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POPULATION PARAMETERS OF GREY GORAL (*Naemorhedus goral goral*) AT TWO DIFFERENT SITES IN MACHIARA NATIONAL PARK, AZAD JAMMU AND KASHMIR, PAKISTAN

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ABSTRACT

Grey goral (*Naemorhedus goral goral*) is a bovid mammal species, endemic to Asia; particularly occurs in southern slopes of the Himalayan mountains. This species is nearly threatened and their population is declining day by day due to illegal hunting and habitat loss. The population parameters of Grey goral were examined in Machiara National Park (MNP) by employing direct visual observations of animal, indirect signs such as pellet groups, and secondary information from wildlife staff and herders during 2012 - 2013. The mean population density of Grey goral in Machiara National Park was 2.66 individuals / km². The range of encounter rate (No./Scan) was 0.00 to 2.9. The population of Grey goral in Machiara site was higher (4.57/ km²) than Serli Sacha site (i.e., 0.76/km²). This might be that Grey goral preferred to use Machiara site due to less disturbance and avoided Serli Sacha site due to higher disturbance as a result of livestock grazing, fuel wood collection and other human related activities. A total of 30 goral herds were observed (Machiara=21, Serli Sacha= 9). The minimum herd size was two while maximum herd size was six. Mean herd size was 1.99 animals where larger groups were frequent in less disturbed areas (38%) in contrast to highly disturbed areas (12%). Number of fawns/female was highest during May (1.12) and June (0.71). Based on reported gestation period of Grey goral around six months, it could be concluded that their peak breeding season in MNP is November and December. Major threats to the survival of Grey goral in MNP are habitat degradation (fodder, fuel wood, medicinal herbs collection) and competition with livestock (over grazing). Future conservation efforts for Grey goral in MNP need to focus on protection and securing disturbance-free habitat.

Key words: Population, Group size, Disturbance, Grey goral, Machiara National Park.

INTRODUCTION

Modern conservation practices are highly dependent on the abundance data of a particular species within dwelling habitat, as it provides information about home range, richness and community structure, which helps to formulate conservation and management strategy of that species. Unfortunately, detailed information on home range, population structure and habitat association is lacking, only distributional data i.e., presence or absence is available at national and regional scales which is not useful in conservation decisions (Gaston *et al*. 2000). Investigations into how to predict fine scale species abundances data from coarse-scale presence-absence data have been recently encouraged in conservation biology (Tosh *et al*. 2004).

Grey goral (*Naemorhedus goral goral*) is a bovid mammal species, endemic to Asia particularly occurs in southern slopes of the Himalayan mountains. In Pakistan, this species inhabits the outer foothills of Himalayan Mountains such as Murree foothills (Punjab), Margalla range (Federal Capital Territory), Khyber Pukhtoon Khwa (KPK) province and at elevations of 2150 - 3100 m in Moji Game Reserve (Azad Jammu and Kashmir) (Roberts, 1997).

Grey goral has been listed as Near Threatened in IUCN Red List because its population is continuously declining (Duckworth and Mackinnon, 2008). The reports suggest continuous decline in the populations of this species throughout its global range including Pakistan (Singh and Singh, 1986; Roberts, 1997). However, absence of the species from some of its previously reported range (Himalayas and Hindukush at 800-2,500 m, Murree Hills, Dir, Swat) in Pakistan may suggest a recent contraction in distribution range of this species and hence, an eminent decline in its population during the last century (Abbas, 2006).

Efforts to estimate Grey goral populations in Pakistan have been evolving since 1989. In Margalla Hills National Park, 40-60 individuals of Grey goral were estimated during 1988-89, where 26 individuals were seen at 10 different locations within the park (Anwar and Chapman, 2000). Abbas (2006) reported a Grey goral population of 681 (558-778) individuals in Pakistan, distributed in seven isolated populations and a sizeable population (147-253 individuals) is confined to Azad

Jammu and Kashmir. Two independent studies estimated 60 animals in Salkhala Game Reserve (Saber *et al*. 1999) and 10 animals in Qazinag Game Reserve (Qureshi *et al*. 1999).

Machiara National Park (MNP) falls in distribution range of Grey goral in Azad Jammu and Kashmir which lacks any systematic studies previously conducted on Grey goral population. The effective management of any animal species can be greatly improved by having accurate knowledge of its population distribution and abundance. The present study provides information about population density, distribution pattern and other aspects of Grey goral occurrence in the MNP.

MATERIALS AND METHODS

Study area: Machiara National Park is located in the Great Himalayan chain that branches off from Nanga Parbat, covering an area of 13,532 ha, lying at 34^{O}-31' N latitude and 73^{O}-37' E longitude, between 2000 m – 4700 m elevation (Fig. 1). The Machiara National Park comprises of 11 compartments, we estimated the population of Grey goral in two compartments within MNP, Machiara (34º31.55' N, 73º38.03' E) and Serli Sacha (34º30.04' N, 73º38.47' E). Mean annual rainfall in MNP is 1526.7 mm, with 84.5 rainy days per year. Maximum rainfall occurs in July with a mean of 327.6 mm, while November is the driest month receiving only 35.4 mm (WWF, 2008). Winters are severe with heavy snowfalls while summers are pleasant and cool (GOAJK, 2005). The park encompass diverse topography i.e., deep valleys, high ridges of mountains with moderate to steep slopes, alpine forests, water bodies and pastures.

The MNP contains moist temperate forests and alpine scrub rangeland ecosystems rich in biodiversity (Qamar *et al*. 2008; Dar *et al*. 2012). This national park falls into Western Himalayan Eco-region and is one of the important global eco-region out of 200 eco-regions in the world (WWF, 2008). Conifer tree species include West Himalayan fir (*Abies pindrow*), West Himalayan spruce (*Picea smithiana*), Himalayan cedar (*Cedrus deodara*), Himalayan white pine (*Pinus wallichiana*), chir pine (*Pinus roxburghii*), yew (*Taxus wallichiana*), and junipers (*Juniperus* spp.). Broadleaf species include horse chestnut (*Aesculus indica*), bird cherry (*Prunus* spp), oak (*Quercus incana*), walnut (*Juglans regia*) and Himalayan pear (*Pyrus pashia*) (Ahmed, 1997; Dar *et al*. 2012).

Forty-two mammal species, more than 100 bird species, six species of reptiles and two species of amphibians have been recorded in the park (Hassan, 2004; Baig, 2004).

This national park is inhabited by 30 villages, having 4,654 households or 29,680 people (Dar *et al*., 2009). About 50% of the population depend on agro-pastoral, having 37, 233 livestock heads to fulfill their needs and to generate income (GOAJK, 2005). Villagers keep cows and buffaloes for dairy products, while goats and sheep for meat and wool production (Dar *et al*., 2009).

Distribution range of Grey goral in MNP was identified only in two sites i.e. Machiara and Serli Sacha, by conducting extensive surveys through direct observations of animal, indirect signs such as pellet groups, and secondary information from wildlife staff and herders. For population study, 18 vantage points were selected in two study sites (ten in Machiara and eight in Serli Sacha) within Grey goral habitat. We have selected randomly 18 vantage points because these points covered the scanning views of most study areas i.e. Machiara and Serli Sacha. Key criteria for the selection were accessibility and clear and wider view of the observation area within the catchment at various elevations in both study sites. Each vantage point covered approximately 400 m^2 area. Every vantage point was scanned at least once a month during 2012 and 2013. Grey goral individuals were observed from these 18 vantage points by scanning technique which involves careful scanning of animals from vantage points using spotting scope or binoculars for a specified period of time (Vinod and Sathyakumar, 1999). Prior to field surveys, all vantage points were marked for identification. Surveys were conducted by six team members (two in each vantage point). All team members were extensively trained in point count sampling methodologies and data collection. In order to increase the scanning efficiency, two people scanned independently from two corners of the vantage points. The scanning was done in early morning and late evening hours when animals were more active and duration varied from one to three hours at each vantage point depending on weather conditions. Area of scan at each vantage point was measured on the ground by measuring wheel and also by counting steps. Number of animals seen, their age category (adult and juvenile) and activity patterns were recorded for every sighting (Vinod and Sathyakumar, 1999). Population density of Grey goral was calculated by using the following formula;

$$\mathbf{D = n/A}$$

Where 'n' is the number of animals counted/seen and 'A' is the area covered/scanned (Vinod and Sathyakumar, 1999).

RESULTS

Encounter Rate: Grey goral were observed at 14 out of 18 scanning sites / vantage points where encounter rate varied from 0.0 to 2.9 (Table 1). Encounter Rate was higher during the winter as compared to summer season which was probably due to their congregation in limited available snow free areas for feeding during winter. Encounter rate was naturally higher in less disturbed areas which suggested that Grey goral do respond adversely to disturbance in their habitat.

Population Density: Mean population density of Grey goral in the study area was 2.66 animals / km² i.e., Machiara; 4.57 animals/ km² and Serli Sacha; 0.76 animals/ km² (Table 2). Paired chi-square test showed a significant difference in population density at both sites ($P < 0.05$, $\chi^2 = 19.1$, df=1). A higher population density was recorded during winter season (3.08/ km²) as compared to summer season (2.26/ km²). Encounter rate and population density of Grey goral in the study area showed a positive correlation ($r^2 = 0.97$, $p = 0.000$). These results indicated that Grey goral encounter rate in an area may be taken as an indicator for Grey goral density. Higher population density in some areas (Cheryal, Revri) was probably owing to low human disturbance due to difficult terrain as these sites are characterized by steep slopes and high ridges and Grey goral are reported to prefer steep slopes and avoid gentle areas (Sathyakumar, 1994).

Group size: The mean group size of Grey goral in the study area was 1.99 animals / group. The minimum size of group was two in 30.39 % cases while maximum group size was six in 0.98 % cases. Group size was larger in winter (2.32 animals / group) than in summer (1.67 animals / group). The prevalence of solitary animals was dominant throughout the year (winter-34.69 %, summer-49.05 %). However, Grey goral were seen in groups of two, three, four, five and six at 30.39 %, 17.64 %, 6.86 %, 1.96 % and 0.98 % of occasions, respectively (Fig. 2). Larger groups (five & six) were observed only in winter range which reflects a response to snow cover and limited availability of snow free areas at south facing slopes of the park.

Larger groups of Grey goral were frequent in less disturbed areas (38%) in contrast to highly disturbed areas (12%) (Table 3). In low disturbance areas, larger groups were encountered more frequently in winter (53%) and summer (22%) as compared to high disturbance areas (21% in winter and 4% in summer) (Table 3). A significant difference was found in occurrence of Grey goral in high and low disturbance areas of MNP ($P<0.05$, $\chi^2=6.64$, df=1).

Fawns with adult females were seen from April to August in study area. Number of fawns/female was highest during May (1.12), followed by June (0.71) and April (0.6), which sharply declined in August (0.33). This data is an indicator of lambing season of Grey goral in the study area. Based on reported gestation period of Grey goral around six months, it can be concluded that their peak breeding season in MNP is November and December (Table 4)**.**

DISCUSSION

This study revealed that the population density of Grey goral in MNP is 2.66 animals / km². The range of encounter rate (No./Scan) was 0.00 to 2.9. Earlier, Abbas (2006) reported a Grey goral population density of 0.21 animals/km^2 in its distribution range in Azad Jammu and Kashmir containing both poor and good quality habitat. The population density recorded by Abbas (2006) was much lower, probably because he did not include MNP in his study. In MNP, population density was higher at Machiara as compared to Serli Sacha which could probably be due to relatively lower disturbance by humans and their livestock in the former. Extensive livestock grazing in Grey goral habitat in Serli Sacha has affected forage availability and quality, unlikely to support its healthy population (Fankhauser, 2004).

Present data showed that Grey gorals were predominantly solitary in existence in MNP (Winter=69 %, Summer=49.05 %). We mostly observed Grey goral solitary in study area where disturbance by livestock grazing pressure and wood cutting were high. Probably because smaller group size could reflect decline in predation risk or resource distribution (Duckworth and Mackinnon, 2008). Small body size, high metabolic rate and selective feeding are the reasons that would favor a solitary life for goral (Pendharkar, 1993). Earlier reports by Anwar and Chapman (2000a) also supported solitary occurrence of Grey goral (42%) as compared to pairs or groups of 3-4 animals (42%) in Margalla Hills National Park, Pakistan. However, Pendharkar and Goyal (1995) reported that males are largely solitary interacting with female groups only during the rut. The juveniles with female were observed during April. Consequently, on the basis of earlier reported gestation period of Grey goral (170-218 days) (Mead, 1989), we speculate that rutting season in MNP starts during November.

Group size of Grey goral population in MNP ranged from 1 to 6 individuals with an average size of 1.99 animals per group. The larger groups seem to reflect a response to snow cover but it might also be an anti-predation strategy. In open areas, animals presumably use each other as cover in an environment otherwise lacking cover (Barrette, 1991). Anwar and Chapman (2000a) suggested that increasing group size in Grey goral gradually increases the sense of security and hence, is associated with a decreasing trend of proportion of time spent in surveillance, i.e. 66.7 % when living as single, 36.1 % as pairs, 44.4 % in group of three, and 25 % in group of four. This led them to propose that animals in larger groups can feed more efficiently than those in smaller groups. Likewise, Abbas (2006) also reported a group size from 1-7 in Pakistan where it was smaller in winters than summers. However, Sathyakumar (1994) recorded no significant seasonal variations in group sizes in Kedarnath Wildlife Sanctuary, India.

During the present study, larger groups were encountered in less disturbed areas during summer and winter range. This might be that Grey goral break into smaller foraging groups due to heavy grazing and other

biotic pressures (livestock grazing, wood collection and grass cutting). The quantity and quality of forage might be lower in heavily disturbed areas and become less suitable to support larger groups of goral. Poor economical condition of local people living around MNP forces them to meet their needs for fuel wood and fodder from the Park area either by direct grazing of their livestock or by grass cutting and as a result, wildlife suffers due to habitat degradation by natural resource limitation. Furthermore, it has been reported that livestock reduces the habitat resources through interspecific competition (Fankhauser, 2004). Livestock usually have an advantage over their wild competitors, as herd densities of livestock are often greater than wild ungulates and aditionaly livestock is usually released to the best grazing grounds, resulting in competitively displacing wild herbivores. The findings of this study are in line to the findings of Vinod and Sathyakumar (1999) in Western Himalaya where they detected larger groups in less disturbed areas of the sanctuary during all seasons of the year.

Fawn/female ratio in the study area indicated that young are born in April and May which has also been reported by Mead (1989) that young in goral are born during April - May and stay with the mother for about one year. These results also fall close to the observation of Roberts (1997) who reported rutting season of Grey goral in November - December in Pakistan. During spring season mostly one female with one fawn were observed in MNP, which indicated that young are born in spring when vegetation is abundant. Earlier, Abbas (2006) reported the fawn/ female ratio as 0.50 during spring in Pakistan. Present data also supported the hypothesis that in Grey goral single offspring are more frequent and twin births are very rare (Roberts, 1997). On the basis of the observation of one female with one fawn during spring season in MNP, we speculate that single births in Grey goral are dominant. After birth, young ones follow their mother up to 4 - 5 months for weaning (Duckworth and Mackinnon, 2008).

Suggested conservation measures: Park administration must be strengthened financially as well as by increasing protection staff, enabling them to protect and monitor wildlife populations efficiently through better communication network. Research studies should be conducted regularly to monitor Grey goral population. An urgent need is felt to increase awareness among local people and involve them in conservation process by providing suitable incentives, alternate resources and means of income.

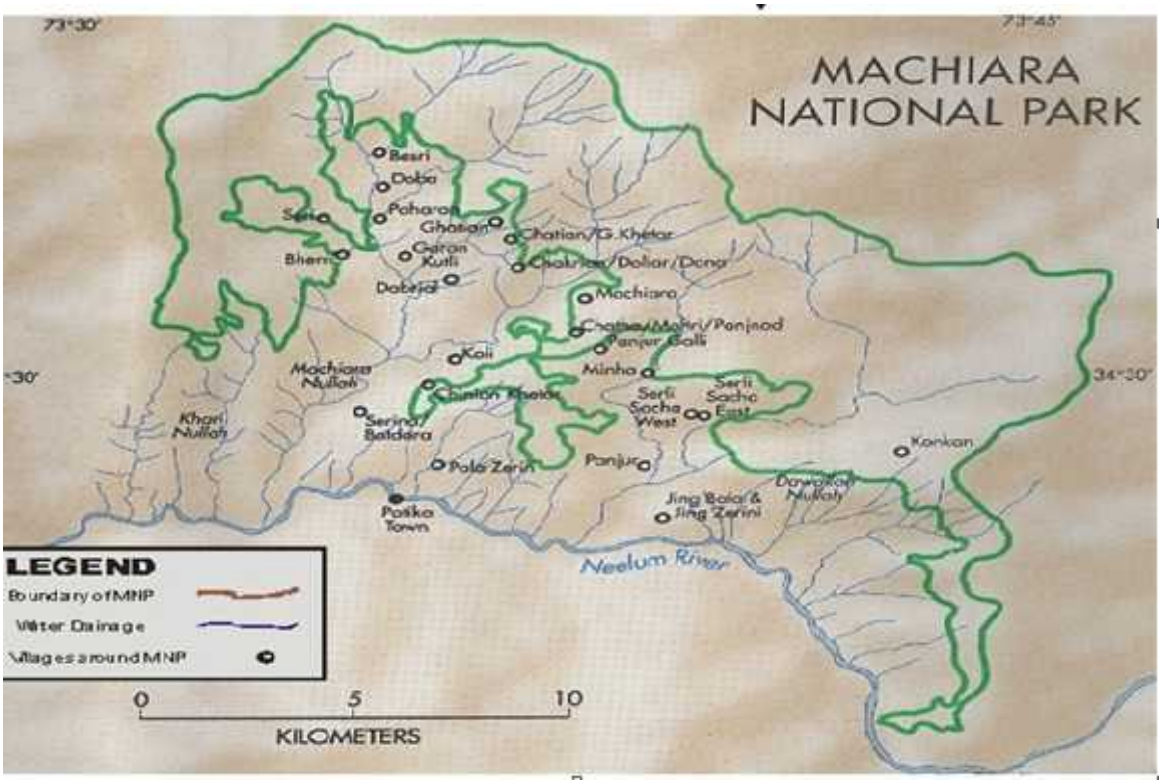

Figure 1. Map of study area indicating Machiara National Park

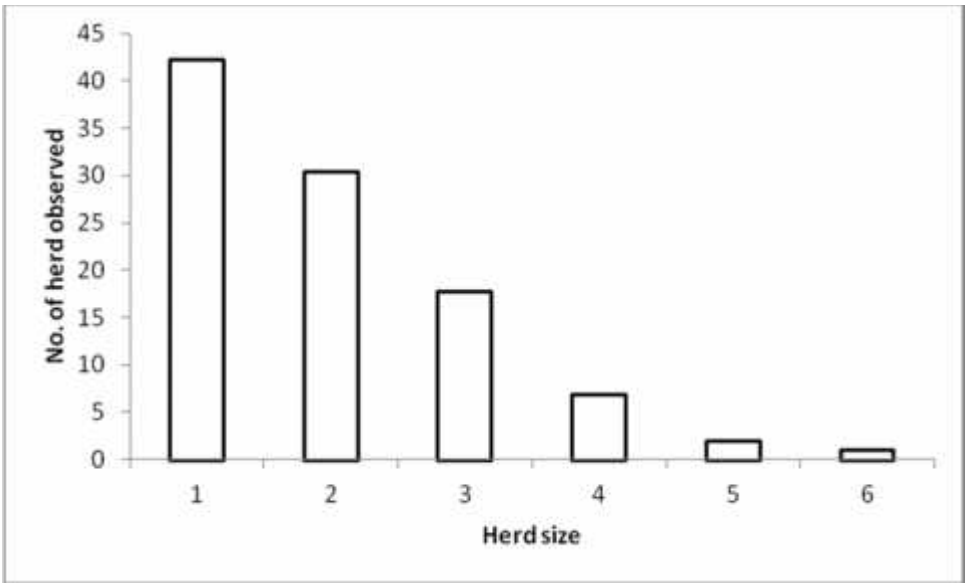

Figure 2. Frequency of Grey goral herd size in Machiara National Park

Table 1. Characteristics of Scanning Areas and Encounter Rate (animals/scan) of Grey goral in Machiara National Park.

Scanning area /vantage point	Coordinates		Extent of human use	Encounter rate
Chukolni	34,31.197 N	073,31.181 E	Moderate	1.3
Cheryal	34,31.741	073,38.842	Low	2.9
Mali	34,31.809	073,38.201	Moderate	1.4
Revri	34,32.549	073,37.408	Low	2.3
Baknari	34,31.162	073,38.269	Moderate	1.1
Kahrachi	34,31.131	073,24.481	Low	2
Domail	34,31.436	73,38.257	Low	1.5
Harbomlan	34,30.752	073,37.871	High	1
Khtahra	34,31.539	073,37.921	High	1.2
Gali	34,30.562	073,33.351	High	1.1
Chitta Kashkar	34,31.617	73,39.657	High	1.9
Dapper	34,31.80	073,39.558	High	1.4
Sabru	34,30.841	073,41.281	Moderate	1.3
Ranga	34,30.541	073,39.116	High	0.9
Buchian Gali	34,30.441	073,40.611	Moderate	0.0
Kai	34,30.147	73,38.493	High	0.0
Taryan	34,30.036	73,38.474	Moderate	0.0
Nalla	34,30.200	73,38.402	High	0.0

Table 2. Population Density of Grey goral in Machiara National Park during 2012-2013

	Population Density (animals / km²)		
Study Sites	**Winter**	**Summer**	**Overall**
Machiara	5.27	3.88	4.57
Serli Sacha	0.89	0.64	0.76
Overall	3.08	2.26	2.66

Table 3. Negative relationship between group size of Grey goral and disturbance in the study area

Season	Level of disturbance	Groups observed	Group size		
			1	2	≥3
Winter	High	19	10	5	4
	Low	30	7	7	16
Summer	High	22	16	5	1
	Low	31	10	14	7
Overall	High	41	17	10	5
	Low	61	26	21	23

Table 4. Changes in number of fawns per female in Grey goral population during different months of 2012-2013.

Month	Female	Fawn	Fawn/Female
March	8	-	-
April	13	9	0.6
May	16	18	1.12
June	7	5	0.71
August	3	1	0.33
September	2	-	-
October	2	-	-
November	5	-	-
December	1	-	-

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REFERENCES

Abbas, F. (2006). A study on Ecobiology of Grey Goral *(Naemorhedus goral)* with reference to Pakistan. (Unpublished) Ph. D. Thesis. University of the Punjab, Lahore, Pakistan. 179 pp.

Ahmed, I. (1997). Draft Report of Machiara National Park, Muzaffarabad, Azad Jammu and Kashmir. WWF, Pakistan.

Anwar, M. and J. A. Chapman (2000a). Group composition and daily activities of grey goral (*Nemorhaedus goral*) in the Margalla Hills National Park. Pakistan J. Agri. Res., 16(1):68-71.

Anwar, M. and J. A. Chapman (2000b). Distribution and population status of grey goral (*Nemorhaedus goral*) in the Margalla Hills National Park. Pakistan J. Agri. Res., 16(2):147-150.

Baig, K. J. (2004). Progress Report, Compilation of Baseline Data for Zoological and Wildlife Studies in Machiara National Park. Department of Wildlife and Fisheries, Government of Azad Jammu and Kashmir, 78 pp.

Dar, M. E. U. I., R. Cochard, R. P. Shrestha and S. Ahmad (2012). Plant resource utilization by local inhabitants around Machiara National Park, Azad Kashmir, Pakistan. J. Food, Agri. Envir., 10 (3&4): 1139 -1148.

Dar, N. I., R. A. Minhas, Q. Zaman and M. Linkie (2009). Predicting the patterns, perceptions and causes of human–carnivore conflict in and around Machiara National Park, Pakistan. Biol. Conserv., 10**:** 2076-2082.

Duckworth, J. W. and J. Mackinnon (2008). *Naemorhedus goral*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.1.

Fankhauser, R. (2004). Competition between domestic and wild ungulates: Do sheep affect habitat use of Chamois. Ph. D. Thesis. Lic. Phil. Nat., University of Berne.

Gaston, K. J. and T. M. Blackburn (2000). Pattern and process in macroecology. Oxford: Blackwell Science.

Gaston, K. J., T. M. Blackburn, J. J. D. Greenwood, R. D. Gregory, R. M. Quinn and J. H. Lawton (2000). Abundance-occupancy relationships. J. Appl. Ecol., 37: 39–59.

GOAJK. (2005). Revised management plan Machiara National Park. Department of Wildlife and Fisheries, Government of Azad Jammu and Kashmir, Muzaffarabad, 138 pp.

Hassan, S. A. (2004). Compilation of Baseline Data for Ornithological studies in Machiara National Park, AJK. PAMP.

Mead, J. I. (1989). *Naemorhedus goral.* Mammalian Species. 335: 1-5.

Pendharkar, A. P. (1993). Habitat use, Group size and activity pattern of goral (*Nemorhaedus goral*) in Simbalbara Wildlife Sanctuary (Himachal Pradesh) and Darpur Reserved Forest (Haryana), India. M. Sc. Thesis, Saurashtra University, Rajkot. 60 pp.

Pendharkar, A. P. and S. P. Goyal (1995). Group size and composition of the grey goral in Simbalbara Sanctuary and Darpur Reserved Forest, India. J. Mammal., 76(3): 906-911.

Qamar, Q. Z., M. Anwar and R. A. Minhas (2008). Distribution and Population Status of Himalayan Musk Deer (*Moschus chrysogaster*) in the Machiara National Park, Azad Kashmir. Pakistan J. Zool., 40(3) 159-163.

Qureshi, M. A., M. S. Awan and M. Anwar (1999). Status of major wildlife species in Qazinag Game Reserve, Azad Kashmir. Proc. Pakistan Congr. Zool., 19: 103-113.

Roberts, T. J. (1997). Mammals of Pakistan. Revised edition. Oxford University Press, Karachi, Pakistan, 525 pp.

Sathyakumar, S. (1994). Habitat ecology of major ungulates in Kedarnath Musk Deer Sanctuary, Western Himalaya. Ph.D. thesis, Saurashtra University, Rajkhot. 242 pp.

Saber, M., M. S. Awan and M. Anwar (1999). Status of major wildlife species and their management in Salkhala Game Reserve Neelum Valley, Muzaffarabad (Azad Kashmir). Proc. Pakistan Congr. Zool., 19: 233-243.

Singh, S. P. and J. S. Singh (1986). Structure and function of the central Himalayan oak forests. J. Plant Sci., 96: 159-189.

Tosh, C. A., B. Reyers and A. S. V. Jaarsveld (2004). Estimating the abundances of large herbivores in Kruger National Park using presence–absence data. Anim. Cons., 7: 55–61.

Vinod, T. R. and S. Sathyakumar (1999). Ecology and Conservation of Mountain Ungulates in Great Himalayan National Park, Western Himalaya. FREEP-GHNP Research Project. Wildlife Institute of India, 93 pp.

WWF. (2008). Boundary Demarcation and Renotification of Protected Areas Project. GIS Laboratory WWF- Pakistan. p. 1-38.