

Full Length Research Paper

Estimation of blue sheep population parameters in the Dhorpatan Hunting Reserve, Nepal

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Blue sheep (*Pseudois nayaur*) are the main prey species of snow leopards (*Uncia uncia*) and are a highly coveted species in Nepal. Currently, the conservation of blue sheep in Nepal is a national concern because it is not clear if populations were affected by the Maoist insurgency beginning in 1996. For this study, we estimated population parameters for blue sheep in the Dhorpatan Hunting Reserve and compared these estimates to studies conducted pre-insurgency. We found that the number (206 sheep) and density (1.8 sheep/km) of sheep in the Barse and Phagune Blocks (study area) have not changed since 1993 and 1976, respectively. A mean of 7 animals/herd from 29 herds were classified by sex. The mean sex ratio was higher for 2006 and 2008 counts (4.82 males/female, SD = 2.52) than pre-insurgency counts (0.82 males/female, SD = 0.06) however there was no significant difference between sex ratios. The proportion of ewes in the population was lower than a 2006 count, but similar to pre-insurgency counts. Population age structure was less variable in 2008 than previous counts. More young rams and fewer ewes were counted since 2006, which may have been due to misclassification of females and/or less poaching pressure on young males. Recent hunting pressure by insurgents may have reduced ewe population numbers, and as a result, lambs numbers.

Key words: Blue sheep, Dhorpatan Hunting Reserve, herd size, population density, population size, *Pseudois nayaur*, sex ratio.

INTRODUCTION

Blue sheep (*Pseudois nayaur*) are the main prey species of snow leopards (*Panthera unca*) in the high altitude biomes of Eurasia and their presence is often an indicator of snow leopards occupancy (Oli et al., 1993). Since blue sheep are the main prey species of snow leopards and other predators in the Himalayas, blue sheep conservation is currently a priority in Nepal.

Estimating blue sheep population parameters and determining causes of mortality are imperative for the proper management of blue sheep, snow leopard, and other carnivore populations in Nepal. Although 10,000 blue sheep were estimated to live in Nepal (Shackleton, 1997; Wegge and Oli, 1997), little is currently known about their populations.

Historically, blue sheep have been harvested in the Dhorpatan hunting reserve (DHR), an international hunting hotspot for those seeking to kill a trophy animal in the Himalaya Range (Wegge 1976; FAO 1980). Each year, the government of Nepal authorizes a blue sheep harvest however it is currently unknown if the harvests are sustainable.

Due to political instability over the recent years (1996-2007 Maoist insurgency period) the DHR went unprotected. The field office moved to the city creating more opportunity for poaching blue sheep as well as other species in the DHR. In order to evaluate the impact this political strife had on the blue sheep population in the DHR, a comparative study was conducted. Specifically, we estimated the abundance, density, herd size, sex ratio, and age structure of blue sheep in the DHR and compared our results to past studies: Wegge (1976), Austegard and Haugland (1993), and Karki and Thapa (2006).

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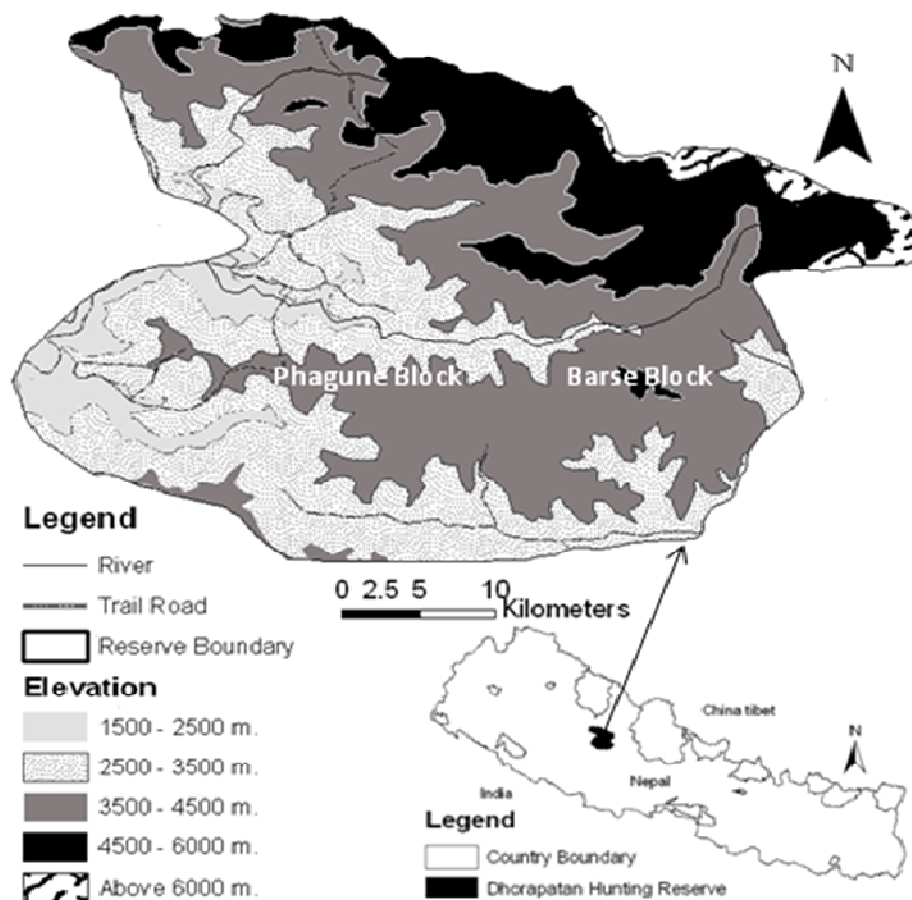


Figure 1. Study area (Barse and Phagune Blocks) in the Dhorpatan hunting reserve.

MATERIALS AND METHODS

Study area

The Dhorpatan hunting reserve is located in the Baglung District in the Dhaulagiri Himalaya of western Nepal (23°30'N-28°50'N, 82°50'E-83°15'E; Figure 1). The Reserve is divided into 7 blocks, covering 1,325 km², and ranges from 2,850 to 5,500 m in altitude (Wegge, 1979). The Phagune and Barse Blocks (study area) cover 265 km² of the Reserve (Figure 1) and are assumed to have high poaching pressure because they are easily accessible. Currently, blue sheep occupy only 115 km² of the study area because they do not use forested (50%) or rugged alpine habitats (25%) (Wegge, 1979). The DHR is located in front of a high saddle connecting the high Dhaulagiri and Hiuchuli and is shielded by several pasturelands south of Utter Ganga. As a result, the study area receives less precipitation than others areas of the Nepal Midlands (Stainton, 1972).

The DHR is characterized by a diversity of plant species. Vegetation found in the drier climatic belt to the north as well as species from the humid zone to the south are represented in the study area. Falling in a transition zone, the dry northern elements are more pronounced at higher altitudes and on southeast aspects. Shaded riparian habitats at low elevation are composed of well-developed mixed hardwood stands made of fir (*Abies spectabilis*) and hemlock (*Tsuga dumosa*), while birch (*Betula utilis*) and rhododendron (*Rhododendron campanulatum*) cover the upper northern slopes to tree line (3,050-3,660 m). The southern slopes

(3,500-2,440 m) are comprised of a wide belt of sparse oak forest (*Quercus semecarpifolia*), interspersed with isolated blue pine (*Pinus excelsa*) and rhododendron (*Rhododendron arboreum*) (Wegge, 1976).

In addition to blue sheep and snow leopards, a variety of other ungulates and carnivores inhabit the Reserve: ungulates include, goral (*Nemorhaedus goral*), Himalayan tahr (*Hemitragus jemlahicus*), wild boar (*Sus scrofa*), Himalayan musk deer (*Moschus chrysogaster*), serow (*Capricornis sumatraensis*) and Indian muntjac (*Muntiacus muntjak*); and carnivores include, leopards (*Panthera pardus*), lynx (*Felis lynx*), wild dog (*Cuon alpinus*), red fox (*Vulpes vulpes*), and wolf (*Canis lupus*). In addition, omnivorous Asian black bears (*Ursus thibetanus*) inhabit forested areas in the DHR and red pandas (*Ailurus fulgens*) are reported in the upper forests of the Lower Seng and Upper Bakre Valleys (Wegge, 1976; Fox, 1985) where they primarily feed on bamboo (*Bambuseae*).

Survey methods

Blue sheep were surveyed using the 'Fixed-Point Count Method' (Jackson et al., 1996; Karki and Thapa, 2006; Schaller, 1973; Wegge, 1976). Population counts were conducted from April – May 2008 using binoculars (8–42 X) and a spotting scope (15–45X). Surveys were conducted from high vantage points along ridgelines in the morning more when animals were likely to be feeding and before viewing was restricted by fog, and in the late afternoon. Blue sheep were classified by sex and separated into the following age

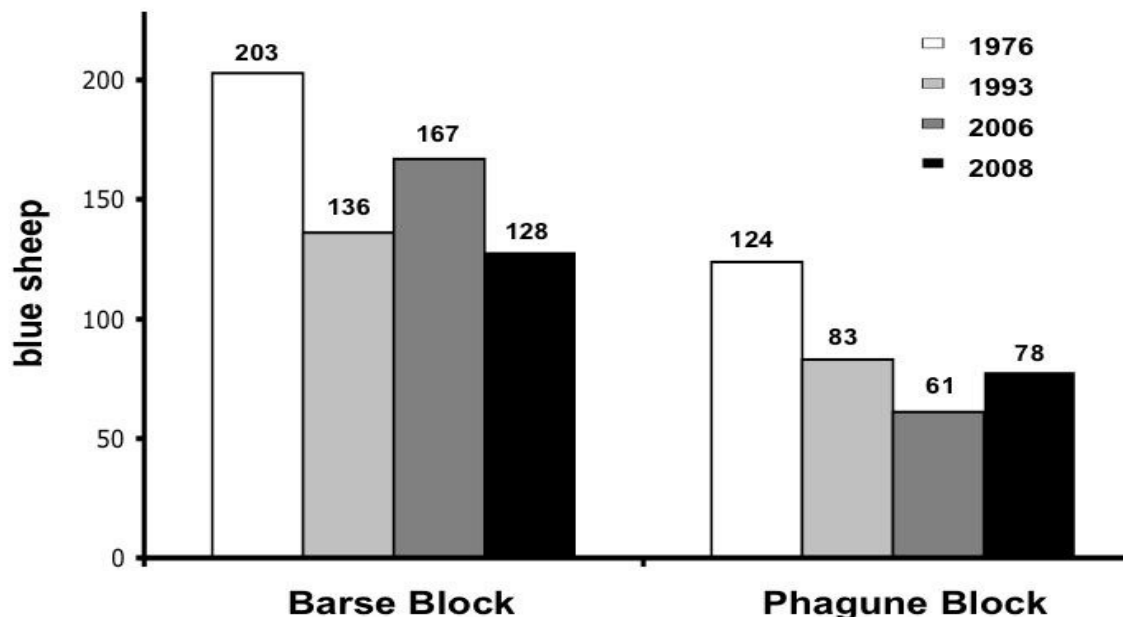


Figure 2. Blue sheep counts in the Barse and Phagune blocks of the DHR, 2008.

Table 1. Blue sheep counts by sex in each block (Sex Ratio = males/female).

Area	Phagune 1976	Barse 1976	Total 1976	Phagune 1993	Barse 1993	Total 1993	Phagune 2006	Barse 2006	Total 2006	Phagune 2008	Barse 2008	Total 2008
Rams	55	88	143	34	67	101	46	152	198	54	101	155
Ewes	69	115	184	49	69	118	15	15	30	24	27	51
Total	124	203	327	83	136	219	61	167	228	78	128	206
Sex ratio	0.80	0.77	0.78	0.69	0.97	0.86	3.06	10.13	6.60	2.25	3.74	3.04

classes according to Wegge (1976): lambs, yearlings, ewes, and rams (Class I: 15-35 cm horns, 2-3 yrs; Class II: 30-45 cm horns that curve backward, 4-7 yrs; Class III: 45+ cm horns curved, 7+ yrs). We used Student's t-test to determine if parameter estimates were significantly different between blocks and a Pearson's chi-square test to compare studies. Significance for all tests was determined using $\alpha = 0.05$.

RESULTS

Population size and density

After correcting for double counts, we counted 128 and 78 blue sheep in the Barse and Phagune Blocks, respectively ($N = 206$). Although population counts were significantly different ($\chi^2 = 37.59$, $p < 0.05$, $df = 3$), the total population ($\chi^2 = 1.12$, $p = 0.57$, $df = 2$) and number of sheep counted between blocks (Barse: $\chi^2 = 5.91$, $p > 0.5$, $df = 2$; Phagune: $\chi^2 = 3.59$, $p = 0.17$, $df = 2$) have not changed since 1993. Historically, there were more sheep in the Barse Block ($t = 3.32$, $p = 0.02$) (Figure 2).

We estimated population density at 1.8 blue sheep/km²

(206 blue sheep/115 km²), while Wegge (1976), Austegard and Haugland (1993), and Karki and Thapa (2006) reported 2, 2.3, and 1.4 blue sheep/km², respectively. There was no significant change to population density during the last 4 decades ($\chi^2 = 0.23$, $p = 0.97$, $df = 3$).

Heard size

A mean of 7 animals/herd from 29 herds ($SD = 5.5$, range = 1-37) were classified by sex. There was no significant difference in average herd size in each block (Barse: $\chi^2 = 2.06$, $p > 0.05$, $df = 11$; Phagune: $\chi^2 = 4.31$, $p > 0.05$, $df = 8$).

Sex ratio

The sex ratio in 2008 was 2.25 males/female and 3.74 males/female in Phagune and Barse Blocks, respectively (Table 1). These ratios were lower than 2006, but higher than the pre-insurgency counts. Sex ratios are

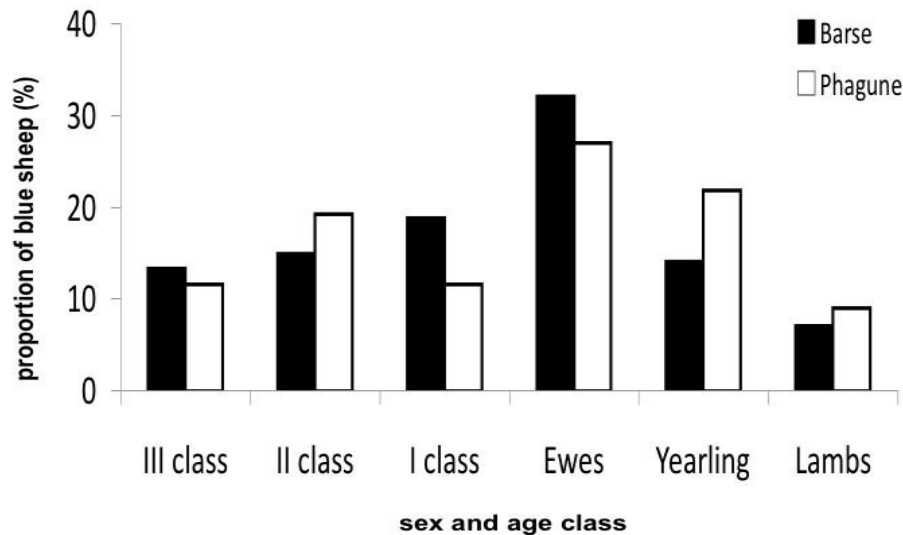


Figure 3. Estimated proportions of blue sheep by sex and age in each block of the study area, 2008.

significantly different throughout years ($\chi^2 = 15.77$, $p = 0.001$ $df = 3$) however the average sex ratio since 2006 (mean = 4.82, SD = 2.52) was not higher than pre-insurgency counts (mean = 0.82, SD = 0.06; $t = 2.25$, $p = 0.27$).

Population age structure

Evidence suggests the population age structure in 2008 was less variable than previous records. Although ewes were counted in the highest proportion (30%) in 2008 (Figure 3), and this has historically been the case in the study area (Figure 4), ewes were more abundant during pre-insurgency counts. The proportions of trophy rams (Class III) and ewes have declined since 2006, but were similar to pre-insurgency counts (rams: $\chi^2 = 5.25$, $p = 0.07$, $df = 2$; ewes: $\chi^2 = 0.06$, $p = 0.97$, $df = 2$) (Figure 4).

The proportion of lambs was significantly different among counts ($\chi^2 = 22.02$, $p < 0$, $df = 3$) (Figure 4), and besides Karki and Thapa ($n = 7$) (2006), we counted fewer lambs ($n = 16$) than previous studies. The proportions of class I and II rams were higher than previous studies, but not significantly different (Class I: $\chi^2 = 5.27$, $p = 0.15$, $df = 3$; Class II: $\chi^2 = 2.8$, $p = 0.42$, $df = 3$) (Figure 4).

DISCUSSION

Population numbers declined after 1976 and have remained relatively constant since 1993 (Table 1). The recent increase in the proportion of sub-adult rams (Figure 4) may be related to a reduction in poaching

since the insurgency period however this increase is not significant and poaching data is incomplete. Another potential explanation for this increase is that livestock depredations have caused herders to poison blue sheep predators (e.g. wolves and leopards). We note that wild boar (*Sus scrofa*), were observed above tree line, suggesting recent predator loss in the DHR.

The variation in heard size may have been due to human presence, predation, or our survey coinciding with the breeding season. In addition, herd sizes may have been influenced by the distribution and quality of forage because patchy, poor quality vegetation cannot support large herds (Wilson, 1981).

Legal harvest of trophy rams in the early 1970s may have influenced our sex ratio estimates (Table 1). The low ratio of males to females in Phagune and Barse historically may have also resulted from poaching or selective hunting (Wegge, 1979) however the government's hunting quota has been historically low.

Although ewe proportions have remained relatively constant throughout the years, female counts have declined this may have been due to females being misclassified in the field as young males.

Local people preferentially hunt large males because they yield larger quantities of meat and their behavioural characteristics make them easier to hunt (Wegge, 1979). Local people complained that since the DHR headquarters moved in 2001, more illegal hunting has occurred in the DHR. They also mentioned that during the insurgency period, the DHR, especially the Barse and Phagune blocks, were the main shelter for Maoist rebels. Hunting pressure by insurgents may have had an additive effect on ewes, thus decreasing their numbers as well as lambs counted during recent surveys. Reports indicate livestock herders may have also responsible for illegal



Figure 4. Estimated proportions of blue sheep by sex and age in the study area over the past 30+ years.

hunting during summer months as well as during winter months near villages.

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