CHAPTER: 1 INTRODUCTION

1.1 Primates

Primates are the order of mammals that includes the monkeys, apes, humans and other similar forms typically having dexterous hands and feet, binocular vision, and a well-developed brain. They are commonly called the monkeys, excluding only the tree shrews, the lemur like forms, the apes, and humans, and therefore embody a tremendous evolutionary and adaptive array of animals. The primates embrace a wide pattern of adaptive modifications in size, structure and habits. No single characteristic alone can be used to differentiate the primates from all other mammals; the integrative feature of the group is its common evolutionary descent. The diversity of primate size, from the diminutive mouse lemurs to the gorillas, and of diet, social systems and habitats, combine to provide rich challenges for the science of conservation biology. The larger primates are widely hunted, many of the smaller ones are prized for commerce and the pet trade, and all suffer from habitat loss. Even where their forests remain, subsistence and commercial hunting in West and Central Africa and South-east Asia are resulting in vast areas of silent and empty forests. The 2000 IUCN Red List of Threatened Species classifies 134 primate species and 224 species and subspecies as threatened (Rylands, 2001).

The Common Langur, *Semnopithecus entellus*, can no longer be called as such appropriately. There are at least 7 species where formerly there was one. The common Langur, entellus Langur, grey Langur, hanuman Langur, true Langur is listed as Near Threatened (NT) or is likely to qualify for a Threatened category in the near future, on the IUCN Red list of Threatened species. According to the latest classification of conservation Assessment and Management Plan (CAMP) Workshop 2002, status of available primate species has been classified for Nepal (Sanjay et al. 2003). CAMP has classified Nepal's Langur into 3 species: *Semnopithecus entellus hector* (Lesser Hill Langur) as Critically Endangered, *Semnopithecus entellus ajax* (Himalayan Grey Langur) and as Endangered *Semnopithecus entellus schistaceous* (Central Himalayan Langur) as Near Threatened. In the recent CAMP Workshop all but one of these different populations of the Common Langur were assessed as threatened.

The report on Hanuman Langur, *Semnopithecus entellus* Dufresne 1797 was published since 1836 on different behavioral aspects. Blanford (1888-91) summarized the then existing knowledge on this species- observations covering various other aspects like ecology, social behavior, eco-ethological investigations and about natural diets were carried out in wild by different scientists in different periods (Srivastava, 1989) .

In Nepal, only three species of monkey Hanuman Langur, Rhesus & Assamese monkey are recorded until to date (Chalise et al, 2005). The Hanuman Langur *Semnopithecus entellus* is the most intensively investigated of Asian colobines. It is a member of the subfamily colobinae of old world monkey belongs within the order primates & is the largest among the sub-family colobinae.

There are 15 species of *Presbytis*, according to Nowak (1999), all distributed over southern Asia. Hanuman Langurs form large groups in India and in several adjacent countries. They are mostly folivorous and inhabit trees but they also walk often on the ground as well. The designation *Semnopithecus* is preferred by some, but *Presbytis* is perhaps even more frequently used as well. Nowak (1999) stated that Hanuman Langurs are now endangered because of an encroaching human expansion.

1.2 Highland Langur (*Semnopithecus entellus ajax*)

The gray Langur (*Semnopithecus etellus*) are a group of old world monkeys and make up the entirely of the genus *Semnopithecus*. Gray Langur (*Semnopithecus entellus*) range from Sri Lanka to the Himalayas in habitats extending from semi desert and subtropical forest to sub alpine scrub (Bishop 1977,1979; Brand-Jones etal.2004; Koenig and Borries 2001) .Though researchers have studied lowland gray Langur extensively, there is little information about the Himalayan varieties even their taxonomy, Bishop (1979) investigated Langur social behavior at Melmchi, north-central Nepal (2442-3050m), with special reference to auditory communication, Boggess (1976) studied social behavior and male membership changes at Junbesi (2442-3505m), in the Everest region of Nepal and Curtin (1975,1982) concurrently collected data on ranging and preliminary information of Langur foraging . The studies, along with several of shorter duration (Vogel 1971), have aided in the definition of a Himalayan

pattern of Langur ecology and behavior that is different in many respects from that of lowland populations. For example, Highland Langur from predominately multi-male. Multi-female troops use expansive home ranges, ecology vocalizations different from those of lowland Langur and exhibit behavioral and morphological buffers to cold weather (Bishop1979). Langur from the southern part of their range is smaller than those from the north.

1.2.1Classification of Highland Langur

Kingdom- Animalia
Phylum- Chordata
Subphylum- Vertebrata
Class- Mammalia
Order- Primates
Family- Cercopithecidae
Subfamily- Colobinae
Genus- *Semnopithecus*
Species- *S. entellus*

In Nepal ecology and behavioral research of monkeys started around 1970s on rhesus of urban areas mostly of religious spots in Kathmandu Valley, Bishop and R. Curtin conducted the ecological and social behavioral research on Langur on highland species around Melamchi and Solukhumbu area Langur monkeys of sub-tropical areas were studied since 1990 (Chalise, 1995,1997). In Sub-tropical Sal (*Shorea robusta*) forest of Ram Nagar Chitwan, this species was extensively studied specially on sex differences in feeding ecology and behavior of Langur (Chalise, 1995). Later Chalise (1998) conducted population census of primate species in different phyto-ecological zones of Nepal.

1.2.2 Geographical Range

The Himalayan Langur are the most wide spread non-human primates, occur throughout the various habitats of the Indian sub continent and Sri-Lanka in the south and from Kathiwar in the east to the Shan state of China in the west (Roonwal and Mohnot, 1977) In Nepal, the Langur monkeys are distributed in different topographical locations from Tarai plane to the valleys of high mountains (Chalise1995, 1997 and1998). Nepal gray Langur (*Semnopithecus entellus*) is a gray Langur endemic to south eastern Asia, including Nepal, China, India, and Bhutan.

There are 15 species of *Presbytis*, according to Nowak (1999), all distributed over southern Asia. Hanuman Langurs form large groups in India and in several adjacent countries such as: Bangladesh, Bhutan, Burma, China, India, Nepal and Pakistan. This species is found in the variety of habitats, including scrublands, rainforests, and in cities, the Hanuman Langur regularly is found in urban areas. Yoshiba (1974) did a detail study of activity pattern of *Presbytis entellus* at Dharwar, similarly Oppenheimer (1973) in singur and Sugiyama (1976, 1977) in Shimla.

1.2.3 Habit and Habitat

Himalayan Langur are well adapted to arboreal as well as terrestrial habitats , Although in forest regions they spend most of the time in trees, in open habitats they can be found up to 80% of their day time on the ground (Chalise,1995). Langurs are vegetarian even though occasional feeding on insects has been observed (Sugiyama, 1964, Yoshiba, 1968, Srivastava, 1989, Chalise, 1995). More than 200 plant species were recorded as food plants in arid area (Srivastava,1989) while 76 species in subtropical area of Nepal (Chalise, 1995) .The plants eaten by them include trees , shrubs, herbs and grasses . They have eaten soil materials (Srivastava, 1989) and licked mosses stone in Nepal, they also have eaten termite soil too (Chalise1995).

These habitats include a wide range of vegetation zones. Semi – desert, dry open scrubs, open cultivated regions, open park woods , dry deciduous forests, moist deciduous evergreen dense forests and mountain forests up to the zones of rather homogeneous

oak-coniferous forests, These habitats are located from sea level up to heights of about 4000 meters (Roonwal and Mohnot, 1997, Vogel , 1997)

The hanuman Langur is a folivorous species but will also consume fruits, flowers, and cultivated crops. They eat seeds, buds blossoms and fruit. Gray Langur feed on leaves, fruits, buds and flowers. Their diet, however, is highly seasonable; with mature leaves being eaten only as a fall back food during the winter months. In the summer, especially before the monsoon, they are highly frugivorous, they also supplement their diet with insects (up to 25% in some months), tree bark and gum.

1.2.4 Physical Description

The Hanuman Langurs are a large and diverse group of Asian leaf eating monkeys. Their average head and body length is 51.0-108.0 cm and tail is 72.4-19.2cm long. The average body mass for an adult male Langur is between 9.0 and 20.0 kilograms, and for the female it is between 7.5 and 18 kilograms (Fleagle, 1988). All are slender in build with long arm and legs. The round head is frequently capped or crested and the face is mostly black with bushy eyebrows and a short nose. The hands are long with opposable thumb. The color of fur changes with the age growth. Infants have red skin and blackish fur within the first six months of life, skin and fur color change to black and gray respectively. Infant and Juveniles are mostly light gray in coat color while adults are dark gray. The color of adults may vary slightly with the age (Chalise, 1995).

1.2.5 Taxonomic Identification

Though Bishop (1979) suggested that only 1 Himalayan Langur taxon be recognized, recent experts proposed 2 high–altitude subspecies (Brandon-Jones, 2004; Brndon-Jones et al., 2004; Napier, 1985) or species (Groves, 2001): pale–armed (*Semnopithecus entellus schistaceus*) and dark-armed (*S. e. ajax*) Himalayan Langur. Pale–armed Himalayan Langurs are apparently very widespread, ranging from Bhutan to possibly Afghanistan, and dark-armed Himalayan Langurs are represented by specimens from Jammu and Kashmir, and Pakistan (Brondon-Jones, 2004). The major feature delineating the subspecies is the darkness of the forelimbs. In *Semnopithecus entellus schistaceus*, the forearms are similar in coloration to the upper arms and back or only

slightly darker, while in *S. e. ajax* the forearms are dark brown or black (Napier1985, p.77).

Taxonomists generally place the Langur of Himalayan north-central Nepal, including Langtang , in *Semnopithecus* (or *presbytis*) *entellus schistaceus* (Napier, 1985) or *S. schistaceus* (Groves, 2001). However, Brandon-Jones (2004).suggests that languor's in the region be classified as the dark –armed Himalayan Langur (*Semnopithecus entellus ajax or S.ajax*) based on photographic evidence: dark forearms in photographs of Melemchi Langurs (Bishop1979). However, the only museum specimens from the Helambu valley, where Melemchi is located, are referring to *Semnopitecus entellus schistaceus* (Brandon-Jones, 2004).

To add to the confusion, Langtang Langurs exhibit adult variation in forearm and back coloration, but none sported differences in forearm and back shading as striking as that of *Semnopithecus entellus schistaceus,* though more data are deeded on intra and inter-troop pelage variation (Oppenheimer, 1977) from highland Langur across their range to test adequately the Brandon-Jones (2004) hypothesis. In addition, researchers often describe Himalayan Langur of both taxa as brown (Brandon-Jones, 2004; Groves, 2001; Napier, 1985). The Langtang Langurs are not brown or brownish, but gray, like populations at Melamchi (Bishop and Bishop, 1978) and Junbesi (Curtin, 1975).

1.3 Statement of the problem/Rationale

Gray Langurs (*Semnopithecus entellus*) range from Sri Lanka to the Himalayas in habitats extending from semi-desert and subtropical forest to subalpine scrub (Bishop 1977, 1979; Brandon-Jones et al., 2004). Though researchers have studied lowland gray Langur extensively, there is little information about the Himalayan varieties, even their taxonomy. There has been no detailed long-term study on population structure, ecology, behavior, distribution throughout the Nepal as well as habitat utilization. It is essential to explore the present status, habits and habitat for the conservation of such species.

1.4 Aims of the study

Objective I. To determine the population status of Himalayan Langur in Langtang area, Nepal

Objective II. To document its habitat composition used by Himalayan Langur in Langtang.

Objective III. To explore the general behavior of Himalayan Langur around Langtang.

1.5 Scope of the study/significance of the study

The extent of intra-specific variability reported in the literature for the behavior of Langur and very little study were done in behavior about the Himalayan Langur (*Semnopithecus entellus ajax*) in highland. So, the present study was to achieve a generalized description of general behavior of Langur troop living in an undisturbed habitat and to compare these data with the research of other study sites on the same species. Besides this current population status, distribution, behavior and factors effecting the Langur population of high mountain area is less known there by suggesting the guideline for the conservation management of wild Langur monkey.

1.6 Limitations of study

1. Harsh and fluctuating environment of the study area created difficulties to follow the animal for long period.
2. Heavy tourist flows and freely left domestic animals in the park used to disturb the research work.
3. The study concentrated for the partial fulfillment of academic degree for masters in Zoology (Ecology)
4. In this research, the researcher being a student has limited time and resources, confined for the short duration.

CHAPTER-2: PRIOR RESEARCH

Non-human primates are not studied thoroughly in Nepal. Few researches have been done on behavior and ecology of primates in different topographical region of Nepal. A few research works have been done on population status and behaviors of primates in different ecological zones of Nepal.

Chalise (1995) studied comparative study of feeding and Behaviour of Male and Female Langurs (*Presbytis entellus*). He found that and average adult Langur spent 32.27 % of the time feeding. Leaf eating accounts for 50 % of the feeding time, i.e. the Langurs aremainly folivorous . However, if fruits or flowers are available they like to eat them (fruits' 21.90 % , flowers' 12.82 %). A small amount of time is spent on insect eating (3.78 %) and stone –soil utilization (3.60 %). He also found that the most utilized plant is of the family Leguminosae (*Spatholobus parviflorus*) from which Langurs eat nearly all parts (36.10 % of the feeding time). The annual distribution of feeding time reveals seasonality, peaking in the winter months and the lowest values are found in spring and during rainy seasons.

Chalise (2001) reported the Crop raiding by wildlife, specially primates and indigenous knowledge of food conservation. The result revealed that monkeys, deer, porcupines, squirrels, birds and other small mammals are responsible for the crop-raiding in the area and reported that monkey species are responsible mainly for the cereals loss among those maize comes ranked first. He reported the interesting indigenous techniques for the driving of crop raiders.

Chalise (2004) studied a case of Population Stability of Semi-Provisioned, Free-Ranging Temple Rhesus Monkeys of Kathmandu Valley, Nepal. He reported a stable population of these species around 350 individuals in the two religious sites Pashupati and Swoyambhu area. He suggested that clean water supply and restoration of natural habitat are urgently needed to manage these populations.

Chalise and Johnson (2005) collected the Farmers attitudes toward the conservation of “pest” monkeys from Nepal. Their survey data demonstrated that public support for

primate conservation can vary significantly across localities, even those struggling with crop-raiding monkeys. They also reported that in Nepal, individual sentiment for the conservation of monkeys is negatively influenced by increasing household affluence (ownership of large livestock). They concluded that conservation sentiment itself affects farmer attitudes regarding the degree depredations would have to be reduced in order to be tolerable, and the acceptability of two potential management measures, namely, translocation and fertility control of problem monkeys.

Chhangani A.K. and Mohnot S.M (2003) studied population ecology of Hanuman Langur in the Arrival; hills of Rajasthan India. They found that the mean troop size was 41.7 and the mean band size was 15.6. The population density of the study area came to about 67 Langur per sq. their census data suggested that a definite increase in the no. of animals in the temple ecosystem while population in the undisturbed forest ecosystems have marginally drop.

Sahoo S.K. and Mohonot S.M. (2004) did a survey of crop damage by Rhesus monkeys (*Macaca mulatta*) and Hanuman Langur (*Semnopithecus intellus*) in Himanchal Pardesh, India. Their study showed that there were too many living in area closer to agricultural field and that Rhesus Population was increasing. Few farmers considered that, they monkey abundance status was acceptable however a majority of farmers favored some short of management to control the monkey population. It can be concluded from the study there for the effective conservation of monkeys by reducing relation for their crop raiding with providing compensation to their crop depredation. To understand the depth of the crop damage caused by monkeys in Himanchal Pardesh, they recommended that to conduct a long term, comprehensive study with specific focus on the level of monkey abundance in different geographical and agro-climatic regions on the agricultural /horticultural crops based on perceived losses and most importantly, on the community participation programme for the monkey management and habitat conservation programme in the areas with high crop damage.

Subedi (2007) studied the behavioral ecology of Hanuman Langur at Devghat, Chitwan. He found that Langurs spend more time in foraging during the early and late morning and

during the early evening. He also stated that Langurs are tree dweller rather than ground dweller because they spend most of the time in trees and only down frequently to the ground during drought season for ground foraging and for crop-raiding to the adjacent crop fields to fill up their hunger.

Conservation Assessment & Management Plan (CAMP) workshop 2002 has classified available primates for Nepal (Sanjay et al. 2003). CAMP has classified Nepal's Langur into 3 species: *semnopithecus entellus hector* (lesser Hill Langur) as critically endangered *semnopithecus entellus ajax* (Himalayan Grey Langur) as endangered and *semnopithecus entellus schistaceous* (Central Himalayan Langur) as Near threatened and Assamese monkey of Nepal designated as 'Nepal population with endangered status based on morphological characteristics. The assessment to the Rhesus Monkey *Macaca mulatta* was categorized as least concern as its abundance population & larger area distribution.

The latest primate census data recorded these three groups of monkeys in different ecological zones of Nepal from Tarai plain to the lap of Himalayan. The population of Assamese monkey recorded in Nepal from different sites shows altogether 282 mature individuals while total population with different age and sex comprises up to 525 (Chalise, 2004). Rhesus is found in different climatologically diverse topographical zones of Nepal. They are common in Tarai plain to mid -hill and up to the valleys of Himalayas. However detail information on their ecology, behavior and distribution throughout Nepal is greatly felt for all available species: Rhesus and Langur are common and the Assamese is strictly protected under the National Park and Wildlife Act 1973 and has considered in endangered status (Chalise, 1997, and 1998). Population density of this animal has been found more in temple, religious place, cities and towns. The total counts of Hanuman Langur population around different localities are 719 until to Date; however more than 200 mature individuals were recorded. The total population of Rhesus recorded is 1696 individuals, with 1065 inside the Kathmandu Valley and 631 out of valley (Chalise, 2004).

In Nepal, Hanuman Langur *S. e. ajax* is reported from east Langtang, Melamchi area *S. e. hector* from central to west Nepal in outer Tarai, and *S. e. schistaceus* is reported from south to north in central Nepal (Chalise,2004).

The main threat of primate conservation in Nepal is habitat loss for agriculture expansion, logging and shifting cultivation followed by the revenge feeling of farmers due to their crop damage (Chalise, 2003).

Hinduism and Buddhism are distinct religions, yet worshipers often use temples interchangeably (Singh, 1999).Both religions share a reverence for nature that stems from their beliefs of reincarnation and karma. Beliefs based on religious values and folklore often serves to protect monkeys at or near temples (Koller and Koller, 1998).

Respects for animals extend beyond the cow to other living creatures including monkeys in Hindu religion (Chapple, 1993). Monkeys are often considered sacred in Hinduism because they are symbiotic incarnations of Lord Hanuman, the monkey god. Monkeys in India such as the Rhesus macaque and the Hanuman Langur represent living incarnations of Lord Hanuman and Hindus would be remiss if they did any harm or failed to help them (Carter and Carter, 1999)

Like Hinduism, Buddhism also teaches a profound respect for nature, especially as it is believed that all animals have been reincarnations of our mothers and fathers in some past life (Burton, 2002). The release of captive monkeys to the forest and the provisioning of gifts such as fruits and vegetables, are common Buddhist practice (Burton, 2002). Monkeys are highly valued because of Buddha's camaraderie with a monkey during one of his incarnations (Majupuria and Majupuria, 1998).

Religion plays on important role in human-animal relationships in Asia and is a major factor in the survival of many Asian primates (Southwick and Siddiqi, 1994). Buddhists display a wide tolerance to animals and traditionally do not slaughter animals for food. Zhao attributes the survival of Tibetan macaques in China to Buddhism (1994 Cited by Knight, 1999). Wildlife has also had a long influence in Hinduism going back 22 centuries wild animals have been protected due to their presence in Hindu mythology

(Bahuguna, 1986). One epic involves a monkey named Hanuman that helped God Rama fight the demon king Ravana. As a result monkeys have long been worshipped & fed by Hindus in East Asia (Southwick et al., 1965), resulting in century's long association with Hindu temples and a more recent association with other city areas. Singh (1969) observed that monkey population very higher in cities of practicing Hindus than elsewhere. The role of religion is theoretically one contributing factor to the commensal nature of rhesus monkeys (Southwick et al, 1965).

Because they are physiologically similar to humans, Rhesus monkeys have been used as research animals to an extent that has greatly reduced their population; India now bars their exportation. The monkeys have been used extensively in research on human blood chemistry, and the Rh factor in blood derives its name from them psychological studies carried out on the animals have aided in the understanding of infant-mother relationships in humans, and rhesus monkey were launched in high- altitude tests of rockets following world war II (http:// encarta.msn.com/encyclopedia).

Rhesus monkeys are used extremely as experimental animal in many primate centers bio-medical institutes and psychological research because of similarity of Rh factor in human blood & in Rhesus monkey. Similar diseases have been found in Rhesus & human such as small pox, measles, tonsillitis, harps 'B' causes by viruses, tuberculosis, bronchitis, tetanus, cold & cough by bacteria. The medicine against AIDS has been experimentation on Rhesus monkeys, which are most successful events in the medical sciences that increase the life span of human by the use of medicines. The other dangerous disease such as hepatitis B, Swelling of liver, Cancer has been experimented on them & the successful result has overcome to save human life (Chalise, 2004 b).

CHAPTER 3 STUDY AREA

3.1 Research Site

Nepal lies between China on the north and India on the east, south and west, with great natural beauty and of a rich cultural heritage, its shape is long, rectangular with eastern line shorter than on the west. Nepal stands on latitude of 26 º2' to 30 º27' north and has its longitude between 80º4' to 88º12' east. The east west length of the country is 800 km parallel to the Himalayan axis and the average northwest width is 140 km. Its total is is about 147,181 Sq. Km its altitude various from 60-220 m in the south rising to 8,848 m at the north. With this small area the country has all its possible Landforms, features of the east except the volcanic and coral islands and marine. The physiographic of the land is very interesting. The country has plain areas in the south, hills and valleys in the middle and lofty Himalayas in the north (Sharma, 1999).

Nepal has been a source of great attractions for her mountains, Landscape, Lakes, green valleys, waterfalls and hillside serrated in the form of an endless series of terraces. The entire northern border has silvery peaks of the Himalayas and the country is the home of perpetual snow (Majupuria and Majupuria, 1999)

Nepal is rich in its natural resources. The ideas of conserving natural resources, as protected areas were first started globally in USA (Train, 1985). In Nepal, its official implementation was started with the department of National Parks and wild life conservation (DNPWC) Act of 1973. There are 16 protected areas in Nepal. Among them 5 National Parks and 3 mountain conservation areas lies on northern mountainous zone. The major protected areas (12%) are situated in the mountainous region of the country (Anon, 1994) Langtang National Park (LNP) is in the central Himalayan region of Nepal, designated in 1970-71 as the first Himalayan National Park and gazette in 28 march 1976 by Nepal Government of Nepal with assistance from the UNDP/FAO. The main purpose of the establishment of this park is to preserve the natural environment and to allow local inhabitations to follow traditional land use practices, which are compatible with resource protection. (Majupuria and Majupuria, 1998). It is the second largest mountain National park of

Nepal. Covering 1,710 sq. km. in three districts, Rasuwa, Nuwakot, and Sindhupalchowk of Bagmati zone in Nepal. LNP record 46 species of mammals including those typical of the area such as , Musk deer, Himalayan Tahr, Snow Leopard, Pika, Himalayan Ghoral, Red panda, Wild dog , Asiatic Black Bear, Leopard, Clouded Leopard and three species of monkeys (Chalise, 2003) . Besides, 345 species of Birds, 11 species of Herpeto-fauna , 30 species of fishes, 58 species of Butterflies and 10 species of spiders are also recorded (BPP, 1995; Khatiwada, 2002).

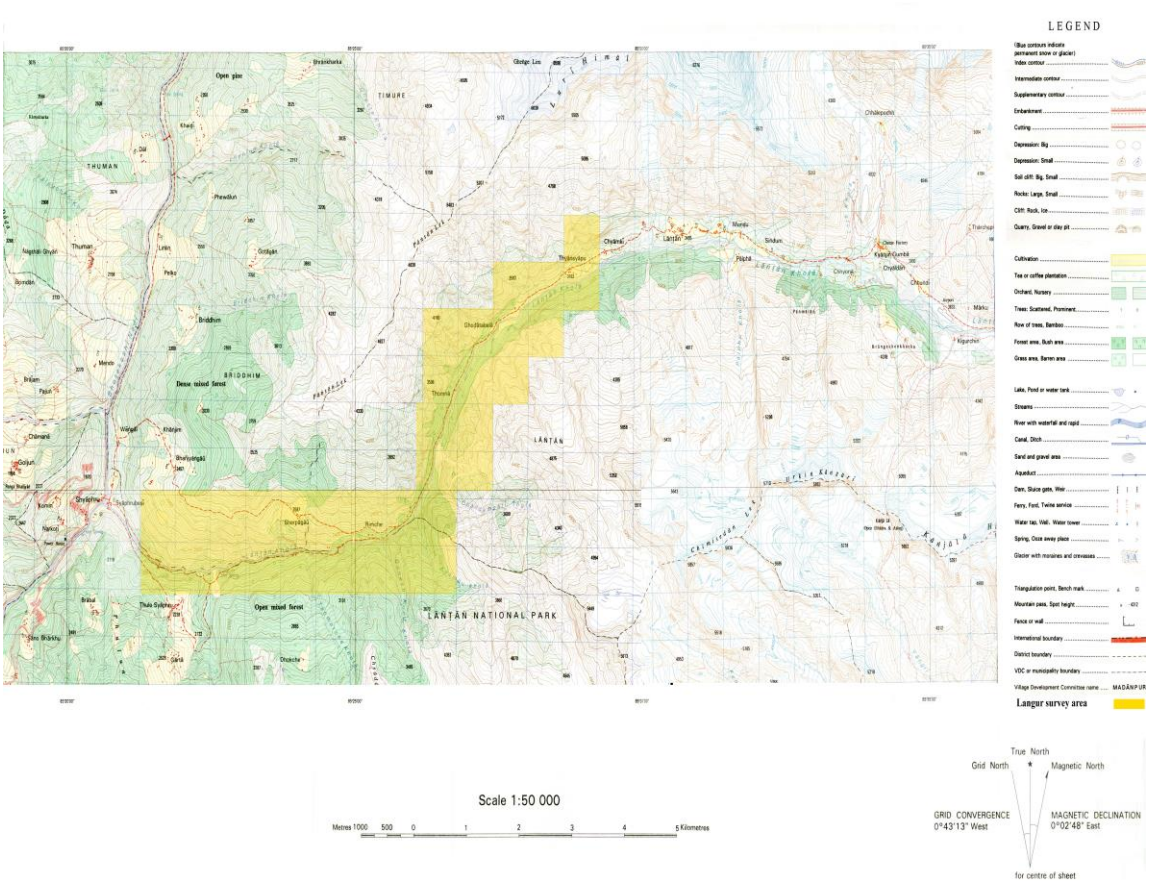

Fig 1: Langtang National Park showing Langur survey area.

3.1.1 Physical Description

Langtang National Park (Longitude 85° 33' 98.4" E, Latitude 28° 12' 47.4 " N) is in north-central Nepal on the Tibetan border. With altitudes varying from 800m to >7200m, habitats range from subtropical forest to perpetual snow (Sayers and Norconk, 2008). The Langtang National park was established in 1976 by Government of Nepal and in 1998, an area of 420 sq. km. in and around park is declared as buffer zone. (Chalise, 2003).

3.1.2 Drainage

LNP consists of many springs, Rivers and Lakes. All the rivers in the park are torrential. Langtang Khola and Bhote Koshi are two major Rivers fed partially by glaciers and those which don't have glacial origins are Trishuli, Phalanga, and Tadikhola.

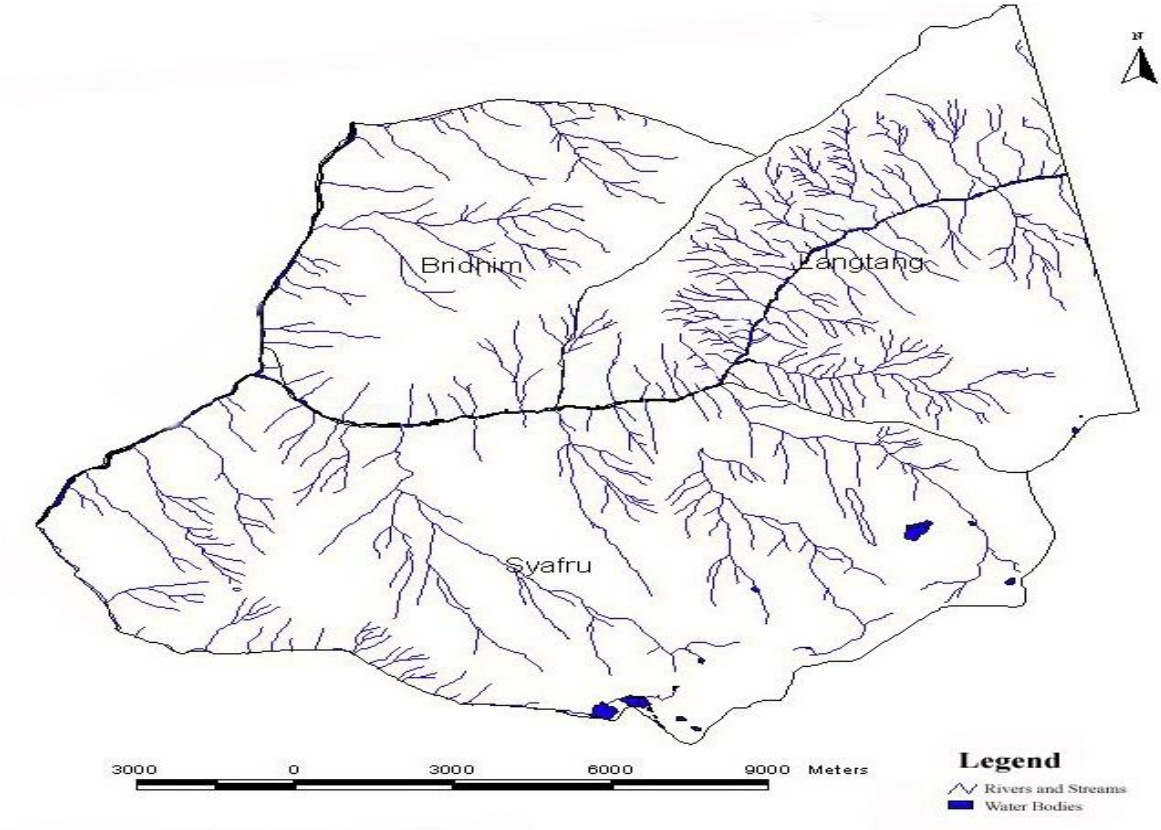

Fig 2 Drainage system in the study area

Monsoon climate affects the River discharge and its velocity. Bhote Koshi at Syafrubensi increased by five fold. A seven fold increase in the Langtang Khola at Syafrubensi and twenty four fold in courses in the Trishuli Khola at Dhunche (DNPWC/DUHE, 1977).

3.1.3 Climate

The coldest and driest months are January, February, March, November; December while the warmest and wettest months are May, June, July, August and September (Fig. 3).

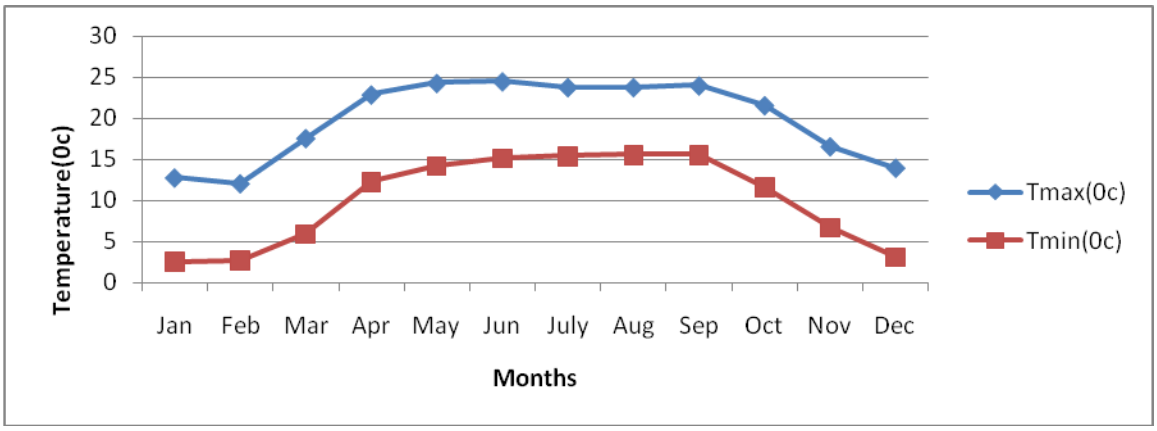

Fig. 3 Temperature (max. and min.) recorded in the year 2007 at Dhunche Station.

Relative humidity is recorded maximum (92.5%) in the month of August and minimun (69.8%) in April 2007. The average relative humidity is recorded 74.08% (Fig. 4).

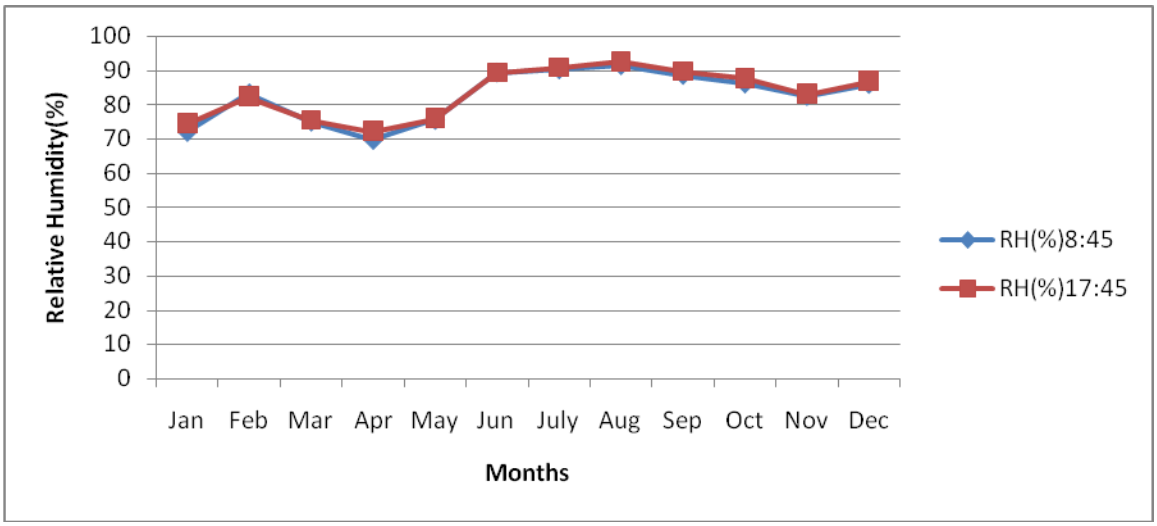

Fig. 4 Relative Humidity recorded in the year 2007 at Dhunche Station.

The seasonal climate is dominated by the southerly monsoon which occurs June to September (Fig. 5). The incidence and type of precipitation is mainly related to aspect, altitude and the presence of rain shadow effect.

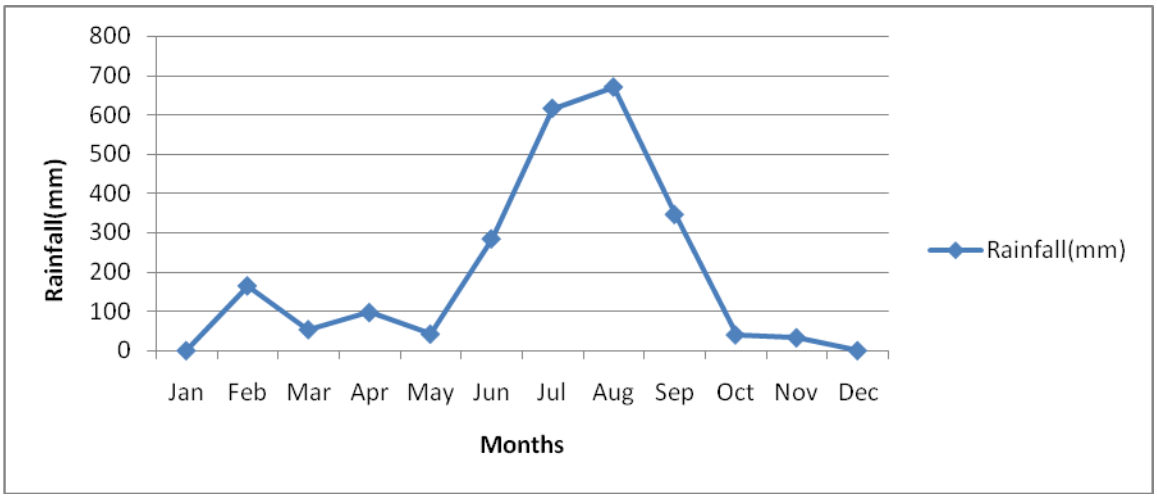

Fig. 5 Rainfall (mm) recorded in the year 2007 at Dhunche Station.

3.1.4 Topography

Dominantly rugged, steeply dissected terrain is the typical feature of the central Himalayan region.

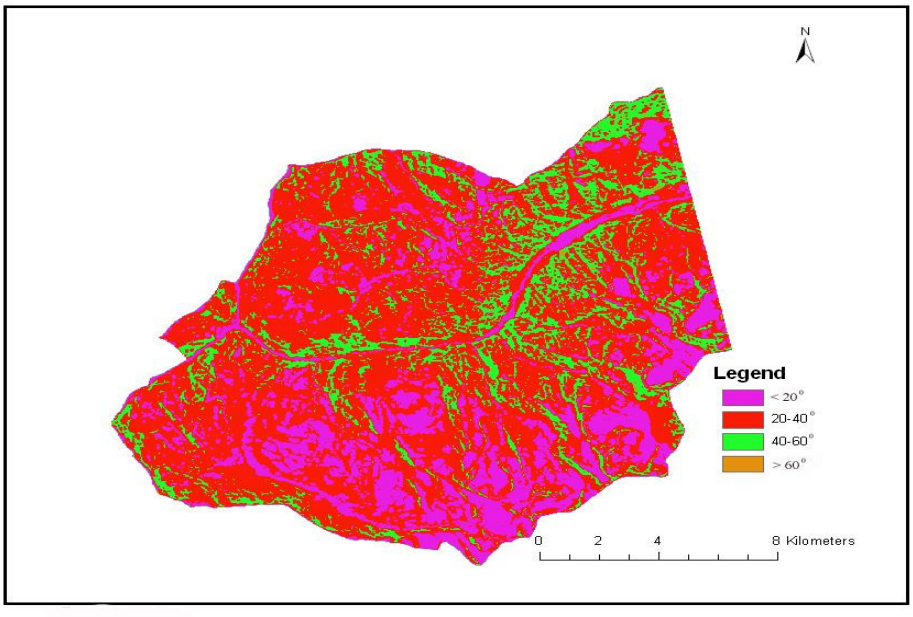

Fig 6 Slope category of the study area

The study area represents the great Himalayan Range (i.e. Langtang, Jugal Himal, Langsisa Himal. Nayakhayang Himal, Yala peak Himal) and the valley of the inner Himalaya (i.e. Langtang valley). The region to the south of the Dyanjing, Lakpa Dorje range and Langsisa range comprises the northeast-southwest curving watershed which separate the Langtang Khola, catchments the western end of the Langttang Himal rises steeply to Langtang Lirung 7245 m, the highest point in the park.

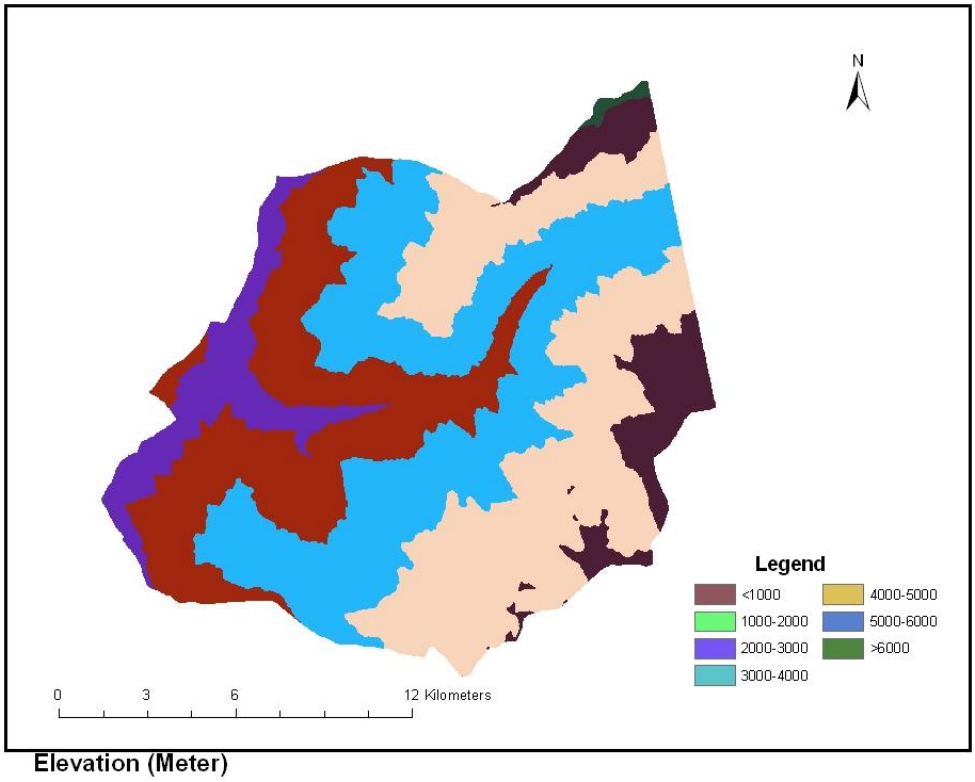

Fig 7 Elevation classification of the study area

3.1.5 Geology and Soil

Although no economically viable minerals concentrations are reported to occur in Langtang, the park may be considerably affected indirectly. Topography vegetation and aspect severely affect local soil patterns. It is difficult to generalize. Mature soil occurs in the lower forested regions, mainly fertile Loams. The upper Langtang valley, the most common textural component is sandy loam with a large proportion of rocks. The mea proportion of land decreases with elevation and loamy sands become predominant become predominant below 2440m, where the practice of pasture burning occurs , the topsoil layer often comprise alternating dark and pale horizon due to ash accumulation

and the pH is more homogenous between them. Soils are fairly acidic, pH 5-6 (Maire, 1973).

3.1.6 Biological Description

3.1.6.1 Flora

More than 100 plant species inducing tree, shrubs and herbs are recorded in Langtang National Park. Twenty one species were found to be endemic for that area. Land use classification revealed. 29.87% grassland and 1.70 percent cultivated land (Khatiwada 2002).

3.1.6.2 Fauna

a. Mammals

Forty-six species of mammals are found in LNP (Khatiwada, 2002). The common primates are Rhesus macaque *(Macca mulatta*), Assamese monkey (*Macaca* as*samensis*), common Langur (*Semnopithecus entellus*) (Chalise 2003) . The carnivores mammals include Fox (Vulpes vulpes), wild dog (*Cuon alpinus*). Himalayan black bear (*Selenarctos thibetanus*), Red panda (*Ailures fulgens*), Martines (*Martes focina, M. flavigula),* Leopard cat (*Felis bengalensis*), Leopard (*Panthera pardus*), Snow Leopard (*Uncia uncial*), the common ungulates are wild boar (*Sus scrofa*), Himalayan musk deer (*Moschuys chrysogaster*), Barking deer (*Muntiacus muntijak*), Ghoral (*Namorhaedus goral*), Himalayan Tahr (*Hemitragus jemlahicus*). Small animals includes royl's pika (*Ochotona royeli*), Himalayan squirrel (*Dremomys lokriati*), and Indian porcupine (*Hystrix indica* (DNPWC, 2004).

b. Birds

The avifauna diversity is rich in LNP which includes 345 birds' species. The notable bird species; Dark romped rose finch (*Carpodacus edwardsi*), Satry tragopan (*Tragopen satyra*), Ubus bukk (*Ibidorhynca struthersii*), Orange rumped honey guide (*Indicator xanthonotus*), Bay wood pecker (*Bhythipicus Pyrrhotis*), Snow pigeon (*Columbia leuconata*), spotted dove (*Streptopelica chinensis*), golden eagle (*Aquila chrysacts*), Tibetan snow cock (*Telragoallus tibetanus*).snow partridge (*Lerwa lerwa*).

Blood pheasant (*Ithaginis cruentus*), Impeyan pheasant (*Lophophorous impejanus*), etc (DNPWC, 2002).

c. Reptiles and Amphibians

Eleven species of herpeto-fauna are found in LNP. Some reptiles are Rock agama, Green Pit viper, Himalayan Keel-back snake etc. and amphibians such as; Himalayan toad (*Bufo himalayanus*), Frog (*Rana polunini*) is common (Chaudhary, 1998). Besides these 30 species of fish, 10 species of spiders and 70 species butterfly has been recorded in LNP (Khatiwada, 2002).

3.1.7 Socio –Economic Aspect

The changing economic and social arrangements have made it difficult for rural people to have access to the basic agricultural resources and remote places such as Langtang has begun to experience changes in their social and political structure, economic life and cultural values (Gurung, 1998). Langtang National Park and its buffer zone covers whole or parts of 15 village development committees (VDC), along them 11 VDC's lies in Rasuwa district, 3 in Nuwakot and 1 in Sindhupalchowk. My Study area covers only one VDC of Langtang with six villages (i.e. Ghodatabela, Thyangseb. Langtang village, Sindom Uundum, Kyabnjin Gumpa). Altogether, there are 60 households, 44 hotels and 13 teashops with a population of 530 individuals (VDC record, 2003).

Langtang people are highly dominated by tradition and custom. The majority of the people living in Langtang belong to Sherpa (Bhotias), Lamas, and Tamang. They celebrate their biggest festival 'Loshar' (New Year) for 15 days. Other important festivals are 'Nehra' for 5 days 'Tohrpu' 'Hulbachheju' and 'Thakpachheju' each for one day. Langtang people are always eager to celebrate those festivals in a magnificent way and hence, they keep some stock of ghee as much as possible. Besides, 'Ghyawa' is celebrated occasionally in a systematic way. Livestock farming is the main occupation of people of Langtang for subsistence economy. Agriculture is the alternative occupation to make the living of people; however, the crop production is low. Besides, some people engage in tourism for their occupation as source of earning.

Livestock movement is between 3000 m to 5000 m elevations and is held from May to September. In winter, they come down to lower elevation at 2000 m. Sheep and goats are grouped into several herds for the summer grazing. These animals are usually grazed in the meadow or Kharka, which is the habitat of many wild ungulates like Himalayan Tahr, Musk deer etc in the summer; the herders make temporary shed or Goth for herding the yaks, sheep, horses, and goats to their respective Kharkas. Dairy Development Corporation opened the Nepal's first cheese factory in LNP. One lies in size Gumpa (Chandan Bari) and other in Kyanjing Gumpa. The cheese factory of Kyanjing Gumba collects the milk from 60 farmers and send to make 6000 kg cheese in a year (pers. comm. with members of cheese factory). The cheese factory established the deposit camp to their kharkas to collect the milk. The depots keep on shifting according to the shifting of both. Farmers also receive loan from cheese factory. Agricultural development Bank provides credit facilities to the farmer and cheese factory's recommendation (Khatiwada, 2004).

CHAPTER: 4 METHODOLOGY

4.1 Preliminary Field Survey

A preliminary field survey was done from 14 February to 25 February 2007, to understand the geophysical and climatic conditions. Survey process included the collection of information by the discussion with park authorities (Warden, Rangers and Game-scouts) of Langtang National Park, local people and officials of INGOs and NGOs working for the conservation of Sacred Himalayan Landscape through community participation. Study area was visited on foot, animals were observed using 10 x 50 mm binoculars and behavioral data collection methods were practiced with experts. A total visually accessible area of 32 km² was selected in two dimensions with help of topo maps (scale: 1:50 000) without taking contours into account for the survey.

4.2 Total Count

Population surveys throughout the study area (32 km²) were carried out from all the accessible trails. The trails were walked slowly at 0.5 km/hr, covering a distance of 6 km per day. Observers paced along trails stopping every 500 meters to search the area for 1/2 hour by applying both visual and auditory cues simultaneously. The topography of the region makes it difficult to undertake systematic surveys. When macaques were encountered, the following data were recorded: locality and its coordinates, detection time, the observer duration of observation, activity and age-sex composition of the group. Age and Sex were categorized properly with the help of Spotting Scope. The birth rate was estimated for each group as the number of infants per adult female at the time of the survey. Countings were repeated 3 times to minimize the bias in distinguishing age and sex of the groups. Population density (D_2) was calculated from the group density (D_1) as: $D_2 = D_1$ x mean group size, Where D_1 = number of identified groups/ area surveyed. All areas were surveyed starting at 06:00 and finishing at 18:00 (Regmi, 2008, Ross and Reeve, 2003).

4.3 Quadrate Sampling

The vegetation sampling was done by quadrate method. The quadrate of 10m × 10m for trees and 5m× 5m for shrubs were laid down for the estimation of quantitative data. Quadrates were laid at every 100m increment of elevation, starting from 1500m asl and

ending at 3200m asl. Altogether 18 quadrates for trees, 36 for shrubs were studied. For that two sub quadrates (5m×5m) were laid down in two corners of the 10m × 10m quadrate for shrubs.

At each location where Langur were encountered and at 100m increment of altitude habitat parameters were measured. The canopy cover was recorded as the percentage of total canopy volume using the following Braun-Blanquet Scale. No canopy cover, 1-20%, 21-50%, 51-75%, and more than 75%, canopy height, ground cover, dominant trees, Shrub species were recorded at 100m interval of altitude on the survey trail.

Specimens of all species were collected and the herbarium prepared as used for identification. Some of the plants were identified using standard references (Hara et al.1978; 1979 and 1982, Stainton, 1988; Baral and Kurmi, 2006) and other plants identification focused on trees and shrubs that could not be identified in the field were collected for latter identification. The deposited plant specimens were identified by specialists from the Tribhuvan University Central Herbarium and National Herbarium Centre, Godawari and Plant Laboratory, Kathmandu. For nomenclature Press et al. (2000) was followed.

4.4 Scan Sampling Method

The behaviors of monkeys were recorded by scan sampling for one minute at intervals of 10 minutes (Chalise, 1997; Martin and Bateson, 1993; Altman, 1974) with the help of a timer, and aided by binoculars. Other events and interesting behaviors of any members of the groups were also recorded whenever they were noticed.

Following behaviours were observed including other social activities of Langur in the area:

Resting: The state when Langur rests with the body supported upon the buttocks with hindquarters lowered on to a supporting surface.

Moving: The behavioural phenomenon in which monkey produces motion displacing from one place to another.

Grooming: The behavioural phenomenon in which monkeys search their own fur or the fur of others for lice, bugs or dirt which include rubbing, licking and scratching.

Foraging: The behavioural activity in which monkey searches for food or wonders in search for food including eating any substance, geophagy, licking stone, drinking water and slight movement in search of food.

4.5 Quantitative Analysis

Field data were used to calculate the different ecological parameters like density, relative density, frequency, relative frequency, basal area, their relative values and importance value index followed as Zobel et al.1987. SPSS ver. 13.0 was used for analyzing the field data.

4.5.1 Density and relative density of tree species

Density represents the numerical strength of the species in a community.

$$\text{Density (P/ha)} = \frac{\text{Total number of individual of a species}}{\text{Total number of quadrate studied} \times \text{Area of quadrate (m}^2\text{)}} \times 10{,}000$$

Relative density is a proportion of density of a species with respect to total density of all species.

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

4.5.2 Frequency and Relative Frequency

The frequency and relative frequency was calculated by using following formulas.

$$\text{Frequency (\%)} = \frac{\text{Total no. of plots in which a species 'A' occurred}}{\text{Total no. of plots sampled}} \times 10{,}000$$

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

4.5.3 Basal area and relative dominance

It is measured from diameter at breast height (dbh) and its basal area was calculated. It is one of the chief characteristics to determine dominance. So, relative dominance was determined as the relative value of basal area.

Basal Area = π (dbh) $^2/4$

The relative dominance was calculated as follows:-

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

4.5.4 Importance Value Index (IVI)

IVI is the sum of relative density, relative frequency and relative dominance of a species in a community. The IVI value of any species in a community ranges between 0-300 and the sum of IVI of all species is 300.

4.6 Statistical Analysis

The relative abundance of the tree species found in systematic and sign plots was measured in terms of Shannon-Wiener index (*H*)

$$H = -\sum_{i=1}^{s} Pi \ln Pi$$

Where, Pi= Proportion of individuals found in the i^{th} species

ln = Natural logarithm

S = Number of species in an area

The differences in the value of Shannon-Wiener index obtained for systematic plots and Langur encountered plots was tested for significance using Student's *t* test.

$$t = \frac{|H1 - H2|}{\sqrt{Var(H1) + Var(H2)}}$$

Which without the absolute sign of numerator, follows Student's t distribution with v degrees of freedom where,

$$v = \frac{((Var\ (H1) + Var(H2))^2}{\frac{(Var\ (H1))^2}{N1} + \frac{(Var\ (H2))^2}{N2}}$$

And,

$$Var\ (H) = \frac{\left(\sum Pi(ln\ Pi)^2 - (\sum Pi \ln Pi)^2\right)}{N} + \frac{S-1}{2N^2}$$

Where, Var (H) = Variance in diversity

N1 and N2 = Number of individuals based on which H1 and H2 are calculated

S = Number of species in a sample

CHAPTER: 5 RESULTS

5.1 POPULATION

5.1.1 Group and Population density

A total of 149 Langur were encountered which were living in 6 groups within the total visually accessible area of 32 km² in Langtang National Park. The mean group size was found 24.83 (Range 7-48) individuals. The group density was found 0.18 groups / km² with a population density of 4.65 individuals/ km².

5.1.2 Age-sex composition

Among the total counted monkeys, 29.53% were adult female, 12.08% adult male, 8.05% sub-adult male, 13.42% sub-adult female, 21.42% Juveniles and 15.43% infant during the study period. (fig 8)

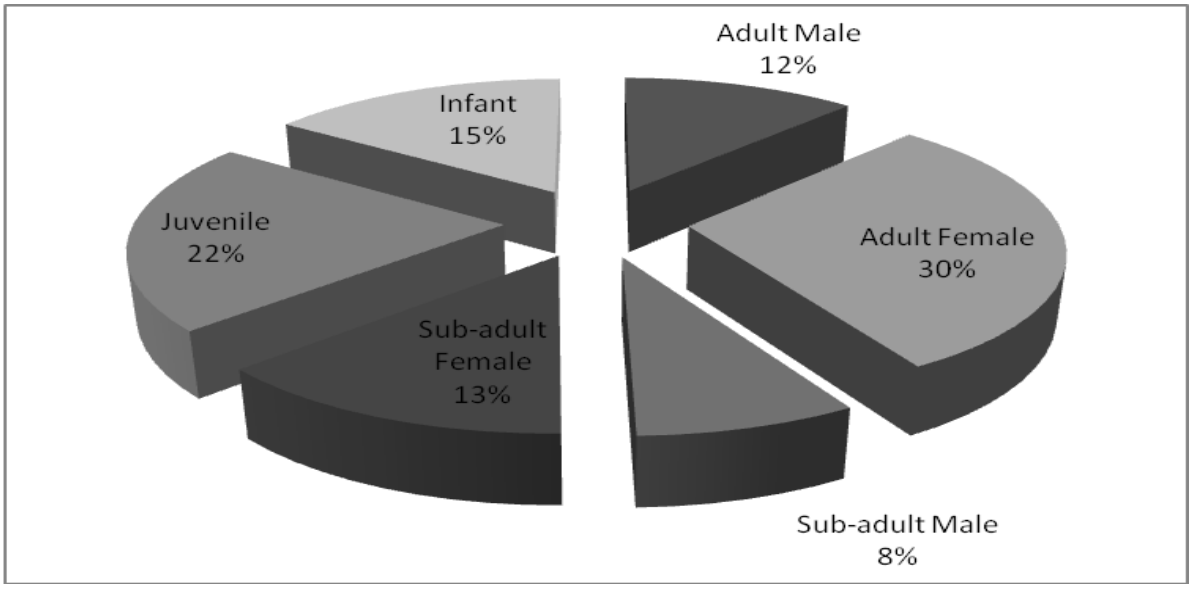

Fig 8 Sex and age composition

5.1.3 Adult Sex Ratio

The adult sex ratio (male to female) observed during the study period was 0.40 (40 males per 100 females) i.e. 1:2.5 (Range 1:1.88-1:3.57).

5.1.4 Female to Infant Ratio

Birth rate (infant to female ratio) was found 0.52 (52 infants per 100 females) during the study period.

5.1.5 Group size and distribution

The average group size was 24.83 (Range 7-48) in the study area. The group size recorded at highest elevation of 2900 m asl at Thyangseb consisted of 7 individuals. The group size recorded at lowest elevation of 1,700 m asl near Safru Bridge consisted of 48 individuals. The largest group size was recorded at an elevation of 1700 m asl near Syafrubensi that consisted of 48 individuals of Himalayan Langurs. The smallest group size was recorded in Thyangseb at an elevation of 2900 m asl that consisted of 7 individuals of Langurs (Table 1).

Table 1 Group size & distribution of Himalayan encountered in different locations of the study area

SN	Location	Group Size	Elevation (asl)
1.	Near Syabru Bridge	48	1700 m
2.	Near Bomboo	21	2040m
3.	Near Pool	16	2190 m
4.	Lama Hotel	17	2560m
5.	Ghoda Tabela	40	3000m
6.	Thyangseb	7	3160m

5.2 HABITAT

The study area had natural forest which has been protected for more than three decades. Grazing and collection of fallen branches for wood fuel were observed. Altogether 58 species (30 trees, 28 shrubs) belonging to 45 genera and 30 families including 12 unidentified were found in the study site. Numerically important families were Fagaceae (7 spp), Ericaceae (5spp) and Rosaceae (4 spp). In systematic plots, families Fagaceae (21%) and Pinaecae (11%) were frequently dominant among the tree species. But in the

Langur encountered plots family Fagaceae (28%) stands in the first rank and followed by the families Rosaceae (18%) and Pinaceae (9%) (Fig 9 and 10).

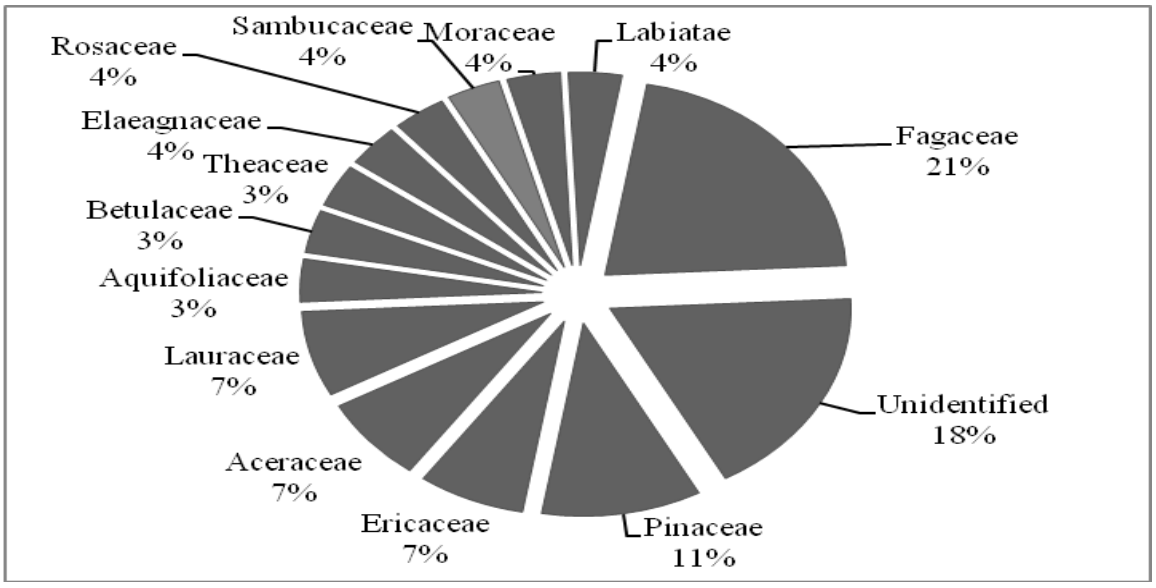

Fig 9 Family wise composition of the tree species in systematic plots

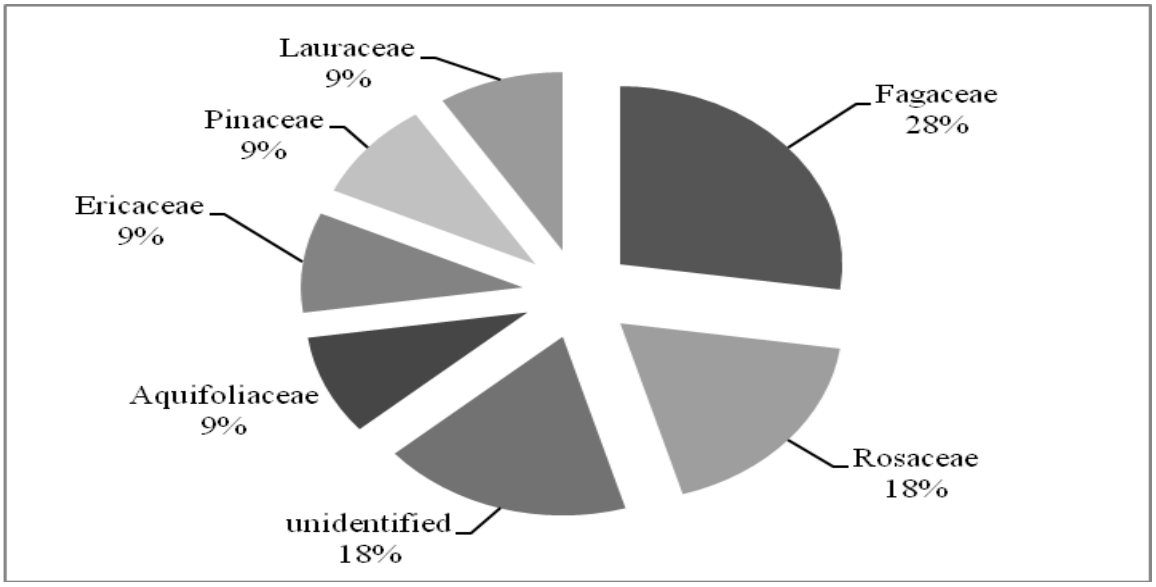

Fig 10 Family wise composition of the tree species in Langur encountered plots

The important Value Index provides a quantitative basis for the classification of community. The IVI value of any species in community ranges between 0-300 and the sum of IVI of all species is 300. In systematic plots, the highest IVI (49.40) was recorded for *Quercus semicarpifolia* followed by *Ilex dipyrena* (29.02), *Alnus nepalensis* (27.52),

recorded for *Leucosceptrum canum*. In Langur encountered plots, the highest IVI (88.29) was recorded for *Queccus semicarpifolia* followed by *Cotoneaster frigidus* (42.31), *Rhododendron campanulatum* (33.36), *Castanopsis indica* (31.27), *Dodecadenia grandifloria* (20.78), *Ilex dipyrena* (19.72). Similarly the lowest IVI (12.36) was recorded for *Euonymus grandiflorus* (Fig 11).

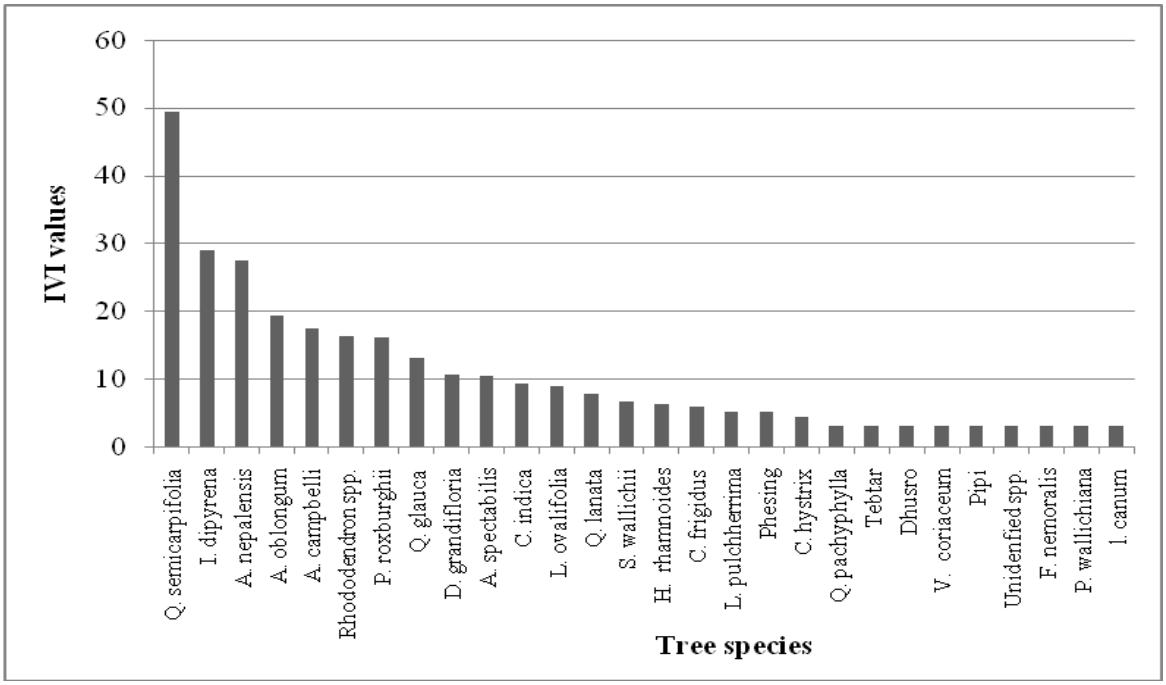

Fig 11 IVI values of the tree species in systematic plots

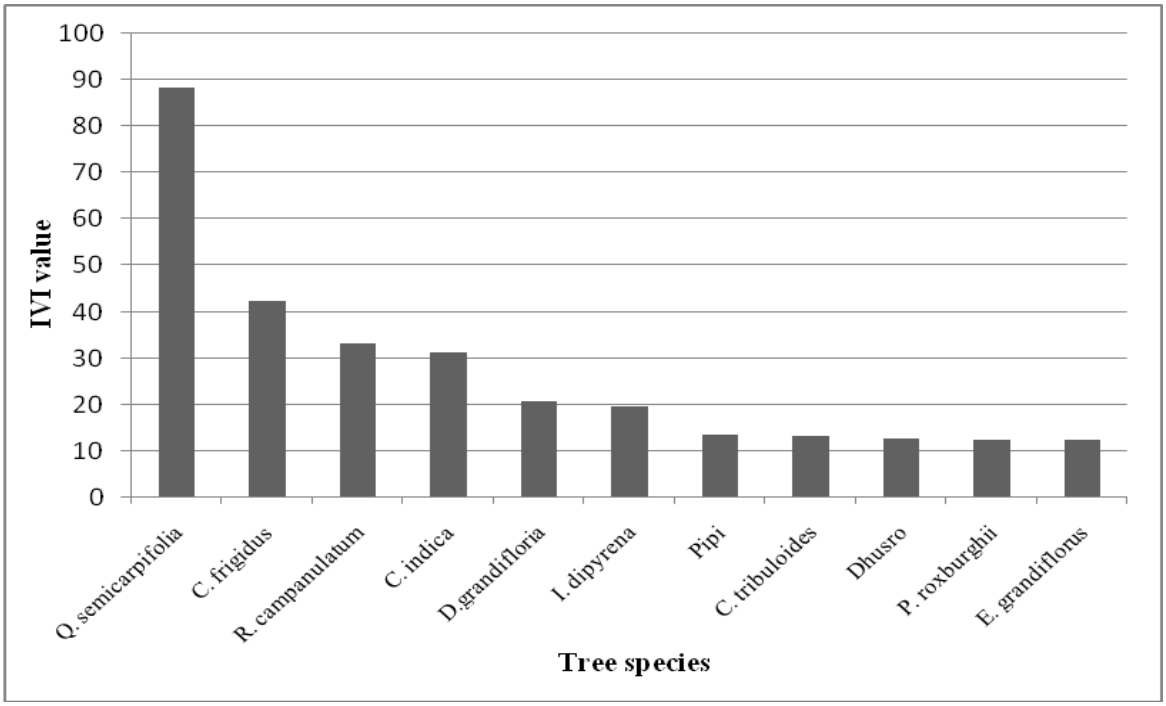

Fig 12 IVI values of tree species in Langur encounter plots

Total number of tree species found in systematic plots were 28. Total density was 61.11 stems ha-¹ systematic plots. *Quercus semicarpifolia* was found to be most dominant trree species that accounted for 61.11 stems ha-¹ of the tree species stands that was followed by *Ilex dipyrena* 50 stems ha-¹, *Rhododendron spp* 44.44 stems ha-¹. Density of *Lindera pulcherrima* 5.55, *Quercus pachyphylla* 5.55 and *Pinus roxburghii* 5.55 stems ha-¹were some tree species having least density. In Langur encountered plots, total number of tree species was 11. Total density was 366.61 stems ha-¹. Among the tree species *Quercus semicarpifolia* has highest density 83.33 that was followed by *Rhododendron campanulatum* 66.66 stems ha-¹, *Cotoneaster frigidus* 50 stems ha-¹. Least density was 16.66 stems ha-¹ for Ilex dipyrena, Pinus roxburghii and Castanopsis tribuloides.

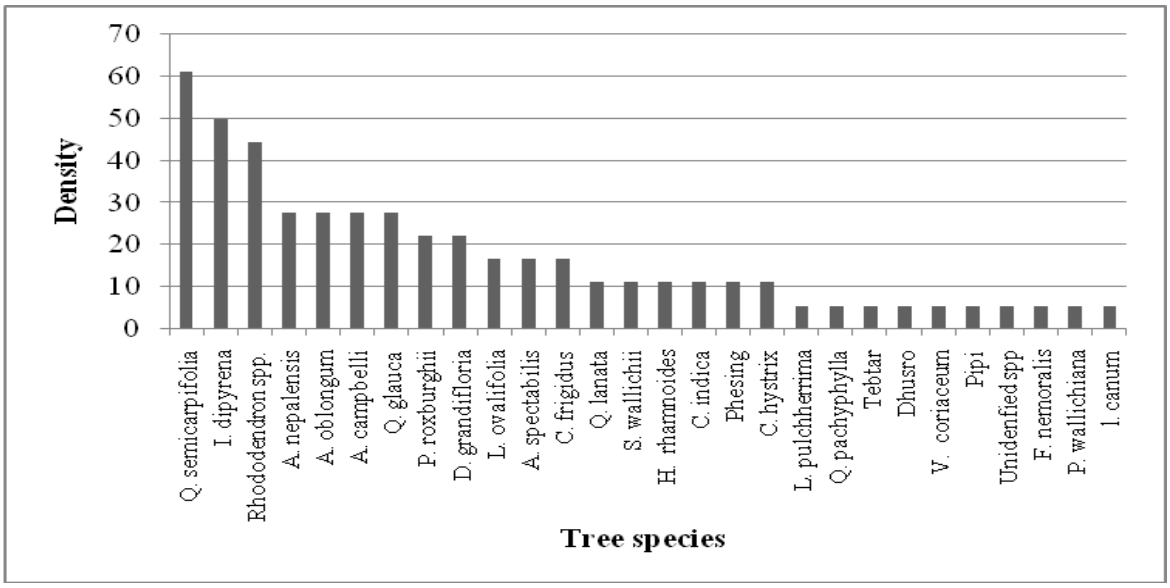

Fig 13 Density of the tree species in systematic plots

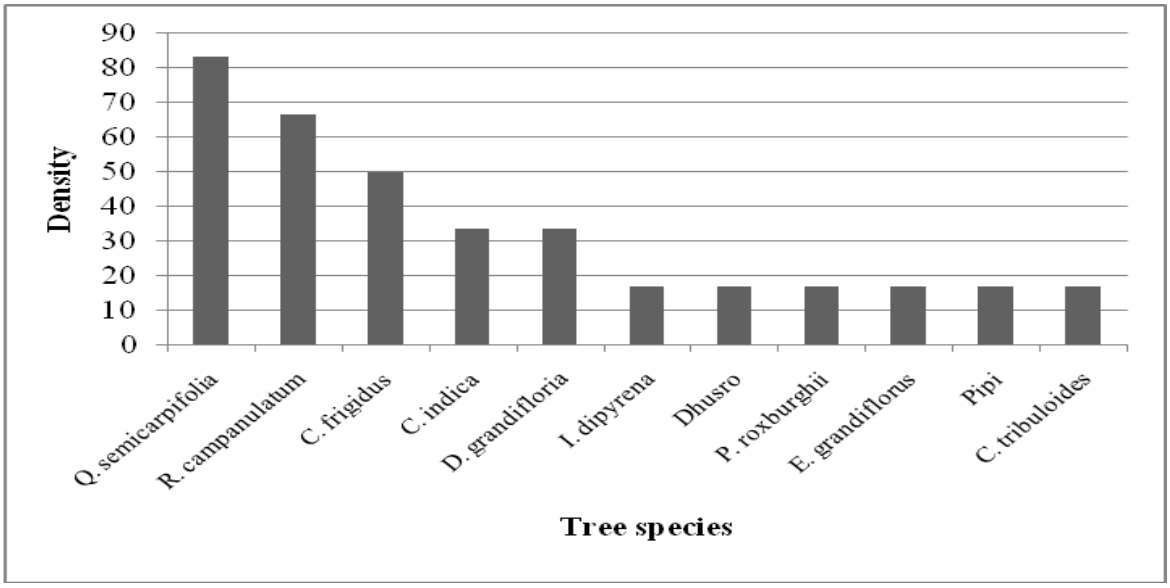

Fig 14 Density of the tree species in Langur encounter plots

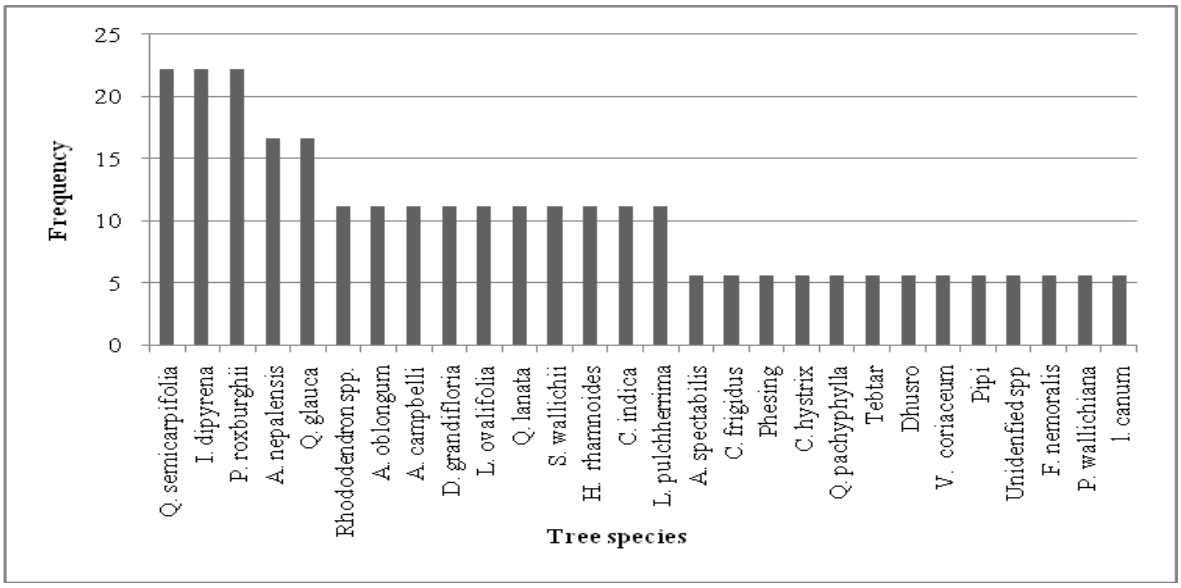

Fig 15 Frequency of the tree species in systematic plots

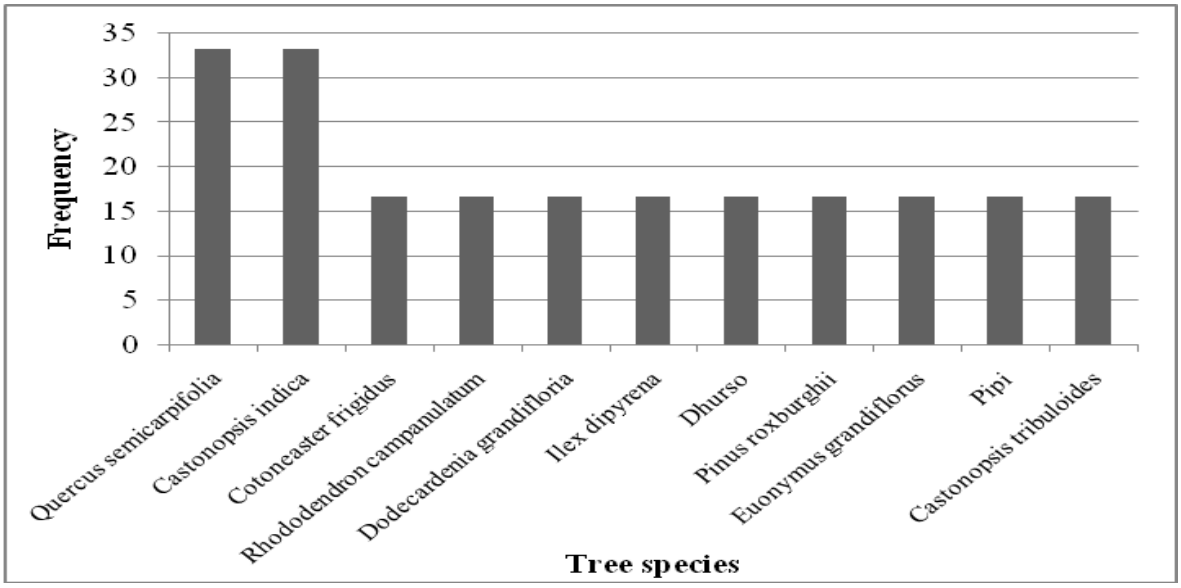

Fig 16 Frequency of the tree species in Langur encounter plots

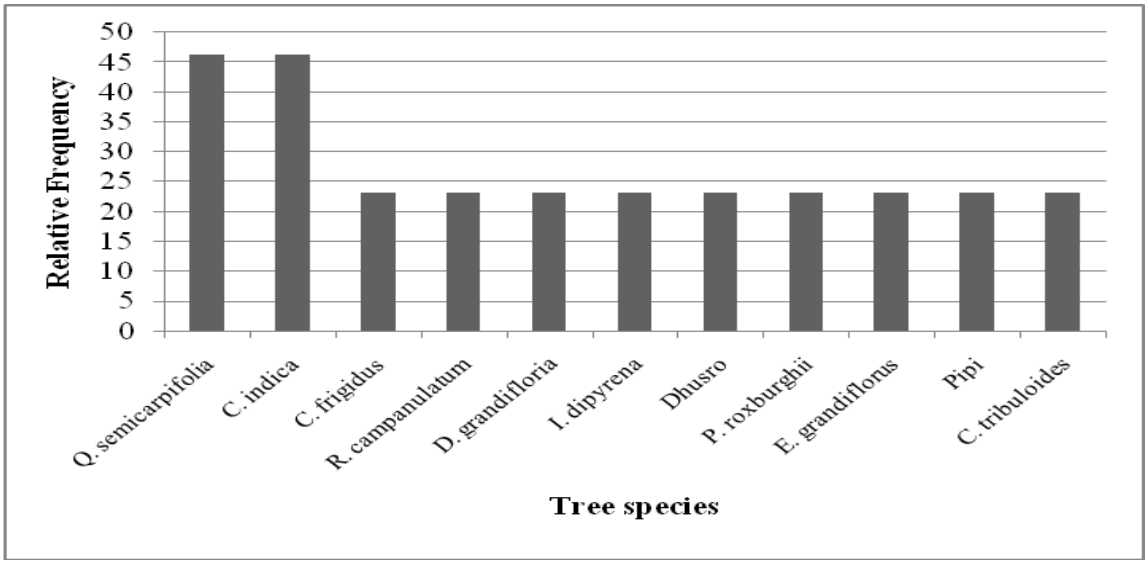

Fig 17 Relative frequency of the tree species in Langur encounter plots

In systematic plots, total basal area was 39.011 m^2ha^{-1}. Dominant tree species at upper camopy cover was Quercus semicarpifolia (IVI 49.40). Similarly, other associated species in sub canopy layer were Ilex dipyrena, Alnus nepalensis, Rhododendron spp, Pinus roxburghii, Acer oblongum, Acer campbelli etc. In Langur encountered plots, total basal area was11.327 m^2ha^{-1}. Dominant tree species at upper canopy layer were Quercus semicarpifolia (IVI 119.089). Sub canopy layer was composed of *Cotoneaster frigidus*, *Rhododendron campanulatum*, *Castanopsis indica*, *Ilex dipyrena* etc. For detail, refer appendix I and II.

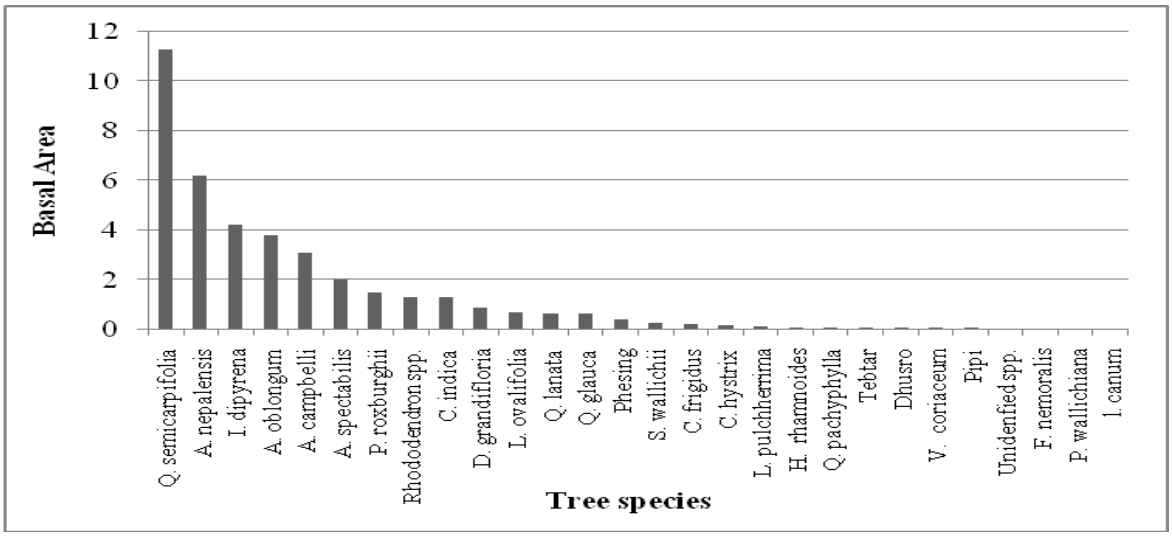

Fig 18 Basal area of the tree species in systematic plots

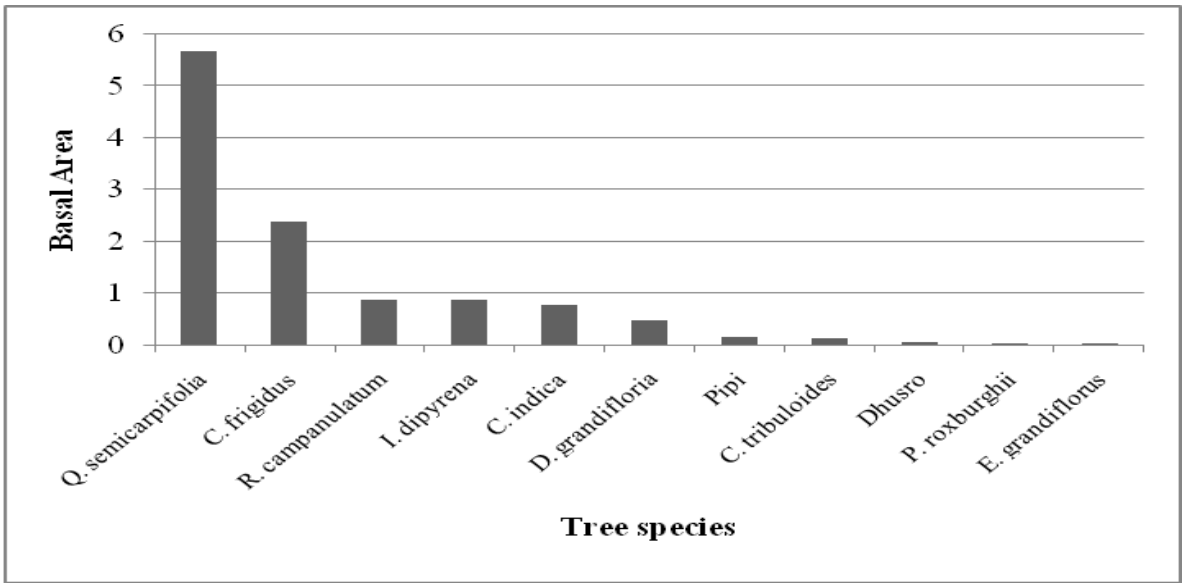

Fig 19 Basal area of the tree species in Langur encountered plots

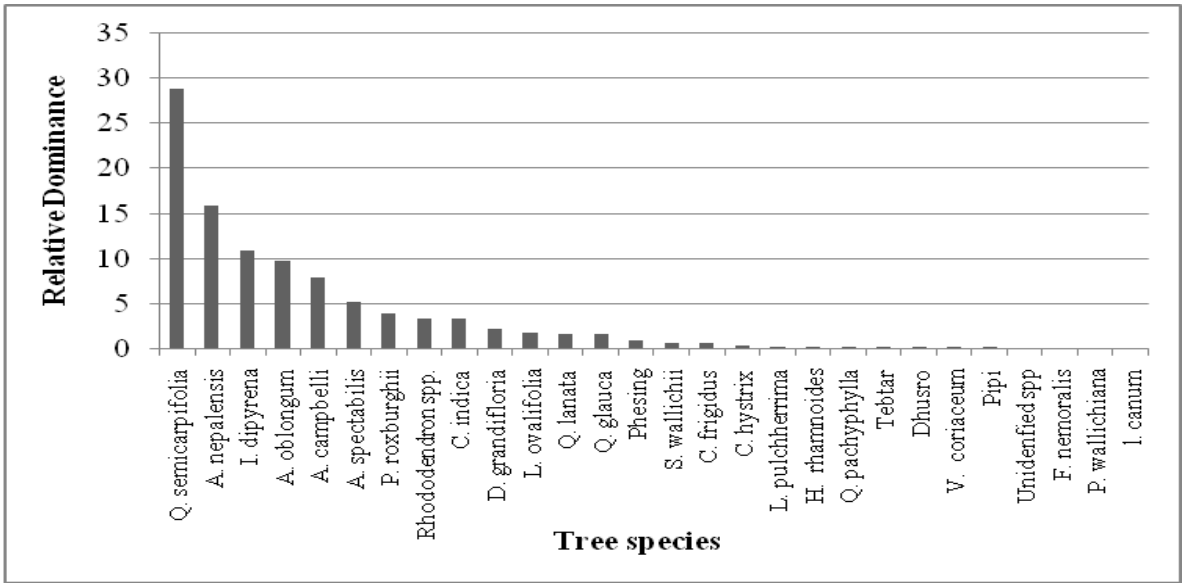

Fig 20 Relative dominance of the tree speices in systematic plots

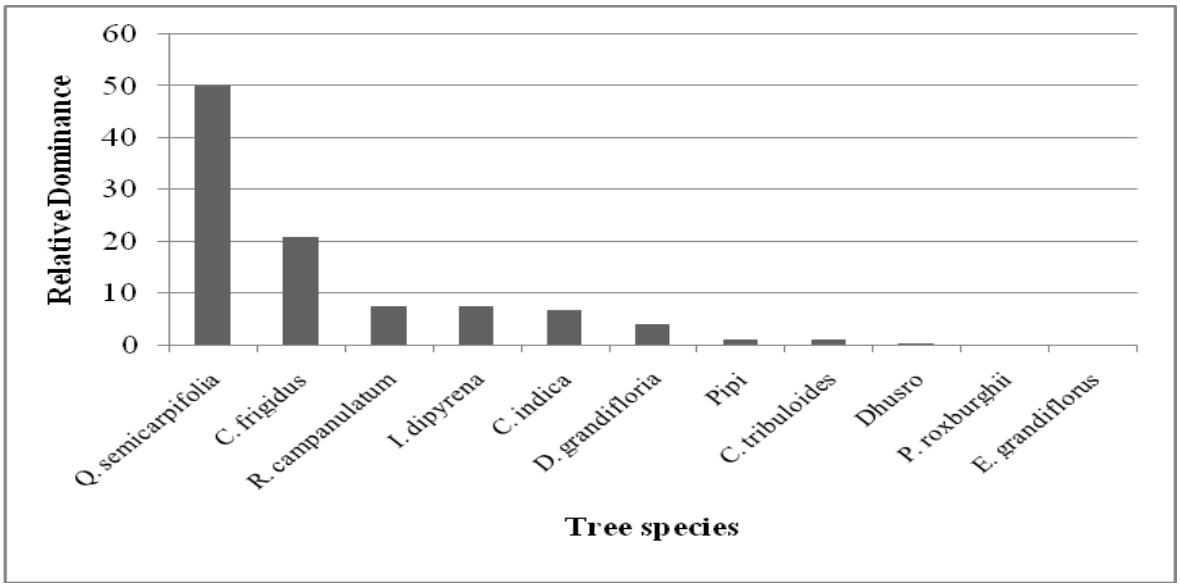

Fig 21 Relative dominance of the tree species in Langur encounter plots

Diversity and Dominance of the tree species in systematic and Langur encountered plots:

Table 2 Values of $\overline{H}$, C and e of the tree species in study area

Plots type	$\overline{H}$ **(Div. index.)**	**C (dom. Index)**	**Evenness (e)**
Systematic plots	3.0748	0.916374466	0.92275249
Langur encountered plots	2.19737	0.916374466	0.91637447

Tab t= 1.96, cal t=4.645682, so, species diversity ($\overline{H}$) differed significantly.

There are significant difference in the diversity index, dominance index and evenness of tree community between systematic and Langur encountered plots (t=4.645682, P= <0.05).

Similarity in the tree species in systematic and Langur encountered plots:

Table 3 Similarity in the tree species in systematic and Langur encountered plots

no of tree species in systematic plots	no of tree species in Langur encountered plots	common species	similarity index (S)	% similarity
28	11	8	0.41025641	41.02564103

Index of similarity (IS) value for tree species was 41.025% between systematic plots and Langur encountered plots. Value of IS depends up on the common tree species present both in systematic plots and Langur encountered plots. The most frequent and common species have greater role on similarity between two stands. So, variation in altitudinal range is the most important factor for determining IS. It may also be due to the different topography, Precipitation and edaphic factors. Floristic similarity is the response of species to the micro and macro environment.

5.3 BEHAVIOUR

The very small troop (n=7) of Thayngsep was selected as focal troop so that identification of individuals and follow up the group made easier for studying general behavior of Langur in the area. This troop consisted of 1 adult male, 3 adult females, 1 juvenile and 2 infants. The focal troop was connected for 84 hrs in order to study the behaviors. Among the four types of behavior (Moving, resting, foraging and grooming), foraging was found as maximum (54%) which was followed by moving (26%), resting (12%), grooming (4.5%) and other social behaviors (3.5 %) (Table 4).

Table 4 Percentage behavior of the focal troop recorded during the study period

Behavior type	Foraging	Moving	Resting	Grooming	Others
Percentage Activity	54	26	12	4.5	3.5

CHAPTER: 6 DISCUSSION

6.1 POPULATION

A population is defined as any group of organisms of the same species occupying a particular space at a particular time (Krebs, 1994) and functioning as a part of a biotic community (Odum and Barret, 2005). The ultimate constituents of the population are individual organisms that can potentially interbreed (Krebs, 1994). The population becomes an important study level when a species is nearing extinction. In order to maintain or re-establish the species; one need to know what space, shelter and food the population requires (Flemming, 1973).

A population study of a wild primate typically involves a considerable investment of time and resources i.e. money, equipment and labour (Ross and Reeve, 2003). But only investing these resources may not be sufficient for the survey of primates in such mountainous topography that preclude the most of the systemic survey methods impractical. So, a total count was carried out from all the accessible trails present in the the survey area. Assessing age will require study of the age classes used by previous researchers and some practice (Ross and Reeve, 2003). So in this study I followed Chalise (1995) to distinguish the age and sex of Langurs and practiced with the supervisor in the field. Group size and composition may be counted and, if groups are stable, then repeated estimations should lead to increasingly accurate counts. However these records may be inaccurate if some classes behave more conspicuously or avoid humans (e.g. mothers with infants) or because the group is widely dispersed and not all animals can be located (Ross and Reeve, 2003). The Langurs' groups in LNP were comparatively more stable and less persecuted by human beings made the group size estimation and composition more accurate.

Though researchers have studied lowland gray Langurs extensively, there is little information about the Himalayan varieties, even their taxonomy (Sayers and Norconk, 2008). This study has aided in the definition of a Himalayan pattern of Langur population that is different in many respects from that of lowland populations. For example, Highland Langurs form predominately multi-male, multi-female troops, use expansive home ranges, employ vocalizations different from those of lowland Langurs, and exhibit

behavioral and morphological buffers to cold weather (Bishop, 1979). The adult sex ratio ranges from 1:1.88 to 1:3.57 in this study also suggests the similar type of multi-male, multi-female troops as described by Bishop 1979 for highland Langurs.

Highland Langurs of Langtang National Park can expand their upper limit of altitudinal distribution up to 3800m to cope with extreme scarcity of food items in winter season (Regmi, 2008) during which these animals have the longest daily paths lengths in search of food items (Sayers & Norconk, 2008). The Langurs were encountered between the altitudes of 1300m-2900m asl in LNP which is similar with the study of Sugiyama, 1976 who studied Himalayan Langurs in Himachal Pradesh, India where these species found between 1500m-3200m asl. These studies add more support in favor of expanding home ranges and upper highland distribution rather than lower one of these animals to avoid intra-specific group competition and to adapt with extremity of food scarcity simultaneously during winter season.

Wangchuk (1995) calculated the population density of Golden Langurs using line transect method covering the area of 58.5 km² was found 2.1 Langurs/ km² and in the present study, the population density of Himalayan Langur was found to be 4.65 individuals/ km². Environmental constrains and human interference might affect group composition and group size (Machairas *et al*., 2003). In fact there are altitudinal demographic differences between the encountered populations in Langtang National Park. Small group size (7) observed in Thyangseb (2900m asl) might be attributed to minimize the foraging costs and predation pressure. However, such an effect is probably confounded with relevant effects imposed by the patchiness of resource distribution that in turn may affect group size itself. Abundance, distribution and quality of food affect group size (Mehlman, 1989; Wrangham, 1980; Menard and Vallet, 1997).

According to Dunbar's Model (1988), group size in primates is optimized to maximizing net reproductive rate, in relation to the availability - dispersion of food and predation risk. As predation risk is concerned, group size is less important in terms of detection than avoidance of predation (Dunbar, 1988). If early detection is the main anti-predatory strategy, then group size can be kept small to comfort food availability (van Shaik and

van Noordwijk, 1983) as in the Himalayan Langur in this study which was found in the group size of 7 individuals at 2900m altitude where they have to face with sparsely distributed and low quality feeding resources and no alternatives (crop-raiding) as in lower altitudes.

6.2 HABITAT

Like other Langurs, highland Langurs are also arboreal and only occasionally descend to the ground. Being the tree dwellers, they use woody deciduous broad-leaved forest of the study area not only for refuges but also for fulfilling their nutritional requirements. The study area had natural forest which has been protected for more than three decades. On the basis of IVI value of the tree species on this study, *Quercus semicarpifolia*, *Ilex dipyrena*, *Alnus nepalensis* and *Leucosceptrum canum* are the dominant tree species in the Langur habitat.

The significant difference in the diversity index, dominance index and evenness of tree community between systematic and Langur encountered plots ($t=4.645682$, $P= <0.05$) indicates that Langurs frequently use specific tree species for foraging, hiding and playing amongst the available tree species in the habitat. It was found that *Quercus semicarpifolia* is mostly used tree species by Langurs in the study area.

Index of similarity value for tree species was 41.025% between systematic plots and Langur encountered plots. Value of Index of similarity depends up on the common tree species present both in systematic plots and Langur encountered plots. The most frequent and common species have greater role on similarity between two stands. So, variation in altitudinal range is the most important factor for determining Index of similarity. It may also be due to the different topography, Precipitation and edaphic factors. Floristic similarity is the response of species to the micro and macro environment.

Chalise (2007) stated that Assamese macaques and the Langurs prefer the habitat near water sources which was further supported by Regmi (2008) and resembles with the

present study that the Langurs encountered nearer to Trishuli river and other streams in Langtang National Park.

6.3 BEHAVIOUR

Behavior performed by an animal can also be helpful for the habitat assessment as the behavior is influenced by type and condition of habitat. The use of daily behavioral profiles in looking for behavioral associations is very effective and agreed strongly with researcher intuitive feelings during the field observations. Generally this method of analysis examines and exhibits the biological processes of the individual or troop on a daily basis (Horwich, 1976).

This study shows the general daily activity of the focal troop consists of a frequent alteration between feeding and resting during the day, with a number of moving periods to change feeding locations. Sayers and Norconk (2008) also resulted that highland Langurs have long daily path lengths for searching feeding locations in the draught season and in harsh climatic conditions where the food items are patchily distributed.

During the study period, social activities associated with rest periods were also recorded. These include play, grooming, scratching, and infants climbing on their mother which is an infantine play form. The study revealed that social behaviors are related to a transition between rest and move periods. Grooming for example often occurred at the end of a long rest and move period. This trend is also supported by Horwich (1976) in Nilgiri Langur (*Presbytis johnii*).

CHAPTER: 7 CONCLUSION

The average group size was 24.83 (Range 7-48) in the study area. The group size recorded at highest elevation of 2900 m asl at Thyangseb consisted of 7 individuals. The group size recorded at lowest elevation of 1,300 m asl near Chilime consisted of 21 individuals. The largest group size was recorded at an elevation of 1700 m asl near Syafrubensi that consisted of 48 individuals of Himalayan Langurs. The smallest group size was recorded in Thyangseb at an elevation of 2900 m asl that consisted of 7 individuals of Langurs. The Langurs encountered nearer to Trishuli river and other streams in Langtang National Park.

This study shows the general daily activity of the focal troop consists of a frequent alteration between feeding and resting during the day, with a number of moving periods to change feeding locations. Highland Langurs have long daily path lengths for searching feeding locations in the draught season and in harsh climatic conditions where the food items are patchily distributed. Long-term research, community outreach and conservation programs should be carried out in the future to ensure the survival of the viable population of the species in the area.

CHAPTER: 8 RECOMMENDATIONS

1. Further research should be focused on Himalayan Langur habitat utilization and using GIS application in the area.
2. Future work on seasonal diet analysis, niche overlapping and inter-troop competition of the species would be additive to lay out the in-depth knowledge in ecology which may answer the question: how are they fit and ecologically adapt in such narrow range of habitat and harsh climatic condition along Trishuli river?
3. Study on Predator-prey relationship between *Panthera pardus* and *Semnopithecus entellus* would be benefit to know the effect of predation on Langur population ecology.

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Appendix I: Values of different parameters for tree species in systematic plots

L. Name/C. Name	Sci. Name	D	RD	F	R F	BA	R. Dom.	IVI
Khasru	*Quercus semicarpifolia*	61.1100	12.6467	22.2200	7.8452	11.2810	28.9175	49.4094
Seto Khasru	*Ilex dipyrena*	50.0000	10.3475	22.2200	7.8452	4.2270	10.8354	29.0281
Uttis	*Alnus nepalensis*	27.7700	5.7470	16.6600	5.8821	6.2010	15.8955	27.5246
Laligurans	*Rhododendron spp.*	44.4400	9.1968	11.1100	3.9226	1.3060	3.3478	16.4672
Sallo	*Pinus roxburghii*	22.2200	4.5984	22.2200	7.8452	1.4950	3.8323	16.2759
Sano Phalant	*Acer oblongum*	27.7700	5.7470	11.1100	3.9226	3.8010	9.7434	19.4130
Kapase	*Acer campbelli*	27.7700	5.7470	11.1100	3.9226	3.0790	7.8926	17.5622
Lekh Chanp	*Quercus glauca*	27.7700	5.7470	16.6600	5.8821	0.6220	1.5944	13.2236
Kalopaile	*Dodecadenia grandifloria*	22.2200	4.5984	11.1100	3.9226	0.8490	2.1763	10.6973
Angeri	*Lyonia ovalifolia*	16.6600	3.4478	11.1100	3.9226	0.6930	1.7764	9.1468
Gobre Salla	*Abies spectabilis*	16.6600	3.4478	5.5500	1.9595	2.0100	5.1524	10.5597
Banjh	*Quercus lanata*	11.1100	2.2992	11.1100	3.9226	0.6500	1.6662	7.8880
Chilaune	*Schima wallichii*	11.1100	2.2992	11.1100	3.9226	0.2370	0.6075	6.8293
Dale Chuk	*Hippophae rhamnoides*	11.1100	2.2992	11.1100	3.9226	0.0750	0.1923	6.4141
Katus	*Castonopsis indica*	11.1100	2.2992	11.1100	3.9226	1.2860	3.2965	9.5183
Ruish	*Cotoneaster frigidus*	16.6600	3.4478	5.5500	1.9595	0.2200	0.5639	5.9713
	Lindera pulchherrima	5.5500	1.1486	11.1100	3.9226	0.0900	0.2307	5.3019
Chaichuya/Phesing		11.1100	2.2992	5.5500	1.9595	0.3730	0.9561	5.2149
Sano Katus	*Castonopsis hystrix*	11.1100	2.2992	5.5500	1.9595	0.1380	0.3537	4.6125
Thulo Katus	*Quercus pachyphylla*	5.5500	1.1486	5.5500	1.9595	0.0660	0.1692	3.2773
Tebtar		5.5500	1.1486	5.5500	1.9595	0.0570	0.1461	3.2542
Dhusro		5.5500	1.1486	5.5500	1.9595	0.0570	0.1461	3.2542
Ghodakhari	*Viburum coriaceum*	5.5500	1.1486	5.5500	1.9595	0.0530	0.1359	3.2440
Pipi		5.5500	1.1486	5.5500	1.9595	0.0450	0.1154	3.2235
Unidenfied spp.		5.5500	1.1486	5.5500	1.9595	0.0380	0.0974	3.2055
Dudhilo	*Ficus nemoralis*	5.5500	1.1486	5.5500	1.9595	0.0250	0.0641	3.1722
Khote Sallo	*Pinus wallichiana*	5.5500	1.1486	5.5500	1.9595	0.0200	0.0513	3.1594
	Leucosceptrum canum	5.5500	1.1486	5.5500	1.9595	0.0170	0.0436	3.1517

Appendix II: Values of different parameters for tree species in Langur encountered plots

L. Name/C. Name	Sci. Name	D	R D	F	R F	BA	R D	IVI
Khasru	Quercus semicarpifolia	83.3300	22.7299	33.3333	46.1872	5.6830	50.1722	119.0893
Ruish	*Cotoneaster frigidus*	50.0000	13.6385	16.6667	23.0936	2.3770	20.9853	57.7173
Gurans	*Rhododendron campanulatum*	66.6600	18.1828	16.6667	23.0936	0.8490	7.4954	48.7718
Katus	*Castonopsis indica*	33.3300	9.0914	33.3333	46.1872	0.7690	6.7891	62.0677
kalopaile	*Dodecardenia grandifloria*	33.3300	9.0914	16.6667	23.0936	0.4530	3.9993	36.1843
Seto Khasru	*Ilex dipyrena*	16.6600	4.5443	16.6667	23.0936	0.8490	7.4954	35.1333
Dhusro		16.6600	4.5443	16.6667	23.0936	0.0490	0.4326	28.0706
Sallo	*Pinus roxburghii*	16.6600	4.5443	16.6667	23.0936	0.0200	0.1766	27.8145
Mayal	*Euonymus grandiflorus*	16.6600	4.5443	16.6667	23.0936	0.0150	0.1324	27.7704
Pipi		16.6600	4.5443	16.6667	23.0936	0.1380	1.2183	28.8563
Musure Katus	*Castonopsis tribuloides*	16.6600	4.5443	16.6667	23.0936	0.1250	1.1036	28.7415

Appendix III: Vegetations recorded in study area

SN	L. Name/C. Name	Scientific Name	Family	Vegetative type
1	Khasru	Quercus semicarpifolia	Fagaceae	Tree
2	Seto Khasru	*Ilex dipyrena*	Aquifoliaceae	Tree
3	Uttis	*Alnus nepalensis*	Betulaceae	Tree
4	Laligurans	*Rhododendron spp.*	Ericaceae	Tree
5	Sallo	*Pinus roxburghii*	Pinaceae	Tree
6	Sano Phalant	*Acer oblongum*	Aceraceae	Tree
7	Kapase	*Acer campbelli*	Aceraceae	Tree
8	Lekh Chanp	*Quercus glauca*	Fagaceae	Tree
9	Kalopaile	*Dodecadenia grandifloria*	Lauraceae	Tree
10	Angeri	*Lyonia ovalifolia*	Ericaceae	Tree
11	Gobre Salla	*Abies spectabilis*	Pinaceae	Tree
12	Banjh	*Quercus lanata*	Fagaceae	Tree
13	Chilaune	*Schima wallichii*	Theaceae	Tree
14	Dale Chuk	*Hippophae rhamnoides*	Elaeagnaceae	Tree
15	Katus	*Castonopsis indica*	Fagaceae	Tree
16	Ruish	*Cotoneaster frigidus*	Rosaceae	Tree
17		*Lindera pulchherrima*	Lauraceae	Tree
18	Chaichuya/Phesing	*Unidentified*	Unidentified	Tree
19	Sano Katus	*Castonopsis hystrix*	Fagaceae	Tree
20	Thulo Katus	*Quercus pachyphylla*	Fagaceae	Tree
21	Tebtar	*Unidentified*	Unidentified	Tree
22	Dhusro	*Unidentified*	Unidentified	Tree
23	Ghodakhari	*Viburum coriaceum*	Sambucaceae	Tree
24	Pipi	*Unidentified*	Unidentified	Tree
25	Unidenfied spp	*Unidentified*	Unidentified	Tree
26	Dudhilo	*Ficus nemoralis*	Moraceae	Tree
27	Khote Sallo	*Pinus wallichiana*	Pinaceae	Tree
28		*leucosceptrum canum*	Labiatae	Tree
29	Gurans	*Rhododendron campanulatum*	Ericaceae	Tree
30	Mayal	*Euonymus grandiflorus*	Rosaceae	Tree
31	Musure Katus	*Castonopsis tribuloides*	Fagaceae	Tree
32	Sunpati	*Rhododendron anthopogan*	Ericaceae	Shrub
33	Bokshi Kanda	*Rosa spp*	Rosaceae	Shrub
34	Chutro	*Berberis aristata*	Berberidaceae	Shrub
35	Timur	*Zanthoxylum spp*	Rutaceae	Shrub
36	Lokta/Kagatipate	*Daphne spp*	Thymelaeaceae	Shrub
37	Gurans	*Rhododendron arboreum*	Ericaceae	Tree
38	Bhojpatra	*Betula utilis*	Betulaceae	Tree
39	Kukurdaino	*Smilax spp*	Liliaceae	Shrub
40	Aldo	*Jasminum spp*	Oleaceae	Shrub

41	Nigalo	*Arundinaria intermedia*	Graminaceae	Shrub
42	Kandapate	*Ampelocissus rugosa*	Vitaceae	Shrub
43	Bhimsenpati	*Buddleja asiatica*	Loganiaceae	Shrub
44	Ainselu	*Rubus ellipticus*	Rosaceae	Shrub
45	Banhade	*Myrsins semiserrata*	Myrsinaceae	Tree
46	Titepati	*Artemesia vulgaris*	Compositeae	Shrub
47		*Elaeagnus spp*	Elaeagnaceae	Shrub
48	Sisno	*Urtica fioca*	Urticaceae	Shrub
49	Kalo Banmara	*Eupatorium adinophorum*	Compositeae	Shrub
50	Allo/Thulo sisnu	*Diospyros malabarica*	Ebenaceae	Shrub
51	Sanototne	*Aconogonium molle*	Polygonaceae	Shrub
52	Kharseuti		Sambucaceae	Shrub
53	Bhakiamilo	*Rhus javanica*	Anacardiaceae	Shrub
54	Bilaune	*Maesa chisia*	Myrsinaceae	Shrub
55	Chetang	*Unidentified*	Unidentified	Shrub
56	Chuletro	*Brassaiopsis polyacantha*	Araliaceae	Shrub
57	Damagedi	*Unidentified*	Unidentified	Shrub
58	Bhalayo	*Rhus succedanea*	Anacardiaceae	Tree
59	Bankurilo	*Asparagus filicius*	Liliaceae	Shrub
60	Chiul	*Unidentified*	Unidentified	Tree
61	Hadekafal	*Myrica spp*	Myricaceae	Tree
62	Archal	*Antidesma acidum*	Euphorbiaceae	Tree
63	Khanayo	*ficus Semicordata*	Moraceae	Tree
64	Setopati	*Artemesia spp*	Compositeae	Shrub
65	Asare	*Viburum mullaha*	Sambucaceae	Tree
66	Kalangu	*Unidentified*	Unidentified	Tree
67	Nepali Dalchini	*Dodecadenia grandifolia*	Lauraceae	Tree
68	Segal	*Unidentified*	Unidentified	Tree
69	Tuni	*Toona ciliata*	Meliaceae	Tree
70	Kafal	*Myrica esculenta*	Myricaceae	Tree
71	Kalanguchhe	*Unidentified*	Unidentified	Tree
72	Chiu-Chiu	*Unidentified*	Unidentified	Tree