



## Research Article

## Is trophy hunting of bharal (blue sheep) and Himalayan tahr contributing to their conservation in Nepal?

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### Abstract

Dhorpatan Hunting Reserve (DHR), the only hunting reserve in Nepal, is famous for trophy hunting of bharal or “blue sheep” (*Pseudois nayaur*) and Himalayan tahr (*Hemitragus jemlahicus*). Although trophy hunting has been occurring in DHR since 1987, its ecological consequences are poorly known. We assessed the ecological consequences of bharal and Himalayan tahr hunting in DHR, and estimated the economic contribution of hunting to the government and local communities based on the revenue data. The bharal population increased significantly from 1990 to 2011, but the sex ratio became skewed from male-biased (129 Male:100 Female) in 1990 to female-biased (82 Male:100 Female) in 2011. Similarly, a recent survey of Himalayan tahr showed that there was a total population of 285 tahr with a sex ratio of 60 Male: 100 Female. Bharal and Himalayan tahr trophy hunting has generated economic benefits through generation of local employment and direct income of \$364072 during the last five years. Government revenue collected from 2007-08 to 2011-12 totalled \$184372. Male-focused trophy hunting as practiced in DHR may not be an ecologically sustainable practice, because its effect on the sex ratio that lead to negative consequences for the genetic structure of the population in the long term. Therefore, the population dynamics and sex ratios of the bharal and tahr must be considered while setting harvest quotas.

## Introduction

Dhorpatan Hunting Reserve (DHR), gazetted in 1987, is the only hunting reserve in Nepal (Fig. 1). Since the establishment of DHR, species such as bharal or “blue sheep” (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), barking deer (*Muntiacus muntjak*), and wild boar (*Sus scrofa*) have been hunted for trophies and game meat. Among the hunted species, the bharal and the tahr are the main targets of international trophy hunters (Karki and Thapa, 2007; Aryal et al., 2010). The bharal, which was the first preferred species for hunting in DHR, is listed as “least concern” in the IUCN Red list of threatened species (Harris, 2014). By contrast, the tahr, the second most prioritised hunting species, is listed as “near threatened” in the IUCN Red list of threatened species (Bhatnagar and Lovari, 2008).

The Government of Nepal generates national revenue through selling hunting permits, and locally hunting creates employment opportunities. The collected revenue is used for management activities of the DHR and redistributed to DHR buffer zone communities for socio-economic development (DNPWC, 2012).

Trophy hunting as a means to generate revenue for species conservation as well as a source of local income has also been practised in other regions of world (e.g., Bond et al., 2004; Leader-Williams and Hutton, 2005; Leader-Williams et al., 2005). However, the potential conservation benefits of trophy hunting are debatable and often controversial.

One potential negative consequence of selective harvesting of trophy males is that it could change the sex ratio of the population leaving disproportionately more females than males (Milner et al., 2007). A skewed sex ratio may create long-term problems for the maintenance of genetic diversity and population health of species. Selective hunting could also cause species decline and possible local extirpation (e.g., Tuytens and MacDonald, 2000; Frank and Woodroffe, 2001; Harris et al., 2002; Coltman et al., 2003; Adams, 2004; Lindsey et al., 2007; Caro et al., 2009).

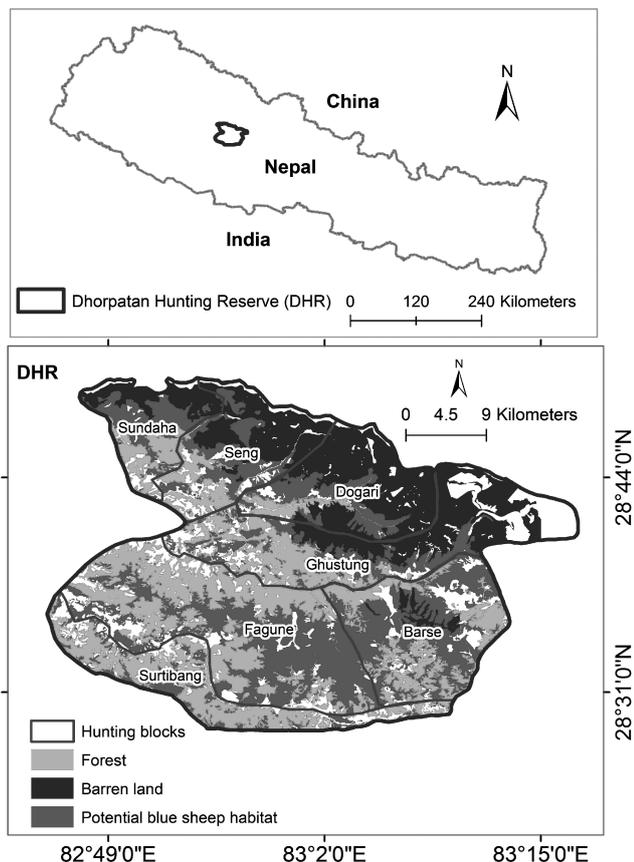
In DHR trophy hunting that targets male bharal started in 1987 and is still ongoing. Trophy hunting quotas should be “expert-based” (Baldus and Cauldwell, 2004; Baldus, 2006; Caro et al., 2009), but in DHR they have been based on scientifically unfounded guesses by the DHR management that often ignores information obtained from field surveys. For example, both in 2007 (Karki and Thapa, 2007) and in 2011 (Kandel et al., 2011), field surveys were conducted to obtain population estimates of bharal and tahr, but the hunting quotas for those years were not based on those estimates.

For trophy hunting to be ecologically sustainable, regular monitoring of population dynamics is required, and scientifically-based harvest quotas to minimize the impacts on population dynamics and trophy quality should be adopted (Caro et al., 2009). In this context, we addressed the question of whether existing trophy hunting practices in DHR were contributing to the conservation of the bharal and tahr. To answer that question, we evaluated the impact of trophy hunting on population size and sex ratio of the bharal and the tahr in the DHR.

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We also quantified the revenues generated from hunting permits and assessed how this revenue was used in various sectors.



**Figure 1** – Location of Dhorpatan Hunting Reserve (DHR) within Nepal (top figure) and land use, potential habitat for blue sheep (bharal) and hunting block within the reserve (bottom figure).

### Materials and methods

The study was conducted in Dhorpatan Hunting Reserve, the only hunting reserve in Nepal (Fig. 1). For ease of hunting, the total area of the reserve (i.e. 1325 km<sup>2</sup>) has been divided into seven blocks: Sundaha, Seng, Dogadi, Ghustung, Fagune, Barse and Surtibang (Fig. 1). The reserve lies between 2000 and 7246 m altitude and is covered by forest at lower elevations and grassland at elevations above the tree line (Kandel et al., 2011). The dominant trees at higher elevation were fir (*Abies spectabilis*), birch (*Betula utilis*) and rhododendron (*Rhododendron campanulatum*), and at lower elevations oak (*Quercus semecarpifolia*), blue pine (*Pinus excelsa*) and rhododendron (*Rhododendron arboretum*) (Aryal et al., 2010; Kandel et al., 2011). Although DHR is famous for blue sheep and Himalayan tahr, the hunted species, there are many other mammal species such as goral (*Nemorhaedus goral*), wild boar (*Sus scrofa*), Himalayan musk deer (*Moschus chrysogaster*) serow (*Capricornis sumatraensis*) and Indian muntjac (*Muntiacus muntjak*), leopard (*Panthera pardus*), lynx (*Felis lynx*), wild dog (*Cuon alpinus*), red fox (*Vulpes vulpes*), wolf (*Canis lupus*) and red panda (*Ailurus fulgens*) (Aryal et al., 2010; Panthi et al., 2012; Aryal et al., 2015).

This study was based on secondary information collected from official data sourced from the Government of Nepal. We extracted data on annual numbers of bharal and tahr hunted and revenues collected by the government for the period between 2007–08 and 2011–12 from various sources such as records and reports of the DHR office and the Department of National Park and Wildlife Conservation (DNPWC), Nepal (Bajimaya et al., 1990; Karki and Thapa, 2007; Kandel et al., 2011). The secondary data were collected during several visits to the DHR in the last five years. In addition, we visited four villages of the

DHR and recorded primary information on the income accrued by local people from the activities related to hunting in DHR and assessed how the revenue gathered by local people had been used locally. We combined the revenues collected under the authority of the Department of National Park and Wildlife Conservation (DNPWC) and the income of local communities and analysed the trend of revenue collection and associated hunting statistics for both bharal and tahr in DHR in last five years.

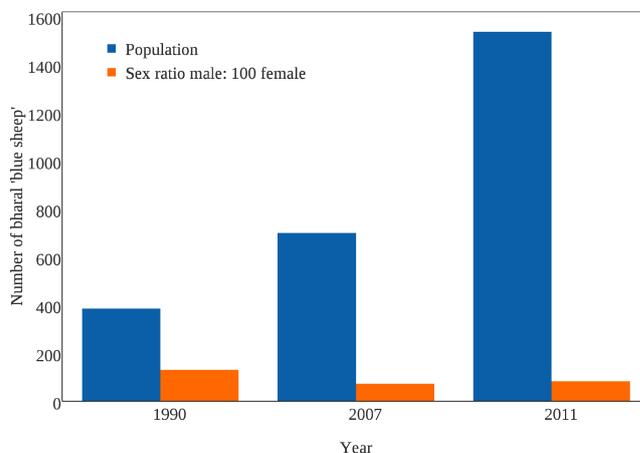
We also calculated population trends, hunting statistics and sex ratios of bharal and tahr using data from past studies (Bajimaya et al., 1990; Karki and Thapa, 2007; Kandel et al., 2011). The surveys conducted in these studies were based on the direct observation method, using vantage point counts, in each block of DHR (Fig. 1). The method is widely used for counting blue sheep and tahr populations (Karki and Thapa, 2007; Aryal et al., 2010; Kandel et al., 2011; Karki and Thapa, 2011; Aryal et al., 2014). With this method, the number of animals encountered, total herd numbers, sex composition, and age classes were counted using powerful binoculars (10×45 to 8×40). Furthermore, hunted rams were classified through direct observation into three categories such as trophy ram, medium ram and young ram and other categories as ewes, yearlings and lambs (Karki and Thapa, 2007; Aryal et al., 2010; Karki and Thapa, 2011). The sex ratio was calculated by dividing number of males by the number of females and reported as number of males per 100 females (Aryal et al., 2010). We analysed the trends of population size, sex ratios and past hunting numbers to examine the ecological impacts of trophy hunting.

### Results

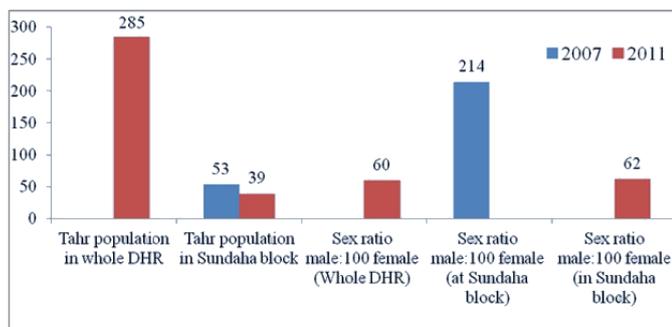
#### Population size of bharal and tahr in DHR (1990–2011)

The bharal population in DHR has increased significantly from about 400 in 1990 to over 1500 in 2011 ( $\chi^2=1.03$ ;  $df=2$ ;  $P=0.042$ ) (Fig. 2). However, the sex ratio in the same period has significantly decreased from 129 males to 100 females in 1990 to 82 males to 100 females in 2011 ( $\chi^2=1.74$ ;  $df=2$ ;  $P=0.036$ ) (Fig. 2). The maximum increase in the bharal population occurred in the period from the year 2008 to 2011.

There were no records of systematic surveys available for population size of the Himalayan tahr despite being the second preferred hunting species in DHR. The most recent survey data available for this species (year 2011) reported 285 tahr in the reserve with a sex ratio of 60 males:100 females (Fig. 3). To compare this value with the survey in 2007, conducted only in the hunting block of Sundaha, we broke down the 2011 figures according to hunting blocks (39 tahr with a sex ratio of 62 males:100 females in 2011 vs 53 tahr with a sex ratio of 214 males:100 females in 2007; Fig. 3). It showed that the sex ratio is highly skewed with a decreased number of males.



**Figure 2** – Population size and sex ratio for bharal “blue sheep” from 1990 to 2011 in Dhorpatan Hunting Reserve (Source: Bajimaya et al., 1990; Karki and Thapa, 2007; Kandel et al., 2011).



**Figure 3** – Himalayan tahr population size and sex-ratio in 2011 (Kandel et al., 2011) and 2006 (Karki and Thapa, 2007) in DHR. In 2011, there were detailed population counts for Himalayan tahr for the whole DHR (i.e., in all blocks) while in 2006, the survey was conducted only at the Sundaha block of DHR.

### Assessment of revenue and local income generated by trophy hunting

Two types of revenue have been generated through trophy hunting in DHR: (1) the revenue collected by DNPWC, a government body; and (2) money collected by the local communities from successful hunters. The money accrued by the local communities is not substantiated on a legal basis, and the figures are not known to government authorities. Each community has set its own local rules for charging hunters and there is no fixed rate across them: the charge can vary from 65000 to 150000 Nepalese rupees (\$867–2000) for a bharal and from 40000 to 100000 Nepalese rupees (\$533–1333) for a Himalayan tahr. Local communities used the money collected for community development activities. For example, in Ranmaikot VDC, the money funded the salary of a school teacher in the local school, upgrading facilities of the local health post, and constructing trails. In Bobong VDC, the money was used to establish a community lodge and maintain a bridge whereas in Gurjakhani VDC, it was used to assist a small hydroelectricity project. During our discussion with local community members, it was revealed that local communities have not used the money for conservation programs and community members expressed their concern that local elites might have misused the funds.

Government revenue collected from 2007-08 to 2011-12 totalled \$184372, with the maximum revenue collected in 2011–12 (\$84627). Government revenue has significantly increased from 2007–08 to 2011–12 ( $\chi^2=1.7$ ,  $df=4$ ;  $p=0.045$ ) (Tab. 1). Similarly, the revenue obtained by local communities increased significantly ( $\chi^2=2.4$ ,  $df=4$ ,  $p=0.032$ ) (Tab. 1). In total, the trophy hunting of bharal and tahr has generated \$364072 over the past five years (Tab. 1).

**Table 1** – Bharal “blue sheep” and Himalayan tahr harvest numbers and revenue generated in DHR, 2007 to 2012.

Fiscal year	Number Harvested		Revenue Generated (in \$)	
	Bharal	Tahr	Government	Local community (average)
2011/12	25	13	84627	51317
2010/11	19	17	27077	45883
2009/10	22	8	33991	41833
2008/09	17	10	34857	36017
2007/08	3	0	3820	4650
<b>Total</b>	<b>86</b>	<b>48</b>	<b>184372</b>	<b>179700</b>

### Discussion

Trophy hunting programs exist in many countries and can provide a long-term economic benefit to national governments and local communities without causing population declines or extinction if they can be managed sustainably (Bond et al., 2004; Leader-Williams and Hut-

ton, 2005; Leader-Williams et al., 2005). However, uncontrolled or poorly managed trophy hunting can lead to population declines and even extinction as in the cases of the quagga (*Equus quagga*) and blue buck (*Hippotragus leucophaeus*) in Africa, Argali sheep in Kyrgyzstan and elephant (*Loxodonta africana*) in Tanzania (Adams, 2004; Rouget, 2004; Lindsey et al., 2007). Overhunting can also lead to changes in sex ratios and phenotypes, and decreases in reproductive success leading to population decline (Bailey et al., 1986; Tuytens and MacDonald, 2000; Frank and Woodroffe, 2001; Harris et al., 2002; Coltman et al., 2003; Caro et al., 2009).

The population of bharal in DHR has been increasing rapidly after 2008 suggesting that rapid population growth after 2008 was due to the active presence of DHR staff in the field, which likely reduced illegal activities (poaching) inside DHR. Conversely, the presence of DHR staff during the insurgency period in Nepal (between 1996 and 2006) was almost negligible due to political instability. Despite the population increase after 2008, the sex ratio of bharal was observed to be skewed toward females. This is mainly due to the over harvesting of males, relative to the female population which is not hunted. While it could be argued that this might not be a problem in a polygynous species like the bharal, it could have long-term genetic consequences if hunters systematically remove dominant males as reported for the big-horn sheep (*Ovis canadensis*; Coltman et al., 2003).

Himalayan tahr was another species targeted for trophy hunting in DHR. Although it is less sought after by trophy hunters than the bharal, trophy hunting of the species continues. Since the Government of Nepal has shifted its focus to bharal hunting, population surveys of tahr are conducted only periodically. Also for tahr, the number of males has declined significantly compared to females. However, it is unknown what the causal factors are for the change in the sex-ratio. It could be due to errors in the surveys or higher number of poaching of male tahr in the region.

Through trophy hunting in DHR, two revenue collection mechanisms have been practiced, one by local people and one by the government in parallel. This has created not only confusion among hunters but also left “illegal” activities unregulated. Therefore, Government should either monitor and legalize the arbitrary revenue collected by local people by establishing a buffer zone management committee and allow them to collect revenue officially or the Government should revise revenue by incorporating the amount charged from local communities and provide a fraction of it to the local community. A precedent exists in Pakistan, where the trophy hunting system of markhor (*Capra falconeri*) has been operating for many decades apparently without harming the target species (Bellon, 2008). The Pakistani government allocated 80% of revenue collected from each hunt to the local community. This incentivised the local communities to preserve viable populations of targeted species, which in turn has discouraged poaching and other illegal activities. To estimate hunting quotas, official counts of fully adult males, young adults, subadults, females and lambs should be carried out annually. Applying best practices developed elsewhere to trophy hunting of the bharal and tahr in Nepal could be beneficial for DHR and support local people and species conservation together. Currently, none of these best practices were evident in DHR.

Since the carrying capacity of the DHR has not been determined, a sustainable harvest quota is as yet unknown. Considering the lack of baseline information, we first recommend that trophy harvest quotas should be estimated conservatively. Secondly, the population should be monitored every 2 to 3 years to document any changes in population size, sex ratios, and productivity. Thirdly, additional research on population productivity, influence of predators such as the common leopard (*Panthera pardus*), snow leopard (*Panthera uncia*) and wolf (*Canis lupus*), prevalence of diseases, and condition of habitats and forage availability need to be carried out to understand ecological interactions including feeding ecology of the hunted species/prey in DHR.

In conclusion, bharal and tahr trophy hunting in DHR have generated significant economic benefits to the government and local communities. However, the current harvest level may not be sustainable as it might have prompted a skewed sex ratio that might be detrimental to

the long-term viability of the population. Further studies on the carrying capacity of the DHR and interactions of bharal, tahr and their predators are necessary in order to design scientifically sound hunting quotas that are ecologically sustainable for bharal and tahr. ☞

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