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Population dynamics and conservation of Suleiman Markhor *Capra falconeri jerdoni* in Suleiman Mountain Range, Pakistan

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Abstract

Suleiman Markhor *Capra falconeri jerdoni* is an endangered wild goat according to the IUCN Redlist, 2012. Little information on its existing population and its dynamics is known in the eastern Pakistan–Suleiman Mountain Range in particular– since 1996. Suleiman Mountain Range, an extension of Hindukush Range, hosts the population of Suleiman Markhor. We studied the current status of Suleiman Markhor in the Suleiman Mountain range covering an area of 260 Km². Vintage point count surveys were conducted during rut and lambing, 2011 seasons. We also studied the effect of aspect, slope and elevation (6000 to 9,000 & above) on the occurrence of Markhor. The present study resulted in the finding that the number of markhors, based on actual sighting, has declined significantly as compare to those reported in 1996 by WWF-Pakistan. Anthropogenic activities like hunting; poaching; competition of livestock for grazing and forest depletion were the major causes for brining the markhors' population near the verge of extinction. A community-based action plan has been suggested for the conservation of this precious resource and its allied biodiversity.

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Introduction

Markhors are generally found in steppic mountain conditions and where rainfall is low and erratic, and are found between 600-3,600 meter altitudinal ranges (Roberts, 1977). The Suleiman Markhor (*Capra falconeri jerdoni)* occurs in scattered isolated populations on all the major mountain ranges immediately to the north and east of Quetta. Markhor has been classified as Endangered according to IUCN Redlist (2012).

The estimated mature individuals of markhor at global level is < 2,500 and the population trend of markhor is "Decreasing" (Valdez, 2008). Stevens *et al* (2011) recorded the mean group size of markhor in the range of 1.5 ± SD 0.71 in eastern forests of Afghanistan. Schaller (1977) estimated that the total population of markhor in Jammu and Kashmir may be 250—300. According to Roberts (1977) Suleiman Markhor occur in low number and have a limited distribution in Pakistan. He further reported that afghan urial are more widespread and common than the Suleiman Markhor but not abundant. Jhonson (1998) estimated population of 695 Suleiman Markhor in Torghar Hills, Toba Kakar Range of Baluchistan. Frisina, *et al.,* (1998) compared the survey results of markhor at Torghar Hills of Baluchistan conducted in 1994 with those of 1997. He inferred an "upward" trend and indicated +118 percent change between 1994 and 1997. Khan and Siddiqui (2011) recorded 700 Markhors between 2006 and 2009 in three areas: Chiltan, Hazarganji and Karkhasa areas. Ahmad (1983) estimated the total number of Suleiman Markhor to be c. 400 in the Koh-e-Suleiman area. Khan (2006) conducted rut season survey to assess the population status of markhor in Suleiman Mountain range in 2006. According to his survey, the population of markhor at Suleiman Mountain range was 99.

Habitat loss (Schackleton 2001; IUCN, 2000; Arshad *et al*., 2012) due to anthropogenic pressure owing to the limited livelihood options (Ali, 2008), poaching (Woodford *et al.,* 2004; Bhatnagar *et al*., 2009), uncontrolled hunting (Johnson, 1998; Arshad *et al*., 2012) and livestock competition for forage (GoNWFP and IUCN, 2004; Woodford, *et al.,* 2004; Arshad *et al*., 2012) are the major causes of depletion of this precious resource.

Previous study conducted by WWF in 2006 indicated the presence of 99 markhor in Suleiman mountain range. Since then no study had been conducted to determine the status of markhor population. There was a dire need to conduct population monitoring to determine the existing status of Markhor in this part of the country to know the population trend in the area. In addition, the study encompassed to find out the threats faced by markhor in the study area and suggest conservation measures for the community based protection and improvement of population of Markhor.

The project holds lots of potential for the future conservation projects and will be of interest not only to fringe communities and major stakeholders of the resource but also to the wider scientific and conservation community**.**

Material and methods

Study area

Located at 31º – 36' North and from 69º – 59' East, Suleiman Mountain Range is an extension of the Hindu Kush in the Balochistan and Khyber Pakhtunkhwa provinces of Pakistan with altitude varying from 500 to 3350 meters above sea level. (WWF-P, 2006)

The climate of the District is extremely cold in the winter and is pleasant in the summer. June, July and August are months when monsoon rains are received. The annual precipitation is 305 mm while the mean maximum temperature is 27Cºand the mean minimum temperature is 6Cº (Government of Balochistan, 2011).

Two distinct forest types exist in the area are dry temperate forest and sub-tropical broad leaved

evergreen forest (Hussain and Iqbal, 2006). Flora includes *Pinus gerardiana* (Chilghoza), *Pinus wallichiana* (Kail or Nashtar), *Olea ferrugenia* (Showan), *Pistachio cabulica* (Ozgai), *Pistachio khinjuk* (Sharawan), *Prunus eburnean* (Wild Almond), *Peroswskia abrotanoides* (Shinshab), *Salsola foetida* (Lani), *Daphne spp* (Laghunrd), *Acacia modesta* (Phulai), *Artimisia maritime* (Jhau), *Zizyphus nummularia* (Karkanda), *Fraxinus zanthoxyloides* (Shang) and *Monothica buxifolia* (Gurgura).

Markhor (*Capra falconeri*) and Urial (*Ovis orientalis*), the former being of Kabul and Sulaiman varieties, lives a solitary life in the glens and cavities of the mountains. Almost extinct, the Urial used to wander on the lower slopes. The leopard (*Panthera pardus*) is occasionally seen, killing a few goats and sheep, and the Black bear (*Ursus thibetanus*) is found here and there. Significant among the birds are chukar partridge, pigeon, and two types of falcons: Barbary (*Falco peregrinus*) and Eurasian Kestral (*Falco tinnuculus*).(Iqbal, 1999).

Data collection

The primary goal of the survey was to identify the current distribution and the status of markhor in Suleiman Mountain Range and to assess the trend in population in relation to the earlier survey conducted by WWF-P in 2006. The survey was also to identify the key threats to markhor and wildlife in general in the surveyed areas. Markhor survey was conducted using vantage point count method (Jackson and Hunter, 1996; Arshad *et al.*,2012). Animals were observed with the help of binocular and spotting scope during the dusk and dawn. Periodic surveys i.e lambing and rut season were conducted to assess the existing population of markhor. Lambing season survey was conducted from May to July 2011. The Rut season survey was conducted from November to December 2011. Herd size and composition was recorded at each observation point. When the possibility of duplicate counting existed, only the first observation was recorded to minimize error. In addition information such as GPS Coordinates; Vegetation type; Aspect; Slope and Altitude were recorded on specially designed data recording sheets. Animals counted were classified into the following categories (Schaller and Mirza, 1971): Young (<1/2 years), Yearling (1 ½ years), female (yearling + adult), Male (class I, class II, class III, and class IV). For identification of the threats to markhor, Stratified random sampling (Snijders, 2001; Mohanty & Sahu, 2012) was adopted for this research to achieve time and cost efficiencies associated with extensive field. Data was collected on the interview schedule constructed on 5 points likert scale from three categories of respondents: local residents (*n=20*), hunters (*n=20*) and elites of the area (*n=20*).

Statistical analysis

The Data was analysed statistically by using Statistix 8.1 software. Means were compared using t-test and ANNOVA at p=0.05 significance level.

Results

Population status of Capra falconeri jerdoni

Mean group size observed during lambing and rut surveys were 1.833±0.752 and 2.142±1.215 respectively. Female dominated the population followed by Yearling and Male i.e following the pattern: Female>Yearling>Male. Co-efficient of variation for number of markhors observed within each class during lambing and rut season was 88.918% and 130.4% respectively. Mean number of makhors within each class, observed during lambing and rut seasons, were 1.571±1.397 SD and 2.143±2.794 SD respectively (Table 1). The mean number of markhor observed during rut season (*Mean*=1.571, SD=1.397) was not significantly different from the mean number of markhor observed during rut season (two-tailed t (6) = -0.56, *P*=0.5957). Therefore, it is concluded that the no. of markhors observed during rut season (*n*=11) did not differ significantly from those observed during the laming season survey (*n*=15)

Population trend

The rut season survey conducted by WWF-P in the year 2006 resulted in the total of 99 direct sighting of markhors in Suleiman mountain range, while the present survey (rut season) found only 15 markhors covering 28 vintage points in the entire range. This depicts an overall change of -84.84% in the markhor population the area (Table 2). The number of markhor observed during the survey conducted in the year 2006 was significantly higher than the number observed during the present survey (t =3.18, df=16, one-tailed, P=0.0029).

Table 1. No of Age/sex group animals during lambing and rut surveys, 2011.

Season	Sex/Age Group							Total	Mean	SD
	Young (< 1/2 years)	Yearling (1 ½ years)	Females (Yearling + Adult)	Male						
				Class I (2 ½ years)	Class II (3 ½ years)	Class III (4 ½ - 6 ½ years)	Class IV (> 6 ½ years)			
Laming, 2011	4	0	3	1	1	1	1	11	1.571	1.397
Rut, 2011	0	0	8	1	1	3	2	15	2.143	2.794
Total	4	0	11	2	2	4	3	26	1.857	2.095

Two-tailed t =-0.56, df= 6, P=0.5957

Population dyanamics

Effect of aspect

Maximum number of markhors (23% each) was observed each on southern and western aspects followed by north-west aspect that had 19% markhor. 12% markhor were observed each at East, north-east and southwest (Fig 2). There was no significant difference in the number of markhors observed on different aspects i.e western, southern, eastern, northern, north western and south western. (F=0.13, $P>0.05$).

Table 2. Comparison of Survey results of 2011 and 2006.

Year of Survey	Male	Female	Total
2006	42	57	99
2011	7	8	15
Change (%)	-83.83	-85.96	-84.84

t =3.18*, df=16, one-tailed, P=0.0029

Effect of elevation

The maximum number of markhor (31%) were found in the elevation range of 6000-7000 ft (asl) followed by 27% and 23% markhors observed between the elevation range of 7000-8000 ft and 9000 ft & above respectively. The balance 19% of them was seen in the elevation range of 8000-9000 ft elevation (Fig 3). There was no significant difference in the number of markhors observed on different elevation ranges under study (F=0.08, $P>0.05$).

Table 3. Annova Table to evaluate the effects of slope on Markhors occurrence.

Source	DF	SS	MS	F	P
Between slopes	2	13.5833	6.79167	6.41	0.0067
Within slopes	21	22.2500	1.05952		
Total	23	35.8333			

Eefect of slope

For both rut and lambing seasons maximum number of markhor were observed on ≥61% slope (n=17) followed by 31-60% slope (n=6) whereas lowest markhors were recorded on slope 1-30% (n=3). There was significant difference in the number of markhor observed on different slopes (F=6.41, P=0.0067) and

we conclude that slope has an effect on the distribution of markhor in the study area (Table 3). Furthermore, the LSD analysis (Table 4) reveals that steep slope (*Mean*=2.125) has more effect on the distribution of animas than moderate slope (*Mean*=0.75) and gentle slope (*Mean*=0.375). However, there is no significant difference between the means of slope category (1-30%) and (31-60%).

Table 4. Least Significant Difference to evaluate the effects of different slopes on Markhors occurrence.

Variable	Mean	Homogenous Group	Standard Error for Comparison	Critical T Value	Critical Value for Comparison
Slope ≥61%	2.1250	A	0.5147	2.080	1.0703
Slope 31-60%	0.7500	B			
Slope 1-30%	0.3750	B			

Threats to Markhor

The most pronounced threat identified by respondents was hunting of markhor with weighted score of 334 and mean value of 5.57±0.6207 SD and was ranked as 1st. The 2nd, 3rd and 4th standing threats were poaching, livestock grazing and loss of habitat with weighted score of 295, 235 and 203 and means values of 4.91±1.3057 SD, 3.92 ±0.8496 SD and 3.4±1.7476 SD respectively (Table 5).

Discussions

Our lambing and rut season survey indicated the presence of 11 and 15 No. of markhor respectively in the study area. These results were based on actual sighting rather than the estimation. WWF-P in 2006 found 99 markhors, hence a decline of 84.84% in the population of markhor was found after the lapse of five years. The fact that the global population of mature markhor had been estimated to be < 2,500 individuals and the trend is declining (Valdez, 2008) also supports the results of present study.

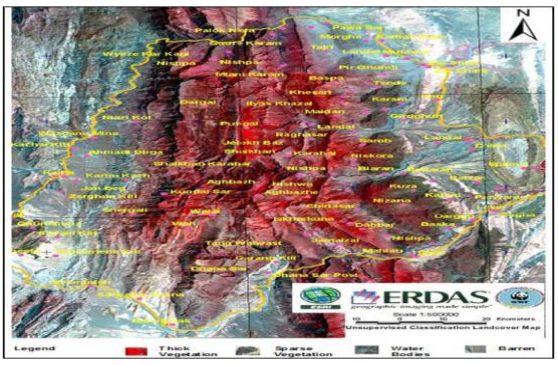

Fig. 1. Map of the study area.

Various authors had investigated the threats to markhor's population. For example, IUCN (2000) reported that habitat loss leads to the extinction of markhor. Similarly, Shackleton (2001) stated that the wild lands are shrinking rapidly due to increase in population and their subsequent increased demand for firewood and timber. Ali (2008) reported that unsustainable use of natural resources by the people lining in and around those areas due to limited livelihood opportunities have led to the depletion of habitat of wildlife and resultantly markhor population is declining in many areas. One of the major threats to markhor is the poaching since nineteenth Century (Burrard, 1925; Lydekker, 1898; Stockley, 1936). Uncontrolled hunting (Johnson, 1998), poaching and livestock competition for grazing the two species, namely Urial and Markhor were threatened of extinction in Torghar Hills of Balochistan (Woodford, *et al*., 2004). Since the goats are in large number and dominant in Chitral, Markhor has to compete with domestic goats for forage (GoNWFP and IUCN, 2004). To sum up, Markhor occurs mainly in highly fragmented populations of relatively small size (100 individuals) that are threatened by habitat loss, uncontrolled poaching, illegal trophy hunting, and forage competition from domestic livestock (Weinberg *et al*., 1997).

During the survey, we interviewed local people, hunters and elites of the area to know the threats to markhor population. The main threats that cause the extinction of markhor in wild are: hunting, poaching, loss of habitat and livestock grazing. The local people particularly Miani tribe of Largha Sherani had been found to enjoy free hunting of markhors primarily for

sports and secondly for meat. Modernization of equipments and ammunition has supported the hunting as hunting is now much easier than in the past. Poaching is another threat faced to the markhor's existence. Poaching of kids is done particularly in lambing season and these kids of markhor are sold to the elites of the down districts of Khyber Pakhtunkhwa at a very high price because wild animals like markhor and cranes are considered as symbol of honour and pride among such people. Chilghoza forest, the principal habitat of markhor, is under tremendous pressure from unsustainable harvesting. The owners of the Sherani tribe mortgage their forests to contractors in lieu of money that ultimately results in heavy loss to this precious natural resource. The local people take their animals in summer to the up-lands Chilghoza forest and other adjoining areas for grazing their animals. Unsustainable livestock grazing practices (*c.* 10,000 livestock heads) has also led to the loss of habitat on one hand and competition for forage with markhor on the other.

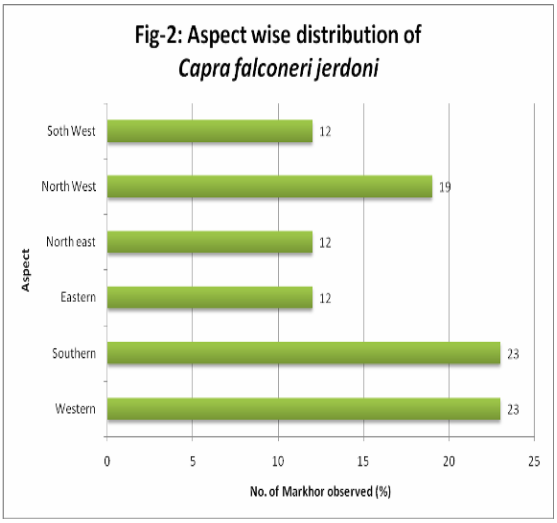

Fig. 2. Aspect wise distribution of *capra falconeri jerdoni*

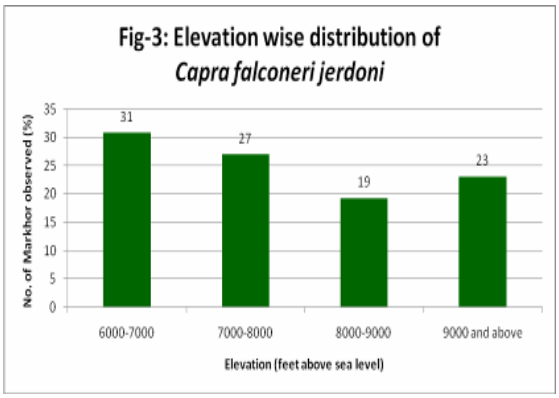

Fig. 3. Elevation wise distribution of *capra falconeri jerdoni.*

Conclusions

It is concluded that the population of Suleiman Markhor *Capra falconeri jerdoni* has declined significantly in comparison to past. This wild goat is at serious risk on extinction from this part of the country. Hunting, poaching, unsustainable livestock grazing practices and habitat destruction are the major threats to markhor. Timely conservation efforts are the need of hour to protect this precious natural resource.

Recommendations

i. Periodic seasonal surveys need to be conducted on regular basis so as to establish population trend of markhor in Suleiman Range;

ii. Capacity of the staff, both professional and para-professional, should be built in survey techniques of markhor and other key wildlife species including data collection, data analysis and report writing. This will ensure in-house capacity and hence they can conduct such surveys and formulate action plans locally and independently;

iii. Markhor population has been successfully managed and conserved in various parts of the country like Chitral and Torghar by involving local communities, NGOs, line departments and other stakeholders. Torghar Model can be successfully replicated in Suleiman Range owing to the fact that

both areas exhibit similar socio-economic and environmental conditions.

iv. Rotational grazing system needs to be put in place so as to avoid competition with markhor and to provide periodic rest to the forage plant communities to regain vigour and growth. The traditional "pargor" system would be a better option in this regard.

v. Alternate livelihood options of the people dependent of Chilghoza forest and its allied biodiversity may be provided. According to research report of WWF-P (2006), Chilghoza nuts can fetch 76% higher revenue as compare to the timber value in a good seed year. Realization of the importance of NTFPs and linking community with market may be a viable option to uplift the socio-economic condition of the community.

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