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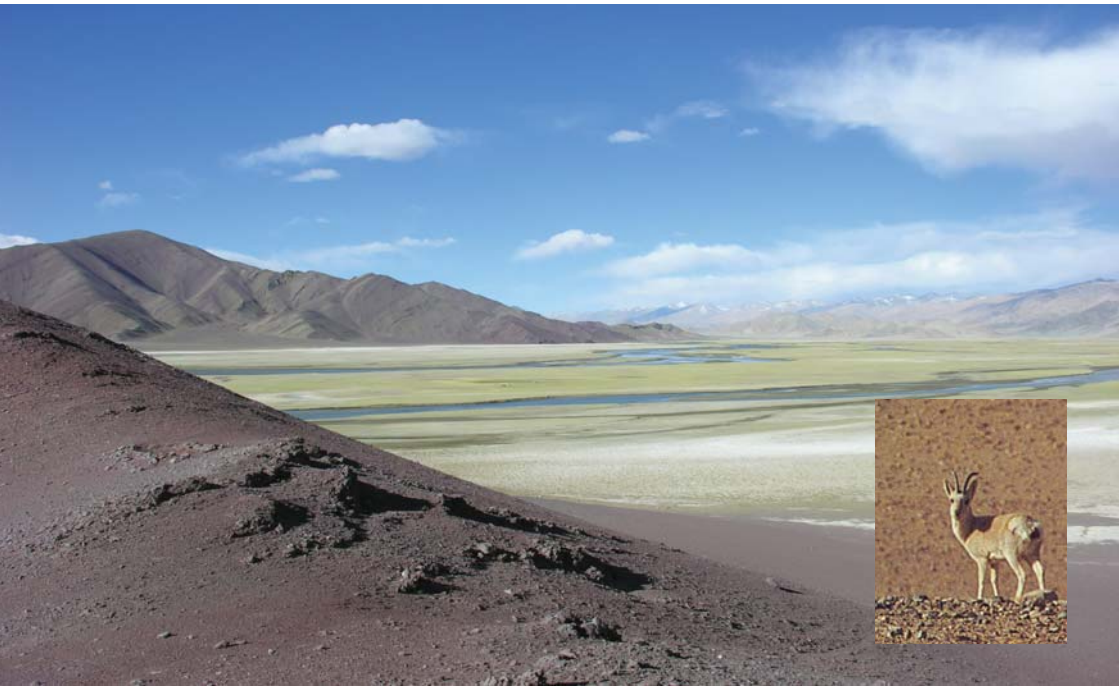
Conserving the Tibetan Gazelle



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International Snow Leopard Trust
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nature conservation foundation

Conserving the Tibetan Gazelle in the Ladakh Trans-Himalaya

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Executive Summary

The Tibetan gazelle *Procapra picticaudata* (*Bovidae*, sub-family *Antilopinae*, tribe *Antilopini*) is endemic to the Tibetan plateau. Within Indian limits, the gazelle has been reported from eastern Ladakh and Sikkim. It had a relatively wide historical distribution, occurring over most of the Tibetan plateau. The species inhabits open plains and rolling mountain slopes, and is partial to relatively mesic sites on the otherwise arid Tibetan plateau. The ecology of the gazelle remains poorly understood. In Ladakh, the gazelles share their habitat with nomadic *Changpa* herders in Ladakh who primarily herd *Changra* goats for their valued *pashmina* or cashmere, along with sheep, yak and horses for a living.

Our surveys covering the gazelle's entire historical range in Ladakh established that the species has undergone a drastic decline in its range from over 20,000 sq km to < 100 sq km since the early 1900's. The gazelle's population today numbers < 50 in Ladakh, with bulk of them being confined to the Kalak Tartar plateau of the Hanle Valley. In this report, we synthesize the results of our recent studies on the ecology of the Tibetan gazelle and the grazing practices and socio-economy of the *Changpa* who use the gazelle's habitat. Based on these studies, we outline a strategy for a species recovery programme.

We found that the gazelle populations did not recover even after hunting was significantly brought down by the region's wildlife department. Increased livestock grazing pressures in the gazelle's habitat (due to influx of Tibetan refugees, loss of access to traditional pastures, as well as the high demand for *pashmina*) has presumably prevented the gazelle's recovery and is precipitating further declines. We also found evidence for mortality of gazelle's during severe winters.

Our studies confirmed that the small surviving gazelle population in fact occurs in a small 30-40 sq km area that receives relatively lower grazing pressure due to lack of drinking water for the nomads and their herds during much of the year. Ecological attributes of patches selected by gazelles were compared with adjoining non-gazelle areas to identify the main factors determining habitat-choice.

Measurements of plant production using exclosures revealed that while in the non-gazelle habitat, domestic goat and sheep removed up to 47 % of the forage biomass, only 29% was removed in the gazelle areas. Although areas selected by gazelles were only marginally more productive than non-gazelle areas, the proportional representation of forbs in plant biomass was significantly higher in the former. Spatial co-occurrence patterns examined using null models revealed a significant inverse relationship between distribution of gazelles and goat-sheep, while they tended to co-occur with wild kiang *Equus kiang* and domestic yak *Bos grunniens.*

Since out-competition by the increasing livestock herds appears to be the primary threat to the species we discussed these findings with the local nomads and the Wildlife Department officials to outline strategies for the gazelle's population recovery in Ladakh. This strategy includes immediate short-term actions that will reduce competition with livestock in Kalak Tartar and result in habitat improvement. A set of long-term objectives and actions that will secure the future of the gazelle in Ladakh is also outlined.

1. The Tibetan Gazelle in Ladakh: An Introduction

Introduction

The Tibetan gazelle *Procapra picticaudata* (*Bovidae*, sub-family *Antilopinae*, tribe *Antilopini*) is endemic to the Tibetan plateau. It has had a relatively wide historical distribution, occurring in most of the Tibetan plateau from the Sichuan and Gansu provinces in the east, Xinjiang province to the north, Greater Himalaya in the south, and the Changthang region of Ladakh in the west. The species inhabits open plains and rolling mountain slopes, and is partial to relatively mesic sites on the otherwise arid Tibetan plateau. The ecology of the gazelle remains poorly understood, with only two studies till date that report its status and distribution in Tibet, and preliminary observations on its diet (Harris and Miller 1995, Schaller 1998).

Within Indian limits, the gazelle has been reported from eastern Ladakh and Sikkim (Fox *et al* 1991, Shah 1994). Eastern Ladakh is an extension of the Tibetan Plateau and is characterized by high altitude plateaus (> 4,200m) and rolling slopes interspersed with lake basins. The vegetation includes open alpine steppe communities with medium to sparse vegetation cover (c. 15 %). Vegetation is usually grass dominated, and the biomass rarely exceeds 15 g m-2 (Schaller 1998; data from adjoining sites in Tibet). The growth season is limited to three to four months (June – September) and temperature regularly falls below – 30° C during the long winters. Until recent surveys were undertaken in Ladakh (Bhatnagar *et al* 2006), the Tibetan gazelle was not a species of priority conservation concern, even though it was listed under the Schedule I of the Indian Wildlife (Protection) Act 1972 (Anon. 1992).

Decline of the Tibetan gazelle in Ladakh

The gazelle was relatively common in eastern Ladakh during the early 20th century when it occurred over much of the c. 20,000 sq km Changthang region (Burrard 1925, Stockley 1936; Fig 1). However, by 1980-90, its range had been reduced to c. 1000 sq km (Fox *et al* 1991). This range reduction and

population declines are believed to have been caused by hunting through most of the last century (Fox *et al* 1991). By 1980, due to the efforts of the states' wildlife department, although hunting was brought under control, the gazelle populations did not recover (Chundawat & Qureshi 1999).

Our range-wide surveys of the gazelle in 2000 could confirm the occurrence of the species only in the Hanle Valley (Bhatnagar *et al* 2006). We found that the two populations that were reported (Fox *et al* 1991, Shah 1996) along the upper Indus valley near Dungti and Tso Kar in the 1980s have gone extinct in the past decade. Enquiries with herders and army personnel did suggest the presence of a hitherto unreported small population near Chumur and Chushul (Fig. 1), but this remains to be confirmed. Our present estimate of the gazelle's range in Ladakh is not more than 100 sq km (Bhatnagar *et al* 2006).

Semi-structured surveys with nomads

Our subsequent intensive observations on the gazelle population in the Hanle Valley (79.01249°E, 32.62485°N; c. 2,800 sq km; Fig. 1) in the late winters of 2001 and 2003 yielded an estimate of c. 30 gazelle in the Kalak Tartar (KTT) plateau of Hanle. This small population is, in fact, the single largest surviving population of the gazelle in Ladakh. We also sighted 6 gazelles (2 males, 2 females and 2 young) in 2001 in the Rique plains of the Hanle Valley (Bhatnagar et al 2006). Herders reckoned that this constituted the entire gazelle population in the area. In 2003, we could locate only 5 individuals. The herders also reported a small population (3-4) near Zarsar until c. 5 years ago (Fig. 1), which is now believed extinct. Thus, we estimated that the Hanle valley may have c. 40 gazelle surviving over an area of 50-80 sq km of KTT and the Rique plains, and including the possibility of some animals in Chushul and Chumur areas, our estimate of the present gazelle population in entire Ladakh is c. 50 over a range of less than 100 sq km (Bhatnagar *et al* 2006). Entire populations have been lost, while others are declining. For instance, the KTT population, which we estimated at c. 30 animals, numbered at least 68 individuals in 1997 (Pfisher 2004), and at least 36 seen in one group in 1998 (Chundawat and Qureshi 1999).

Causes for the gazelle's decline in Ladakh

Throughout the last century the Tibetan gazelle was a common victim of hunting (Mallon & Kingswood 2001). Even early authors such as Burrard (1925) commented on the decline of the gazelle in Ladakh due to excessive hunting. During the 1960's, large contingents of the Indian Army and paramilitary forces moved into eastern Ladakh. According to the elders in the herding communities, the gazelle was commonly hunted by the army as the animals could be easily approached on vehicles. Hunting pressure perhaps escalated further with the influx of Tibetan refugees, some of whom admitted to hunting gazelles in the past.

Hunting was brought under control by the 1980's due to better implementation and awareness of conservation laws. Yet, the gazelle populations continued to decline. This is perhaps to be expected, as small populations are more vulnerable to extinction due to stochastic events, and demographic and genetic causes (Soule 1987, Korn 1994). Additionally, excessive livestock grazing in its habitat seems to have played a significant role in preventing the recovery of the gazelle in Ladakh (Bhatnagar *et al* 2006).

The project

It became clear through our earlier work that the Tibetan gazelle was on the brink of local extinction in Ladakh, and conservation efforts were needed to stabilize and increase its population. Before a conservation plan could be drawn, the species needed some scientific research. In 2004, the Rufford Foundation came forward to support our work on trying to understand the ecology of the gazelle, so that its future in Ladakh could be safeguarded. In 2005, the Whitley Fund for Nature joined hands with our efforts. The Department of Wildlife Protection, Jammu & Kashmir, facilitated the work. Our main objectives were:

1. Studying the ecology and habitat use of the little known Tibetan gazelle
2. Assessing whether gazelle faces competition from livestock
3. Developing an understanding of the pastoral society, livestock grazing practices and land use changes in Hanle
4. Initiating steps to assist in the recovery of the gazelle population of Hanle Valley.
5. Spreading awareness and the need to conserve the Tibetan gazelle, on the brink of local extinction in Ladakh.

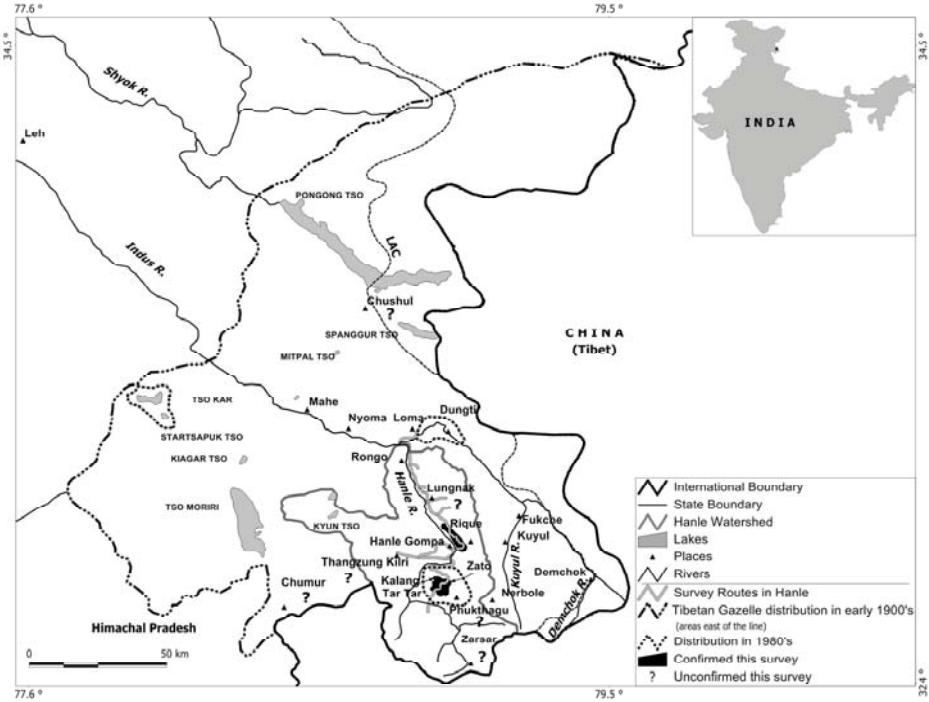
To meet the project objectives, we conducted field work through different seasons in 2004 and 2005 to gather information on gazelle ecology and develop

links with the local community. We subsequently held consultations with the local wildlife department on 22 August 2006 through a day-long workshop to appraise them of our findings and get their inputs to develop a specific management plan for gazelle recovery in Ladakh (Appendix 2). We then jointly approached the community in Hanle on 24 August 2006 to brief them on the project findings and obtain their inputs into the plan and participation in the implementation (Appendix 3).

The report

The following sections of this report summarize our findings, as well as outline a conservation plan for preventing the gazelle's imminent extinction in Ladakh, and for facilitating its population recovery. Chapter 2 details our findings of the ecology of the gazelle, and its relationships with sympatric livestock and wild herbivores in Hanle. We try to answer questions regarding the causes of gazelle decline in Ladakh and the persistence of a small population in Hanle. Chapter 3 is a detailed account of the local community, its landuse patterns, grazing practices, and recent socioeconomic changes it is undergoing. Chapters 2 and 3 set up the ecological and socioeconomic contexts, based on which, a conservation plan is outlined in Chapter 4

Figure 1. The past and present distribution of the Tibetan gazelle in Ladakh



2: Factors Affecting Distribution of the Tibetan Gazelle in Ladakh

Tsewang Namgail, Sumanta Bagchi, Charudutt Mishra and Yash Veer Bhatnagar

Abstract

An understanding of the factors that determine the distribution and habitat-choice of endangered species is critical for conservation planning. The Tibetan gazelle *Procapra picticaudata* is on the verge of extinction in India with less than 50 individuals left in the Hanle valley of eastern Ladakh, and the initiation of a recovery program is hindered by lack of ecological information on the species. We assessed biotic and abiotic correlates of its occurrence in the Hanle valley. Ecological attributes of patches selected by gazelles were compared with adjoining non-gazelle areas to identify the main factors determining habitat-choice. Resource selection functions revealed that gazelles use south-facing and avoid north facing slopes during summer, while they tend to avoid north facing slopes during winter. They select high elevation areas during both summer and winter compared to valley bottoms. They are restricted to areas with relatively low livestock grazing pressures. Measurements of plant production using exclosures revealed that while in the non-gazelle habitat, domestic goat and sheep removed up to 47 % of the forage biomass, only 29% was removed in the gazelle areas. Although areas selected by gazelles were only marginally more productive than non-gazelle areas, the proportional representation of forbs in plant biomass was significantly higher in the former. Spatial co-occurrence patterns examined using null models revealed a significant inverse relationship between distribution of gazelles and goat-sheep, while they tended to co-occur with wild kiang Equus kiang and domestic yak *Bos grunniens*. Future *in situ* recovery programs for the gazelle need to focus on acquiring forb-dominated areas and freeing them of livestock grazing through dialogue and participatory conservation programs involving the local pastoral community.

Keywords Competition, extinction, gazelle, livestock, Monte Carlo simulation, pastoralism, Ladakh, Trans-Himalaya.

Introduction

Understanding factors that influence distribution and abundance of species is a fundamental theme in ecology (Andrewartha & Birch 1954). These factors or

determinants of niche-space operate in a hierarchical manner, ranging in scale from microsites to broad climatic regimes (e.g. Forman 1964). Factors influencing habitat choice by animals, or selection of various interspersed vegetation patches, have received considerable research attention and their understanding at these 'intermediate' scales have assisted conservation planning for metapopulation persistence and reserve-design (Rosenzweig 1981, Doak *et al* 1992, Lindenmayer 2000). In this paper, we examine the factors that influence habitat choice by the last surviving populations of Tibetan gazelle *Procapra picticaudata* in India. These data are relevant to developing much needed *in situ* recovery programs for the species (Bhatnagar *et al* 2006).

Mammalian herbivores are important components of many terrestrial ecosystems (Frank *et al* 1998; Olff *et al* 2002), and human interventions are causing extinctions and/or major changes in composition of herbivore-assemblages across the world. With the intensification of pastoralism, native herbivores have become severely depleted both in diversity and abundance in many parts of the world (Prins 1992). The Trans-Himalaya is one such ecosystem where pastoralism is altering native herbivore assemblages (Mishra *et al* 2002). Trans-Himalayas encompass 2.6 million sq km of the Tibetan plateau and its marginal mountains. Northern Indian regions of Ladakh and Spiti (*c.* 186,000 sq km) represent the western extension of this unique high altitude and cold-arid Tibetan ecosystem. These regions harbour a diverse assemblage of large mammalian herbivores such as the Tibetan argali *Ovis ammon*, Tibetan antelope *Pantholops hodgsoni*, Bharal *Pseudois nayaur*, Tibetan gazelle, Himalayan ibex *Capra siberica*, Kiang *Equus kiang*, Ladakh urial *Ovis vignei*, and several types of domestic livestock including goat, sheep, donkey, horse, cattle and the domesticated form of wild yak *Bos grunniens*. Compared to the records of 19th century explorers (e.g. Burrard 1925; Stockley 1936) populations of native ungulates are very low at present, perhaps due to past hunting and habitat degradation associated with increasing livestock populations (Fox *et al* 1991; Schaller 1998). Forage competition from increasing livestock populations has probably caused local extinctions of many native ungulates in recent years (Mishra *et al* 2001; 2002; Bagchi *et al* 2004; 2004).

At present, among the most vulnerable species is the small sized ruminant, the Tibetan gazelle (14kg body mass Mishra *et al* 2002) whose range has contracted drastically in the last few decades both in Tibet (Schaller 1998) and in Ladakh, where it is on the verge of local extinction (Bhatnagar *et al* 2006). The species was once common in Ladakh, spread across a range of *c.* 20,000 sq km

(Fox *et al* 1991). Today, it is restricted to < 100 sq km, and the largest population, not exceeding 50 individuals, occurs in the Kalak Tartar plateau and surrounding areas of the Hanle River Basin (Bhatnagar *et al* 2006; Fig. 1). Despite hunting being banned in the 1980's followed by greater legal protection, the gazelle populations continued to decline, presumably due to intensified livestock grazing in its habitat. The small remnant small population of the Hanle Valley is an important opportunity for initiating a species recovery program (Bhatnagar *et al* 2006). Although the Kalak Tartar population has also declined in the past 10 years, Bhatnagar *et al* (2006) speculated that the primary factor that has enabled the gazelle to persist here is the relatively lower livestock grazing intensity on the plateau. This is because livestock herders are constrained by the non-availability of drinking water and therefore spend less time in the area.

We undertook this study to generate ecological information on this last surviving population of gazelles in Ladakh to facilitate the design of a recovery program. We determined the biotic and abiotic factors that influence habitat-choice by investigating the habitat characteristics, vegetation correlates and spatial distribution of gazelles vis-à-vis other wild and domestic ungulates.

Material and Methods

Study area

The Hanle basin (32^0N, 79^0E) is an extension of the Tibetan plateau into Ladakh and covers the catchments of River Hanle, a major tributary of the River Indus (Fig. 1). The region is characterized by low precipitation (200-400 mm annually, mostly as snow) and low temperatures (between -30^oC in winters and 20^oC in summers). Elevation ranges between 4700m and 5100 m. Plant growth is confined to a short period (May-August) and vegetation is dry-alpine steppe with grasses (*Stipa, Festuca, Poa*), sedges (*Carex*, *Kobresia*) alongside forbs and small shrubs (*Artemisia*, *Salsola*, *Saussurea*), while the tree layer is absent (Bagchi *et al* 2006). Based on our previous surveys in the region (Bhatnagar *et al* 2006), we intensively sampled the Kalak Tartar plateau of Hanle Basin. About 2000 goat-sheep (body weight 25-30 kg) of the local nomadic (*Changpa*) herders use the Kalak Tartar area for a short period of about 20 days in early summer before they move further up the Hanle valley. Lack of potable water in the area during summer curtails this grazing period as herders cannot find suitable camping grounds. However, they return to the area with both yak and goat-sheep in winter following snowfall (Bhatnagar *et al* 2006). Such seasonal movements are a common feature of nomadic herders in central

Asia (Fernandez-Gimenez 2000). Wild kiang however (250-300 kg) use the area throughout the year alongside gazelles.

Data collection and analyses

Physical habitat selection

Gazelles were observed from an all-terrain vehicle. Habitat variables such as slope angle, aspect and elevation were recorded at the animal locations. The gazelle's habitat affinities were assessed by the ratio of habitat use and availability (Manly *et al* 2002). The proportion of available habitat was assessed by recording the aforementioned variables from n = 51 random locations (Marcum & Loftsgaarden 1980). All the habitat variables were classified into separate categories for statistical analysis. The selection ratio for each category was calculated as $\hat{w}_i = \frac{o_i}{\pi_i}$, where o_i is the proportion of used units in category i, and π_i is the proportion of available resource units in category i. Subsequently, the standard error of a selection ratio was calculated as $SE^{(\hat{w}_i)} = \frac{\hat{w}_i}{\sqrt{\left(\frac{1}{u_i} - \frac{1}{u_+} + \frac{1}{m_i} - \frac{1}{m_+}\right)}}$ where u_i is the used resource units in category i, u_+ is the total number of used units sampled, m_i is available resource units in category i and m_+ is the total available units in category i (Manly *et al*, 1999).

To statistically test for habitat selection, the log-likelihood Chi-square statistic was calculated as $\chi^2_L = 2\sum\left[\left\{u_i \ln \frac{u_i}{E(u_i)}\right\} + \left\{m_i \ln \frac{m_i}{E(m_i)}\right\}\right]$, where $E(u_i)$ is the expected value of u_i, and $E(m_i)$ is the expected value of m_i, for a null hypothesis of no selection. In case of a habitat selection, simultaneous Bonferroni-adjusted 100 (1- α)% confidence intervals were calculated for each habitat category as $\hat{w}_i \pm Z_{\alpha/(2 I)}\, SE(\hat{w}_i)$, where i is the number of habitat categories and $SE(\hat{w}_i)$ is the standard error of selection ratio. A habitat is used selectively if the confidence limits exclude unity. Under positive selection (preference), the interval is > 1, and under negative selection (avoidance) it is < 1.

Spatial distribution and sympatric ungulates

We recorded spatial distribution of gazelles in different pastures of the Kalak Tartar region using pellet counts (Neff 1968) in n = 123 randomly located 5x10 m quadrats. The influence of sympatric ungulates (goat-sheep, yak and kiang) on the spatial distribution of gazelles was assessed using data on the presence-absence of their faecal pellets in plots, which were then statistically compared to a null model following Bagchi *et al* (2004). Plot-based co-occurrence (or conversely separation) between gazelles and the other species was calculated by the *C-score* index (Stone & Roberts 1990). This index is calculated as $C_{ij} = (r_i\text{-}S)(r_j\text{-}S)$, where r_i is the number

of plots with species *i* and r_j is the number of plots with species *j* with *S* being the number of shared sites. When there are *N* species, there are *N (N - 1)/2* species pairs and *C-score* = $2\Sigma \frac{C_i}{N(N-1)}$. This measures the tendency of any two species not to co-occur in the same plot, with larger values indicating greater separation between them. Deviation of observed *C-scores* from co-occurrence due to random chance was assessed through 100 Monte Carlo simulations using Ecosim 6.10 software (Gotelli & Entsminger 2001). In this null-model, species were assigned randomly to plots (100 iterations), so that the occurrence of one species in a plot is independent of the others. This approach is adopted from Connor & Simberloff (1983) (see Gotelli & Graves 1996; Gotelli 2000 for reviews).

Vegetation characteristics

From the presence/absence of gazelle pellets in the plots, as well as from direct sightings of gazelles between May-September 2004 and January-March 2005, we could demarcate the specific area selected by gazelles. We delineated 2 blocks – parts that were selected by gazelles (*c*. 45-50 sq km), and surrounding areas (*c*. 40-45 sq km) where gazelles did not occur. To investigate if these two blocks differed in vegetation cover, data were collected using a line-intercept method where we recorded the plant species (or any other substrate such as soil or rock) at every 0.5 m interval along a 20 m transect (*n* = 38 randomly laid transects in each block in July-August 2005, i.e. during peak standing biomass; Muller-Dumbois & Ellenberg 1974). We also investigated the difference in above-ground net primary productivity between these two blocks by 2x2 m exclosures (*n* = 7 inside the area selected by gazelle and *n* = 5 outside). We paired these exclosures with adjacent control plots (i.e. grazed and ungrazed) at the beginning of the growth season (May). At the end of the growing season (August), vegetation was clipped to the ground level from two 1x1 m quadrats in each exclosure and control plot.

Gazelles are known to feed preferentially on forbs (Schaller 1998). Such small ruminants (14-15 kg body weight) rely on high-quality forage (van Soest 1982; Illius & Gordon 1987) and fermentation of forbs is more viable compared to grasses (Foley & Cork 1992; Iason & van Wieren 1999). Therefore, we sorted the clipped plants from each spatial unit into two functional groups: graminoids (grasses and sedges) and forbs (herbs and small shrubs) and oven-dried them to obtain dry-weights. We also assessed the grazing intensity (extent of forage removal) in the two blocks by examining the difference in biomass between fenced and control plots (McNaughton 1979), and comparing the data from the two areas

with a general linear statistical model using SAS v. 9.0 (SAS Institute, Cry, NJ). Data are presented as $\overline{X} \pm SE$ and statistical significance adjudged at $\alpha = 0.05$ in all cases.

Results

Gazelles disproportionately used relatively flat areas (6^0-15^0) in both summer ($\chi^2_L = 13.02$, $df = 3$, $P < 0.005$) and winter ($\chi^2_L = 14.39$, $df = 3$, $P < 0.005$). They also preferred south-facing slopes and avoided the north-facing slopes during winter ($\chi^2_L = 16.68$, $df = 3$, $P = 0.06$), while they tended to avoid the north-facing slopes during summer ($\chi^2_L = 3.74$, $df = 3$, $P = 0.29$; Table 1). There was a weak preference for low elevation areas (4751m-4900m) in winter ($\chi^2_L = 7.24$, $df = 3$, $P = 0.06$), while relatively higher areas were avoided both in summer as well as winter (Table 1).

Five species of graminoids and 17 species of forbs were recorded in the vegetation sampling. Plots in the areas selected by gazelle had higher overall vegetation cover (45.2±1%) than of adjoining areas (27.2 ± 1%; $F_{1, 75} = 133.3$, $P < 0.001$). Net above-ground primary productivity was marginally higher in areas selected by gazelles ($F_{1, 10} = 4.67$, $P = 0.056$, Fig. 3). Proportional contribution of forbs to overall biomass was 48.7 ± 2% in areas selected by gazelles compared to 39.5 ± 2% in the adjacent areas (Fig. 3). After accounting for the correlation between forb biomass and total biomass ($R = 0.69$, $P = 0.01$), there was a significantly higher proportion of forbs in areas selected by gazelles compared to adjacent areas (ANCOVA, $F_{1, 9} = 6.65$, $P = 0.02$; Fig. 3). Comparing fenced and control plots showed that 47 ± 6% of plant biomass was consumed by herbivores (wild and domestic) in areas outside gazelle range, while 29 ± 5% was consumed in plots inside the gazelle area ($F_{1, 10} = 5.05$; $P = 0.04$), thereby showing lower grazing intensity inside the gazelle area compared to outside.

Of the 123 plots, gazelle dung pellets were recorded in 47 (38%), kiangs' in 56 (45%), yaks' in 43 (34%) and goat-sheep in 88 (71%). Pair-wise comparisons showed that co-occurrence of gazelles and goat-sheep was significantly lower than expected by random chance (Table 2). On the other hand gazelles tended to co-occur with kiang and domestic yak.

Discussion

Many native ungulates of the Trans-Himalaya have co-evolved in sympatry since the Miocene (e.g. Randi *et al* 1991; Harrison *et al* 1992) and they show resource

partitioning (e.g. Namgail *et al* 2004), similar to ungulates in other ecosystems (e.g. Bagchi *et al* 2003). In comparison, domestic livestock have been introduced relatively recently (1-3 thousand years ago, Goldstein & Beal 1990), and their interactions with native species are more likely to be competitive. Our data show that gazelles avoid areas used by domestic goat-sheep but co-occur with kiang and yak. Thus, it appears that gazelles have a predominantly competitive relationship with sheep-goat, and a possible indirect facilitative interaction with the wild kiang and domestic (but native) yaks (facilitation through habitat modification; Vesey-Fitzgerald 1960; Bell 1971).

Gazelles had a higher affinity towards flat areas during both summer and winter. This could be related to the animal's cursorial strategy against predators. Gazelles avoided north facing slopes during winter, which could be attributed to snow-pack on such slopes as against the south facing slopes receiving greater insolation. Avoidance of higher reaches during winter could also be due to the presence of more snow on the higher slopes.

Forage competition between livestock and wild herbivores of the Trans-Himalaya is increasingly being documented (Bagchi *et al* 2004; Mishra *et al* 2004). Previous estimates show that large herds of goat-sheep, as in our study area, can consume more than 200 kg of forage per day (dry weight) of which 50-55% can be forbs (Bagchi *et al* 2004). Gazelles depend on high-quality forage (forbs) compared to fibrous forage (grasses, Foley & Cork 1992; Iason & van Wieren 1999), with 70-90% of their diet consisting of forbs (Harris & Miller 1995; Schaller 1998; Miller & Schaller 1998). This constraint on smaller bodied ungulates such as the gazelle arises because metabolic requirements (M) scale as $M \propto B^{3/4}$ of the body-mass (B), while the gut-capacity (G) varies as $G \propto B^{1}$ (Demment & van Soest 1985). These allometric relationships make smaller ruminants like the gazelle dependant on high-quality forbs. Therefore, such high rates of removal of forbs by livestock can disproportionately affect gazelles. On the other hand, kiang and yak predominantly feed on graminoids (58-95% of their diet, Schaller 1998; Mishra *et al* 2004). Bulk-feeding on grasses and sedges by these large-bodied herbivores could potentially favour the growth of forbs and attract gazelles into areas grazed by them (Huisman & Olff 1998). We thus speculate that kiang and yaks could be facilitating gazelles, but this remains to be investigated in future research. Additionally, goat-sheep are husbanded in large herds, and are accompanied by herders and guard dogs that may cause direct disturbance and result in interference competition as in other parts of Trans-Himalaya (Namgail *et al* 2004).

Even though areas selected by gazelles had higher vegetation cover, they were only marginally more productive than adjoining areas. This could be because low-growing prostate life-forms are common among plants of low-temperature environments (e.g. Johnson & Tieszen 1976; Rawat & Adhikari 2005), and higher vegetation cover does not necessarily correspond with higher production. But importantly, a larger fraction of productivity in these areas is due to forbs.

It is important to facilitate the recovery of small populations and prevent their local extinctions (see Berger 2003). The present study fills certain gaps in understanding ecological requirements of the Tibetan gazelle at a critical time when the species is threatened with local extinction in India, and is undergoing range-reductions in Tibet (Bhatnagar *et al* 2006). Gazelles occur in relatively flat and south-facing pastures at relatively low-elevations. These areas are not intensively used by goat-sheep, especially during the growth season, and have proportionately higher representation of forbs. These characteristics can be used to identify potentially-suitable gazelle habitat in areas adjoining Kalak Tartar and eventually extended to its former geographic range in Ladakh. Once identified, potentially suitable areas need to be relieved of livestock pressures to facilitate their colonization by gazelles. In this manner, acquisition of even small-sized patches can be of high conservation importance (Berger 2003), as seen in a variety of other taxa (e.g. marsupials, Lindenmayer 2000; birds, Fischer & Lindenmayer 2002). Dialogue with local pastoralists can lead to reduction of livestock pressures from high-priority areas (Mishra *et al* 2003). Participatory programs whereby certain incentives are provided to the local pastoralists are likely to play an important role in this process. In the past, such initiatives have been undertaken in other parts of the Trans-Himalaya (see Mishra *et al* 2003; Bagchi & Mishra 2006 for a case study in nearby Kibber Wildlife Sanctuary). Our study provides ecological information for initiating a participatory recovery program for the Tibetan gazelle in India.

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Table 1. Estimated seasonal habitat selection indices for the Tibetan gazelle Procapra picticaudata in Hanle Valley, Ladakh, India. $\hat{w}_i$ is the estimated habitat selection ratio; se($\hat{w}_i$) standard error of selection ratio; $\hat{w}_i$ (l) and $\hat{w}_i$ (u) 95% lower and upper confidence limits, respectively.

	Winter				Summer			
Slope angle (deg.)	**ŵi**	**se(ŵi)**	**ŵi(l)**	**ŵi(u)**	**ŵi**	**se(ŵi)**	**ŵi(l)**	**ŵi(u)**
<5	0.589	0.250	0.029	1.149	0.464	0.283	0.000 c	1.096
6-15	2.074 a	0.470	1.021	3.128	2.444 a	0.563	1.183	3.704
16-25	0.675	0.199	0.230	1.120	0.378 b	0.190	0.048	0.803
>25	0.135 b	0.143	0.000	0.456	0.000	0.000	-	-
Slope aspect								
Northern	0.315 b	0.127	0.030	0.599	0.472 b	0.213	0.000 c	0.948
Southern	2.159 a	0.512	1.013	3.305	1.473	0.444	0.480	2.467
Eastern	1.041	0.487	0.000 c	2.131	0.971	0.566	0.000 c	2.240
Western	0.515	0.229	0.001	1.029	1.236	0.499	0.118	2.354
Elevation (m)								
<4750	1.214	0.750	0.000 c	2.894	1.133	1.001	0.000 c	3.376
4751-4900	1.474 a	0.208	1.009	1.940	1.114	0.206	0.653	1.575
4901-5050	0.374 b	0.170	0.000 c	0.755	0.243 b	0.175	0.000 c	0.635
>5050	0.000	0.000	-	-	2.380	1.281	0.491	5.251

[a] (preference) and [b] (avoidance) [c] a negative lower limit was replaced with a 0 since a proportion cannot take a negative value.

Table 2. Spatial co-occurrence of the Tibetan gazelle Procapra picticaudata *with sympatric livestock and kiang* Equus kiang *in the Kalak Tartar area of Ladakh, India. A low* C-score *value indicates a tendency of co-occurrence, while high values indicate avoidance.* C-score *between species-pairs is based on distribution of faecal pellet groups in 123 plots. Superscripts denote the nature of association between a species-pair, – denotes avoidance, and + denotes co-occurrence. All values were significantly different (P < 0.01) from random chance and adjudged by a null-model with 100 Monte Carlo iterations.*

Species	**Goat-sheep**	**Kiang**	**Yak**	**Gazelle**
Goat-sheep	…	1090–	1216–	1650–
Kiang		…	608+	252+
Yak			…	480+

Figure 1. Map of the study area (Kalak Tartar plateau and adjoining areas) in the Hanle River Basin, eastern Ladakh, India.

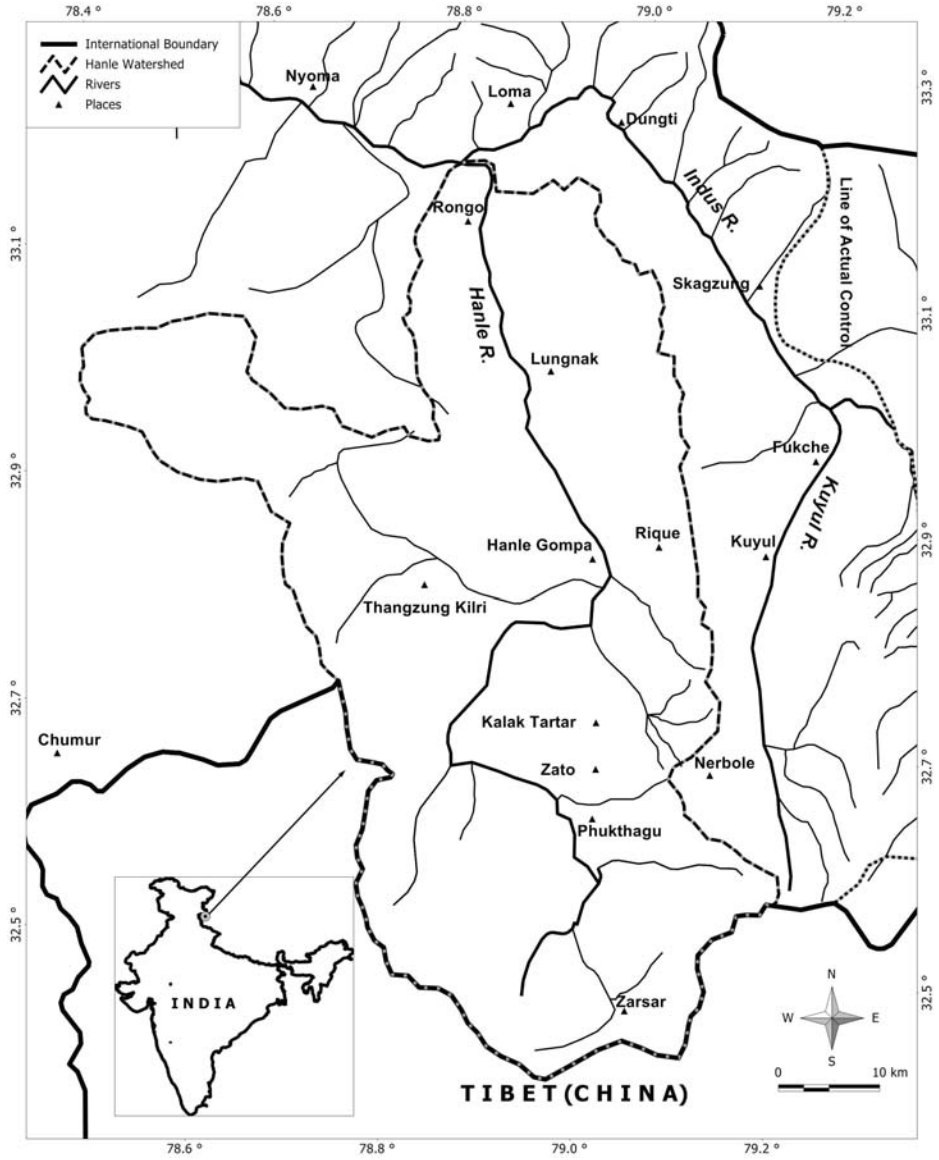


Figure 2. Summary of terrain use by the Tibetan gazelle in Kalak Tartar area, Ladakh, India during two seasons (winter and summer). Bars indicate percent use and availability of categories of (a) elevation, (b) slope angle and (c) slope aspect.

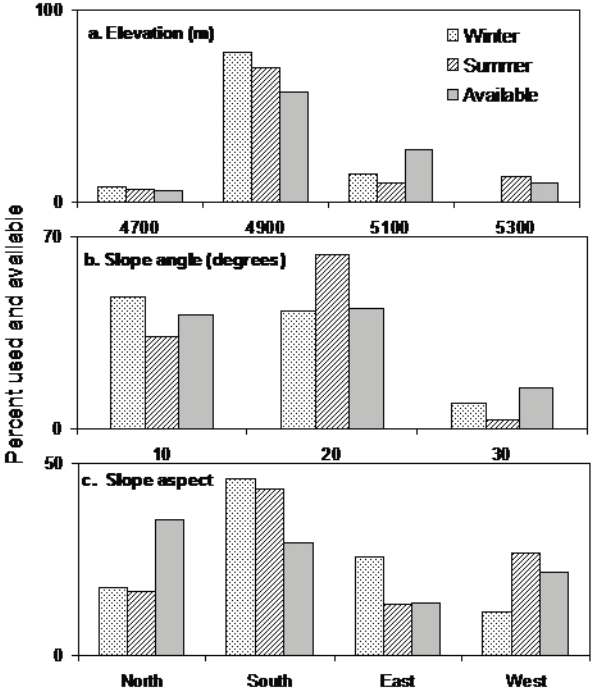
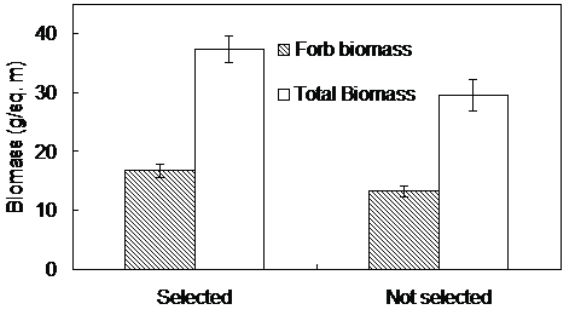


Figure 3. Mean (±SE) above-ground biomass of forbs (hashed bars) and all functional groups combined (clear bars) in n = 12 fenced plots in the Kalak Tartar plateau, Ladakh, India. Data are from two blocks – with (left) and without gazelle (right). See text for statistical differences between the groups.



3: Pastoral Nomads of the Indian Changthang: production systems, landuse and socio-economic changes

Tsewang Namgail, Yash Veer Bhatnagar, Charudutt Mishra and Sumanta Bagchi

Abstract

The Changthang Plateau of Tibet is inhabited by the indigenous *Changpa,* who are a pastoral people following Buddhism. *Changpa* also inhabit India's Hanle Valley of eastern Ladakh. We describe the production system and evaluate the recent landuse and socio-economic changes of the little known *Changpa* of Hanle Valley, and discuss the plausible causes and consequences of these changes. The society has undergone considerable change in the last three decades, with about 50% of the population of Hanle Valley currently comprising of Tibetan refugees (popularly known as TRs), who fled Tibet. In our surveys in the Hanle Valley, we recorded 280 families with a human population of about 1,500, and a livestock population of about 27, 000, or 18 head per capita. Cashmere or *pashmina* goats comprised bulk of the livestock population (65%), followed by sheep (27%), yak (5%), horse (2%) and cow (1%). Livestock production is the mainstay of the economy with *Pashmina* wool being the main source of income. The livestock population has increased almost two-fold during the last two decades, largely due to the influx of the TRs with their livestock and the Government's emphasis on *Pashmina* production. The socio-economy of the area is also in flux due to modern developmental initiatives. Some of the most notable changes include the increasing use of motor vehicles for transportation, breakdown of the polyandry system, and the cessation of the traditional barter trade that made people more dependent on cash. These changes may have important ramifications for the long-term sustainability of the pastoralism in Changthang.

Keywords Pastoralism, livestock production, socio-economy, Changthang, Ladakh

Introduction

Pastoralism, the use of rangelands for livestock production, is widespread in many semi-arid and arid regions of the sub-Saharan Africa, Middle East and Central Asia (Homewood & Rodgers, 1987, Goldstein & Beall, 1990). It is the key production system in drylands where agriculture is impractical (Dyson-Hudson & Dyson-

Hudson, 1980). The exact origin of pastoralism is disputed (Blench, 2004), but it is generally held that it originated about 10,000 years bp. The earliest forms of pastoralism probably involved management of wild populations of animals, as is the case with the present day reindeer herding in the subarctic areas (Manderscheid, 2001). Today, c. 20% of the earth's land surface comprises rangelands, and livestock production is an important source of economy in many parts of the world (Blench, 2004). The pastoral systems are, however, changing all over the world, largely due to modern developmental initiatives and markets (Manderscheid, 2001; Fox *Et al,* 2004).

The Changthang region in the Indian Trans-Himalayan area of Ladakh represents the western extension of the Tibetan Plateau, an important highland grazing ecosystem (Goldstein & Beall, 1990). A pastoral community, known as the *Changpa,* has grazed the rangelands of Changthang for several millennia. The *Changpa* are Buddhists and share cultural and linguistic affinities with Tibet (Rizvi, 1996). They originally migrated into Ladakh from Hor of Tibet in the 8th century A.D. (Jina, 1995). The *Changpa* have been practising nomadic pastoralism in Ladakh ever since, although they lost access to several traditional pastures on the Tibetan side when India and China fought a war in the region in 1962 (Ahmed, 1997). Around the same time, the region saw a heavy influx of Tibetan refugees (popularly known as TRs), who, like the *Changpa,* rear a variety of livestock including horse, yak, sheep and goat. These livestock types are adapted to the hostile and marginal pastures of the region, and provide myriad products and services. The rangelands of Changthang reportedly produce the finest cashmere wool or Pashmina in the world (Ahmed, 1996; Mishra *et al*, 1998).

Studies on the production system, socio-economy, ecology and lifestyle of the people of Changthang suggest considerable changes in the socio-economy and rangeland tenure, particularly during the period after the war between India and China (Saberwal, 1996; Ahmed, 1996; Jina, 1999; Chaudhuri, 2000; Hagalia, 2004; Goodall, 2004; Rawat and Adhikari, 2005). These studies have been conducted primarily in the Rupshu-Kharnak area that is relatively closer to the district headquarters, Leh, and is one of the important tourist destinations. However, there is virtually no information on production systems and socio-economy from other, more distant parts of Changthang, especially the eastern Hanle Valley (c. 3000 sq km; 32^{o}N, 78^{o}E). Due to the political sensitivity of the area, this valley is out of bound for foreign nationals, and Indian nationals too need a special permit to visit the area. Tourism has therefore largely been restricted here. The area has remained

relatively remote, and pastoralism in the region is little understood. The present article aims to fill this gap by describing pastoral use, socio-economy, and changes in land use from this little known region of Changthang.

The Hanle Valley is also important for wildlife conservation. It supports the last surviving population of the Tibetan gazelle *Procapra picticaudata* in Ladakh, a species that is on the brink of extinction in India (Bhatnagar *Et al* 2006a). Hunting in the past, and excessive livestock grazing in its high altitude habitat, have caused a dramatic range reduction for the gazelle in Ladakh, i.e., from c. 30,000 to less than 100 sq km within the last century. The species is in very urgent need of a recovery programme and its continued survival in Ladakh hinges on the support and involvement of the people of Hanle Valley, which also supports a relatively high density of kiang *Equus kiang*, a species that grazes alongside livestock. Although traditionally tolerated, the kiang today is a subject of concern and conflict, as the people believe that they compete with livestock for forage, and are thereby compromising *Pashmina* production (Bhatnagar *et al* 2006b). Management programmes for both these species will need to involve the local community of Hanle Valley, and will need to be founded on a good understanding of their ecology, as well as that of the land use and socio-economy of the resident people. This study is also a step towards generating information on human ecology and socio-economy that could assist in the designing of conservation programmes.

Our main objectives were to understand the current grazing system, land tenure, and socio-economy of the *Changpa* and the TRs of the Hanle Valley. In this article, we give an overview of the nomadic pastoralism in this valley, describe the livestock production system, assess the landuse and socio-economic changes, and discuss the plausible causes and consequences of these changes. Understanding these issues is crucial for evaluating the future of pastoralism in Changthang, undertaking steps to make it sustainable and economically viable, and for integrating the concerns of wildlife conservation into the existing landuse practices.

Study Area

The Hanle Valley is located at about 270 km southeast of Leh, the district headquarters. Hanle was originally Umle (from Umboo ~ Myricaria and Le ~ Corral), as historically there was a corral, made of Myricaria twigs, located near the Hanle monastery. The Hanle River originates in the Zangskar range in eastern Ladakh, and runs northwards draining into the Indus River at Loma. It meanders

across a vast expanse of sedge-meadows, which serve as critical pasture for both domestic and wild herbivores. The topography is characterised by undulating terrain interspersed with rocky hills, and the elevation ranges from 4,400- 5,800 m above sea level. The environment of Changthang is characterised by extreme coldness, aridity, high radiation and strong winds. Due to the low precipitation the plant productivity is very low (Rawat and Adhikari, 2005). The growth season is confined to a short period (June-August) in summer, and the vegetation is characterised by alpine steppe communities with medium to sparse cover (20%). The most dominant plants of the area include *Stipa* spp., *Carex* spp., *Artemisia* spp., *Salsola* spp. and *Oxytropis* spp. There are no trees except for willow *Salix* spp. planted near human settlements by the local people and the Forest Department. The large mammals of the area include the Tibetan gazelle, Tibetan wild ass, blue sheep *Pseudois nayaur* and their predators such as the snow leopard *Uncia uncia,* Tibetan wolf *Canis lupus*, red fox *Vulpes vulpes* and Tibetan sand fox *V. ferrilata* (Namgail *et al*, 2005). The area is also rich in birds and small mammals (Bagchi *Et al*, 2006).

The pastoral people of Hanle Valley move between pastures grazing their livestock that consists predominantly of goats and sheep. In the past three decades, six permanent base-settlements/villages have also been established, namely Pungug, Khaldu, Naga, Shadey, Bug and Zhingsoma in the valley (Fig 1). Among the variety of livestock they own, yak is used for meat, milk (demo or the female yak) and transportation (less so in recent years), while horses are used for riding, carrying loads and more recently ploughing agricultural fields. Many families have also started keeping cows for milk, though this trend started in the early 1970s. All the livestock except the cows are grazed in the high pastures (> 4500 m) during most of the year. The cows are grazed in the riverine pastures near the human settlements. The primary livelihood of the nomads revolves around the Pashmina from goats. In addition to grazing livestock, the people also extract shrubs like Artemisia spp. from the ranglenads for fuel.

Methods

Our surveys were carried out between June-August 2004, and January-March 2005. Data were collected largely through semi-structured interviews of people both in the villages and the high pastures. Information on family size and livestock holdings were obtained by interviewing one adult member of all the 280 families (148 *Changpa* and 133 TR) in the valley. However, the per capita income from *Pashmina,*

khuloo (yak hair) and wool were determined by interviewing one adult member, preferably the head, of a sample of 25 *Changpa* and 52 TR families. Information on land use and socio-economic changes were gathered by interviewing seven elderly people in the villages. Information on modern developmental activities was collected by interviewing the village headmen, and also by opportunistically interviewing more than 10 knowledgeable people. People were opportunistically asked open-ended questions regarding the changes in their pastoral life and the causes and consequences of these changes. The village headmen of both the TRs and the *Changpa* were consulted for the preparation of resource use maps to understand the grazing patterns. GPS locations of the *rebos* (herder camps) were recorded to generate a map of the movement patterns of the nomads.

The livestock population of Nyoma Block, the headquarters of Changthang, were obtained from the Sheep Husbandry Department, Leh. Three officials from this department were also interviewed in June 2004 and April 2005 to gather information on the government's recent interventions in enhancing livestock production.

Results

The data on the *Changpa* and the TRs are pooled and presented together. However, distinctions are made at some places, e.g., the per capita income from *Pashmina,* which would be useful for future comparison. There were six villages in the Hanle Valley; the Rongo Village was not included in the analysis because it is about 50 km away from these villages, and has separate grazing territories and regulations. In the six villages that were surveyed, there were 280 families, both *Changpa* and TR. These families had a human population of about 1,500 people or an average of 5 people per family. There were about 27, 000 head of livestock in early 2004 in the area (Table 1), which translates to 19 head of livestock per capita. Goats (65%) comprised bulk of the livestock population, followed by sheep (27%), yak (5%), horse (2%) and cow (1%). The sheep and goat population in the Nyoma block of Changthang almost doubled in the last five years (Fig. 2).

The sample of 52 TR families, surveyed for the assessment of income from animal fibre, had a human population of 288, while the 25 *Changpa* families surveyed had a human population of 138. In the year 2003, the 52 TR families sold a total of 1,287 kg (4.5 kg per capita) of *Pashmina* at an average rate of US $ 25/ kg (Table 2), whereas the sample of 25 *Changpa* families sold 439 kg (3.2 kg per capita). The annual per capita income from *Pashmina* for TR was thus about US $

115, while that of the *Changpa* was about US $ 80 (Table 2). An adult goat produces about 250 grams of raw *Pashmina* per annum. The nomads sell their produce to the middlemen (small scale traders from Leh) who in turn sell it to the traders from Kashmir, although this trend is on the decline (see discussion).

The pastoral society of the area is patrilineal and male-dominated. There is however a marked gender role in the *Changpa* pastoral production system with the women mostly involved in milking and dairy processing, while males are responsible for shearing cashmere wool, herding and selling of animals. In the past, *Changpa* society was predominantly polyandrous, where several brothers married a single woman, which perhaps served as a population control mechanism. But this is declining due largely to the change in people's attitude, mainly that of the younger generations, towards this institution. The family is the primary unit of production, but communal cooperation is an important feature of the *Changpa* society. Livestock are individually owned but communally grazed. The traditional barter trade, which made several subsistence commodities such as barley available to the *Changpas* has also ceased to function.

Livestock production system

The 280 livestock owning families in Hanle Valley are divided into different herding units: *Kharloog, Dique, Raque, Yulpa* and *Maque*. Historically, these groups had different tasks. For instance, *Kharloog* (from *Khar* ~ palace and *loog* ~ sheep) herded the sheep of the Hanle Monastery, the *Dique* (from *Di* ~ yak and *que* ~ herd) herded the yaks, *Raque* (*Ra* ~ goat and *que* ~ herd) herded the goats, *Yulpa* (villagers) herded the livestock of the village, and *Maque* (from *Mamo* ~ ewe and *que* ~ herd) herded the female sheep. Prior to the arrival of the TRs, the livestock population was apparently smaller and the grazing patterns were more relaxed for these groups, without a clear-cut demarcation and distribution of pastures. But the increase in human and livestock population associated with the immigration of TRs in the 1960s led to a more regulated grazing pattern with clearly demarcated pastures earmarked for different seasons (Table 3). For instance, *Yulpa* during the summer season (June-Sept.) graze the Zhung demo pastures, while *Maque* graze the sedge meadows downstream of the Hanle River, and the *Raque* group graze the valleys and mountain slopes of the right bank of the Hanle River downstream of the Hanle Monastery. The *Kharloog* and *Dique* graze in Nalang and Lokbuk, respectively, during summer (Table 3). All the groups bring the livestock back to the villages in autumn for feeding on stubble in the agricultural fields and the sedge meadows

near the villages before they are again taken to the high pastures during winter.

Most of the families (44%) possessed small herds (< 50 head), while 3% of them possessed very large holdings (> 300 head; Fig. 3), with rest of the families having herds between 50 to 300 livestock. As a part of the initial adjustments of the TRs in the local grazing system, an upper ceiling of 25 livestock per person was agreed upon for the TRs as a livestock-population regulatory mechanism. No such restrictions are there on the *Changpa*. In families with large herds (>200), all the members move with the livestock herd, except for the school-going children and old people, who stay back in the villages. Families with fewer livestock (100-150 head) usually send only one or two members to the high pastures. Families with less than 50 head of livestock usually make adjustments amongst themselves and the livestock of a few families is herded together. In such cases, the herding families are paid, either in cash or in kind such as butter, meat etc., for their services. Such arrangements allow a considerable reduction in manpower required for herding, and allow families to engage in other activities such as agriculture, small business enterprises, and perhaps cross-border trade to supplement their income.

Socio-economic and land use changes

The socio-economy of the pastoral people of Hanle is in flux. Amongst the most striking are the increasing use of motor vehicles for transportation, and the decline of the polyandry system. Currently there are eight trucks, two tractors, 16 light motor vehicles (cars and jeeps) and about 30 motorbikes in the six villages surveyed. Moreover, there is a bus service plying weekly between Leh and Hanle. The affluent families are also acquiring television sets, and most of them have shifted from the traditional open hearth to the smokeless Light-Petroleum-Gas Stoves. They are also putting a lot of emphasis on education; currently each village has a primary

Nomads increasingly replace pack animals with vehicles

school. There is a special school for children of the TRs at Pungug, which has a limited number of seats for the *Changpa* children also.

The nomadic people are settling down in areas with good access to water, and concrete-houses are increasingly being built in these areas. In the Khaldu village alone, currently there are more than 30 concrete houses as against only three single-room structures in the 1960s. Furthermore, the diet of the people has presumably undergone considerable changes, with the Government providing food provisions such as sugar and rice on subsidized rates. Most of these changes have been accompanied with an increasing dependence on cash, integration with cash markets, and termination of traditional barter with other parts of Ladakh for barley and clothes.

Historically, livestock production was the major land use in the area, as the high altitude and aridity did not allow agricultural production. Nevertheless, some nomads started cultivating barley and green pea in the early 1970s. These crops consistently failed for numerous years due to harsh climate and short growing season with frequent early frosts. Thus, they used the crops only for stall-feeding in winter. However, in recent years improved varieties that have a shorter growth period were introduced by the Agricultural Department, Leh, which has enabled the nomads to cultivate the crops for grain as well as livestock forage. Presently, most of the *Changpas* (almost 70%) in the Hanle Valley cultivate for sustenance. Most of the people that practise agriculture are also involved in other commercial activities such as grocery shops, and perhaps cross-border trade for supplementing their incomes.

Discussion

Livestock Population: is the growth sustainable?

The livestock population is on the rise all over Changthang. It was estimated at *c.* 200,000 in 1999, which is twice that in the late 1970s (Richard 1999; Bhatnagar & Wangchuk 2001). The increase is more dramatic in case of goats, which is presumably related to the increasing demand for *Pashmina*. Examining the causes of this increase suggest that the trend may not be ecologically sustainable.

The increase in livestock population in Changthang began with the arrival of the TRs with their livestock in the early 1960s, as well as the loss of access to pastures across the Tibetan border (see Bhatnagar *Et al* 2006b). This inflated the stocking density considerably. A further increase was facilitated by addressing two important issues that presumably had restricted the livestock population

historically – the control of diseases and offsetting starvation mortality during extremes of winter. Livestock diseases such as foot-and-mouth, Peste des petits ruminants, echthyma and contagious caprine pleuro-pneumonia have been brought under control through frequent vaccination camps conducted by the government (Anon. 2002). Medicines are provided to the pastoralists at 50-70% subsidy. The livestock are also protected from ecto-parasites as the government provides livestock dipping facilities.

Special tents for sheep and goat kids protect them from predators

With people adopting cultivation since about four decades ago, supplementary forage grown in the fields has presumably helped the now agro-pastoral families in off-setting some amount of starvation related livestock mortality. In traditionally agro-pastoral communities in the Trans-Himalaya, the ability to raise supplementary forage in crop-fields is one of the most important factors limiting livestock populations (Mishra *Et al* 2003), and an important cause of overstocking of rangelands (Mishra *Et al* 2001). In Changthang, supplementary emergency fodder supplies provided by the Government during severe winters further help in reducing mortality. For instance, the *Changpa* of the Nyoma block were provided with 1,540 quintals of supplementary livestock feed (0.06 quintal/ livestock head) during the financial year 2001-02 to off-set winter mortality. During the winter of 2004-05, the *Changpa* in Hanle were provided *c.* 15 tons (*c.* 1 quintal/ household) of fodder to overcome the forage shortage due to heavy snowfall. The Border Area Development Programme of the Government further assists the *Changpa* in construction of godowns for cattle feed, kidding and lambing sheds, and in provisioning of vital equipments such as *Pashmina* combing tools.

The TRs also get similar material as well as financial assistance from the Tibetan Government in Exile and international organisations like Appropriate Technology for Tibetans. For instance, the heavy losses of livestock during severe

winters are compensated, so that they can re-establish a minimal herd size required to support the family. Besides these, the Tibetan Government also confers loans to those in need, and provides cattle feed during winter.

Our data show that *Pashmina* is an important source of income of the pastoralists of the Hanle Valley. We also found the per capita income of the TRs from *Pashmina* to be higher than that of the *Changpa,* which is presumably related to the latter's involvement in other commercial activities such as small business enterprises. Although the overall increase in livestock populations in the region may not be ecologically sustainable, in general, *Pashmina* production is likely to increase. Both theGovernment of India and the Ladakh Autonomous Hill Development Council are making a concerted effort to increase the *Pashmina* production in Changtang through provision of enhanced veterinary care, assured supply of feed for severe winters discussed above, and by providing improved livestock breeds. The Sheep Husbandry Department, Leh, distributed 80 *Pashmina* bucks and 220 veterinary kits amongst the *Changpa* of Nyoma block during 2001-02 (Anon. 2002).

Socio-economic changes

The traditional polyandry, which was a population control mechanism in the past, has been considered as a primitive system by the younger generation of the *Changpa*, who are increasingly opting for monogamous families (Ahmed, 1996). This has resulted in the formation of nuclear families, and thus increase in the human as well as livestock populations. Consequently, the reduced manpower per family is resulting in some families finding it difficult to sustain nomadism as a way of life, a trend that has also been observed in other parts of Changthang (Chaudhuri 2000, Hagalia 2004). However the pastoral people in Hanle are switching over to alternative sources of income that need less man power, which is in contrast to the situation in Rupshu-Kharnak area, where people are moving to the urban centres such as Leh (Goodall, 2003). This discrepancy in the emigration trend between the two areas could be related to the less exposure of Hanle people to tourists and opportunities to work in the tourism industry.

The border conflict with China in the 1962 led to a major influx of Indian Army personnel into the Changthang area. One of the major changes associated with this was the construction of a road-network, which made this previously remote area accessible, and enhanced the mobility of the *Changpa*. The people's abandonment of yaks and horses as a means of transport in favour of motor

vehicles could be attributed to this infrastructure development. At any rate, the market accessibility was enhanced, and the *Changpa*s began taking their produce, especially wool and *Pashmina,* to the market themselves, thereby becoming less dependent on the middleman.

A sedentarization of the nomads in the Hanle Valley has occurred gradually over the years, in contrast to the nomadic pastoral areas of Tibet where such a process was imposed by the government (Goldstein & Beall 1990). The pressures or incentives for the *Changpa* of Hanle were presumably subtler; sedentarization would facilitate the delivery of goods and services by both the Government and the aid agencies. Important amongst these are the delivery of medicine, food provisions and emergency relief supplies during severe winters. This perhaps also encouraged people to construct houses at some places for storing such supplies; agricultural production perhaps reinforced this sedentarization process, as cultivation of barley needs frequent weeding and irrigation. This is especially so because the nomads of Rupshu-Kharnak, who do not practise agriculture, spend relatively less time in the village, and important events takes place outside the village (Ahmed, 1996). The need for education of the children may also have contributed towards their settlement. This is again in contrast to the situation in Rupshu-Kharnak, where there were mobile schools until very recently (Balaram, 2006).

The drastic increase in livestock population in the rangelands, together with increased opportunities, presumably prompted several *Changpa* families to look for alternative options of sustenance such as agriculture cross-border trade, and small business enterprises (Khaldu village headman, pers. comm.). Barley is very important for *Tsampa,* the staple diet, and *Chhang,* a local brew, and its cultivation perhaps increased following the cessation of the traditional barter trade, which historically made this and other commodities available

Tractors increasingly replace draught animals in agriculture

to the *Changpa.* The Government's watershed development schemes may also have promoted agricultural production, as such government efforts encourage people to cultivate. Large areas (*c.* 120 hectares) in the Hanle River Basin have been fenced off under the aegis of this and other government schemes (pers. obs.). The importance being given to agriculture has probably transformed their movement patterns too. For instance, during autumn, when more manpower is needed for harvest and stubble on agricultural fields is available for livestock to forage on, many nomads congregate near their villages. A similar trend is seen in late spring when ploughing and sowing requires more manpower. Such land use changes are also reported from the Tibetan Plateau (Miller, 1995) and other rangelands across the world (Blench, 2004 and the references therein).

Conclusions

The people of the Hanle Valley represent a unique pastoral community that has survived on the marginal rangelands of Changthang for several millennia. Today, their production system, land use, and socio-economy are in flux, largely due to the modern developmental initiatives. Such changes may have important implications for the long-term sustainability of pastoralism in Changthang. The livestock population, especially that of the goat, is increasing, and may continue to increase apace due to the increased demand for *Pashmina*, while yak and horse population may decline in the future as the nomads are increasingly using motor vehicles for transportation. Such changes in livestock holding pattern and herd dynamics may affect the rangeland resources, and the ecosystem functioning. Although, the region has a unique grazing pattern with pastures divided amongst different grazing groups, more innovative grazing schemes may be needed in future to cope with the high rate of increase in livestock population. The government's emphasis on *Pashmina* production needs to be reviewed. The rangeland dynamics of the region needs to be studied in detail, which is crucial for developing conservation and developmental strategies that can achieve the goal of enhancing the livestock production without harming the ecosystem.

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Table 1. Livestock holding pattern of the Changpa and the Tibetan refugees (TR) in the Hanle Valley, eastern Ladakh, India. Figures in parentheses are row percentages.

Group	Human	Yak	Horse	Sheep	Goat	Cow	Total
Changpa	741	652 (5.2)	291 (2.3)	3644 (29.1)	7762 (62.0)	170 (1.4)	12519
TR	710	704 (4.8)	253 (1.7)	3764 (25.8)	9826 (67.3)	58 (0.4)	14605
Total	1451	1356 (5.0)	544 (2.0)	7408 (27.3)	17588 (64.8)	228 (0.8)	27124

Table 2. Pashmina, wool and Khuloo (yak-hair) sold by the Tibetan refugees and Changpas in the year 2003. Figures are in kgs, and figures in parentheses represent approximate annual income in US $.

	Tibetan refugees (n = 52)			Changpas (n = 25)		
Fibre type	/Household	/Capita	Total	/Household	/Capita	Total
Pashmina	24.8 (632)	4.5 (114)	1287 (32860)	17.6 (448)	3.2 (81)	439 (11209)
Wool	26.3 (112)	4.8 (20)	1367 (5817)	24.2 (103)	4.4 (19)	606 (2579)
Khuloo	4.7 (6)	0.9 (1)	246 (314)	5.9 (7)	1.1 (1)	147 (188)

Table 3. Shows seasonal grazing pastures of nomadic pastoralist groups (both Changpa and Tibetan refugees) of Hanle Valley, Changthang, India

Group	Summer	Autumn	Winter	Spring
Kharloog	Tak Nakpo, Nalang	Village	Chhumik Marpo, Tsilung	Kyangma Chhumik (Kalak Tartar)
Dique	Logbuk, Pongnak	Village	Srubra, Zakle, Sang Nakpo & Giagra	Tungung
Yulpa	Zong Chhenmo	Village (Pungug)	Gongra	Doksa
Raque	Palzue	Village (Khaldo)	Dhuti	Rathar, Lato karpo
Maque	Zhung, Chogul	Damochhe	Village (Pungug)	Daggo, Skilag, Dara

Figure 2. Increasing trends in sheep and goat populations in the Nyoma Block of the Indian Changthang (Source: Sheep Husbandry Department, Leh)

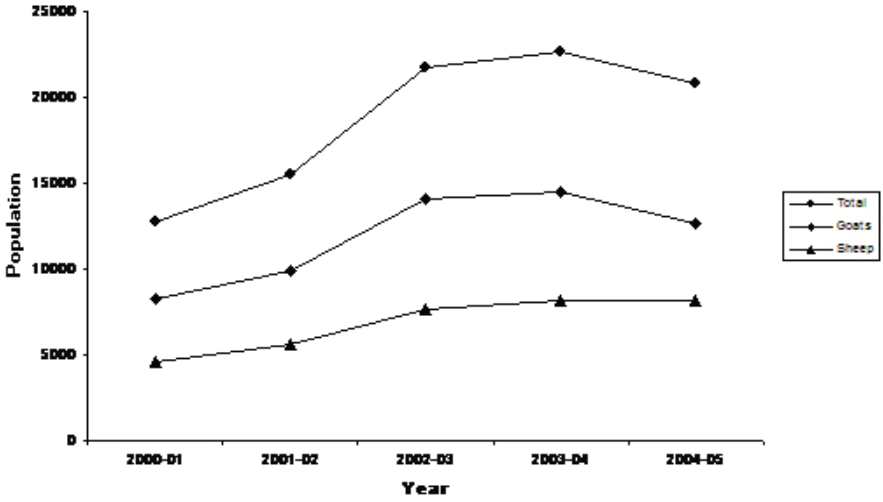
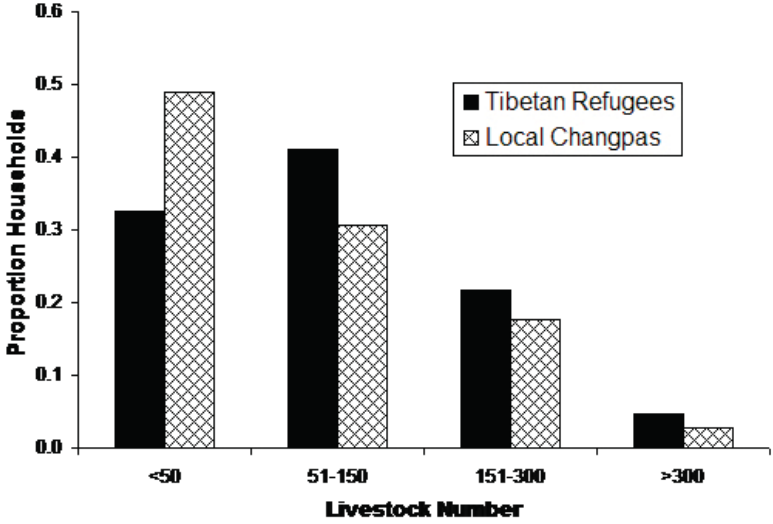


Figure 3. Livestock holding pattern of the Tibetan refugees and the local Changpas in the Hanle Valley of the Indian Changathang



4: A Strategy for Conservation of the Tibetan Gazelle in Ladakh

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Abstract

Tibetan gazelle populations in Ladakh have declined drastically in the past three to four decades due to over-hunting followed by out-competition by an increasing livestock population being reared for the valuable *pashmina* wool by the nomadic communities that inhabit these areas. The largest population of c. 40 gazelles occurs in the Kalak Tartar area of the Hanle Valley needs to be protected and a population recovery facilitated, which could later help in restocking gazelles in its erstwhile range in Ladakh. Based on our studies, a strategy to conserve the Tibetan gazelle in Ladakh is proposed. We identify both short term and long term objectives for the conservation of the Tibetan gazelle, and outline the actions required to meet them. There is an urgent need to initiate a participatory species recovery programme involving partnerships between the Wildlife and other departments of the government, scientists, and the local community members.

Keywords Tibetan gazelle, threats, population recovery, management, pastoralism, Ladakh, Trans-Himalaya

Introduction

The Tibetan gazelle *Procapra picticaudata* occurs in China and India. Across its range, its populations are believed to be declining (Bhatnagar et al. 2006a). It has particularly undergone a drastic range reduction in Ladakh over the last century, from *c.* 20,000km^2 to less than 100km^2 today, with the last 50 animals surviving precariously in the Hanle Valley of eastern Ladakh (Chapter 2). A majority of its surviving population is now confined to the Kalak Tartar plateau of the Hanle Valley. Our surveys estimated a population of *c.* 40 animals in Kalaktartar, and less than 10 in the Rique plains. Very small unconnected populations of 4-5 gazelles also persist in places such as Thagzung Kilri and Zarsar in the Hanle Valley, and Chumur and Chushul, over 100km from the Kalak Tartar population (Fig 1, Chapter 1). Most populations are insular with very little possibility of any genetic exchange among them. Excessive hunting in the past caused large scale local extinctions

of the gazelle. Although hunting was brought under control particularly over the last three decades, intensification of livestock grazing in gazelle habitat during this period has presumably resulted in further out-competition of the species (Chapter 1 & 2). The Kalak Tartar population itself survives in a small pocket of the landscape where the livestock grazing intensity has been traditionally relatively low due to non availability of drinking water for livestock, and local herding practices (Chapter 1). It thus appears that the Kalak Tartar population persists in a small 'island' of suitable habitat surrounded by a landscape made unsuitable due to excessive livestock grazing pressures.

The Tibetan gazelle is thus on the brink of local extinction in Ladakh and implementing a well planned species recovery programme is urgently required. Based on the ecological and socio-economic information presented in previous chapters, the present chapter outlines a strategy for conservation of the Tibetan gazelle. We identify both short term and long term objectives of the species recovery plan, and outline the on-ground activities required to meet those objectives.

Vulnerability of small populations

Small populations are more vulnerable to extinction, especially if the deterministic causes of decline persist (Soule 1986). The probability of extinction of small populations is higher due to catastrophic disease incidents, genetic, demographic and behavioural constraints, and environmental stochasticity. Small populations have relatively low genetic variability (heterozygosity), that makes them more vulnerable to a mass cause of mortality like disease or susceptibility to severe cold or drought. In small populations mating often occurs between closely related individuals due to lack of choice which may result in 'inbreeding depression' which involves a reduction in individual fitness thus increasing chances of extinction (Frankham 1995, Bijlsma *et al.* 2000). Studies show that populations at higher levels of inbreeding are more prone to extinction and beyond a threshold size, populations may suddenly go extinct (Frankham 1995). Small populations may also have a higher risk of accumulating mildly deleterious genetic mutations that ultimately make them more vulnerable to extinction. Empirical estimates indicate that populations with effective sizes smaller than 100 (and actual sizes smaller than 1,000) are highly vulnerable to extinction via a mutational meltdown on timescales of approximately 100 generations (Lynch *et al.* 1995).

Disease epidemics can result in the local extinction of species, as exemplified by the African lion (*Panthera leo*) due to canine distemper (Roelke-

Parker *et al* 1996) and gaur (*Bos gaurus*) due to rinderpest (Karanth 1982). Disease tends to reduce the fitness and thus recruitment in populations, and this contributes to further population declines. Partly as a result of increased homozygosity, small populations are more vulnerable to disease outbreaks.

Inverse density dependence at low population sizes, also called the Allee effect, contributes to the vulnerability of small populations (Stephens & Sutherland 1995). Underlying this vulnerability is the random fate of each individual, i.e. demographic stochasticity. This is inherent to any demographic process, regardless of the environment or quality of habitat, and its strength increases as population size gets smaller. In particular, random fluctuations in the proportion of males and females and the way they pair for reproduction (i.e., the social mating system) are important in determining extinction risk of populations, and their negative effects get accentuated at low population sizes (Legendre *et al.* 1999). Small populations may result in unfavourable sex ratios or unavailability of breeding individuals in a population that may ultimately result in greatly reduced recruitment in the population (Dennis 2002). Some studies suggest that the adverse effects of demographic stochasticity on territorial species may be more pronounced (Lande 1987). Finally, small populations are vulnerable to environmental stochasticity where a catastrophic event such as a severe winter or drought can easily kill the entire population (Jacobson *et al.* 2003).

Threats and causes of decline of the Tibetan gazelle

Any plan to look at the recovery of the gazelle has to consider working at multiple scales and time frames. The gazelle in Ladakh is exposed to numerous threats as discussed for the small populations above, but some specific ones need further discussion. Threats such as competition from livestock are more widespread, while hunting may be an issue locally. In this section we briefly discuss some threats and their current relevance to gazelle conservation. As discussed in Chapter 1, there were two groups primarily responsible for hunting in Changthang in the past – the military and the Tibetan refugees. Hunting by these groups continued until early 1980's when the local Wildlife Department curtailed it. Hunting was essentially for food rather than for sport. Rations were in short supply, especially during the period when India and China fought a war in 1962. We were informed by nomads that there were occasions in the late 1960's when entire truck-loads of gazelles were hunted in certain valleys. During seasonal aggregations, such hunting may have led to immediate extinctions of entire populations in valleys. Although hunting

was brought under control, the gazelle populations failed to recover, and in fact, continued to decline. It is likely that the small surviving populations of the gazelle faced genetic, stochastic and Allee effects which were precipitating continuing declines. The species was also being presumably out-competed by an increasing livestock population (Chapter 2). The sudden intensification of livestock grazing was caused due to the influx of Tibetan refugees who were also pastoral, and the subsequent interventions by the Government to boost cashmere or *pashmina* production in the region. The increase in number of families due to a reduction in polyandry and the addition of Tibetan refugee households resulted in the need for further partitioning of the pastures. These developments resulted in intensification of grazing cycles and consequently in the decline in pasture quality (Hagalia 2004, Bhatnagar *et al*. 2006 b).

To summarize, the gazelle population in Ladakh today faces the following threats:

1. Small population and associated genetic, demographic, and behavioural threats (discussed above).

2. Competition with livestock: This is probably the foremost threat to gazelle's survival in Ladakh today. Competition and presumably the degradation of pastures has rendered most of the habitat unsuitable and has restricted the gazelle to very small pockets that have relatively lower grazing pressures. As discussed in Chapter 2, gazelle, being a small ruminant, needs more nutritious forage than larger herbivores and thus tends to consume a greater proportion of forbs, which usually are more nutritious than the graminoids. Our data also shows that the proportion of forbs in the areas used by gazelle was higher than adjacent unused areas that had greater livestock grazing pressures (Chapter 2).

3. Severe winters and associated forage scarcity: Gazelle live in harsh environments where severe and prolonged winters can cause heavy mortality. Between October 1998 to May 1999, for example, Changthang received relatively heavy snowfall. With the already sparse and dry forage now covered by snow, there was considerable mortality of gazelles. Gazelles of Kalak Tartar declined during this episode from *c.* 70 to *c.* 40 individuals (Chundawat & Qureshi 1999, Pfister 2001). Livestock also suffered losses, but the Government was able to provide emergency supplies of livestock feed. Starvation mortality during such episodes has the potential to wipe out the entire surviving population of gazelles.

4. Potential disease outbreaks and transfer of alien diseases: Fatal diseases such as *Peste des petits ruminants* (PPR) and Foot and Mouth disease (FMD) have been recorded in livestock sympatric with the gazelles of the Changtang. The latter is an alien disease and was presumably introduced in the local livestock through un-quarantined livestock imported into Ladakh from other parts of the country and also neighbouring Tibet. There was a PPR outbreak in livestock during the winter of 2003-04 in the Rongo village in the Hanle valley (Dr Phuntsok, Sheep Husbandry Dept, Leh, Pers. Comm.). While we have not documented any disease related mortality in gazelles, diseases such as PPR can potentially wipe out the existing population of Hanle in a single year. Such diseases could cause greater harm if outbreaks coincide with severe winters.

5. Lack of awareness among local herders, officials and military regarding the precarious status of the gazelle: Although most of the local herders were aware of the occurrence of gazelles in Hanle, they were unaware that the species has already been lost from most of Ladakh. During our meetings, most of them agreed that excessive livestock grazing could be one of the causes of the gazelle's decline (Annex 2). They also saw a potential for tourism in the region if a participatory conservation programme for the species could be implemented and its population recovery facilitated (Annex 2). We see a possibility for gazelles to serve as an icon of their local heritage and this can be potentially used to garner support from the nomads.

The other major target group for promoting awareness about the gazelle is the armed forces, which has a considerable presence in Ladakh. Many of the soldiers and officers we spoke to were unaware of the existence of the species or its precarious status. Such a lack of awareness could potentially lead to further hunting of the species, and should be an important matter of concern for any conservation programme.

Goals & Strategy

Averting the imminent local extinction of the Tibetan gazelle from Ladakh will require a two-pronged strategy – consolidating the gazelle population in the Hanle Valley, and subsequently facilitating a re-colonization of parts of its former range. Immediate steps are needed to minimize the risk of starvation related mortality in winter, reduce competitive pressures from livestock in its habitat, completely removing any threats of hunting, and promoting local awareness about the precarious status of the species. All these activities need to be carried out with the

participation and involvement of the local community. Below we set out both the short-term objective and immediate action required in Hanle Valley, and the long-term objectives and related action.

Short-term objectives

1. Ensure survival of the gazelle population in Hanle Valley and arrest further declines: Exclude all causes such as starvation related winter mortality and disease outbreaks so that the existing population does not dwindle further. Further ensure that no hunting is undertaken by anyone - neither locals nor outsiders.

2. Facilitate recovery such that the Hanle population serves as a "source" population for future action

The possible actions to meet these short-term objectives, and their merits and limitations are outlined below:

1. *Supplemental winter feeding*: The sparse forage in gazelle habitat often gets covered by snow and becomes unavailable for prolonged periods during severe winters, which can lead to mass starvation. The risk of winter mortality due to starvation needs to be completely removed, as it can deplete the entire population in a single catastrophic event. The Wildlife Department had experimented with provisioning gazelles in Kalak Tartar with c. 80 quintals of with alfalfa imported from the plains and other parts of Ladakh during the winter of 2004-05, which the gazelles did not accept. However, during the winter of 2005-06 a similar amount of fodder was provided that was used by kiangs and some gazelle (Angchuk, Range Officer, *pers comm*.). Gazelles and small antelopes have been reported to often reject provisioned fodder (see Raman et al. 1996). In the case of the Tibetan gazelle, the non-use of provisioned fodder may also have been due to inappropriate placement of the fodder. Continued small scale experiments to provision gazelles should perhaps continue. It may be desirable to start a participatory programme involving the residents of Hanle who could be engaged in growing local species of forbs such as *Oxytropis* sp. and *Astragalus* sp. through initial trials.

The extent of provisioning, however, would need to be strictly controlled. Excessive consumption of very nutritious forage in winter, when most of the available forage is of relatively low quality, can potentially cause rumen acidosis and lead to mortality (Owens *et al*. 1998).

2. *Provisioning supplemental feed to herder households using gazelle areas*: Rather than attempting to provide imported fodder to the gazelles, it could be used for provisioning local livestock, thereby deflecting the winter and spring grazing pressures from the gazelle habitat. Our data suggest that a relatively small number of livestock (c. 2000 sheep & goats belonging to c. 16 households) use this area for on an average 30 days every winter-spring. This would translate to a fodder requirement of c. 420 quintals (based on an average winter consumption of 0.7kg dry forage per day (Foose 1982, Bhatnagar *et al*. 2006b)). Caution however needs to be exercised here that provisioning of supplemental feed should not catalyze further increase in livestock population.

3. *Creating grazing-free areas through community participation*: The Kalak Tartar and Zato slopes, particularly the forb dominated areas, will need to be freed from livestock grazing through agreements with the community, and incentive programs (e.g. Mishra *et. al* 2003). One means of such compensation was discussed above whereby supplemental feed is provided to households using the region (point 2 above). In return for lost grazing, the community can also be provided alternatives and incentives such as assistance with fencing of their crop-fields to prevent crop damage from the kiang, a problem that seems to be intensifying in recent years with the emergence of cultivation as an important occupation (Chapter 3).

Another option is to find alternate suitable pastures where affected households can be encouraged to graze during winter months. We have confimed that such pastures do exist in the upper reaches of Kuyul catchment, which is about a days walk from the existing winter camping area. Some households from the Kharloog pa group already take their livestock to these pastures during winter, the critical period. For this the Kuyul people charge Rs. 20/yak and 4/ sheep or goat for the three months during the winter. Involvement and support of the Stockchen Rimpoche, the head lama of the Tashi Choeling nunnery in Hanle, will be extremely useful.

Eventually, these efforts will need to be expanded to include other potential adjacent sites such as Phuktagu, Zato, Giagra, Dokpadesa, Srubra and Zakle so that gazelle range in Hanle could be expanded to c. 100km2 from the present 20km2. However, it must be emphasized that these recommendations are only indicative, and will need to be discussed with the community. Only mutually acceptable recommendations should be implemented, since imposing any of the steps without the communities' support will be detrimental to gazelle

conservation.

4. *Habitat improvement*: Even if livestock grazing can be curtailed in gazelle habitat, it may be important in the initial stages to seasonally protect some patches of forb-dominated vegetation to facilitate greater forage biomass availability to gazelles in winter. In addition to livestock, there is a high density of kiang *Equus kiang* in the Hanle Valley including Kalak Tartar (Bhatnagar *et al*. 2006b) that may deplete resources for gazelle. This may not however be a major constraint as kiangs prefer coarser grass species (Schaller 1998) and may thus help facilitating growth of forbs by thinning the grass cover (Chapter 2). Small, low-impact protective fencing of forb patches during summer, which can be removed as winter approaches, will facilitate greater forage availability to gazelles during winter. Our studies have identified that the south-facing slopes of the Dokpadesa, Giagra, Zato, that are south facing (lower snow pack) and are exposed to wind (blowing away snow) were used more during winter and spring by the gazelle. Forb patches within these areas need to be seasonally protected.

5. *Community involvement and protection - establishing a gazelle protection force:* A small group of motivated youth from the local community needs to be engaged to work closely with the staff of the Wildlife Department. They would serve to act as guards and informers to deter hunting, as well as participate in other conservation actions. They will need to be sensitized and trained in all aspects of gazelle conservation and monitoring, and will serve as the bridge between conservation agencies and the local community. This will also provide an opportunity, albeit small, for local herders to benefit from the continued presence of gazelles in the region.

6. *Livestock disease control and vaccination of livestock:* The regional Sheep Husbandry Department has a vaccination programme for local livestock. Greater co-operation between the Wildlife and Sheep Husbandry departments, closer monitoring and vigilance are required to ensure that the entire livestock population in and around gazelle habitat is periodically vaccinated.

7. *Control of the feral dogs:* Feral dogs in the Hanle basin pose a direct threat to the small gazelle population in the Rique plains, though the Kalak Tartar region remains relatively protected so far. This is part of a larger problem that needs to be addressed regarding conservation of other species such as black necked cranes *Grus nigricollis*. There seem to be two causes of the abundance of feral dogs in the valley. Firstly, nomads keep guard dogs, which are not necessarily

trained for shepherding, and often become feral. Secondly, the military camps in the valley produce large amounts of garbage that helps sustain the dog population. These large packs are known to prey on crane eggs and also harm gazelle, kiang and even livestock. It is important that an extermination drive is undertaken and the nomads as well as the military are made aware of the ways in which they can help reduce the dog menace in the valley.

8. *Continued research and monitoring:* Further research on the ecology, and in particular on the population structure, diet, and disease and parasite loads of the gazelle needs to be promoted. A good monitoring programme for the gazelle and local landuse needs to be initiated. It is also important to understand the genetic diversity of these gazelle populations that have undergone drastic reductions in both range and population size and are now restricted to very small insular populations. Given the small population size, it is important to promote noninvasive techniques for research and for gathering such genetic information that can shed light on levels of heterozygosity and duration of isolation.

9. *Education and Awareness:* Important stakeholders who directly affect the gazelle, and can play a key role in its conservation, are the herders and the armed forces. While the former depend on the area for their livelihood and have a historical presence, the personnel from the armed forces are present in the area over short periods. Both these groups need to be made aware about the precarious situation of the gazelle, the importance of Hanle Valley, and their role in the conservation of the species. Some immediate action can be through awareness material such as posters and hoardings. Given the short tenure of military personnel in the area, it is important that attractive material with these messages is made available to them periodically. We have designed and begun distribution of a desktop poster (Plate 1) that can assist in generating such awareness.

Some informative signboards also need to be put up in Hanle to make people aware about the existence of the gazelles and ensure greater visibility of the J&K Department of Wildlife Protection in the region. One such signboard near the Loma Bridge and one near Kalak Tartar with a brief message about the region being the last refuge of the Tibetan gazelle in Ladakh, their small numbers, and continuing threats to their survival will be appropriate.

This ongoing process will evolve into long-term goals so that all stakeholders are informed about progress in conservation efforts and their own changing

roles. The unique partnership between managers, local communities, scientists and the military needs to be promoted as a model.

Long-term objectives

1. Facilitate the recovery of the gazelle population in Hanle Valley to over 100 individuals such that this population can serve as a source

2. Restock historical populations of the Tibetan gazelle after habitat improvement

We discuss some possible actions to meet these long-term goals and their merits and limitations below:

1. Generating a surplus of over 100 gazelle in Hanle: The 'largest' population of the gazelle in Ladakh numbers just about 40 animals restricted to the Kalak Tartar plateau. This current range of the gazelle needs to be expanded to include many other sites within the Hanle Valley. We expect that with the implementation of actions listed in the previous section, the current population can colonize adjoining areas and eventually grow to a population of over 100 in Hanle. As discussed above we need to gradually expand the 'gazelle area' in Hanle from the present 20-30km^2 to cover over 100km^2, in the next 5-10 years. This can hopefully expand the population to a level when ex-situ conservation and possible relocation to other sites becomes a feasible option.

2. Identify other remnant populations and secure them for gazelle: An important step is to clearly identify all areas where gazelle were known to occur in the past or where small populations may still occur. Potential areas are listed in Chapters 1 and 2 and include Tso Kar, Chushul, Chumur. The extant threats to gazelles or their habitat in these sites will need to be understood, Conservation efforts then should focus on working with local communities in a manner similar to that outlined above.

3. Captive breeding, restocking or reintroductions: From the surplus of the 100 gazelle a captive breeding facility could be started for the gazelle using the IUCN guidelines to develop a stock of gazelle that can then be reintroduced into selected and restored sites.

Conclusion

The Tibetan gazelle in Ladakh is in a precarious state and may go extinct due to continuing pressures, notably livestock grazing, and other stochastic and genetic

risks faced by small populations. Conservation efforts to prevent the species from extinction in Ladakh need to begin with the largest surviving gazelle population of Kalak Tartar in the Hanle valley. Owing to the critical nature of this population, immediate steps are required to avert any further declines of the species in Hanle. Their survival through severe winters needs to be facilitated through habitat improvement using seasonal low impact fences, and by making the Kalak Tartar and adjacent Zato slopes free from grazing through herding contracts and incentives to herders. One such alternative is to provide supplemental forage to the households who use the region during the short period of winter and spring so that they can discontinue using Kalak Tatar. Similar efforts can be undertaken in the adjacent parts of Hanle valley so that the gazelle population here eventually crosses 100. A gazelle protection force from the local community needs to be established. Livestock health care and vaccination need to be strengthened to minimize any threat of disease outbreaks. Simultaneously, other potential sites need to be identified and protected/ improved in a similar manner. The surplus over 100 gazelle in Hanle can then be used in a scientifically designed captive breeding program (using IUCN guidelines) to create a pool for restocking gazelles in select restored sites. All these efforts should be backed up with education and outreach programmes for all stakeholder groups – particularly local herders and the military, to elicit their informed participation in the gazelles' recovery. We believe that a truly inclusive and participatory species recovery programme, involving partnerships between wildlife managers, local communities, scientists, livestock husbandry departments, and the military, can secure the future of this fascinating species of Ladakh's highlands.

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Short Communication

Decline of the Tibetan gazelle in Ladakh, India

Yash Veer Bhatnagar, Rinchen Wangchuk and Charudutt Mishra

Abstract The Tibetan gazelle *Procapra picticaudata* is endemic to the Tibetan plateau. In the Ladakh region of northern India its range declined from *c.* 20,000 km^2 in the early 1900s to *c.* 1,000 km^2 in the late 1980s. Here we report the results of our recent (1999–2003) assessments of the gazelle's conservation status in Ladakh. Range-wide surveys indicate that the present population of the Tibetan gazelle in Ladakh is *c.* 50, restricted to a range of *c.* 100 km^2. Populations in the Tso Kar basin and Dungti have gone extinct within the past decade. Throughout the last century hunting was the primary cause of the gazelle's decline. Although hunting has been brought under control in the last two decades, intensified livestock grazing appears to have prevented the gazelle's recovery and may be precipitating further declines. The species needs immediate, participatory conservation management, as well as a reassessment of its IUCN Red List status.

Keywords Antilopinae, declines, livestock, *Procapra picticaudata*, Tibetan gazelle, Trans-Himalaya.

The Tibetan gazelle *Procapra picticaudata* is endemic to the Tibetan plateau. Its historical distribution was wide, occurring across most of the Tibetan plateau from Sichuan and Gansu provinces in the east, Xinjiang province in the north, Greater Himalaya in the south, and the Changthang region of Ladakh in the west. The species inhabits open plains and mountain slopes, and relatively mesic sites on the otherwise arid Tibetan plateau. The ecology of the species remains poorly understood, with only two studies of its status and distribution in Tibet and preliminary observations on its diet (Harris & Miller, 1995; Schaller, 1998). Here we present the results of surveys of the species in the Ladakh region of India, and summarize the factors that have determined the gazelle's current precarious status and are likely to influence the prospects for its survival.

Within India the gazelle has been reported from eastern Ladakh and Sikkim (Fox *et al.*, 1991; Shah, 1994). Eastern Ladakh is an extension of the Tibetan plateau and is characterized by high altitude plateaus (> 4,200 m) and rolling slopes interspersed with lake basins. The vegetation includes open alpine steppe communities with *c.* 15% vegetation cover. Vegetation is usually dominated by grass, and biomass rarely exceeds 15 g m^{-2} (Schaller, 1998; data from adjoining sites in Tibet). The growth season is limited to June–September and temperature regularly falls to –30°C during the long winter.

The gazelle was relatively common during the early 20th century when it occurred over much of the *c.* 20,000 km^2 Changthang region in eastern Ladakh (Burrard, 1925; Stockley, 1936; Fig. 1). However, by the early 1980s excessive hunting had reduced this range to *c.* 1,000 km^2 (Fox *et al.*, 1991). Although hunting was brought under control by the late 1980s, gazelle populations did not recover (Chundawat & Qureshi, 1999). The species is currently accorded the highest conservation status in Schedule I of the Indian Wildlife (Protection) Act 1972 (Anon, 1992). Its Red List status has been categorized as Critically Endangered within India (Anon, 1998).

In October 1999 and August 2000 we surveyed the entire historical range of the gazelle in Ladakh. We searched for gazelles from a slow moving vehicle (10–12 km h^{-1}) covering 1,232 km in eight blocks (Kharu-Changla, Changla-Tangtse, Parma Valley, Pongong Tso (south bank), Chushul-Tsagala-Loma, Loma-Demchok (Upper Indus), Loma-Rongo-Hanle (Khaldu), and Hanle – Kalang Tar Tar. In the non-motorable areas of Hanle *c.* 20 km was covered on foot. In all areas we interviewed local people about the past and current occurrence of the gazelle.

The survey confirmed the occurrence of the gazelle only in the Hanle Valley. Two populations reported

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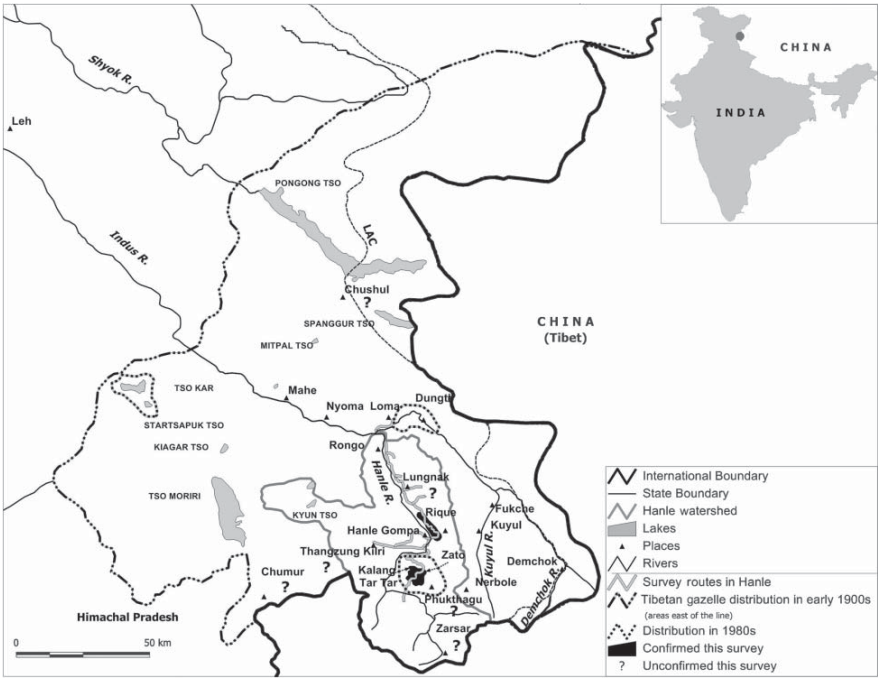

Fig. 1 Past distribution of the Tibetan gazelle in Ladakh and the present distribution in the Kalang Tar Tar (KTT)-Zato plateau and the Rique plains of the Hanle valley. The distribution in the early 1900s is deduced primarily from Burrard (1925) and Stockley (1936), and that in the 1980s is based on Ranjitsinh (1981) and Fox *et al.* (1991). The inset indicates the position of the main map on the border between India and China.

along the upper Indus valley near Dungti and Tso Kar (Fox *et al.*, 1991; Shah, 1996) have gone extinct within the last decade. Enquiries with herders and army personnel suggested the presence of a hitherto unreported small population near Chumur and Chushul (Fig. 1), but this is unsubstantiated.

We made observations of the gazelle population in Hanle Valley (*c.* 2,800 km^2; Fig. 1) in the late winters (April) of 2001 and 2003. The valley has six permanent settlements, inhabited by the original pastoral *Changpa* and those from Tibet who came as refugees since the 1960s. The total livestock population in the valley (mainly goats and sheep) is *c.* 30,000 (Sheep Husbandry Department, Nyoma, unpub. data, 2001). We searched for gazelles from a slow moving vehicle between Rongo and Kalang Tar Tar (Fig. 1). The main and adjoining valleys along the Hanle River were scanned, covering a distance of *c.* 100 km. We also conducted *c.* 95 km of foot surveys in Kalang Tar Tar-Zato and between the Lungnak Lungpa and the Hanle Gompa, the two areas where we confirmed the gazelle's presence during the earlier survey. In addition to direct sightings, we recorded gazelle dung and latrine sites as an index of their abundance along 71 transects (30 * 2 m), where we also enumerated livestock dung. Gazelle dung (average length $\pm$ SE 9.4 $\pm$ 1.7 mm) is smaller than adult sheep-goat dung (13.7 $\pm$ 1.8 mm) and was thus easily discernable (Y.V. Bhatnagar, unpubl. data), and because domestic lambs and kids are grazed by herders separately near camp sites there was no confusion between livestock and gazelle dung. Interviews with *c.* 50 herders yielded further information on gazelle occurrence and about livestock holdings and movement patterns.

We estimate the gazelle population in Kalang Tar Tar to be *c.* 30 based on our sightings (a maximum of 17 individuals in four groups seen during April 2003) and

interviews with local herders. These individuals are restricted to an area of *c*. 20 km² in the upper part of the plateau. This is presently the single largest population of the gazelle in Ladakh. Extensive searches in adjoining areas, covering 5–10 km in all directions, yielded no sightings, although we did record old dung in the Phuktagu area (Fig. 1).

On the Rique plains we sighted a maximum of six gazelles (two males, two females and two young) during the 2001 survey. Herders believed this constituted the entire gazelle population in the area. In 2003 we located only five individuals. In contrast to the relatively well vegetated (25–35% plant cover) Kalang Tar Tar, this flat valley at 4,300–4,500 m is a stony desert with sparse plant cover (8%). According to herders these gazelles colonized the area from Kalang Tar Tar after a severe winter in 1998–99. The herders also reported a small population (3–4) near Zarsar and in Thangzung Kilri until *c*. 5 years ago (Fig. 1) that they now believed to be extinct.

Our estimate is that *c*. 40 Tibetan gazelle survive in the Hanle valley over an area of 50–80 km² of Kalang Tar Tar and the Rique plains. Thus, including the possibility that there are some individuals in Chushul and Chumur, our estimate of the present gazelle population in Ladakh is *c*. 50 over a range of <100 km². Entire populations have been lost and others are declining. The Kalang Tar Tar population, for example, numbered at least 68 in 1997 (Pfister, 2004), and at least 36 in 1998 (Chundawat & Qureshi, 1999).

Across the Tibetan plateau the species occurs patchily at very low densities (Schaller, 1998). It is reported to feed on forbs and some dwarf shrubs and sedges; life-forms that are patchily distributed in the grass-dominated Tibetan plateau (Schaller, 1998). Thus, the species may be naturally restricted in distribution and abundance.

Despite its inherently low density the species was commonly hunted throughout the 20th century (Mallon & Kingswood, 2001). Even early authors (Burrard, 1925) commented on the decline of the gazelle in Ladakh due to excessive hunting. During the 1960s large contingents of the Indian Army and paramilitary forces moved into eastern Ladakh and, according to the elders in the herding communities, the gazelle was commonly hunted by the army as the animals could be easily approached in vehicles. Hunting pressure possibly escalated with the influx of Tibetan refugees, some of whom admitted hunting gazelles in the past.

Our own observations, interviews with herders, and talks with officials of Ladakh's Wildlife Department, suggest that hunting has been uncommon since the 1980s due to the implementation, and also awareness of, conservation laws. The gazelle populations have, however, continued to decline. Small populations are known to be more vulnerable to extinction (Soulé, 1987; Korn, 1994), and livestock grazing may have played a significant role in preventing the recovery of the species in Ladakh. Our data from dung transects in Hanle suggest a possible negative correlation between the abundance of livestock and gazelles (Spearman's $R^2 = 0.67$, $P = 0.08$). The Kalang Tar Tar area, with the largest remaining gazelle population in Ladakh, is a region of relatively low livestock grazing, as it forms the upper fringe of the spring pastures for local livestock, and is *c*. 10 km from the summer pastures. Similarly, on the Rique plains the small population of gazelle is restricted to a narrow patch that is relatively free from livestock grazing due to local herding practices.

Across Ladakh the livestock population has doubled in the last 30 years (Bhatnagar & Wangchuk, 2001), although data are not available specifically for eastern Ladakh. The number of families rearing livestock increased with the influx of Tibetan refugees and because of the breakdown of the herders' traditional polyandrous system (Headman of Khaldu village, pers. comm., 2001; Hagalia, 2004). Rearing of the *pashmina* goat for its valuable wool has also been significantly promoted in eastern Ladakh, and has included the provision of supplemental feed (Bhatnagar & Wangchuk, 2001). In addition, the loss of many traditional pastures due to border disputes with China (e.g. Skagzung in the upper Indus) has intensified the grazing pressures in eastern Ladakh (Phuntsok, 2000; Hegalia, 2004). In summary, as in the case of other Trans-Himalayan mountain ungulates (Mishra *et al*., 2004; Bagchi *et al*., 2004) it appears that resource competition with livestock, and other collateral effects of livestock grazing, have prevented the recovery of the Tibetan gazelle.

The Tibetan gazelle is on the brink of local extinction in Ladakh. Conservation efforts to stabilize and increase its population are required with livestock-free areas created in and around the gazelle's existing range by providing incentives to the herding community (Mishra *et al*., 2003). In the longer term, reintroduction plans need to be devised for areas such as the Tso Kar basin, after reducing pressures there and restoring the habitat.

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Biographical sketches

Yash Veer Bhatnagar and Charudutt Mishra study grazing systems, pastoralism, carnivore ecology and human-wildlife conflicts in the high altitudes of the Himalaya. They also run community-based conservation programmes and jointly direct the India Program of the International Snow Leopard Trust.

Rinchen Wangchuk is an avid naturalist and works for the Snow Leopard Conservancy. His primary interests are evolving innovative community-based tourism programmes and conflict resolution mechanisms for conservation of the snow leopard range.

Appendix 2: Tibetan Gazelle Conservation In Ladakh

Workshop to formulate strategy for conservation of the gazelle in Hanle, Ladakh, 22 August 2005, Leh. J&K Department of Wildlife Protection and Nature Conservation Foundation, Mysore & International Snow Leopard Trust-India

The Nature Conservation Foundation (NCF) has been studying the status, distribution, ecology and conservation issues of the Tibetan gazelle in Ladakh for over two years. The team has documented hitherto unknown aspects of the species' ecology and conservation through rapid surveys and detailed ecological studies, which were conducted with permissions and support of the J&K Dept of Wildlife Protection (JKDWP).

The studies were designed to produce relevant scientific information regarding the rapid decline of the Tibetan gazelle in Ladakh through focused and short research studies, in order to enable the formulation and implementation of urgent conservation programmes. On the completion of bulk of the research, NCF and JKDWP organized a joint workshop in Leh on 22 Aug 2005 to revisit the research findings and develop a joint conservation plan for the Tibetan gazelle under the existing Memorandum of Understanding between these two bodies.

The first part of the workshop dealt with presentations from NCF and was followed by detailed discussions on opportunities for conservation. Dr. Yash Veer Bhatnagar, Senior Scientist, NCF, presented an overview of the early research conducted by NCF documenting the severe decline in the gazelle's range in Ladakh from *c.* 20,000km^2 in the early 1900's to < 100 km^2 by the year 2000. The population of the gazelle during this period has reduced to a mere 50 animals surviving precariously in Ladakh today. Dr. Bhatnagar briefly touched upon the historical factors causing this decline – primarily past hunting and the subsequent intensification of livestock grazing.

These alarming findings had led NCF to begin a more detailed study on the species' ecology to investigate reasons for continuing declines after the reduction in hunting since the 1980's, as well as to develop a basic understanding of the gazelle's ecology and habitat use in the Hanle Valley. Some of these research findings were presented by Mr. T. Namgail, Research Scholar, NCF, particularly on the habitat characterization of the gazelle in Hanle, which he had jointly conducted

with Mr. Sumanta Bagchi, Research Scholar, NCF. His presentation demonstrated that the small gazelle range in Hanle is restricted to a 'habitat island' that has higher vegetation cover and biomass, particularly of forbs that are known to be preferred by the gazelle. This small patch receives lower livestock grazing pressures compared to the surrounding landscape, with lower forage off take by herbivores compared to the adjacent areas devoid of the gazelle. This research has also established that livestock grazing, in particular by goat and sheep, is primarily preventing the gazelle's recovery in the Changthang. The primary means for gazelle recovery thus has to deal with managing livestock grazing in the region.

Dr. C. Mishra, Executive Director, NCF, then presented the possible short-term & long-term approaches that can be followed for species recovery. In the short-term, our goal should be to halt further declines and facilitate some population growth of the gazelle in the Kalang Tar Tar (KTT) plateau of Hanle. This could be done with provisioning supplemental forage in the critical winter season, or improving the habitat through social/ low impact temporary fencing of parts of the winter range of the gazelle to increase forage availability for the species. We need to find means of reducing or completely excluding livestock grazing pressures from KTT through incentive based participatory programmes. He also reviewed the challenges and limitations of managing small populations based on experiences worldwide with other species. In the long-term it is hoped that further adjacent areas can be freed from livestock grazing so that the population increases to about 100 gazelle, a minimum figure considered for ensuring survival of most species. The surplus over 100 from this population can then be considered for reintroduction/ restocking of former gazelle areas after habitat improvement, either directly or through a captive breeding programme. Other potential areas for the gazelle in Ladakh need to be surveyed and their potential for long-term conservation of the species assessed.

These presentations were then followed by a detailed discussion on the options available for gazelle conservation led by Mr. Jigmet Takpa, Regional Wildlife Warden, Ladakh with significant contribution by Mr. Saleem Ul-Haq, Wildlife Warden, Leh and the range officers of the JKDWP. The three range officers, Mr. Rauf, Mr. Angchuk and Mr. Khatuk, also participated enthusiastically in the discussions. The primary points of discussion were as follows:

1. Mr Takpa said that given the gravity of the situation, JKDWP should immediately post guards in Hanle and strengthen the network of informers

there. The 'Gazelle Guards' will be primarily responsible for ensuring that there is no hunting of the gazelle and for subtly making continued presence of the department felt to all possible offenders and the community too. They will also supervise the conservation programmes that are initiated.

2. Some informative signboards need to be put up in Hanle to make people aware about the existence of the Changthang WLS and the 'Gazelle Reserve' and ensure greater visibility of JKDWP in the region. One such signboard near the Loma bridge and one near Kalak Tar Tar with a brief message about the region being the last refuge of the Tibetan gazelle in Ladakh, their small numbers, and some continuing threats that the species faces will be appropriate.

3. The option of freeing areas from grazing is clearly the only approach to ensure survival and increase in gazelle population. This can be achieved through a combination of incentive programmes and persuasion. To begin with, the 20-30 km^2 of the KTT can be made free of grazing and then other areas can be added at a later date. The help of Stockchen Rimpoche, the head lama of the Tashi Choeling nunnery, needs to be sought to achieve this. In return for lost grazing, the community can be provided alternatives and incentives such as assistance with fencing of their crop-fields to prevent crop damage from the kiang. It was stressed by Mr Saleem that other incentive programmes will also need to be devised to secure long-term co-operation of the community for gazelle and wildlife conservation.

4. Supplemental feeding has numerous potential problems as gazelles and antelopes generally do not take to supplemental forage in the wild. The experiment during the winter of 2004-05 by the department for provisioning the gazelle was also not very successful. Other options such as providing forage to livestock grazing in KTT were discussed. Production of locally grown fodder for provisioning gazelles of the Lal Pahari-Rique plains was also discussed.

5. Habitat improvement can be achieved by erecting small temporary fences in the wintering areas determined during the study so that more biomass accumulates there during summer. This can be opened up for the gazelle in winter so that they have access to higher biomass of natural forage during winter.

6. It was pointed out by Dr. Mishra and agreed by all that many of these measures will have to be taken up as small scale experiments and carried out in a scientific manner. It was also pointed out that given the odds, we must be

prepared for failure, in spite of the best efforts.

7. Mr Saleem pointed out that the Gazelle Guards need to be sensitized and trained in all aspects of gazelle conservation so that they have a good grasp of the scientific principles as well as the long-term vision for the conservation of the species.

8. The discussions in the meeting will be captured in the final chapter of the joint report being developed by NCF and will detail all possible options for conservation, their pros and cons. This chapter will be lead by the JKDWP. The specific recommendations from this chapter will be incorporated in the Management Plan being developed by the JKDWP for Changthang.

9. It was agreed that a separate project on gazelle recovery should be developed jointly by the JKDWP and NCF that includes some continuing specific research, monitoring and experiments in gazelle conservation. This has to go hand in hand with the primary effort to free areas from livestock grazing.

10. It was pointed out by Mr Namgail that the Khaldu-Zarsar road passing through KTT is causing disturbance to the gazelle and efforts should be made to realign that road.

11. Feral dogs can pose a problem to gazelle and other wildlife and efforts should be made to control their population.

Action points

- Department will immediately enhance staff presence in Hanle
- Dr Bhatnagar, T. Namgail and Mr Angchuk, RO, Nyoma, will leave for Hanle to conduct a preliminary consultation with the community in Hanle
- Yash Veer to prepare final draft of report chapter on Gazelle Management Strategy to the CWLW, J&K, Mr Takpa and Mr Saleem for comments. Document to be finalized
- Report printed
- Development of joint project for gazelle conservation to be initiated after discussions with Dr. C.M. Seth.

Participants	
Mr. Jigmet Takpa, Regional Wildlife Warden, Ladakh	Dr. C. Mishra, Executive Director, NCF
Mr. Saleem Ul Haq, Wildlife Warden, Leh	Mr. T. Namgail, Research Scholar, NCF
Mr. Rauf, Range Officer, Nubra	
Mr. Angchuk, RO, Nyoma	
Mr. Khatuk, RO, Leh	

Appendix 3: Tibetan Gazelle (Gowa) Conservation In Hanle

Minutes of the Hanle Meeting on the 25th of Aug. 2005.

All the leaders of the villages in the Hanle Valley and conservationists from the Wildlife Department and the International Snow Leopard Trust gathered at Tashi Choeling monastery, Hanle, at 10:00am on 25 Aug 2005.

Objectives

- Appraise the community about the broad findings of the 5-year study on the gowa by NCF-ISLT
- Discuss ways to develop joint conservation strategies for the Tibetan gazelle in the Hanle Valley and implement it

The visiting conservationists, represented by Mr T. Namgail, conveyed the following message based on the findings of the studies on the Tibetan gazelle carried out over the last five years:

1. The past vast distribution of gowa in the entire Changthang, and its now getting restricted primarily in the Hanle valley, and here too mainly on the Kalak tar tar (KTT) plateau.

2. Stressed that the population and the distribution range has severely declined and that merely 50 might be surviving at present in a very small area of KTT, with little future.

3. With such a small population, the species can go extinct anytime due to winter starvation or disease.

4. It was stressed that it is a matter of pride to have gazelle in Hanle, probably the only area where it has any future chances of survival & recovery.

5. We are here to find the communities suggestions on reversing the declining trend in gowa population and learn about the opinion of the community on the matter.

6. The gazelle has other potentials and can also attract eco-tourists in the future, aspects on which we can provide some help.

The views of the Department the J&K Department of Wildlife Protection represented by Mr. Tsering Angchuk, RO, Nyoma:

1. Stressed the need to understand the ecological balance, and how one thing is related to the other, and annihilating one species can affect the entire ecosystem. As an e.g., the extermination of birds (sparrows) in China led to a population explosion of insects which devastated the crops. Consequently the locals needed to reintroduce the birds from other areas

2. Suggested that there is a need to free certain key areas from grazing for the protection of the gazelle

3. They understand the importance of conserving wildlife with the assistance of the local community, and strict policing is not possible

    a. Provided examples from the plain areas, where local communities were forcefully expelled from the reserved forests, and the local people later retaliated by burning up bulk of the forests

4. The problem of the kiang could be solved at a local level

5. The Wildlife Department has got a funding from the world bank to solve the human-wildlife conflicts

Local perceptions of the causes of the decline in gazelle population

1. Hunting by military personnel as well as some locals
2. The shortage of fodder
3. Increased depredation by the Tibetan wolf

The local communities suggested the following

1. When asked about the possibility of freeing some areas for grazing, they suggested that they will have a meeting with the concerned herders and get back to Mr Angchuk, RO, Nyoma. They agreed that this was one clear way of securing the gowa population in Hanle.

2. There should be watchmen for each small population of gazelle in the area (Raque herd, KTT herd and Thangchung kiri herd).

3. The issue of kiang surfaced again and again, but the conservationists tried to focus on the recovery program for the gazelle. But when queried about what can be done to solve the kiang 'problem', they said that they don't know or nothing can be done. They did not ask for extermination of the species.

4. Locals complained about wolf preying on domestic livestock, and that the predators should be exterminated (the first response of Mr. Angchuk was w.r.t. this complaint)

5. There should be a joint survey by the Department of Wildlife Protection and locals to have a reliable estimate of both gazelle and kiang in the Hanle Valley. They disagreed with the estimate of <500 kiang by the Department and NCF and felt that it was much more and thus offered this suggestion.

Main issues regarding the pasture degradation by kiang

1. The issue of pasture degradation by kiang was put before the government several times.

2. No firm action has been taken till now

3. People have lost hope, and have stopped complaining about it

4. Request the Wildlife Department to redress the issue

Participants		
1.	Stanzin Angchuk	Sarpanch, Buk
2.	Cheme Dorje	Member, Punguk
3.	Nurboo Zangpo	Member, Rongo
4.	Yashi Galtso	Member, Dique, Khaldo
5.	Kunzang Dorje	Panch, Khaldo
6.	Tashi Angchuk	Numberdar, Khaldo
7.	Samchot Tashi	Member, Rongo
8.	Urgian Dorje	Chorpon, TR
9.	Karma Tashi	Chorpon, TR
10.	Tsring Lhundup	Chorpon, TR
11.	Cheme Dorje	Chorpon, TR
12.	Cheme Dorje	Member, Punguk
13.	Paljor	Chorpon, TR
14.	Rinchen Namyal	Chorpon, TR
15.	Sonam Paljor	Chorpon, TR
16.	Sonam Chodan	Member, Khaldo
17.	Tsering Gurmet	Numberdar, Buk
18.	Tashi Rigzin	Member, Rongo
19.	Stanba Tundup	Chorpon, TR
20.	Yash Veer Bhatnagar	Senior Scientist, NCF, Mysore
21.	T. Namgail	Research Scholar, NCF
22.	Tsering Angchuk	RO, Nyoma

The Tibetan gazelle Procapra picticaudata *is on the brink of local extinction in Ladakh. This report summarizes the results of studies on gazelle ecology and the causes of its decline. It also examines the socioeconomics of the nomads who share the range with gazelle in eastern Ladakh. A strategy, including both long-term and short term measures for averting the imminent gazelle extinction from Ladakh and enabling its recovery is outlined in this report, which was a collaborative effort of the Nature Conservation Foundation, the J&K Department of Wildlife Protection and the International Snow Leopard Trust.*