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Conservation Status of Ladakh Urial (*Ovis vignei vignei* Blyth, 1841) in Gilgit Baltistan, Pakistan

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ABSTRACT

Ladak hurial (*Ovis vignei vignei*) is a threatened wild sheep, vulnerable and listed in the Appendix 1 of Convention on International Trade in Endangered Species of Fauna and Flora, present in small pockets of northern Pakistan including Chitral district in Khyber Pakhtunkhwa, Gilgit-Baltistan (GB), and in Ladakh (Jammu and Kashmir) in India. Based on rapidly declining population due to various threats and restricted geographic range, these urial are considered Vulnerable globally as per IUCN Red List 2015.2 of threatened animals. The present study was designed to collect information on the current conservation status of these urial in Gilgit-Baltistan during January to September, 2013. Data were collected through direct observations, using trail walks and vantage points, as well as by collecting information from local residents, shepherds, and hunters using a questionnaire. A sum total of 172 individuals were recorded from four main localities (Bunji, Nanga Parbat, Nagar, and Skardu) comprising twenty four herds (mean size=7.17±3.19) with 1.91 animals/km^2 overall population density. Of these, 128 individuals could be classified as females (n=66; 38.37%) and males (n=62; 36.05%), while remaining 44 (25.58%) individuals including young ones (n=29) could not be sexually identified. Besides direct sighting minimum population (172 individuals), an overall estimated population comprising ca. 432 individuals (4.79 urial/km^2) was also figured out based on local information as collected through questionnaires. The population of Ladakh urial has been declining during the last few decades due to illegal hunting and habitat degradation by increasing livestock population and extraction of wood, fodder and medicinal plants. Its distribution range has also been shrinking and they have been extirpated from at least six previously known localities during the last decade. To ensure the continuous survival of the existing urial population, a comprehensive research based integrated strategy is required.

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Authors' Contribution
RAM designed the study. MSD and MK collected field data. MSD wrote the article. UA, SSB, BA and MSA statistically analyzed the data.

Key words
Wild sheep,
Vulnerable animals,
Conservation status
Ladakh urial

INTRODUCTION

The urial (*Ovis vignei;* Bovidae: Artiodactyla) is an upland medium sized wild sheep, considered as the wild ancestor of the domestic sheep, *Ovis aries* (Mallon, 1983; Shackleton, 1997). The taxonomic status of the species and of the subspecies is unclear. They are either considered as a single species (*O. orientalis*) or two separate species as *O. orientalis* and *O. vignei* (Nadler *et al.*, 1973; Roberts, 1997; Rezaei, 2007). However, as the natural habitat range of these two sheep is overlapping and different species of the genus *Ovis* can hybridize producing fertile offsprings, hence, most of the traditional classifications considered only one species with several subspecies (Nadler *et al.*, 1971; Valdez *et al.*, 1978). Urial has now been considered as separate species (*O. vignei*, 2n=58) separated from Asiatic mouflon (*O. orientalis*, 2n=54) and Argali (*O. ammon*, 2n=56) on the basis of difference in number of chromosomes (Shackleton, 1997; Roberts, 1997; Nadler *et al.*, 1973). Based on molecular analysis, Rezaei *et al.* (2010) suggested that *O. vignei* diverged from *O. orientalis* about 3.5 million years ago. The Cytochrome *b* phylogeny, based on mitochondrial DNA showed that individuals from hybrid populations appear either in *vignei* or *orientalis* taxon, independently from their geographic origin. Thus, these two groups from two distinct evolutionary lineages are hybridizing in their contact zones (Rezaei *et al.*, 2010). Three subspecies of urial are found in Pakistan, namely Afghan urial (*O. orientalis (vignei) cycloceros* including *O. v. blandordi:* the former considered to be occurring north of Quetta and the latter south of Quetta and in Sindh west of Indus*)*, Punjab urial (*O. orientalis (vignei) punjabiensis*), and Ladakh urial (*O. orientalis vignei* or *O. vignei vignei)* (Valdez, 2008; Shackleton, 1997; Mallon, 1983; Rezaei, 2007).

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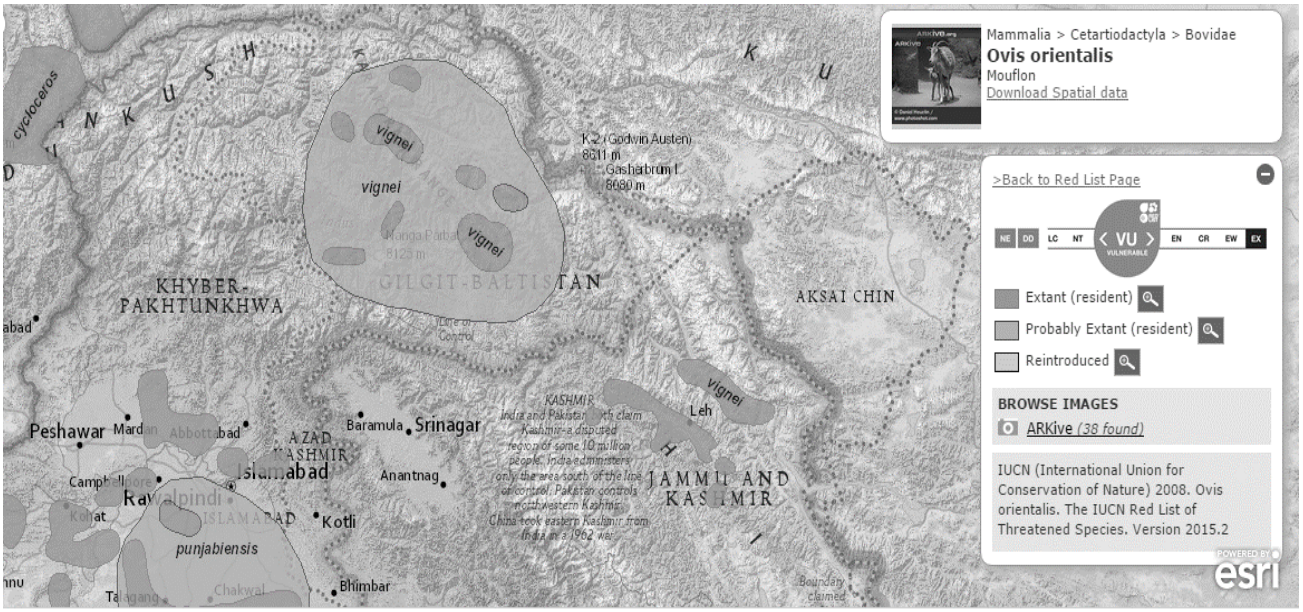

Source: maps.iucnredlist.org.

Fig.1. Worldwide distribution of Ladakh urial.

The Ladakh urial is the smallest and least studied among wild sheep with very restricted distribution range confined to Ladakh (Indian held Kashmir) and Gilgit-Baltistan (Pakistan) (Roberts, 1997; Valdez, 2008). The distribution of these urial in Chitral is also reported in few unpublished records. Hess (1997) reported their presence between Chitral and Drosh, while only two individuals were reported from Chitral in 1986 (Anonymous, 1986). In Ladakh it is distributed infrequently in a narrow band along the valley-bottom, to the foothill boundary and some of the major tributaries of the Indus and Shyok-Nubra rivers. Most of the urial population is found along the Indus valley westward from Likchey to Khalsi villages, and around the junction of the Nubra and Shyok valleys (Valdez, 2008; Fox *et al.*, 1991; Mallon, 1983, 1991) (Fig. 1). In Ladakh, the population had been reduced to a few hundred individuals in the 1960s and 70s through hunting for trophies and meat (Fox *et al.*, 1991; Mallon, 1983; Chundawat and Qureshi, 1999). However, with the protection under the Indian Wildlife Protection Act 1972, and resultant decrease in hunting, the population has increased to about 1000-1500 individuals in its range in Ladakh (Chundawat and Qureshi, 1999; Raghavan and Bhatnagar, 2003).

In Pakistan, Ladakh urial has been reported from Chitral district in Khyber Pakhtunkhwa (KP) and Baltistan district (Skardu region) in the Northern Areas (Gilgit-Baltistan; GB). In Chitral district, it was reported from the western and eastern banks of the Kunar River between Chitral town and Drosh (Roberts, 1997). A small population had been recorded in Hispar Valley, Nagar, Rondu, region of Gilgit district and Bunji Valley in Astore district (Hess *et al.*, 1997; Roberts, 1997; Sheikh and Molur, 2004). Its range encompassed most of the Western Himalayas (Himalayan/Karakoram/Hindu Kush mountain region) on rolling slopes at from 1500 m to above tree line (Schaller, 1976; Roberts, 1997). However, urial from higher elevations, historically made altitudinal migrations to lower valleys to avoid winter snows (Schaller, 1976; Fox *et al.*, 1991). These elevations and habitats, however, correspond to the region most heavily utilized by humans, and a combination of overhunting, disturbance, and competition with livestock. Hence, Ladakh urial like many other wild animals is affected by competition with livestock, leading to the brink of extinction (Roberts, 1977; Schaller, 1979; Mallon, 1991; Shackleton, 1997; Chundawat and Qureshi, 1999).

Besides, the habitat of these urial is arid and of low primary productivity, hence their densities are often naturally low (<one/km^2). With increasing human populations, the grazing pressure from domestic livestock is increasing significantly. In addition, the mountain habitats are also severely destroyed and shrunken due to severe livestock grazing and deforestation for fodder and fuel wood by the local communities. Again the major cause is directly related to increasing human numbers, in this case their rising energy demands for fossil fuels, hydroelectric power, and fuel wood (Shackleton, 1997;

Raghavan and Bhatnagar, 2003).

Based upon various threats, all subspecies of urial have been globally considered as vulnerable in the IUCN Red List of Threatened Animals (2015) because their population is believed to be declining by at least 30% over three generations due to hunting, hybridization and habitat deterioration (Valdez, 2008; IUCN, 2015).

In Pakistan, around 1900, the Ladakh urial used to be a common animal of northern Pakistan. According to Schaller (1976) < 1,000 animals were left in Pakistan. Hess (1997, 1999) estimated only 200-400 individuals for 1983-1988. In 1992 a total of 57 urial was estimated by NWFP (Khyber Pakhtunkhwa) Wildlife Department. The total estimated for the Northern Areas for 1993 was 400-500 urial (G. Tahir, Wildlife Wing, Northern Areas Forest Dept., in litt. to G. Rasool). There were probably <600 Ladakh urial in total in Pakistan (Hess *et al.*, 1997, Schaller, 1976 and G. Tahir in litt. to G. Rasool). According to Rasool (1999) the previous estimated population had dropped down to 200 - 300 urial in the whole of the GB, Pakistan (https://www.cites.org/eng/cop/11/prop/30.pdf)‼¶⊥: *Prop. 11.30 of Cites for Inclusion of all subspecies of Ovis vignei (not yet listed by CITES) in Appendix I of CITES:*

In Pakistan, Ladakh urial have severe threats of habitat degradation, poaching, lamb picking, and disease transfer from domestic livestock. Hence the national status of the species is considered endangered (Sheikh and Molur, 2004). IUCN Red List 2015.2 places it as vulnerable. It is also listed in the Appendix 1 of Convention on International Trade in Endangered Species of Fauna and Flora. However, their conservation status has not been studied properly for the last two decades. Khan and Zahler (2004) reported that the last remaining Ladakh urial population in Pakistan is very small and fragmented; hence they need to be immediately located and surveyed for taking proper conservation measures to ensure their continued survival. Keeping this in view, the present study was designed to collect the information on the current conservation status of these urial in GB.

MATERIALS AND METHODS

Study area

Gilgit-Baltistan formerly called Northern Areas is situated in the extreme north of Pakistan between 43-40 to 37-04 north latitudes and 72-30 to 77-50 east longitudes, sandwiched among the highest peaks of Karakoram and Hindu-Kush in the north and those of western Himalayas in the south. GB covers an area of 72,971 km² and an estimated population approaching 1,000,000 (Khan, 2012).

The biogeographic position of GB is very unique. Three of the world's great mountain ranges- the Himalayas, Karakoram and Hindu Kush- meet at the confluence of Gilgit and Indus rivers, while the Karakoram Range joins the Pamir and Kun Lun ranges in the north. The landscape is dominated by some of the world's highest mountain peaks, including 5 peaks over 8,000 m elevation above mean sea level (amsl), which overshadows the biological richness of this region (Virk *et al.*, 2003).

Monsoon rains are rare due to blockage by the high Himalayan mountains, while snowfall largely occurs in areas above 4,000 m amsl. The area has the highest concentration of glaciers, including some of the longest glaciers of the world *e.g.*, Siachin Glacier, 78 km long (Virk *et al.*, 2003; Zain, 2010). Based on this unique geography, a number of significant species of mammals are found in the area, including some of the globally threatened species of mammals and birds (Virk *et al.*, 2003).

Methods

Field surveys were conducted from January to September, 2013 to collect data on the current distribution and conservation status and of Ladakh urial in Gilgit-Baltistan. The information was collected through direct (by actually seeing the animal and its direct evidences *i.e.*, hairs and fecal pellets) as well as indirect methods (by collecting the information from local residents, shepherds, hunters, community wildlife rangers, forest guards and game watchers of the study area using questionnaires and group discussion).

General surveillance was carried out initially with the help of local people and hunters in all potential, previously reported habitats of the Ladakh urial. During these surveys, all visible surrounding areas were scanned carefully for direct observations of animals, as well as their signs of presence *i.e.*, fecal pellets and hair. All detections were marked as the distribution sites and GPS coordinates were recorded on the spot using data sheets. Based on the general surveillance findings, the vantage points (n=25) were marked for further detailed study. For estimating the population, the vantage point method as described by Schaller (1998) was used, as this is the most appropriate method to count wild ungulates in the rugged mountainous habitats (Ali, 2008). Time specification for taking direct observations was adjusted according to the activity patterns of the animal (0700-0900 and 1500-1700 hours winter; 0500-0800 and 1800-2000 hours summer). The best time for observation of urial is usually 0700 to 0900 hours and 0300 to 0500 hours (Ayaz *et al.*, 2012). All the animals in different herds, observed during scanning were counted with the help of binoculars (Canon, 8×40 mm) and spotting scope (Bushnell, 20-60×65mm). Efforts were made to classify each of the

observed animal into one of the following age/sex categories; female, young, yearling and male. Males were further classified by size, using horn length as an indicator of age, as class I (1-3 years old), class II (3-4 years old), class III (5-6 years old) and class IV (>6 years old) as proposed and defined by Schaller and Mirza (1974) and as adopted by Awan (1998). For seasonal fluctuations in population, monthly surveys were carried out from February to October. GPS (Garmin etrax 20) was used to record the information on locations and elevations. Area covered at each vantage point was calculated in ArcGIS (ver. 9.1) through the convex polygon method on the basis of coordinates taken in the field using a GPS. Visual scan based counting of individuals was considered as the exact minimum population used in density calculations of the Ladakh urial at different localities. Besides, direct sighting of animals, information on population and conservation status of Ladakh urial was also collected from local hunters, shepherds and other knowledgeable people, using semi structured questionnaires (n=100). This population was considered as 'estimated population' to estimate the population densities of urial in different localities.

RESULTS

Distribution

Ladakh hurial was found distributed in about 90.1 km^2 surveyed areas in different localities of Gilgit and Baltistan (Fig. 2). In Gilgit, the presence of Ladakh urial was confirmed at Bunji Valley (Rehman Nallah, Nelli Daar, Pooring Boori, Nelli Harae, Jachaa, Ramgat Thock, Dadar Misiken, Burmay, Fataro Lot, Budayba, Chooko Jail, Mayar Dass, Burmay Gutum, Burchi), Nanga Parbat (Jalipur, Jabar Daar, Shero-Taaey, Shero-Munair, Boori Baizer, Batchulee Goolo Shut, Raikot) and Nagar (Huru). In Baltistan region, the urial were recorded from Skardu, which included sub-localities, Thalay, Nar Gorro, Safranga and Karrpochu (Table I).

Direct sighting population

Ladakh urial was present as small fragmented populations in some localities of GB. A total of 172 individuals was recorded with an overall population density of 1.91 individuals/km^2 (Table I). Bunji Valley in Gilgit appears to be the main population hub of Ladakh urial in GB with a population of 109 individuals and 2.51 individuals /km^2 population density (Table I).

Nanga Parbat and Nagar were two other localities in Gilgit zone containing populations of 38 and 3 individuals with overall population densities of 1.58 and 0.70 urial/km^2 respectively (Table I). In Baltistan, Skardu was the only locality still supporting the urial population, where 22 individuals with a population density of 1.20 individuals/ km^2 were recorded. Hence, the highest population density (2.51/km^2) of urial was recorded in Bunji Valley of Gilgit zone followed by Nanga Parbat (1.58 /km^2), Skardu (1.20/km^2) and Nagar (0.70/km^2) (Table I).

Indirect population estimates

Besides the direct sightings, a population comprising of a total of about 432 individuals was estimated in the aforesaid localities of GB. These estimates are based on the information of local wildlife watchers, local shepherds and hunters as they have long associations with these areas having key information about urial (Table II). Majority of indirect based population estimates coincides (r=0.96) with the direct sighting populations in different localities of the study area, except Skardu where direct sightings were relatively lower as reported by the local communities (Fig. 3).

Herd composition and sex ratio

During the survey, 172 animals were observed comprising 24 herds with mean herd size as 7.17±3.19 individuals (Table III). The whole population comprised of females (n=66; with mean size per herd = 2.75±1.03), males (adults, n=38; 1.58±0.83, yearlings, n=24; 1.00±0.88), young (n=29; 1.21±1.18) and unidentified adults (n=15; 0.63±0.97) (Table III). Hence, among a total of 128 (74.42%) sexually identified individuals, 38.37% (n=66) were females and 36.05% (n=62) were males, while remaining 25.58% (n=44) could not be sexually identified. However, statistical comparison of male and female ratio suggested non-significant difference (X^2*=0.125, df=1, p=0.724*) between the two genders.

Mature males were further divided into four different age classes *i.e.*, I, II, III and IV (Table III). Maximum males were in class III (n=11; 0.88±0.65) and I (n=10; 0.80±0.50). There was a highly significant difference between the composition of different age and sex groups in different herds (X^2*=26. 87, df=3, p=0. 000*), and also between different age classes among males in the (X^2*=13. 96, df=4, p=0. 007*).

Among a total of 128 sexually identified individuals, 81.25% (n=104) were classified as adult/breeding individuals, while remaining 18.75% (n=24) were sub adults and young *i.e.*, non-breeding population. Statistically, the ratio of adult and sub adult animals in the population was significantly different (X^2*=16.56, df=1, p=0.000*).

Spatio-temporal population dynamics

The majority of urial were recorded at the elevation

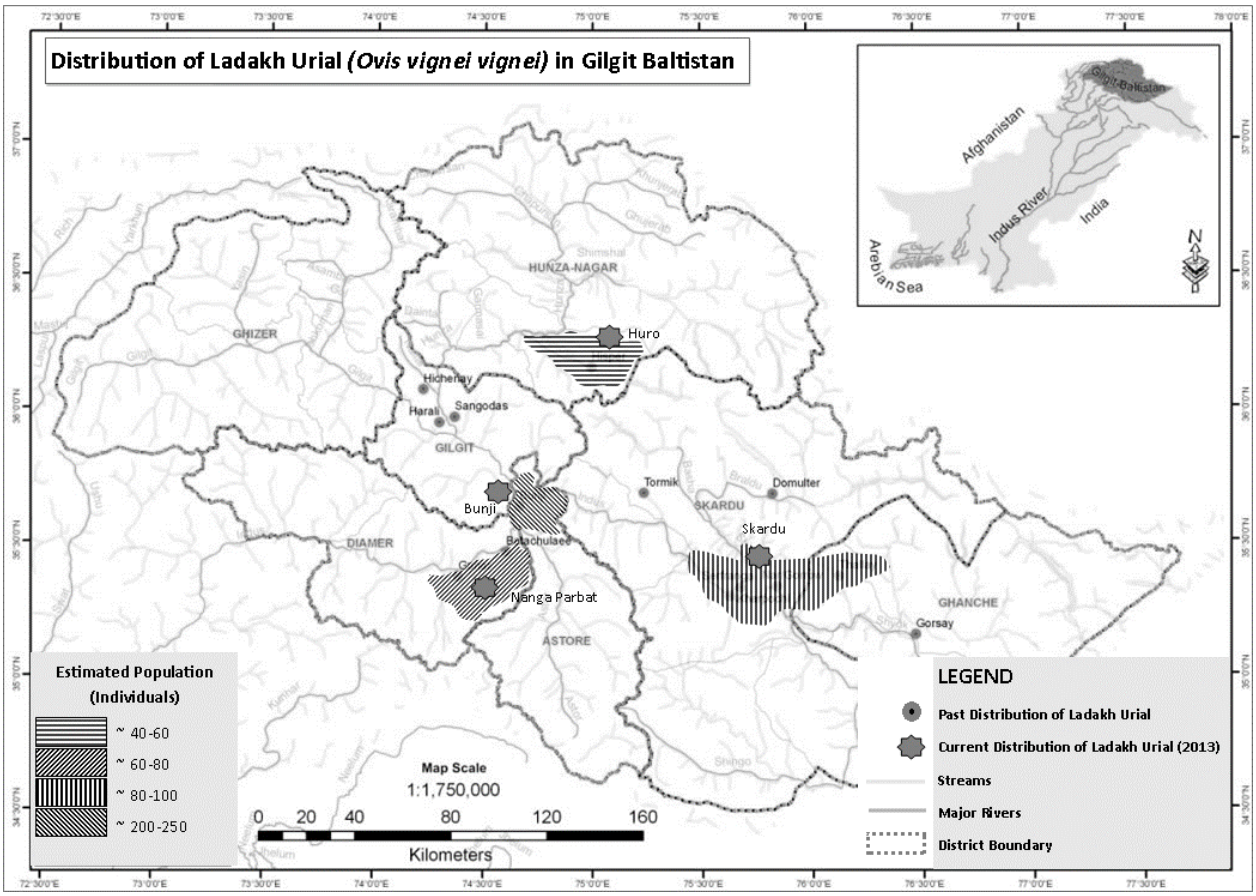

Fig. 2. Distribution range of Ladakh urial in Gilgit-Baltistan (2013)

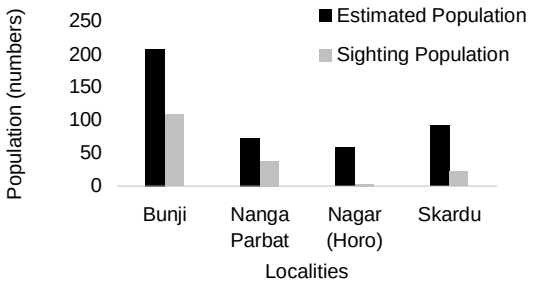

Fig. 3. Comparison of direct sighting and estimated population of Ladakh urial in GB (2013)

range of 2600-3000 m amsl, while the minimum between 4000 to 5000 m amsl showing a continuous decline with increasing elevation (Fig. 4). There was a highly significant difference between the population at different elevation range groups (X^2=*34. 56, df=3, p=0. 000*) suggesting that it was not evenly distributed among all elevation zones. The maximum numbers of urial were sighted during April (n=172), while the minimum in June (n=90). Almost similar seasonal variation pattern was recorded in all localities (Fig. 5).

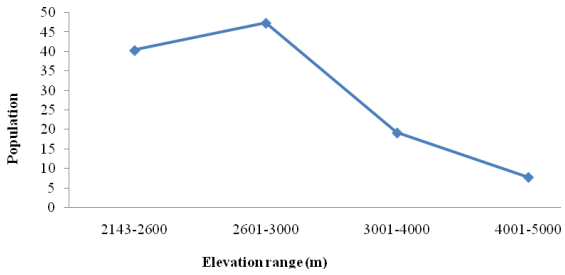

Fig. 4. Altitudinal variation of urial population in GB during 2013.

Human interference and resource overlapping

Humans and their livestock were found involved in habitat overlapping with Ladakh urial in the study area.

Heavy human interference, in terms of livestock grazing, forest cutting, illegal hunting and medicinal plant extraction, poses severe threats to the remaining Ladakh urial population (Table IV).

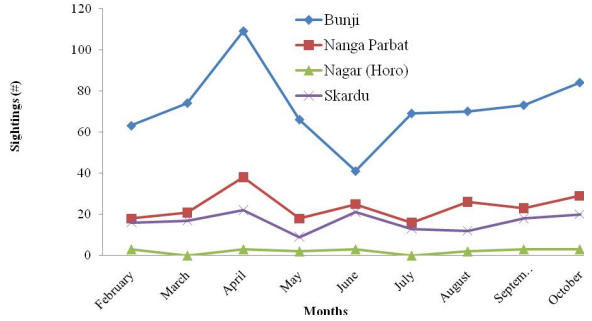

Fig. 5. Seasonal population fluctuations of urial at different study sites

Livestock grazing and fodder collection

A total of 153,368 livestock heads was reported by respondents to have with their households which included cattle (n=42,067), buffaloes (n=6640), goats (n=51,754), sheep (n=29,516), horses (n=264), donkeys (n=1454), yaks (n=790), and mules (n=114). The highest portion of this livestock population contained goats and sheep (n=81,270) (Fig. 6). There were strong negative correlations between the direct sighting (*r=-0.87; p=0.123*) as well as estimated (*r=-0.88; p=0.110*) urial populations and livestock populations in different localities. However, statistically this relationship was non-significant.

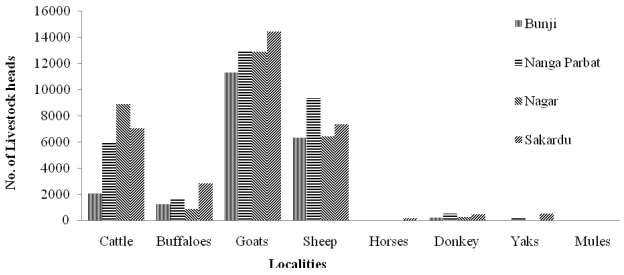

Fig. 6. Livestock population in different localities during 2013.

Wood extraction

The practice of fuel wood and timber extraction by local human communities of the area has continued for hundreds of years. Based on information from respondents, the relative extraction of common plants illegally harvested for timber and fuel wood from the natural habitat of Ladakh urial are given in Figure 7.

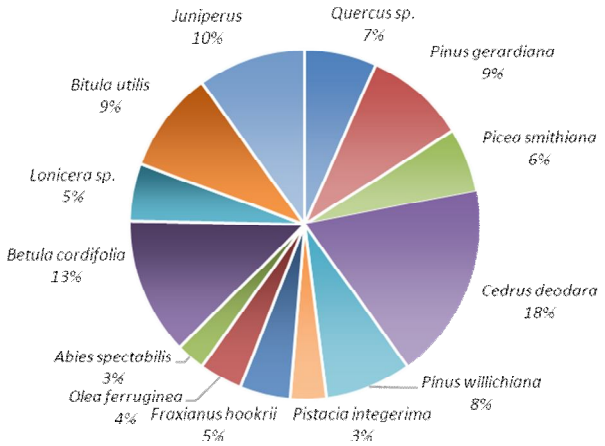

Fig. 7. Relative percentage of fuelwood/ timber plants harvested by local communities in the study area.

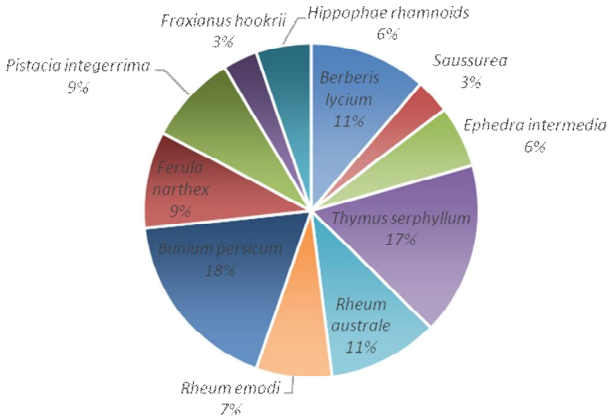

Fig.8. Relative percentage of medicinal plants extracted by local communities in the study area.

Illegal hunting

During 2000-2013, about 70 illegal killings of Ladakh urial were reported from different areas of GB with gradually increasing trend leading to the maximum in 2013 (n=15; Table V) (information collected through interviews). None of these cases was however registered with the concerned Wildlife Department for any legal action against the culprits.

Extraction of medicinal plants

To meet domestic as well as commercial needs, the communities around the study area as well as a large number of nomadic families (visiting the area during summer) extract a huge amount of medicinal plants through unsustainable methods. The detail of most

Table I.- Distribution and population of Ladakh urial in GB observed during 2013.

Zone	Locality	Vantage point	Sub localities	GPS Location	Elevation (m)	Area Surveyed (km^2)	Urial sighted (#)	Population density (km^2)
Gilgit	Bunji	B1	Rehman Nallah	N35°36.413´ E74°40.183´	2913	2.5	5	2.00
		B2	Nelli Daar	N35°36.809´ E74°40.518´	2814	2.3	3	1.30
		B3	Pooring Boori	N35°36.275´ E74°40.497´	2880	3.2	3	0.94
		B4	Nelli Harae	N35°36.259´ E74°40.482´	2862	2.4	3	1.25
		B5	Jachaa	N35°36.259´ E74°40.482´	2555	3.5	5	1.43
		B6	Ramgat Thock	N35°36.149´ E74°40.691´	2735	3.7	15	4.05
		B7	Dadar Misiken	N35°36.149´ E74°40.691´	2430	3.0	9	3.00
		B8	Burmay	N35°36.609´ E74°39.882´	2513	3.1	6	1.94
		B9	Fataro Lot	N35°35.958´ E74°39.897´	2525	3.5	16	4.57
		B10	Budayba	N35°47.786´ E74°40.453´	3117	4.5	18	4.00
		B11	Chooko Jail	N35°47.445´ E74°40.304´	2800	2.8	5	1.79
		B12	Mayar Dass	N35°47.258´ E74°40.514´	2683	3.3	9	2.73
		B13	Burmay Gutum	N35°47.064´ E74°40.321´	2455	2.9	6	2.07
		B14	Burchi	N35°46.405´ E74°39.997´	2177	2.7	6	2.22
		Sub total				**43.4**	**109**	**2.51**
	Nanga Purbat	NP1	Jalipur	N35°.44189 E74°.48788	2143	4.6	9	1.96
		NP2	Jabar Daar	N35°.43488 E74°.49135	2764	4.3	6	1.40
		NP3	Shero-Taaey	N35°.41544 E74°.49314	3288	3.6	7	1.94
		NP4	Shero-Munair	N35°.42462 E74°.49860	3295	3.7	3	0.81
		NP5	Batchulee Goolo Shut	N35°.42010 E74°.51242	4051	4.5	8	1.78
		NP6	Raikot	N35°.42249 E74°.51947	4204	3.4	5	1.47
		Sub total				**24.1**	**38**	**1.58**
	Nagar (Horo)	**NH1**	**Huru**	**N36°13573 E74°47021**	**3145**	**4.3**	**3**	**0.70**
Baltistan	Sakardu	S1	Thalay	N35°18359 E76°09259	2832	4.8	5	1.04
		S2	Nar Gorro	N35°20502 E74°40084	2198	4.6	4	0.87
		S3	Safranga	N35°18146 E75°38244	2303	4.7	6	1.28
		S4	Karrpochu	N35°21245 E75°48130	2456	4.2	7	1.67
		Sub total				**18.3**	**22**	**1.20**
G. Total		**25**				**90.1**	**172**	**1.91**

Table II.- Estimated population of Ladakh urial in different localities of GB (2013).

Zone	Localities	Area surveyed (km^2)	Indirect estimated population	Population density (km^2)
Gilgit	Bunji	43.4	208	4.79
	Nanga Parbat	24.1	73	3.03
	Nagar (Huro)	4.3	59	13.72
Baltistan	Skardu	18.3	92	5.03
	Total	**90.1**	**432**	**4.79**

Table III.- Population structure of Ladakh urial during survey conducted in study area (2013).

Locality	No. of groups	Animals per herd (#)	Females	Males					Unidentified sex	
				Yearling	Adult					
					Class I	Class II	Class III	Class IV	Young	Adult
Bunji	13	8	3	1	1	0	1	0	2	0
		7	3	1	0	2	0	0	0	1
		9	2	2	1	1	0	0	3	0
		8	4	1	0	0	1	0	2	0
		15	5	2	1	1	0	1	3	2
		13	4	2	0	1	1	0	2	3
		5	2	1	1	0	0	1	0	0
		4	2	0	1	0	0	0	0	1
		8	3	0	0	0	2	0	0	3
		3	3	0	0	0	0	0	0	0
		11	4	2	1	0	0	1	2	1
		12	3	2	1	1	1	0	3	1
		6	3	0	0	1	0	1	0	1
Nanga Parbat	6	7	3	0	1	0	0	1	2	0
		8	3	2	1	0	0	0	2	0
		6	3	0	0	0	0	1	2	0
		3	0	0	0	2	1	0	0	0
		5	2	1	0	0	0	0	2	0
		9	3	3	0	0	0	1	2	0
Nagar	1	3	1	1	0	0	1	0	0	0
Skardu	4	5	3	1	0	0	0	0	0	0
		7	2	1	0	0	2	0	2	0
		4	3	0	0	0	0	1	0	0
		6	2	1	1	0	1	0	0	2
Total	24	172	66	24	10	9	11	8	29	15
Mean± SD		7.17± 3.19	2.75± 1.03	1.00± 0.88	0.80± 0.50	0.72± 0.64	0.88± 0.65	0.64± 0.48	1.21± 1.18	0.63± 0.97

frequently extracted plants along with their relative extraction is given in Figure 8.

Local knowledge and perceptions about urial

Data collected on perceptions of the locals about urial, a survey of 150 respondents focused upon hunters, herders and local knowledgeable peoples, revealed positive results. The majority (n=79, 53%) of respondents were happy with urial's presence and in favor of (n=61, 41%) its conservation in their respective areas. A small proportion (5 %) of respondents favored its conservation only if the animal was not problematic, while another 2% respondents considered urial a threat to their family as well as their village as they were in direct competition with the livestock for resource utilization. About 71% (n=107) of respondents viewed that Ladakh urial population had declined over the last few decades. Other 23% (n=34) claimed that it had increased, while, 6% (n=9) were unaware of the urial abundance in the area.

Table IV.- Human Interference in urial habitats in GB.

Locality	Location	Factors					
		Human interference	Human settlements	Grazing	Tree cutting	Agricultural activities	Hunting
Bunji	Rehman Nallah	***	**	***	**	-	**
	Nelli Daar	***	*	***	*	-	**
	Pooring Boori	***	*	***	*	-	**
	Nelli Harae	***	**	***	*	-	**
	Jachaa	***	**	***	*	-	*
	Ramgat Thock	***	***	***	*	***	***
	Dadar Misiken	***	**	***	**	-	***
	Burmay	***	*	***	**	-	
	Fataro Lot	**	*	***	*	-	
	Budayba	***	**	**	**	-	
	Chooko Jail Mayar Dass	**	*	***	*	-	
	Burmay Gutum	**	*	***	*	-	
	Burchi	***	**	**	**	-	
Nanga Parbat	Jabar Daar Jalipur	***	**	***	***	-	
	Shero-Taaey	***	-	***	**	-	
	Shero-Munair	**	-	***	**	-	
	Boori Baizer	***	*	***	**	-	**
	Batchulee Goolo Shut	***	*	***	**	-	***
	Raikot	***	**	***	***	-	***
Nagar	Huru	***	**	***	***	-	***
Skardu	Thalay	***	**	***	**	-	***
	Nar Gorro	***	*	***	**	-	***
	Safranga	***	*	***	***	-	***
	Karrpochu	***	*	***	**	*	***

Absent;* low intensity;** medium intensity;*** high intensity.

Table V.- Illegal hunting of Ladakh urial (*based on interviews*) in GB during 2000-2013.

Sr.No.	Year	Locality	Number hunted
1	2000	Neeli Daar, Pooring Boori, Burmay, Burchi, Ramghat Thock,	5
2	2001	Nanga Parbat, Bunji, Sakardu (Karpouchu)	4
3	2002	Bunji (Burmay), Nelli Daar	2
4	2003	Nanga Parbat	1
5	2004	Bunji (Burmay), Nelli Daar	3
6	2005	Nagar (Huru), Bunji	3
7	2006	Bunji (Burmay), Nelli Daar	4
8	2007	Nanga Parbat, Skardu	2
9	2009	Bunji (Burmay), Nelli Daar, Chooko Jail, Ramgat	6
10	2010	Bunji, Burmay, Nelli Daar, Jachaa	9
11	2011	Bunji, NelliDaar, Jachaa	3
12	2012	Nanga Parbat, Skardu, Rehman Nullah	13
13	2013	Bunji, Rehman Nullah, Jachaa, Pooring Boori, Burmay, Dadar Misikin	15
		Total	**70**

DISCUSSION

Ladakh urial is the smallest and least studied among wild sheep with very restricted distribution range (Roberts, 1997). In Pakistan, small fragmented population of Ladakh urial is now primarily confined to Gilgit-Baltistan (GB) and Chitral district in Khyber Pukhtunkhwa (Schaller, 1976; Roberts, 1997; Khan and Zahler, 2004, Safdar Ali Shah Chief Conservator Wildlife, KP, personal communication). However, the updated records of its conservation status were not available since the last decade. The current study aimed to investigate the current conservation status of these endangered wild sheep in one of its remaining habitats *i.e.*, Gilgit-Baltistan. During present study 172 urial were observed during the survey of about 90.1 km^2 area at twenty five different locations of four main localities (Bunji, Nanga Barbat, Huru, Sakrdu) in GB with an average population density of about 1.27 urial/km^2 (Table I). This is the minimum population based on direct sighting and counting of all animals observed in different localities in the study area. Hence, it is the exact minimum population and population density of Ladakh urial found in GB as the numbers would not be less than observed in the field.

Besides, the population in all localities was also estimated on the basis of reported information by the local communities, shepherds and hunters. This population comprised of about 432 animals with 4.79 urial/km^2 population density distributed in the same localities as mentioned before. The two population counts of Ladakh urial statistically coincide with each other as there was no significant difference between the means of these two populations ($t=2.143$, $df=6$, $p=0.076$). Thus, it can be concluded that the indirect population estimates are also correct and reliable. However, the estimated population was not considered in other demographic analyses e.g., group composition, age, sex ratios etc. In all these parameters only direct sighting populations were analyzed in detail.

In GB, the majority (63%) of the urial population was found in Bunji Valley with 1.66 individuals/km^2 population density followed by Nanga Parbat (21%; 0.99 urial/km^2) and Skardu (14%; 0.90/km^2). Bunji and Nanga Parbat localities are the main population hub of the remaining Ladakh urial population in GB. In Bunji Valley, the community based organization (CBO) is working for the protection and conservation of natural resources, including wildlife with special emphasis on flare-horned markhor (*Capra falconeri falconeri*) for trophy hunting. Due to the reason the urial population still exists in the area, however, this population is also decreasing as illegal hunting still exists in the valley. Similarly, in Nanga Parbat areas, several wildlife conservation and social development organizations are actively involved in natural resource conservation with due support of different conservation organizations, yet due to lack of education and unemployment, illegal hunting still occurs.

The population density estimates are based on the areas covered during surveys of different localities. The actual area of Ladakh urial distribution range would be larger than the area surveyed. Therefore, the density measurements can vary as the area surveyed varies. Based on current field studies, it is anticipated pragmatically that the last remaining population of Ladakh urial in GB is not more than ca. 350-450 individuals. Nevertheless, these urial are very rare in the area, while the area is immense. Due to very limited time and resources, surveys were carried out only in the most potential previously known selected sites or as indicated by the local experienced hunters, shepherds and wildlife watchers. It is, therefore, strongly suggested to conduct more comprehensive research studies on these globally threatened animals for their proper conservation management in the area.

The direct sighting population of urial (n=172 individuals) was composed of 24 herds with mean herd size 7.17±3.19 animals ranging between 3-15 individuals. Group size of these urial varies among different habitats and localities. In Ladakh, these urial are reported with mean group size ranging between 3.7-12.1 and 1-14 by Raghavan and Bhatnagar (2003) and Namgail *et al.* (2010). Group size plays an important role in the survival of the group-living populations in terms of social interactions and anti-predator strategies. In Bunji Valley, the group size was larger as compared to other localities. This may be ascribable to the availability of undisturbed safe habitat, hence the population is also larger in this locality. In disturbed habitats, the populations may be found in small fragmented groups according to the availability of shelter to save them from being detected. Besides, the larger groups may also be preferred as the anti-predator strategy (Geist, 1971); urial rarely use cliffs as escape terrain, and prefer speedy running towards ridge lines to escape danger and hence living in large groups would be the most favorable anti-predator strategy.

Among a total of 172 animals seen, 157 individuals could be classified according to their age and sex composition comprising females (n=66, 42.04%), young (n=29, 18.47%), yearling (n=24; 15.29%) and adult males (n=38; 24.20%). A highly significant difference ($X^2=26.87$, $df=3$, $p=0.000$) among the composition of

different age and sex groups in different herds suggested that different age and sex groups were not evenly distributed in the population. There was a significant difference in the numbers of young, adult males and females. This information can be very helpful for formulating conservation management strategy. Similarly, among the total identified individuals, number of adult individuals was significantly higher ($X^2=16.56$, $df=1$, $p=0.000$) than the sub-adult/non-breeding population. Almost equal number of males and females (with non-significant difference; $X^2=0.125$, $df=1$, $p=0.724$) and the greater number of breeding individuals than the sub-adult or non-breeding population suggests a low birth rate of urial population in the area; 66 females of breeding age are assumed to give birth to at least 66 offsprings, whereas only 29 young were observed in all the four locations. The presence of 29 young ones in the area suggests that the population is reproductively active though at a lower ebb. All these findings indicate that the current urial population is facing a pathetic situation in GB, however, it can be sustained if the conservation measures are adopted immediately by the concerned organizations.

Similarly, the number of adult males of class III was significantly higher ($X^2=13.96$, $df=4$, $p=0.007$) than other male classes. Individuals in this class are fully mature and physically strong and hence can survive against several ecological factors. The relative scarcity of adult males in class IV (the oldest individuals), may be due to preferential hunting, more chances of being preyed upon by the predators as well as low chances of survival against different environmental factors, as the oldest animals usually become sick and weak at the last stages of their lives.

In spite of the healthy status of population structure, the Ladakh urial population has declined during the last two decades as inferred by the comparison with the findings of earlier studies. The population of urial did not increase in the area, most probably due to competition with livestock, illegal hunting and other anthropogenic activities in the habitat of urial. Moreover, its known distribution range in Pakistan has now extremely shrunk and fragmented. Consequently, during current study, the presence of these urial could only be confirmed from four localities of GB signifying its extirpation from at least six recently known localities *viz*. district Gilgit, Hunza, Tormik, Domultar and Gorsay of Skardu district (Fig. 2; Schaller, 1977; Hess *et al.*, 1997; Roberts, 1997; Sheikh and Molur, 2004). Roberts (1997) estimated 500-600 Ladakh urial for Baltistan and 700-800 for Gilgit region while Hess *et al.* (1997) recorded around 600 Ladakh urial in Pakistan. A huge pressure of poachers has been reported, especially in winters when the animals are forced by snowfall to descend to lower elevations and come close to villages in search of grazing (Schaller, 1977; Mallon, 1983; Hess *et al.*, 1997; Roberts, 1997). There is a long tradition of hunting in the study area and weapons are used by everyone without any confrontation with law implementing agencies. Hunting of urial by the local community is generally carried out to fulfill their meat requirement. The results of the current study also suggest that the trend of illegal hunting of Ladakh urial is gradually increasing in the study area. This may be due to easy access of the community to modern weapons, poor enforcement of legislation, over population, lack of alternate sport activities, increasing poverty and unemployment and political associations of the local masses which is used to safeguard against any legal actions by the law enforcement agencies. All these factors promote illegal hunting which have already resulted into the complete extermination of these urial from several localities of their historical ranges in Pakistan *e.g.,* Hunza, Chitral and Gilgit districts (Stockley, 1936; Schaller, 1977).

The main occupation of the people in the study area is pastoralism. Livestock rearing is the major source of their livelihood. Most of the livestock are moved to pastures at high altitudes (4500–5000 m) in summer (June-Oct), and brought down to lower pastures around the villages or stall-fed in winter. In some localities *e.g.*, Bunji, round the year grazing of livestock on pastures is available. No effective grazing management system is employed and the entire livestock population is grazed openly in most of the area. Livestock seriously compete with urial for food due to overlapping niches. Besides direct grazing in the field, fodder collection is also a common practice in the area. Local herders cut the smaller branches of trees, especially *Olea ferruginea* and *Pistacia integerrima* for livestock forage during winter months. All pastures and surrounding hills were generally overgrazed beyond their carrying capacities.

Such resource competition with the livestock might be among the main reasons for urial population decline in the area, as the urial remain at comparatively low elevations and share their resources with livestock (Mallon, 1983). Current study suggested a strong negative correlation between the numbers of livestock and direct sighting of urial population ($r=-0.87$) as well as estimated population ($r=-0.88$) in the localities with its distribution. Furthermore, the major portion of livestock population is composed of goats and sheep which directly compete with urial due to similar niches (Fig. 6). Livestock population is increasing day by day, resulting in the continuous decline of the urial population that has been pushed to occupy marginal habitat towards upper elevations where the food is scarce.

Ladakh urial population is facing several threats not only in Pakistan, but also in its distribution range. In Ladakh their population had been reduced to a few hundred individuals in the 1960s and 70s through hunting for trophies and meat collection (Fox *et al.*, 1991; Mallon, 1983; Chundawat and Qureshi, 1999; Namgail, 2009). In the past, the species has been able to co-exist with the predominantly Buddhist Society of Ladakh, however, the recent increase in the population of both humans and their livestock has placed immense pressures on its habitat (Shackleton, 1997; Chundawat and Qureshi, 1999; Raghavan and Bhatnagar, 2003; Valdez, 2008). Besides, in certain areas of Ladakh, these urial often descend to the agricultural fields and damage crops, and retaliation of local farmers may result (Namgail, 2009).

Besides, the anthropogenic causes, densities of these urial often remain very low naturally as their habitat is usually arid and semi-arid with low primary productivity (Shackleton, 1997; Raghavan and Bhatnagar, 2003). The growth of Ladakh urial population is naturally slow because of the paucity of food plants in the habitat. Most of the area supporting habitat of Ladakh urial in the study area is barren with sand, stones and rocks and dispersed vegetation in a very low density.

CONCLUSION

In GB Ladakh urial were recorded from four main localities including 24 locations in Gilgit-Baltistan, with a total observed population of 172 individuals comprising of 24 herds with mean herd size 7.17±3.19 and an overall population density of 1.91 individuals/km^2. The total estimated population of Ladakh urial in GB is ca. 350-450 individuals, the majority of which inhabits Bunji Valley followed by Nanga Parbat and Skardu. Further detailed studies are required to properly monitor these pockets of population with particular emphasis on investigating the root causes of rapid decline.

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Statement of conflict of interest

Authors have declared no conflict of interest.

REFERENCES

Ali, S., 2008. *Conservation and status of Markhor* (Capra falconeri) *in the Northern parts of North West Frontier province, Pakistan*. M.S. thesis, The University of Montana, Missoula, pp. 13.

Anonymous, 1986. *Detail survey report of Wildlife Division Chitral for the year 1985-86*. Mimeographed report.

Awan, G.A., 1998. *Ecology of Punjab urial* (*Ovis vignei punjabiensis*) in the Salt Range, Punjab. M. Phil. thesis, Quaid-i-Azam University, Islamabad Pakistan, pp. 78.

Ayaz, S., Muhibullah, A. A., Jamil, M., Khan, M. A. and Qamar, M.F., 2012. Behaviour and biology of *Ovis orientalis* (Urial) in Kotal Wildlife Park and Borraka Wildlife Sanctuary in Kohat. *J. Anim. Pl. Sci*., **22**: 29-31.

Chundawat, R. and Qureshi, Q., 1999. *Snow leopard intensive management study report*. Wildlife Institute of India.Dehradun.

Fox, J.L., Nurbu, C. and Chundawat, R.S., 1991. The mountain ungulates of Ladakh, India. *Biol. Conserv.*, **58**: 167-190.

Geist, V., 1971. Mountain Sheep. *A study in behavior and ecology*. University of Chicago Press, Chicago.

Hess, R., Bollmann, K., Rasool, G., Chaudhry, A.A., Virk, A.T. and Ahmad, A., 1997. Pakistan. In: the IUCN/SSC Caprinae Specialist Group: *Wild sheep and goats and their relatives* (ed. D.M. Shackleton). Status Survey and Conservation Action Plan for Caprinae. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN, 2015. *Ovis orientalis*. The IUCN redlist of threatened species 2008 (2015.3): e.T15739A5076068. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T15739A5076068.en . Downloaded on 20 October 2015.

Khan, B., 2012. Biodiversity of Gilgit-Baltistan: Potential, challenges and opportunities. *Wildlife of Pakistan*, **1**:18-20.

Khan, M. and Zahler, P., 2004.Status and new records of Ladakh urial (*Ovis orientalis vegnei*) in Northern Pakistan. *Caprinae.*1-3.

Mallon, D.P., 1983. The status of Ladakh urial (*Ovis orientalis vignei*) in Ladakh, India. *Biol. Conserv*., **27**:373-381.

Mallon, D.P., 1991. Status and conservation of large mammals in Ladakh. *Biol. Conserv.*, **56**: 101-119.

Nadler, C.F., Lay, D.M. and Hassinger, J.D., 1971. Cytogenetic analyses of wild sheep populations in northern Iran. *Cytogenetics*, **102**: 137-152.

Nadler, C.F., Hoffmann, R.S. and Woolf, A., 1973. G-band patterns as chromosomal markers, and the interpretation of chromosomal evolution in wild sheep (*Ovis*). *Experientia*, **291**: 117-119.

Namgail, T. 2009. Mountain ungulates of the trans-Himalayan region of Ladakh, India. *Int. J. Wildern.*, **15**:35-40.

Namgail, T., Van Wieren, S.E., Mishra, C. and Prins, H.H.T., 2010. Multi-spatial co-distribution of the endangered Ladakh urial and blue sheep in the arid Trans-Himalayan Mountains. *J. Arid Environ.*, **74:**1162-1169.

Raghavan, B. and Bhatnagar, Y. V. B., 2003. *Rapid survey for the endangered Ladakh urial (Ovis vignei vignei) in Leh District of Ladakh Trans-Himalaya.* Report submitted to the Wildlife Trust of India, New Delhi.

Rasool, G., 1999. In litt. to U. Grimm, 6.09.1999. https://www.cites.org/eng/cop/11/prop/30.pdf. Retrieved on 31-05-2016.

Rezaei, H.R., 2007. *Evolution and taxonomy of the wild species of the Ovis genus* (*Mammalia, Artiodactyla, Bovidae) inferred from a mitochondrial phylogeny*. Ph.D. thesis, University of Joseph, Fourier, pp. 45-68.

Rezaei, H.R., Naderi, S., Chintauan-Marquier, C., Taberlet, P., Virk, A.T., Naghash, H.R., Rioux, D., Kaboli, M. and Pompanon, F., 2010. Evolution and taxonomy of the wild species of the genus *Ovis* (Mammalia, Artiodactyla, Bovidae). *Mol. Phylogenet. Evol.,* **54**: 315–326.

Roberts, T.J., 1977. *Mammals of Pakistan*. London, Ernest Benn, pp. 361.

Roberts, T.J., 1997. *The mammals of Pakistan*. Oxford University Press, Karachi.

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

Schaller, G.B., 1977. *Mountain monarchs: Wild sheep and goats of the Himalayas*. University of Chicago Press, Chicago.

Schaller, G.B., 1979. *Stones of silence: Journeys in the Himalayas*. The University of Chicago Press, Chicago.

Schaller, G.B., and Mirza, Z.B., 1974. On the behaviour of Punjab urial (*Ovis orientalis punjabiensis*). In: *The behavior of ungulates and its relation to management*, (eds. V. Geist and F. Walther), IUCN publications. pp. 306-323.

Schaller, G.B., 1998. *Wildlife of the Tibetan steppe*. University of Chicago Press, Chicago, IL, USA.

Shackleton, D.M., 1997. *Wild sheep and goats and their relatives*: Status survey and conservation action plan. IUCN/SSC Caprinae Specialist Group. IUCN, Switzerland and Cambridge, UK.

Sheikh, K.M. and Molur, S., 2004. *Status and red list of Pakistan's mammals*. Based on the Conservation Assessment and Management Plan. IUCN Pakistan, pp. 312.

Stockley, C.H., 1936. *Stalking in the Himalayas and Northern India*. H. Jenkins, London.

Valdez, R., 2008. *Ovis orientalis*. In: IUCN 2013. *IUCN redlist of threatened species*. Version 2015.3. <www.iucnredlist.org>. Downloaded on 02 20 October 20132015.

Valdez, R., Nadler, C.F. and Bunch, T.D., 1978. Evolution of wild sheep in Iran. *Evolution*, **321**: 56-72.

Virk, A.T., Sheikh, K.M. and Marwat, A.H., 2003. *NASSD background paper*: *Biodiversity*. IUCN Pakistan, Northern Areas Programme, Gilgit. x+74 pp.

Zain, O.F., 2010. A socio-political study of Gilgit-Baltistan Province. *Pakistan J. Soc. Sci.,* **30:**181-190.