punjab, Pakistan****Rizwan Hanif<sup>1</sup>, Mumtaz Akhtar<sup>1</sup>, Muhammad Iqbal Ch.<sup>2</sup>, Manzoor UI Hassan<sup>2</sup>, Mian Muhammad<sup>3</sup>**<sup>1</sup>Department of Biological Sciences, The Superior University, Lahore, Punjab, Pakistan.<sup>2</sup>Department of Statistics, The Superior University, Lahore, Punjab, Pakistan.<sup>3</sup>Department of Zoology, University of Mianwali, Mianwali, Punjab, Pakistan.**ABSTRACT**

A comprehensive study was conducted at the Kalabagh Game Reserve between November 2024 and April 2025 to estimate the density and the population of Punjab urials (*Ovis vignei punjabiensis*) using the sample count technique, line transect method and secondary information. Eleven potential sites were selected, including Bandowali, Dargah, Herowali, Dheranwali, Saran, Rodhan, Draï, Soka, Rodywali, and Harnikalan. Using the transect method, 60% of the total area was sampled and 532 Punjab Urial were estimated with a population density of 8.9 animals/km<sup>2</sup>. When the vegetation in the research area was evaluated, approximately thirty-two plant species were found, including thirteen different kinds of grasses, four different types of herbs, and fifteen different kinds of trees and shrubs., Pearson's correlation (r) was applied to compare the estimated and observed populations. Indicating statistical significance is a value of 0.9. Numerous urials had good ram survival in later age classes and strong lamb and ram survival rates in prior years.

**Keywords:** Punjab urial; *Ovis vignei punjabiensis*; Kalabagh Game Reserve; population density; conservation.

**INTRODUCTION**

The Punjab Urial (*Ovis vignei punjabiensis*) is a subspecies of wild sheep endemic to northern Pakistan. It is one of six mammalian species predominantly found in northern Punjab, Pakistan. It is classified within the genus *Ovis* and family Bovidae. It's typical habitat at high altitudes, reaching up to 1500 meters, in the Salt Range and Kala Chitta Range. This population is reproductively, historically, and biogeographically distinct, characterized by large horns similar to those of the Marco Polo sheep (*Ovis ammon polii*), a reddish-grey body hair, long, thin legs, a greyish face and creamy white underparts. The IUCN Red List of Threatened Species classifies the species as endangered (Michel et al., 2020).

Although domestic sheep are numerous on most mainlands, wild sheep have experienced significant declines in both population numbers and distribution in recent times. Mountains in eastern Eurasia and western North America are home to wild *Ovis*. The International Union for the Conservation of Nature has categorized the Punjab Urial as vulnerable (VU) due to a decline in its population over the last 30 years (Michel et al., 2020). Three species of Urial are known in Pakistan's Punjab Urial (*O. v. punjabiensis*), It may be found in Punjab's salts and Kala Chitta mountains; Ladakh urial (*O. v. vignei*), which is established in Chitral and Gilgit Baltistan; and Baluchistan urial (*O. v. blanfordi*), which is based in Baluchistan and Sindh (Khan, et al., 2015). Urial prefers to be near ridgelines, crests, and cliffs, and the distance to a ridgeline is particularly crucial to their escape

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plan (Geist., 1971). Its diverse habitats span a broad latitudinal gradient in Pakistan, from sea level to The distribution of Punjab Urial within the reserve is influenced by factors such as vegetation cover, water availability, and human activity. Urial tend to prefer steep, rocky slopes with sparse vegetation, which provide both food and protection from predators (Schaller., 1977). However, habitat fragmentation and encroachment by livestock have restricted their range, leading to isolated subpopulations with limited genetic exchange (Ayaz et al., 2012).

A key component of wildlife protection and the long-term viability of animal populations is habitat management. On the other hand, one of the biggest risks to the survival of species is habitat deterioration. To sustain the demands of the species, a suitable or viable habitat must have a number of essential elements, such as enough food, water, cover, and space (Suleman et al., 2021). To comprehend the evolution of life and assess the dynamics of the species' populations, these factors must be looked into (Nilsen et al., 2004). Previous studies have shown that every element of a species environment influences its ability to reproduce, which in turn impacts the species' chances of surviving. Ultimately, the most reliable and consistent method of determining a species' capacity for reproduction is to look at its habitat components (Uboni et al., 2017).

A number of variables, including human activit, water availability, and vegetation cover, affect the distribution of Punjab urine within the reserve. Urial typically favor rocky, steep slopes with little vegetation because they offer food and predator protection (Schaller et all., 1974). However, their distribution has been limited due to habitat fragmentation and livestock encroachment, resulting in isolated subpopulations with little genetic exchange.

## MATERIALS AND METHODS

### Study Area

Established in the early 1930s, Kalabagh Game Reserve (KGR) is located approximately 25 km southeast of Kalabagh town in District Mianwali, Province Punjab, Pakistan. It is situated inside a tiny massif that is the Salt Range's westernmost extension (32°52'N, 71°39'E). The Nawab of Kalabagh has maintained private ownership of this land for many centuries. It was not until the 1930s that the Punjab urial received formal protection within the reserve. According to Nawab Malik Muhammad Asad, the Urial population at that time was very limited. Following the implementation of strict protection measures, including a ban on general hunting, except regulated trophy hunting under special permits, the urial population began to recover. By 1966, the population was estimated to be approximately 500 individuals (Mountfort & Roberton, 1978) While diminishing in other Salt Range regions. The Urial population in Kalabagh has proliferated due to protective measures.; estimates of their numbers in 1988 and 1992 were 700 and 850, respectively (Hess et al., 1997).

Due to its natural vegetation and topography, the Salt Range has historically supported a wide variety of wildlife, including the Punjab urial (*Ovis orientalis punjabiensis*), Chinkara (*Gazella bennettii*), Chakur (*Alectoris chukar*), See see partidge (*Ammoperdix griseogularis*), Grey francolin (*Francolinus pondicerianus*), and Black francolin (*Francolinus francolinus*). The Indian wolf (*Canis lupus pallipes*), Leopard (*Panthera pardus*), yellow-throated marten (*Martes flavigula*), golden jackal (*Canis aureus*), jungle cat (*Felis chaus*), and red fox (*Vulpes vulpes*) were among the important carnivores. However, the numbers and distribution of the majority of species have significantly decreased due to habitat degradation and unregulated hunting in the past. Currently, the only major wild ungulates in the KGR are Chinkara and Urial. Wild boar (*Sus scrofa*) is also present. Only a small number of cattle and sheep graze within the KGR, and they are located close to the game guard headquarters at Jaba. In the research area, precipitation mostly takes the form of rain. During the thirty years between 1961 and 1990, the average yearly rainfall was 454 mm, according to data gathered from the meteorological station of the Mianwali Meteorological Department, which is situated about 30 km southwest of the Kalabagh Game Reserve. About 60% of the rainfall falls during the summer, making it distinctly seasonal. The monsoon season begins in mid-July and lasts until mid-September, while winter precipitation often begins in January and lasts until early March. With January being the coldest month and June being the warmest, there are also clear signs of climate extremes. In June, the average maximum daily temperature often rises beyond 40 °C.

### Field Survey Methodology

The study was conducted in Kalabagh Game Reserve, a protected area located within the Salt Range of District Mianwali, Punjab. The terrain of the reserve is characterized by rugged hills, cliffs, valleys, and patches of dry scrub forest, which offer suitable habitat for the Punjab Urial. Fieldwork was carried out over a period of five months, from November 2024 to April 2025, encompassing 28 field days and approximately 168 hours of survey effort. Observations were conducted during peak activity hours early morning (06:30 to 09:30) and late afternoon (15:30 to 18:30) when urials are most visible and active. A total of 33 surveys were conducted across different habitats to maximize coverage

and minimize duplication (Figure 1). The line transect sampling method was employed as the primary survey technique, which is widely recognized for estimating population density in wildlife studies. Eleven transects were established, each corresponding to a key location within the reserve known for Urrial presence: Jaba, Saran, Dheranwali, Rodhan, Draï, Soka, Rodywali, Bandowali, Dargah, Herowali, and Harnikalan. The transects varied in length from 1.5 to 3.2 km, with an average length of 2.4 km, depending on the terrain and accessibility. To avoid double counting and spatial overlap, adjacent transects were spaced at least 1.5 km apart and not surveyed on the same day. Observers either walked along the transects or used fixed vantage points based on topographical constraints. Every urrial sighting was recorded along with group composition (males, females, juveniles), sighting angle and distance (measured using rangefinders and compasses), GPS coordinates, and weather conditions. Binoculars (10×42) and spotting scopes (15–45×60) were used to assist with identification and group classification.

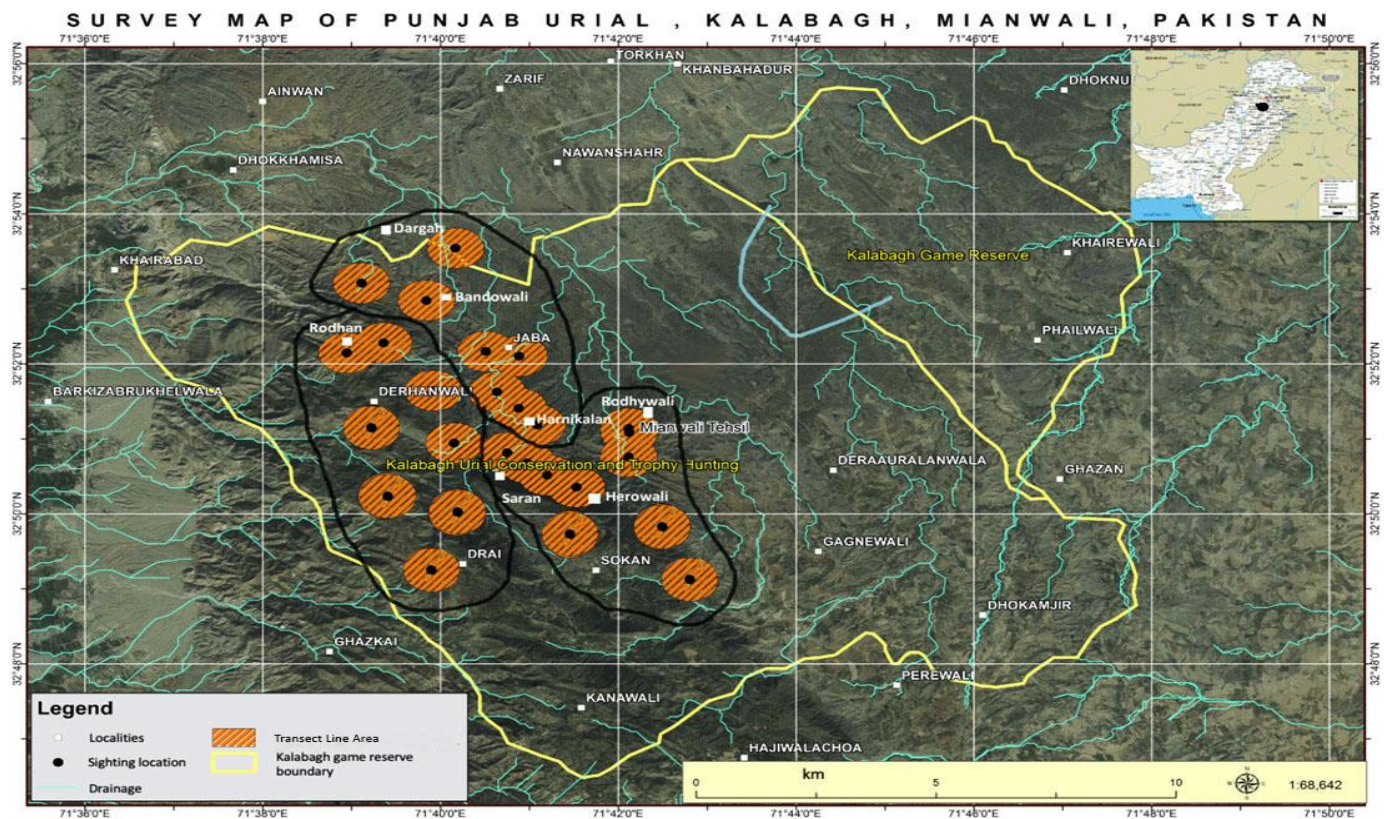


Figure 1. Locations of Punjab Urrial in Kalabagh game reserve, Pakistan 2024 -2025.

## RESULTS AND DISCUSSION

During the survey, an estimated 532 urrial, with a population density of 8.9 animals/km<sup>2</sup>, were found in the research region. The results obtained are discussed below;

### Vegetation

Vegetation structure and composition strongly influence the distribution, density and detectability of Punjab urrial. Vegetation determines forage availability (seasonal grasses and forbs) and protective cover (shrub and rocky cover) that affect survival and predation risk, and it also alters observer detection probability during field surveys. Dry subtropical semi-evergreen scrub forest is the predominant habitat type in the region. *Acacia modesta*, *Olea ferruginea*, *Salvadora oleioides*, *Zizyphus nummularia*, *Dodonaea viscosa*, *Zizyphus nummularia*, *Prosopis glandulosa*, *Justicia adhotoda*, and *Calotropis procera* are among the primary plant species. *Zizyphus nummularia* and *Maytenus royleanus* are expected to grow in certain revines and on high slopes where *Dodonaea viscosa* predominates. Shrubs are uncommon and typically dispersed. Grass, specifically *Cymbopogon jwarancusa*, *Elusine compressa*, *Heteropogon contorus*, *Aristida adsensionis*, *Cynodon dactylon*, and *Saccharum* sp., is the main ground cover (Table 1).

### Population Status of Urrial

In total, in the 11 localities, there are 111 males, 176 females, and 32 young individuals, totaling 319 urrial. The average

Table 1. Vegetation analysis of Kalabagh Game Reserve.

| Trees and Shrubs                                   |         |            |           |             |              |       |          |                 |
|--|---------|------------|-----------|-------------|--------------|-------|----------|-----------------|
| Species  | Density | R. Density | Frequency | % Frequency | R. Frequency | Cover | R. Cover | Important Value |
| <i>Acacia modesta</i> (Phulai)                     | 2.1     | 9.0        | 0.7       | 73%         | 7.86         | 73    | 7.774    | 24.594          |
| <i>Salvadora oleoides</i> (Metha Jaal)             | 1.6     | 6.7        | 0.5       | 53%         | 5.71         | 53    | 5.644    | 18.081          |
| <i>Tamarix aphylla</i> (Athel)                     | 1.1     | 4.5        | 0.6       | 60%         | 6.43         | 60    | 6.389    | 17.300          |
| <i>Acacia hydasypica</i> (Kikar)                   | 2.1     | 9.0        | 0.9       | 93%         | 10.00        | 93    | 9.911    | 28.874          |
| <i>Capparis decidua</i> (Karir)                    | 1.9     | 8.1        | 0.9       | 87%         | 9.29         | 87    | 9.265    | 26.673          |
| <i>Carissa opaca</i> (Karonda)                     | 1.5     | 6.4        | 0.8       | 80%         | 8.57         | 87    | 9.265    | 24.279          |
| <i>Dodonaea viscosa</i> (Sanatha)                  | 1.6     | 6.7        | 0.7       | 67%         | 7.14         | 67    | 7.135    | 21.000          |
| <i>Maytemus royleamus</i>                          | 0.8     | 3.4        | 0.6       | 60%         | 6.43         | 60    | 6.389    | 16.179          |
| <i>Periploca aphylla</i> (Barar)                   | 1.2     | 5.0        | 0.6       | 60%         | 6.43         | 60    | 6.389    | 17.860          |
| <i>Lanata indica</i> (Wild saag - Lantana)         | 1.3     | 5.3        | 0.5       | 53%         | 5.71         | 53    | 5.644    | 16.680          |
| <i>Prosopis glandulosa</i> (Honey Mesquite)        | 0.9     | 3.6        | 0.4       | 40%         | 4.29         | 40    | 4.260    | 12.187          |
| <i>Rhazya stricta</i> (Harmal)                     | 3.7     | 15.4       | 0.9       | 93%         | 10.00        | 93    | 9.903    | 35.310          |
| <i>Ziziphus nummularia</i> (Jharber)               | 0.8     | 3.4        | 0.4       | 40%         | 4.29         | 40    | 4.260    | 11.907          |
| <i>Justicia adhatoda</i> (Malabar)                 | 1.4     | 5.9        | 0.3       | 33%         | 3.57         | 33    | 3.514    | 12.968          |
| <i>Grawia tenax</i> (Phalsa)                       | 1.8     | 7.6        | 0.4       | 40%         | 4.29         | 40    | 4.260    | 16.108          |
| Herbs  |         |            |           |             |              |       |          |                 |
| Species  | Density | R. Density | Frequency | % Frequency | R. Frequency | Cover | R. Cover | Important Value |
| <i>Abutilon fruticosum</i> (Shrubby indian Mallow) | 4.7     | 0.123      | 0.7       | 73%         | 23.40        | 0.73  | 23.323   | 46.850          |
| <i>Fagonia indica</i> (Dhamasa)                    | 5.7     | 0.148      | 0.9       | 87%         | 27.66        | 0.87  | 27.796   | 55.603          |
| <i>Ochthochloa compressa</i> (Sand Couch Grass)    | 7.3     | 0.191      | 0.8       | 80%         | 25.53        | 0.80  | 25.559   | 51.282          |
| <i>Rhynchetytrum repens</i> (Natal Grass)          | 20.7    | 0.538      | 0.7       | 73%         | 23.40        | 0.73  | 23.323   | 47.265          |
| Grass  |         |            |           |             |              |       |          |                 |
| Species  | Density | R. Density | Frequency | % Frequency | R. Frequency | Cover | R. Cover | Important Value |
| <i>Acrachne racemosa</i>                           | 7.3     | 0.061      | 0.7       | 73%         | 8.15         | 0.73  | 8.11     | 16.320          |
| <i>Aristida cyanantha</i>                          | 10.7    | 0.088      | 0.5       | 53%         | 5.93         | 0.53  | 5.89     | 11.903          |
| <i>Aristidamuttabilis</i>                          | 6.3     | 0.052      | 0.6       | 60%         | 6.67         | 0.6   | 6.67     | 13.386          |
| <i>Chrysopogon serrulatus</i>                      | 20.7    | 0.171      | 0.9       | 93%         | 10.37        | 0.93  | 10.33    | 20.874          |
| <i>Cymbopogon jwarancusa</i>                       | 12.0    | 0.099      | 0.9       | 87%         | 9.63         | 0.87  | 9.67     | 19.395          |
| <i>Cynodon dactylon</i>                            | 14.0    | 0.116      | 0.8       | 80%         | 8.89         | 0.8   | 8.89     | 17.893          |
| <i>Dichanthium foveolatum</i>                      | 8.0     | 0.066      | 0.7       | 67%         | 7.41         | 0.67  | 7.44     | 14.918          |

|                               |     |       |     |     |      |      |      |        |
|-------------------------------|-----|-------|-----|-----|------|------|------|--------|
| <i>Digitaria sanguinalis</i>  | 7.3 | 0.061 | 0.6 | 60% | 6.67 | 0.6  | 6.67 | 13.394 |
| <i>Heteropogon contrortus</i> | 7.3 | 0.061 | 0.7 | 73% | 8.15 | 0.73 | 8.11 | 16.320 |
| <i>Ochthochloa compressa</i>  | 8.7 | 0.072 | 0.9 | 87% | 9.63 | 0.87 | 9.67 | 19.368 |
| <i>Saccharum griffithii</i>   | 7.3 | 0.061 | 0.7 | 67% | 7.41 | 0.67 | 7.44 | 14.912 |
| <i>Sccharum spontaneum</i>    | 5.3 | 0.044 | 0.5 | 53% | 5.93 | 0.53 | 5.89 | 11.859 |
| <i>Sporobolus diander</i>     | 6.1 | 0.050 | 0.5 | 47% | 5.19 | 0.47 | 5.22 | 10.457 |

population density is 8.9 per km<sup>2</sup>, and the combined estimated population is 532. These figures can help to plan resource allocation, infrastructure, and services based on population size and density in each locality (Table 2).

Table 2. Punjab Urial population observed at Kalabagh Game Reserve.

| Sr. No | Locality   | Observed Population |        |       | Total Population |
|--------|------------|---------------------|--------|-------|------------------|
|        |            | Male                | Female | Young |                  |
| 1      | Dheranwali | 9                   | 13     | 4     | 26               |
| 2      | Drai       | 10                  | 16     | 4     | 30               |
| 3      | Dargah     | 8                   | 12     | 2     | 22               |
| 4      | Sokan      | 8                   | 13     | 0     | 21               |
| 5      | Saran      | 8                   | 16     | 4     | 28               |
| 6      | Jaba       | 18                  | 35     | 8     | 61               |
| 7      | Rodywali   | 11                  | 17     | 0     | 28               |
| 8      | Bandowali  | 8                   | 10     | 3     | 21               |
| 9      | Harnikalan | 12                  | 19     | 2     | 33               |
| 10     | Rodhan     | 10                  | 13     | 3     | 26               |
| 11     | Herowali   | 9                   | 12     | 2     | 23               |
| Total  |            | 111                 | 176    | 32    | 319              |

The minimum estimated population of Punjab was 26 and the maximum estimated population was 122, with an average of 87. Based on direct observation, density/km<sup>2</sup> was determined as 8.9 and a total area of 37 km<sup>2</sup>, 319 urial were observed during the study period. The total estimated population is 532. Pearson's correlation, denoted by *r*, was used to compare the observed and estimated populations; the value of *r* was 0.9, indicating statistical significance. Among these localities, Jaba shows the highest observed population of 61 urial and an estimated population of 122, with a relatively high density of 12.2. On the other end, Dargah and Herowali show the lowest population densities of 5.5 and 5.8, respectively, indicating more sparsely populated areas. The Dargah and Herowali localities have low total populations and densities, implying small and less crowded population. (Table 3)

Table 3. Population density and estimation of Punjab Urial at study sites.

| Sr. No | Locality   | Observed Population |        |       | Total Population | Population Density | Estimated Population | Sample Fraction |
|--------|------------|---------------------|--------|-------|------------------|--------------------|----------------------|-----------------|
|        |            | Male                | Female | Young |                  |                    |                      |                 |
| 1      | Dheranwali | 9                   | 13     | 4     | 26               | 8.7                | 43                   | 60%             |
| 2      | Drai       | 10                  | 16     | 4     | 30               | 15.0               | 60                   | 50%             |
| 3      | Dargah     | 8                   | 12     | 2     | 22               | 5.5                | 39                   | 57%             |

|       |           |     |     |    |     |      |     |      |
|-------|-----------|-----|-----|----|-----|------|-----|------|
| 4     | Sokan     | 8   | 13  | 0  | 21  | 10.5 | 32  | 67%  |
| 5     | Saran     | 8   | 16  | 4  | 28  | 9.3  | 47  | 60%  |
| 6     | Jaba      | 18  | 35  | 8  | 61  | 12.2 | 122 | 50%  |
| 7     | Rodywali  | 11  | 17  | 0  | 28  | 7.0  | 42  | 67%  |
| 8     | Bandowali | 8   | 10  | 3  | 21  | 10.5 | 42  | 50%  |
| 9     | Hamikalan | 12  | 19  | 2  | 33  | 11.0 | 55  | 60%  |
| 10    | Rodhan    | 10  | 13  | 3  | 26  | 6.5  | 26  | 100% |
| 11    | Herowali  | 9   | 12  | 2  | 23  | 5.8  | 40  | 57%  |
| Total |           | 111 | 176 | 32 | 319 | 8.9  | 532 | 60%  |

Pakistan has a highly diverse and unique assemblage of flora and fauna, both phytogeographically and physiographically, as a result of the confluence of Palearctic and Indomalayan biogeographic regions. Among the three recognized subspecies of *Ovis vignei*, the Punjab Urial (*Ovis vignei punjabiensis*) has particular significance as a prominent game species in Pakistan, especially within the Punjab province. Being native to the Salt Range and the Kala Chitta Range, this subspecies is endemic to the area and therefore of vital ecological and conservation significance (Roberts., 1997).

The current study reveals that the Punjabi people's food is mainly composed of herbaceous plants, with grasses, trees, and shrubs coming in second and third, respectively. There was seasonal change in feeding choices, which is consistent with trends found in other research (Hussain et al., 2015). Favorite fodder grasses according to current research and previously published data (G. A. Awan, Festa-Bianchet, & Ahmad, 2006); (Hussain et al., 2015; Iqbal et al., 2012); (Habiba et al., 2015). Throughout the year, the plant species most commonly linked to the Punjab urial include *Olea ferruginea* and *Acacia modesta*; *Dodonaea viscosa*, which is present all year round; *Zizyphus jujuba*, which is mostly consumed in the winter; *Zizyphus nummularia*, which is used in both the winter and monsoon seasons; *Acacia nilotica*, which is preferred in the winter and summer; *Adhatoda zeylanica*, which is consumed in the spring and summer; and *Maytenus royleana*, which is preferred in the spring and winter. There have been some reports of minor seasonal variations in this species' availability and abundance, which could be caused by a variety of factors, including changes in the grazing habits of urials, climate change, and the gradual loss of natural habitat brought on by urbanization.

The Punjab Urial is now only found in locations that are ideal for it. These regions are spread throughout six districts of Pakistan: Attock (Hussain et al., 2015), Kohat (Ayaz et al., 2012), Mianwali (Awan et al., 2005), Chakwal (Hussain et al., 2015), Jehlum (Hussain et al., 1913), (Habiba et al., 2015), and Khushab (Khan et al., 2015). The results of our findings indicate that reintroduction efforts in appropriate habitats should be given priority, even though several conservation initiatives, management techniques, and designated protected areas are now in place to support declining populations. The long-term preservation of the species might be fully addressed by a combined strategy that makes use of both in-situ and ex-situ conservation techniques. With the use of geospatial tools, the findings of this study can be a useful tool for wildlife authorities creating conservation and management strategies for the endangered Punjab urial.

## CONCLUSION

In conclusion, this study represents a significant advancement in our understanding and conservation of the Punjab urial in the Kalabagh Game Reserve. By providing up-to-date and reliable population estimates, the study provides a scientific basis for the creation of effective conservation strategies intended to ensure the long-term survival of this endangered species. The findings also lay the foundation for future research and monitoring initiatives that complement the overall objective of protecting Pakistan's biodiversity. To lessen the burden on the native vegetation in the urial habitat, it is advised to provide livestock with defined grazing areas and alternative environmental resources to the local population living close to the reserves. The pet trade and illegal hunting must be stopped by strict law enforcement, and mining and other activities in wildlife sanctuaries must be closely watched. Enhancing the technology and infrastructure of wildlife department personnel who work in law enforcement is essential. Additionally, local communities

and non-governmental organizations have to be involved in promoting awareness of the significance of species and the Punjab Uri conservation effort.

### AUTHOR'S CONTRIBUTION

Rizwan Hanif conceptualized and designed the study, conducted field surveys, collected and analyzed the data, and drafted the manuscript under the supervision of Prof. Dr. Mumtaz Akhtar. Prof. Dr. Muhammad iqbal and Manzool UI Hassan helped in statistical analysis. KJ and KI and SA assisted in the initial draft. MA and UF helped with data collection MM helped with data analysis, literature review, and manuscript editing. All authors have read and approved the final version of the manuscript.

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### AVAILABILITY OF DATA AND MATERIAL

All data produced throughout this research is presented in this published article as tables.

### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All fieldwork and data collection procedures were conducted in according to relevant national and institutional guidelines for wildlife research and ethical standards. No animals were captured or harmed during the surveys, as the study relied solely on observational methods such as direct sighting, vantage point surveys, and indirect signs. Informed consent was not applicable as the study did not involve human participants.

### CONSENT FOR PUBLICATION

This study does not include any personal data from individuals in any capacity. All authors have consented to its publication.

### CONFLICT OF INTERESTS

All authors attest to the validity of manuscript contents and agree for submission.

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