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Population Dynamics of Balochistan Urial (*Ovis vignei blanfordi*) in South Eastern Balochistan, Pakistan

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Key words
Conservation, Lasbela, Urial, Ungulates, Demographic trend, *Ovis vignei*, Capture-mark-recapture analysis

ABSTRACT

The Balochistan urial (*Ovis vignei blanfordi*), classified as vulnerable by the IUCN Red List, inhabits dry juniper scrub ecosystems across its range. However, information on free-ranging populations in Pakistan, particularly southeastern Balochistan, is limited. This study investigated the population dynamics of Afghan Urial in southeastern Balochistan using a four year distance sampling survey with double observers (2019-2022). Line transects with double observer surveys were employed to estimate population size, herd size, and density. Capture-mark-recapture analysis further refined population estimates. The study revealed that the population estimates and temporal variations during the study period were 207.57, 169.24, 177.75, and 160.78 with a mean herd size of 7.62, 7.36, 6.03, and 5.66 in 2019, 2020, 2021, and 2022, respectively. The population declined significantly during the study period, from 860 individuals in 2019 to 534 in 2022, reflecting a 38% decrease. The male to female ratio varied across years ranging from 1:1.01 to 1:1.28. Poaching, livestock overgrazing, habitat degradation, and climate change were identified as key threats to the urial population. The study underscores the importance of continuous monitoring and effective conservation strategies to safeguard the Balochistan urial population. Urgent conservation efforts are needed to address poaching, manage livestock grazing, improve habitat quality, and adapt to climate change. Collaboration with local communities is crucial for successful conservation.

INTRODUCTION

Wild ungulates, like the Balochistan urial (*Ovis vignei blanfordi*), play a vital role in ecosystem health. They influence vegetation structure, species composition, and nutrient cycling (Augustine and McNaughton, 1998; Bagchi and Ritchie, 2010; Pascusal-Rico *et al*., 2021). Ungulate populations also impact predator density (Carbone and Gittleman, 2002). effective monitoring of their demographics and population status is crucial for conservation efforts (Yoccoz *et al*., 2001). South Asia boasts a rich diversity of wild ungulates, offering opportunities for sustainable management. However, the region has witnessed a significant decline in ungulate populations and distribution ranges over the past century. Robust assessments of population trends, sizes, and extinction risk are essential for implementing and evaluating conservation measures. The International Union for Conservation of Nature (IUCN) Red List of Threatened Species relies on such assessments.

The Balochistan urial is classified as vulnerable by the IUCN (Michel and Ghoddousi, 2020). Its range spans Afghanistan, Tajikistan, Uzbekistan, Kazakhstan, Turkmenistan, northwestern India, and eastern Iran. This

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adaptable species inhabits diverse ecosystems, from dry subtropical scrub in northern Pakistan (Siraj-ud-Din *et al.*, 2018) to evergreen subtropical forests in Punjab (Suleman *et al.*, 2020) and scrub ecosystems in Balochistan (Ghalib *et al.*, 2019). Their habitat choices for foraging vary based on vegetation, with preferences for trees in northern areas and grasses in Punjab (Ghalib *et al.*, 2019; Suleman *et al.*, 2021).

The Balochistan urial (*Ovis vignei blanfordi*) is widely distributed in Balochistan, particularly in mountain ranges like the Chiltan Hills (Quetta and Kalat), Hinglaj Range (Khuzdar), Karhan Hills (Karhan), Mekran Coast Ranges (Gawadar), Takatu Hills (Pishin and Quetta), and Toba Kakar Range (Pishin and Zhob). These habitats range from 2750 to 4000 meters above sea level. While preferring steep terrain for escape cover, they can adapt to degraded habitats with heavy livestock presence (Ghalib *et al.*, 2007, 2019).

The Balochistan Wildlife Act 1974 offers legal protection to the Balochistan urial. However, anthropogenic activities pose significant threats, including poaching, lamb picking, habitat degradation due to agricultural practices, and livestock overgrazing in core habitats (Siraj-ud-Din *et al.*, 2016). Limited information exists on the population trends and status of the Balochistan urial (Virk, 1991). While some studies have documented urials in protected areas (Frisina *et al.*, 2006), the population status of free-ranging urials across Balochistan remains largely unknown. This highlights the urgent need for research on their spatial ecology to inform conservation strategies and improve their survival prospects.

To address the information gap, this study was conducted in the southeastern Balochistan districts of Khuzdar and Lasbela. We aimed to investigate the demographic trends and current population status of the Balochistan urial. This research contributes valuable baseline data for conservation efforts in Balochistan, Pakistan. Understanding population dynamics will be crucial for implementing a holistic approach to enhance urial populations across different ecoregions of the country.

MATERIALS AND METHODS

Study area

The study was conducted in the Khuzdar (27.5758° N and 66.8082° E) and Lasbela (25.8700° N and 66.7129° E) districts situated along the Sindh-Balochistan border (Fig. 1). These areas also bordered the Arabian Sea on the southern side (Khan *et al.*, 2021). Study areas are located at an altitude of 1494 meters above sea level and receive water from rivers and streams, originate from the Moro and

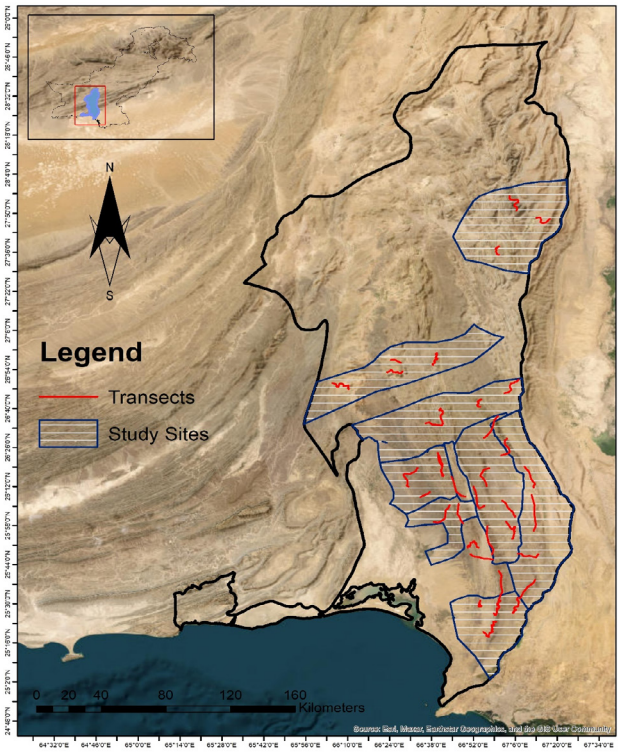

Fig. 1. Map of the study areas.

Pub hills in the northern and eastern regions (Khan *et al.*, 2021). During the summer, temperatures typically average 32°C, with April and May being the hottest months. In winter, January has the lowest temperatures, averaging 19°C. The majority of precipitation occurs in summer months, particularly in July and August (Fund, 2015). Xerophytic vegetation covers the study area, which includes trees, shrubs, and grasses. Tree species include Dhamasa (*Fagonia arabica*), Senegal gum (*Acacia rupestris*), Karira (*Capparis decidua*), jand (*Prosopis cineraria*), Indian jujube (*Ziziphus mauritiana*), peelu (*Salvadora oleoides*), phulai (*Acacia modesta*), and Gum arabic tree (*Vachellia nilotica*). The higher slopes have been densely occupied by wild olive, while the lower slopes have been occupied by Athel pine (*Tamarix aphylla*) and Mazari palms (*Nannorrhops ritchiana*), (Sarfraz, 1997). The shrub species included comprising of hedge Euphoria (*Euphorbia neriifolia*), saltwort (*Salsola aphylla*), Milkvetch (*Astragalus* spp.,), Siberian pea–tree (*Caragana polyacantha*), seaworm wood (*Artemisia maritima*), Indian rennet (*Withania coagulans*), camel thorn (*Alhagi camelorum* and bindweed (*Convolvulus spinosus*). The grass species encompassing of jawankush grass (*Cymbopogon jwarancusa*), hoary cress (*Lepidium draba*), cogon grass (*Imperata cylindrical*), Aucher's chrysopogon

(*Chrysopogon aucheri* and sarkana (*Saccharum munja*). These study areas are rich in wild fauna, i.e., gray wolf (*Canis lupus*), hill fox (*Vulpes vulpes griffithii*), Asiatic jackal (*Canis aureus*, striped hyena (*Hyaena hyaena*), cape hare (*Lepus capensis*, porcupine (*Hystrix indica*), hedgehog (*Hemiechinus auritus megalotis*), Sindh ibex (*Capra egagrus*, Afghan urial (*Ovis vignei cycloceros*), chinkara (*Gazella bennettii*), desert cat (*Felis silvestris*), and bush rat (*Golunda ellioti*), (Ghalib *et al*., 2007).

Data collection

We applied a double observer survey using line transects (Table I) over a four year period (2019–2022) to determine the spatial distribution and current population status of Afghan urial. The study area was divided into smaller blocks (union councils) as shown in Figure 1. The two observers, OB_1 and OB_2 surveyed the area following the same routes but OB_2 started 30 minutes later (Tumursukh *et al*., 2016). A similar approach has been used to evaluate the populations of other wild ungulates such as, blue sheep– *Pseudois nayaur*, alpine ibex – *Capra ibex*, mountain sheep– *Ovis ammon*, urial– *Ovis vignei*, and screw horn goat– *Capra falconeri* (Tumursukh *et al*., 2016; Suryawanshi *et al*., 2017).

Table I. Survey sites, elevation and the length of transects travelled to record Urial in the South Eastern Balochistan, Pakistan.

S. No	Survey sites	Latitude	Longi-tude	Elevation (meter)	Transect travel (km)
1	Khato	25.59649	67.01429	609.6	23.7
2	Mola	25.87226	66.95578	914.4	19.8
3	Hub Kohan	25.85096	66.96059	731.52	14.6
4	Lahot Kohan	25.78245	66.88508	640.08	13.7
5	Pubh	26.07918	66.73105	883.92	16.8
6	Chapar	26.09836	66.88460	3475	18.3
7	Konyang	26.30482	66.6911	3750	16
8	Chibbi	26.27256	66.90923	3253	15.4
9	Padani	26.16913	66.77281	2940	16.5
10	Para	26.42860	67.06474	3157	15.5

Both observers were supplied with binoculars (08 x 42 WP Field 7.0, SICONG), spotting scopes (20 x 60 Swarovski), 20x zoom lens Canon cameras (to capture photographs of herds and their habitats), and a GPS device (Garmin ETrex 30x) for collecting data. Whenever an Afghan urial herd was spotted, the individuals were classified as males, females, and young. The males were further classified into class I (0 - 2.5 years), class II (2.5 - 3.5), class III (3.5 - 4.5), and class IV (> 4.5 years) based on their horns and body size. At the end of the day, both sets of observer's cross-tally their data using herd sighting location, composition, time, and unique characteristics, such as male-only herds, to verify unique and common herds and avoid double-counting. We removed the datasets that contained any instances of double counting. The methodology was followed as previously explained by Masood (2011) and Khanyari *et al*. (2021).

Data analysis

The data from each study site, gathered through a double-observer survey, were organized using a capture mark recapture framework. Three different codes were applied based on the sightings of urial herds: 11 indicated a herd seen by both observers, 10 for OB_A, and 01 for OB_B. To estimate the urial population, we employed a Bayesian behavioral capture–recapture model, utilizing the BBRecapture package in R software (Team, 2020). We followed the same analysis techniques previously guided by Suryawanshi *et al*. (2021) and Khanyari *et al*. (2021) for estimating the number of herds, mean group size, total population, confidence intervals (CIs), and detection probability for both observers. We calculated urial's density by dividing the estimated population by total area of study sites (Masood, 2011; Khanyari *et al*., 2021).

The urial population was ascertained by the standard deviation calculator (https://www.calculator.net) using the following equation:

$$\sigma^2 = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(xi-\mu)^2}$$

$$\sigma^2 = \frac{(xi-\mu)^2}{N}$$

Where x_i = an individual value, μ = the mean/expected value, and N = the total number of values.

In addition, the confidence interval was determined by the below equation (https://www.calculator.net):

$CI = \bar{X} \pm Z \times \sigma/\sqrt{n}$

Where Z = the Z-value for the chosen confidence level, $\bar{X}$ = the sample mean, σ = the standard deviation, and n = the sample size.

RESULTS

In the current study, Balochistan urial herds were observed in ten different study blocks: Khato, Mola, Hub Kohan, Lahot Kohan, Pubh, Chapar, Konyang, Chibbi, Padani and Paraat elevation ranges from 609.6 to 3750 meters above sea level. A total distance of 365.24 km transects was surveyed for four consecutive years between 2019 and 2022. The estimated numbers of herds were 207.57, 169.24, 177.75 and 160.78 with a mean herd

size of 7.62, 7.36, 6.03 and 5.66 in 2019, 2020, 2021 and 2022, respectively (Fig. 2). The detection probabilities for both, OB_1 and OB_2, were 0.34 to 0.37 and 0.28 to 0.37, respectively. The numbers of Balochistan urial herds observed by OB_1, OB_2, and both observers are shown in Table II.

Population dynamics of Balochistan *urial*

In 2019, 860 Balochistan urial's were counted, including 300 males, 360 females, and 200 juveniles, with a male to female ratio of 1:1.2. In 2020, we counted 725 individuals, containing 277 males, 298 females, and 150 juveniles, with male-to-female ratio of 1:1.18. In 2021, the counted individuals were 676, containing 310 males, 239 females, and 127 juveniles, with male-to-female ratio of 1:1.28. In 2022, we counted 534 individuals with 210 males, 212 females, and 112.

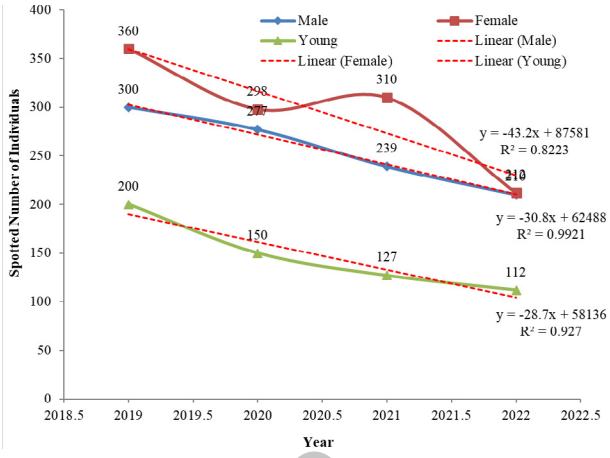

Fig. 2. Age structure and year-wise relative abundance of Balochistan urial in the study area.

Table II. Urial population estimates and temporal variations during the study period.

Variable	Year			
	2019	**2020**	**2021**	**2022**
Herd sighted by observer 1	20	20	23	22
Herd sighted by observer 2	52	44	41	38
Herd sighted by observer 1 and 2	39	34	42	38
Estimated number of herds	207.57	169.24	177.75	160.78
Mean herd size	7.62	7.36	6.03	5.66
Estimate population	1582	1245	1072	911
Density	0.023	0.021	0.006	0.016
Variance in mean herd size	0.01	0.02	0.03	0.03
Variance in estimated number of herds	915.55	551.25	513.01	423.21
Variance in estimated population	53689.35	30374.57	19597.91	14460.23
95% confidence interval	459.99	345.99	277.91	238.72
Detection probability of observer 1	0.34	0.37	0.35	0.35
Detection probability of observer 2	0.28	0.31	0.36	0.37

Table III. Population dynamics of Balochistan urial: Observations and ratios in 2019-2022.

Year	Total numbers of individuals detected				Population Mean ($\bar{X}$) ± SD	95.0% confidence interval (CI)	Male-female ratio
	Adult male	**Adult female**	**Young**	**Total**			
2019	300	360	200	860	70.0±65.99	286.667 ± 74.68	1:1.2
2020	277	298	150	725	241.7±65.38	241.7 ± 73.98	1:1.18
2021	239	310	127	676	225.3±75.33	225.3 ± 85.25	1:1.28
2022	210	212	112	534	178.0±46.77	178.0 ± 52.82	1:1.01
Overall	1026	1180	589	2795	931.7±250.33	250.326 ± 283.27	

DISCUSSION

The unique ecosystem of Balochistan landscapes serves as a crucial habitat for various wildlife species, including the Balochistan urial (*Vignei blanfordi*). This keystone species plays a pivotal role in shaping the trophic dynamics of semi-desert and hilly terrains, regulating vegetation through grazing and serving as prey for carnivore species like the gray wolf (*Canis lupus*), striped hyena (*Hyaena hyaena*) and Balochistan black bear (*Ursus thibetanus gedrosianus*) (Ghalib *et al*., 2019). However, the conservation status of the Balochistan urial remains precarious due to multiple threats, including poaching, habitat degradation, and competition with domestic livestock (Bagchi *et al*., 2003; Bagchi and Ritchie, 2010)

The study revealed a declining urial population in southeastern Balochistan from 2019 to 2022, aligning with previous national studies (Frisina, 2002; Begum *et al*., 2013; Khan *et al*., 2015) and highlighting the vulnerability of this subspecies. Several key threats likely contribute to this decline, such as habitat degradation from overgrazing by livestock, habitat fragmentation due to human activities, and fuelwood collection, which degrade urial habitat quality and reduce resource availability. Additionally, uncontrolled poaching poses a significant threat to Urial populations, as observed in other studies (Virk, 1991; Siraj-ud-Din *et al*., 2018). Balochistan is particularly vulnerable to climate change, with increased droughts and altered precipitation patterns (Jamro *et al*., 2020), which can negatively impact vegetation growth and water availability, further affecting urial populations. Climate change exacerbates the vulnerability of ungulate species, necessitating the integration of climate considerations into conservation strategies (Faghih-Sabzevari and Farashi, 2022).

Monitoring the spatial-temporal distribution and population trends of *Ovis vignei blanfordi* is essential for understanding its population dynamics and formulating effective conservation plans (Suryawanshi *et al*., 2012). Present study provides valuable insights into the population size and sex ratio of Balochistan urial herds, indicating fluctuations influenced by various factors, including predation, environmental conditions, and management practices

Present study revealed Balochistan urial herd sizes ranging between 5 and 7 individuals, with fluctuations likely influenced by factors such as predation, environmental conditions, and management practices. These findings are similar to those reported for other urial populations in Pakistan, such as those in Gilgit-Baltistan (Siraj-ud-Din *et al*., 2016) and Chitral (Schaller *et al*., 1977). It is important to note that herd size variations can occur between geographically distinct urial subspecies. For instance, studies suggest larger herd sizes for Ladakh urial in India (15-30 animals) (Khara *et al*., 2021) and smaller herd sizes for Wakhan urial in Afghanistan (8-10 animals) (Moheb *et al*., 2023). This highlights the potential influence of subspecies and regional ecological factors on herd size dynamics. This study observed a slight female dominance in the male-female ratio, which aligns with the pattern reported for Punjab urial by Habiba *et al*. (2015). It's important to note that female dominance is common in free-ranging ungulate populations. Deviations from this expected pattern, as discussed by Berger and Gompper (1999), may be linked to environmental or anthropogenic stress factors (Berger and Gompper, 1999; Habiba *et al*., 2015).

Present study provides the first-ever density estimates for urial in southeastern Balochistan, highlighting the data gap addressed by this research. Historical population estimates from Balochistan and surrounding areas provide context for our findings (Mirza and Asghar, 1980; Malik, 1987; Olson-Edge and Edge, 1987; Frisina *et al*., 2006). However, weak enforcement of wildlife laws hinders reliable population monitoring across the region (Sial, 2014; Khan *et al*., 2015).

The declining urial population underscores the urgency for effective conservation measures. Our findings suggest a multi-pronged approach. This includes stricter enforcement of existing protected areas and creating new ones in crucial urial habitats, alongside restoration efforts to improve vegetation cover and carrying capacity. Additionally, regulating and reducing livestock grazing pressure within urial habitats is critical to minimize competition for resources. Combating poaching requires increased patrolling, stricter enforcement of hunting laws, and engaging communities in conservation efforts. Furthermore, long-term strategies must consider the impacts of climate change through sustainable water management practices and habitat restoration programs that enhance drought resilience. Finally, continued monitoring of urial populations and habitat conditions is essential to assess the effectiveness of these strategies and adapt them as needed, with research into the specific impacts of climate change on urial populations being particularly valuable. By implementing these comprehensive measures, we can work towards reversing the decline of Balochistan urial populations and ensure their long-term survival in their natural habitats.

CONCLUSIONS

The four-year study in southeastern Balochistan has provided valuable insights into the population dynamics

of the Afghan urial (*Ovis vignei blanfordi*), a vulnerable ungulate species. The findings reveal a significant decline in the population of the species, with a 38% decrease over the four-year study period. The threats identified, including poaching, livestock overgrazing, habitat degradation, and climate change, underscore the complexity of the challenges facing the urial population. This decline highlights the urgent need for effective conservation strategies to safeguard this species.

To address these threats, it is crucial to implement effective conservation strategies, such as increasing anti-poaching efforts including increased law enforcement presence and community engagement, implementing sustainable grazing practices to minimize competition for resources and habitat damage, and improving habitat quality. Collaboration with local communities is essential for successful conservation efforts, as their involvement and support are crucial for the long-term survival of the Balochistan urial population. Local communities often have valuable knowledge about the species and their habitat, and involving them in conservation efforts can help to build support for these endeavors.

DECLARATIONS

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Ethics statement

We followed the Balochistan Wildlife Protection Act of 1974 and pertinent international conventions for the safety of the animals under observation throughout the entire investigation. No animal was in any way threatened or hurt while the information/data was being gathered.

Data availability statement

Please contact the author if you would like access to the data.

Statement of conflict of interest

The authors have declared no conflict of interest.

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