

Habitat Ecology and Conservation Status of Wild Ungulates in Northern Parts of Changthang Wildlife Sanctuary, Ladakh

FINAL REPORT



Investigators
Dr. G.S. Rawat & Dr. K. Sankar

Research Fellow
Ashwini Kumar Upadhyay



भारतीय वन्यजीव संस्थान
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January 2011

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Acknowledgments

We are thankful to the Department of Wildlife Protection (DoWP), Government of Jammu & Kashmir, especially Shri R.L. Srivastava, former Chief Wildlife Warden of the state and Shri Jigmet Takpa, Regional Wildlife Warden, Ladakh for granting necessary permission to undertake the research work in the area and facilitating field work. We also thank Mr. Tahir Shawl, Mr. Salim Ul-Haq and field staff of Changthang WLS for extending necessary help and sharing valuable information about the study area.

We express our gratitude to the Indian Security Forces for providing the necessary support and permission visit Changchenmo Valley. Our special thanks are due to Col. A.S. Siddhu, Director (Ecology), Environment Cell, Army Headquarters for timely release of permission letters. We are thankful to DG-ITBP, ADG (Operations) and Mr. J.V.S Choudhary DIG-ITBP (Ladakh) for extending the required help and logistic support. The Commanding Officers of Indian Army at Leh, Phobrang, Tsogshalu and Hot Spring camp extended full support and logistics during the study period. Special thanks to the Commandant, other ranks and jawans of the 15th batallion at Hot Spring for their co-operation, assistance and support during the entire period of field work without which it would not had been possible to carry out this project in this desolate valley.

We extend our sincere thanks to the District Collector, Leh for necessary permission to visit inner line areas for the field work. We are also thankful to Mr. Rinchen Wangchuk, Program Director, Snow Leopard Conservancy for sharing his experiences from his last visit to the Changchenmo Valley.

We are thankful to Shri P.R. Sinha, Director and Dr. V.B. Mathur, Dean, WII for encouragements and necessary administrative support for execution of the project. We thank Shri Gyanesh Chhibber, Secretarial Assistant to the Research Coordinator, Shri A.K. Dube, Accounts Officer, all the staff of WII Laboratory, Herbarium, GIS & Computer Cell, Library & Documentation Centre for their help and cooperation. Our special thanks are due to Dr. Amit Kotia and Mr. Rupesh Ranjan Bharati who assisted in preparation of final report.

- Investigators

EXECUTIVE SUMMARY

1. An ecological study on the wild ungulates was carried out in the northern parts of Changthang Wildlife Sanctuary, Ladakh during 2007 – 2009 with a view to ascertain the population status, distribution and habitat use pattern. The five species of sympatric ungulates found in this part of Trans-Himalaya include chiru or Tibetan antelope (*Pantholops hodgsoni*), wild yak (*Bos mutus*), Tibetan argali (*Ovis ammon*), kiang (*Equus kiang*) and blue sheep (*Pseudois nayaur*). Specific objectives of the study were: (i) To study the population status and distribution of wild ungulates in northern parts of Changthang WLS, (ii) To study the habitat characteristics and habitat use by the ungulates, (iii) To identify the major threats and suggest conservation strategies, and (iv) To evolve protocol for monitoring wildlife populations in the study area.
2. The study area was located in the north and north-east of Pangong Tso covering Phobrang surrounds and Changchenmo Valley which vary in altitude from 4450 to 5800m asl. The entire landscape is spread over an area of >3100 km². However, intensive study was conducted within <500 km² around Phobrang and Changchenmo. The study area is characterized by cold arid environment with very sparse vegetation cover which can be categorized into moist and mixed meadows, desert steppe and scrub steppe. About 12% geographical area is covered by perpetual snow and glaciers, 1.6% area is represented by moist and marsh meadows and over 84% area is under sparsely vegetated desert steppe which is further divisible into various landscape units and habitat types. The study area is the only place within Indian territory where these five sympatric ungulates co-exist.

3. Based on a reconnaissance trip we classified the study area into various strata. Field work was carried out during 2007 – 2009 covering two summer and one winter season. Line Transects and trail monitoring were followed for the collection of data on population structure, status and distribution of ungulates in various areas on seasonal basis. In each strata transects varying in length of 6-8 kms were walked. A total of 503 km were monitored in 42 trails, spending 249.85 hrs of observation. Data based on direct sightings and indirect evidences of ungulate species were recorded along transects in the survey blocks. Habitat parameters were quantified using standard methods. Conservation and management issues were identified based on primary and secondary data collected from the survey area.

4. The study reveals that of the five species of sympatric ungulates, chiru and wild yak use only parts of Changchenmo Valley while remaining three species are found in both the areas. In Changchenmo Valley we estimate a population of 20 – 30 chiru, 110 – 120 wild yak, 125 – 150 kiang, 120 - 130 blue sheep and 35 – 50 Tibetan argali. Based on the past reports and present study we conclude that number of chiru population in Changchenmo Valley is on decline. Our study reveals that chiru males do use Changchenmo Valley during winter. For the first time, we report a new location of chiru i.e., Thratsang La in Changthang plateau.

5. Blue sheep, being smallest of all the ungulates, selected steep and glaciated zones with short forbs and a few graminoids. Chiru males and wild yak were confined to eastern part of Changchenmo Valley, especially with higher cover of graminoids (*Carex moorcroftii*, *Stipa purpurea*, *Leymus secalinus* and *Scirpus* sp.). Kiang occupied most of the habitat categories except steep slopes and cliffs. Highest altitudes were used by blue sheep followed by wild yak, Tibetan argali, chiru and kiang. Kiang and argali showed preference for south facing slopes while other species used in proportion to availability.

6. The major conservation issues in the study area include (i) Small and fragmented populations of threatened ungulates, (ii) Degradation of rangelands and loss of productivity, (iii) Possible genetic contamination of wild yak, (iv) Presence of feral dogs around security camps, (v) Lack of alternate livelihoods for the local people, (vi) Inadequate infra-structure and man power for the PA management. Appropriate recommendations to deal with above issues have been given.

7. The study area is partly controlled by the Indian security personnel, who have taken keen interest in the conservation and monitoring of threatened wildlife in the area. A detailed monitoring protocol based on vehicle survey, on-foot patrol and animal observations from the fixed positions have been suggested.

1. INTRODUCTION

1.1 Background

The large mammalian herbivores, i.e., ungulates occupy a considerable area on earth and are important both ecologically and economically. Wild ungulates in different grazing systems have had a considerable impacts on human lives throughout history (Olf *et al.* 2002). The ungulates have been a main source of protein for mankind. Domesticated forms like yak, sheep and goats have greatly influenced the socio-economic conditions of several societies in the Himalayan region. The role of wild ungulates in the tourism industry in many remote regions, where development reached relatively late, is still significant (Mishra *et al.* 2004). In many cases, especially in the North-east India, they form a main source of protein (Datta *et al.* 2006). Since, the abundance of wild ungulates strongly influences livestock depredation by carnivores, they can have strong socio-economic implications (Mishra 1997). Mountain ungulates do have strong influence on vegetation structure, ecosystem functioning as primary consumers (Prins & Hearne 2003), nutrient cycling (McNaughton 1997, Augustine 2003) and standing biomass (Koppel & Prins 1998, Rawat & Adhikari 2006, Mishra 2001, Bagchi *et al.* 2006).

Ungulates were common up to the late Pleistocene (*ca.* 30,000 years BP) dominating the terrestrial ecosystems worldwide (Owen-smith 1987, Johnson 2002). After massive extinction, the herbivores of Eurasia were reduced to almost 45% genera. The ultimate cause of these extinctions is largely linked to climate change. However, there seems to be consensus that humans directly through hunting and indirectly by converting the forested habitats to other land use practices also contributed to their decline (Miller 1990). The studies have indicated that highest levels of competition takes place among the species of similar body weight and that increase in populations of domestic livestock in many areas have led to competitive exclusion of wild herbivores having similar body size (Mishra *et al.* 2004, Bhatnagar *et al.* 2006). Decline in the populations of wild ungulates in many parts of Indian Trans-Himalaya may be ascribed to this (Schaller 1998, Miller & Schaller 1996).

The Indian Trans-Himalaya is, characterized by alpine arid environment with very low primary productivity and strong seasonality. Yet it supports a diverse assemblage of mountain ungulates many of them being globally threatened, e.g., Tibetan antelope

(*Pantholops hodgsoni*), Tibetan argali (*Ovis ammon*) and wild yak (*Bos mutus*). Historically, these species had a wider distribution both within Indian territory and on Tibetan plateau (Schaller 1998). Most of these species inhabit open plains and rolling mountain slopes. However, the areas with higher productivity in the Trans-Himalaya coincide with extensive human landuse (LEDeG 2001). With an increased cash driven economy, there has been a decreased tolerance towards wildlife due to perceived forage competition between wild ungulates and livestock, increased negative attitude towards predators and other conflicts.

Conservation programmes for the alpine arid rangelands of Ladakh and adjacent regions, which harbour populations of wild yak, tibetan antelope, and other wild animals need better understanding of animal-habitat relationship, information on the ecology, status, and distribution. Also, there is a need for better understanding of rangelands and impact of livestock grazing on wildlife habitats. Keeping these in view, this study was undertaken in the northern parts of Changthang Wildlife Sanctuary (WLS), especially in Phobrang and Changchenmo Valley, which has a remnant assemblage of highly threatened mountain ungulates, characteristic of the Tibetan plateau.

1.2 The wild ungulates of Indian Trans-Himalaya

The characteristic wild ungulates of Indian Trans-Himalaya include caprids, bovids and an equid. Typical caprids are Asiatic ibex (*Capra ibex sibirica*), Tibetan argali (*Ovis ammon hodgsoni*), Ladakh urial (*Ovis orientalis vignei*), and Bharal or blue sheep (*Pseudois nayaur*), while bovids are represented by Tibetan antelope or chiru, Tibetan gazelle (*Procarpa picticaudata*) and wild yak. Tibetan wild ass or Kiang (*Equus kiang*) is the sole representative of equidae. Biogeographically the Indian Trans-Himalaya is divided into two provinces, viz., the 'Ladakh Mountains' or Zone 1A and the 'Eastern Plateau' or Zone 1B (Rodgers & Panwar 1988). The Ladakh Mountains harbour ibex, bharal and urial. In the eastern (Changthang) plateau, ungulates such as Tibetan antelope, Tibetan gazelle, Tibetan wild ass and wild yak, are found alongwith the more widely distributed blue sheep and occasional argali. In the eastern Himalaya, a small portion of Tibetan plateau extends into Sikkim (Biogeographic province 1 C), represented by typical Trans-Himalayan elements such as blue sheep, Tibetan argali, Tibetan wild ass and Tibetan gazelle. Unlike the Trans-Himalaya, the mountain ungulates of Greater Himalaya have different origin (Oriental). The

typical ungulates of Greater Himalaya are the Himalayan tahr (*Hemitragus jemlahicus*), Himalayan musk deer (*Mochus chrysogaster*) and the lower elevation grasslands are inhabited by goral (*Nemorhaedus goral*), serow (*Capricornis sumatraensis*), barking deer (*Muntiacus mutijac*), wild pig (*Sus scrofa cristatus*). While more moist areas in the eastern Himalaya have serow and takin (*Budorcas taxicolor*) with recently reported leaf deer (*Muntiacus putaoensis*) and Chinese goral (*Nemorhaedus caudatus*).

The wild ungulates of Indian Trans-Himalaya are confined to a few protected pockets (Anonymous 2001). For example, the Asiatic ibex is reported from only 8 protected areas, which altogether constitute around 11,000 km² area. Similarly, Ladakh Urial, Tibetan wild ass and Tibetan argali are reported from 2 PAs each in Ladakh, their habitats being limited in extent. However, most widely distributed species is bharal, which is reported from >15 PAs and has over 17000 km² as intact habitat. Two species of mountain ungulates in Indian Trans-Himalaya, i.e., chiru and wild yak need special attention from the conservation agencies. Chiru migrates long distances indicating that the species requires an enormous home range. One of the populations of this species is known to migrate between India and Tibet across the international boundary, the summer range being northern and north-eastern parts of Ladakh i.e., Dauletbeg Oldi (DBO) area of Karakoram WLS and Changchenmo Valley in Changthang. This species, despite full legal protection across its distribution range has been heavily hunted in Tibet during recent decades for its finest wool (locally called *shahtoosh*). Another species of international conservation significance is wild yak. Once numbering in millions, now only about 12-14,000 individuals are left on the Tibetan Plateau (Schaller 1998). Wild yak inhabits the rugged terrain and extremely harsh climatic conditions. Superbly adapted to the rugged conditions of the highest plateau on earth, wild yak is a keystone species of the Tibetan plateau as its presence signifies one of the least unspoiled ecosystems in Central Asia (Miller 1990; Miller and Schaller 1996). Northern parts of Changthang wildlife sanctuary has one such potential to study rangelands with past and present distribution of the above-mentioned species.

The Department of Wildlife Protection (DoWP), The Government of Jammu & Kashmir (J&K) has made a few attempts at estimating the populations of chiru and wild yak in DBO and Changchenmo areas (Anonymous 2005). It is reported that every year, chiru migrate to the high Depsang Plains and upland valleys of Changchenmo (in the former area alongwith new born kids). However, there are no evidences or records of females giving birth within

Indian territory (Schaller 1998, Anonymous 2005). Anecdotal reports reveal that prior to 1947 there was larger population of Chiru in Karakoram Range and Changchenmo area. During 1980's presence of migratory populations of chiru and wild yak was confirmed in the area (Ul-Haq & Bashir 1996). Reliable estimates of chiru from DBO area (250-300 individuals) came only after 1994 (Ul-Haq & Bashir 1996). The DoWP, based on another survey, estimated that more than 45 wild yak and about 200 Tibetan antelope may be using the Changchenmo Valley. Again in the year 2001 a survey was done in DBO, confirming presence of at least 111 individual chiru but the population comprised only females and lambs. The adult females and young ones arrive DBO area in April - May and migrate back to Tibetan plateau by September -October (Bhatnagar & Wangchuk 2001). Latest surveys by DoWP in the year 2005, indicate that DBO and Changchenmo Valley may have 200-250 and 55-60 chiru respectively. The data on the populations of Chiru from the Tibetan plateau (China) is fragmentary. Schaller (1998) mentions that there are about four migratory populations and a number of resident populations of Tibetan antelope in Tibet. Further, he describes that during spring females separate from the males and travel to desolate and unhabited terrain, whereas males move to relatively shorter distances. Both the sexes remain segregated except during the midwinter rut, when males maintain harem of several females. Mortality of the young is high due to high snow fall and resultant forage scarcity and malnutrition (Schaller 1998). Yet the detailed biological explanations of Chiru migration to different parts of Tibet and India are lacking. This warrants an in depth study of the migratory populations.

The J&K Government has given highest priority to the conservation of chiru and wild yak by assigning them the status of Schedule I species under the state Wildlife (Protection) Act 1978. These species have already been listed under the Schedule I of India's Wildlife (Protection) Act 1974. Considering the need for an active protection and conservation measures for these species this study was initiated in collaboration with the DoWP, Govt of J&K. Since this area falls under the jurisdiction of Indian army and Indo-Tibetan Border Police, these organizations have been actively supporting the cause of wildlife conservation in the region. An important component of this project, i.e., developing long term monitoring protocol for the wild ungulates was taken up in collaboration with the security personnel.

1.3. Review of Literature

1.3.1 International Studies

Explanation for herbivore coexistence starts with the competitive exclusion principle (Hardin 1960), which states that potentially competing species can coexist only if they occupy different realized niches. Though other aspects such as differences in predation pressure and disease susceptibility have been mentioned to be important in structuring niches, partitioning of the food resource is generally accepted to be the basis of herbivore niche differentiation and coexistence of ungulates. Resource partitioning among the sympatric species have also been explained based on the digestive physiology, by classifying them into functional groups such as grazers (diet of graminoids), browsers (diet of dicotyledons) and intermediate feeders (both resources). But this probably does not hold in all the areas (Gordon & Illins 1994, 1996). Several studies have emphasized the importance of body size for explaining the separation of feeding niches amongst herbivores along resource quality and quantity axes.

First body-size based explanation for herbivore resource partitioning was given in 1932 by Kleiber. This study led to universally accepted law called Kleiber's law, which states that an organism's basal metabolic rate is positively correlated to body mass of a range of mammals with an increase factor 0.75. This holds true for a range of endothermic and ectothermic species across 18 orders. Best explanations are based on blood vessel properties in animals and vascular systems in plants (West *et al.* 1997, Brown *et al.* 2004). Several studies have used body mass as the basis to explain the resource partitioning among herbivore species. By combining observation that rumen volume is isometric with body size (Demment 1982). It has now been generally accepted that larger herbivores can tolerate a lower quality diet than smaller ones, also known as the Jarman-Bell principle (Bell 1970, Geist 1974, Jarman 1974, Demment & van Soest 1985). These studies defined quality in terms of food digestibility as the ratio between easily cell digestible constituents (like proteins) and poorly digestible cell wall components (fibre: cellulose, lignin) i.e., low quality food has a low protein-fibre ratio. As nitrogen is the main constituent of protein, nitrogen content is often measured as an estimate of food quality. The Jarman-Bell principle has subsequently been the basis of a range of studies that tried to explain the coexistence of different herbivores species (McNaughton & Georgiadis 1986, Owen-Smith 1988, Du Toit & Owen-Smith 1989, Bugalho 1995, Belovsky 1997, Ritchie & Olff 1999, Wilmshurst *et al.* 2000, Olff *et al.* 2002). The basis of these studies have been the premise that there is sufficient variation in food quality and quantity (resource heterogeneity) available to ungulate species to be able to coexist.

1.3.2 Studies on mountain ungulates in India

Wild ungulates form critical component of Trans-Himalayan ecosystems and major prey base for the apex predator i.e., the snow leopard (*Uncia uncia*) Jackson & Hunter (1996). Hence they are considered important indicators of habitat quality in the Trans-Himalaya. Uptill now, in the Indian context, resource use by the mountain ungulates has been studied in terms of habitat use and food plants consumed but at different spatio-temporal scales. Studies in the past decade have revealed information on the overlaps in resource utilization between domestic and wild mountain ungulates (Johnsingh *et al.* 1999, Bhatnagar 1997, Manjrekar 1997, Mishra 2001, Namgail 2001, Raghavan 2003, Bagchi *et al.* 2004, Rawat *et al.* 2006). Above mentioned studies have revealed coexistence of mountain ungulates in terms of habitat use and food habits. Despite detailed information on resource partitioning among herbivores, clear evidence of competitive exclusion shaping herbivore community is still lacking as reported by Mishra *et al.* (2002) for Trans-Himalayan region. Clear empirical evidences are needed to prove competitive exclusion and nature of herbivore communities. Studies on Asiatic ibex and livestock by Bhatnagar (1997) and Bagchi *et al.* (2004) found that livestock limited the ibex accessibility to habitats. Similarly, Mishra *et al.* (2004) depicted competition between blue sheep and livestock. Studies by Raghavan (2003) and Namgail (2001) on Ladakh urial and Tibetan argali in the presence of livestock respectively showed shifting of wild ungulates to the sub-optimal habitats and food plant species in the diet. Recent studies on Tibetan gazelle has revealed that even in the absence of hunting the population could not recover over a long period of time because of heavy livestock grazing (Bhatnagar *et al.* 2006). Studies on wild ungulates in Tso Kar basin inhabited by wild ass, argali, blue sheep and domestic livestock revealed spatial resource partitioning between the wild ungulates and livestock during resource crunch period of the severe winter season, when livestock are present in the basin (Rawat *et al.* 2006). Johnsingh *et al.* (1999), based on a detailed study in Pin Valley National Park, concluded that the domestic livestock restricted the habitat use by Asiatic ibex. All other studies on the mountain ungulates in Trans-Himalaya *viz.*, blue sheep by Mishra (2001), Asiatic ibex by Bagchi *et al.* (2004), Ladakh urial by Raghavan (2003), Tibetan argali by Namgail (2006), Tibetan gazelle by Bhatnagar *et al.* (2006) and kiang by Antoine (2006) compared direct sighting data of resource use to arrive at effects of livestock grazing. All the above mentioned studies have considered only one species in investigation except in Rawat *et al.* (2006). While Johnsingh *et al.* (1999), Raghawan (2003), Bagchi *et al.*

(2004), Mishra (2004), Rawat *et al.* (2006) also investigated overlap in feeding niches between livestock and the respective mountain ungulate species. Namgail (2001) investigated changes in behavioral traits due to livestock presence concluding its effects on lowered ungulate fitness and reproductive health. The effect of interspecific competition, either exploitative or interference, on ungulate distribution is a central theme of Indian mountain ungulate ecology. When sympatric species are asymmetric in their competitive abilities, the dominant species usually secures the highest quality habitats. Therefore, the dominant species reduces the fitness of the subordinate species more than the reciprocal effect (Namgail 2001). Such competitive asymmetry has been demonstrated between domestic and wild ungulates in grazing systems of Africa as well as North America, where livestock cause shifts in habitat by the wild species (Stevens 1966, Loft *et al.* 1991, Fritz *et al.* 1996). Such shifts result in reduced foraging opportunities for some mammalian species (Lima & Dill 1990), and can demonstrate interspecific competition, leading into bottom-up and top-down effects in the ecosystem (Diamond 1978).

Recently, high extinction risk in herbivores of Central Asia has been attributed to the long dispersal distance and small-area of occupancy collectively (Collen *et al.* 2006). Emphasis on the understanding the mechanisms of rangeland degradation contributing to the extinction process is required. Still, current knowledge on the interacting mountain ungulate strategies of habitat selection in resource poor ecosystems is in a state of infancy. Habitat selection is not only responsible for species coexistence, but provide one of the most convenient mechanisms for measuring competitive interactions, and the various community structures caused by interactions between the mountain ungulate species of Indian Trans-Himalaya. In some parts of Trans-Himalaya, studies have proven that domestic livestock can competitively exclude wild ungulates (Mishra 2004).

Northern parts of Changthang WLS offer excellent opportunity to study the habitat ecology of sympatric ungulates. This is the only place in India where five species of mountain ungulates i.e., chiru, wild yak, blue sheep, tibetan argali and kiang co-exist. This study aimed at documenting the population status and habitat use by these species. Field work was carried out during 2007 – 09 covering two summers and one winter season.

1.4 Objectives

Major objectives of the study were as follows:

- (i) To study the population status and distribution of wild ungulates in northern parts of Changthang WLS,
- (ii) To study the habitat characteristics and habitat use by the ungulates,
- (iii) To identify the major threats and suggest conservation strategies, and
- (iv) To evolve protocol for monitoring wildlife populations in the study area.

2.0 STUDY AREA

2.1 The Indian Trans-Himalaya

The Indian Trans-Himalaya, located in the rain shadow zone, north of Great Himalayan massif is one of unique and most interesting biogeographic zones. This region is characterized by low primary productivity, harsh climatic conditions owing to alpine arid environment, low human populations and fragile landscape. The flora and fauna of the Trans-Himalaya exhibit close affinities with the Palaearctic region, many of which have global conservation significance. The Indian Trans-Himalaya is also well recognized for its high altitude rangelands that offer important grazing resources for wild ungulates and livestock and the lakes and marshes that are of significance for several migratory birds particularly the Black necked crane. Most charismatic mammals of Trans-Himalaya include endangered snow leopard, Himalayan brown bear, Tibetan wolf, Eurasian lynx, Pallas cat, Red fox, Tibetan argali, Tibetan antelope or chiru, Tibetan gazelle, Wild yak, Ladakh urial, Asiatic ibex, Blue sheep, Tibetan wild ass and the Tibetan woolly hare. The human settlements are concentrated along the flat river valleys. However, nomadic pastoral practices are all pervasive in the Trans-Himalaya. Thus livestock grazing and excessive fuel wood collection by the local people leading to habitat degradation are the major conservation issues. People – wildlife conflicts in the form of cattle lifting by predators such as snow leopard and Tibetan wolf has resulted in the conflict between local people and the PA management.

2.2 The Changthang Plateau

A significant portion of the Indian Trans-Himalaya in the state of J&K is represented by a vast table land that forms western extension of Tibetan plateau. This physically imposing landscape is popularly known as Changthang, that literally means the 'northern upland' or northern plains (Tibetan, *Chang* = north; *Thang* = flat area). Indian Changthang is spread over an area of over 22000 km² and located between 32 ° 44' 30.22" to 34 ° 54' 11.97" N

latitudes and 78° 43' 33.21 to 80° 49' 10.02" E longitudes. It is bounded by the Zaskar range on the south and Karakoram range in the north-west. On the east the plateau extends up to south-western part of Qinghai province and Xinjiang in Tibetan Autonomous Region (TAR) of China. Northern part of the plateau terminates in Aksai Chin, one of the most arid and desolate tracts. The Indian Changthang has been recognized as a distinct bio-geographic province 1 B in India (Rodgers & Panwar 1988).

The Changthang plateau is well known for its unique geo-hydrological, biogeographic, socio-political and aesthetic values. The altitude of this landmass ranges from 4000 – 5500m above sea level (asl), mean elevation being about 4500 m. A considerable proportion of this landmass comprises inland lake basins, characterized by alluvial fans and sandy plains. Internal drainage in some of the basins has resulted in concentration of salts and minerals over the millennia making the water bodies brackish. Administratively Changthang region in Eastern Ladakh falls in two developmental blocks of Leh district viz., Nyoma and Durbook.

The palaeo-history of the Chang Thang and Tibetan plateau is as interesting as its present environment. This plateau was uplifted as a result of the collision of Indian plate with Eurasia which began during middle Eocene, nearly 45 – 50 million years ago (Zhu et al., 1995). The two land masses welded along the valleys of the Yarlung Tsangpo and Indus (Wadia 1967, Valdia 2001). The northern edge of Indian plate is believed to have slid a short distance beneath the southern edge of Asia that led to great compression, folding, and thrust faulting that resulted in the uplift of Himalaya and recession of Tethys sea. Although mechanism of uplift of Tibetan plateau has been a controversial subject, most of the geologists believe that tectonic activities in the core of Asian plate led to crustal shortening, thickening and extrusion which caused thickening of the plateau. According to Molnar (1989), uplift of the plateau continued till late Miocene and during last 2-10 million years the plateau has uplifted by 1000 – 2000m in elevation. The rise in the elevation and subsequent glaciation during Pleistocene caused drastic decline in temperature and depauperation of flora and fauna on the plateau. Re-establishment of the vegetation relied upon the flora of surrounding areas. After the plateau rose up to its present level during Quaternary period, it developed its own special plateau climate. The palynological studies indicate that for a part of Holocene there were stands of

Tamarix, *Salix* and *Betula* in the basins of Pangong Tso, especially in protected localities with adequate moisture (Gasse et al., 1996). Trees and tall shrubs gradually vanished from the plateau by late Holocene. Influenced by the flora and fauna from the arid region of middle Asia, the present desert steppe ecosystem was evolved. Much of this plateau was gradually colonized by hardy and grazing resistant grasses such as *Stipa purpurea*, *S. orientalis*, *S. roborovskyi*, and a large number of cold hardy cushion forming species such as *Androsace robusta*, *Arenaria bryophylla*, *Thylacospermum caespitosum* and other specialized growth forms. The growing aridity and frigidity also influenced the faunal distribution. For instance, *Pantholops*, the sole endemic genus of mammals, got separated from Central Asian desert genus *Saiga* during Miocene. During Pliocene an equid *Hipparion* was a prominent member of the fauna. Other taxa such as *Ochotona* spp., *Lepus oiostolus*, *Marmota himalayana*, *Vulpes ferrilata* adapted and dispersed on the plateau. Likewise, *Tetraogallus*, a native genus of birds, a few pipits and larks specialized on the plateau.

2.1 The intensive study area:

The intensive study area lies in the northern parts of Changthang WLS, eastern Ladakh. This area is located in the north of Pangong Tso that occupies an area of over 3100 km², bound by the line of actual control (LAC) with China on the east (Fig 2.1). The intensive study area is divisible into two parts, i.e., (i) Phobrang area and surrounding pastures, (ii) Changchenmo Valley, beyond Marshmik La (5595m). Phobrang (4450m) is the last village north of Pangong Tso, well known for its lush green pastures in its upper catchments. The Changchenmo Valley is aligned in East-West direction and has an altitudinal range of 4400 to over 5700m asl, average altitude being 4725m asl. This area is drained by Changchenmo river which has several smaller tributaries viz., Kugrung, Silug Yogma, Silung Barma and Silung Kongma. Changchenmo and Kugrung rivers meet near Tsogshalu (opposite K-Hills) and finally merge with Shyok River. Much of the study area is dry and desolate having less than 10% vegetation cover. This area has five species of wild ungulates and one large carnivore, most of them are globally threatened, viz., Tibetan antelope, wild yak, Tibetan argali, blue sheep, Tibetan wild ass or kiang and Tibetan wolf. In addition, the study area harbours smaller mammals such as Tibetan woolly hare (*Lepus capensis tibetanus*) and Himalayan marmot

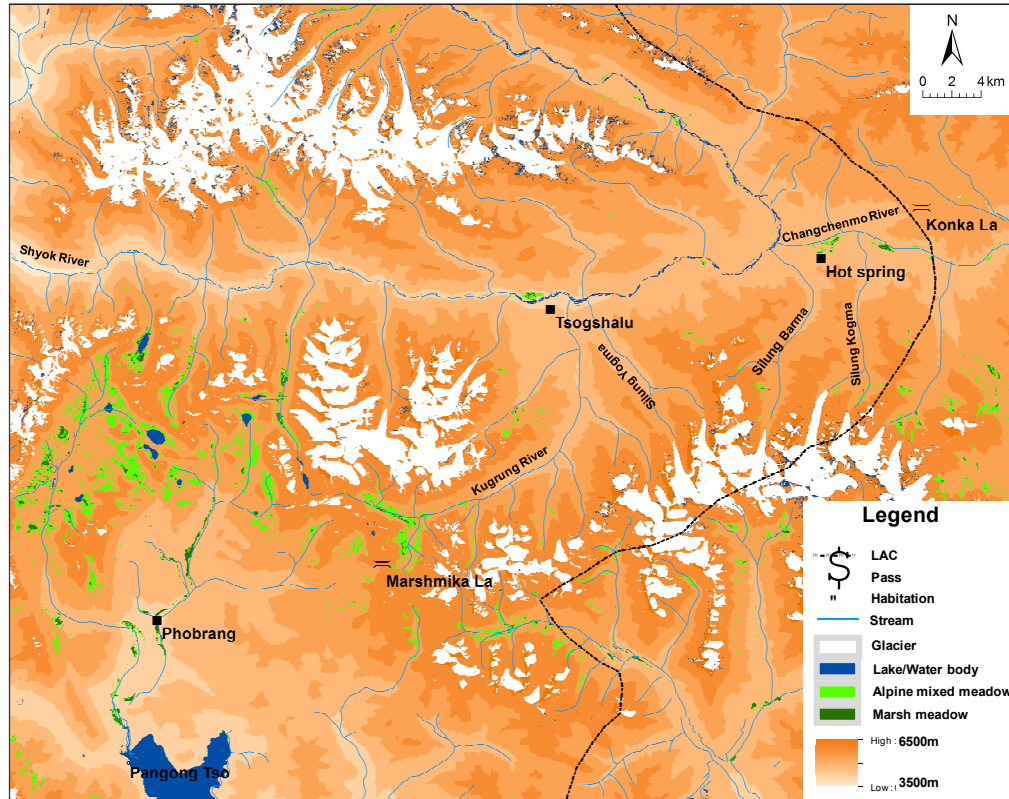


Fig 2.1 Map of intensive study area (Phobrang surrounds and Changchenmo Valley, Eastern Ladakh)

Table 2.1: Per cent area under various cover types in Phobrang – Changchenmo Valley, Eastern Ladakh

SN	Land use / Land Cover Class	Approximate Area	%
1.	Snow/Ice (Glacier)	372.04	11.93
2.	Water body	52.32	1.63
3.	Alpine mixed meadow	51.08	1.63
4.	Marsh meadow	7.46	0.23
5.	Desert steppe, rocky and scree slopes	2635.10	84.51
	Total	3118.00	100

(*Marmota himalayana*). During summer, maximum temperature goes up to 35 °C and in winter it drops to – 42 °C. Wind blows with high velocity that may reach up to 50-60 km per hour in some parts of study area resulting in fierce dust storms.

The natural vegetation of the study area comprises typical desert steppe, high alpine mixed meadows, a few stretches of scrub steppe, riverine scrub and marsh meadows. Unlike lower parts of Changthang WS, this valley has virtual absence of *Caragana* scrub, while *Krascheninnikovia punges* (*Eurotia pungens*), *Artemisia minor* and *Potentilla pamirica* form scrub steppe on gently undulating slopes. In drier slopes typical desert communities such as *Stipa – Oxytropis – Alyssum* and *Christolea crassifolia – Oxytropis microphylla* are frequent. *Carex moorcroftii – Leymus secalinus* and *Potentilla anserina – Potentilla bifurca* communities are frequent in moist, seasonally inundated valley bottoms in Changchenmo. Around Marsmik La, sparse fell-field communities with moss or cushion-like growth forms, e.g., *Thylacospermum caespitosum*, *Waldhemia stoliczkae*, *Draba altaica*, *Arenaria bryophylla* and *Androsace robusta* are frequent. Hot Spring area has characteristic sedge dominated vegetation represented by species of *Carex*, *Kobresia*, *Scirpus*, *Triglochin*, *Pucciniella*, *Ranunculus* and *Polygonum*.

Changchenmo valley is accessible from Phobrang village, from where a fair weather road leads towards Marsmik La (5458m asl). The north facing slopes beyond this pass are strewn with frost-shattered debris. The ground beneath is in permafrost condition – a common feature around such heights. The valley beyond Marsmik La is deep and dissected, at places giving an impression of ancient glacial deposit characterized by terminal and lateral moraines. The valley beyond Marsmik La represents Shyok suture zone that is tectonically intercalated between the rocks of the Indus - Tsangpo suture and Karakoram range (Srimal 1986, Sinha 1992, Thakur 1992, Sinha & Upadhyay 1995). The major thrusts, which make both boundaries, are known as Shyok thrust and Karakoram thrust respectively. The Shyok suture zone is a complex association of Late Palaeozoic to Miocene rocks including turbidites and ophiolitic mélanges with volcanic, calcalkaline magmatic rocks, granite batholith and molasses-type sequence forming an accretionary complex.

Changchenmo Valley is free from permanent human habitation. However, this area is used by security personnel for patrol and defense of national borders. Till recently livestock grazing was not allowed in much of the valley. However, around Marsmik La, the *Changpa* herders from Phobrang area graze their livestock (yaks, horses, sheep and goats) during summer.

3.0 METHODS

3.1 General

The study area was traversed during initial six months (June to October 2007) for a reconnaissance. During this period, major landscape features, vantage points for observation of animals, major vegetation types were noted and possible camping sites were decided. Various terrain features, drainage pattern and vegetation cover in the study area were further verified with the help of false colour composite obtained from the latest LANDSAT satellite imagery available in the web. A unsupervised maximum likelihood classification using Landsat ETM+ spectral bands 1, 2,3,4,5 was carried out. Unsupervised classification technique using the image of year 2000 for the study area. Out of the 4 classes created in unsupervised classification, glacier, snow, ice and clouds occupied 5.2% cover. The other two classes represent the desertic formations (40.9 %) and undulating terrain with sparse vegetation (33.2 %).

3.2 Population structure, status and distribution of ungulates

The Line Transect method (Burnham *et al.* 1980) and trail monitoring were followed for the collection of data on population structure, status and distribution of ungulates in various areas on seasonal basis. The study area was stratified into survey blocks with transects and trails varying in length (6-8 kms). All transects/trails were surveyed along trails, stream courses and contours. A total of 503 km were monitored in 42 trails, spending 249.85 hrs of observation. Data based on direct sightings and indirect evidences of ungulate species were recorded along transects in the survey blocks. For each ungulate sighting, following parameters were recorded:

- i Date and time of sighting,
- ii. Group size and composition (males, females, sub-adults, young/yearlings and unknown sexes),
- iii. Activity (feeding, resting, walking, grooming),
- iv. Altitude (in m asl),
- v. Aspect (all cardinal directions based on compass directions),

- vi. Degree of slope (flat 0-16°, gentle 16- 25°, steep 25-34°, very steep 34-50°),
- vii. Habitat type and vegetation structure,
- viii. GPS coordinates (latitude and longitude) at which the animal was sighted wherever possible.

In addition to field surveys, the official records at the DoWP and knowledgeable defense personnel at Leh were consulted in order to ascertain the past distribution of chiru and other ungulates in the study area. Possible areas of local migration were surveyed for indirect evidences. The slopes were scanned from the vehicle moving at a constant, slow pace and occasionally the slopes were scanned from vantage points.

The transects were located along stream and river courses. A few rides were used as vantage points to scan the area, especially around Phobrang. Once an animals were sighted, the time of sighting, location (coordinates), number of individuals in the group, sex and age composition, position on the slope, elevation, aspect and habitat attributes were recorded. Uniform coverage of the entire study area either using vantage points or ridge walks (Jackson and Hunter 1996) was done as the main sampling method for direct observations on the sympatric mountain ungulates. Each vantage point or trail was monitored regularly in each season. The area visible from each vantage point or ridge walk was marked on a 1° x 1° grid map of the study area. Relative abundance for each mountain ungulate species was calculated by the proportion of total number of individuals sighted for each species and total area monitored from every vantage point or ridge walk monitored. Additionally, data were arranged habitat wise and season wise to give relative abundance as per the different habitats or seasons for each mountain ungulate species.

3.3 Habitat characterization and habitat use by ungulates

A hierarchy of sampling protocol was used to find the different habitat types in the study area on the basis of terrain features and vegetation association types. The major habitat types included:

- (i) Ridge tops and plateaus: Habitats which were generally on higher elevations.

- (ii) Slopes: These are generally gradual and undulating slopes or plain areas between the ridge tops and valley bottoms.
- (iii) Valley bottom: At the base of a valley this type of habitat very often had a stream or a water body associated with it.

The study area was stratified into major visually distinguishable terrain features by validating unsupervised classified image of LANDSAT satellite image using ERDAS (Earth Resource Data Analysis System) Imagine software (ERDAS 1994). Within each terrain feature few visually distinguishable vegetation types (scrub steppe, desert steppe, riverine scrub, marsh meadows and high alpine mixed formations) were identified for random sampling. Within each such vegetation type data on vegetation species composition from a 10m x 10m plot were collected. Data on each plot included terrain characters, plant cover, height of vegetation (average or maximum), cover and abundance of each plant species. Plant species were categorized into forbs, graminoids and shrubs. The species were systematically enumerated in different habitats and species were identified using relevant literature such as Kachroo *et al.* (1977), Polunin & Stainton (1987), Aswal & Mehrotra (1994). Environmental data included factors that influence vegetation types such as aspect, slope and edaphic factors. In addition to above mentioned sampling, point-intercept method was used to estimate vegetation cover and other parameters following Mueller-Dombois & Ellenberg (1974) and Rawat & Adhikari (2005).

A single species exhibits different patterns of habitat use depending on biotic and abiotic factors. For each direct sighting from vantage points, ridge walks and other occasional incidental instances were marked on the 1° x 1° grid map of the study area. Observation on the altitude, group size, group structure (sex, age class) and activity were also recorded. Sampling was done for terrain features and vegetation parameters within 20m of the animal location and categorized into broad categories. Other ungulate species present in proximity were also recorded. Observations were made using spotting scope or a pair of binoculars. The proportional use of each habitat type to the availability for each sympatric mountain ungulates were determined and compared for the significance difference across the sympatric species. Different habitats were assessed by the ratio of habitat use and availability (Manly

2002). The proportion of available habitat were assessed by recording the variables from random locations (Marcum & Loftsgaarden 1980).

3.4 Identification of threats and analysis of management issues

Based on the detailed information collected and questionnaire surveys (from defense personnel, local communities around Phobrang village and Ladakh Scouts), conservation and management issues were identified. This was done jointly with the DoWP and defense personnel.

3.5 Development of long term wildlife monitoring protocols

Monitoring the populations of threatened species, their habitats and anthropogenic pressures in and around PAs are the integral part of management. In the absence of a regular monitoring program in the DoWP, the PA management would not be in a position to evaluate the progress of management interventions such as protection, habitat improvement, etc. Since the study area has regular presence of security personnel, it was decided to develop simple techniques and identify key indicators / parameters for repeat observations without additional man power and infra-structure with the help of security personnel in the area. The field staff, park warden and security personnel were consulted to discuss the need for such a monitoring programme. It was felt that during the regular patrol, observations from the key posts the security personnel could record the certain parameters of animal and habitat parameters in addition to the routine information without much work load. This may greatly benefit the PA management because monitoring the remote areas without the help of security personnel would not be feasible in any case. A few parameters considered for the development of such a protocol include: Number of animal species sighted from the vehicle between known locations and distances; Encounter rates of threatened fauna per km walk in different trails; Encounter rates of indirect evidences (droppings / scats, scrapes, foot prints) along selected trails; Systematic recording of livestock killing by wild predators; Incidences of mortality due to inclement weather conditions.

4.0 STATUS AND DISTRIBUTION OF UNGULATES

4.1 Background

Population status and spatial distribution of wild ungulates in the intensive study area, i.e., Changchenmo valley and adjacent areas of Phobrang and Pangong Tso were ascertained based on the data collected along trails, observation posts and *ad-libidum* sightings during 2007 – 2009. Total sampling effort were as follows:

Trail monitoring : 58 trails (average length 6kms, 394 kms-monitored)

Scan points : 4 (75 minutes average time spend per post per season)

Number of ungulate sightings: 191 (five species): Kiang (n=97), Tibetan antelope (n=33);

Tibetan argali (n=27); Wild yak (n=22) and Blue sheep (n=12)

Total individuals of all species classified for age and sex: 1516

Habitat characteristics and habitat use by ungulates was sampled in different habitat types, where ungulates were directly sighted or for indirect evidences for the use in five replicates of 1x1m quadrats. Sampling was done at 492 sites for collection of the habitat parameters in different habitat types. Altogether, five species of ungulates were sighted in the study area. These are: chiru or Tibetan antelope (*Pantholops hodgsoni*), wild yak (*Bos mutus*), Tibetan argali (*Ovis ammon*), kiang (*Equus kiang*) and blue sheep (*Pseudois nayaur*). Population status and factors affecting their distribution are presented in this chapter.

4.2 Overall populations of ungulates

The study area has a rich assemblage of sympatric ungulates, but overall populations of all the ungulates is relatively low. Based on total counts from the trails, vantage points and *ad-libidum* sightings, we estimate that within an area of ca. 500 km² area of Changchenmo Valley there is a population of 20 – 30 chiru, 110 – 120 wild yak, about 125 – 150 kiang, 120 - 130 blue sheep and 35 – 50 Tibetan argali. The figures obtained from the total counts of these species during summer of 2009 and encounter rates (animals per km walk) are given in Table 4.2. It is evident that lowest encounter rates are for the chiru, followed by wild yak, blue sheep and Tibetan argali. Kiang is most frequently sighted ungulate.

Table 4.2: Estimated populations (based on total count) and encounter rates of wild ungulates in Changchenmo Valley, Ladakh

SN	Species	Total count	Encounter rates (animals per km walk)
1.	Tibetan antelope	23	0.05
2.	Wild Yak	112	0.28
3.	Kiang	130	20.63
4.	Blue sheep	122	0.30
5.	Tibetan argali	38	0.40

The group size of wild ungulates vary considerably during summer and winter seasons. In case of blue sheep and wild yak group sizes were much higher during summer seasons as compared to other species (Fig. 4.2).

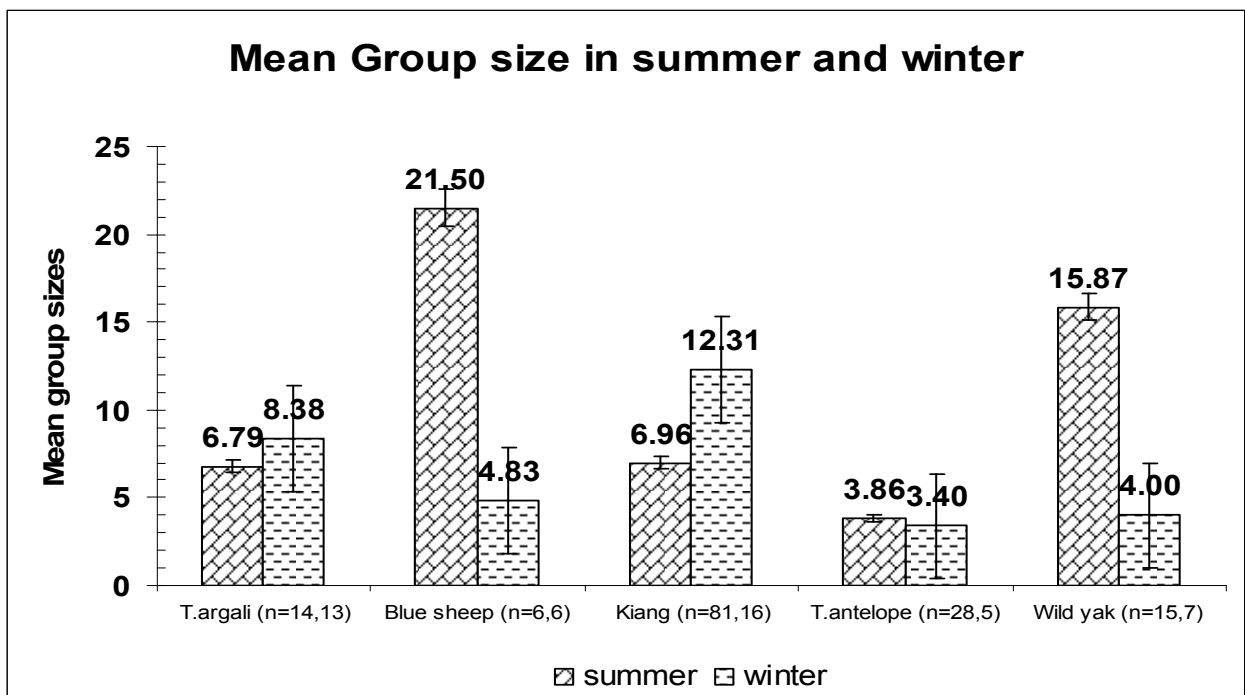


Fig. 4.2 Mean group size of sympatric ungulates during summer and winter seasons in Changchenmo Valley, Ladakh

4.3 Status of individual species

4.3.1 Chiru or Tibetan Antelope (*Pantholos hodgsoni*)

Chiru or the Tibetan antelope, an endemic species of Tibetan plateau (Fig. 4.3.1a) is threatened with extinction (IUCN, 2004). It is one of the world's hardest animals that can survive in temperatures as low as -40°C . It can sustain such extreme cold temperature, because of presence of a layer of dense, fine wool (Shatoosh) that fetches a considerable price in the international, illegal market. Chiru is listed in Appendix-I under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) making all international trade in Chiru products illegal. The species is also listed as "Vulnerable" (A 1c) by the World Conservation Union (IUCN). This species is also listed in Schedule-I of the Wildlife (Protection) Act of India and also in Schedule-I of the Jammu and Kashmir's Wildlife (Protection) Act, amendment 2002. In China, the Chiru is listed as a Class-I protected species under the Law of the People's Republic of China on the Protection of Wildlife (1989).

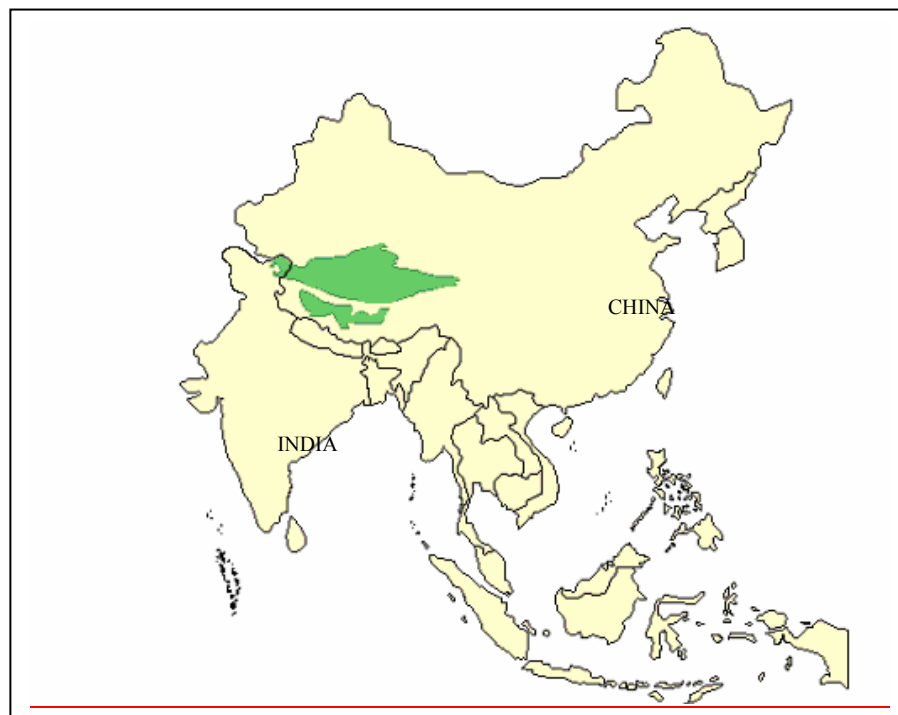


Fig. 4.3.1a: Global distribution Tibetan antelope (*Panthelops hodgsoni*). Source Ahmed et al. 2006

During the study period (2007-2009), we had a total of 40 sightings of chiru in Changchenmo Valley. Mean group size was 4. The largest herd sighted was of 12 individuals. However, the number of sightings were even lower during 2009 (Fig 4.3.1b). While in 2004 survey a total of 63 individuals were sighted with mean group size of six individuals. In the year 2005-2006 from Changchenmo Valley, a total of 120 individuals were sighted in 19 groups (Ahmed 2006) with a mean group size of 6 individuals. One significant finding during this study was sighting of 3 individual sub-adult males during winter. This confirms the presence of chiru in Indian territory during winter. Only males were seen in Changchenmo during all the surveys and studies. In the year 2009-2010 there were only six sightings with biggest group of eight individuals of chiru.

The distribution and movements of chiru are influenced by the time of the day, vegetation and habitat. These attributes are, in turn, influenced by altitude, aspect, and slope. Chiru showed strong preferences for riverine habitats that could be attributed to the fact that these habitats offered abundant food as well as shelter. When area offered higher altitudes also Chiru population in the Changchenmo valley, used areas dominated by *Scirpus planifolius*, *Kobresia royleana*, *Kobresia pygmaea*, *Oxytropis humifusa* and *Potentilla anserina*.

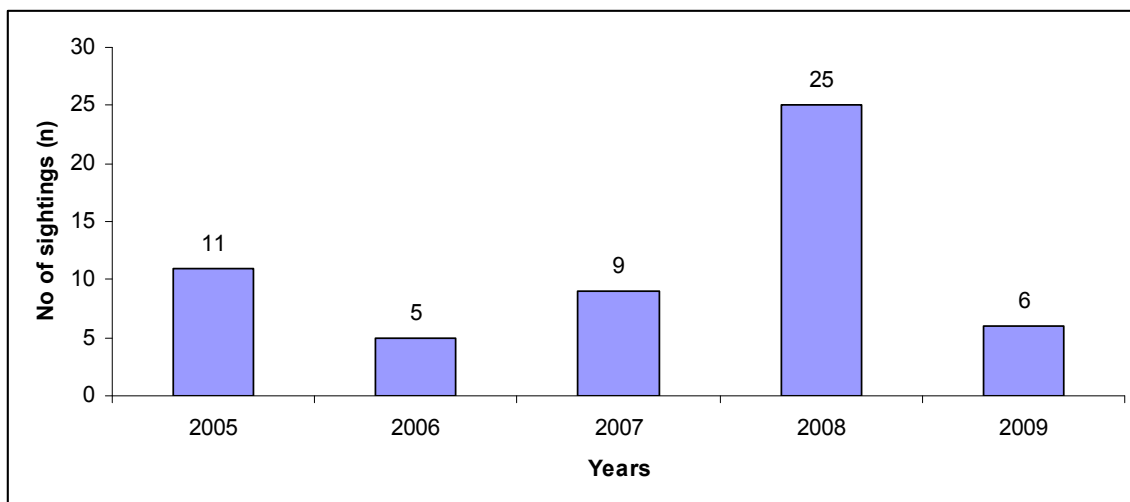


Figure 4.3.1b: Chiru sightings in Changchenmo Valley during 2005 to 2009 (Based on Anonymous 2005, Ahmed *et al.*, 2006 and Present Study).

Regular monitoring of various transects during 2007-2008 reveal that chiru males use valley bottoms, gentle slopes and ridge tops around Hot Spring area, Silung Barma and Silung

Yogma nullahs. Presence of chiru in these areas were also confirmed by the past herders of Phobrang area. However, all the individuals were males (sub-adult and adult). The habitat wise distribution of Chiru in the study area is shown in Fig. 4.3.1C.

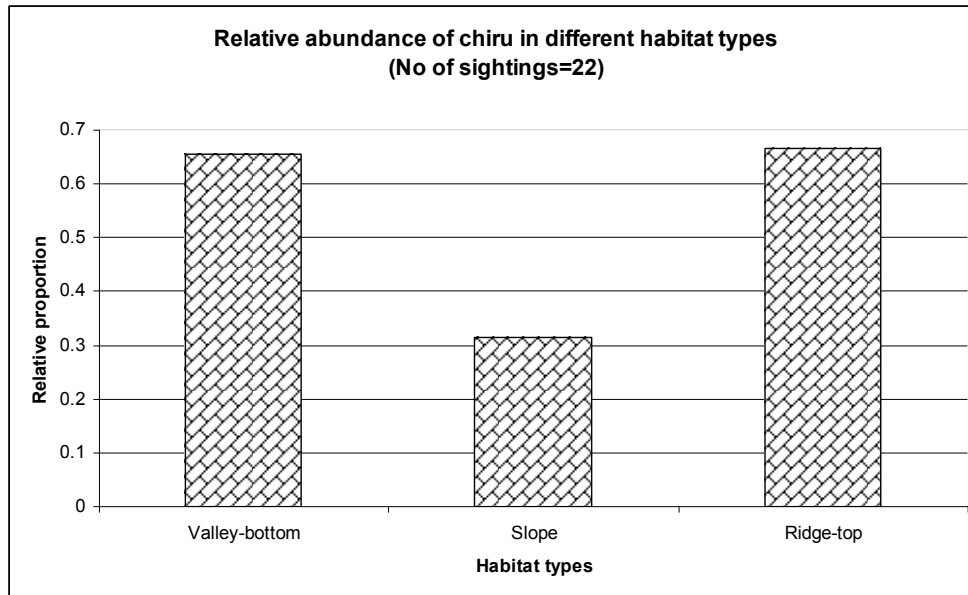


Figure 4.3.1C: Relative abundance of Chiru in different habitats in Changchenmo Valley, Ladakh

During 2009, for the first time we recorded presence of chiru in Thratsang La area. It is important to note that earlier surveys (1995 and 2006) estimated a total population of 200 and 60 individuals respectively in this valley. This study reveals that up to a maximum of 23 individuals used this area during 2008-09 indicating a sharp decline in their number. There is no evidence of chiru poaching reported that migrate to the ravines and meadow slopes of northeast Ladakh into Indian Territory from July to September only. We report a rapid decline in number of chiru even in the absence poaching within Indian territory.

The group composition (age-sex composition) in chiru is known to vary across seasons. A seasonal migration to calving ground may lead to a change in age-sex composition of the group. The climate (especially snowfall) has also been identified as the regulatory factor of variation in age-sex composition within a group. This is because mortality among calves may vary with the age and sex composition of the group. Earlier studies conducted by Schaller

(1998) reported a ratio of 29% males, 53% females and 18% young in the populations of Chang Tang Nature Reserve, China.

4.3.2 Wild yak or Dong (*Bos mutus*) :

Wild yak, the closest ancestor of the domestic yak (*Bos grunniens*), is geographically restricted and highly endemic to high altitudes (over 5000 m) of Central Asia. Historically, the distribution of wild yak extended to the north-east Siberia and reached south to the headwaters of the Hwang Ho. However, their distribution has narrowed down to the Tibetan plateau and Qinghai province of TAR due to large scale hunting for meat and wool (Schaller 1998). Wild yak, like all other high altitude mammals, bears two types of hair. The outer coat is of long and coarse but lustrous hair (guard hairs) while the undercoat is of wool fibre. The coarse hair is used for making ropes, tent felts and the undercoat fibres for making valuable products, fine garments, shoes. Killing wild yak is apparently common in Tibet which has resulted in a sharp decline in its number. Therefore, the wild yak is listed as Vulnerable (IUCN, 2003) and as an Appendix-I species under CITES. Wild Yak is also listed as a Schedule-I species in the Wildlife (Protection) Act of India, 1972.

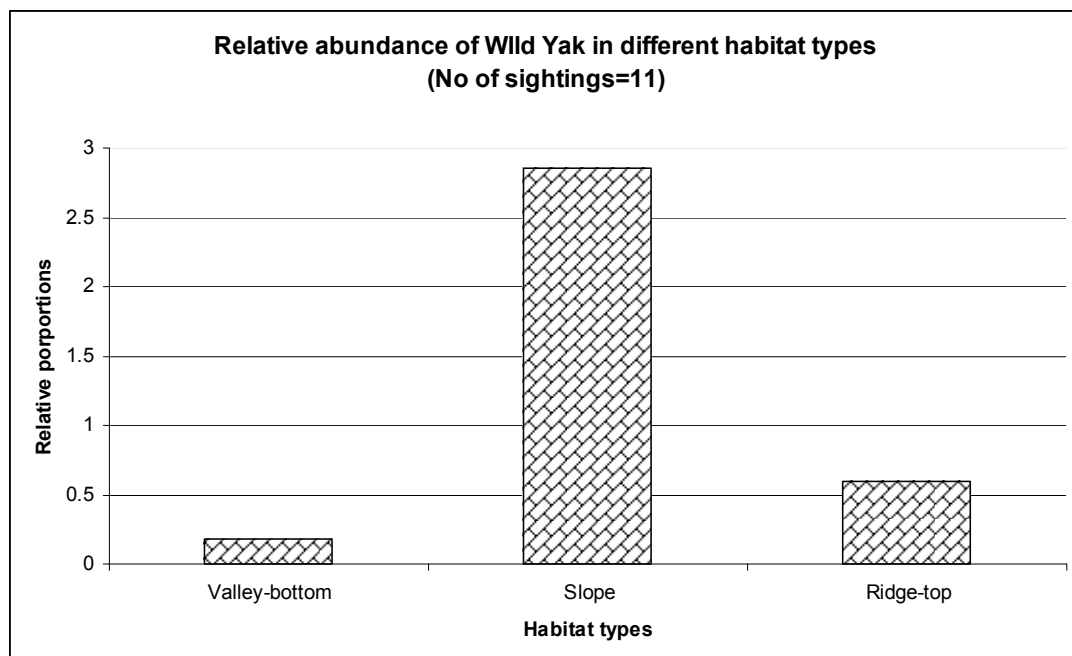


Figure 4.3.2: Relative abundance of wild yak in different habitats in Changchenmo Valley

In Changchenmo Valley, wild yak were sighted in the high ground near Silung Yogma, Kugrung river and slopes adjacent to Konka La. The wild yak were always seen between 4,705-5,300 m, well within their established altitudinal range. In all, 112 individuals of wild yak were recorded in the study area. Available literature reveals that wild yak in TAR of China is often found in larger herds (mean herd size 24 individuals). However, occasional large herds of up to several hundred individuals have been seen at times. The single individual of wild yak was the lowest and highest of 12 individuals for wild yak herd were found in Changchenmo area (mean herd size 3.5). Wild yak were generally found on slopes, higher than areas occupied by chiru in the Changchenmo area. Only on two occasions they were seen in nallah beds (Fig 4.3.2).

4.3.3 Tibetan argali (*Ovis ammon hodgsoni*):

Tibetan argali has a very patchy distribution in Indian Trans-Himalaya, Tibetan plateau and adjacent mountain ranges. Total world population of this species is said to be less than 7000 (Namgail et al., 2004). It forms one of the important prey base for the highly endangered snow leopard (*Uncia uncia*). Within India, Tibetan argali occurs in Eastern Ladakh and Sikkim with estimated populations of approximately 180 – 200 each. While Sikkim population is confined within a small area of less than 200 km², Ladakh populations are scattered in 6-7 scattered, isolated populations. Namgail *et al.* (2004) have estimated a population of about 80 individuals in the proposed Gya-Miru WLS, eastern Ladakh.

Phobrang and Changchenmo areas, north of Pangong Tso were said to be one of the important localities for the long term conservation of Argali where high densities of this species were reported earlier (Bhatnagar 2001). During present investigation we estimate that Changchenmo area could support about 35 – 50 individuals of argali. Maximum total count within entire study area in a single day was 38 individuals. Mean group size comes to 7.1 ± 1.48 (N = 20). Sightings of more male groups in the study area indicates that Changchenmo area could form only one part of argali range. The female: fawn ratio for this species was 5.9:1. Namgail et al. (2004) has reported the occurrence of 75 males for every 100 females in Gya Miru area and the lamb : female ratio of 45 : 100. The higher slopes of Phobrang with plenty of moist meadows and gently undulating terrain could support more populations of Tibetan argali, which needs further verification.

4.3.4 Blue sheep (*Pseudois nayaur*)

Blue sheep or bharal extend over a vast range in Himalaya from the Karakoram in the west to western Arunachal Pradesh in the east. However, their densities vary considerably depending upon the degree of protection and primary productivity of the alpine meadows. It has been observed that in Ladakh blue sheep may be more frequent towards Zaskar ranges and mid west. Best population of blue sheep may be in Hemis NP. Of all the sympatric ungulates in the study area blue sheep are more adapted to utilize most steep and rocky terrain and possibly more tolerant of environmental extremes and wide altitudinal range. In the study area blue sheep were sighted frequently close to Marsmik La. We estimate a population of 120 – 130 individuals. There was a considerable variation in mean group size between summer (21.50) and winter (4.83), mean group size for the entire study period being 16.30 ± 2.36 individuals.

4.3.5 Tibetan wild ass or kiang (*Equus hemionus kiang*)

Kiang, the largest of the wild asses, is an animal of open to gently undulating terrain all across Tibetan plateau wherever suitable forage, especially grasses and sedges are abundant. It reaches its highest densities in wide lake basins and desert steppe up to about 5300m asl. The species confines itself to the plateau except at the western end, where it has penetrated the dry Yarkant and Oprang Valleys between the Kunlun and Karakoram mountains as far west as the Shimshal Pass at the Pakistan-China border (Schaller 1998). In Ladakh best populations of Kiang are in Hanle Valley and Tso Kar basin of Changthang wildlife sanctuary. Kiang was widely distributed in the study area but showed preference for higher plateau and higher slopes with mean group size of 6.39 individuals per group. It is estimated that the Changchenmo Valley (part of the study area) may have a minimum of 130 individuals, with an overall encounter rate of about 20 kiangs per km walk.

Bhatnagar (2001) has reported the highest abundance of kiang along upper Indus from Loma to Demchok followed by Kalang Tar Tar area south of Hanle. Further, it has been estimated that in whole of Ladakh kiang population may be around 2000 as it has lost a considerable habitat in most of its range.

4.4 Conclusion

Phobrang and Changchenmo areas in the northern parts of Changthang WLS, eastern Ladakh, harbours five species of wild ungulates, viz., chiru, wild yak, Tibetan argali, blue sheep and kiang. Of these, first two species are confined to Changchenmo Valley while remaining three species are found in both the areas. In Changchenmo Valley (500 km² that could be surveyed during present investigation), we estimate a population of 20 – 30 chiru, 110 – 120 wild yak, 125 – 150 kiang, 120 - 130 blue sheep and 35 – 50 Tibetan argali. Based on the past reports and present study we conclude that number of chiru population in Changchenmo Valley is on decline. Our study reveals that chiru males do use Changchenmo Valley during winter. For the first time, we report a new location of chiru i.e., Thratsang La in Changthang plateau.

5.0 HABITAT CHARACTERISTICS AND USE BY UNGULATES

5.1 Background

The study area represents typical high altitude desert environment with very low precipitation and primary production. The flat stream banks and relatively greener pastures north of Pangong Tso have been occupied by the local herders who, unlike most of the Changpas have reclaimed part of the land for agriculture and resorted to sedentary life (Phobrang). Only part of the family moves to higher pastures with livestock. According to sheep husbandry department, LAHDC, Phobrang area has about 8000 goats, 2000 sheep and 250-300 yaks. The villagers use most of the pastures around Phobrang and the slopes located towards south east (way to Chertse). Like other Changthang, flat upland valleys and upper basins of larger snow and ice fields harbor higher vegetation cover. During present investigation, only part of pastures around Phobrang (between village and Marsmika La) and Changchemo Valley could be studied. Thus, the study area is divisible into two distinct zones: (i) Phobrang surrounds with heavy livestock grazing pressure, (ii) Changchenmo Valley, that lies on the north-eastern side of Marsmik La, up to line of actual control (LAC). This chapter describes habitat characteristics, vegetation cover and use of various habitat parameters by the sympatric ungulates in the study area.

5.2 Habitat and vegetation characteristics

Phobrang and surrounding landscape has broadly three land use categories (i) habitation and cultivation along lower gentle slopes, (ii) sedge meadows along flat stream courses and around water bodies, and (iii) Desert steppe (mixed) all over the area varying in species composition and cover. On the other hand, Changchenmo valley (beyond Marsmik La) is much more diverse in terms of topography and altitude. The major land forms in this valley include flat river valleys and terraces (sandy plains), lower slopes, scree slopes, plateaus and ridges. Only a small portion of the river valley (Hot Spring area) supports marsh meadows with lush green vegetation. On the whole, the marsh and moist meadows constitute about 2% of entire study area, most of which occur in the upper catchments of Phobrang and upland valleys of Kugrung and Bahu nallas. But for the flat river valley, much of the lower slopes in Changchenmo have desert steppe with <5% vegetation cover.

The study reveals that, though total extent of green cover in Changchenmo valley is much lower but at the local scales ground cover, especially of graminoids is higher in valley bottoms in Changchenmo Valley as compared to Phobrang area (excluding upper catchments, north of Phobrang which were not sampled). The mean % cover of graminoids, herbs and shrubs within Changchenmo and Phobrang areas are given in Figures 5.2 a and b.

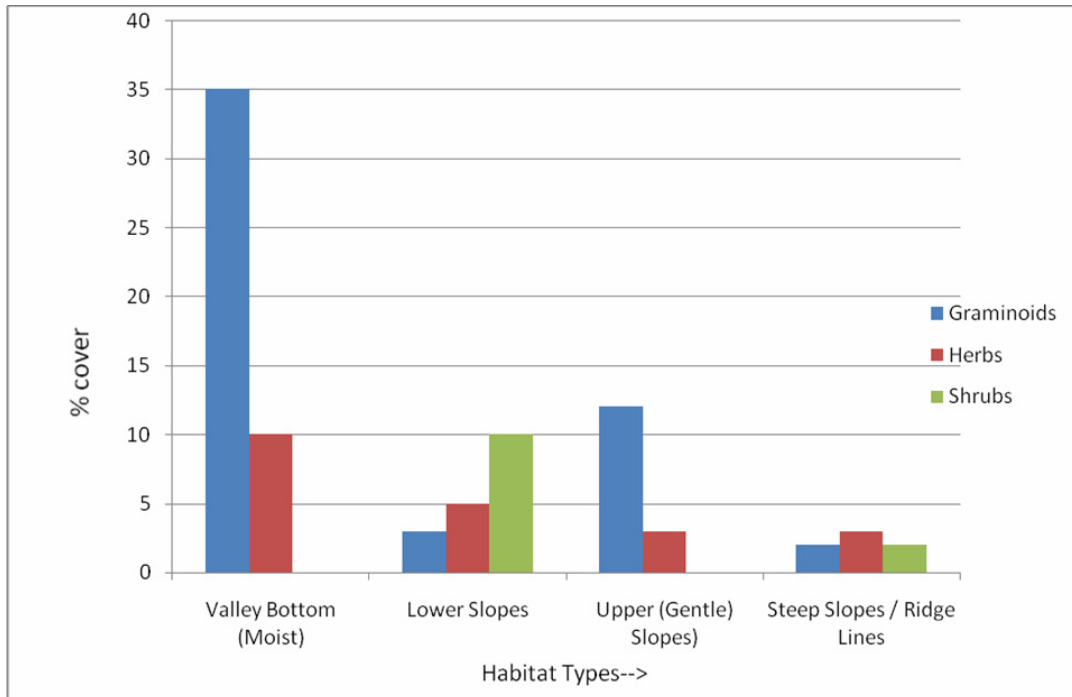


Fig 5.2a: Mean % Cover of graminoids, herbs and shrubs around Phobrang area

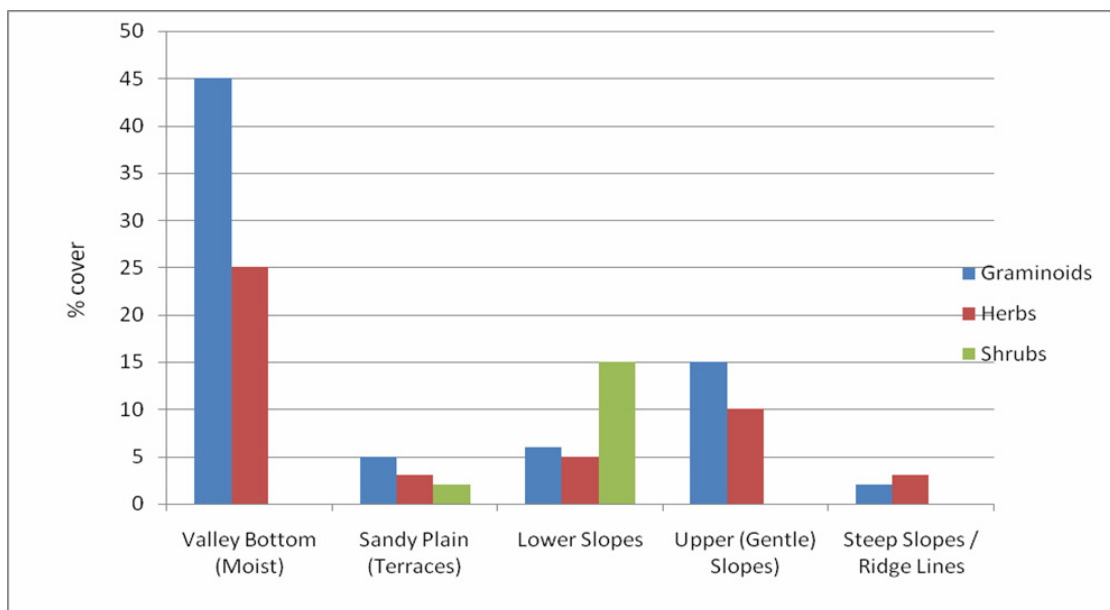


Fig 5.2b: Mean % cover of graminoids, herbs and shrubs across various habitat types in Changchenmo Valley, Eastern Ladakh

The study area is relatively low in plant species diversity. Based on systematic enumeration of vascular plants we report a total of about 131 species (Appendix -1). This includes about 40 species of graminoids (Poaceae, Cyperaceae, Juncaceae and Juncaginaceae) and 91 species of dicots. Proportion of shrubs in the study area is extremely low, represented by *Krascheninnikovia pungens*, *Potentilla salesoviana* and *Ephedra gerardiana*. Most dominant vegetation type in the study area is formed by *Artemisia minor* – *Potentilla pamirica*.

5.3 Habitat use by ungulates

5.3.1 Food selection

All the species of ungulates exhibited spatio-temporal separation in terms of habitat use. Detailed analysis of food selection based on micro-histological analysis is under way. However, from the preponderance of palatable species in feeding areas it can be ascertained that blue sheep, smallest of all the five ungulates preferred alpine mixed meadows dominated by dwarf forbs and a few graminoids. The selection ratio of various vegetation classes for various species (Fig. 5.3) reveals that chiru males and yaks selected greater vegetation cover dominated by *Carex moorcroftii*. Other classes of vegetation were fed in proportion to availability.

Feeding areas of Chiru were characterized by flat river valleys dominated by graminoids *viz.*, *Carex moorcroftii*, *Kobresia royleana*, *Stipa jacquemontii*, *Carex spp.*, *Poa spp.*, forbs such as *Oxytropis tatarica*, *Potentilla bifurca* and *Loentopodium pusillum*. Schaller (1998) reports a considerable seasonal change in the diet of Chiru. Earlier studies conducted by Miller (1997) and Schaller & Gu (1994) also report that Chiru is a mixed feeder but favour graminoids compared to forbs. According to Harris & Muller (1995) Chiru males are mixed feeder with preference to *Kobresia spp.*, while females and young ones depend more on forbs especially *Potentilla bifurca*.

Wild yaks were restricted to Hot Spring area in adjacent valley drainages with good supply of water before Tsogshalu in summers but during the winter season a group of wild yak were sighted in Bahu nallah just before Marasmik la as well. Argali and kiang were present in most of the study area. In summer chiru and wild yak used areas with alpine sedge meadows with vegetation cover (>60%). In winters most of the habitat types are covered with snow. Hence chiru and wild yak occupied snow free areas such as table lands, crags and ridges and undulating areas even though over all ground cover was <20%.

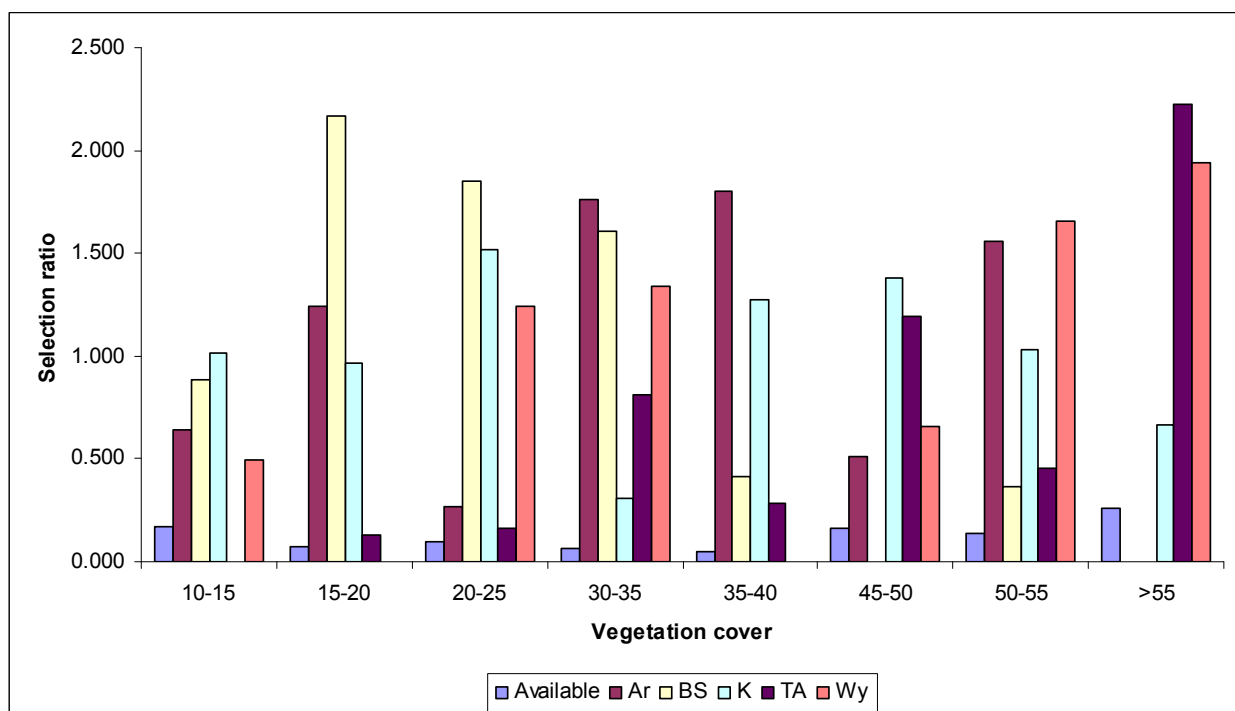


Fig 5.3 Selection ratio of various vegetation cover classes by sympatric ungulates in the study area: Ar = Tibetan argali; BS = Blue sheep; K = Kiang; TA = Tibetan antelope; Wy = Wild yak]

5.3.2 Use of other habitat parameters

Chiru males used valleys and lower slopes between 4700 – 5000m asl during summer months (June – October). Although a considerable area (nearly 100 km²) falls above this altitude, Chiru preferred lower altitudes. It implies that females and young ones are likely to occupy higher slopes to the east or north of Changchenmo across the line of actual control. Argali were seen mostly on gentle slopes, scree bases and ridgelines and they avoided plateau and sandy plains (Fig 5.3.2a). They used middle altitudes (4700 – 4900m) more compared to

other altitudinal ranges both during summer and winter. . Altitudes between 4701-4900m were utilized maximum by all sympatric ungulates except wild yak, which were found at higher altitudes even during winters. Altitudinal range between 4901-5100m was occupied more in summer season than in winters by all the ungulate species. Higher altitude class > 5101m was used by blue sheep and wild yak in both the seasons.

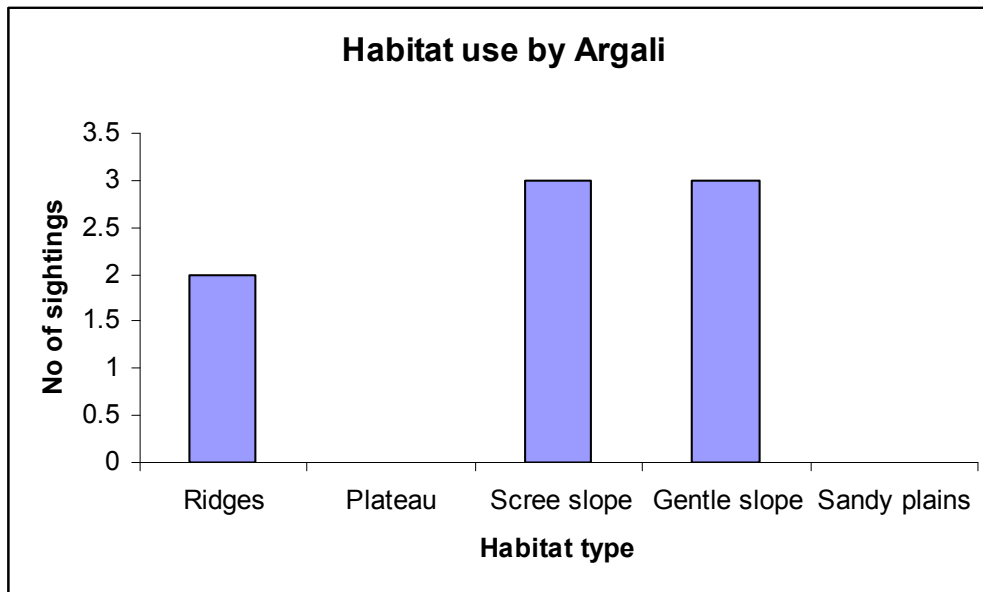


Fig 5.3.2a: Number of Argali sightings (2008) in various habitat types

Blue sheep populations were sporadically distributed especially near cliffs and rugged terrain e.g., Bahu nallah, Manglung nallah, Silung Yogma. Blue sheep population in the valleys east of Pangong Tso preferred slopes with >30° gradient. These slopes had characteristic species such as *Kobresia royleana*, *Euphorbia tibetica*, *Oxytropis microphylla* and *Oxytropis tatarica*. Most of the sightings (>90%) were within 20-30m distance from the escape terrain and gentle slopes were consistently avoided (Fig 5.3.2b).

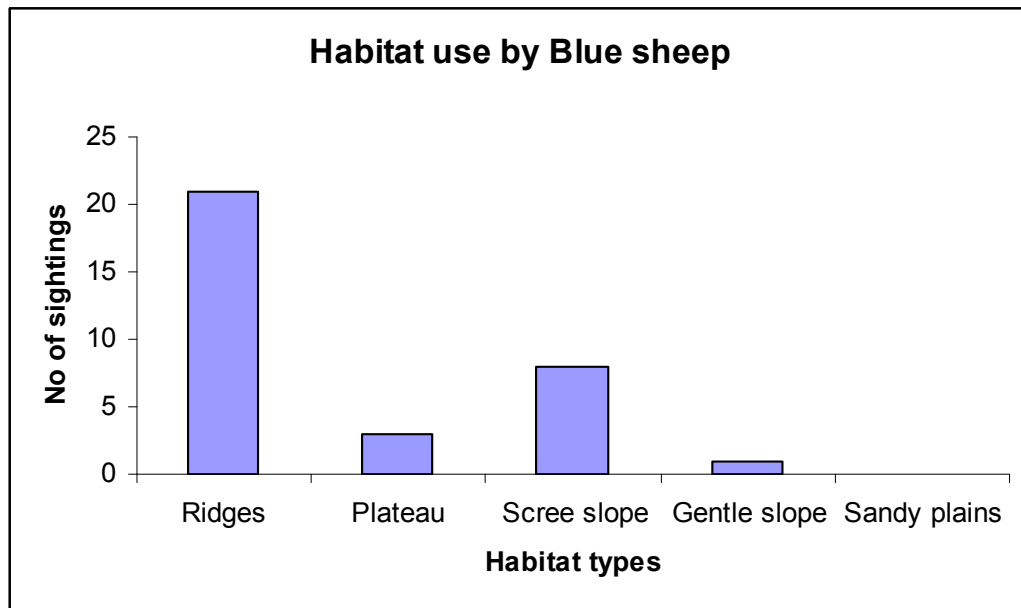


Fig 5.3.2b. Blue sheep sightings across various habitat types in the study area
Kiang used most of the habitat types (except cliffs and scree slopes) uniformly (Fig 5.3.2 c)

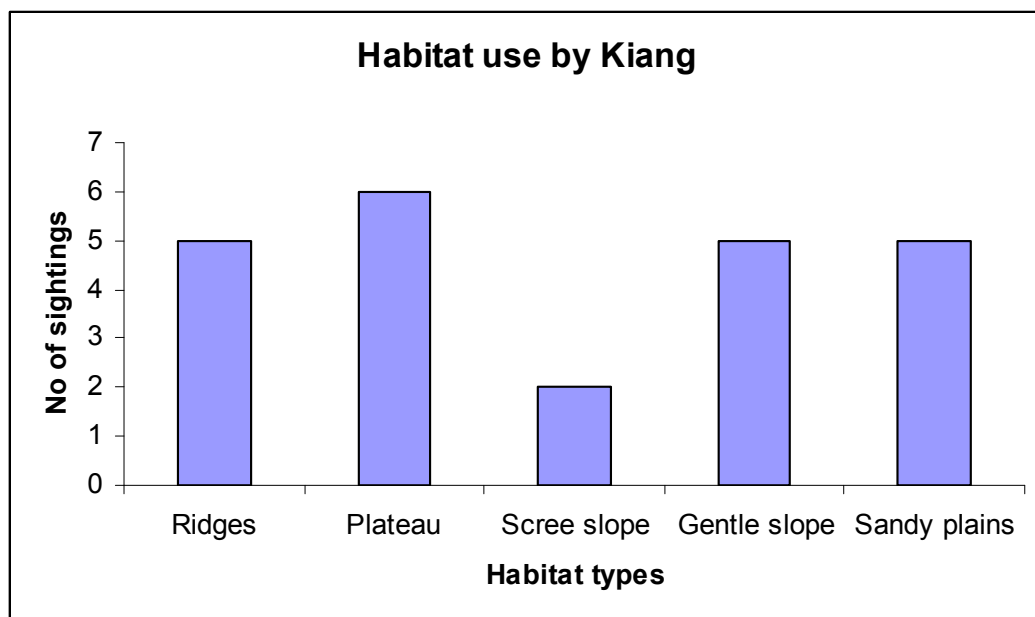


Fig 5.3.2c: Kiang sightings across various habitat types during 2008 - 09

While wild yak, chiru and blue sheep showed no preference for aspects, kiang and argali preferred south and eastern aspect significantly [argali: $N = 27$, $\chi^2=14.55$; kiang $N = 97$, $\chi^2 = 9.44$]. We found that during winter only kiang used the lower altitude <4700m in Changchenmo Valley.

5.4 Conclusion

Co-existence of five wild ungulate species, *albeit* in low populations, in these seemingly low-productive environments could be attributed to their habitat separation and niche differentiation manifested by their morphological and physiological differences. Blue sheep, being smallest of all the ungulates, selected steep and glaciated zones with short forbs and a few graminoids. Chiru males and wild yak were confined to eastern part of Changchenmo Valley, especially with higher cover of graminoids (*Carex moorcroftii*, *Stipa purpurea*, *Leymus secalinus* and *Scirpus* sp.). Kiang occupied most of the habitat categories except steep slopes and cliffs. Highest altitudes were used by blue sheep followed by wild yak, Tibetan argali, chiru and kiang. Kiang and argali showed preference for south facing slopes while other species used in proportion to availability.

6.0 CONSERVATION ISSUES AND STRATEGIES

6.1 General

The Changthang wildlife sanctuary was established in 1987 under section 17 of Jammu & Kashmir Wildlife (Protection) Act. At the time of initial notification, it was not mandatory to settle the traditional rights and land use practices of the local communities. Hence, all the settlements and grazing areas of the *Changpa* herders were included within the sanctuary. Over the years socio-economic conditions and aspirations of the *Changpa* herders have changed and so have the management needs of the protected areas. Although, in official records the sanctuary area is shown as 4000 km², actual area on the ground is far greater. For example, Phobrang and Changchenmo Valley alone are spread over 3100 km². Ironically, status of Changchenmo Valley has remained uncertain as it is sometimes considered as an integral part of Changthang WS but in several documents it has been listed as a separate sanctuary. Since, the Changthang plateau in eastern Ladakh spreads well over 22000 km², there is a tremendous scope to reorganize the sanctuary and come up with long term plan for biodiversity conservation in this region that can also cater to the needs of development. Though, livestock and pastoral communities are pervasive all over Changthang region, it would be extremely important to revise the boundaries of the sanctuary, designate a few core areas representing critical wildlife habitats and key grazing areas for the herders through a consultative process. Changchenmo Valley, undoubtedly, deserves the status of a special core zone within Changthang WLS or of a separate sanctuary so that the last remaining populations of wild yak, chiru and other ungulates of this biogeographic province within India could be conserved for posterity.

6.2 Conservation Issues & Strategies

Based on the primary and secondary information, major conservation issues identified for the study area are: (i) Small and fragmented populations of threatened ungulates, (ii) Degradation of rangelands and loss of productivity, (iii) Possible genetic contamination of wild yak, (iv) Presence of feral dogs around security camps, (v) Lack of alternate livelihoods for the local

people, (vi) Inadequate infra-structure and man power for the PA management. These issues and strategies are discussed below:

- i. ***Small and fragmented populations of threatened ungulates:*** Almost all the wild ungulate species in the study area are small and isolated. Hence they are extremely vulnerable to local extinction. In case of Tibetan antelope, only males use the study area, mostly during summer season. During the present study one case of over wintering of chiru males in Changchenmo area and also another locality (Thratsang La) of the species within Indian territory was recorded. Wild yaks occupy a small portion of Changchenmo valley during summer and status of their wintering ranges is not known. It has been observed that a few herders from Phobrang area take their livestock to Marsmik La and beyond during winters (approximately 1500 sheep and goats and 60 -70 domestic yaks). So far, this valley has remained free from livestock grazing which may have been the reason for better conservation status of these ungulates. Increasing pressure from domestic livestock could cause further impose pressure on rangelands and wildlife habitat. This needs to be checked on priority basis through proper dialogue and appropriate compensatory measures so that small populations of wild ungulates do not get competitively excluded.

- ii. ***Degradation of rangelands and competitive exclusion of wild ungulates:*** It has been established that livestock population in Changthang region has been growing steadily since past two decades or so (Rawat et al. 2006). Present study reveals that overall vegetation cover, especially proportion of palatable forbs is very low and even in Changchenmo Valley which has limited livestock grazing, >70% area falls under desert steppe. The crucial moist / marsh meadows occupy less than 2% of the geographical area in the region. Since domestic livestock are accompanied by the herders and domestic dogs, competitive exclusion of wild ungulates especially Tibetan argali cannot be ruled out in this area. For instance, Bhatnagar & Wangchuk (2001) report sighting of over 80 argali around Phobrang within a short period. However during three years of our stay in this area we did not come across so many individuals and our estimate of argali in this area is less than 50 individuals.

- iii. Possible genetic contamination of wild yaks:** Limited area available for wild yaks, coupled with increasing use of Changchenmo Valley by domestic yak poses yet another threat in the form of possible genetic contamination of wild yak. It has been observed that bulls of domestic yaks frequently stray far and wide in the valley that could increase the chances of intermingling with wild females. Wild yaks are purely black or dark brown in colour and they lack any mixed colour pattern of white (one of the indications to identify groups of domestic yaks from a distance). Use of these areas by domestic yaks could also lead to transmission of vector born diseases. Therefore, appropriate measures to vaccinate domestic yaks on regular basis would be extremely important.
- iv. Presence of feral dogs around defense camps:** The problem of feral dogs around defense establishments in the interior posts has been a major issue in many border posts (e.g., Chundawat & Rawat 1994). During the present study a total of over 25 feral dogs were counted in the study area and we recorded one case of predation on argali by feral dogs. Presence of dogs also led to avoidance of prime feeding area by chiru on two occasions. The dogs can be the source of communicable diseases among wild animals and they can be potential threats to wild ungulates. Hence it is extremely important to control the populations of feral dogs. Accumulation of non-biodegradable waste such as iron scrap, poly-packs, tetra-packs and empty fuel cans around habitations and camps is yet another conservation issue in this area.
- v. Lack of alternate livelihoods to the local communities:** Historically, the only and most important means of livelihood for the local communities in Changthang area has been nomadic pastoralism. The herders used to produce wool, meat and milk products for exchange with food grains, clothes and other commodities at some *Mandis* and low altitude villages. According to elderly people around Phobrang, the local people of this area used to visit parts of Tibet (Rutok county) to procure wool, borax and other products which was one of the important source of alternate livelihood during earlier times. At present, most of the herders around Phobrang make a living by raising livestock (60% of annual income), marginal agriculture and odd jobs in government sponsored schemes including construction works. As this area is not open for tourists, opportunities related to eco-tourism and other enterprise based income generation are limited. This increases their dependence on pastures.

vi. ***Inadequate infra-structure and man power for the PA management:*** The Changthang WLS also suffers due to lack of inadequate infra-structure and lack of trained man power. Presently there is one Range Officer and two wildlife guards to man the sanctuary that spreads across much of the Changthang plateau. The staff lacks necessary clothing, equipment, housing, and training necessary for effective management of the sanctuary. Provisioning more resources to this area to achieve effective conservation is an urgent requirement.

6.3 Recommendations

Wild ungulates around Phobrang and Changchenmo valley are extremely vulnerable to local extinction due to their small populations, stochastic events, relatively small habitat island available that is free from anthropogenic pressures and uncertainties of land use and practices on either side of LAC. Persistence of these ungulates in Changchenmo valley can be partly attributed to relief from intensive livestock grazing but the present situation could change anytime unless adequate long term measures are taken. This valley also supports one of India's only population of wild yak. However, based on the latest assessment of wild ungulate populations and habitat conditions, we anticipate that ungulates of this area may further decline in future. Therefore, maintenance of viable populations of wild ungulates should be an important long term objective of DoWP, Govt. of J&K. This study highlights the ecological importance of Changchenmo valley and need for international dialogue to restore peace on either side of LAC so as to help the highly threatened species of ungulates. In order to achieve the long term conservation of threatened wildlife in this area we recommend the following points to be implemented by the DoWP, Govt. of J&K:

- i. Implement the regular wildlife monitoring programme with the assistance from security personnel following the monitoring protocol as suggested in this report (see Chapter 7).
- ii. Notify Changchenmo Valley as a separate sanctuary and prepare conservation management plan for the area through consultative process involving security personnel and local herders.

- iii. Establish Wildlife Range Office at Phobrang and deploy regular staff for watch and ward, regular monitoring and coordination with the security personnel. The Wildlife staff posted at Phobrang must be given adequate training, remote area allowances and other infra-structure.

- iv. Prohibit Changchenmo Valley for livestock grazing. The herders familiar with this area could be given part time employment for the regular patrolling and monitoring of wildlife in the area and they may be appropriately compensated for not grazing in the valley.

- v. Take necessary steps for eradicating feral dogs from Changchenmo Valley and also for vaccinating the livestock on a regular basis.

7.0 MONITORING PROTOCOL

7.1 Background

Changthang WS in Eastern Ladakh, especially Changchenmo Valley represents the last refuge for two critically endangered ungulates viz., chiru or Tibetan antelope (*Pantholops hodgsoni*) and wild yak (*Bos mutus*) in India. It is estimated that there may be less than 130 wild yaks and around 40 -50 Chiru in this valley. This area is also home to various other charismatic species such as Tibetan argali (*Ovis ammon*), kiang (*Equus kiang*), snow leopard (*Uncia uncia*) and Tibetan wolf (*Canus lupus chanco*). The Department of Wildlife Protection (DoWP), Government of Jammu & Kashmir has inadequate man power and resources to protect and monitor the populations of these species on its own. Moreover, this area falls under the jurisdiction of Indian Army and Indo Tibetan Border Police (ITBP). The officials from these organizations have shown keen interest in conservation of flora and fauna in the region. Present study was undertaken in collaboration with the study security personnel who not only provided necessary permission to work in the region but also provided logistic support. The research team joined the patrol parties and tested some of the methods for collection of basic data on the presence – absence, location and number of important species in the study area. Accordingly, simple protocols for vehicle based surveys, on-foot patrols and data from the observation posts have been designed. The methodology and approaches for each of these are given below:

7.1 Vehicle based observations

The stretch between Pangong Tso and Hot Springs is usually traversed by the vehicles during June to October. This stretch is divisible into four sectors as follows:

- i. Pangong Tso to Phobrang Camp: 8 kms
- ii. Phobrang to Marsmika La: 12 kms
- iii. Marsmika La to Tsokshalu camp: 9 kms

iv. Tsokshalu to Hot Spring Camp: 10 kms

Each sector of road passes through distinct habitat and anthropogenic use gradient. Detailed information of the vegetation and habitat types on either side of each km segment is available with the DoWP. The wild animals sighted from the vehicles during to and fro movement can be recorded in the format (Pro-forma 1) given at the end of this chapter.

7.2 Observations during foot march:

Several long and short range patrol routes have been established by the security personnel in the area concerned. Although the security personnel would not like to reveal the names of all the localities especially close to LAC, the routes which can be used by the wildlife staff accompanied by the security personnel could be used for recording wildlife evidences. Such routes, if needed, could be further characterized for habitat parameters by an experienced Wildlife Biologist so that data can be interpreted more meaningfully. The data sheet suggested for recording animal evidences along on-foot patrol is given (Pro-forma 2).

7.3 Recording animal evidences from the observations posts (OPs):

Observation posts (OPs) or vantage points having commanding view of specific habitats, movement routes of animals or feeding areas are of immense use for monitoring animal activities, population structure, interactions etc.

Data Sheet - 1

WILDLIFE MONITORING BY VEHICLE

Date:

Starting time:

Name of the Driver:

Starting Place:

Destination:

Initial km reading

km. reading at the end:

Weather condition:

Animal Sightings:

SN.	Time	Animals seen*	Number	Location Dist. From the Road**	Notes on habitat (Approx. Altitude)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

* This should include domestic livestock.

**Route map with km location would be ideal from this purpose. Animals location with respect to km stones and name of the closest village / settlement should be mention.

Other Note :- (e.g. : Kills close to roads, information supplied by local people at the stoppage, topography of the place where animal was sighted, e.g. slope, ridges, valley; terrain type e.g., rocky, smooth area, cliff, ridgeline should be recorded.

Signature, Group Leader
(Name and Designation)

Data sheet - 2

DATA SHEET FOR RECORDING WILDLIFE EVIDENCES DURING PATROLS ON FOOT

Date:

Time of Departure:

1. Location of the base camp (code):
2. No. of persons in the group:
3. Starting point:
4. Approximate distance (kms) covered:
5. Weather condition:
6. Weather surveyed area is frequently visited by villagers/ tourists or restricted:
7. Direct sighting and indirect evidences (fresh signs, tracks, calls, kills, etc) of animals:

SN.	Time	Animal seen*/ No. Evidence	Distance	Altitude	Note**
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

* Including domestic livestock

** Activity of animals at the time of sighting and type of terrain/slope they were seen should be recorded.

Signature, Group Leader
(Name and Designation)

Data sheet - 3

**DATA SHEET FOR ANIMAL OBSERVATIONS FROM FIXED POSITIONS
(OBSERVATION POSTS)**

Date:

1. Weather condition:
2. Area Code:
3. Observation time: Beginning..... End.....
4. Wild animals observed:

SN.	Species	Group Composition*	Activity* *
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

* Number of males, females, young ones or unidentified sex

** Feeding, Resting, Grooming, Moving, Sparring, Rutting or any other behavior

5. Any other observation :

Name of the observer

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Appendix – 1: An annotated list of vascular plants collected and recorded from Changchenmo Area, Eastern Ladakh [Abundance: S= Sparse, O= Occasional, R= Rare, F= Frequent;

SN	Botanical Name	Family	Abund.
1.	<i>Allium przewalskianum</i> Regel.	Amaryllidaceae	R
2.	<i>Alyssum canescens</i> DC.	Brassicaceae	F
3.	<i>Androsace robusta</i> Hand.-Mazz.	Primulaceae	S
4.	<i>Arenaria bryophylla</i> Fernald.	Caryophyllaceae	O
5.	<i>Arenaria festucooides</i> Benth.	Caryophyllaceae	F
6.	<i>Arenaria glanduligera</i> Edgew.	Caryophyllaceae	S
7.	<i>Arnebia guttata</i> Bunge	Boraginaceae	S
8.	<i>Artemisia minor</i> Jacq.	Asteraceae	F
9.	<i>Artemisia salsoloides</i> Willd.	Asteraceae	F
10.	<i>Artemisia santolinifolia</i> Turcz. ex Krasch.	Asteraceae	F
11.	<i>Aster flaccidus</i> Bunge	Asteraceae	F
12.	<i>Astragalus heydei</i> Baker	Fabaceae	O
13.	<i>Biebersteinia odora</i> Steph.	Geraniaceae	O
14.	<i>Blasmus compressus</i> (L.) Panz. ex Link.	Cyperaceae	F
15.	<i>Calamagrostis holciformis</i> Jaub. & Spach.	Poaceae	O
16.	<i>Calamagrostis</i> sp.	Poaceae	F
17.	<i>Carex gracilentia</i> Bieb. ex Boeck	Cyperaceae	F
18.	<i>Carex microglochin</i> Wahlb.	Cyperaceae	F
19.	<i>Carex moorcroftii</i> Falc. ex Boott.	Cyperaceae	F
20.	<i>Carex nivalis</i> Boott	Cyperaceae	F
21.	<i>Carex orbicularis</i> Boott.	Cyperaceae	S
22.	<i>Carex parva</i> Nees	Cyperaceae	O
23.	<i>Carex sagaensis</i> Yang	Cyperaceae	O
24.	<i>Carex stenophylla</i> Wahlb	Cyperaceae	S
25.	<i>Carum carvi</i> L.	Apiaceae	O
26.	<i>Catabrosa aquatica</i> (L.) P. Beauv.	Poaceae	O
27.	<i>Catabrosella himalaica</i> (Hk.f.) Tzv.	Poaceae	S
28.	<i>Chamaerhodos sabulosa</i> Bunge	Rosaceae	F
29.	<i>Chenopodium pamiricum</i> Illj.	Chenopodiaceae	S
30.	<i>Chorispora sabulosa</i> Camb	Brassicaceae	F
31.	<i>Christolea crassifolia</i> Camb	Brassicaceae	F
32.	<i>Chrysanthemum pyrethroides</i> Fedtsch.	Asteraceae	F
33.	<i>Corispermum tibeticum</i> Iljin	Chenopodiaceae	S
34.	<i>Crepis flexuosa</i> (DC.) Hk. f. & T.	Asteraceae	F
35.	<i>Delphinium brunonianum</i> Royle	Ranunculaceae	R
36.	<i>Dilophila salsa</i> Thoms.	Brassicaceae	R
37.	<i>Draba altaica</i> Bunge	Brassicaceae	O
38.	<i>Draba oreades</i> Schrenk	Brassicaceae	O
39.	<i>Dracocephalum heterophyllum</i> Benth.	Lamiaceae	F
40.	<i>Elaeocharis</i> sp.	Cyperaceae	F
41.	<i>Elsholtzia eriostachya</i> Hk.f. var.	Lamiaceae	F
42.	<i>Elymus dahuricus</i> Turcz. Ex Griseb.	Poaceae	F
43.	<i>Elymus jacquemontii</i> (Hk.f.) Tzv.	Poaceae	F
44.	<i>Elymus nutans</i> Griseb.	Poaceae	F
45.	<i>Elymus semicostatus</i> Nees ex Steud.	Poaceae	F
46.	<i>Elymus</i> sp.	Poaceae	R
47.	<i>Ephedra gerardiana</i> Wall.	Ephedraceae	R
48.	<i>Eremopoa persica</i> (Trin) Rozhev.	Poaceae	F
49.	<i>Eritrichium canum</i> Kitam.	Boraginaceae	O
50.	<i>Erodium tibetanum</i> Edgew.	Geraniaceae	S

51.	<i>Euphorbia tibetica</i> Boiss.	Euphorbiaceae	F
52.	<i>Festuca olgae</i> (Regel) Krevot.	Poaceae	O
53.	<i>Gentiana crassuloides</i> Bureau & Franchet	Gentianaceae	O
54.	<i>Gentiana leucomelaena</i> Maxim.	Gentianaceae	S
55.	<i>Glaux maritima</i> L.	Primulaceae	O
56.	<i>Halerpestis tricuspis</i> (Maxim.) Hand.-Mazz.	Ranunculaceae	F
57.	<i>Hedinia tibetica</i> (Thoms.) Ostenf.	Brassicaceae	S
58.	<i>Heteropappus semiprostratus</i> Griens.	Asteraceae	S
59.	<i>Juncus leucomelas</i> Royle ex D.Don	Juncaceae	O
60.	<i>Juncus thomsonii</i> Buchen	Juncaceae	R
61.	<i>Kobresia pygmaea</i> Cl.	Cyperaceae	F
62.	<i>Kobresia royleana</i> (Nees) Boeck.	Cyperaceae	O
63.	<i>Kobresia schoenoides</i> Steud.	Cyperaceae	O
64.	<i>Kraschennikovia pungens</i> (Pazij) Podl.	Chenopodiaceae	F
65.	<i>Lancea tibetica</i> Hk.f. & T.	Scrophulariaceae	O
66.	<i>Leiospora pamirica</i> Botsch. & Wedde.	Brassicaceae	R
67.	<i>Leontopodium fimbrilligerum</i> Drumm.	Asteraceae	S
68.	<i>Leontopodium pusillum</i> (Beauv.) Hand.-Mazz.	Asteraceae	S
69.	<i>Lepidium apetalum</i> Willd.	Brassicaceae	F
70.	<i>Leymus secalinus</i> Tzvelev	Poaceae	F
71.	<i>Lindelofia anchusoides</i> (Lindl.) Lehm.	Boraginaceae	O
72.	<i>Marrubium lanatum</i> Benth.	Lamiaceae	S
73.	<i>Microgynoecium tibeticum</i> Hk.f.	Chenopodiaceae	O
74.	<i>Microula tibetica</i> Benth.	Boraginaceae	R
75.	<i>Nepeta eriostachya</i> Benth.	Lamiaceae	O
76.	<i>Nepeta floccosa</i> Benth.	Lamiaceae	F
77.	<i>Nepeta laevigata</i> (D.Don) Hand-Mazz.	Lamiaceae	F
78.	<i>Nepeta longibracteata</i> Benth.	Lamiaceae	S
79.	<i>Oxytropis chiliophylla</i> Royle ex Benth.	Fabaceae	S
80.	<i>Oxytropis humifusa</i> Kar. & Kir.	Fabaceae	R
81.	<i>Oxytropis microphylla</i> DC.	Fabaceae	F
82.	<i>Oxytropis tatarica</i> Jacq. ex Baker	Fabaceae	R
83.	<i>Parrya nudicaulis</i> (L.) Regel.	Brassicaceae	S
84.	<i>Pedicularis longiflora</i> Rudolph.	Scrophulariaceae	O
85.	<i>Pedicularis rhinanthoides</i> Schrenk.	Scrophulariaceae	O
86.	<i>Pegaeophyton scapiflorum</i> (Hk.f.& T.) Marq.	Brassicaceae	F
87.	<i>Pleurospermum brunonis</i> (DC.) Benth ex Cl	Apiaceae	R
88.	<i>Pleurospermum candollii</i> (DC.) Benth ex Cl.	Apiaceae	R
89.	<i>Poa attenuata</i> Trin.	Poaceae	F
90.	<i>Poa koelzii</i> Bor	Poaceae	O
91.	<i>Poa pagophylla</i> L.	Poaceae	F
92.	<i>Poa</i> sp.	Poaceae	F
93.	<i>Polygonum cognatum</i> Meissn.	Polygonaceae	O
94.	<i>Polygonum islandicum</i> Hk.f.	Polygonaceae	R
95.	<i>Polygonum molliaeforme</i> Boisse	Polygonaceae	S
96.	<i>Polygonum sibiricum</i> Lam.	Polygonaceae	F
97.	<i>Potentilla anserina</i> L.	Rosaceae	F
98.	<i>Potentilla bifurca</i> L.	Rosaceae	F
99.	<i>Potentilla pamirica</i> Wolf.	Rosaceae	R
100.	<i>Potentilla salesoviana</i> Steph.	Rosaceae	S
101.	<i>Potentilla</i> sp.	Rosaceae	R
102.	<i>Potentilla supina</i> L.	Rosaceae	F
103.	<i>Primula involucrata</i> Wall. Ex Duby	Primulaceae	S
104.	<i>Pucciniella distans</i> (Wahlb) Parl.	Poaceae	F
105.	<i>Pucciniella himalaica</i> Tzv.	Poaceae	F

106.	<i>Ranunculus brotherusii</i> Edgew.	Ranunculaceae	F
107.	<i>Ranunculus pulchellus</i> Mey	Ranunculaceae	F
108.	<i>Ranunculus</i> sp.	Ranunculaceae	R
109.	<i>Rhodiola tibetica</i> (Hk. f. & T.) Fu	Crassulaceae	F
110.	<i>Saussurea glacialis</i> Herd.	Asteraceae	O
111.	<i>Saussurea glanduligera</i> Sch.-Bip.	Asteraceae	S
112.	<i>Saxifraga cernua</i> L.	Saxifragaceae	O
113.	<i>Scirpus cariciformis</i> Vest.	Cyperaceae	O
114.	<i>Scirpus setaceous</i> L.	Cyperaceae	F
115.	<i>Silene gonosperma</i> (Rupr.) Bocquet	Caryophyllaceae	S
116.	<i>Silene moorcroftiana</i> Wall. ex Benth	Caryophyllaceae	S
117.	<i>Silene stewartii</i> (Edgew.) Maj.	Caryophyllaceae	O
118.	<i>Stipa jacquemontii</i> Jaub. & Spach.	Poaceae	F
119.	<i>Stipa orientalis</i> Trin	Poaceae	O
120.	<i>Tanacetum tibeticum</i> Hk.f. & T.	Asteraceae	F
121.	<i>Taraxacum officinale</i> Wigg., s. l.	Asteraceae	F
122.	<i>Taraxacum</i> sp.	Asteraceae	F
123.	<i>Thermopsis inflata</i> Camb.	Fabaceae	O
124.	<i>Thylacospermum caespitosum</i> (Camb.) Schi	Caryophyllaceae	O
125.	<i>Triglochin maritimum</i> L.	Juncaginaceae	F
126.	<i>Triglochin palustris</i> L.	Juncaginaceae	F
127.	<i>Trisetum spicatum</i> Richt.	Poaceae	F
128.	<i>Urtica hyperborea</i> Jacq. ex Wedd.	Urticaceae	F
129.	<i>Waldhamia glabra</i> (Decne)Regel	Asteraceae	S
130.	<i>Waldhemia nivea</i> (Hk.f.& T.) Regel.	Asteraceae	R
131.	<i>Waldhamia tomentosa</i> (Decne)Regel	Asteraceae	R

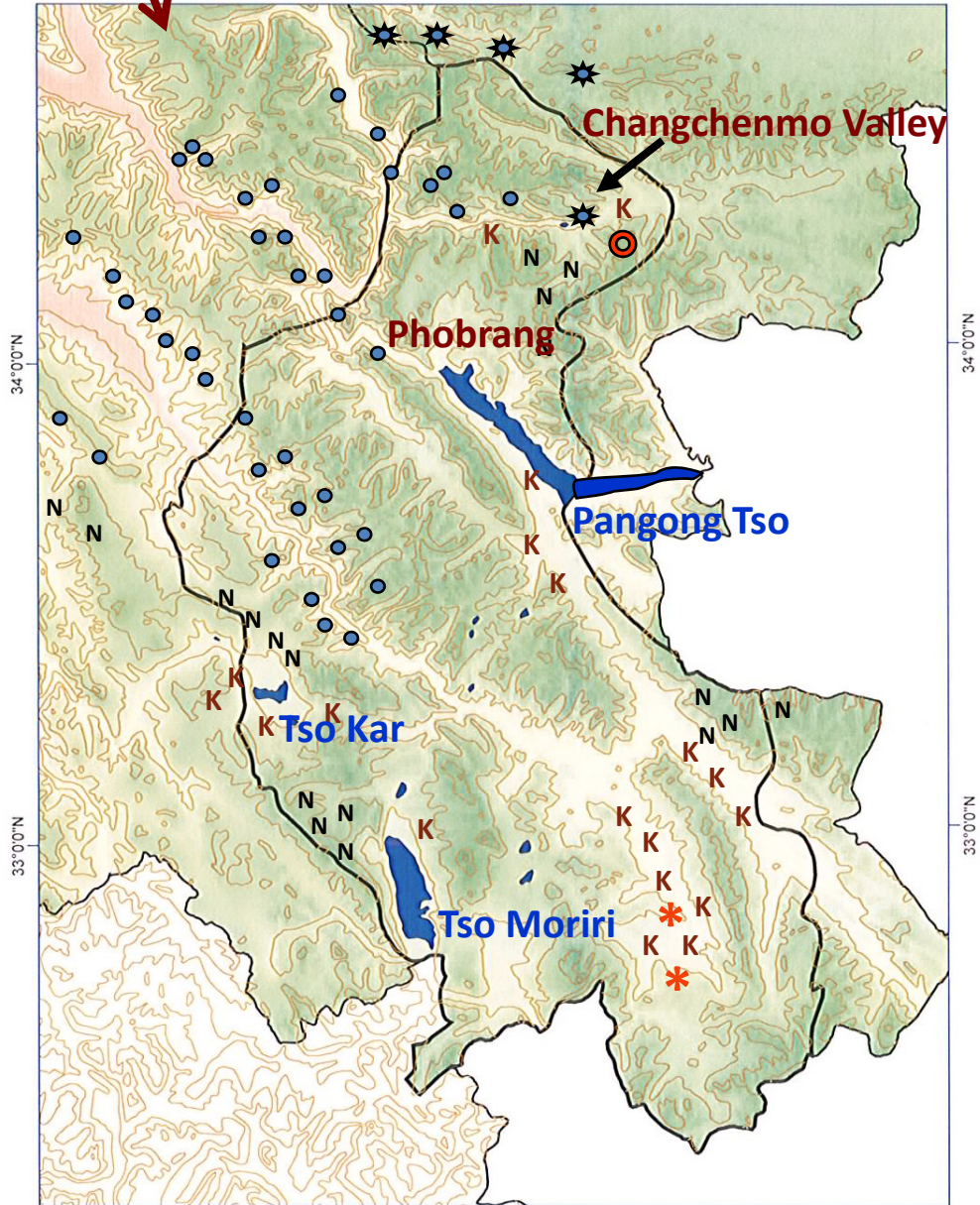
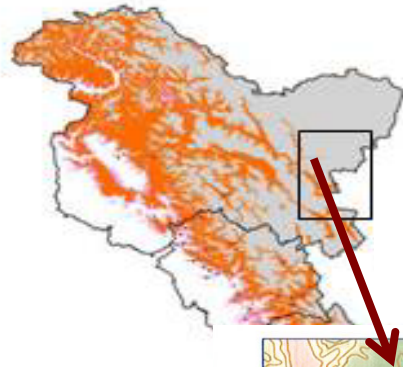
Appendix -II

Birds sighted in Karakoram and Chang Chenmo valley during survey

S.No.	Species	Scientific Name	Family
1	Black Redstart	<i>Phoenicurus ochruros</i>	Muscicapidae
2	Brandt's Mountain Finch	<i>Leucosticte brandti</i>	Fringillidae
3	Common Hoopoe	<i>Upupa epops</i>	Upupidae
4	Common Raven	<i>Corvus corax</i>	Corvidae
5	Common Rosefinch	<i>Caprodacus erythrinus</i>	Fringillidae
6	Desert Wheatear	<i>Oenanthe deserti</i>	Muscicapidae
7	Dipper	<i>Cinclus cinclus</i>	Cinclidae
8	Golden Eagle	<i>Aquila chrysaetos</i>	Accipitridae
9	Hill Pigeon	<i>Columba rupestris</i>	Columbidae
10	Himalayan Snowcock	<i>Tetraogallus himalayensis</i>	Phasianidae
11	Horned Lark	<i>Eremophila alpestris</i>	Alaudidae
12	Kestrel	<i>Falco tinnunculus</i>	Falconidae
13	Lammergeier	<i>Gypaetus barbatus</i>	Accipitridae
14	Large Billed Crow	<i>Corvus macrorhynchos</i>	Corvidae
15	Lesser Sand Plover	<i>Charadrius mongolus</i>	Charadriidae
16	Little Bunting	<i>Emberiza pusilla</i>	Fringillidae
17	Little Stint	<i>Calidris minuta</i>	Scolopacidae
18	Oriental Skylark	<i>Alauda gulgula</i>	Alaudidae
19	Oriental Turtle Dove	<i>Streptopelia orientalis</i>	Columbidae
20	Red Billed Chough	<i>Pyrrhocorax pyrrhocorax</i>	Corvidae
21	Red-headed Bunting	<i>Emberiza bruniceps</i>	Fringillidae
22	Robin Accentor	<i>Prunella rubeculoides</i>	Fringillidae
23	Rufous-breasted Accentor	<i>Prunella strophiatea</i>	Passeridae
24	Rufous-tailed Thrush	<i>Monticola saxatilis</i>	Muscicapidae
25	Snow Pigeon	<i>Columbia leuconota</i>	Columbidae
26	Streaked Rosefinch	<i>Carpodacus rubicilloides</i>	Fringillidae
27	Tibetan Sandgrouse	<i>Syrrhaptes tibetanus</i>	Pterocelidae
28	White Wagtail	<i>Montacilla alba ssp personata</i>	Passeridae
29	White-winged Redstart	<i>Phoenicurus aureoreus</i>	Muscicapidae
30	Wood Sandpiper	<i>Tringa glareola</i>	Scolopacidae
31	Yellow Wagtail	<i>Montacilla flava</i>	Passeridae

Plate 1

Distribution of Wild ungulates in Changthang, Eastern Ladakh (Black polygon shows sanctuary area)

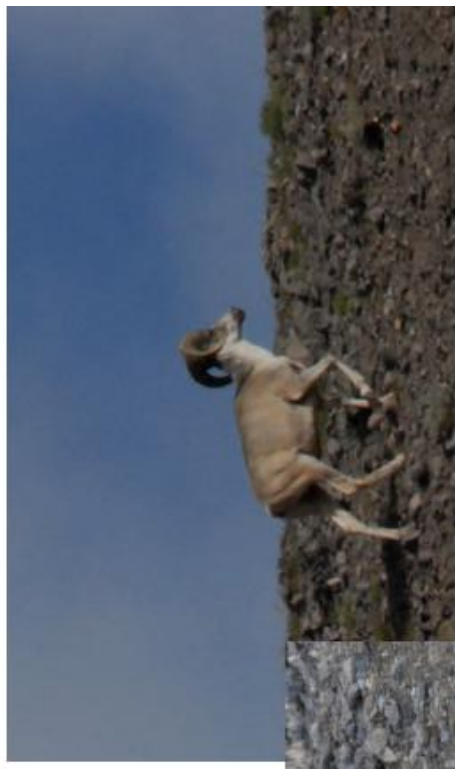


- * T. Gazelle
- W. Yak
- ★ Chiru
- N Nayan
- K Kiang
- Bharal

Plate-2
Wild Ungulates of Changchenmo Valley



Soz (Chiru)



Nayan (T. argali)



Napo (Blue sheep)



skiang (wild ass)



Dong (wild yak)

Plate-3



A : A view of Silung Yokma showing wild yaks; B & C: Landscapes within Changchenmo Valley

Plate 4



A : A view of Phobrang village and pastures; B : Changchenmo Valley; C : A view from Marsimika La facing north

Plate-5
Common Plants of Changchenmo Valley



A : *Oxytropis tatarica*; **B** : *Oxytropis microphylla*; **C** : *Potentilla pamirica*; **D** : *Alyssum canescens*; **E** : *Stipa jacquemontii*; **F** : *Tanacetum tibeticum* and *Kraschenninikovia pungens*; **G** : *Chenopodium pamiricum*