STUDY ON VARIOUS HABITAT COMPONENTS OF PUNJAB URIAL IN ITS DISTRIBUTION RANGE

S. Suleman[1*], W. A. Khan[1], K. M. Anjum[1], W. Shehzad[2], S. G. M. D. Hashmi[1], Attaullah[1], K. Iqbal[1] and R. Raja[3]

[1]Department of Wildlife and Ecology, University of Veterinary and Animal Sciences, Lahore, Pakistan [2]Institute of Biochemistry and Biotechnology, University of Veterinary and Animal Sciences, Lahore, Pakistan [3]institute of Pure and Applied Biology, Bahauddin Zikariya University, Multan, Pakistan
[*]Corresponding author: saharsuleman59@gmail.com

ABSTRACT

The present study is the first of its kind being reported from Pakistan for Punjab Urial (*Ovis Vignei Punjabiensis*) which was aimed towards assessing various components of its habitat (vegetation, food preference, land cover, and water) throughout the whole of its distribution range *viz*. Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts) and Kala Chitta Range (Attock District). For assessment of vegetation in the whole study area (64 study sites), all dominant plant species of potential habitat were studied by quadrate method while the food of Punjab Urial was identified on predetermined line transects. Concurrently, a total of 180 water samples were obtained for various water quality attributes. A total of 74 families including 284 species were identified with Poaceae (21 %) as a majorly contributing family, followed by Asteracea (6 %), Solanaceae (3 %), and the remaining being within the range of 0.7 to 1 %. Within this vegetation, herbs, grasses, trees and shrubs were 56 %, 16 %, 16 % and 12 %, respectively. Overall, 51 % of food of Punjab Urial comprised of herbs while the rest of it was grasses, trees and shrubs being 19, 16 and 14 %, respectively. All the studied water quality attributes had a statistical difference (P ≤ 0.05) within districts of study with Kohat having least quality.

Keywords: Punjab Urial, *Ovis vignei punjabiensis*, Habitat components

INTRODUCTION

Habitat management has been considered a mainstay in wildlife conservation and propagation, and its loss is the biggest threat to wildlife. A viable habitat consists of certain established elements namely: food, water, cover and space (Correa *et al.,* 2016; Nilsen *et al.,* 2004). It is inevitable to study these elements not only for the assessment of population dynamics of species but also to understand the evolution of life (Nilsen *et al.,* 2004). Previous studies have also indicated that all the elements of habitat influence the reproductive potential of a species, and hence determine its successful thriving as a species (Biagolini-Jr *et al.,* 2017). Ultimately, studying elements of a habitat is a gold standard and reliable measure of the reproductive success of species (Uboni *et al.,* 2017).

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 up to 1500 m elevation. This reproductively, historically and biogeographically unique population has big horns (resembling *Ovis ammon polii viz*. Marco Polo sheep), greyish face, creamy white belly, long slender legs and reddish-grey body fur (Hussain *et al.,* 2017; Awan *et al.,* 2005). It has been documented as an endangered in the Red List of Threatened Species by the IUCN (Michel and Ghoddousi 2020).

Punjab Urial has been studied by various workers regarding its different aspects such as population dynamics (Awan *et al.,* 2006; Khan *et al.,* 2015), habitat suitability (Habiba *et al.,* 2015), immunology (Hussain *et al.,* 2017), food/feeding habits (Hussain *et al.,* 2015), and distribution through remote sensing (Bradley *et al.,* 2012). However, the literature reveals that all the work conducted is quite patchy as it tends to present results at a localized level (district or a sanctuary/wildlife park), hence, not incorporating the whole of the Punjab Urial's range.

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 lingering threats to Punjab Urial (Awan *et al.,* 2006; Ayaz *et al.,* 2012; Habiba *et al.,* 2015; Khan *et al.,* 2015). The present work is a continuation of our broader work/project which was conducted in Pakistan, throughout the potential range of Punjab Urial, with three main objectives: To establish GIS-derived distribution mapping, to study habitat suitability index, and to study various elements of habitat. From our thorough studies, we have submitted a conclusion that the habitat of Punjab Urial is gradually shrinking and is presently mostly confined to the Salt

Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts). Based upon the findings and conclusions of our studies, this work is aimed towards assessing various components of habitat (vegetation, food preference, land cover, and water) for Punjab Urial throughout the whole of its distribution range *viz*. Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts) and Kala Chitta Range (Attock District).

MATERIALS AND METHODS

Geo-location of the study: The study was conducted at two Punjab Urial ranges *viz*. Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts) and Kala Chitta Range (Attock District) covering a total of 7953 km^2 (Fig. 1). The Salt Range lies between 32°41" to

32°56"N and 71°50" to 74°E, whereas the Kala Chitta range lies between 33°52"N and 72°10"E (Arshad *et al.*, 2014).

Both 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 of varying heights (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; 2006).
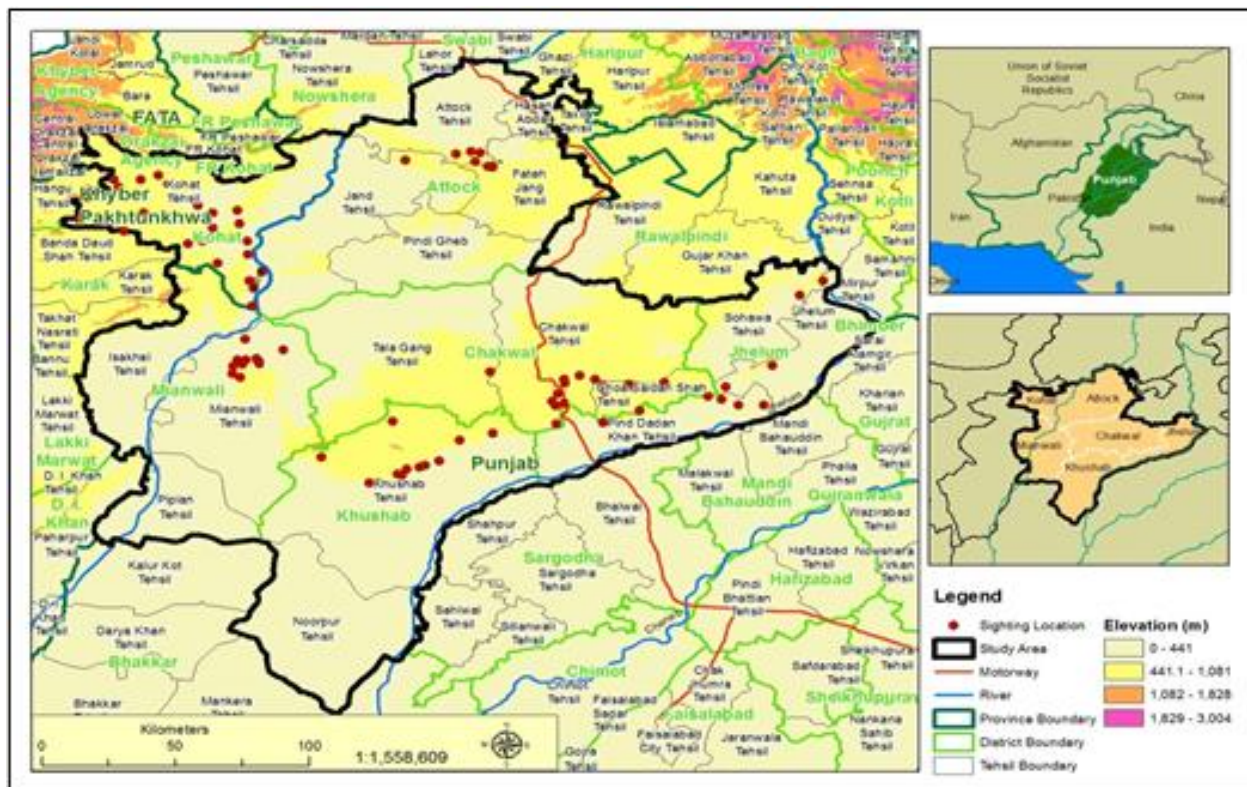
Fig 1: Study Area consisting of Kala Chitta and Salt Ranges and their six districts in Pakistan selected for studying various habitat components of Punjab Urial (*Ovis vignei punjabiensis*)

Period of study: The study was conducted from March 2015 to September 2017 during all four prevalent seasons of Pakistan.

Selection of field survey sites: For the selection of field survey sites, earlier published literature (Awan *et al.,* 2004a,b; Awan, 2006) was taken into consideration, allied with newer potential sites proposed by local hunters, local community representatives and officials of Punjab Wildlife & Parks Departments, WWF-Pakistan

and Pakistan Wildlife Foundation. 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.

Field Surveys and observations: A specific Performa was developed regarding various aspects of Punjab

Urial's habitat *viz*. vegetation, food preference, land cover, and water.

For assessment of vegetation in the whole study area, all dominant plant species of potential habitat were studied by the quadrate method. Quadrate sizes were 10 m x 10 m for trees, 4 m x 4 m for shrubs and 1 m x 1 m for herbs/grasses (Kufeld *et al*., 1980). Five quadrats were laid down, each for trees, shrubs, and herbs/grasses at each site. Prominent plant species and their cover were also recorded by using the Ocular estimation method (Boswell *et al.,* 2017). Density, frequency, the abundance of the plant species, and the cover was determined as prescribed earlier (Awan, 2006; Iqbal *et al*., 2012) (Table 1).

Table 1: The category of frequency and abundance of plant species in the Kala Chitta and Salt Ranges of Punjab Urial (*Ovis vignei punjabiensis*).

Frequency and abundance		Food preference	
Category	Percentage	Category	Percentage
Very abundant	81- 100	Most preferred	81 – 100
Abundant	61- 80	Preferred	61 – 80
Common	41- 60	Common	41 – 60
Occasional	21- 40	Occasional	21 – 40
Rare	0 – 20	Rare	0 – 20

Concurrently, the food of Punjab Urial was identified on predetermined line transects of 2000m in length and 500 m in width (length of transect varied according to visibility range). Field binoculars (Nikon 7576 Monarch 5, 8 × 42, Nikon Corporation, Japan) were used to study the animals. Feeding and foraging activity was observed for approximately 3-4 hrs in the early morning and late evening. With the help of a plant taxonomist, all the plant species present in the Urial habitat were recorded and food items were identified by following the sign of browsing and number of bites per plant species (Hussain *et al*., 2015). At every site of Urial, core habitat at least 100 bites were recorded. The assessment was based on fodder and its type, its percentage and its availability for Punjab Urial in an area (Awan *et al*., 2006; Hussain *et al.,* 2015).

Table 2. List of water quality attributes and their analyses methods used in the study

Sr. No.	Parameters	Analysis Method and Reference
1	Alkalinity (mmol/L as CaCO3)	2320, Standard method (Rice *et al.,* 2012)
2	Ammonia –N	(HACH-DR/2800) Salicylate Method (Bower & Holm-Hansen, 1980)
3	Biochemical Oxygen Demand	Five days incubation BOD test (Rastogi *et al.,* 2003)
4	Chemical Oxygen Demand	(HACH-DR/2800) Dichromate, Reactor Digestion ColoriMethod (Patnaik, 2002)
5	Carbonate (mg/L)	2320, Standard method (Rice *et al.,* 2012)
6	Chloride (mg/L)	Titration (Silver Nitrate), Standard Method (Rice *et al.,* 2012)
7	Conductivity (mS/cm)	EC meter, Hach-44600-00, USA
8	Dissolved Oxygen	DO Meter HANA
9	Hardness (mg/L)	EDTA Titration, Standard Method (Rice *et al.,* 2012)
10	Nitrate Nitrogen (mg/L)	Cd. Reduction (Hach-8171) by Spectrophotometer
11	Nitrite	(HACH-DR/2800) NitriVer Pillows, Colorimeter
12	pH	pH Meter, Hanna Instrument, Model 8519, Italy
13	Sulfate (mg/L)	SulfaVer4 (Hach-8051) by Spectrophotometer
14	Total Dissolved Solids (mg/L)	2540C, Standard method (Rice *et al.,* 2012)
15	Turbidity (NTU)	Turbidity Meter, Lamotte, Model 2008, USA
16	Free Carbon Dioxide	HCl- Titration, Standard Method (Rice *et al.,* 2012)
17	Electrical conductivity (EC)	On spot using Hydro Lab

Statistical analysis: Statistical analyses were conducted through Statistical Package for Social Science (SPSS for

The results of land cover attained in this work were tallied with those attained from Pakistan Forest Institute, Peshawar, Pakistan.

For water analyses, a total of 180 water samples were collected from different water bodies/aquifers supposed to be used by the Urial from the whole study area of the Punjab Urial habitat. These samples were analyzed for nutrient, mineral and conventional attributes.

For required water quality parameters analysis three water samples were collected in separate containers from each sampling site. The physical attributes were analyzed through Hydro Lab MS-5 (Multiparameter Mini Sonde, OTT HydroMet, Lindbergh Loveland, CO, USA) at the spot, while other attributes were analyzed by following the standard methods at the laboratory of the Department of Fisheries and Aquaculture, University of Veterinary and Animal Sciences, (Pattoki Campus), Lahore. In this study total of 17 water quality parameters were analyzed (Table 2). By using standard methods Polystyrene bottles of 0.5 and 1.5 liters were used to store water samples for physico-chemical parameters and sterilized amber color glass containers (100mL) were used to collect a water sample for Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).

Windows version 12, SPSS Inc., Chicago, IL, USA). Density, frequency, the abundance of the plant species, and the cover was determined through percentages. For water quality attributes, mean (±SE) values were deduced. The difference between various districts and ranges was analyzed using ANOVA with Tukey's posthoc test. Results with P ≤ 0.05 were considered statistically significant.

RESULTS

Vegetation: The overall results for vegetation in the whole of the Punjab Urial's study habitat *viz*. Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts) and Kala Chitta Range (Attock District) revealed a total identification of 74 families including 284 species. *Adhatoda vasica*, *Zaleya pentendra*, *Achyranthes aspera*, *Aerva javanica*, *Digera muricata*, *Artemisia scoparia*, *Sonchus arvensis*, *Capparis decidua*, *Chenopodium spp*, *Convolvulus arvensis*, *Euphorbia spp*, *Accacia modesta*, *Prosopis spp*, *Dodonaea viscosa*, *Withania somnifera* and *Peganum harmala* were most abundant and dominant species. The most contributing

family was Poaceae (21 %) followed by Asteracea (6 %), Solanaceae (3 %), and the remaining were within the range of 0.7 to 1 %. Similarly, from the total 284 species observed in the whole range, 132 were found to be very abundant (46 %), 51 were common (18 %), 44 were occasional (16 %), 35 were rare (12 %), and 22 were found to be abundant (8 %).

Food preference: Regarding food preferences of Punjab Urial within the whole distribution range, from the total of 284 plant species identified, 193 were not used (68 %), 27 were rarely used (9 %), 20 were occasionally used (7 %), 19 were most preferred (7 %), 13 were preferred (5 %), and 12 were commonly used by the Urial. Overall, 51 % of the food of Punjab Urial comprised of herbs while the rest of it was grasses, trees and shrubs being 19, 16 and 14 %, respectively. *Acacia modesta*, *Olea ferruginea*, *Brachiaria reptans*, *Cenchrus ciliaris*, *Cenchrus setigerus*, *Cynodon dactylon*, *Dichanthium annulatum*, *Fagonia bruguieri*, *Peganum harmala*, *Digitaria sanguinales*, *Whithania somnifera* and *Ohyla nodiflora* were the most preferred food of Punjab Urial

Land cover: Regarding the land cover, based on maps developed by the Pakistan Forest Institute, Peshawar, Pakistan, the total area of six districts of our target study was 3.2 million hectares (ha). In it, the shrubs and bushes covered 12 % of the total area while agricultural land had a maximum land cover that was 52 %. Similarly, the rangeland, sub-tropical broad-leafed forest, barren land, settlements water bodies and plantation constituted 14, 10, 5, 3, 3, and 1 %, respectively. Results of our study, however, revealed that Punjab Urial's habitat was seen to be restricted only in 7953 km^2. The overall and district-wise results for land cover are presented in Table 4. From the total plant species identified in the entire habitat of projected species, the herbs, grasses, trees and shrubs were 56 %, 16 %, 16 % and 12 %, respectively. A similar trend was noticed for all districts of the study range (Table 3).

Table 3: Overall land cover in the Kala Chitta and Salt Ranges of Punjab Urial (*Ovis vignei punjabiensis*).

Sr. No.	Range	District Name	Total Species (n)	Total Families (n)	Herbs (%)	Grasses (%)	Trees (%)	Shrubs (%)
1		Chakwal	209	68	52	20	16	12
2		Jehlum	195	74	54	18	15	13
3	Salt	Khushab	171	62	54	11	19	16
4		Kohat	165	59	62	18	13	7
5		Mianwali	155	51	56	13	20	11
6	Kala Chitta	Attock	183	63	54	19	16	11
		Total in Study area	284	74	56	16	16	12

Water: The results for water analyses of the whole of Punjab Urial's range are given in Table 4. All the studied attributes had a statistical difference (P ≤ 0.05) within

districts of study. Mostly the pH of water ranged from 6.4 to 7.9 with a mean (± SE) value of 7.22 ± 0.03. Statistically higher (P ≤ 0.05) COD value was observed

for Jehlum district being 46.4 ± 0.68 ppm. The water samples from the Kohat district revealed statistically higher (P ≤ 0.05) TDS (1165.5 ± 37.4 ppm), turbidity (23.44 ± 0.84 NTU), hardness (329.74 ± 10.8 mg/L) and electric conductivity (1082.7 ± 9.6 mS/m) as compared to other districts.

DISCUSSION

The present work is the first of its kind being reported for Punjab Urial (*Ovis vignei punjabiensis*) from Pakistan to assess various components of habitat (vegetation, food preference, land cover, and water) for this specie throughout the whole of its distribution range *viz.* Salt Range (Chakwal, Jehlum, Khushab, Kohat and Mianwali Districts) and Kala Chitta Range (Attock District).

In the present study, a total of 74 families including 284 species of plants were identified throughout the whole range of Punjab Urial *viz.* Salt and Kala Chitta Range, with Poaceae being the highest contributing family. Earlier published literature mostly has covered patchy details of habitat study in small regions/or some game reserves of these two ranges. A total of 20 plant species including 8 trees, 5 shrub and 7 grass species were reported in Kala Chitta Range (Iqbal *et al.*, 2012). In contrast to our study, they reported *Dodonaea viscosa* as the most dominant of all plant species. Similarly, in another study (Awan, 2006), Awan reported *Acacia modesta* (Fabaceae family) and *Dodoneae viscosa* (Sapindaceae Family) as the most prevalent plant species. Chaudhry *et al.* (2001) reported 116 plant species that designate the Punjab Urial habitat in Chumbi Surla Wildlife Sanctuary while Ahmad (2009) described 24 plant species associated with the species habitat in Kufri (Soon valley) (Chaudhry *et al.*, 2001; Ahmad, 2009). Lesser number of families and plant species with *Acacia modesta* and *Dodoneae viscosa* as dominant species have been reported for various game reserves of these ranges elsewhere too (Habiba *et al.*, 2015; Bradley *et al.,* 2012). None of the studies has incorporated the whole of the distribution range of Punjab Urial for recording the vegetation. The difference in results in vegetation could plausibly be attributed to changing weather patterns which have altogether altered the patterns of vegetation (Hope *et al.*, 2004). Latest studies have proven that altered weather patterns in terms of climate change induce habitat vulnerability which may lead to alterations in vegetation types of that habitat (Hope *et al.*, 2004; Comer *et al.*, 2019).

The results of the land cover of the present study for the whole of the Punjab Urial's range revealed that from the total plant species identified (n = 284) in the entire habitat of projected species, herbs were most abundant, followed by grasses, trees and shrubs. Among herbs, *Achyranthes aspera, Aerva javanica, Amaranthus viridis, Anthriscus nemorosa, Chenopodium album, Chenopodium murale, Convolvulus arvensis, Conyza bonariensis, Launaea nudicaulis, Solanum nigrum, Seasamum indicum* and *Euphorbia prostrata* were few of the abundant species. Our results do not coincide with earlier published reports. Dominant percentage (31 %) of grasses has been reported in Punjab Urial's range elsewhere (Habiba *et al.*, 2015). Similarly, Iqbal (Iqbal *et al.*, 2012) reported trees to be dominant over shrubs and grasses in Kala Chitta range. Differently prevailing herbs and shrubs have been reported as compared to our results (Habiba *et al.,* 2015; Chaudhry *et al.,* 2001; Awan, 2006). The variation in results could be the result of drastic weather changes and the difference in study sites by various researchers.

Regarding the food preference of Punjab Urial, the present study revealed that majorly its food comprised of herbs followed by grasses, trees and shrubs. It was noticed that the feeding preferences of Punjab Urial change as per changing seasons as reported elsewhere (Hussain *et al.*, 2015). Preferred forage items as per the present results and earlier published data (Awan, 2006; Iqbal *et al.*, 2012; Hussain *et al.*, 2015; Habiba *et al.*, 2015) are *Accacia modesta* and *Olea ferruginea* (throughout the year) *Zizyphus jujuba* (in winter season), *Zizyphus nummularia* (in winter and monsoon), *Accacia nilotica* (in winter and summer), *Adhatoda zeylanica* (in spring and summer), *Dodonea viscosa* (throughout the year) and *Mytenus royleana* (in spring and winter season). Slight variation in abundance of these plant species in different seasons has though been reported earlier which could again be attributed to climate change, altered grazing patterns of Urial and gradual loss of habitat owing to urbanization.

Description of habitat and the home range for any species cannot be completed without the detailed study of water availability and water quality parameters. Punjab Urial uses water for consumption from seasonal springs at few places, and from dotted ponds scattered throughout its distribution range as reported earlier (Iqbal *et al.*, 2012). The present study for the first time analyzed water quality attributes of samples attained from throughout the distribution range of Punjab Urial. None of the samples showed a pH of less than 6. Rather an alkaline trend was noticed in all samples having a range within those prescribed by the WHO. Similarly, all other studied water attributes were within the range of the WHO. However, the water samples from Kohat district revealed higher TDS, turbidity, hardness and electric conductivity values as compared to other districts not being within WHO's proscribed limits. As no previous work has been reported on water samples being consumed by the Punjab Urial, hence the comparison is difficult. However, in a general perspective, our results tally with research works conducted on drinking water of Salt Range (Afzal *et al.*, 1998; Iqbal *et al.*, 2014).

Table 4: Mean (±SE) values for water quality attributes in the Kala Chitta and Salt Ranges of Punjab Urial (*Ovis vignei punjabiensis*).

Sr. No.	Parameter	Attock	Chakwal	Jehlum	Khushab	Kohat	Mianwali	Overall Mean
1	pH	6.64±0.05	6.52±0.05	7.76±0.03	7.48±0.03	6.46±0.04	7.96±0.04[*]	7.22±0.03
2	Free Carbon Dioxide (ppm)	2.95±0.04	2.94±0.03	2.73±0.03	3.04±0.04	4.26±0.1	2.93±0.03	3.09±0.02
3	Dissolve Oxygen (mg/L)	6.87±0.1	8.17±0.06[*]	7.58±0.1	6.72±0.06	6.61±0.13	8.35±0.15[*]	7.43±0.01
4	COD (ppm)	20.9±1.18	28.85±1.3	46.4±0.68[*]	25.14±0.9	34.37±1.32	30.97±0.9	32.3±1.0
5	BOD (ppm)	6.53±0.06	6.5±0.04	5.58±0.06	6.68±0.03	6.11±0.05	7.07±0.05	6.38±0.02
6	TDS (ppm)	798±10.64	526.9±8.4	864.1±20.2	736.8±10.8	1165.5±37.4[*]	518.15±8.6	757.9±15.2
7	Turbidity (NTU)	23.48±0.37[*]	10.09±0.4	16.19±0.4	13.67±0.3	23.44±0.84[*]	16.48±0.4	16.5±0.1
8	Nitrite (mg/L)	0.55±0.01	0.65±0.01	0.4±0.01	0.69±0.01	3.14±2.53[*]	0.39±0.01	0.89±0.03
9	Alkalinity (mg/L)	134.1±2.52	238.3±3.6	164.93±3.5	163.94±2.2	435.5±11.6[*]	199.52±2.9	217.9±3.2
10	Ammonia (ppm)	89.33±1.45[*]	124.03±1.8	151.88±2.3	168.47±2.5	180.78±5.4	119.58±2.3	141.8±2.1
11	Chloride (mg/L)	240.14±3.1	298.4±3.1	242.38±3.2	239.14±2.5	385.04±18.8[*]	311.42±2.4	283.1±1.0
12	Sulphate (mg/L)	125.24±1.7	248.94±2.2[*]	134.9±1.8	173.92±2.3	164.26±4.11	129.09±2.3	163.8±2.0
13	Conductivity	34.86±0.5	41.45±0.43	32.21±0.7	33.17±0.6	35.48±0.9	48.36±0.42[*]	37.5±0.4
14	Electric Conductivity (mS/m)	802.14±6.3	802.64±7.4	911.55±8.6	1130.5±10.5[*]	1082.7±9.6	916.03±8.2	946.7±3.2
15	Hardness (mg/L)	121.9±5.5	259.06±4.1	131.64±5.1	109.47±3.02	329.74±10.8[*]	354.45±3.3[*]	214.4±3.5
16	Carbonates (ppm)	74.71±2.8	128.61±2.5[*]	77.4±1.69	69.5±1.82	53.85±1.3	108.88±2.5	86.52±1.0
17	Nitrate & Nitrogen (mg/l)	5.63±0.05	8.51±0.05	9.06±0.05	7.47±0.03	4.88±0.12	6.63±0.04	7.28±0.02

COD = Chemical Oxygen Demand; BOD = Biochemical Oxygen Demand; TDS = Total Dissolved Solids
[*]Significant at P≤0.05 within rows.

In a nutshell, the distribution range of Punjab Urial is reducing with time. Furthermore, the density, frequency, abundance and land cover of vegetation within both the Ranges are also changing due to altering climatic conditions. Habitat vulnerability as per climate change needs to be studied in detail especially for these two ranges, in context to the species under discussion. The results of the study may help the conservation policies of this species directionally. It is also recommended, that keeping in view the findings of this study, the database of Pakistan Forest Institute, WWF-Pakistan, Pakistan Wildlife Foundation, and other relevant authorities may be updated regarding the habitat of Punjab Urial.

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