Chapter I

1. Introduction

1.1 General Background

Nepal is a small mountainous country with an area of 147,181 km^2 lying at 26° 20' to 30° 27' N latitude and 80° 04' to 88° 12' E longitude. It is situated in the Central Himalayas in between the arid Tibetan plateau of the north and Gangetic plains in the south. Nepal is characterized by diverse physiographic zones, heterogeneous climate and altitudinal variations from about 75 to 8,848 m (Mt. Everest). Owing to these diverse characteristics, Nepal contains biological species of both Indo-Malayan and Palaeoarctic realms, including endemic Himalayan flora and fauna. The country has about 54 % of the surface area under some sort of vegetation cover (forest area 29 %, shrub land 10.6 % and grassland 12 %) (HMGN-DFRS 1999).

Phytogeographically, Nepal is also known to contain plants and animals species as found in various floristic sub-regions including Sino- Japanese, Irano-Turanian, Central Asiatic and Indo-Malayan floristic regions. Wide altitudinal variation and diverse climatic condition within a small area make the physiography of Nepal unique in the world. According to (Stainton 10972), Nepal can be divided into 7 natural zones which occur in the following order from south to north: 1. Terai and Bhabar, 2. Foothills, 3. Mahabharat Range, 4. Midlands, 5. Himalayas, 6. Inner Himalayas and 7. Arid Zone, On the basis of climatological, floristic and ecological data, (Stearn 1960) divided Nepal into three major regions: Western, Central and Eastern Nepal. It could be divided into several small units based on plant and animal distribution in different altitudes, their endemism and characteristics.

A total of 118 ecosystems with 75 vegetation types and 35 forest types have been identified in different physiographic zones in these realms (BPP 1995). Out of this, 80 types of ecosystems are represented in protected areas (National Park, Wildlife Reserve, Hunting Reserve and Conservation Areas) network alone.

Red Panda is a rare animal found in the temperate forests of Nepalese Himalaya and adjoining few countries. It is enlisted under threatened species which need intensive

study for its conservation from national and international agencies. Its distribution is only constraint in the Himalayan range of the Oriental region, and is in the danger for survivable due to habitat encroachment from human activities and livestock grazing. The complex ecology of Red Panda is poorly known due to the extremely low population size, their spooky behavior and the restricted distribution in inaccessible remote area. In this regard, assessment of faunal diversity in protected areas is important. Present study was an attempt to attain the ecological appraisal of Red Panda in (DHR), Nepal.

1.2 Statement of the problem

The Red Panda *Ailurus fulgens fulgens* (Cuvier 1825*)* is vulnerable species (IUCN 2008). Its distribution is restricted to the Himalayan foothills of Nepal. Due to increasing land use change, formation of different patches of forest and deforestation by human activities, Red Pandas are facing pressure for their survival. Unless a comprehensive study of ecology and existing threats is conducted, no reasonable management recommendation and conservation action plan can be established. The study was concentrated on assessment of the Red Panda in the DHR. None of the studies related to Red Pandas were carried out so far in DHR. In this connection, the present study was an initiative to elucidate the distribution, and ecology of Red Panda in the Reserve. This comprehensive study concerned for the distribution of Red Panda in different blocks of Reserve, analysis of socio-ecological factors for its distribution and site-specific conservation measures.

1.3 Objectives of the study

The main objective of this study is to collect basic ecological information of Red Panda in the Dhorpatan Hunting Reserve. The other specific objectives are:

- to find out the distribution of Red Panda
- to assess the habitat utilization and
- to identify conservation threats of the Red Panda**.**

1.4 Research hypothesis

The hypotheses of this study are:-

- Red Pandas are uniformly distributed in the three blocks of DHR,
- distribution of Red Panda with altitude is positively correlated up to certain limit and
- Red Panda's distribution doesn't differ with the aspect of the slope.

1.5 Limitations of the study

The study was based on the observation of Red Panda signs and habitat utilization in its probable habitat. Population status in the study area was mysterious due to methodological limitation. Since Red Panda live above the pine forest of 3,000-3,900 m, the study ignored all places including forest area below and above this altitude. Only three blocks of DHR namely Barse, Fagune and Surtibang were selected for the study due to limited accessibility of material available, It was due to selection of only preferred habitat with ignoring the place where lacking of probable food and shelter of Red Pandas during the study period.

Chapter II

2. Species Description

2.1 Taxonomy

Various synonyms are used for the Red Panda, eg, Cat Bear, Panda Bear, Lesser Panda, etc. In Nepali, it is called "Habre"; in local languages "Naututoo" and “Pude Kundo". It is also known as "Hoptanga", "Telegama or Hoprakpa" and "Sankam" in Bhotia, Tamang and Lepcha language respectively.

The taxonomy of Red Panda has been the subject of debate. It was originally placed in the family Procyonidae because of its superficial similarities in teeth, round skull, fringed tail and other morphological similarities with raccoon (Wozencraft 1989 cited in Glatston 1994). The family procyonidae is divided into two sub-families: Procyoninae and Ailurinae. The former occurs in temperate and tropical areas of the Western Hemisphere and latter is confined to the Old World (Nowak & Pardiso 1983).

Anatomical and cytogenetic studies suggest that Red Pandas are closely related to Giant Panda and Bears. It has now been proposed to classify Red Panda in its own separate family Ailuridae (Eisenberg 1881 cited in Glatston 1994; Wilson & Reeder 1993).

2.2 Habitat

Red Panda is a habitat specific and inhabits in the mountain forests with bamboo thickets However, within these forests Red Panda has several microhabitat requirements, a dense under storey of fallen logs, fruiting vegetation and bamboo and close proximity to water source (Pradhan et al. 2001a; Wei et al. 1999, & Yonzon 1989).

Different factors like vegetation type, food availability, sheltering and aspect, slope position, human disturbance and source of water are the main ecological factors found in the Sichuan Province (Wei et al. 1998).

The average elevation of Red Panda distribution during the whole year is 3233±218 m with an altitudinal range extending from 2,800-3,900 m (Yonzon 2000). They are generally limiting to a narrow altitudinal band where temperate fir- ringal bamboo habitat predominates. In some cases, Red Panda has also been reported beyond this altitudinal range. Wild mammals sharing habitat with Red Panda (*Ailurus fulgens*) are *Budorcas taxicolor, Capricornis sumatraensis, Felis bengalensis, Felis chaus, Vulpes vulpes, Canis lupus pallipes, Canis aureus, Hemitragus jemlahicus, Moschus chrysogaster, Muntiacus muntjac, Nemorhaedus goral, Ursus thibetanus* etc (Chakraborty 1999).

The cluster analysis of Red Panda was produced by four distinct clusters of vegetation communities corresponding to the altitudinal zones (Saha et al. 2000). The vegetation zone are oak forest (2,700-2,800 m), broad leaf deciduous forest (>2,800-3,100 m), the broad leaf coniferous forest (>3,100 -3,300 m) and the coniferous forest (>3,300-3,600 m) which is the main range of habitat which favors Red Panda distribution (Saha et al. 2000).

2.3 Morphology

Red Panda is approximately 60 cm long, with relatively a long and furry tail of 40 cm marked with 12 alternating red and buff rings. The tail is used for balance when in the tree, it is carried straight and horizontally while on the ground. It has rounded head; shortened rostrum and large, erect, and pointed ears. Its body is covered with long, coarse of reddish brown fur dorsally while the undercoat is soft, dense, and woolly with black color. There is no sexual dimorphism. The face is predominantly white with reddish-brown "tear" marks under the eyes. The feet are plantigrade. The legs are black, short with thick fur on the soles of the paws which serves as thermal insulation on snow-covered or ice surfaces. The Red Panda is a bamboo feeder with strong, curved and sharp semi-retractile claws standing inward for firm grasping to facilitate substantial movement on tree branches and seizing leaves and fruits (Yonzon 1989).

2.4 Behavior

Red Panda is a solitary animal, however sometimes; it is seen in a pair or a group of three. Red Panda is found to travel a linear distance of 1.75 km with high mobility in January and February, which is for breeding activity. Though it is active all times of the day and night it is more active between dawn and dusk (Yonzon & Hunter 1989).

Red Panda is an arboreal animal; it takes refuge above the ground level on rocky outcrops and on trees. About 86 % of its resting sites are on trees, mostly on *Abies spectabilies* in summer and *Junipers, Betula, Rhododendron* and *Acer* trees in winter (Yonzon & Hunter 1989).

Red Panda is partially territorial. They have glandular sacs in the anal region (Nowak & Paradiso 1983) which are used to secrete a scent to mark their territories. Home range varies between 1.4-11.6 km^2. The average total home range was 5.12 km^2 for males and 2.37 km^2 for females (Yonzon 1989). Home range size is determined by habitat quality, social system and Red Panda density.

Mating occurs in early winter i.e. from January. The oestrus cycle peaks in January-February and the gestation period is 114-156 days. Litter is born between June and July and normally a liter size is 1-4. Before parturition the female begins to carry sticks, grasses, leaves, and barks of *Birch-Betula* species to a suitable nest site which may be a hollow tree or a rock crevice. The young attain adult size in one year, become sexually mature in 1.5 years, and stay with their mother for about a year, or until the arrival of next litter (Yonzon 1989).

2.5 Food Habit

Primary diet of Red Panda is Arundinaria leaves and shoots (Jonson et al. 1988; Yonzon & Hunter 1989). Other dietary component includes berries, fruits, mushrooms, roots, acorns and lichens. The Red Panda does little more eating than sleeping due to its low-calorie diet. Bamboo shoots are more easily digested than leaves, and exhibit the highest digestibility in the summer and autumn, intermediate in the spring, and low in the winter. These variations correlate with the nutrient contents in the bamboo. The Red Panda poorly processes bamboo, especially the cellulose and cell wall components. This implies that microbial digestion plays only a minor role in its digestive strategy. The transit of bamboo through the Red Panda's gut is very rapid (2-4 hours). In order to survive on this poor-quality diet, it has to select high-quality sections of the bamboo plant such as the tender leaves and shoots in large quantities (over 1.5 kg of fresh leaves and 4 kg of fresh shoots daily) that pass through the digestive tract fair rapidly so as to maximize nutrient intake (Wei et al. 1999).

Chapter III

3. Literature Review

3.1 Distribution of Red Panda

3.1.1 Global

There are two sub-species of Red Pandas; the first one is *Ailurus fulgens fulgens* which inhabits the bamboo dominated temperate forests of Nepal, India. Bhutan, Myanmar and China so called Indian Red Panda and another one is *Ailurus fulgens styani* called Chinese Red Panda found only in South Western China in Sichuan and Yunnan Provinces. These two species are separated by the Nujiang River, which acts as a biogeographical barrier (Glatston 1994; Roberts & Gittleman 1984).

Red Pandas are distributed in the large tracts of high altitude forests throughout northern Bhutan from Jigme Dorji National Park, Thrumshinga National Park, Torsa National Park, Kulong Chu Wildlife Sanctuary and Black Mountain National Park (Yonzon et al. 1997). In Myanmar the species is restricted to the northern mountains bordering of India and China, especially Shan and areas of north Putao (Rabinowitz & Khaling 1998). Red Pandas in India are confined to the northeast in Sikkim, Northern West Bengal where these prefer temperate and alpine forests between 1,500 and 4,800 m, with the exception of tropical forests between 700 and 1,400 m in Meghalaya, (Choudhury 2001; Prater 1980, & Pradhan et al. 2001b). Similarly, in China, it is confined to parts of Sichuan, Yunnan and Tibet (Reid et al. 1991; Wei et al. 1998; Wei et al. 1999, & Wei et al. 2000).

After estimating the potential habitat in all totals of five Red Panda range countries, it covers as an area of 142,000 km^2, the average density of one Panda per 4.4 km^2, by considering the global estimated population size of Red Panda is 16,000-20,000 (Choudhury 2001).

3.1.2 National

In Nepal, Red Pandas have been confirmed in eight protected areas which include Khangchenjunga Conservation Area, Manaslu Conservation Area, Makalu Barun National Park, Sagarmatha National Park, Langtang National Park, Annapurna Conservation Area, Dhorpatan Hunting Reserve and Rara National Park (Shrestha 1988; Yonzon 1989; Jackson 1990; Yonzon et al. 1991; Yonzon & Hunter 1991a,b; Chaudhary 1992; Fox et al. 1996; Karki 1999; Karki & Jendrzejewski 2000; Shrestha & Ale 2001; Mahato 2003, 2004; Sharma & Kandel 2007; Sharma 2008). The Red Panda has also been reported from community–managed and National Forest land in Jamuna and Mabu Villages of Ilam in eastern Nepal (Williams 2004). These studies demonstrated that the distributions of Red Pandas in Nepal are in the elevation from 2,500-4,000 m in temperate and sub–alpine forests.

The total population of Red Panda in Nepal is about 314 individuals based on the ecological density of one Red Panda per 2.9 km^2 within 912 km^2 potential habitats (Yonzon et al. 1997). In the Langtang National park, 73 individuals of Red Panda were estimated comprising 4 different populations (Yonzon 1989). Similarly, more than 11 Red Pandas were present in Rara National Park within an area of 31 km^2 (Sharma 2008). About 68% of the potential Red Panda habitat lies outside the protected area and their population and conservation status is not known.

3.2 Conservation threats

Poaching is one of the Red Pandas major threat; fur is used to make hats and clothing for children and fur of tail is used to give gifts of newly married couples and the purchase of skin was quite prevalent in the past e.g. 29 pelts were sold in the period of 1979-1981 in Sichuan Province of China (Yu et al. 1983).

Similarly in LNP, two cubs were killed by the Tibetan Mastiff in 1985. During the monsoon of 1986 and 1987, there were as many as 25-40 dogs at one time in a single Kharka which guards domestic stock from leopard and wild dog also chased and killed Red Panda in LNP (Yonzon 1989).

Chapter –IV

4. Study Area

4.1 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 Lulang Khoria) and Rukum district (Takasara, Hukam, Maikot, and Kola). It occupies 795 km^2 of Rukum, 292 km^2 of Baglung and 238 km^2 of Myagdi and hence altogether occupying 1,325 km^2 areas. The Reserve lying along the central Himalayan of western Nepal ranges from 2,000-7,246 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 7 Hunting blocks: Surtibang, Fagune, Barse, Ghustung, Dogari, Seng and Sundaha (Wegge 1976).The intensive study area belongs to the 3 Hunting blocks (Barse, Fagune and Surtibang) and was selected on the basis of the reconnaissance survey in the Reserve.

4.2 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 2,530 m), the maximum temperature occurs during summer (June measuring 20.7$^{\circ C}$ on average) while temperature lowers below 0$^{\circ C}$ during winters (-0.2$^{\circ C}$ on average in January). The mean annual precipitation measures 1,787.3 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 (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 (II, III &IV).

4.3 Flora

Both drier and humid conditions occur in different areas of the Reserve. So, the Reserve is obviously rich in both types of vegetations thriving 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 (2,850-3,100 m):- consists of Oak (*Quercus semicarpifolia*), Blue-pine (*Pinus wallichina*), *Rhododendron arboreum*, Hemlock (*Tsuga dumosa*), Spruce (*Picea smithiana*), etc.

- Sub-alpine vegetation (3,000-3,900 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 4,000 m):- consists of grasses and sedges. Also comprises of *Rhododendron anthopogan* 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 medicinal herbs like Yarsa gumba (*Cordyceps sinensis*), Panchaunle (*Orchis latifolia incarnate*), Padamchal (*Rheum emodi*), Satua (*Paris polyphylla*), Bikh (*Aconitum* spp.), Kutki (*Picorhiza scrophulariflora*), Selajit (Rock exudates), Jatamasi (*Nardostachys grandiflora*) and many more.

4.4 Fauna

The Reserve supports 18 species of mammals (13 NRDB species), 137 species of birds (15 NRDB species) and 1 of reptile (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 9,600 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 thibetanus*). Leopard (*Panthera pardus*) is a predator on livestock throughout the Reserve below the elevation of 4,500 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.

4.5 Settlements, land use 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 inhabited 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).

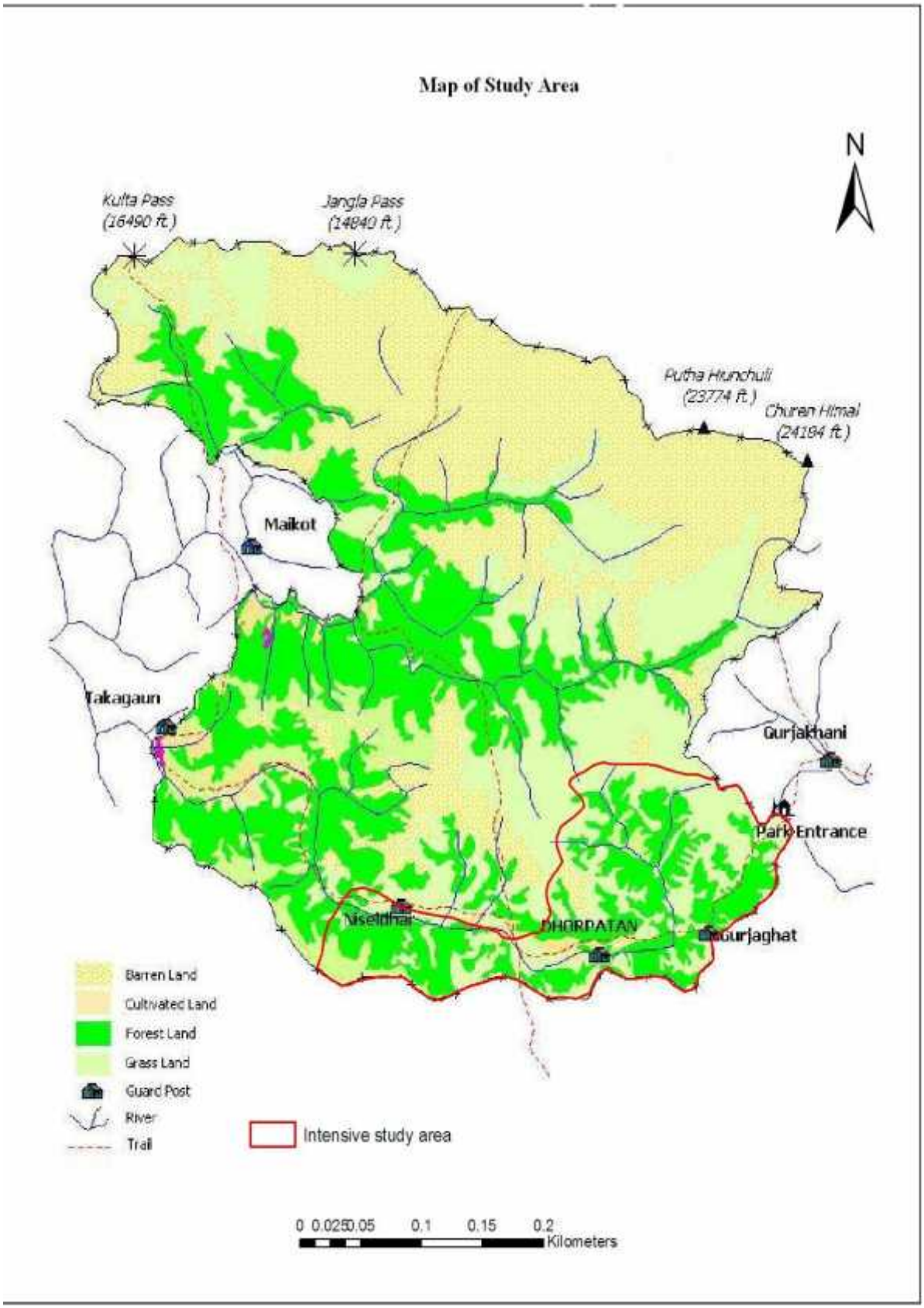
Tibetan refugees are engaged in trade of agricultural products, mules, horses in Dolpa and Tibet.

Around 1,300 families with about 80,000 herds of livestock move into Dhorpatan’s alpine pastures during summer (Heinin & Kattel 1992). Summer huts (locally called as “Goths”) are seen even above 4,500 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 Utterganga River near Dhorpatan, is in Surtibang block. Every year on the day of "*Janai Purnima*" in August, a religious fair is held here which is attended by many local devotees.

Figure- 1, Map of the study area with intensive study



Chapter-V

5. Methodology

5.1 Reconnaissance Survey and Site selection

Reconnaissance survey was conducted in February 20th-26th, 2007 to find out the probable site for distribution and occurrence of Red Panda in DHR. The survey was based on study site visits, field observation, and interactions with local people, herders and Reserve staffs.

5.2 Line-transect sampling method

In line-transect method (Burnham et al. 1980), the investigator walked through a fixed path and recorded the distribution of Red Panda by using sign transects. The number and type of livestock, their disturbances and vegetation utilization were also recorded by line transect method. Natural demarcation like springs, ridges, rivulets and furrows of the hill were used as reference line. Each transects run perpendicular to the reference lines. 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. In each transect the number of times the animal encountered and signs of the animal (e.g. pellet and foot print) were recorded within 5 m horizontal distance on either sides from the transect line.

In each transect, paired quadrats (10 m×10 m) were sampled on either sides of 5 m distance from the transect line at each 100 m increment in elevation from 3,000 to 3,900 m. The numbers of quadrats sampled varied with transect due to unequal elevation of the hills in the sampling areas. A total of 120 quadrats were sample in the three blocks; 42 in Barse, 38 in Fagune and 40 in Surtibang. In each quadrat, faecal pellets (old and fresh), habitat variables such as altitude, latitude, longitude, aspect and slope were recorded. The specific locations of fecal pellets occurrence were marked on the map to demonstrate the area covered by the species (Sutherland 1996). The total numbers of individuals of each woody plant species were counted. Stumps, dead standing trees and fallen logs were identified and counted. Square quadrats of 4×4 m^2 were used for sampling of the shrubs. Identification of plant species follows

Polunin and Stainton (1986). Observations were started early in the morning (about 7.0 AM).

Fecal pellets determined the distribution, relative abundance and habitat use of Red Panda. Density, Frequency, Dominance and Importance Value Index of tree species were calculated following (Curtis 1994). The distribution pattern of faecal pellets and its correlation with elevation were determined.

5.3 Participatory Appraisal

Information of human pressure on the distribution of Red Panda in the study area was collected by participatory appraisal method at Patan valley of DHR. The valley has human settlement along the forest margin. The information was collected through various means. A total of 280 households were interviewed through semi-structured questionnaire during the study period which are about 5% of the total households content just inside and surrounding area of DHR which was conducted 105 households from western side and 175 from the eastern side, with the head of the family and in some cases the person above 21 yrs. The interview focused on family composition, educational level, employment, living standards, household/livestock ratio, firewood/fuel wood consumption, etc. Herdsmen were asked about distribution of Red Panda, name and plant parts that Red Panda used, crop and livestock depredation and number of their livestock. During the period of the questionnaires survey locals were made aware about the value of wildlife especially focused on the importance of Red Panda conservation.

5.4 Data Analysis

The collected data were categorized and tabulated to determine status, distribution and habitat condition of Red Panda.

5.4.1 Variance to Mean Ratio

Data on animal location by their droppings were recorded in each habitat type which was used to determine the distribution pattern. Distribution pattern of Red Panda was calculated by variance to mean ratio (Odum 1971) which is based on the fact that in Poisson distribution, the variance (S^2) is equal to the mean.

If $S^2/\ \overline{X}$ <1, distribution is uniform.

If $S^2/\ \overline{X}$ = 1, distribution is random.

If $S^2/\ \overline{X}$ >1, distribution is clumped.

5.4.2 Chi-Square test for goodness of fit (χ2)

The chi –square test for goodness of fit test was carried to determine whether the individuals of the Red Panda according to habitat availability through their droppings. The test was performed by setting the hypothesis that the Red Panda was uniformly distributed in all habitat types. The hypothesis was tested at 5 % level of significance.

Under H_0, the test statistic is given by

$$\chi^2 = \frac{(O_i - E_i)^2}{E_i}$$

Where, O_i = Observed value and E_i = Expected value

5.4.3 Vegetation Analysis

The data collected in the field were used to calculate Density, Relative density; Frequency, Relative frequency; Dominance, Relative dominance and Important Value Index of the tree species were calculated by using the following relation (Shrestha & Ghimire 1996; Smith 1980).

5.4.3.a Density and Relative Density

$$\text{Density} = \frac{\text{Total number of individual of species}}{\textit{Total number of plot sampled} \times \textit{Area of a plot}} \times 100$$

$$\text{Relative Density (\%)} = \frac{\text{Density of individual species}}{\textit{Total Density of the all species}} \times 100$$

5.4.3.b Frequency and Relative Frequency

$$\text{Frequency (\%)} = \frac{\text{No. of plots in which species occured}}{\textit{Total number of plots sampled}} \times 100$$

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of a species}}{\textit{Total frequency of all species}} \times 100$$

5.4.3.c Basal Area

Basal area is refers to the ground, actually penetrated by the stems in the soil. Thus it can be calculated as follow:

Basal Area (B. A.) = πr^2 m^2

B. A. = $\pi D^2 /4$ or B. A. = $C^2 /4\pi$

Where, r = Radius at breast height

D = Diameter at breast height

C = Circumference at breast height

5.4.3.d Dominance and Relative Dominance

Dominance is the total basal area of a species in a unit area.

Dominance (m^2 /ha) = Density of a species ×Average basal area per tree.

$$\text{Relative Dominance } (\%) = \frac{\text{Dominance of a species}}{\textit{Total dominance of all species}} \times 100$$

5.4.3.e Importance value Index (IVI)

The overall picture of ecological importance of a species in relation to the community structure can be obtained by adding the values of Relative Density (R.D), Relative Frequency (R.F), Relative Dominance (R. Dom) was known as Importance Value Index of the species. It was calculated by following formula.

Importance Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance or R.D. + R. F. + R. Dom.

Chapter VI

6. Results

6.1 Red Panda distribution

Red Panda signs and markings were confirmed only in 72.18 km^2 inside the study area of DHR. From March-May 2007, four Red Pandas were sighted. Two Red Pandas were observed in Barse Block; one at 3,220 m elevation on 30 April (28º 29' 12.0'' N, 083º 09' 44.6'' E) and another at 3,300 m elevation on 10 May (28º 30' 59.0'' N, 083º 06' 05.3'' E). The first of the Red Pandas encountered in Barse Block was observed on a northeast facing slope on Ratmata Hill. The Panda was excavating when first observed at a distance of 200 m. We saw termites that were terrifying and moving horribly. The Red Panda immediately climbed up to the crown of an *Abies* tree. It was alert to the presence of observers but its movement was relatively slow. It climbed approximately 2 m in 10 minutes from one branch to another. During this movement the Red Panda looked toward the observers on that occasions and frequently licked its upper lip. When the Panda reached the higher branch it ceased climbing but did turn frequently toward the observers it observed movement and blinked its eyes often. This Red Panda was observed for about 90 minutes (15h30-17h00). The second observation of Red Pandas in Barse Block occurred at Phedi which lies above the Chhantung. These sighting points were dominated by *Abies spectabilies* with understory bamboo and 50 m far from water source. This Red Panda was observed briefly on a south-facing slope.

In September 2004 two Red Panda were encountered at Ratmata (Barse Block) by herders and thought that these were Chamree (described by the herders as a species of small carnivore which kills livestock) and pelted stones at them after which the Red Pandas left. A hunter (Chak Bahadur Malla Pers. comm.) had also seen Red Pandas at Ratmata and Simpani of Barse block. According to park staff, one Red Panda was found dead in a trap at Dharkharka at 3,730 m elevation (28º 30' 49.8'' N, 083º 11' 05.2'' E) in 2004 (Jung B. Adai, Pers. Comm, 15 May, 2007). We did not observe evidence of Red Pandas in this location during our survey; thus, Red Pandas may no longer be present in this area. Most of the responses by herders were supported this assumption.

In Surtibang block a Red Panda was observed at an elevation of 3,400 m on 15 May (28º 28' 18.7'' N 083º 01' 28.5''E). This Panda was observed for 30 minutes (17h25-17h55) before departing. The distance between the Red Panda and the observer was about 250 m. The Panda rolled over the branch of *Betula utilis* and escaped it immediately toward the large *Abies* tree. The tail was almost straight during this movement. The Red Panda climbed onto a large branch of the *Abies* tree, where it opened mouth for some time. It may have vocalized but we could not be certain because of the distance.

Similarly, another Red Panda was observed at the Garpa in Fagune Block at an elevation of 3,610 m on 19 May (28º 31' 11.0'' N 083º 03' 48.5'' E). It was climbing an *Abies* tree when first observed and turned toward the observers, fixing fore and hind limbs on the bark of the tree. The bark of the tree seemed to rupture and it appeared to begin falling but it adjusted its body and climbed slowly up the tree. All of these Red Pandas were similar in body size and coloration. There was no sexual identification of these individuals during the study period.

Table-1, Variance-Mean Ratio

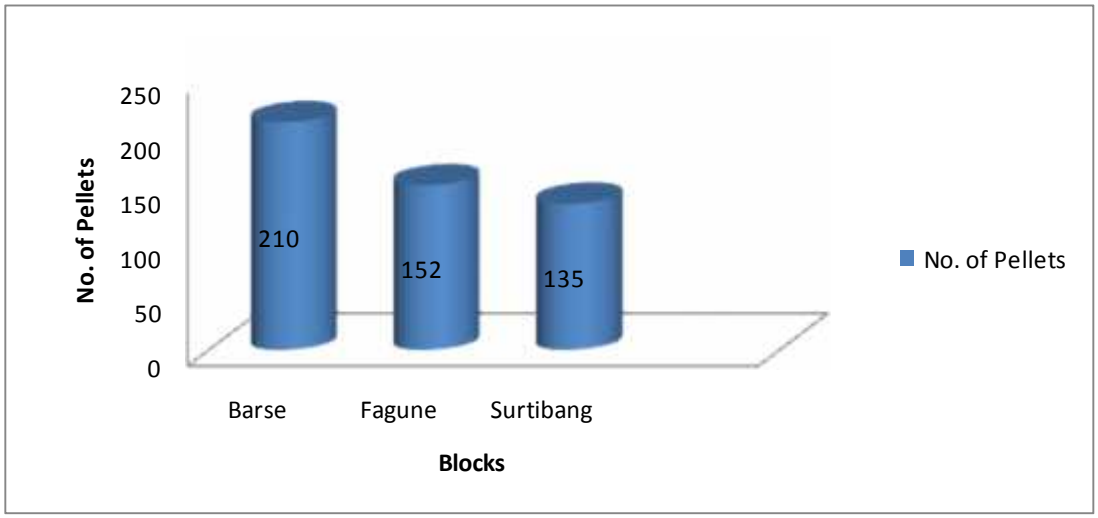
Name of the Block	Variance-Mean ratio value	Degree of Freedom (d.f.)	Calculated- $\chi 2$
Fagune Block	10.14> 1	8	70.99
Barse Block	25.26> 1	8	201.89
Surtibang Block	2.05>1	4	14.96

The Variance/Mean ratio is found to be greater than 1 and the value of calculated Chi-square ($\chi 2$) is greater than the value of table Chi-square ($\chi 2$) at 5% level of significance.

6.2 Abundance

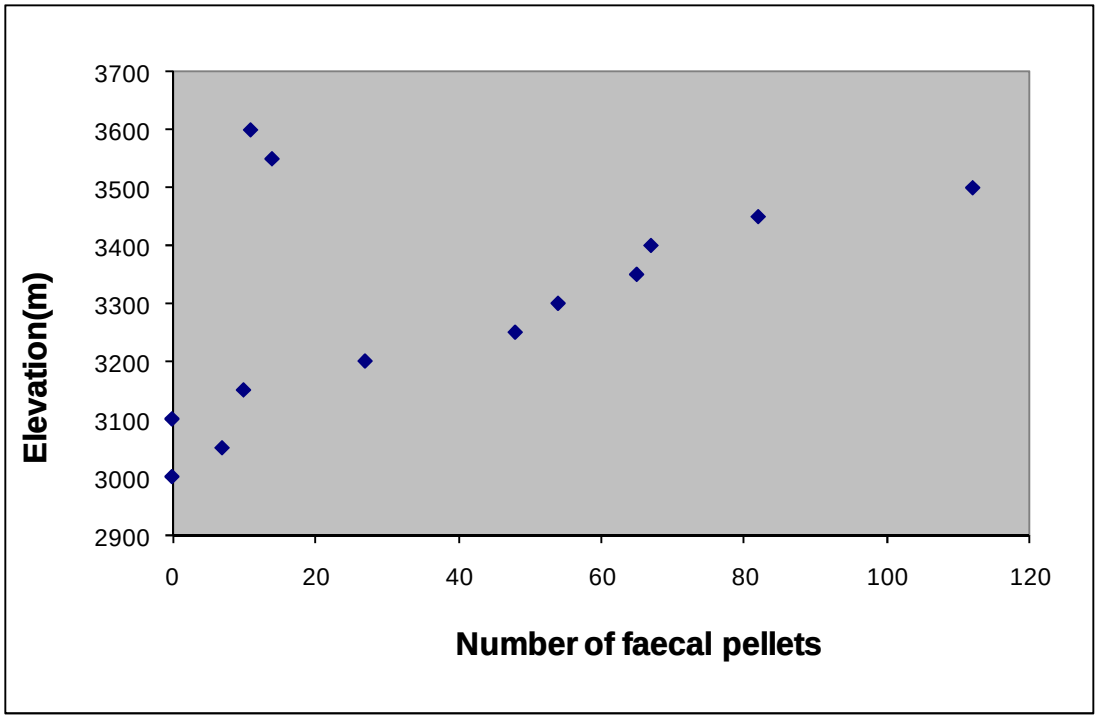
Over all, Red Panda pellet groups were observed from 3,000-3,700 m (Fig.-3). Frequency of pellet groups increased markedly from 3,000-3,500 m then declined sharply at higher elevations. No pellet groups were observed at elevations above 3,700 m. Distribution of pellet groups corresponded positively with the abundance of *Arundinaria* spp. and available water resources. There were no faecal pellets of Red Panda in Fagune and Surtibang blocks from 3,000-3,200 m where as in Barse block it was recorded above the height of 3,000 m.

Figure-2, Distribution of Red Panda pellets in different blocks



The faecal pellets encounter rates of the Red Panda were different at each three blocks of the Reserve. Barse block showed the highest encounter rate of 22 pellets/h followed by the Fagune block 20 pellets/h and least encounter sign was recorded in the Surtibang block of 6 pellets/h.

Figure-3, Faecal Pellets of Red Panda with elevation



A correlation analysis of the combined data for the distribution of faecal pellets with increasing elevation up to certain limit was r = +0.52, P.E = 0.14; t = 1.99, p = 0.05 at 11d.f (Appendix-V).

6.3 Slope/Aspect

The highest pellet groups (42 %) were encountered on the slope of 34° followed by 38° (31 %) and least pellet groups of 27 % were encountered in 40^0 slopes. Similarly, Red Pandas mostly preferred northwest (N-W) facing slope with 45 % pellet groups which was followed by northeast (N-E) facing slope of 32 %, least pellet groups were recorded on southeast (S-E) facing slope of 23 % and there was no any sign recorded in southwest (S-W) facing slope.

Figure- 4, Red Panda pellets with different slope degree

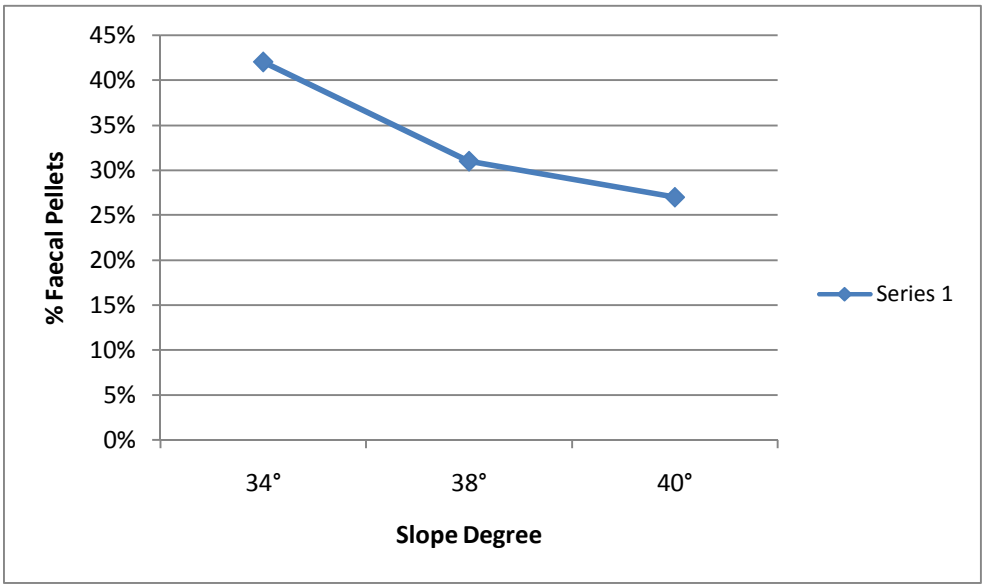
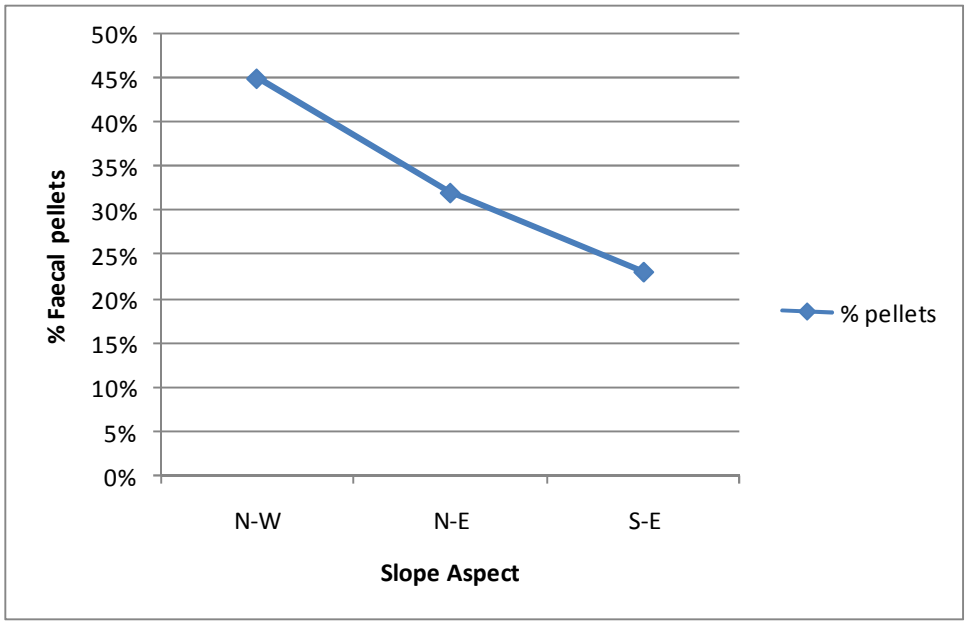


Figure- 5, Red Panda Pellets with slope aspect



6.4 Habitat Utilization

A total of 25 species of trees (Appendix- IX, X and XI), and 20 species of shrubs (Appendix- XII) were recorded from the study area. *Juniperus* and *Pinus* were observed predominantly at lower elevation (<3,200 m). *Abies* and *Rhododendron* were abundant from 3,200 to 3,500 m, and *Rhododenron* and *Betula* trees were above 3,500 m. Among the shrubs *Arundinaria* was the most dominant at 3,200-3,500 m. In all blocks similar type of vegetation were found and *Abies spectabilis, Rhododendron* spp. and *Betula utilis* were most prominent with high IVI values. In all blocks *Abies, Rhododendron* and *Betula* were found dominant. The faecal pellets abundance of Red Panda was highest in the areas where *Abies, Rhododendron, Betula* and *Arundinaria* were dominant. The species *Abies* was important for providing shelter for Red Panda, *Rhododendron* and *Betula* for movement and *Arundinaria* was for nutritive value.

6.5 Food habit and materials used

The Red Panda is an unusual member of Carnivora because it feeds mainly on *Arundinaria's* leaves and shoot. According to the herdsmen of the study area, the Red Panda feeds on berries, bird's eggs, bamboo leaves, and the small leaves of other plants (and it has been speculated that it also eats mice, birds, vegetables, fruits, acorns and roots).

Table-2, Information about plants and their parts used by Red Panda as in formed by various stakeholders in the study area

Plant species	Researcher	Park staff	Herdsmen	Local people
Abies specatabilis	Resting, climbing	Resting	Rest, escape, searching nest	Rest, hide, escape
Rhododendron campanulatum	Digging the root of this tree for termite and also the site for bamboo feeding	Escape	For easy movement and also eats leaves of bamboo by sitting there.	Hide
Betula utilis	Resting and defecating	-	Its bark used for nest	Hide and for easy movement
Juniperus indica	-	-	Hide, rest, for nest	Rest, escape, searching nest
Sorbus microhylla	-	Feeding the fruits	Resting, feeding	Resting, escaping
Arundinaria spp.	Leaves and shoot	Leaves and shoot	Leaves and shoot, Tusa	Leaves and tender shoot

6.6 Threats on Red Panda

6.6.1 Human interference

There were 5,569 households with total of 35,310 people in the DHR and its buffer zone where most of the inhabitants use to live during spring and summer seasons. Due to extreme cold, they moved down to warm areas during winter season. These inhabitants were mostly from the Bobang, Adhikari Chaur and Nishi VDCs of Baglung district. Historically, the area had been used by indigenous Nepali villagers for livestock grazing and for cultivation of potato and other crops in the fertile Utter Ganga river valley in summer.

Table-3, The number of households, population size and total number of livestock in the villages inside the buffer zone area of Dhorpatan Hunting Reserve.

		Baral, 2001			Current study		
S.N	VDC areas	Household	Population	Livestock	Household	Population	Livestock
1	Bobang	900	5,850	19,800	910	6,250	21,000
2	Adhikarichaur	340	1,250	7,922	350	1,300	10,000
3	Bungadovan	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	Lulangkhoria	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

More than 90% households have at least one dog for security which chases the Red Panda.

Park management inferences were relatively nil and just started to reestablish during the research period. Many important trees were also looped and felled as a mean of timber and agriculture implements. The over exploitation was also for Diyalo (for lighting), stall feeding, forage, fodder, and fuel wood. Commercial poaching of Red Panda in the study area wasn't reported but few events of non-targeted trapping had been reported in the study area. The herders killed Red Panda for its skin for their domestic use and for fun as well but they were hesitating to tell such activities during

questionnaire survey. A total of 160 traps were gathered and handed to the Reserve officials during the field visit (Plate-3).

6.6.2 Livestock pressure and grazing

Many years ago, only the local villagers used the Hunting Reserve for grazing their domestic animals (Junga B. Adai Pers. Comm. April 29, 2007. During field visit, researcher regularly observed livestock grazing in the forest of DHR (Plate-8), Such livestock were from buffer VDCs including with other VDCs like Burtibang, Devisthan, Bhimgithe, Taman, Gwalichaur, Ransing Kitini, Kungkhani, Bohora Gaun, Takam, Darbang, Babiyachaur, Arthunge, some parts of Gulmi and Dolpa also use to carry their livestock for grazing every year in monsoon season. In the lower altitude of the Reserve burn practices were common to make the land suitable for livestock grazing and poaching of other wild species as well. On the basis of questionnaires survey with herdsmen and local people showed that cattle were the dominant group (47 %), followed by Goat/Sheep (34 %), Horse/Mule (11 %) and least dominant group were Buffalo (8 %) (Figure-4), Over 90 % of the farmers graze their livestock and only milking animals were stall fed. The grazing inside the Reserve (locally called Buki – high altitude areas, >3,000 m) lasts from mid-April to October.

Figure-6, Percentage of various livestock grazing in DHR.

6.6.3 Energy Sources

Most of the inhabitants in the Reserve depend upon the fuel wood of DHR followed by electricity which was produced from local hydropower station. Kerosene occupies the third position which was used by the villagers in a fewer amounts. The least percentage of energy sources use by the locals of DHR are Solar panels (figure-7).

Figure 7, Energy profile in DHR

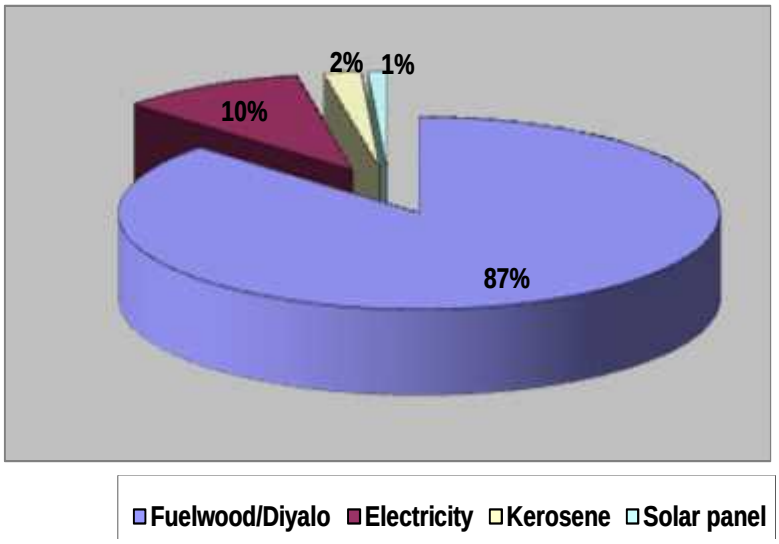


Figure-8, GIS map showing distribution of Red Panda pellets which was positioned through GPS.

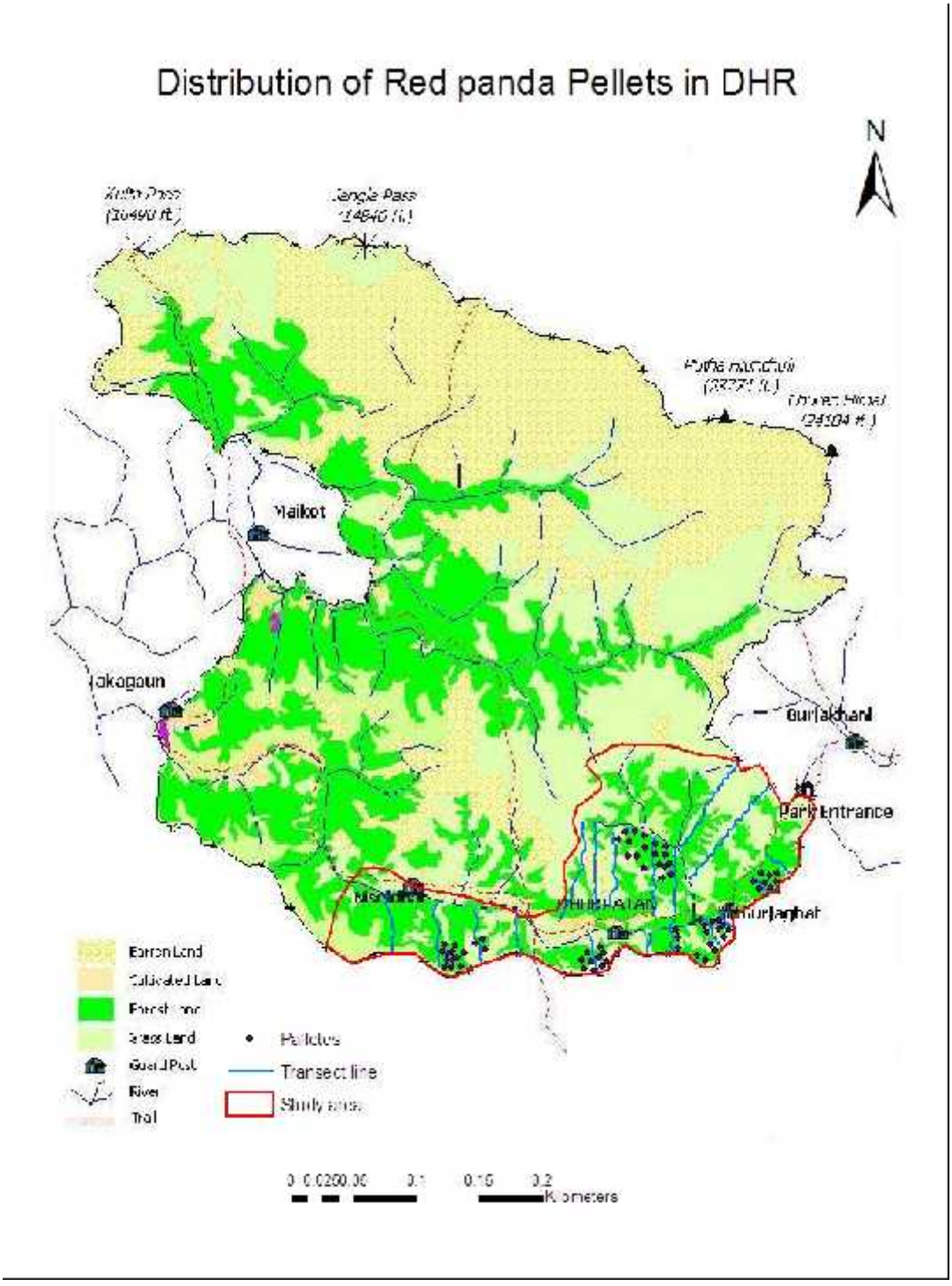


Plate-1, Dhorpatan Hunting Reserve Headquarter.

Plate-2, Trap recorded during the study period

Plate-3, Leg snares along with the trapped Koklas Pheasant

Plate-4, Researcher observing panda pellets below *Abies* tree.

Plate-5, woman taking *Arundinaria* spp. from the Reserve to feed her

Plate-6, Forest destroyed with fire

Plate-7, Researcher interviewing with local people

Plate-8, Local people grazing their livestock inside the Reserve

Plate-9, Researcher positioning Panda pellets through GPS.

Plate-10, Bamboo leaves left over after fed by the Panda

Plate-11, Bamboo thickets (the suitable feeding site of panda)

Plate-12, summer hut made by herder to keep their livestock

Plate-13, Tree hole which was the probable nest of Red panda

Plate-14, Bamboo destroyed to feed their livestock

Plate -15, fresh faecas pellets of Red Panda on the unchopped

Plate- 16, Red Panda resting on the branch of Abies, tree

Chapter-VII

7. Discussion

The recorded four Red Pandas were similar in the morphological characters and all were adult. The distribution of Red Panda in DHR was from 3,000 m to 3,700 m and abundant in the range between 3,200 m to 3,500 m elevation. This data concluded that Red Pandas were restricted within the narrow range of habitat which was dominated by *Arundinaria* spp. with excess amount of water sources. Similar type of narrow range of distribution in Langtang National Park was also described by Yonzon and Hunter (1991b), where Red Pandas were distributed within the altitudinal range of 3,000-4,000 m whereas by Mahato (2003) the Red Panda signs were recorded between 2,800 m and 3,650 m altitude in Kangchenjunga Conservation Area. Sharma (2008) also defined the presence of Red Panda from 3,100 m to 3,600 m in Rara National Park. Similarly, a narrow range of habitat condition of Red Panda was found to occur between 2,600 m to 3,600 m in the Singhalila National Park (Pradhan et al. 2001).

No any sign of footprints of the Red Panda were recorded throughout its distribution site due to lack of snow freezing all over the areas even in the bank of water source containing mud. Winter is the best season for recording the Red Pandas foot prints but during this field visit, distribution was confirmed by recording their dropping sites. The elevation from 3,200 to 3,500 m was the core area in all three blocks where higher numbers of pellets of the Red Pandas were found because of dominant *Arundinaria* spp. with large number of dead fallen logs, *Abies* and *Rhododendron.* These all provide easy access to food, shelter and mobility for Red Panda. Red Panda defecates in the feeding sites which were also described by Wei et al. (2000) that was due to its short alimentary canal and defecates rapidly after feeding and needs large amount of feeding resources in short interval of time.

The result of variance mean ratio of Red Panda pellets in Fagune, Barse and Surtibang blocks were 10.14, 25.26, and 2.05 which concluded that the distribution pattern of Red Panda in these blocks was clumped type with significant value of Chi – square test of above blocks 70.99, 201.89 and 14.96 respectively. So it was presumably explained by the fact that in natural habitats resources such as food, water and cover

were not distributed uniformly in all areas of blocks. A correlation analysis of the combined data for the distribution of faecal pellets with increasing altitude up to certain limit showed positive correlation but the data were not significant by the students t- test ($r = +0.52$, P.E = 0.14; $t = 1.99$, $p = 0.05$ at 11d.f). This data showed that faecal pellets encounter rates increased up to certain elevation only after the uniform distribution of suitable habitat and other resources in the study areas. All the droppings of Red Pandas were found in 30^{o}- 40^{0} slope with highest 45 % in northwest (N-W) facing slope followed by 32 % of northeast (N-E) and 23 % which was least percent in the southeast (S-E) facing slope which was due to favorable condition of feeding, water resources, fallen logs, abundant resting trees and less human interferences in northwest facing than other aspects of slope condition. Assuming that distribution of Red Pandas didn't differ with slope aspect, a Chi-square test performed showed that slope aspect differ the distribution pattern of Red Panda or there is a significant different with respect to slope aspect ($\chi 2$ Cal.=7.35, at 0.05 level of significance and 2 d.f). Similarly, Yonzon (1989) also described the affinity of Red Panda towards in north facing slope.

The Red Panda sign encounter rate 22 pellets/h was highest in Barse block followed by the Fagune block of 20 pellets/h and least sign encounter rate of 6 pellets/h was found in Surtibang block. The highest percent (42.25 %) of pellets occurred in the Barse block followed by 30.59 % and 27.16 % in Fagune and Surtibang blocks respectively. This showed the distribution of Red Panda was highest in the Barse block followed by the Fagune and least number in Surtibang block which were due to having less human interference and livestock grazing in the Barse block than remaining blocks. With respect to altitudinal gradient, sign encounter rate of Red Panda in all three blocks of the study area indicated that the highest abundance were in the range of 3,200-3,500 m elevation which showed some extent of similarity to the result of Williams' (2004) Red Panda encounter rate in Ilam district and Pradhan et al. (2001) in Singhalila National Park where Red Panda pellet groups abundance rate was highest around 3,200 m altitude. Similarly by Yonzon (1989), the core area of Red Panda occurred at an altitude of 3,233±218 m in Langtang National Park.

Juniper's and *Pinus* with high Important Value Index were more dominant at lower elevation (<3,200 m). *Abies* and *Rhododendron* were abundant from 3,200 to 3,500 m and *Rhododendron* and *Betula* trees were above 3,500 m. Among the shrubs *Arundinaria* was the most dominant at 3,200-3,500 m. In all blocks similar type of vegetations *Abies, Rhododendron* and *Betula* were found dominant. The Red Panda sign encounter rate was highest in the areas, where *Abies, Rhododendron, Betula* and *Arundinaria* were dominant. *Abies* was used for resting and nesting within its large hole, *Rhododendron* provides easy access to climb on large trees and also for feeding leaves of bamboo through its branch. The soft bark of *Betula* is used for the formation of nest during the parturition. So, these trees are important for the survival of Red Panda, especially for nesting, sleeping, and sheltering. The dead fallen logs and small tree branches were mostly used in feeding site for movement, escaping and climbing which were comparable with the result by Pradhan, et al. (2001a) where Red Pandas used trees mostly for nesting, sleeping, shelter, and feeding site.

There was no direct competition in the consumption of *Arundinaria* spp. between Red Panda and livestock. The later one feeds the leaves and shoots of *Arundinaria* below 1-1.5 m and above 1.5 m by Pandas but main problem was the trampling of shoots and mature bamboo by the livestock. The average height of *Arundinaria* spp. in study area was 2.3 m. There was not any record of destructions or harms by Red Pandas to the human society including their livestock so there was one way pressure towards Red Panda instead of conflict. Summer huts made by herdsmen to keep their livestock were scattered in every blocks which showed that animal husbandry was the main livelihood option for the local people in and around DHR, such process causing a severe threat to Red Pandas' habitat by consumption and destruction of its food. Red Panda is a very shy animal due to which livestock might be creating disturbance in their mating activities. Most of the livestock (about 90 %) graze in the DHR above 3,000 m, which was also the suitable habitat of the Red Panda whereas Kandel and Sharma (2008) reported that the main threats for Red Panda were mainly by livestock grazing, summer huts and fodder collection in DHR. Similarly, by Bajimaya (1990), the presence of huts and livestock in DHR was the major threat for wild animals which may have chance of poaching of wild animals. The result was also comparable with the Williams' (2004) in Ilam where the analysis of sign plots and tree usage

indicated that Red Pandas preferred more diverse and mature forest with greater canopy cover and little livestock disturbance.

The number of livestock grazing in DHR has been increased by 22.33 % in six years in comparison to the report of (Baral 2001). It was due to open access and interferences from adjoining villages and districts. The grazing inside the Reserve for Buki in the high altitude areas >3,000 m up to 4,000 m lasts from mid-April to October where as grazing was the most significant disturbance to Red Panda habitat as in the case of LNP (Fox et al. 1996; Karki 1999; Yonzon 1989).

The traditional livestock guarding techniques i.e. keeping dogs was another main threat that chases adults and may kill cubs to the Red Panda during breeding season; more than 90 % households had at least one dog for security. The incidences of killing Red Panda around villages and transition zones may be due to human interventions and their dogs. During breeding season the Red Panda carried its cubs from one place to another due to the disturbances caused by human, dog and livestock. At the same time it may chance to kill these cubs by natural predators like leopard, buteo which is also described by Yonzon (1989) in LNP with 86 % of cub mortality and 44 % of adult. Similar type of result was recorded by William (2004) in Jamuna and Mabu village of eastern Nepal where two Red Pandas were killed by an account of dog offence.

Because of the violence and insurgency, the management offices and check posts were transferred to the urban areas (District head quarters Baglung), after that there was apathy of government. Illegal felling and looping of trees, non- targeted trapping, local level poaching for its skin and fun etc. were the main threats of Red Panda in DHR. On the other hand, the world's burning issue of climate change and natural disasters like landslides causes the habitat fragmentation divide the Red Panda habitat which create severe threat to Red Panda. The over exploitation was also for Diyalo (for lightning), stall feeding, forage, fodder, and fuel wood. Local people directly involved in the collection of forest products to fulfill their daily need in spite of investment on solar panel. Altogether 160 traps, which were collected and handed to the Reserve authorities during field visit seen mainly for *Moschus chrysogaster* (Musk Deer) and birds like *Ithaginis cruentus* (Blood Pheasant), *Pucrasia macrolopha* (Koklas) (Plate-3), *Lophophorus impejanus* (Danphe) etc. but the

occasional death of Red Panda was also reported. One Red Panda was found dead in trap at Dharkharka (3,733 m elevation) in 2004 (Jung B. Adai Pers. Comm. May 15, 2007). Similar traps were recorded in SNP by Mahato (2004) that were placed in and around the Red Panda habitat.

Another threat of Red Panda habitat was fire by poachers and herders. Fire had been deliberately set at Reserve area for wildlife trapping and to promote sprouting of grasses and fodder species for their livestock. Mainly, the herdsmen use to fire to get new flushes of grass for their livestock annually and poachers to find out the suitable spot for the targeted wildlife. Sometimes fire escaped from hunter's campfire and caused the extensive damage of wildlife and their habitat. On the basis of questionnaires survey with herdsmen and local people, the population size of Red Pandas might be larger towards northeast part of DHR, which lies in Myagdi district. Three years before, two Red Panda were encountered at Ratmata hill of Barse block in different seasons of the year on the branch of *Abies* trees. Hunter (Chak Bahadur Malla) had also seen Red Panda at Ratmata and Simpani of Barse block. Most of the respondents of questionnaire survey were ignorant about the occurrence of Red Panda in DHR which was similar to the data by Mahato (2004) in SNP where threat to Red Panda conservation was due to lack of people's concern toward it.

Chapter-VIII

8. Conclusion and Recommendations

8.1 Conclusion

The distribution of Red Panda in the form of different patches which showed that the distribution of natural resources that requires for Red Panda was of unequal throughout the blocks. Barse block was seen to be most suitable habitat than remaining blocks for the distribution of Red Panda where signs were recorded at 3,000 m elevation but in case of Fagune and Surtibang blocks there were not any signs below 3,200 m. The core area of Panda was found 3,200 to 3,500 m elevation due to presence of preferred habitat of Red Panda which was dominated by *Abies spectabilis, Rhododendron campanulatum, Betula utilis, Juniperus indica,* and *Arundinaria* spp. with suitable water resources which provide ample food value and habitat for Red Pandas but human interferences, live stock grazing, non-targeted and local/domestic poaching etc. have threatened the existence of the species in the study area. Due to political conflicts and other factors, government authority was virtually absent and thus the rules and regulations of the Reserve were not implemented properly. The Reserve was appeared as grazing land rather than a protected area. Therefore, it is necessary to initiate the use of alternative natural resources and enhance their income source to the local people for the conservation of Red Panda in DHR.

8.2 Recommendations

- After establishment in1983, no management plan has been developed in DHR. Therefore, DHR management plan should be drawn as soon as possible for the conservation of Red Panda and other wildlife.
- The DHR may be priority area for Red Panda and other game species. Research on various aspects of the Red Panda and its limiting factors should be effectively conducted to strengthen the knowledge.
- Regular monitoring should be carried out and new potential sites for Red Pandas should be surveyed.
- Preferred habitat of Red Panda should be maintained in the non-conflicting area.
- Alternative energy resources project should be implemented to minimize the consumption of forest products.
- Establish Local and National Red Panda conservation groups.
- Local people should be encouraged for their active participation on Red Panda conservation.
- Public awareness program should be conducted.

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Appendix

Appendix: I

Questionnaire form for the Red Panda's information:

Respondent's Name:…… Age:……..

VDC:…… Occupation:……..

Family members (No.):…….

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

Khet ☐ Bari ☐

……

b. What kinds of corps do you grow?

……

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

……

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

Yes ☐ No ☐

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

……

Information based on Red Panda.

a. Do you know Red panda?

Yes ☐ No ☐

b. Have you ever seen Red panda?

Yes ☐ No ☐

If yes

Where……. b) When……..... c) How many……

Male ☐ Female ☐ didn't identify ☐

c. Do you know about trade of Red panda?

……

d. What products do they trade?

……

e. Where do they supply?

……

f. Do you know about its distribution in DHR?

Y☐ No ☐

g. Are the Red Pandas really attractive to nature?

……

h. In your opinion, what are the major threats of Red Panda?

☐ Habitat destruction. ☐ Livestock grazing

If yes, how?.....

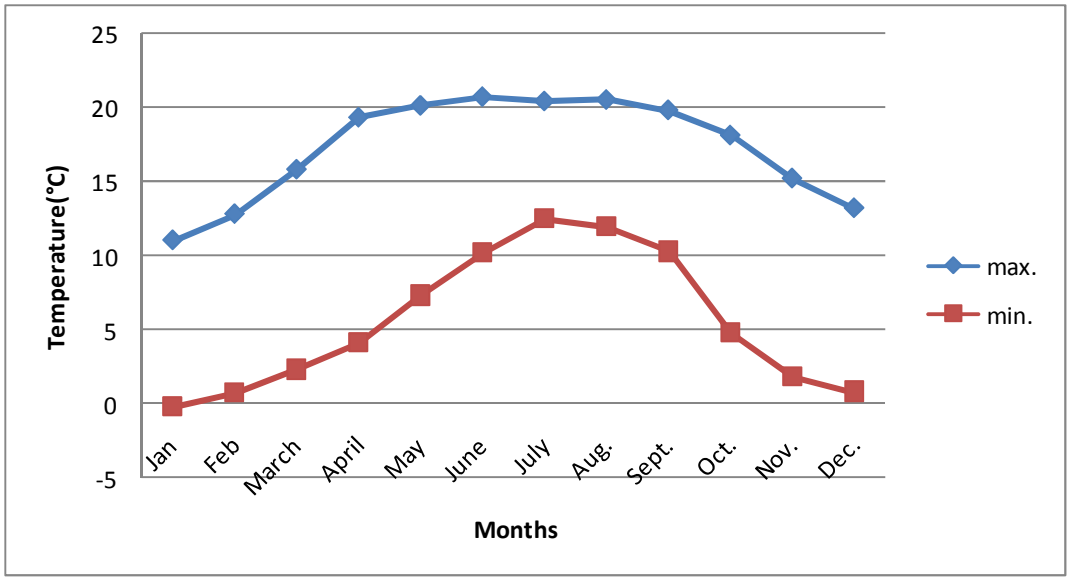
☐ Poaching ☐ Livestock pressure

i. What can be done to conserve Red panda?

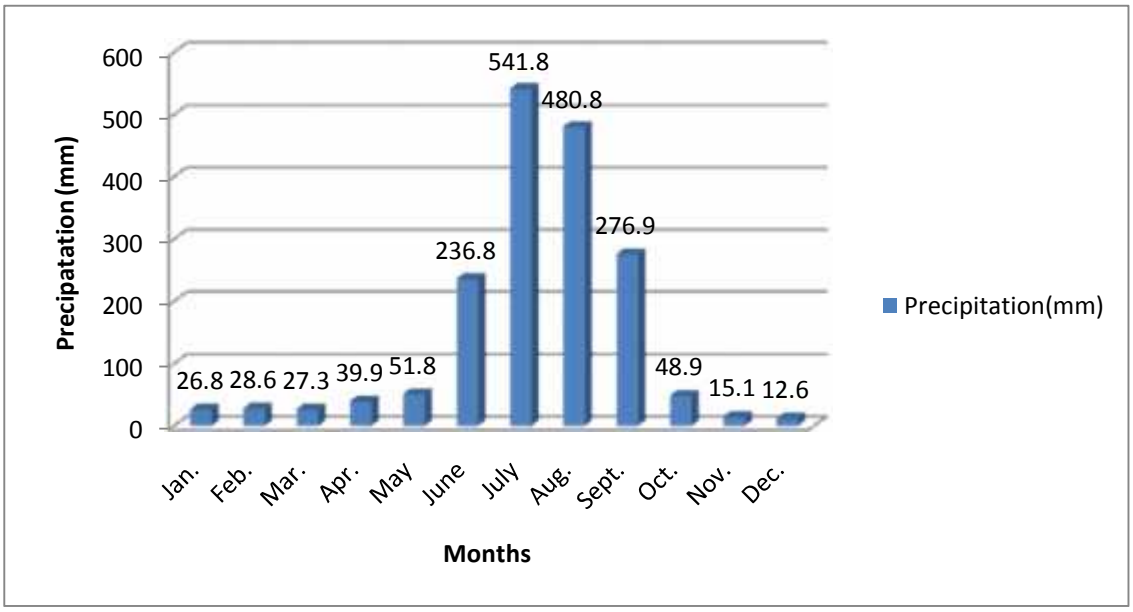
……

……

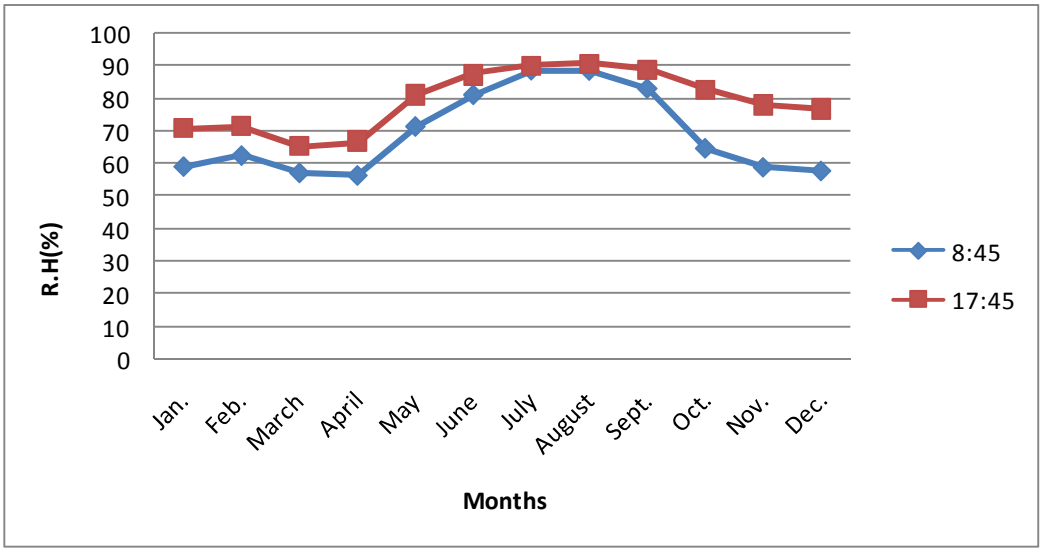
Appendix-II, Mean annual maximum and minimum temperatures for 1999-2006 at Gurgakhani station, Myagdi (Source: Government of Nepal, Department of Hydrology and Meteorology)



Appendix-III, Mean annual precipitation for 1997-2006 at Gurgakhani station, Myagdi (Source: Government of Nepal, Department of Hydrology and Meteorology).



Appendix-IV, Mean annual Relative Humidity for 1999-2006 at Gurgakhani station, Myagdi (Source: Government of Nepal, Department of Hydrology and Meteorology)



Appendix-V, Number of faecal pellets of Red Panda in different elevation at the interval of 50 m

S.N.	Elevation (m) (X)	No. of faecal pellets (Y)
1.	3000	0
2.	3050	7
3.	3100	0
4.	3150	10
5.	3200	27
6.	3250	48
7.	3300	54
8.	3350	65
9.	3400	67
1.	3450	82
11.	3500	112
12.	3550	14
13.	3600	11
Total		497

Correlation = +0.52

Appendix-VI, Faecal pellets of Red Panda in different blocks

Block	Number of Faecal pellets
Barse	210
Fagune	152
Surtibang	135

Appendix- VII, Total number of grazing animals in DHR

S.N.	Animals	Total number
1	Cattle	91,547
2.	Goat/Sheep	66,745
3.	Horse/mules	2,0245
4.	Buffaloes	15,782
	Total	1,94,319

Appendix-VIII, Faecal pellets in different three blocks sighted during field visit

Observed site	Elevation	No. of pellets	Old/Fresh
Surtibang Block	3501 m	21	Old
	3503 m	14	18 Fresh
	3450 m	20	12 Fresh
	3401 m	55	15Fresh
	3338 m	25	Old
Fagune Block	3609 m	5	Old
	3629 m	6	Old
	3409 m	12	Old
	3490 m	8	Old
	3536 m	41	Old
	3465 m	20	15Fresh
	3505 m	37	12Fresh
	3573 m	14	7 Fresh
	3547 m	9	Old
Barse Block	3297 m	19	Fresh
	3450 m	34	Old
	3395 m	65	25 Fresh
	3200 m	5	Old
	3220 m	22	9 Fresh
	3320 m	29	Old
	3277 m	17	7 Fresh
	3254 m	12	6 Fresh
	3054 m	7	Old
Total		497	126 Fresh

Appendix-IX,

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

SN	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. arboretum*	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-X,

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

SN	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-XI,

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

SN	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-XII, List of shrubs recorded in the study area during field visit.

1.	Name of shrubs
2.	*Arundinaria sp.*
3.	*Barberies angulosa*
4.	*B. aristata*
5.	*Piptanthus nepalensis*
6.	*Rubus foliolosus*
7.	*R. hoffmeisterianus*
8.	*Spiraea arcuata*
9.	*Rosa sericea*
10.	*R. microphylla*
11.	*R. webbiana*
12.	*Ribes takare*
13.	*Ribes griffithii*
14.	*Ribes orientale*
15.	*Rhododendron nivale*
16.	*R. anthropogan*
17.	*Cotoneaster frigidus*
18.	*C. microphyllus*
19.	*Salix calyculata*
20.	*Ratomunte*
21.	*Panigedi*