GIS-BASED DISTRIBUTION AND POPULATION ESTIMATION OF PUNJAB URIAL (*Ovis Vignei Punjabiensis*) IN PAKISTAN

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ABSTRACT

The present work is the first of its kind being reported from Pakistan which was aimed to establish GIS-based distribution and population estimation of Punjab Urial (*Ovis Vignei Punjabiensis*) throughout its geographical range viz. Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali districts) and Kala Chitta Range (Attock district). Geographical coordinates were used to develop the distribution maps. Line transects and point count methods were used to estimate the population. Spatial analyst tool (Proximity) in ArcGIS software was used to demarcate the distribution area. A total of 3484 individuals of Punjab Urial were observed in the study area (7953 Km²) with a population density of 0.4 animals/Km². A statistically significant difference ($P \leq 0.05$) was observed between both the Salt Range and Kala Chitta Range. District-wise results for population distribution revealed significantly ($P \leq 0.05$) higher number of animals observed in Mianwali district of Salt Range with a population density of 2.4 animals/Km² while the lowest numbers of animals were observed in Attock district of Kala Chitta Range with a population density of 0.08 animals/Km². In a nutshell, presently, the Salt Range is the main habitat for Punjab Urial in Pakistan and harbors the maximum number of animals. Furthermore, keeping in view the results on the population density of the present study it can be deduced that the habitat of Punjab Urial is gradually shrinking to Salt Range only.

Key words: Punjab Urial, *Ovis vignei punjabiensis*, Population estimation, Global Positioning System

<https://doi.org/10.36899/JAPS.2021.4.0317>

Published online December 18, 2020

INTRODUCTION

The academic, scientific and conservational priority of governments, conservation agencies and other stakeholders is to monitor populations of rare and endangered species. It helps in updating the data for them and for devising long-term directional strategies to attain species conservation. It also helps identify and locate those biotopes which need immediate conservation and propagation (Austin, 2007). The last decade has witnessed the use of various precise and accurate mapping tools such as Species Distribution Mapping, Abundance Models, and Satellite tracking, etc. for this purpose. These models have helped extensively in various research endeavors (Bradley *et al.* 2012) such as testing of ecological theories (Petitpierre *et al.* 2012), assessing range dynamics of species (Kissling, 2013), development of invasion risks (Kremen *et al.* 2008), the study of population dynamics of species (He *et al.* 2015), and preservation of species-specific habitats (Lurgi *et al.* 2015). The pertinent advantage of these models is considered to be the formulation of 'habitat suitability maps' for a specific species. Regarding large mammals and birds, the Global Positioning System (GPS) receiver is extensively being used through relocation data sampling (Saqib *et al.* 2006; Johnson and Gillingham, 2008). It is considered as highly precise and repeatable

and provides position determination on earth's surface as well as in the air (Tomkiewicz *et al.* 2010).

Owing to its geomorphological and ecological location, Pakistan is richly endowed with a diverse range of mammalian fauna, especially wild sheep. The Punjab Urial (*Ovis vignei punjabiensis*), a member of the Bovidae family and *Ovis* Genus, is one of the six mammalian species which are endemic mostly to Northern Punjab, Pakistan. It is mostly present in Salt Range and Kala Chitta Range at 1500 m elevation. Punjab Urial closely resembles the Marco Polo sheep (*Ovis ammon polii*), it has big horns and greyish face, creamy white belly, long slender legs and reddish-grey body fur (Awan *et al.* 2004a, b). It has been documented as endangered in the Red List of Threatened Species by the IUCN (IUCN, 2018). Gradual degradation of its habitat, illegal hunting and poaching, unimplemented wildlife laws, forest fires, overgrazing, and food competition with the livestock are a few factors that are constant threats to Punjab Urial (Awan *et al.* 2006; Ayaz *et al.* 2012; Habiba *et al.* 2015; Khan *et al.* 2015).

Substantial research work on Punjab Urial from Pakistan has previously been conducted. However, it is too sketchy and patchy because it encompasses results on its distribution, population and habitat only for a limited area (at a localized scale) such as for a district or a specific sanctuary/game reserve (Awan *et al.* 2006; Ayaz

et al. 2012; Iqbal *et al.* 2012; Habiba *et al.* 2015; Khan *et al.* 2015). The present work is the first of its kind which was planned to establish GIS-based distribution and population mapping of Punjab Urial in the whole of its distribution range (Salt Range and Kala Chitta Range). It is expected that the findings of this study will help the wildlife protection and conservation authorities in the formulation of appropriate strategies to maintain a sustained population of Punjab Urial in its habitat in Pakistan.

MATERIALS AND METHODS

Study Area: The study was conducted at two mountain ranges *viz.* Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts) and Kala Chitta Range (Attock District) covering a total of 7953Km² (Table 1; Figure 1). The coordinates (Arshad *et al.* 2014) and the area of each study district have been presented in Table 1.

Table 1. Detail of ranges and their districts in Pakistan selected for devising GIS-derived distribution mapping of Punjab Urial (*Ovis vignei punjabiensis*)..

Sr. No.	Range	District Name	Study Area (Km ²)	GPS Coordinates	Total Population	Density (Animals/KM ²)
1	Salt	Chakwal	1888	32°55'49"N 72°51'20"E	537	0.28
2		Jehlum	1972	32°56'33"N 73°43'32"E	644	0.33
3		Khushab	1546	32°17'55"N 72°21'3"E	735	0.47
4		Kohat	1297	33°35'N 71°26'E	82	0.06
5	Kala Chitta	Mianwali	580	32°35'7"N 71°32'37"E	1430	2.4
6		Attock	670	33°46'0"N 72°22'0"E	56	0.08
Total		7953		3484	0.4

Figure 1. Study area consisting of Kala Chitta and Salt Ranges and their six districts in Pakistan.

Both the ranges are dry sub-tropical areas with semi-evergreen scrub forests and the dominating topography is Steppe-Mountains and rocks of sandstone and limestone. The mountains are low ranges of broken hills with varying heights of Pothohar-shaped terrain (Habiba *et al.* 2015). There is an almost barren habitat with low productivity and erosion is common due to the sedimentary nature of rocks that are tilted throughout the area at very high angles. Hence, low hills, flat plains, saline plains, sandy or rocky habitat, seasonal streambeds and banks are its pivotal features. Climate is harsh, hot and dry, with temperatures ranging from 2-45°C (Awan *et al.* 2005; Awan *et al.* 2006). In the whole of the study area, herbs were most abundant while dominant plant species recorded were *Dodonaea viscosa*, *Acacia modesta*, *Olea ferruginea*, *Zizyphus maruritiana* and *Zizyphus nummularia*.

The study was conducted from March 2015 to September 2017. A total of 24 field surveys in six study districts were conducted for ground data collection. Field survey sites were selected based on earlier published literature (Awan *et al.* 2004a, b; Awan *et al.*, 2006). Furthermore, newer potential sites proposed by local hunters, local community representatives and officials of Punjab Wildlife & Parks Departments, WWF-Pakistan and Pakistan Wildlife Foundation were also incorporated. After thorough field surveys, the existence of the species was confirmed at 120 sites. From these, 64 sites were recorded as potential habitats of the species throughout the year whereas, at the remaining 56 sites, the animals occasionally visited in different seasons.

At each site two to three consecutive days were spent. Data was collected, early in the morning (starting at dawn) and late in the evening (two hours before dusk). Both 'direct' and 'indirect' method observations were conducted for assessing the population of Punjab Urial (Khan *et al.* 2015). Fresh tracks, droppings and body parts (hairs, horns and other dead remains) were used as the sign of Punjab Urial's presence in the study area.

Based on the elevation profile in the study area, both Line transects and Point count methods were applied. In the Line transect method; animals were counted while traversing along predetermined transects lines. The distance at which the animals were flushed was recorded. Average flushing distance was used to calculate the effective width of the strip covered by an observer. In the point count method, the animal was observed at a specific point with a fixed-radius point count or open-radius point count methods. Analyses were the same as for transect methods except the perpendicular distance was replaced by radius and the area was $\pi \times r^2$. The point count method was applied in only those areas which had difficult terrains and the continuous straight transects were difficult (Khan *et al.* 2015).

Total 240 transects each of 5x1Km in the whole study area were taken to assess the population of Punjab

Urial. The distance of each flush of the animal was recorded and the average of the distance was calculated to determine the actual width of the area covered by the observer. Around 1200Km² (230x5x1) area was searched that makes about 14% of the total study area with a sample fraction of 0.136. At each site population of the animal was estimated as per formula (Habiba *et al.* 2015):

$$\text{Population of the area} = \frac{\text{N o o a}}{\text{A o t s (l x w)}} \times \text{Total area}$$

$$\text{Population density} = \frac{\text{Animal observed}}{\text{Total study area}}$$

$$\text{Sample fraction} = \frac{\text{Area searched}}{\text{Total area}}$$

$$P = AZ / 2XY$$

Where;

P = Population

A = Total area of study

Z = Numbers of animals flushed

Y = Average flushing distance

X = Length of strip

Area of circle = πr^2

r = radius of the circle

$\pi = 22/7$

After confirmation of the presence of species at a specific site, geographical coordinates were recorded using GPS Receiver. These GPS coordinates were used for the development of species distribution maps.

Binoculars (Nikon 7576 Monarch 5, 8x42, Nikon Corporation, Japan), handheld GPS receiver (GPSMap® 76CSx, Garmin Ltd., USA), searchlights (Fos LED 15W), digital camera (Nikon D7200, DSLR, Nikon Corporation, Japan), field guide books, measuring tapes and maps of each district in the study area were used as field-kits and equipment for data collection during field surveys.

Statistical Analysis: Statistical analyses were conducted through Statistical Package for Social Science (SPSS for Windows version 12, SPSS Inc., Chicago, IL, USA). ANOVA and unpaired t-test were used to deduce the difference of population within districts, and within two ranges, respectively. ArcGIS 9.0 was utilized to develop species distribution maps through GPS coordinates.

RESULTS

Overall results revealed that throughout the whole of the study area (Salt and Kala Chitta Range including 06 Districts), a total of 3484 Punjab Urals was spotted with a population density of 0.4 animals/Km² (Table 1; Figure 2). Significant statistical difference ($P \leq 0.05$) was observed between both ranges with 3428 animals spotted in Salt Range and 56 in Kala Chitta Range (Table 1; Figure 2).

In Kohat district, a total of 40 transects were applied (16 line transects and 24-point counts) that covered about 15% of the total study area (1297Km²) of this district. The population density was estimated as 0.06 animals/Km² (Table 1; Figure 3).

About 13% area of the total study area (1972Km²) was observed by applying 54 transects in district Jehlum for Punjab Urial population assessment. Due to the difficult terrain in this district mostly the point count method was applied. With 0.33animals/Km² population density, a total of 644 animals were spotted in the whole district of Jehlum (Table 1; Figure 4).

From 1546Km² area in Khushab district, about 14% area was observed in 46 transects. Total 735 animals were observed with 0.47 animals/Km² (Table 1; Figure 5).

A total of 1430 animals were observed in district Mianwali and the population density was 2.4animals/Km². About 24% of the total study area (580Km²) was evaluated in 28 transects (Table 1; Figure 6).

About 17% of the total study area (670Km²) was observed in district Attock by applying 24 transects. The total estimated population was 56 and the population density was 0.08animals/Km² (Table 1; Figure 7).

Similarly, 537 animals were observed in district Chakwal. About 13% area of the total study area (1888Km²) was covered by applying 50 transects. The population density in Chakwal district was recorded as 0.28animals/Km² (Table 1; Figure 8)..

Figure 2. Map showing distribution and population of Punjab Urial in Pakistan.

Figure 3. Map showing distribution and population of Punjab Uril in district Kohat.

Figure 4. Map showing distribution and population of Punjab Uril in district Jhelum.

Figure 5. Map showing distribution and population of Punjab Uril in district Khushab.

Figure 6. Map showing distribution and population of Punjab Uril in district Mianwali.

Figure 7. Map showing distribution and population of Punjab Uril in district Attock.

Figure8. Map showing distribution and population of Punjab Uril in district Chakwal.

It was revealed that the highest number of animals ($n = 1430$) was noticed in the Mianwali district of Salt Range, whereas, lowest number ($n = 56$) was for Attock in Kala Chitta Range (Table 1; Figure 4). A statistically significant difference ($P \leq 0.05$) was noticed for results within districts.

DISCUSSION

The present research work is a novel one from Pakistan as it was conducted at a national scale to establish GIS-based distribution and population of Punjab Urial in the whole of its distribution range *viz.* Salt Range and Kala Chitta Range (including a total of six districts of Pakistan).

From a historical perspective, the species was found in Khair-e-Murat Range (Maan and Chaudhry, 2001), Koho-i-Murat Range (Shackleton, 1997), Suleman Range (Francis, 1945), Margalla Hill Range, Salt Range and Kala Chitta Range (Roberts, 1997). However, with time, it has shrunk only to Salt Range and Kala Chitta Ranges (Awan *et al.* 2004a, b) due to increased poaching, grazing pressure, depleting natural resources, and urbanization (Awan *et al.* 2005; Awan *et al.*, 2006). Our results are quite conclusive that Punjab Urial is confining itself to the Salt Range only, which might be due to loss of its habitat at other sites.

Previous work has reported population dynamics of Punjab Urial but these studies were quite sketchy and localized, hence the complete comparison is not possible. Schaller and Mirza (1974), and Mirza *et al.* (1980) estimated the population in the whole of the distributional range and reported 0.5 and 0.8 animals/Km² population densities in about 2000Km² and 2500Km² areas, respectively. However, in the present work population density has been recorded as 0.4 animals/Km². The previous and present population number and density cannot be compared due to the difference in the study area, as the study area in previous studies was too small as compared to the current study.

A significantly higher number of animals were spotted at Salt Range as compared to those in Kala Chitta Range in the current study. The results are in line with previous work (Awan *et al.* 2006; Khan *et al.* 2015) which has identified Salt Range as the main habitat for this species. Our number of animals is also quite close to those reported by Awan *et al.* (2006), who reported a total of 3508 Punjab Urial from the Salt Range. The results of the population in Kala Chitta Range (56) are substantially lower than those reported by Mirza *et al.* (1980) and Iqbal *et al.* (2012) who reported the total population as 213 and 101 respectively. The decreasing population might be due to illegal hunting, poaching and lack of implementation of wildlife legislations.

District-wise results of the study revealed that the highest population density of 2.4 animals/Km² was

noticed in the Mianwali district covering an area of 580 Km². The district harbors Kalabagh Game Reserve (KGR) which was established in the 1930s and is considered as a protected haven for Punjab Urial, hence it harbors most of the Urial population of Salt Range. A plausible justification for the highest population in this district could be enriched habitat, less danger of poaching and fewer trends of urbanization owing to its 'protected status'. While the comparison of current study results with the historical studies conducted in Kalabagh Game Reserve shows that the population of this protected area is also declining as Mountfort (1969) and Awan *et al.* (2004a, b) estimated 3.6 animals/Km² in 137Km² area, Schaller (1977) reported 13 animals/Km² in 40Km² area, Chaudhry *et al.* (1988) counted 6.2 animals/Km² in 137Km² area and Frisina *et al.* (2007) estimated 7- 23 animals/Km² in 21Km² areas. Lower population density may be attributed to the fact that the whole of the Kalabagh Game Reserve area was investigated in present his study. Another factor that is responsible for the population decrease is the disease spectrum as reported by Awan in 2005.

In district Jehlum, the population density of Punjab Urial is decreasing as Mirza *et al.* (1980) reported 0.49 animals/Km² in 1181Km² area, Chaudhry *et al.* (1988) counted 0.53 animals/Km² in 341Km² area, Azam *et al.* (2008) estimated 4.89 animals/Km² in 19Km², Habiba *et al.* (2015) navigated 2.68 animals/Km² in 20 Km² areas, and Arshad and Hussain (2018) made an estimate of 0.16 in 358Km² while our study determined 0.33 animals/Km² in 1972 Km² area.

Ayaz *et al.* (2012) reported 30 Punjab Urials from two protected areas of district Kohat which is not comparable to the present work as it gives the count only from two protected areas of the district. Khan *et al.* (2015) reported 1.39 animal/Km² population density of Punjab Urial from Soan valley in district Khushab covering an area of about 80Km² but in present work, it is recorded as 0.47 animals/Km² from the whole distribution range in district Khushab (1546Km²).

Azam *et al.* (2008) reported a total of 220 animals from Chumbi Surla Wildlife Sanctuary Chakwal that is a protected area. In the present study higher numbers of animals (537) in Chakwal district might be due to the large study area. The population of Punjab Urial is rapidly decreasing in Attock as it was 213 in 1980 (Mirza *et al.* 1980), 101 in 2012 (Iqbal *et al.* 2012) and now only 56 animals left in the whole district. Mirza *et al.* (1980) reported 68 animals from the Sargodha district but now the species is no more present in this locality.

In a sum-up, Salt Range is the main habitat for Punjab Urial in Pakistan, apropos to the time of this study. Within this range, the Mianwali district harbors the maximum number of animals. Furthermore, the present study reveals that the habitat of Punjab Urial is gradually

shrinking to the Salt Range only. This envisages in-situ and ex-situ strategies for the conservation of this endangered species, particularly in this range. It is also recommended, that keeping in view the findings of this study, the database of Punjab Wildlife and Parks department, WWF-Pakistan and Pakistan Wildlife Foundation should be updated regarding Punjab Urial's distribution maps.

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