

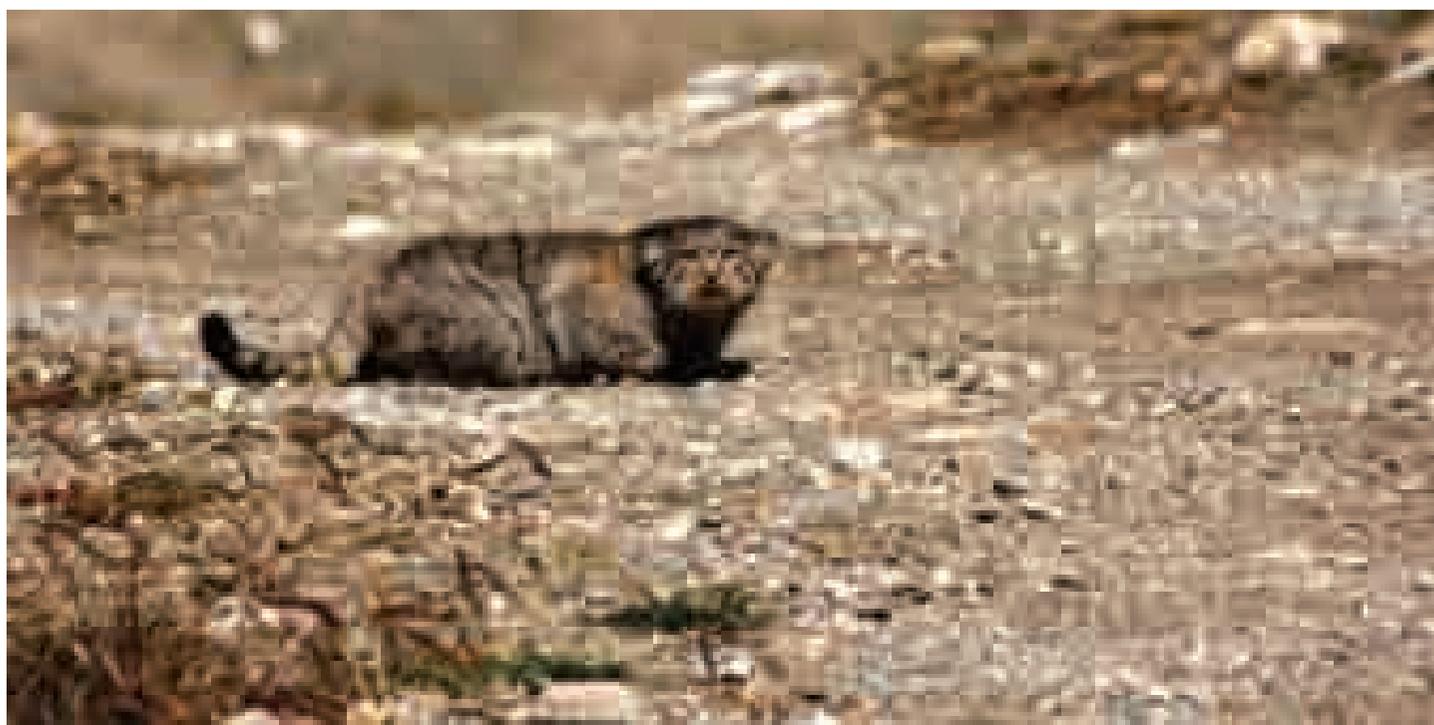
ECOLOGY AND CONSERVATION OF UNGULATES IN TSO LHAMO, NORTH SIKKIM

Pranav Chanchani, G.S.Rawat and S.P.Goyal

ABSTRACT

The Tso Lhamo region, a cold desert sited at an average elevation of about 4,500 meters in the Sikkim Trans-Himalaya, is unique in its geography and ecology. Drawing on some of the findings of our recent field study, this essay delineates habitat use and food section of the region's four wild ungulates - Tibetan argali, Tibetan gazelle, Kiang, and Blue sheep as well as its seasonal population of domesticated yak and sheep; and it graphs select interactions between and among all these species. Over the course of this paper we demonstrate that Tso Lhamo supports healthy populations of the endangered Tibetan argali and Tibetan gazelle. Our surveys also documented the presence of eight other species of mammals, including the elusive Pallas's cat, which is a new record for the state of Sikkim. The diversity of wild fauna at large and wild ungulates in particular is attributable to the mosaic of habitats and plant communities. Furthermore, this essay reveals that while the argali, gazelle, and blue sheep populations of Tso Lhamo appear to largely be resident in this trans-Himalayan area, the Kiang show considerable movement across the political border between India and the Tibet Autonomous Region (China). The persistence of endangered species in Tso Lhamo has been hitherto promoted by its inimitable environmental conditions and a non-hunting ethos in this landscape, which is regarded as sacred realm. Seasonal migrations by the Dokpa herders of yak and sheep from Tso Lhamo to lower elevations also appears to be beneficial to wildlife populations; it reduces potential for competition between wild and domestic ungulates in the long, harsh, winter months. Topsoil erosion, the building of roads and other infrastructure and over-grazing, however, can quickly have a negative impact on wildlife habitats and their current populations. To prepare for this scenario, we propose that specific conservation measures be enacted. Establishing a community reserve in partnership with local communities, government agencies and non-governmental organizations would be a good choice as it would promote conservation without attenuating traditional livelihoods. We also perceive the need for commencing a long-term population monitoring program involving various stakeholders including wildlife biologists and defense personnel to better understand the ecology and behavior of these rare and beautiful mammals.

KEYWORDS: *ungulate; Trans-Himalaya; Tibetan argali; Tibetan gazelle; Kiang; Blue sheep*



Pallas's Cat sighted near Leten in September 2007. This area where this cat was sighted had marmot and pika colonies. At about 4,800 m., this sighting was also a high altitude record for this species

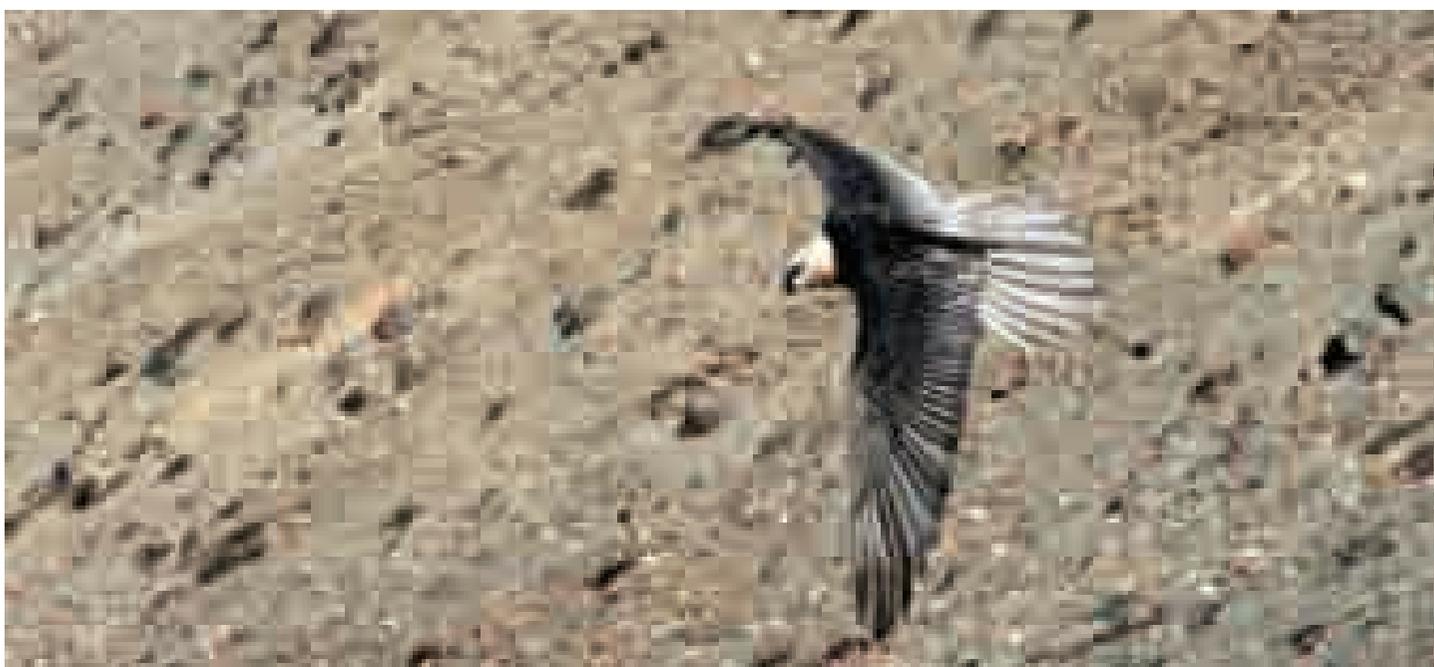


The Lachen chu (Chombo chu) lazily meanders westwards through sedge meadows and sandy banks

INTRODUCTION

The Tso Lhamo region is a small, picturesque, cold desert in the Sikkim Trans-Himalaya. A 400 km² extension of the Tibetan plateau within the political boundaries of India this region has its origins in the prehistoric Sea of Tethys. Evidence of its watery origins survive today in the persistence of the brackish Gyamtshona lake and in fossils of oceanic mollusks which lie scattered on slopes and in gullies. Tso Lhamo, which lies mostly at an altitude of over 4500 meters, remarkably contains more than sixty-five glacial lakes, twelve glaciers, and four peaks that rise above 6700 meters. These are Mount Paunhunri (7125m), Mount Chomo Yummo (6829m), Mount Khangchengyao (6889m) and Mount Gurudongmar (6715m). These formidable natural barriers, however, did not deter seers such as Guru Padmasambhava and many pilgrims and traders headed to and from Tibet from traversing through it. Even more remarkable is the assemblage of flora and fauna that this realm supports to this day.

Tso Lhamo is today home to a number of species that are listed as 'endangered' (schedule I) in the Indian Wildlife Protection Act (IWPA). Prominent among mammalian fauna are top predators such as the Snow Leopard (*Uncia uncia*), the Tibetan Wolf (*Canis lupus chanko*) the Tibetan Sand Fox (*Vulpes ferrilata*), and their prey base. The prey species include the Tibetan Argali (*Ovis ammon hodgsonii*), Tibetan Gazelle (*Procapra picticaudata*) Kiang (*Equus Kiang polygodon*) and Blue Sheep (*Pseudois nayaur*). The wind swept frontier also hosts felines such as the elusive Pallas's Cat (*Felis Manul*) and birds such as the handsome Tibetan snow cock (*Tetraogallus tibetanus*). The former was only recently spotted in the area (Chanchani 2008). The rare Tibetan Antelope (*Pantholops hodgsoni*) reported in Tso Lhamo in the mid 19th century now appears to be locally extinct (Hooker, 1854). Aridity, altitude, and frigid temperatures notwithstanding, the pastures of Tso Lhamo - particularly the sedge meadows along its watercourses - harbour yaks, sheep, and goats herded by nomadic Dokpa pastoralists. The Indian army also maintains a presence in the region. Despite the diversity of endangered wild and domestic ungulates that exhibit distinct habits and habitat preferences, there are only few recent studies on them (Ganguly-Lachungpa 1996, 1997; Shah 1994).



Lammergeyers were seen circling round and feeding on animal carcasses, including that of a yak killed by wolves. Other large raptors include griffons and golden eagles

The unique geography, ecology, and pastoral practices of the Tso Lhamo region and the urgent need for their conservation raises a series of interconnected questions. How many wild and domestic ungulates inhabit the region? What are the major vegetation communities on which they depend? How are these species distributed in space and time, in relation to resources and to one another? Do wild and domestic ungulates compete for the same resources as has been reported elsewhere in similar environments (Mishra *et al*, 2004, Namgail *et al*, 2007)? Moreover, are ungulate populations in Sikkim connected with other populations in adjoining areas of the Tibet Autonomous Region (China). And finally, can prudent land and pasture management permit the co-existence of humans and wild ungulates in this fragile landscape?

Drawing on the results of an intensive study conducted by us over two field seasons comprising of a total of about 150 days undertaken between December 2006 and September 2007, this article first analyzes the landscape, flora, fauna, and pastoral practices of the Tso Lhamo region. It then outlines crucial facts about population, distribution and resource use patterns of four wild ungulates. Finally, there is a discussion of potential conservation measures that can be adopted.

METHODS

A key to understanding the ecology of the four wild ungulates of Tso Lhamo lies in investigating patterns of their distribution and abundance. As species are neither randomly dispersed in space nor in time, but vis-à-vis resources in the environment, and other species in the landscape, these agents must be also carefully documented and understood.

Characterization of vegetation communities and landscape

Vegetation sampling was carried out in a total of 344 releves (294 between December 2006 and end April 2007 and 60 in August and September 2007). About half of these releves were at placed at randomly selected sites within the 33 grids picked for sampling. The remainder of the releves were placed at sites where ungulates were seen feeding. Each releve comprised of five 1m x 1m plots. Within each plot we noted the species present along with their mean height and percentage cover within the grid. Cluster analysis and measures of diversity and richness were derived from releve plot



Team members look for the wary kiang

data using softwares PC ORD and TWINSpan. Using a combination of remotely sensed and data gathered in the field we also prepared a classified image of land cover and vegetation.

Mammalian surveys: occurrence, abundance, and distribution

Mammalian field surveys were also conducted in both field seasons. The study area was initially divided into ten blocks ranging from 19 to 33 km² in size based on topography and vegetation. Using a satellite image the area was further subdivided into 130 1 x 1 minute grids. 33 of these were randomly selected for sampling ensuring that grids were selected from each block. It was our endeavor to survey each of these grids multiple times in the two sampling seasons. While surveying grids, the research team used a combination of methods to detect and record locations of animals including traversing across the grid on foot and scanning from vantage points. All opportunistic animal sightings en-route to the grids were also recorded. Estimates of animal abundance were obtained from nine line transects. 7 of these were vehicle transects and 2 of them foot transects. They varied in length from 2.4 km to 15 km. Each of these transects was repeatedly surveyed and the presence, locations, counts and group structure of ungulates detected along the transects were recorded. Density estimates were then calculated by manually defining the view shed along each transect to estimate the area that was effectively surveyed. More details on these methods can be found in Chanchani 2007 and Chanchani *et al.*, 2010.



Tibetan Snow Cocks are commonly observed or heard calling in the transition zone between the greater and Trans-Himalaya, especially on steep slopes with rocky outcrops and juniper shrubs



Domestic sheep are herded in flocks of 200-500 animals. Like yaks, they spend the winter months in Tso Lhamo

Animal habitat relationships

Broadly, a combination of releve plot data and animal observations along transects and foot surveys allowed an analysis of animal habitat relationships. More specifically, we adopted a use availability design using standard analytical procedures such as ANOVA and GLM's to study resource selection by wild and domestic ungulates. Our analytical approach entailed a comparison of randomly selected sites with sites where ungulates were seen foraging. Predictor variables in our models included slope, aspect, elevation, and vegetation parameters such as species richness and the presence of important forage species.

RESULTS

Vegetation communities

Hierarchical cluster analysis using average abundance (percent cover) values for each plant species in every releve, based on Euclidian distance and Ward's linkage measures indicated nine clusters of vegetation communities. Clusters were analyzed at approximately 53% similarity. Of these we identify three major graminoid communities, five scrub steppe and mixed herbaceous communities and one alpine mist scrub and transitional plant community.

Kobresia sedge meadows are a major graminoid community. These occur in areas of permanent moisture along river and stream courses and the edges of lakes and seepages up to an elevation of 5500 m. Major species include *Kobresia pygmaea*, *Kobresia schoenoides* and *Kobresia royleana*. Associates include *Juncus*, *Pedicularis*, *Poa*, *Trisetum*, and *Gentianella*. *Carex moorcroftii*, which grows in homogenous patches in level or gently sloping areas, forms another graminoid community. It often occurs in close association with *Stipa orientalis* and along the fringes of *Kobresia* meadows. *Stipa* patches form the third graminoid community. *S. orientalis* is among most widely distributed grasses in the Tso Lhamo region. It tends to occur in small patches on gentle slopes as well as steeper scree slopes. *Stipa* associates include *Phlomis rotata*, *Anaphalis* sp. and *Stipa* sp. Scrub steppe and mixed herbaceous communities include the following: *Ephedra gerardiana* – *Anaphalis* – *Artemisia* – *Oxytropis*, *Lonicera spinosa* – *Elymus nutans*, *Androsace* – *Arenaria* – *Saussurea serecia*, *Potentilla biflora* and *Hedinia* – *Elsholtzia* – *Dracocephalum*. The *Juniperus* – *Rhododendron* – *Anaphalis* community is found in the transitional zone between the greater and Trans-Himalaya, covering an extensive area between Thangu and Giagong villages. Associates include *Ephedra* sp., *Juncus* sp, *Salix* sp, *Hippophae tibetana* and *Myricaria prostata*.

Wildlife occurrence, pastoral practices, and land use

Tso Lhamo's magnificent wildlife has been long appreciated. Sir J.D. Hooker, a British explorer who spent time in region in the 1830's was awestruck by the diversity and abundance of animal life. We were as astonished as him, for this



A Sand Fox in its summer pelage. The winter coat is lighter and denser. Foxes were sometimes observed excavating pika burrows and pair formation occurs in the winter



Male Tibetan Gazelle forages on withered forbs in a valley in the winter. Females are hornless

small region supports sizable populations of globally threatened ungulates, some of which are among India's most endangered species. The realm is a stronghold for the Tibetan Argali, which are distinguished by their enormous set of curved horns. A population of as many as 200 individuals are concentrated in an area of roughly 50 km², centered around Lake Gyamtshona. Tso Lhamo is also home to the country's most significant population of the nimble Tibetan gazelle. The area around Kerang supports a Kiang population. At least one observer believes that the Kiang in the Tso Lhamo region is actually a sub-species called the Southern Kiang (Shah, 1994). Eurasian lynx (*Lynx lynx*), wolves and sand foxes are the major predators. Among the smaller herbivores Himalayan marmots, (*Marmota himalayana*) Plateau Pikas (*Ochotona curzoniae*) and Woolly Hares (*Lepus oiostolus*) commonly occur in the area. The Siberian weasel (*Mustela sibirica*) is less common. This high altitude landscape also harbours diverse bird life including migratory waterfowl species that come to breed in the wetlands of the meandering Teesta in the broad Chombo chu valley.

Hooker also recorded the presence of the Tibetan Antelope or Chiru (*Pantholops hodgsoni*) in Tso Lhamo. His sketches have outlived this species; the chiru now appears to be locally extinct. Hooker and other British travelers who followed in his wake also mentioned the prevalence of domestic yaks and sheep that are herded in this region. For many generations, the Dokpa herders have endured sub-zero winter temperatures while grazing their livestock on the withered remains of vegetation and guarding them against the attacks of wolves and feral dogs. Currently, these herders migrate to the Tso Lhamo cold desert with its limited snow-cover in October-November and return to their summer ranges in the adjacent Lasher-Giagong regions by early May.

This system makes a large area available for grazing throughout the year and allows the Dokpas to use forage resources in a sustainable manner. Incidentally, it also reduces disturbance and the potential for resource competition during the summer when the argali and gazelle drop their young. Apart from the forage that their one thousand yaks and an equal number of sheep consume, the herders extract little from their environment. The rudimentary shelters that they live in often blend impeccably with the stark landscape. There being no wood in Tso Lhamo, yak dung serves as the source of fuel for heating and cooking through the winter months. Dairy is not a prominent industry and livestock primarily serves as a meat source for the Dokpas and the larger population of the relatively low lying Lachen region.

Multiple communities regard Tso Lhamo and its myriad life forms as sacred. Even the slaughter of livestock is carried out at lower altitudes outside the region. The absence of hunting is testified by the relative fearlessness of most wild animals here. And while a majority of wild species are respectfully tolerated by the Dokpas, they dread wolves and other predators who sometimes attack their livestock.

Besides the Dokpas, the other significant human population in Tso Lhamo comprises of the Indian Army and other Indian defense forces. These agencies are protecting our nation's borders with Tibet Autonomous Region (China). Although large human presence and settlements are generally undesirable in pristine wildlife habitats, the defense forces in Tso Lhamo are playing a small role in protecting its wildlife. Their presence in the area has restricted the entry of casual visitors, tourists and livestock grazers in some portions of the region which happen to be important wildlife areas. Further, the army is refraining from hunting and is committed to preventing from others from doing so.

Army presence has however resulted in some the development of some infrastructure: the most damaging of which is probably the construction of paved and unpaved roads. Given the ease of road building in Tso Lhamo, new roads are often made in important wildlife areas. This damages the vegetation and results in a loss of valuable topsoil.



A long, harsh winter sometimes forces the Tibetan Argali to feed in close proximity to yaks

Abundance and distribution of wild ungulates

The mean density for argali per square kilometer was $4.40 (\pm 3.54 \text{ SD})$ in the summer and $5.93 (\pm 5.03)$ in the winter, with the highest concentrations in the Gyamtshona, Mirdo-Kongra La and Chulung La regions. Mean group size was $23.3 (\pm 20.56 \text{ SD})$. The high standard deviation is explained by enormous variation in group size. Large congregations of argali were often seen. A herd of 107 individuals was recorded in the winter. Their adult male: female ratios were 37:100, whereas the juvenile: adult female ratio was 45:100. For gazelles, the mean summer density was $1.36 (\pm 1.99)$ and winter densities were $1.16 (\pm 1.75)$. Their population in Tso Lhamo appears to have two major areas of concentration; one in the Gyamtshona-Mirdo belt and the other in the Sebu-laOloten zone near Kerang. Mean group size for gazelles was $6.5 (\pm 6.17)$ with much variation in group size, the largest being 31 individuals. For gazelles, the adult male: female ratio was 23:100, whereas the juvenile: adult female ratio was 38:100. Due to sparse data, we could only calculate encounter rates for Kiang. The kiang population in the area is small and confined to a petite area. Our summer encounter rate was $0.1 (\pm .04)$ and the winter encounter rate was $0.03 \pm (0.05)$. Of the ungulates, the status of kiang appears to be delicate. Surveys in the region in 1994 indicated that the population may be around 80-120. We speculate that about 20 kiang frequent this region and the optimal population size of this species in the region may not be much higher. Kiangs are extremely wary of humans: most individuals cannot be approached at distances under 500 meters.

Our study also revealed that populations of argali, gazelle, and kiang are restricted to small belts within Tso Lhamo; these three species were seldom observed south of the Teesta. Further, while the argali and gazelle co-occur in space, the kiang were found to be restricted in their distribution. Blue sheep were largely segregated from the three other species. They were primarily found in the transition zone between the greater and trans-Himalaya. Little trans-boundary movement was observed for the argali and gazelles. Although Kiang sometimes strayed far across the international border, they preferred to stay close to it at most times. Although the entire area lay under snow cover for over two months no significant weather induced mortality was observed in wild ungulates.

Even in the absence of livestock during the summer months, the argali remained in the same venues as in the winter months. Gazelles were now spotted in basins in greater numbers than they had in the winter. No spatial overlap was observed in the distribution of argali and blue sheep; this is perhaps because the two species are similar in size and dietary requirements. There is little existing scientific data on population trends of wild ungulates in the Tso Lhamo area. The fitness and endurance of the animals during the severe winter of 2006-2007, however, may serve as an indicator of their good health.



A herd of male and female Tibetan Argali on a scree slope during the winter rut.
By March, males and females form separate herds



A band of Blue Sheep by the Teesta Khangtse glacier at 5,400m

Animal habitat relationships

The wild and domestic ungulates were generally spatially and occasionally temporally synchronous in their use of resources within the study area. Still, we found some inter-species differences in habitat use. Argali, gazelles, domestic sheep, and yaks were sighted at a mean elevation of around 5100 meters in the winter. Kiangs were sighted at a mean elevation of 5287 meters in this period. Blue sheep occupied a wide range of habitats and were sighted close to Thangu village at about 3500 meters and also on high slopes near the Kanchangyao peak at 5400 meters. Argali used scree slopes to a great extent, and gazelles using both slopes and basins, kiang showed an affinity for gently sloping plateaus and rolling hills. Blue sheep were frequently sighted in meadows in the proximity of steep terrain, moraine, and cliffs.

Blue sheep were commonly observed feeding in the areas dominated by the *Juniperus – Anaphalis – Rhododendron* community. Argali and gazelles were most commonly observed in areas dominated by an *Ephedra – Anaphalis – Artemisia* forb community, interspersed with grasses *Stipa orientalis* and *Elymus nutans*. Sheep, yak, and kiang tended to feed in similar areas as argali and gazelles; the major difference being that these domestic ungulates and kiang were frequently seen feeding in sedge meadows dominated by *Kobresia* sp. and *Carex moorcrofti*. Over the winter domestic yaks and sheep were repeatedly observed feeding on sedges and graminoids in basins along watercourses. Other ungulates were seldom sighted in such areas. Ungulates were seen to differ in their diets though a preference for some grasses and legumes like *Oxytropis* sp. was ubiquitous. More details of ungulate–habitat relationships can be found in Chanchani (2007).

Readers are referred to the following sources for more detailed information on the range wide status and ecology of these species Mallon 1991, Shah 1994, Fox and Johnsingh 1997, Shakleton 1997, Schaller, 1998, Harris and Loggers 2004, Mishra *et al.* 2004, Namgail *et al.* 2004, Shrestha *et al.* 2005, Bhatnagar *et al.* 2006, Namgail *et al.* 2007, IUCN 2008, Namgail *et al.* 2008, Namgail *et al.*, 2009.

DISCUSSION

In an era where the wildlife of the Tibetan Steppe has been pushed to the brink of extinction by humankind's pursuit for progress and development, and on account of rampant hunting, Tso Lhamo is surprising rich in wildlife. This is particularly true in the case of Tibetan argali and the Tibetan gazelle. Argali populations have been declining across the species range (Schaller 1998) and in Ladakh they remain small. (Namgail *et al.*, 2009). While the global range-wise status of gazelles is not as precarious, the species is on the decline and very small populations persist in Ladakh (Bhatnagar *et al.*, 2006, Namgail *et al.*, 2008). The results from our surveys indicate that populations of argali and gazelle species in Tso Lhamo are comparable in size to populations in Ladakh, which is a significantly larger and better studied region (nearly 60,000 km²) where several protected areas exist. The non-hunting tradition prevalent among the herders, Indian army and other defense personnel, which have been mentioned earlier in this essay, are probably the single most important factor responsible for the current densities of argali and gazelles.

But rest we must not as the persistence of a few adverse developments can have a significant impact on wildlife populations. Given the small extent of Tso Lhamo and our finding that a majority of wild ungulates occupy an area of 70 km² or less, the construction of roads and other infrastructure can hurt wildlife numbers - particularly if these activities occur in winter or summer feeding areas. The degradation of topsoil and a subsequent loss of already scant vegetation cover, along with the omnipresent threat of infectious diseases spreading from livestock to wildlife are two other issues that must merit attention.

In Ladakh, and elsewhere in the Tibetan plateau, resource competition between wild and domestic ungulates is a major factor that has led to a decline in wild ungulate populations (Schaller 1998, Mishra *et al.*, 2004 Bagchi *et al.*, 2004., Namgail *et al.*, 2007). In Sikkim, the potential for direct competition between the two is considerably reduced as domestic ungulates are seasonally herded to summer pastures south of the Tso Lhamo region. As these periods coincide with the months when argali and gazelles give birth to their young, the absence of livestock, herders, and their dogs is probably beneficial for the survival of their offspring. With the harsh weather conditions and the scarcity of

forage between November and April the winter survival of wild ungulates seems to be influenced by the nutrition they receive in the summer months. If competition for forage occurs between livestock and argali, gazelles and kiang in Tso Lhamo, it is most likely to occur in the resource scarce winter months when animals tend to converge at wind-swept sites that are snow-free.

As Tso Lhamo is an important wildlife area there is an urgent need to devise a long time conservation strategy. Conservation in this region is, however, complicated by socio-political factors. The rangelands of Tso Lhamo have had a long history of livestock grazing. Grazing patterns have changed over time. With the delineation of current international boundaries the herders who reportedly moved across the landscape into adjoining pastures in Tibet, are unable to do so. This has resulted in high concentrations of yaks and sheep (over 1000 individuals of each) in Tso Lhamo. Further, the challenge that Dokpa herders and their livestock face in the winter months on account of severe weather and fluctuating resource availability over different years are daunting. Given the tradition of livestock grazing and the fact that the livelihoods of many depend on pastoral practices, it seems imprudent to conceive of a protected area that eliminates humans at this juncture in time. Moreover, as Tso Lhamo is sited along an international border the Indian army will continue to maintain a presence in the region in the years to come.

Still, the local extinction of the Chiru from the region and the range wide trend that indicate decline in populations of argali, gazelles, and kiang make it imperative that some conservation action be initiated in the Tso Lhamo region. The creation of a Conservation Reserve-where conservation is carried out in consultation with local communities on government land - may be an ideal solution. This will require the forging and maintenance of strong partnerships between government agencies, local communities, and non-governmental organizations. It is equally important that policies be evolved to make supplemental fodder available for livestock in the winter to reduce their dependence on the already depleted winter pastures. It is also imperative that livestock are regularly vaccinated against disease.

The conservation of Tso Lhamo would be also benefit from a spirited involvement of the Indian army through sensitization programs and through their active conservation of wildlife and key habitats. We also recommend that some critical wildlife habitats areas - most notably the Mirdo Kongra La valley, the Chomodo Bamcho La region, and the Oloten Sese La region up to the Teesta Khangste Glacier be protected from heavy grazing and undue anthropogenic pressures. Conservation should also go hand in hand with regular monitoring of wildlife by scientists to monitor population trends and behavior over time. Finally, there a need to expand scientific research beyond Sikkim's boundaries into proximate areas in the Tibet Autonomous Region in order to gain some insights into the population dynamics of wild ungulates and refine strategies for their long term conservation.ong term conservation.



Woolly Hare commonly inhabit rocky, gently sloping areas where they are incredibly camouflaged. They sit motionless until a predator approaches to 2-5 feet from them

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