Chapter I

1Introduction

1.1 General background

Nepal, a Himalayan country is an 'epitome of the world', and is situated along the southern slope of the Himalayan ranges. Its geographic position lies within 26° 20' N to 30° 26' N latitude and longitude of 80° 03' E to 88° 15' E with an area of 1,47,181 sq.km. between the Asian giants, Republic of India to the south, east and west and the People's Republic of China to the north (BJC 2007). This fascinating landlocked country, though small in terms of its area just occupying 0.3 % of total landmass of Asia and 0.03 % of the world (Sah 2005) is rich in biodiversity. The country is best owed of vast wealth of natural resources and is probably one of the richest store houses of biodiversity. Nepal, one of the most remote and inaccessible is enriched with great majestic biodiversity as it forms the meeting point of the Himalayan and low lying animals.

The ever increasing human pressure has led worldwide habitat degradation which results on the extinction of numerous plants and animals. Due to such increasing threats to the biodiversity, the government of Nepal, in 1973, gazetted the first National Park of the country as the Royal Chitwan National Park to conserve the species in situ. At present Nepal has got 16 protected areas; 9 National Parks, 3 Wildlife Reserves, 3 Conservation Areas, and 1 Hunting Reserve with buffer zones occupying 19.70 % of the total land area of the country (DNPWC 2008). Dhorpatan Hunting Reserve (DHR) is the only hunting reserve of the country till the date. The DHR serves as a very good habitat for Himalayan Musk deer, which of course adds to the country’s biodiversity. But the population and its conservation status is unknown due to scanty information throughout the reserve.

Population is a changing entity and is of course, characteristically dynamic over time. But the natural population is disturbed by the human activities.

Estimation of the population size and structure is important for the development of conservation strategies especially in relation to land use change and human population (Berry 1987).

Musk deer are unique species with extensive distribution and reproductive rate. However, due to the over exploitation and habitat degradation, survival of Musk deer is threatened throughout the world (Jiang 1995).

Musk deer population is ever decreasing throughout the world (Wemmer 1998). One of the main causes of the declining of wildlife throughout the world beside habitat destruction is unregulated commercial exploitation, triggered by substantial financial incentives. This is also true in the case of Musk deer. DHR allows the trophy hunting of the blue sheep but poaching of other species including Musk deer is continually increasing for its most valued musk. Musk deer may be hunted as the prime target for the glands, or killed incidentally while hunting other animals (Zhou et al. 2004).

Because of public encroachment into the reserve and the extension of the agricultural fields has been increasing day by day (Lal Bahadur Mal Pers. Comm.), the wildlife including Musk deer are threatened and their population of course are undoubtedly diminishing.

For the proper management and conservation of wild animals, proper ecological study is essential.

The concern to save the threatened species from exploitation either by habitat degradation or poaching has been the subject of research for many years.

1.2 Objectives

The principal goal of the research is to identify the ecological status of Musk deer in DHR and the other specific objectives are;

1. to determine the distribution and population status of Musk deer,
2. to assess the present habitat structure and its utilization by the Musk deer and
3. to find out current threats to Musk deer population in the study area.

1.3 Research hypothesis

Following hypotheses are defined to complete this research:

- ❖ the Musk deer are uniformly distributed in the three blocks of DHR,
- ❖ the Musk deer distribution doesn't differ with the aspect of the slope and
- ❖ the Musk deer show equal preference of all types of habitats.

1.4 Justification

Musk deer (*Moschus chrysogaster*, Hodgson 1839*)* is an endangered species (IUCN 2008). The foremost aim of carrying this study on *Moschus chrysogaster* is to add the information

of this species, which helps for the formation of conservation strategy. Due to its elusive behavior, different aspects for a viable population are unknown. So a proper study should be carried out to know the population status and the requirements for a sustaining population so that appropriate conservation efforts can be implemented.

Detail study of *Moschus chrysogaster* has already been carried out in the Sagarmatha National Park (Green 1987; Kattel 1992). The results of this project in this habitat will give detail information on the status and distribution of the endangered *Moschus chrysogaster*, which is very important for sound management and preservation from extinction.

Up to now, no work has been done on *Moschus chrysogaster* in Dhorpatan Hunting Reserve, Nepal. This study will focus on the population status and distribution of *Moschus chrysogaster*.

The reserve did not have any security personnel to monitor the illegal hunting of other animals. Moreover, the reserve's office has also been transferred to District headquarter at Baglung. In these circumstances the status and population of Musk deer (as well as others) is a big deal of research.

Thus, the selection of the research topic for the dissertation in Dhorpatan Hunting Reserve is justified and holds a great significance in itself.

1.5 Limitations of the study

Among seven hunting blocks of the reserve, only the three; Surtibang, Fagune and Barse blocks were surveyed. It is because of the harshness of the topography and remoteness of the other blocks. The study was limited to the surrounding hills of the Dhorpatan valley and the other parts were not surveyed due to their physical inaccessibility and rough terrain. The specific site of the study was selected after the interaction with the game scouts of the reserve, local people, herders and the hunters. Other potential sites, if any beyond their experiences might have been missing. Silent drive count method requires larger manpower and is expensive as well. So, this method of population density determination was only employed in the Barse block of the Dhorpatan Hunting Reserve.

Chapter II

2 Species Description

2.1 Taxonomy

Himalayan Musk deer popularly known as “Kasturi Mirga” in Nepal and India were originally classified as members of the family Cervidae (Flower 1875) but more recently, they have come to be regarded by most authors as a separate family Moschidae (Flevrov 1952; Groves and Grubb 1987; Homes 1999). Moschidae is often considered as a subfamily of Cervidae (Allen 1940; Tate 1947).

Following four types of species of Musk deer have been broadly accepted (Green 1998):

- Siberian Musk deer (*Moschus moschiferus*)
- Forest Musk deer (*M. berezovskii*)
- Himalayan Musk deer (*M. chrysogaster*)
- Black Musk deer (*M. fuscus*)

There is however, broad agreement on the recognition five species of Musk deer in China (Groves et al. 1995; Sheng 1998). Alpine Musk deer (*M. sifanicus*) is the fifth species along with above four species.

2.2 Morphology

The Himalayan must deer (*Moschus chrysogaster*) is a small animal with no antlers and face glands, but having a gall bladder (Negi 1996). The body is dark brown, speckled with grey and covered with coarse and brittle hair. Individual hairs contain air filled cells for superior insulation (Green 1985). The body reaches up to 80-100 cm long and 50-70 cm tall at shoulder (Negi 1996) and a weight of 13-18 kg (Zhivotshenko 1988). Both males and females possess clearly elongated upper canine teeth, extending below the lower lip. The length of male canine usually reaches up to 6-8 cm and in rare instances as much as 10 cm and is used in fight between rivals (Homes 1999). The hind legs are longer than the front legs giving the curved shape, like a bow to the body. The rear parts are more powerful than the front parts showing jumping type of movement rather than running.

Their toes are large for their body size and can be spread to find secure footing in mountains and on snow (Homes 1999).

2.3 Habit, Habitat and Behavior

Musk deer usually occurs at an altitude of 3000 to 4400 meters where temperate climate prevails (Green 1986; Shrestha 1997).The characteristic habitat of Musk deer constitutes of rugged mountains with mixed forest. It prefers to inhabit steep forested or shrub covered slopes mainly in the sub-alpine zones where thick under growth of rhododendron, bamboo, and other shrubs (Bannikov et al. 1978; Green 1987)

Musk deer are very shy and solitary animal found most active during dawn and dusk. At night, Musk deer can be seen in the open areas of their habitat as they graze, while during the day they remain in dense cover (Huffman 2004). Neighboring individuals may utilize common latrines. It depends on its sense of hearing to locate sources of danger. When frightened they make broad leaps up to 6 meters. Male Musk deer are highly territorial, tolerating only female Musk deer within their home range and defending their home range against other males of the species and home range may range from 13-22 ha (Green 1998).

2.4 Feeding

Musk deer primarily feeds upon the leaves of trees, shrubs and forbs. These small bodied ruminants are true selectors of their food. They select forage plants which are high in cell soluble and readily fermentable hemicelluloses at all times (Kattel 1992). They prefer lichens such as *Usnea longissima* as winter stable food and do exhibits unique type of behavior of tree climbing to obtain arboreal lichens (Negi 1996).

2.5 Reproduction

The rut takes place in winter (November to early January) and continues until spring. The gestation period is 178-198 days (Green 1989). A birth of single juvenile is noticed and born from May to June. Male attains maturity at two years of age (McNeely 1973) and female at 18-19 months (Shapisnikov 1956). Pregnant deer have a greater preference for salt than other individuals. Frequent urination occurs just before labor. As soon as the fawn

is born, the mother licks it clean. The young are weaned after three and half months (Tewari and Singh 2000).

2.6 Predators

In wild, Musk deer are subjected to a number of natural predators. The main predators are Wolverine (*Gulo gulo*), Grey wolf (*Canis lupus*), Leopard (*Panthera pardus*), Snow leopard (*Uncia uncia*), Lynx (*Lynx lynx*), Fox (*Vulpes vulpes*) and Yellow-throated marten (*Martes flavigula*).The fawns are attacked by large birds of prey such as *Corvus macrohynchus*, *Aguila hemilasius* and *Buteo hemilasius* (Zhou et al. 2004). In the recent years, predator populations of mammalian have declined for many reasons, so they no longer have a significant impact on the Musk deer population (Wang 1996).

Chapter III

3 Study Area

3.1 Physical description

DHR was established in 1983 and then gazetted in 1987 as the only hunting reserve of the country. It lies at approximately between 28° 27' 40" to 28° 50' 0" north latitude and 82° 26' 30" to 83° 13' 20" east longitude. The reserve is said to occupy 12 VDCs of Baglung (Bungadhovan, Bobang, Khungkhani, Adhikarichour and Nisi), Myagdi (Gurgakhani, Muna and Lulangkhoria) and Rukum district (Takasera, Hukam, Maikot and Kola). It occupies 795 sq.km. of Rukum, 292 sq.km. of Baglung and 238 sq.km. of Myagdi and hence altogether occupying 1325 sq.km. area. The reserve lying along the central Himalayan of western Nepal ranges from 2000-7246 m in elevation (Sah 2005).

The reserve extends up to the Putha, Churen and Gurja Himal in the north while bounded by Uttar Ganga River in the south. It is bounded by Dharkhani, Jhalke and the ridge of Lama Kyang from the east while the Khariwang Khola, Pelma Khola, Kulta Bhanjyang and Jaljala Bhanjyang limits the reserve from the west. The reserve is divided into seven hunting blocks: Surtibang, Fagune, Barse, Ghustung, Dogari, Seng and Sundaha (Wegge 1976).The intensive study area belongs to the three hunting blocks (Barse, Fagune and Surtibang) and was selected on the basis of the reconnaissance survey in the reserve.

3.2 Climate

The reserve exhibits temperate, sub-alpine and alpine type of climates due to its variation in altitude and topography. The monsoon lasts until the beginning of October. Day temperature is very low during winter due to strong winds. Higher elevations remain covered by cloud in the morning, later cleared by the wind. According to the Gurgakhani station (located in Myagdi district at 2530 m), the maximum temperature occurs during summer (June measuring 20.7°^{C} on average) while temperature lowers below 0°^{C} during winters (-0.2°^{C} on average in January). The mean annual precipitation measures 1787.3 mm. The reserve receives maximum precipitation during July (541.8 mm on average) and minimum during December (12.6 mm on average). The maximum mean relative humidity (R.H) recorded at 17:45 is noticed in August (90.7 %) and minimum in March (65.3 %).

The maximum temperature of 22.8°C was recorded in July, 2006 while minimum temperature of -0.5°C was recorded in January, 2006 (Source Department of meteorology and hydrology).The mean annual maximum and minimum temperature, mean annual precipitation and mean annual relative humidity recorded at Gurgakhani station have been shown in the appendix 9 (No. 1, 2 & 3 respectively)

3.3 Flora

Both drier and humid conditions occur in different areas of the reserve. So, the reserve is obviously rich in both types of vegetations flourishing best in these types of contrasting conditions. The drier area also supports grasses and bamboo especially at higher elevations favoring red panda and blue sheep in the rain shadow of the Himalayas (Wegge 1976).

The reserve comprises of Upper temperate, Sub-alpine and Alpine vegetation cover (Stainton 1972).

- Upper temperate mixed forest (2850-3100 m):- consists of Oak (*Quercus semicarpifolia*), Blue-pine (*Pinus wallichina*), *Rhododendron arboreum*, Hemlock (*Tsuga dumosa*), Spruce (*Picea smithiana*), etc.

- Sub-alpine vegetation (3000-3900 m):- consists of Thingre salla (*Abies spectabilis*), Birch (*Betula utilis*) *and Rhododendron campanulatum*. Higher elevation comprises *Juniperus indica, J. recurva* and *J. squamata* replaces them still at higher elevation.

- Alpine scrub (above 4000 m):- consists of grasses and sedges. Also comprises of *Rhododendron anthropogan* and *R. nivale.*

According to BPP (1995) GIS analysis of relative cover of Centre Nationale Researches Scientifique's (CNRS's) ecosystem type shows that the predominant ecosystems of the reserve are:-

- Lower sub-alpine *Abies spectabilis* forest -19 %
- Upper sub-alpine Rhododendron-birch forest -18 %
- Lower sub-alpine Rhododendron mesophytic scrub land -18 %
- Mesophytic mat patches and vegetal rock -13 %

The reserve is also enriched with medical herbs like Yarsa gumba (*Cordyceps sinensis*), Panchaunle (*Orchis latifolia incarnate*), Padamchal (*Rheum emodi*), Satua (*Paris polyphylla*), Bikh (*Aconitum* spp.), Ketuke (*Picorhiza scrophulariflora*), Selajit (Rock exudates), Jatamasi (*Nardostachys grandiflora*) and many more.

3.4 Fauna

The reserve supports 18 species of mammals (13 NRDB species), 137 species of birds (15 NRDB species) and 1 of reptile (0 NRDB species) (BPP 1995). The most worthy animal of the reserve is the blue sheep and occurs above the timber line. Their number ranges between 700-740 individuals within 9600 ha (Wilson 1981). Other large game species are Ghoral (*Nemorhaedus goral)*, Serow (*Capricornis sumatraensis*), Himalayan thar (*Hemitragus jemlahicus*), Barking deer (*Muntiacus muntajak*), and Wild boar (*Sus scrofa*).

The reserve is crowned with other important mammals like Lynx (*Felis lynx*), Red panda (*Ailurus fulgens*), Snow leopard (*Uncia uncia*), Wild dog (*Cuon alpines*), Wolf (*Canis lupus*) and Himalayan black bear (*Selenarctos thivetanus*). Leopard (*Panthera pardus*) is a predator on livestock throughout the reserve below the elevation of 4500 m.

Wild boar, Ghoral and Himalayan thar are the secondary trophy animals beside the principal trophy animal blue sheep as recommended by Wegge (1976). The quotas are actually set annually by DNPWC.

Threatened avian-fauna of the reserve are Cheer (*Catreus wallichii*), Danphe (*Lophophorus impejanus*), Monal (*Tragopan satyra*) and Himalayan snow cock (*Terogallus himalayansis*). Koklas pheasant (*Pucrasia macrolopha*) and Blood pheasant (*Ithaginis cruentis*) are also frequently noticed in the reserve.

3.5 Settlements, land usage and culture

The reserve is surrounded by villages on all sides except to the north. Majority of the inhabitants of these villages belong to mongoloid race including Magar, Thakali and Gurung. These villages are also occupied by Kamis, few Brahmins, Nauthars (Adai, Matey-Adai, Bhandari, Chota-Bhandari, Kathair, Kayeth, Kumai and Thapa) and Tibetan refugees (Sah 2005). Amalgamation of different ethnic groups has resulted in a mixed type of cultures. Most of the inhabitants of the Dhorpatan valley live there only during the

spring and summer seasons while move down to lower elevations called as “Aula” by the local people in winter. However, the Tibetan refugees, who established their village in 1960, live in the valley throughout the year round.

The people here are hit hard by poverty and due to the economic inefficiency; they heavily depend on the forest resources for their livelihood. Agriculture and livestock farming is the only available options and has become the tradition of the people. Historically the reserve area has been used by the villagers for summer grazing and for potato crop production in fertile Uttar Ganga river valley (Wilson 1981).

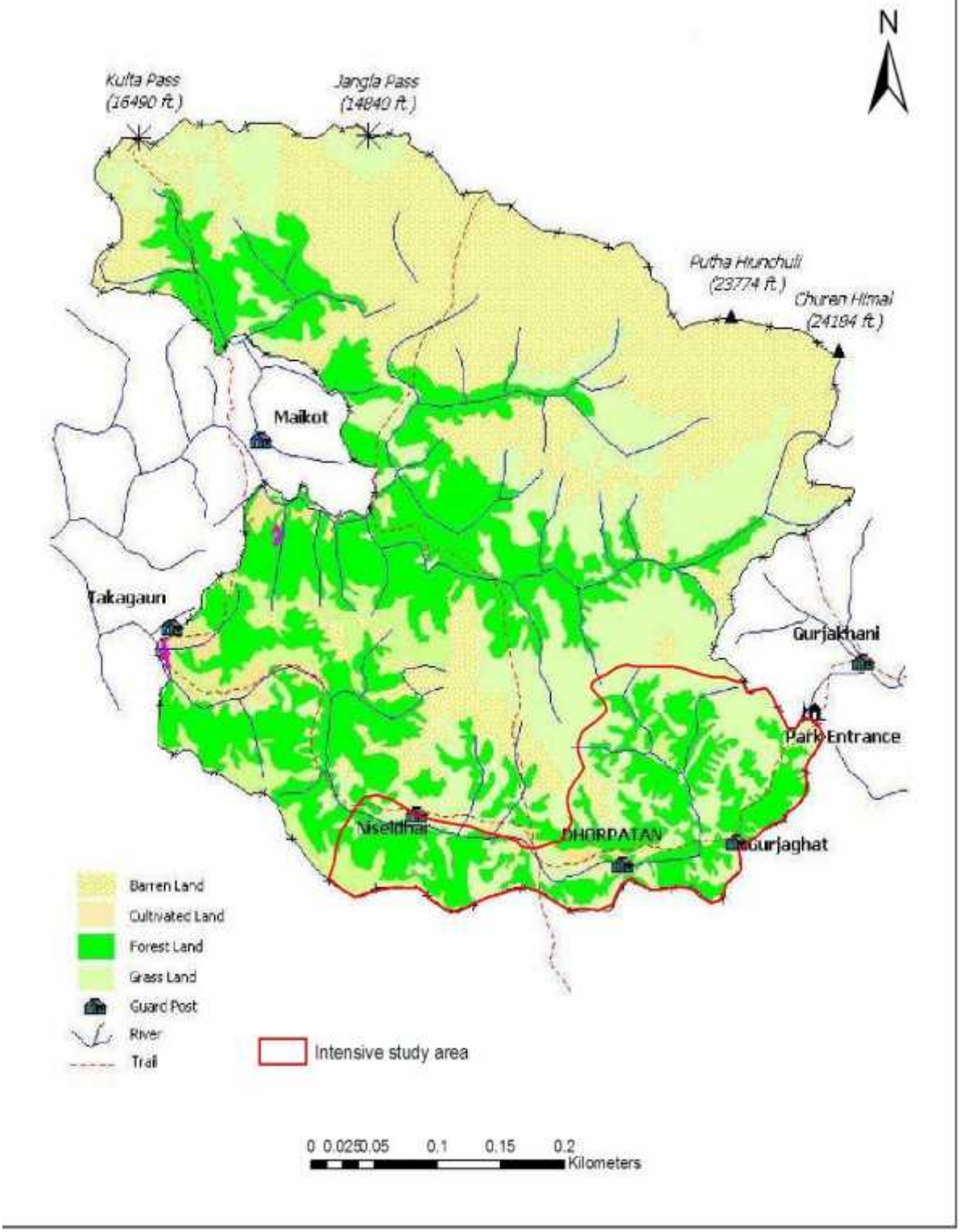
Tibetan refugees are engaged in trade of agricultural products, mules, horses in Dolpa and Tibet.

Around 1,300 families with about 80,000 herds of livestock move into Dhorpatan’s alpine pastures during summer (Heinin and Kattel 1992). Summer huts (locally called as “Goths”) are seen even above 4500 m. “Buki” this is how the local people define their highland summer pastures.

Expansion of agriculture land is another severe problem that threatens the reserve’s biodiversity. The people produce buck wheat, potato, barley to sustain their livelihood.

Dhorbaraha, a Hindu religious place on the banks of Uttar Ganga River near Dhorpatan, is in Fagune block. Every year on the day of "*Janai Purnima*" in August, a religious fair is held here which is attended by many local devotees.

Map of Study Area



Chapter IV

4 Literature Review

4.1 Distribution of species

The Himalayan Musk deer is distributed in Afghanistan, Bhutan, China, India, Myanmar, Nepal and Pakistan. Himalayan Musk deer is widely but discontinuously distributed throughout the Himalaya, ranging in altitudes from 3000 m-4400 m (Green 1985).

They are distributed from 2200 m to 4300 m (7250-14200 ft) of elevation on the eastern and southern edge of Tibet and southern slopes of the Himalayas within moderate to steep slopes (Green 1987; Kattel 1992).

In Nepal it is found in Jatapokhari, Chipuwa, Taplejung and Arun valley in eastern part of the country whereas they are found in Dhorpatan and Manang in the central and Bajhang, Doti, Namlang valley, Tibrikot and Markhov Lake in the western (Jamwal 1972). The species is also found in Rara National Park, Langtang National Park, Kanchanjunga Conservation Area (KCA), Sagarmatha National Park, Makalu-Barun National Park, Langtang National Park, Manaslu Conservation Area, Annapurna Conservation Area (ACA), Shey-Phoksundo National Park and Khaptad National Park (Bolton 1976; Borradaile et al. 1977; HMG/Nepal 2002).

It is protected mammal and is listed as an endangered species by the National Park and Wildlife Conservation Act 2029 B.S (1973 A.D) in Nepal. It is listed in Appendix I for Nepal, Afghanistan, India and Pakistan while in Appendix II for Bhutan and China under CITES.

4.2 Population status

Bannikov et al. (1978) estimated the population of Siberian Musk deer in the former Soviet Union at 100,000, based on the mean population density of 0.6 ind./sq.km. However with the disintegration of the Soviet Union, the population has apparently declined significantly and was currently estimated to total around 50,000-60,000 (Homes 1999). The area of potential habitat for Musk deer south of the Himalayas is about 50,000 sq.km. with an optimum population density of 3 to 6 ind./sq.km. and this area will provide space for 200,000 animals (Green 1986). He, however, suggested the mean population density is around 0.6 ind./sq.km.,which places the total population of Musk deer in the southern Himalayas at no more than 30,000 animals. Richard and Cai (1990) estimated

approximately 2-3 ind./sq.km. in Baizha forest of south central Qinghai Province, China. Musk deer occurred at reasonable density of 5-6 ind./sq.km. in Sagarmatha National Park (Uprety 1979). The average population density of Musk deer in Humde was 4.5 ind./sq.km. and 3.4 ind./sq.km. in the Pisang of Manang (Aryal 2005). Similarly in 2007 he counted 15 Musk deer in Lumbubiyo forest and estimated population density of 2.4 ind./sq.km. in Chichugan forest of Marpha VDC of Mustang. Twenty five Musk deer has been found in Phroste with male: female ratio of 2:5 (Rajchal 2006).

4.3 Threats

The main threats of the Musk deer survival are habitat loss and poaching to procure musk pod from the males. But the use of the traps and snares also kills females and young indiscriminately (Blower 1974). Mukhopadhyay et al. (1973) described that musk is reputed to be a cardiac and general stimulant and is used to support the active functioning of the heart. The unique flavoring quality of musk is one of the important factors for its high value in the international market. Besides being used in flavoring delicacies, it is also used in costly wines and perfumes (Tewari and Singh 2000). Sathyakumar et al. (1993) reported livestock grazing and the associated impacts have led to low Musk deer densities in many areas in Kedarnath Wildlife Sanctuary, India. The most important market for musk products now is in Asia, for Traditional East Asian Medicine (TEAM). Musk is included in about 300 pharmaceutical preparations in traditional Chinese and Korean medicines as a sedative and a stimulant to treat variety of ailments of the heart, nerves, breathing and sexuality and is therefore one of the most commonly used animal products in this type of medicine (Mills 1998). Musk deer have been killed for thousands of years, however, meat is not considered tasty and the hide is not particularly valuable as the hairs fallout easily (Heptener and Naumov 1961). The overriding cause of the intense hunting of Musk deer has always been the demand for musk.

Jackson (1979) described the traditional hunting of Musk deer by the mountain people in western Nepal, where they were killed with poisoned bamboo (*Arundinaria* spp.). Selling just a small quantity of musk yielded sufficient income to meet sustainable portion of the annual living costs of the whole family in Nepal during 1970's. At least 3 to 5 Musk deer may be killed in order to secure one male with sufficiently large musk gland (Jackson

1979; Green 1986). Musk remains one the most expensive natural products in the world today. At the end of the 1970s, the market value of musk reached US$ 45,000 per kg, or two or three times its weight in gold (Green 1986). The local traders could get only around NRs. 4,28,816 per kg at local level (Rs 5000 per tola) (Aryal 2007).

Chapter V

5 Methodology

5.1 Reconnaissance survey

Prior to the actual field work in March-May, 2007, a reconnaissance survey was carried out from 20th Feb. 2007 to 26th Feb. 2007. This was done by questionnaire and discussion with concerned people like local hunters, villagers, herders and park staffs. The experiences of the game scouts and herders were found very prolific for the survey in determining the habitat and occurrence area of the Musk deer in the reserve.

5.2 Distribution

Distribution pattern was identified on the basis of direct observation, presence and absence of the pellets and tracks and other marks (hairs, scraping of the food plants). It was also aided by the questionnaires and interviews with the herders, reserve staffs and other key informants like hunters. To compare the distribution pattern of the deer in the three blocks; pellet groups density were determined along a line transect of 1000 m long ranging from the elevation of 3000 m to 4000 m in all the three blocks studied. Natural demarcation like springs, ridges, rivulets and furrows of the hill were used as reference line. Each transects run perpendicular to the reference lines. The reference line was fixed at 3000 m at the valley floor of the Dhorpatan. In each transect, the number of pellet groups of the animal encountered were recorded within 5 m width of the line transect. A total of 18 line transects were defined with the interval of 1 km horizontal distance. There were 7 transects in Barse, 5 in Fagune and 6 in Surtibang blocks.

$$\text{Pellet density} = \frac{\text{Total pellet groups}}{\text{Transect area} \times \text{Transect No}}$$

Variance (σ^2) of pellet groups occurring at various altitudes was determined by using the following formula:

$$\sigma^2 = \frac{1}{N}\sum fx^2 - \left(\sum \frac{fx}{N}\right)^2$$

Where, x = altitude N= Total No. of variates

It gives the variance of occurrence of Musk deer at various altitudes and gives the idea of its distribution with altitude.

A chi-square test was also performed, developing a null hypothesis that "the Musk deer are uniformly distributed in the three blocks of the reserve under study."

$$\chi 2 = \sum_{i-1}^{n} \frac{(Oi - Ei)^2}{Ei}$$

χ2= chi-square

Oi= Observed value

Ei= Expected value

n = Total no of observations

5.3 Population status

The survey for population of the Musk deer was conducted only after knowing the distribution pattern of the Musk deer or knowing the key habitat where they occurred. The areas with no any signs (pellets, tracks, marks) were assumed to be devoid of Musk deer population. Population density of the Musk deer was determined by **silent drive count method** in the Barse block.

The silent drive count method (Green 1985) was applied in Dharkharka and Khokriban of this block for the estimation of the population density of the Musk deer. In both of these areas, a baseline of approximately 1000 m was fixed at the elevation of 3000 m and was driven to the elevation of 4000 m. Each of these areas was divided into two blocks with the baseline of about 500 m.

The silent drive method involved more time, manpower, funds. So, the most potent habitat was first identified and 25 men placed at equal intervals silently drived the animals along their line of travel. These man recorded the animal sighted (species, number and time). 5 observers were placed above the forest level and other vantage points to record the animals that were driven out. To avoid the repeated counting of the same animal, they were flushed

outside the study area. All men had watches that were set to the watch of the drive count co-coordinator. The drive count was done during early morning as it is considered as ideal time to conduct the drive count.

5.4 Habitat structure (Vegetation analysis)

Floristic survey was conducted by the quadrat sampling method on either side (10 m) of the line transect. Sample plots were laid at every 100 m increase in the elevation while ascending from 3000 to 4000 m. Sample plots were also laid where pellet groups and other marks (hairs, tracks, etc.) were observed.

Total of 120 quadrats were plotted (42 in Barse; 38 in Fagune and 40 in Surtibang). Sample plot size for plants were used as suggested by Schemnitz (1980): that is 10m x 10m for trees, 4m x 4m for the shrubs (approximately up to 3m in height) and 1m x 1m for herb layer in composite plot. The plant species were identified with the help of plant taxonomist from Central Department of Botany. Local names were used for the plant species that were not identified. The density, relative density, frequency, relative frequency, dominance, relative dominance and Important Value Index (IVI) were calculated by using the following relation (Smith 1980; Shrestha & Ghimire 1996).

1. Density and Relative density (RD)

$$\text{a) Density of species A} = \frac{\text{Total no. of individuals of species A}}{\text{Total no. of plots sampled x area of a plot}}$$

$$\text{b) Relative density of species A} = \frac{\text{Density of species A}}{\text{Total density}} \times 100\%$$

2. Frequency and Relative frequency (RF)

$$\text{a) Frequency of species A} = \frac{\text{No. of plots in which species A occurs}}{\text{Total no. of plots sampled}} \times 100\%$$

$$\text{b) Relative frequency of species A} = \frac{\text{Frequency of species A}}{\text{Total frequency of all species}} \times 100\%$$

3. Relative dominance (R Dom.)

$$\text{Relative dominance of species A} = \frac{\text{Total basal area of species A}}{\text{Total basal area of all species}} \times 100\%$$

Basal area

Basal area of a species is the cross sectional area that the stem of that species occupies and was determined by the formula as follows:

$$\text{Basal area} = \left(\frac{\pi d^2}{4}\right)$$

Where, d=diameter of tree at breast height (usually measured by a DBH tape)

Important value index (IVI)

IVI of a tree species was obtained by the summation of the relative density, relative frequency and relative dominance.

IVI= Relative density + Relative frequency + Relative dominance

(RD + RF + R Dom.)

5.5 Habitat utilization

Habitat utilization by the Musk deer was determined by faecal sample plot observation. Pellet groups along the line transect, within the quadrat sampled were counted. The number of pellet groups in different habitat types (Forest, shrub land and open grassland) was counted. This is the most useful indirect method for determining the habitat utilization trends of ungulates (Seidensticker 1976).

The habitat preference was calculated by the following formula:

$$\textbf{HP } (\%) \text{ of any habitat} = \frac{\text{No. of pellet groups in that habitat}}{\text{Total No. of pellet groups in all habitat types}} \times 100$$

Where, HP = Habitat preference

5.6 Threats

To meet this objective, direct observation and questionnaire surveys were used. Some formal and informal interviews were done to determine the existing threats to the Musk deer. The past and present hunting techniques were also inquired with the locals and the hunters. The present hunting techniques were better observed during the field visit. Snares were searched and collected from the Musk deer habitat.

Questionnaire method

Questionnaire method was employed in order to gather various key information regarding the subject of interest to meet various objectives. A total of 280 respondents (excluding the herders) at Gurjaghat, Chentung, Dhorpatan valley and Uttar Ganga were interviewed using the semi structured questionnaires (Appendix 8). 30 herders were also interviewed to determine the distribution and threats of the Musk deer.

Chapter VI

6 Results

6.1 Distribution and population status

6.1.1 Distribution

Altitude

In DHR the pellet groups were found from 3400 m to 4000 m of elevation within this highest pellet groups (50 %) were found in the Surtibang block in the altitudinal range of 3400-3600 m, while the highest pellet groups of 89 % in the Fagune were encountered in the altitudinal range of 3600-3800 m. Similarly, in Barse highest pellet groups (60 %) were found from the range of 3600-3800 m. No pellet groups were noticed below 3400 m and above 4000 m (Fig. 1). Figure 1 showed the distribution of pellet groups at different altitudes in the three study blocks.

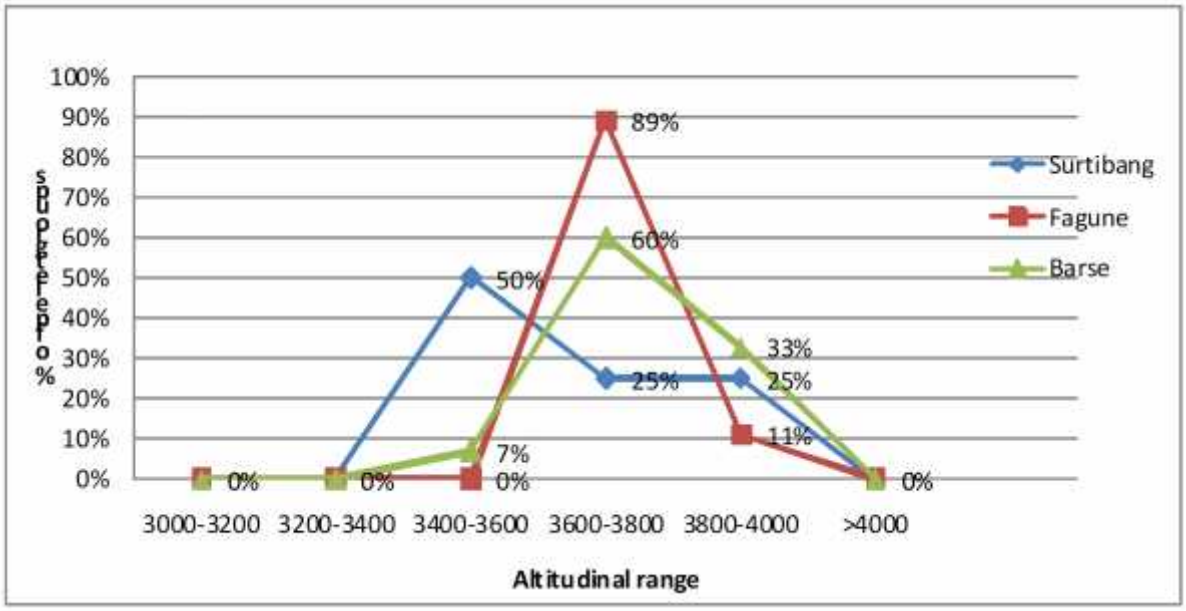


Figure 1: % of pellet groups encountered at different altitudinal range in the three study blocks.

Variance (σ2) of distribution of Musk deer with altitude was highest in Surtibang block (i.e. highest standard deviation) followed by Barse block and then the Fagune (Table 1).

Table 1: Variance and Standard deviation of distribution of Musk deer with altitude.

S. No	Block	Variance (σ^2)	Standard deviation (σ)
1.	Surtibang	32737.0	180.9
2.	Fagune	2476.9	46.8
3.	Barse	4200.2	64.8

Pellet group density in the three blocks

28 pellet groups were noticed in the study area of which 4 were encountered in Surtibang, 9 in Fagune and 15 in Barse block (Appendix 3). This comprised 14 % of pellet groups in Surtibang, 32 % in Fagune and 54 % in Barse.

Pellet group density in Surtibang was 133.33 per sq.km; in Fagune it was 360.00 per sq.km while highest pellet group density of 428.57 per sq.km was recorded in Barse block. The figure 2 showed the occurrence of pellet groups in the 3 blocks.

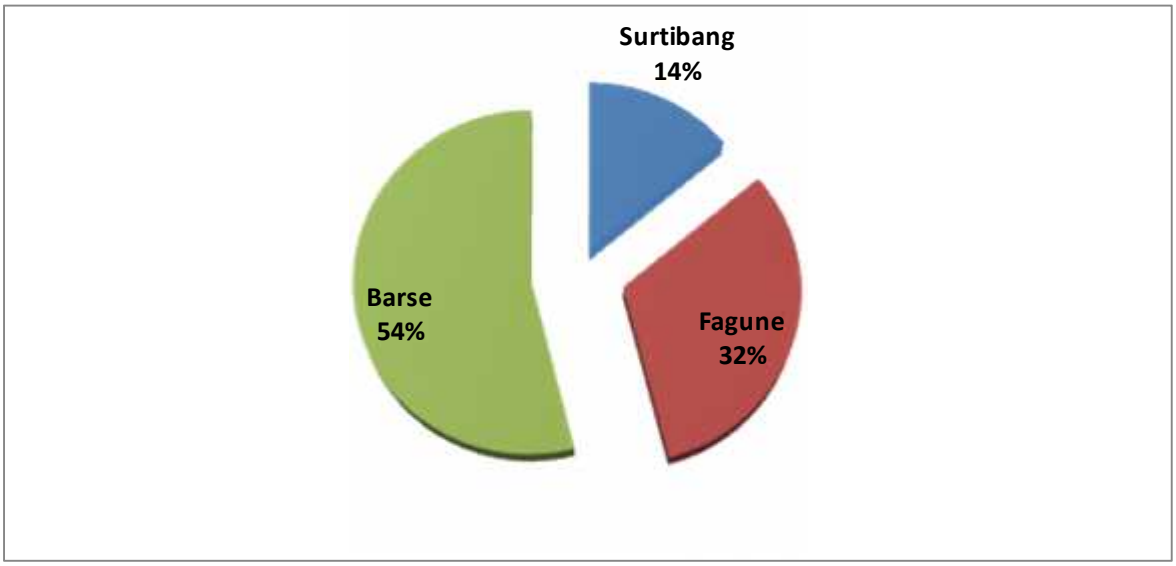


Figure 2: % of pellet groups in the 3 blocks under study.

Slope/Aspect

The maximum pellet groups (46 %) were encountered on the slope of 60° followed by 40° (29 %) and 45° (25 %) (Fig.3). Musk deer mostly preferred the North-East (N-E) slope where highest pellet groups (39 %) were noticed. The North-West (N-W) slope with 32 % pellet groups was the second most favored aspect of the study area (Fig.4).

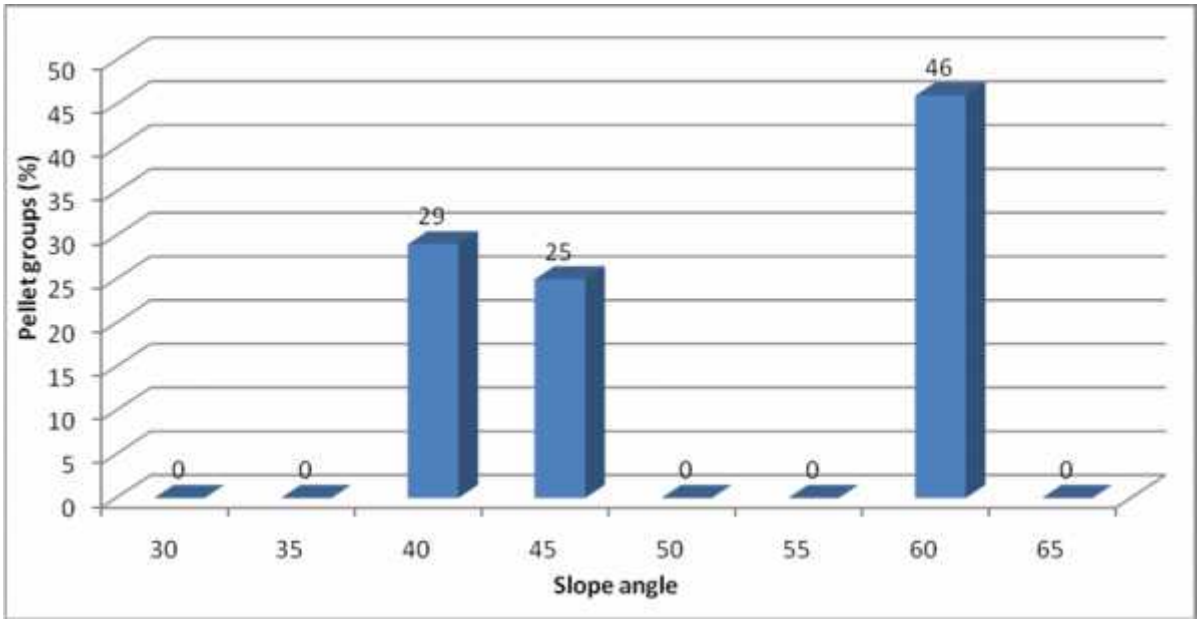


Figure 3: Distribution of pellet groups in different slope angles.

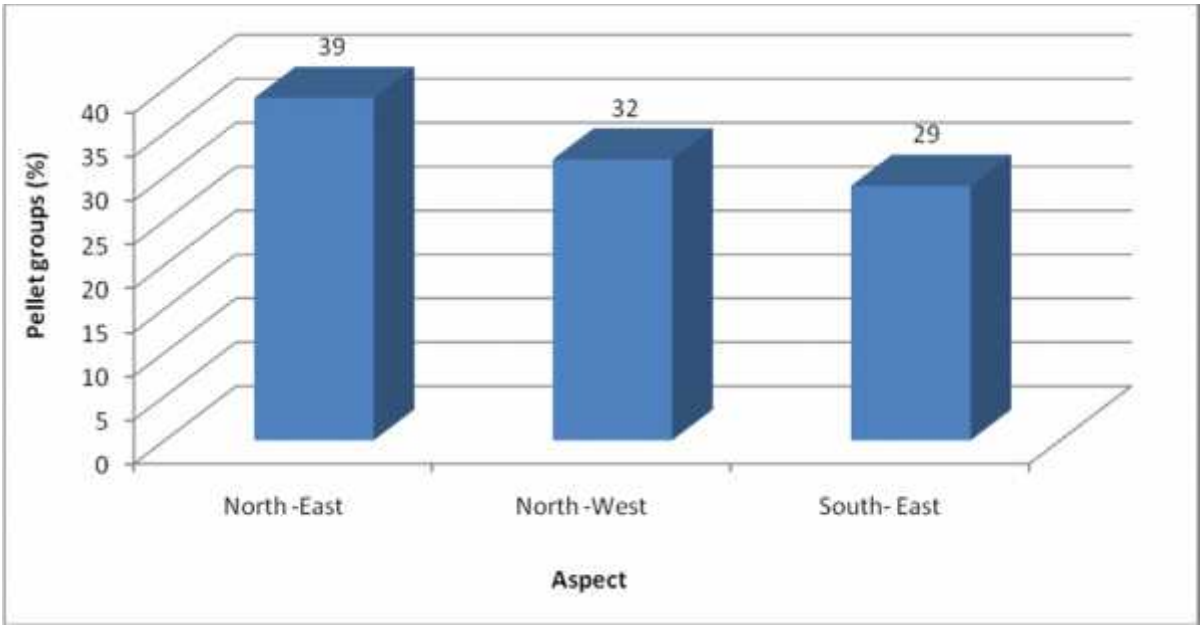


Figure 4: Distribution of pellet groups in different aspects.

6.1.2 Population

A total of 3 Musk deer were counted during a silent drive in approximately 2 sq. km. area of the Barse block and population density was therefore estimated at 1.5 ind./sq. km. Population census in detail is shown in table 2.

Table 2: Population composition recorded in 4 census blocks of Dharkharka and Khokriban of Barse block through silent drive count method.

Site	**Census block**	**Male**	**Female**	**Unclassified**	**Juvenile**	**Total**
Dharkharka	I	1	-	-	-	**1**
	II	-	1	-	-	**1**
Khokriban	III	-	1	-	-	**1**
	IV	-	-	-	-	**-**
Total:		**1**	**2**	-	-	**3**

6.1.3 Population trend

The population trend (increasing, decreasing or unchanged) was determined by the interview with the local respondents (N=280) and herders (N=30). The Musk deer population has decreased (lowered) radically (Junga Bahadur Adai; Lal Bahadur Mal and Dhan Bahadur Adai Pers. Comm.) as compared to past decades. About 76 % of the local respondents and 98 % of the herders interviewed, agreed that the Musk deer population is decreasing throughout the reserve while the others were not sure exactly about the Musk deer's population.

Table 3: Opinion of local respondents and herders about the population trend of Musk deer in the reserve.

S. N	Opinion	No. of respondents	Percentage (%)	No. of herders	Percentage (%)
1.	Decreasing	213	76	29	98
2.	Increasing	0	0	0	0
3.	Same as before	0	0	0	0
4.	Not sure	67	24	1	2
	Total (N)	280	100	30	100

6.2 Habitat structure (Vegetation analysis)

A total of 25 species of trees and 20 species of shrubs (Appendix 4) and 30 species of herbs (Appendix 4) were recorded in the study area. *Juniperus* and *Pinus* were observed predominantly at lower elevation (<3200 m). *Abies* and *Rhododendron* were abundant from 3200 to 3500 m, and *Rhododenron* and *Betula* trees were above 3500 m. Among the shrubs *Arundinaria* was the most dominant at 3200 - 3500 m. Similar type of vegetation were found in all of the three blocks studied. *Abies spectabilis, Rhododenron* spp. and *Betula utilis* were most prominent with high IVI values (Appendices 5, 6 & 7).

6.3 Habitat utilization

Three different types of habitats (Forest, Shrub land and Grassland) were defined from the study areas for the observation of the Musk deer pellets. Total of 28 pellets were recorded from all types of habitats of the study area. Highest number of pellet groups (15 groups) i.e. 53.57 % were found in forest areas followed by shrub land and grassland with 28.57 % and 17.86 % respectively (Table 4).

Table 4: Habitat utilization (Habitat preference) by Musk deer.

S.N	Habitat types	Habitat preference (H.P)
1.	Forest area	53.57 %
2.	Shrub land	28.57 %
3.	Grassland	17.86 %

6.4 Threats

6.4.1 Interaction with livestock

Questionnaire survey and field observation showed that most of the habitats that Musk deer preferred were encroached by domestic animals (ungulates). Of the total respondents interviewed, about 89 % agreed that livestock used the same habitat that was used by Musk deer and other wild ungulates. 7 % of them were not sure while remaining 4 % argued that their livestock didn't overrun the habitat of any wild ungulate (Table 5). Similar questions were also interviewed with 30 herders. All of the herders agreed that the livestock they were handling caused harm to the natural habitat of the wild animals including Musk deer. The livestock have threatened the wildlife by grazing in the wild habitat, habitat destruction by trampling and frightening them.

Table 5: Opinion of the local respondents and herders about the utilization of the same habitat by the Musk deer and their livestock.

S. N.	Opinion	No. of local respondents	%	No. of herders	%
1.	Yes	249	89	30	100
2.	No	11	4	0	0
3.	Not sure	20	7	0	0
	Total	280	100	30	100

Cattles, horses, mules, sheep, goats and buffaloes were observed grazing in wide altitudinal range above 3000 m. Huge herd of these livestock are ascended to higher altitude to the summer pastures every summer. The livestock graze at their summer pasture land for about 6-7 months as the herders keep their livestock at Goths at high altitude alpine pasture from around April/May to September/October every year. About 5,569 households living in the DHR and its buffer zone area with 12 VDCs raised about 1,39,144. However, about 1,94,319 livestock (Fig. 6) were known to graze in the summer pasture of the reserve.

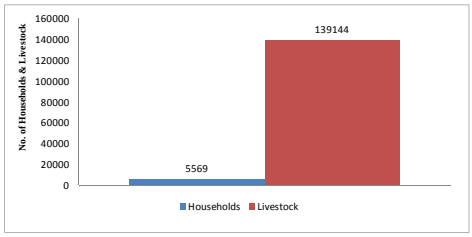


Figure 5: Number of households and livestock.

The composition of livestock grazing in DHR is shown in figure 6.

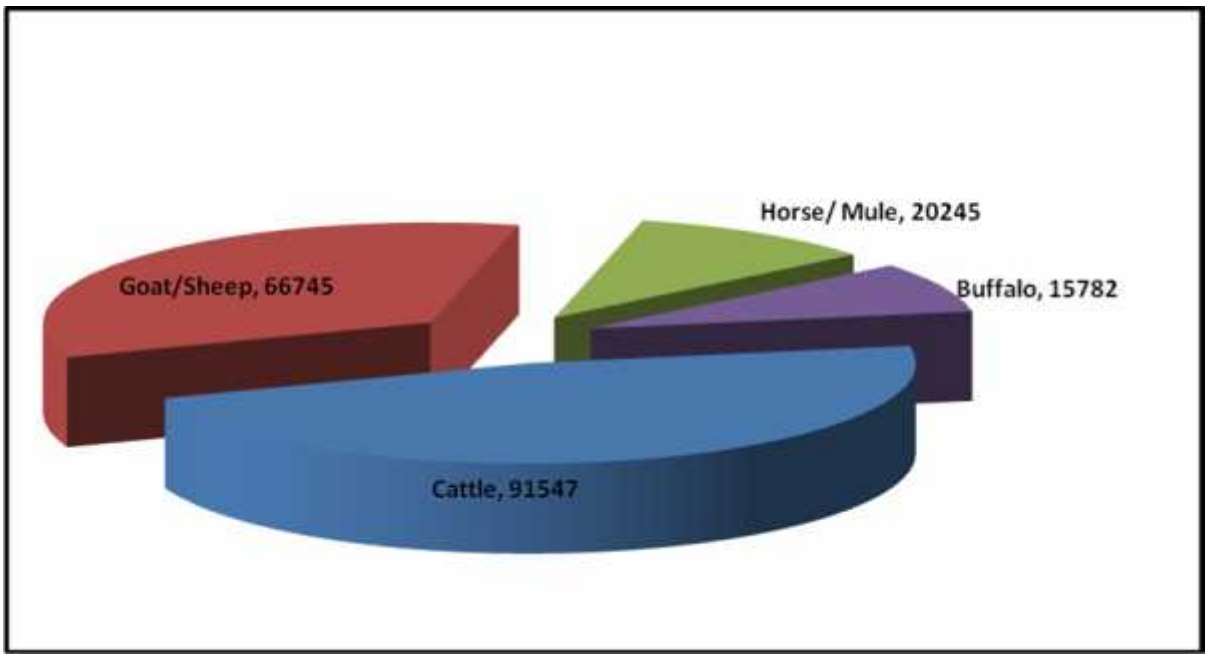


Figure 6: Composition of livestock grazing in DHR.

6.4.2 Poaching

Poaching was a major threat for the Musk deer population in the study area. During the study period many snares and some signs of poaching (Appendix 1) of Musk deer were found in the study area. 40 % of the local respondents considered poaching as the threat to the Musk deer.

According to the local respondents, the surrounding villages served easy shelter to the poachers. Many of the local people, who preferred anonymity, alleged that every year the Tibetan refugees are involved in trade of food items and handicrafts with Tibet through Dolpa and the poachers make the easy way to export the musk pod intruding into the trade. The hunters and poachers are said to use various hunting techniques (Table 6).

Table 6: Past and present hunting techniques used by hunters and poachers.

Past techniques	**Present techniques**
Trained hunting dogs	Snares (leg snares)
Traditional poisons	Traps
Bow and arrow made of bamboo (sometimes arrows are also dipped in poison)	Modern guns (mostly fitted with silencers)
splinter dipped in poison	

A total of 160 snares were gathered from the study area during the study period with 43 leg snares from about 500 m of the snare line in Dharkharka and Khokriban of the Barse block alone. The occurrence rate of the snare was 86 snares per km.

6.4.3 Conflict between the Reserve and local people

Majority of the local respondents interviewed showed disappointment towards the rules and laws enforced by the reserve. The people here had to suffer from crop raiding by wildlife especially by wild boar, barking deer and depredation of livestock by leopards, wolves, etc. The local people complained that they didn't get any types of compensation from the reserve or from the government's side. Many other causes (no easy access to daily

imperative requirements like fire wood, timber collection, etc.) have brought up the conflict and the people were negatively affected.

Out of total respondent interviewed about 78 % (i.e. 218) showed their disappointment as they didn't get any types of compensation to their lost property while remaining 22 % hesitated to response (Table 7).

Table 7: Opinion of the local respondents about the compensation to their lost property by wildlife.

S.N.	Opinion	No. of respondents	%
1.	No compensation	218	78
2.	No reply	62	22

5.4.4 Habitat destruction

A large number of the local people were seen collecting fodder (mostly "Khasru" i.e. *Quercus* spp.) for their livestock. The habitat has also been destroyed to some extent during collection of Diyalo (for lightning), stall feeding, forage and fodder collection. 28 % of the respondents interviewed informed that deforestation as the source of threat while 5 % of them argued that fire acts as the threat for the Musk deer (Fig.7)

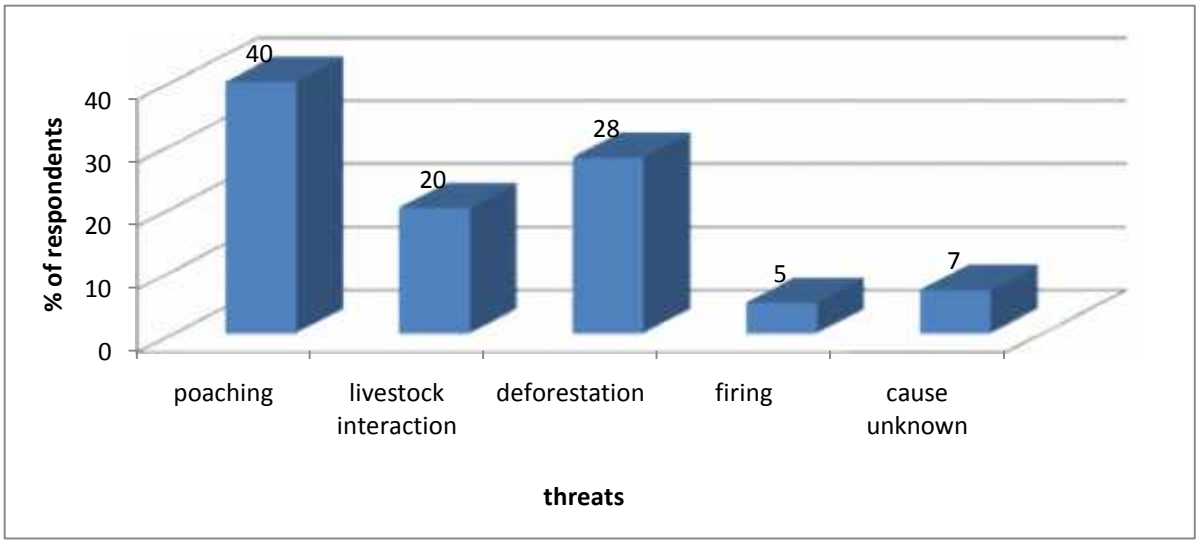


Figure: 7 Major threats of the Musk deer according to local respondent.

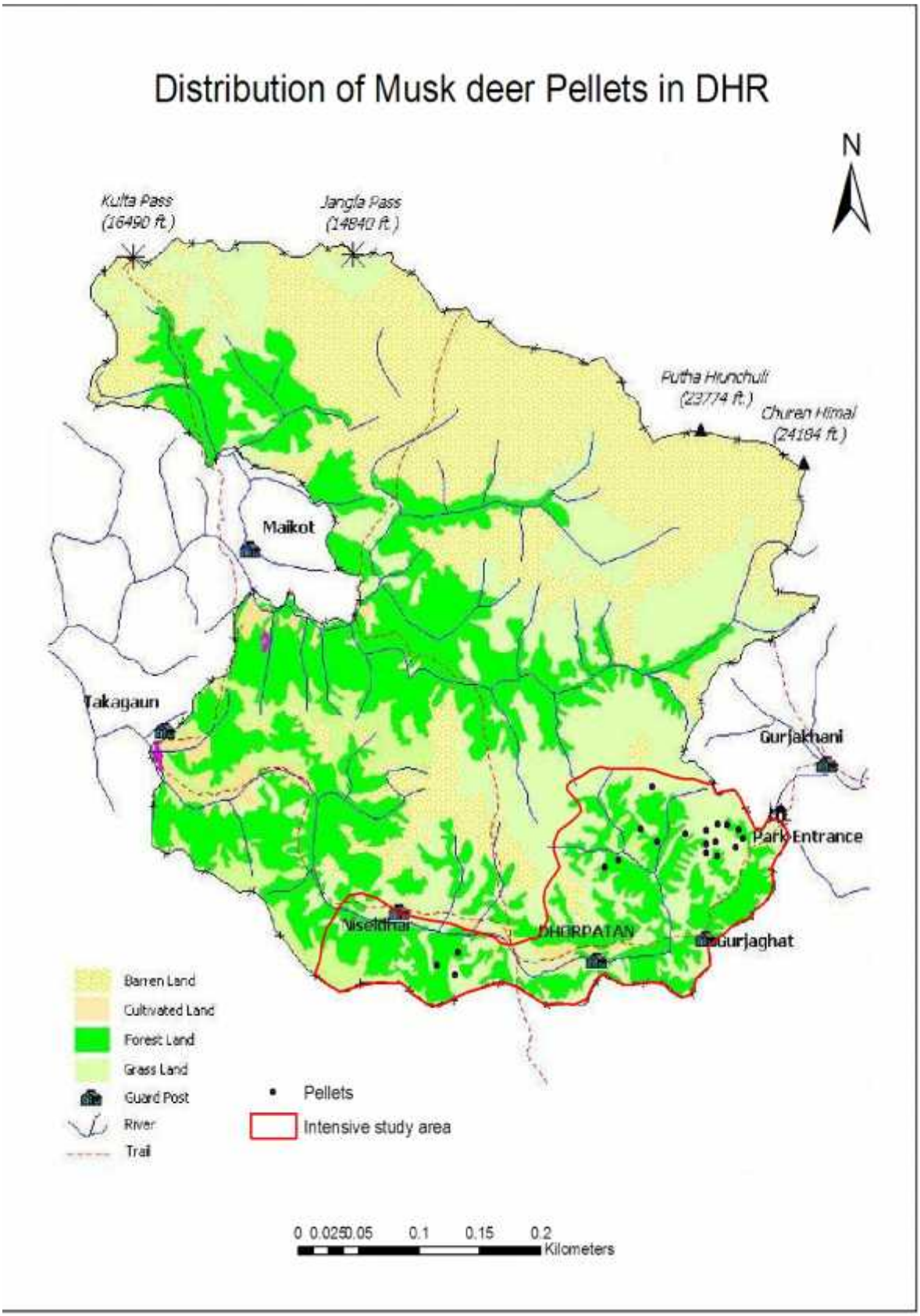

Distribution of Musk deer Pellets in DHR
N
Kulta Pass
(16490 ft.)
Jangla Pass
(14840 ft.)
Putha Hiunchuli
(23774 ft.)
Churen Himal
(24184 ft.)
Maikot
Takagaun
Gurjakhani
Park Entrance
Nisel Dhar
DHORPATAN
Gurjaghat
Barren Land
Cultivated Land
Forest Land
Grass Land
Guard Post
River
Trail
Pellets
Intensive study area
0 0.025 0.05 0.1 0.15 0.2
Kilometers

Plate1: Forest area destroyed with forest fire.

Plate 2: A *Pinus* tree being almost about to fell due to Diyalo extraction.

Plate 3: Wooden tiles stacked for roofing houses.

Plate 4: A house being roofed with the wooden tiles.

Plate 5: Researcher observing the Koklas pheasant trapped in a leg snare initially set for the Musk deer.

Plate 6: Observing Musk deer hairs thrown away by poachers inside a Goth.

Plate 7: Leg snares set for Musk deer.

Plate8: Carcasses of Musk deer encountered during the study period.

Plate 9: Faecal pellets of Musk deer.

Plate 10: Researcher interviewing with the local.

Plate 11: Researcher laying down a quadrat.

Plate12: Rhododendron thickets (it acts as a prime habitat for Musk deer).

Chapter VII

7 Discussion

The altitudinal distribution range of the Musk deer in the study area of the reserve was quite narrow and ranged from 3400-4000 m of elevation. The Musk deer were found restricting themselves within the thickets of shrubs and in the forest area of this range. Highly abundant deer pellet groups was found at 3600-3800 m which is dominated by *Betula* and *Rhododendron* spp. These species are actually preferred by the Musk deer for shelter and for their food as well. However, the maximum pellet groups in Surtibang were encountered within 3400-3600 m. It could be because of the habitat destruction due to forest fire. No signs of the deer were found above the altitudinal range of 4000 m. It should be probably due to the arrival of the breeding season. The Musk deer usually give birth to their offspring from May to June. During these days the Musk deer are fund of forbs and woody plant leaves, particularly of temperate evergreen oak (*Quercus* spp.) and lichens (*Usnea* spp.). Due to these reasons the Musk deer were found more abundantly within the narrower range of elevation. Aryal in 2005 and 2007 reported similar type of results in Manang and Mustang respectively. But this altitudinal range is narrower than 3000-4400 m as suggested by Green (1985) and 2200-4300 m (Kattel 1992).

Variance (σ^2) of distribution of the Musk deer faecal pellets was highest in Surtibang followed by Barse and Fagune blocks (Table 1).This greatly signified that the Musk deer's distribution in Surtibang block varied with altitude i.e. it was not found to be even with altitudinal variation. This might be perhaps due to habitat destruction in the block. The habitat in this block was found heavily destructed by forest fire that occurred few years back. The Musk deer was more or less uniformly distributed with altitude in the Fagune block (minimum variance/standard deviation).

Largest number of pellet groups occurred in the Barse followed Fagune and Surtibang block (Fig. 2). This showed that larger population of the deer was distributed in the Barse followed by the Fagune and the Surtibang. This was due to the less human interference in the Barse block followed by the Fagune and the Surtibang. The Surtibang block was subjected to high pressure of human and their livestock encroachment. This clearly

reflected that the Musk deer prefer the habitat free from any types of external interference. The chi-square contingency test showed that the Musk deer distribution in the three blocks was highly insignificant i.e. they are not equally distributed in all the three blocks ($\chi 2$ calculated at 0.05 level of significance and 2 d.f = 72.3). This result rejected the first hypothesis that assumed the equal distribution of Musk deer in all three blocks.

The Musk deer were forced towards more rugged terrains and steeper slopes of 60° due to the prevailing threats of livestock and human encroachment. The Musk deer were found to utilize the North-Eastern (N-E), North-West (N-W) and South-Eastern (S-E) aspects of the study area. The deer utilized all of these three aspects almost equally, however slightly greater preference was shown towards the N-E aspect (Fig. 4) as it had served it the most coveted habitat with least external interference. And these preferred this slope due to the warmer condition during night. A chi-square test performed ($\chi 2$ calculated = 1.58 at 0.05 level of significance and 2 d.f) accepted the second hypothesis that "the Musk deer distribution doesn't differ with different aspect of the slope".

A total of three Musk deer (1 male, and 2 female) (Table 2) were encountered during a silent drive in Dharkharka and Khokriban of Barse block. Approximately an area of 2 sq.km was surveyed and hence the population density of 1.5 ind./sq. km was determined. The Barse block of DHR inhabited a poor population of the Musk deer, albeit the reserve serves as an ideal habitat for these ungulates. This is smaller with comparison to the density of 4.5 ind./sq.km in Humde and 3.4 ind./sq.km in Pisang area of Manang district within the Annapurna Conservation Area as estimated by Aryal (2005) and 5-6 ind./sq.km by Uprety (1979) in Sagarmatha National Park. However, it supported a larger population density than 0.6 ind./sq.km as estimated by Green (1986) for the southern Himalayan region. Though there are no records and researches being done regarding the population of the Musk deer, the local residents argued that these animals have largely decreased during the last couple of decades (Table 3).

Vegetation analysis in the study area showed that the DHR provides a sound habitat for the Himalayan Musk deer. Of the 25 species of trees recorded in the study area, fir (*Abies spectabilis*), *Rhododendron campanulatum*, *R. arboretum* and birch (*Betulla utilis*) were

most prominent. Among the shrubs *Arundinaria* spp. was most prominent at 3200-3500 m while *Cotoneaster microphyllus*, *Rhododendron anthropogan* and *R. nivale* prominently occurred at and above the forest area. Musk deer mostly used the *Arundinaria* spp. as a source of diet in absence of other high quality forage or if they are in short supply. The Musk deer usually conceals within the thickets of these shrubs during the day lights which was also defined by Kattel (1992). Similarly, he also suggested that the Musk deer in Sagarmatha National Park mostly used blue pine (*Pinus wallichiana*), fir (*Abies spectabilis*), juniper (*Juniperus recurva, J. wallichiana),* birch (*Betulla utilis),* rhododendron *(R. companulatum, R. campulocarpum, R. anthropogan, R. lepidotum*) and shrubs (*Prunus* spp., *Sorbus* spp. and *Cotoneaster microphyllus*). These plant species not only provided shelter to the deer but also provided with the easily digestible foliage. These most coveted species are also found in the reserve and hence serves as the ideal habitat for the Musk deer.

The Himalayan Musk deer preferred the forest areas the most. The shrub land was the second most preferred habitat type while the Musk deer in the study area of DHR preferred the grassland the least (Table 4). They were forced to confine themselves within the forest areas as the grassland and the shrub land were encroached heavily by the livestock. This was due to crepuscular habit of Musk deer and was known to be active between the dawn and the dusk. These shy animals graze at the open grassland during the twilight while conceals itself within the thickets of shrubs or within the dense forest during the day. This type of behavior obviously, encourages the deer to prefer the forest then other habitat. Aryal (2007) has also made similar observation in Mustang.

A chi-square contingency test enlightened that the habitat preference of the Musk deer was not same ($\chi 2$ calculated at 0.05 level of significance and 2 d.f = 22.67) and the third hypothesis that “the musk shows equal preference of all types of habitat” was rejected. Because of human interference, livestock pressure and habitat destruction by fire it was not possible on equal utilization of habitat in the reserve.

The Himalayan Musk deer in the DHR were threatened by the livestock encroachment into their habitat. The domestic ungulates were grazed in most of the places of all blocks of DHR. The number of livestock and households has been increasing every year; perhaps

due to the fact that the government is planning to connect the Dhorpatan valley with the district headquarter of Myagdi with roads (Chak Bahadur Malla Pers. Comm.). A total of 1,39,144 livestock belonging to 5,569 households graze above 3000 m every summer. The number of livestock had increased by 22.33 % in last 6 years as compared to the data suggested by Baral (2001); however the increment in the household number was only about 2%. Moreover about 1,94,319 livestock grazed every year inside the Reserve (Fig. 6) as additional livestock are brought from other distance villages like Burtibang, Muna, Darbang, etc. It is note of worthy that only 1300 households with about 80,000 livestock invaded the reserve about a couple of decades earlier (Henin and Kattel 1992). Thus the reserve is increasingly being pressurized by livestock. These domesticated animals are ascended to higher altitudes to the alpine pasture (Buki) every year due to the lack of ample grazing areas at lower elevations of the Dhorpatan valley and were grazed there for about 5-6 months. Majority of the local respondents and the herders agreed that the livestock used the common habitat of the wildlife including the Musk deer (Table 5). According to the local residents the interaction of the livestock was one of the major threats to the Musk deer (Fig. 7). Livestock pressure was found higher in Surtibang and the Fagune blocks. Some similar observations were made by Sathyakumar et al. (1993) where they suggested that increased livestock grazing and the associated impacts have lowered Musk deer density in Kedarnath Wildlife Sanctuary.

The population of Musk deer in the study blocks of the DHR has suffered with heavy pressure of poaching. Several signs of poaching were noticed during the survey (Appendix 1). The reserve is surrounded by villages from all sides which provided easy shelters to the poachers. It is the alluring price of musk that encourages the poachers in killing the Musk deer. About a couple of decades ago the local poachers received about Rs. 200 per tola (1 tola = 11.66 grams) (Lal Bahadur Mal Pers. Comm.). Once there was a big trade of musk pod, a couple of decades ago excess hunting substantially reduced the Musk deer population in the reserve (Chak Bahadur Malla Pers. Comm.). During the field work 160 snares were collected and was handed over to the reserve official. 43 leg snares were seen along a 500 m of snare line at Dharkharka with the occurrence rate of 86 snares per km. Trapping for animal is danger of killing any type of age and sex of Musk deer. Carcasses of the Musk deer were found nearby a snare (Plate 8). It will be great chance of declining

on the population after trapping of female deer although this is not target animal of poachers. Sheng (1998) also reported snares as the major threat to the deer. He spotted 11,704 snares in the Xinglongshan Nature Reserve in 1980, causing the death of about 213 Musk deer. Yang and Feng (1998) observed the snare density of 15/sq.km in high mountains of 3000 m in Baiyu County, Shichuan province of China. Though there were no any records about the actual number of Musk deer in the past, it is known from the personal communication that the Musk deer population heavily lowered in last two decades. The political turmoil and the period of insurgency during the past abetted the poachers to clean up the greater number of this species (Lal Bahahur Mal Pers. Comm.). The local residents informed that the poachers trade the Musk deer to Chinese markets through Dolpa. According to the local respondents, the poachers used traditional hunting techniques like hunting dogs, poisons, bow and arrow, etc. in the past. These are replaced by modern hunting techniques like leg snares (Plate 7), traps and modern silencer loaded guns (Table 6). The old techniques were replaced with modern guns and snares to conceal the illegal hunting. Liu and Sheng (2000) also reported that in the last two decades, poachers have been using modern guns and snares made of wire, the latter in particular offering easy kills. The poaching of Musk deer is also a major threat elsewhere in the world. Poaching was also noticed as the major threat of the Musk deer in Sagarmatha National Park by Rajchal (2006).

Conflict between the reserve authority and the people has made them reluctant to conserve the wildlife. The reserve authority has vexed the local residents by not providing compensation of any type to the loss caused by the wild animals (Table 7). It has gradually led to the loss of social control for wildlife management and wildlife hunting was continued.

Felling of trees and fire were observed as the major causes of habitat loss and degradation. This habitat destruction has also seriously threatened the Musk deer in the DHR. The numbers of livestock raised and grazed in DHR were well beyond the capacity of the reserve and the starving animals were provided with the fodder. Many of the local residents were seen carrying a huge load of fodder on their backs during the survey period. Khasru (*Quercus* spp.) was the most preferred fodder followed by the *Arundinaria* spp.

The bark of *Pinus* spp. is usually deeply scraped for easy ignition of firewood for cooking and was also used as “Diyalo” for lightening (Plate 2). This actually indirectly helped in felling of these species. Majority of the households in DHR and its buffer zone greatly depend upon the biomass energy (especially firewood) for cooking. Forest is also cleared up during the timber collection. Most of the houses are made up of wood to combat the cold winter nights. Even the houses roofed with wood plates were noticed during the study period (Plate 4).

Catastrophic forest fire that takes place occasionally has also played a vital role in decreasing the Musk deer population in the DHR. The fires were sometimes accidental but were set voluntarily, in the belief that new, soft and tender grasses sprout out, but miserably this fire occasionally turned to be a catastrophic (Fodder collectors Pers. Comm.). Herders (most of them preferring anonymity) said that the hunters/poachers set the fire to trap the targeted prey species. Similarly Aryal (2005) reported that the habitat destruction through deforestation and fire in the North West Humde area of Annapurna Conservation Area had greatly threatened the deer's survival.

Chapter VIII

8 Conclusion and Recommendations

8.1 Conclusion

Musk deer, popularly known as “Kasturi Mirga” here in Nepal is vanishing from its geographic epicenter of the Himalayas owing to the tremendous pressures and threats. Himalayan Musk deer is one of the most pristine wildlife species that has glorified the biodiversity of Nepal. Since, there is no previous data on population of Himalayan Musk deer in DHR, this study provides an important institute to a new era of effective management, and is one of the important elements for proper management of this species.

Musk deer were not equally distributed among the three blocks. The greater percentage of the pellet groups were encountered in the Barse block followed by Fagune and the Surtibang. Musk deer distribution in the Surtibang block showed high degree of ununiformity along the altitudes (σ=180.9). The Musk deer in the Fagune block showed uniformity with different altitudes with least value of standard deviation (σ=46.8). The standard deviation of Musk deer distribution at different altitudes in the Barse was 64.8.

Musk deer in the DHR used a narrow range of elevation of about 3400-4000 m Musk deer and mostly concentrated around 3600-3800 m of altitudinal range and the slope of about 60° was highly preferred by the Musk deer in the three blocks of DHR. Encounter of pellet groups was almost similar along the N-E, N-W and S-E aspects of the study area.

The Barse block of DHR had poor population of the Musk deer. The population density was determined as 1.5 ind./sq.km. The Himalayan Musk deer population in the DHR has been decreasing affected by number of factors like human activities (deforestation, extension of agriculture land, fire, fodder collection, etc.), livestock encroachment and poaching.

A total of 25 species of trees, 20 species of shrubs and 30 species of herbs were recorded in the study area. The most prominent tree species were *Abies spectabilis*, *Rhododendron* spp. and *Betula utilis.* The Musk deer in the DHR used the forest area the most with high

habitat preference (HP=53.57 %) followed by shrub land (HP=28.57 %) and grassland (HP=17.86 %).

Musk deer in this habitat has been threatened by poaching, livestock grazing, and habitat destruction (by deforestation and fire). The encounter rate of leg snares was very high (about 86 snares per km of the snare line). Livestock number has increased by 22.33 % in last six years and has been continually threatening the wildlife including the Musk deer.

8.2 Recommendations

From the study done following recommendations are suggested:

1) People living around the reserve area are very much reluctant in conserving the wildlife as they do not get any compensation to their lost property. The government and the concerned authority should bring up appropriate programs to provide compensation so that the effective conservation in the local level can be promoted.

2) Green (1989) has already suggested that musk can be extracted from the live Musk deer. So, in this circumstance the government and relative agencies should bring programs to proliferate the captive culture. This will of course discourage poaching.

3) Poaching should also be discouraged by increasing the patrolling by the Reserve staff in the wildlife habitat. The reserve should also increase the number of guard post in the reserve area.

4) The Musk deer's survival in the Reserve is seriously threatened. So is now high time to do something about the conservation of this animal. The reputed NGOs in wildlife research should involve themselves or should encourage the junior researchers in the conservation and monitoring of the Musk deer in the Reserve.

5) The population survey of the deer was done only in the Barse block of DHR and it is recommended for other researcher to conduct the research in other remaining blocks to enlighten the situation of the deer throughout the reserve.

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Appendix: 1

Some signs of poaching:

Site	Latitude/Longitude	Elevation(m)	Remarks
Khokriban forest	N-28 º31'06"/E-083º11'07.1"	3643	Sites where the poachers had thrown away the hairs of Musk deer inside a Goth
Khokriban forest (Barse block)	N-28 º31'22.5"/E-083º07'06.9"	3754	

Appendix: 2

The number of households, population size and total number of livestock in the villages inside the buffer zone area of Dhorpatan Hunting Reserve.

SN	VDC areas	Baral, 2001			Current study		
		Household	Population	Livestock	Household	Population	Livestock
1	Bobang	900	5,850	19,800	910	6,250	21,000
2	Adhikarichour	340	1,250	7,922	350	1,300	10,000
3	Bungadhovan	180	995	3,960	200	1,000	5,000
4	Khungkhani	200	4,400	4,350	200	4,450	5,250
5	Nisi	870	1,814	8,551	900	4,900	25,862
6	Gurgakhani	180	1,136	2,117	190	1,150	2,218
7	Muna	416	2,522	2,781	420	2,550	3,089
8	Lulang khoria	254	1,381	1,146	258	1,400	1,548
9	Takasera	716	3,847	31,217	720	3,900	31,827
10	Maikot	900	4,977	19,800	915	5,250	21,000
11	Hukam	352	2,187	8,800	352	2,210	9,000
12	Kola	150	840	3,300	154	950	3,350
	Total	**5,458**	**31,199**	**1,13,744**	**5,569**	**35,310**	**1,39,144**

Appendix: 3

Sites where faecal pellets were observed:

Observed site	Latitude/longitude	Elevation(m)	No. of pellet groups
Surtibang Block	N-28º 28’ 29.1’’/E-083º 01’ 28.3’’	3496	2
	N-28º 28’ 11.1’’/E-083º 01’ 15.3’’	3674	1
	N-28º 27’ 58.2’’/E-083º 00’ 15.0’’	3938	1
Fagune Block	N-28º 31’ 16.2’’/E-083º 03’ 43.0’’	3684	1
	N-28º 30’ 59.0”/E-083º 06’ 04.6”	3685	2
	N-28º 31’ 08.9’’/E-083º 03’ 44.7’’	3709	2
	N-28º 31’ 06.2’’/E-083º 03’ 41.5’’	3775	3
	N-28º 31’ 04.9’’/E-083º 0.3’ 42.0’’	3809	1
Barse Block	N-28º 31’ 26.5’’/E-083º 07’ 10.1’’	3598	1
	N 28º 30’ 23.3’’/E-083º 10’ 19.1’’	3678	2
	N-28º 31’ 02.3’’/E-083º 11’ 10.2’’	3698	1
	N-28º 30’ 49.8’’/E-083º 11’ 05.2’’	3733	2
	N-28º 31’ 22.5’’/E-083º 07’ 06.9’’	3754	2
	N-28º 31’ 57.7’’/E-083º 11’ 05.8’’	3768	2
	N-28º 31’ 22.8’’/E-083º 07’ 06.9’’	3826	4
	N-28º 30’ 37.2’’/E-083º 11’ 04.07’’	3903	1
Total:			**28**

Appendix: 4

Herbs and Shrubs recorded in the study area:

Name of herbs	**Name of herbs**	**Name of shrubs**
Calthapalustris himalensis	*Imperata* spp.	*Arundinaria* spp.
Trollius acaulis	*Dipsancus inermis*	*Barberies angulosa*
Paraquilegia microphylla	*Fragria nubicola*	*B. aristata*
Delphinium cashmerianum	*Fragria daltoniana*	*Piptanthus nepalensis*
Ranunculus hirtellus	*Arenaria densissima*	*Rubus foliolosus*
Anemone poluanthus		*R. hoffmeisterianus*
A. terasepala		*Spiraea arcuata*
A. obtusiloba		*Rosa sericea*
A. rupicala		*R. microphylla*
Clematis montana		*R. webbiana*
Meconopsis regia		*Ribes takare*
M. discigera		*Ribes griffithii*
M. dhwjii		*Ribes orientale*
Thermopsis barbata		*Rhododendron nivale*
Potentilla atrosanguinea		*R. anthropogan*
Pleurospermum benthamii		*Cotoneaster frigidus*
Morina polyphylla		*C. microphyllus*
Cirsium verutum		*Salix calyculata*
Cassiope fastigiata		Ratomunte
Primula glomerata		Panigedi
Primula skkimensis var. hopeana		
Boschniakia himalaica		
Eurphobia cognate		
Eurphobia wallichii		
Arisaema griffithii		

Appendix: 5

Density, Relative density, Frequency, Relative Frequency, Dominance, Relative Dominance and Important Value Index of tree species in Barse block:

S.N	Name of plant species	Density/ha	R.D.	Frequency	R.F.	Dominance	R. Dom.	IVI
1.	*Abies spectabilis*	402.4	12.62	76.19	17.29	21.96	66.58	96.49
2.	*R. arboreum*	728.6	22.85	52.38	11.89	5.59	16.95	51.69
3.	*Rhododendron campanulatum*	619.1	19.42	59.5	13.51	0.4	1.21	34.14
4.	*Betula utilis*	390.5	12.25	66.66	15.13	1.99	6.03	33.41
5.	*Sorbus microphyla*	123.8	3.88	47.62	10.81	0.75	2.29	16.98
6.	*R. barbatum*	190.5	5.97	26.19	5.9	0.1	0.3	12.17
7.	Theulo	119.1	3.73	30.95	7.02	0.11	0.33	11.08
8.	*Pinus wallichiana*	33.33	1.05	11.9	2.70	0.46	1.39	5.14
9.	*Acer acuminatum*	40.5	1.27	11.9	2.70	0.35	1.06	5.03
10.	*J. indica*	33.33	1.05	9.52	2.16	0.22	0.67	3.88
11.	*Viburnum nervosum*	35.7	1.12	11.9	2.70	0.02	0.06	3.88
12.	*J. recurva*	16.66	0.52	2.38	0.54	0.68	2.06	3.12
13.	*Prunus rufa*	19.1	0.6	9.52	2.16	0.06	0.18	2.94
14.	*V. cotinifolium.*	19.1	0.6	9.52	2.16	0.006	0.02	2.78
15.	*Prunus carmesina*	28.57	0.89	4.76	1.08	0.03	0.09	2.06
16.	Arya	7.14	0.22	4.76	1.08	0.06	0.18	1.48
17.	*Acer campbellii*	7.14	0.22	2.38	0.54	0.15	0.45	1.21
18.	*Lyonia ovalifolia*	11.9	0.37	2.38	0.54	0.04	0.12	1.03
Total				**440.41**		**32.98**		

Appendix: 6

Density, Relative density, Frequency, Relative Frequency, Dominance, Relative Dominance and Important Value Index of tree species in Fagune block:

S.N	Name of plant species	Density/ha	R.D.	Frequency	R.F.	Dominance	R. Dom.	IVI
1.	*Abies spectabilis*	134.21	3.24	68.42	16.23	7.72	59.66	79.13
2.	*Rhododendron campanulatum*	371.05	23.45	92.11	21.86	0.85	6.57	51.88
3.	*Betula utilis*	384.21	9.28	81.58	19.35	2.76	21.32	49.95
4.	*Sorbus microphyla*	100.00	2.42	57.89	13.74	0.33	2.55	18.71
5.	*R. Arboreum*	121.05	2.93	42.11	9.99	0.21	1.62	14.54
6.	*J. recurva*	39.47	0.95	23.68	5.46	0.27	2.08	8.49
7.	*J. indica*	21.05	0.51	13.16	3.12	0.2	1.55	5.18
8.	*Pinus wallichiana*	18.42	0.45	10.52	2.50	0.21	1.62	4.57
9.	Theulo	26.32	0.64	13.16	3.12	0.05	0.39	4.15
10.	*Prunus rufa*	7.89	0.19	5.26	1.25	0.3	2.31	3.75
11.	*Lyonia ovalifolia*	13.15	0.32	5.26	1.25	0.01	0.08	1.65
12.	Kalobhojpatra	5.26	0.13	5.62	1.33	0.02	0.15	1.61
13.	*V. cotinifolium.*	5.26	0.13	2.63	0.62	0.01	0.08	0.83
	Total			**421.40**		**12.94**		

Appendix: 7

Density, Relative density, Frequency, Relative Frequency, Dominance, Relative Dominance and Important Value Index of tree species in Surtibang block:

S.N	Name of plant species	Density/ha	R.D.	Frequency	R.F.	Dominance	R. Dom.	IVI
1.	*Abies spectabilis*	185	6.09	62.5	14.79	26.87	72.3	93.18
2.	*Rhododendron campanulatum*	377.5	12.43	60	14.19	0.54	1.45	28.07
3.	*Betula utilis*	217.5	7.16	70	16.56	1.49	4.01	27.73
4.	*R. Arboreum*	230	7.57	55	13.01	0.56	1.51	22.09
5.	*Tsuga dumosa*	40	1.32	20	4.73	4.54	12.22	18.27
6.	*Quercus baloot*	55	1.81	27.5	6.50	0.82	2.21	10.52
7.	*Acer acuminatum*	42.5	1.39	27.7	6.55	0.2	0.54	8.48
8.	*Sorbus microphyla*	47.5	1.56	17.5	4.14	0.12	0.32	6.02
9.	Theulo	67.5	2.22	7.5	1.77	2.60	0.07	4.06
10.	*Polygonum spp.*	20	0.66	12.5	2.96	0.01	0.03	3.65
11.	Arya	15	0.49	12.5	2.96	0.06	0.16	3.61
12.	Unidentified	30	0.99	7.5	1.77	0.24	0.64	3.4
13.	*Q. lanata*	7.5	0.25	5	1.18	0.6	1.61	3.04
14.	*Pinus wallichiana*	12.5	0.41	7.5	1.77	0.08	0.22	2.4
15.	*R. barbatum*	7.5	0.25	2.5	0.59	0.5	1.34	2.18
16.	*Acer campbellii*	7.5	0.25	7.5	1.77	0.04	0.1	2.12
17.	*J. recurva*	7.5	0.25	5	1.18	0.06	0.16	1.59
18.	*Prunus rufa*	5	0.16	2.5	0.59	0.25	0.67	1.42
19.	*J. indica*	5	0.16	5	1.18	0.03	0.08	1.42
20.	Kalobhojpatra	5	0.16	5	1.18	0/03	0.08	1.42
21.	*Lyonia ovalifolia*	2.5	.08	2.5	0.59	0.09	0.24	0.91
Total				**422.7**		**37.16**		

Appendix: 8

Questionnaire form for the Musk deer's information:

1. Respondent's Name: …… Age: ……

VDC: ……... Occupation:..……...

Family members (No.): ……

2. Do you have any cultivable field? If yes, how much?

Khet ☐ Bari ☐

……

3. What kinds of corps do you grow?

4. Do wild animals damage your crops or domestic animals? If yes, what are they?

……

5. Do you get any compensation for the damage caused?

Yes ☐ No ☐

6. On your opinion what should be done to avoid the possible damage by the wild animals?

……..

7. Information based on Musk deer.

Do you know Musk deer?

Yes ☐ No ☐

Have you ever seen Musk deer?

Yes ☐ No ☐

If yes

a) Where……. b) When……..... c) How d) many……

☐ Male ☐ Female ☐ didn't identify

8. Do you know about trade of Musk deer?

……

❖ What products do they trade?

……

❖ Where do they supply?

…….....

9. Do you know about its population trend?

☐ Increasing ☐ Decreasing ☐ Same as before

☐ Not sure

10. Are Musk deer beneficial ☐ harmful? ☐

Why? ……..

11. What are the major threats in your opinion?

☐ Habitat destruction.

If yes, how?

.....

☐ Poaching

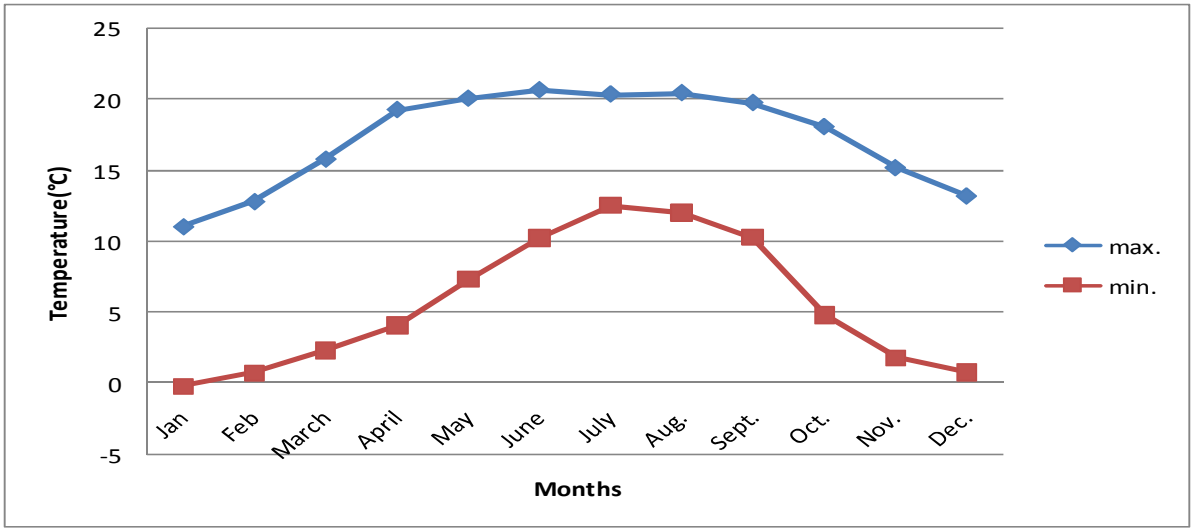
☐ Livestock pressure

12. What can be done to conserve Musk deer?

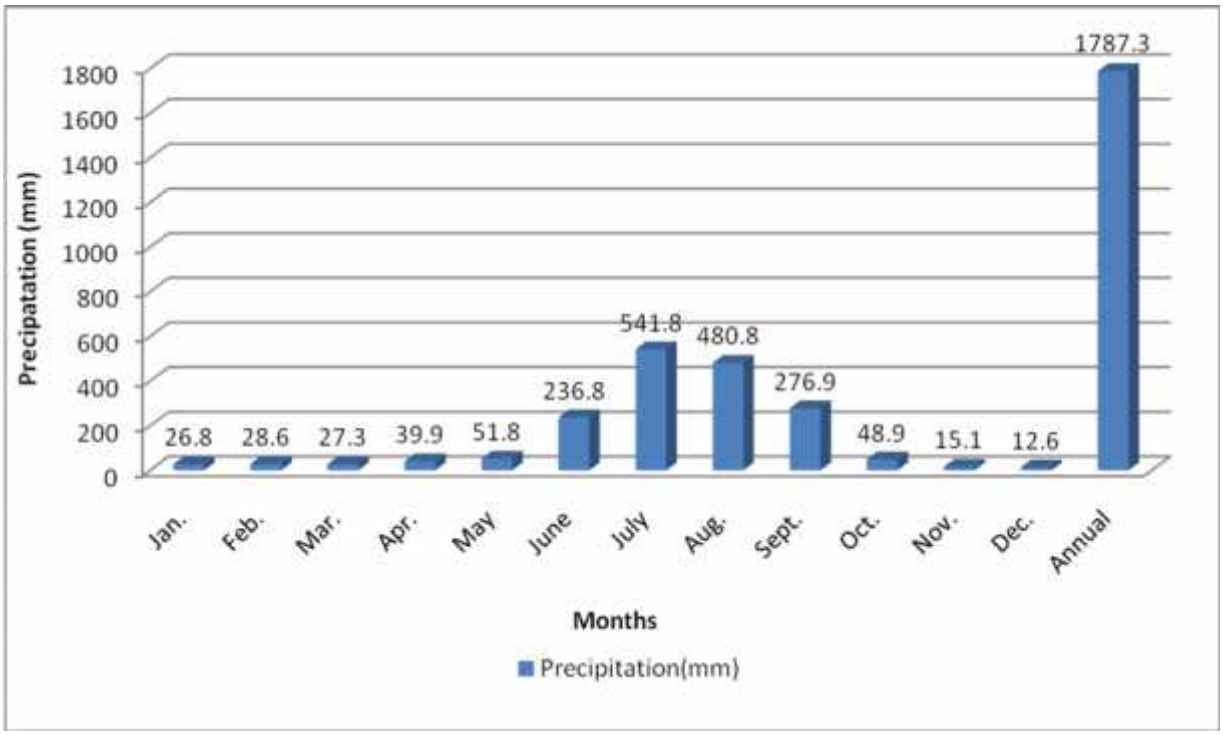
……

Appendix: 9

1. Mean annual maximum and minimum temperature for 1999-2006 at Gurgakhani station, Myagdi. (Source: Nepal government, Department of hydrology and Meteorology)



2. Mean annual precipitation for 1997-2006 at Gurgakhani station, Myagdi. (Source: Nepal government, Department of hydrology and Meteorology)



3. Mean annual relative humidity (R.H) for 1999-2006 at Gurgakhani station, Myagdi. (Source: Nepal government, Department of hydrology and Meteorology).