CHAPTER-1 INTRODUCTION

1.1 General Background

Two species of macaques have been reported from Nepal; Rhesus Macaque (*Macaca mulatta* Zimmermann, 1780) and the Assamese macaque (*Macaca assamensis* McClelland, 1840) among which the latter one is less explored nonhuman primate of Nepal (Chalise, 2000) categorized as 'Vulnerable' (IUCN, 2007). Its distribution is restricted to the Himalayan foothill regions of Nepal. The taxon is designated as threatened due to its restricted distribution of less than 22,000 km², an estimated area of occurrence of about 914km² with continuing decline in area, decreasing quality of habitat, and declining population. Given its restricted extent of occurrence, increasing threats to the individuals and habitat, and decreasing numbers in fragmented patches, the Nepal Assamese population is categorized as 'Endangered' (Molur *et al.*, 2003). Likewise the National Parks and Wildlife Conservation Act of 1973 lists the Assamese macaque as a protected species of Nepal (GoN/Nepal, 1973) and appendix II of CITES. Of equal concern is the fact that these animals are considered as crop-raiding pest in Nepal (Chalise, 2001) and, as such, conflict between local people and the macaque is on the rise. This, in turn, presents an additional threat to the survival of the macaques. Given the decreases in natural habitat and population numbers along with increasing threats due to retaliation for crop raiding, there was critical need to evaluate the population status of Assamese macaque in Langtang National Park and help with generating solutions to deal effectively with the human-monkey conflict. The aim of this study therefore was to assess the Assamese macaque population in Langtang National Park. This comprehensive work included population surveys, analysis of socio-ecological factors and site-specific conservation measures.

1.1.1 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 (Raylands, 2001).

Men and monkeys share the same root of evolution. The lively inquiring minds, the structure of the hand, the social system and mother infant relationship and manipulative skills of the monkeys certainly makes us ponder about what W. S. Gilbert had said about man: “Man however well-behaved at best is only a monkey shaved”. In anatomy and behavior monkeys are our closest relatives. They may hold the key to our origins and the roots of what we consider the human characteristics of friendship, love, aggression, language and tool use (Linden, 1992: Cited in Subba, 1998).

1.1.1.1 Macaque

Macaque, name for Old World monkeys of the genus *Macaca*, related to mangabeys, mandrills, and baboons. Macaques are classified in the phylum Chordata, subphylum Vertebrata, class Mammalia, order primates and family Cercopithecidae. Among extant primates, *Macaca*, comprising 22 well-characterized species (Bradon-Jones *et al*., 2004), represents the largest and one of the most ecologically adapted and socially diverse of all the nonhuman primate genera and occupies a geographical range that is only smaller than that of *Homo* (Sinha *et al.*, 2005). They are also notorious as ‘crop pests’ (Crockett and Wilson, 1980; Roonwal and Mohnot, 1977) making many species vulnerable to the consequences of conflict with human agriculturalists (Priston, 2005).

In terms of wide distribution, numerous populations and range of habitat types exploited, macaques have thus achieved outstanding evolutionary success. Although their distribution and numbers have reduced drastically since the Pleistocene, when

macaques reached the pinnacle of their evolution, the ecological adaptability and behavioral flexibility of the genus has undoubtedly contributed to their colonizing success and the ability of some species to thrive in habitats undergoing drastic human modification. Macaques can be slight, with very long tails, or stocky, with short limbs and short tail or in a few species, no tail. They are highly intelligent and display a great variety of calls and facial expressions. A typical macaque is the rhesus monkey (*Macaca mulatta*) of South Asia which has been widely used in medical and other scientific experiments; the Rh blood factor, found in humans as well as monkeys, is named for it. The stump-tailed macaque (*Macaca arctoides*) is a nearly tailless, very hairy macaque with a naked pink face, found at high altitudes in South East Asia. One of its close relatives the Japanese macaque (*Macaca fuscata*) is the northernmost primate other than man. Its social organization has been extensively studied, and it has been found that there are culturally transmitted behavior differences among different troops. The single non-Asian macaque is the so-called Barbary ape (*Macaca sylvanus*), a large, tailless species of North West Africa, with one colony on the Rock of Gibraltar; it is the only nonhuman primate found in Europe (Colin, 2005).

Rhesus and Assamese macaques have been reported in the highlands of Nepal, Bhutan and India (Prater, 1971; Fooden, 1982a; Chalise, 2003 and Wada, 2005). Habitat segregation of those two species in the Himalayan regions highlights their relationships with regard to interspecific competition and evolutionary dispersal of macaques (Fooden, 1982b; Wada, 2005).

1.1.1.2 The Assamese Macaque

The Assamese Macaque is also known as the Himalayan Macaque or the Hill Monkey. The Assamese Macaque's pelt is dark to yellowish brown in color. The adult Macaque has red skin. The Assamese Macaque has a hairless face and cheek pouches to store food in while foraging. The Macaque's body length measures from 50 to 73 centimeters (20 to 29 inches). The Assamese Macaque's short tail is between 19 and 38 centimeters (7.5 to 15 inches) long. Himalayan form has longer tail than Indian one. The average body weight of the adult male Assamese Macaque is between 10 and 14.5 kilograms (22 to 32 pounds). The female weighs between 8 and 12 kilograms (17 to 26 pounds) (Flannery, 2004).

1.1.1.2.1 Taxonomy

The Assamese Macaque belongs to the family Cercopithecidae and subfamily Cercopithecinae of the order primates. Three subspecies of Assamese macaque have been reported until now and they are: Eastern Assamese Macaque (*Macaca assamensis assamensis*), Western Assamese Macaque (*Macaca assamensis pelops*) and Assamese Macaque 'Nepal Population'. The Assamese monkeys of Nepal are considered 'Nepal Population' by CAMP workshop 2003 due to taxonomic confusion (Molur *et al*., 2003). This population is different from Assamese monkeys described up to now from South-East Asia in respect to the head-body length, tail length, T/HB ratio and weight. The body fur and facial coloration also differs in males and females than so far described population of this species. So, Nepali Assamese macaque should consider a new subspecies however; need further taxonomic investigation (Chalise, 2003).

1.1.1.2.2 Habit and Habitat

The Assamese Macaque inhabits mountain, evergreen, bamboo, and deciduous dry forests, at elevations from 300 to 3,500 meters (980 to11, 500 feet). The Assamese Macaque 'Nepal Population' inhabits between the elevations of 480m to 2500m in different parts of midhills Nepal. The Assamese Macaque eats fruits, leaves, and insects but prefers young leaves. They also lick stones and eat aquatic larva and soil (Chalise, 2003).

1.1.1.2.3 Global Distribution

The Assamese Macaque is recorded from Nepal, India (Mussoorie, Assam), Bhutan, Bangladesh, upper Burma, south China, Cambodia, Laos, Vietnam and north Thailand (Molur *et al*., 2003).

1.1.1.2.4 Distribution in Nepal

In Nepal, Assamese Macaques are recorded from 380 m in Mulghat Tamor to 2350m asl in Langtang. They are found in the Basin of Arun River around Apsuwa confluence, Bhumlingtar, Heluwabeshi; Tamor River, Bagmati, Trishuli, Sunkoshi, Gandaki and Karnali River basin at higher elevation but warmer valleys. Thus, Nepal population can be located in subtropical hill Sal forests areas to mixed deciduous forest, temperate broadleaved forest with rocky outcrops and along the riverside steep

sloppy forests of above altitude. The species confirmed from Kimni Acham, Dadeldhura, Ramdi Palpa, Langtang NP and Helambu area, Makalu-Barun NP and Bhumlingtar, Hariharpur and Nagarjun forests of Kathmandu. The population so far 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; Chalise *et al*., 2005a; Chalise, 2006).

1.1.1.2.5 Assamese Macaque 'Nepal Population'

Nepal population of Assamese macaques inhabits between the elevations of 380 m to 2350 m in different parts of Nepal. They have body weight 15-18kg in males and 12-15 kg in females. Head and body length are around 2 ft long with tail length of 14 inches. Similar observation of differences was recorded for Langtang and Ilam specimen (Chalise, 2003; Chalise, 2005b).

The fur coloration of Assamese monkeys observed in Nepal varies from dark-brown to blackish-brown on the back, and whitish blond to ashy white on the abdomen. In the adult female, the cheeks and around the eyes are mostly crimson-red to pinkish red. These colors are absent in adult males, which are mostly whitish-yellow on the face, but dark violet or blackish color of skin around the nose. One or two adults seen in each group had overall darker (wet blond) and dark ashy fur coloration. The pelage coloration of infants and juveniles also varied, but they are generally blonder than the older individuals. The palm, sole and nails are dirty brown, while there off-white ischial callosities are conspicuous from a distance, especially in darker individuals. Female juveniles have more pinkish ear tips and faces than male juveniles (Chalise, 1999; Chalise, 2003).

The Assamese monkeys of Nepal are considered 'Nepal population' and categorized as "Endangered" by CAMP Workshop 2003 due to taxonomic confusion and shrinking population in their typical natural habitat (Molur *et.al*. 2003). This population is different from the Assamese monkeys described up to now from South-East Asia in respect to the head-body length, tail length, T/HB ratio and weight. The body fur and facial coloration also differs in males and females than so far described population of this species (Chalise, 2003; Chalise, 2005a; Chalise, 2005b).

1.2 Statement of the Problem

Due to increasing land use and forest fragmentation by human-beings the Assamese macaques are facing pressures to utilize the new habitats including private land, orchard farms, degraded forest areas and abandoned land in fringe areas. This often results in increased human-monkey conflict. To date, there have been no systematic studies of Assamese macaque populations in the fragmented forests regions of Langtang National Park. Unless a comprehensive study of the Population Status and existing threats is conducted, no reasonable management recommendation and conservation action plan can be established. This population is different from the Assamese monkeys described up to now from South-East Asia in respect to the head-body length, tail length, T/HB ratio and weight. The body Fur and facial coloration also differs in males and females than so far described population of this species (Chalise, 2003; Chalise, 2005a). Considering the fact that the 'Nepal Population' of Assamese macaque may be a new subspecies, the research and conservation of this macaque species felt greatly in Nepal for further taxonomic investigation.

1.3 Aims of the study

Objective I. To determine the population status of Assamese macaque in Langtang National Park

Objective II. To explore the general behavior of Assamese macaque in the area

Objective III. To assess the threats to the Assamese macaque in the area

1.4 Research Hypothesis

Presence or absence of macaque damage is significantly related to the distance of farm to the forest.

1.5 Importance of the Study

Non-human primates are not studied thoroughly in Nepal. A few research works had been done on population status and behaviors of primates (Chalise and Ghimire, 1998; Chalise, 2006) in different ecological zones of Nepal (*Semnopithecus* species at Ramnagar, Chitwan, in Sworgadwari forest of Pyuthan, and Sangekhola of Tanahun; Assamese of Hariharpur Gadhi, Makalu- Barun, Rasuwa and Dhading; Rhesus in Ghodaghodi of Kailali and Pashupati, Swoyambhu, Thapathali and Sankhu of Kathmandu). In these areas, the primates are considered as pest of crop-field. News of

maize field raiding by monkeys is commonly featured in local media. However, a detail study on their actual impact in the crop-harvest and economical loss is still lacking. Till to date not a single viable solution has been suggested by concern authority on this problem except sometime assigning to a special commission for the investigation. Therefore this study had concentrated on the assessment of population status of Assamese macaque and its interaction with local farmers in the area. The results of this study will be supportive to minimize the human-macaque conflict and its management more effectively.

1.6 Limitations of the Study

- Heavy tourist flow and freely wandering domestic animals in the park disturbed the research work.
- In some places, monkeys were persecuted by local people so made it difficult to see and follow the group regularly.
- This study was concentrated only for the partial fulfillment of academic degree for Masters in Zoology (Ecology). Therefore we couldn't spend year round time regularly in the field.

CHAPTER-2 REVIEW OF THE LITERATURE

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.

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.

Khatiwada *et al.* (2007) studied the population status of Assamese macaque in Kathmandu, Rasuwa and Dhading districts. They found that the macaques are patchily distributed in the fragmented forests in these areas where macaques have been continuously facing the problem of habitat encroachment by the local people.

Khatry (2006) studied monkey-human conflict in Vijayapur Area with the major objective of analyzing human- monkey conflict in Vijayapur Area Dharan, Eastern Nepal. He found that food scarcity; increasing population of monkey; monkey habitat loss; internal migration; artificial provisioning and religious faith are the causes of increasing monkey problems.

Kawamoto *et al.* (2006) studied the distribution of Assamese macaques in the Inner Himalayan region of Bhutan and their mtDNA diversity. He recorded no groups of rhesus macaques (*Macaca mullatta*) in his survey, in contrast with the survey results in the Nepalese Himalayas. He concluded that the macaques of the Inner Himalayan regions in Bhutan are Assamese macaques and that they appear to be of a lineage distinct from Assamese macaques in the Indo-Chinese region (subspecies *Macaca asaamensis assamensis*). On the basis of degree of mtDNA diversity, he also concluded that the Assamese macaques in Bhutan are of a more ancient ancestry than

M. a. assamensis. He suggested the earlier speciation of Assamese macaques on the basis of greater mtDNA diversity than that of rhesus macaques.

Sinha *et al.* (2005) recorded a new species Arunachal macaque (*Macaca munzala*) from Western Arunchal Pradesh, Northeastern India which shares morphological characteristics independently with the Assamese macaque (*Macaca assamensis*) and with the Tibetan macaque (*Macaca thibetana*).

Cooper *et al.* (2005) studied the Reconciliation and Relationship Quality on a group of Assamese macaques living near the Tukeswari temple near Goalpara, Assam, India. They found that females reconcile most often with valuable and compatible social partners.

Chalise and Johnson (2005) collected the Farmers attitudes toward the conservation of "pest" monkeys: The view 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.

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 Pashupati and Swoyambhu area. He suggested that clean water supply and restoration of natural habitat are urgently needed to manage these populations.

Chalise (2003) studied Assamese macaques (*Macaca assamensis*) in Nepal. He indicated some differences from the Assamese macaques of Makalu-Barun Area from those so far described from south-east Asia and suggested for the molecular genetic studies in order to resolve the taxonomic status.

Schino *et al.* (2003) studied the Grooming among female Japanese macaques to test some predictions derived from the application of biological market theory. Contrary to expectations, they found that Japanese macaques do not time match the duration of grooming episodes, their degree of reciprocation is not related to rank distance, and they do not distribute their immediately reciprocated and nonreciprocated grooming in different ways.

Cooper and Bernstein (2002) studied the Counter Aggression and Reconciliation in Assamese macaques living at the Tukeswari temple in the district of Goalpara in the state of Assam, India. They found that the proportion of agonistic episodes that involved counter aggression is relatively low and counter aggression, however, occurred more often among males than among females, and it is the most common when females initiated aggression against males. They reported that the frequency of reconciliation is low for fights among males and for fights among females, but reconciliation were particularly rare for opposite-sexed opponents.

Bhattarai (2002) studied the General Behavior and Habitat Use of Assamese macaque in Syafrubensi Area of LNP. He found that *Macaca assamensis* used broad-leaved conifer mixed forest and grassland with scattered trees of Urticaceae family abundantly. He recorded the time spent on sitting as highest as 33.3% followed by 29.6% on feeding, 28.2% on walking, 6.4% on grooming and 1.1% on mating.

Chalise (2001) studied the Crop raiding by wildlife, specially primates and indigenous knowledge of food conservation and found 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.

Cooper and Bernstein (2000) studied the Social Grooming in Assamese Macaques living on the Tukeswari temple grounds in Assam, India. They found in accordance with social bonding that females, as the long-term residents of this matrifocal group, groom each other and juveniles more often than males groom one another or juveniles. They also reported that males groom females more often and for longer

durations than females groom males and, whereas both males and females groom juveniles more often than juveniles groom them, juveniles groom their elders for longer durations.

Chalise (1999, 2000) studied the behavior of Assamese monkeys of Makalu-Barun Area, Nepal and proposed for the detail investigation including molecular analysis of this species that could expose the hidden truth and provide firmed ground of its taxonomic status.

Shrestha (1999) studied the Agonistic Behavior of Rhesus Monkey in Pashupati Area. She found that *Macaca mulatta* have shown agonistic behavior at any time of feeding, resting, moving, grooming. She also reported more concisely that mostly, the agonistic behavior is shown during feeding time in comparision to others.

Sakha (1999) studied the Feeding Behavior of Rhesus Monkey in Pashupati Area. She found that monkeys of Pashupati area are very calm and they never snatch and fight for provisional foods. She also reported that almost on every season, feeding increases during morning and afternoon because visitors come and give to them.

Cooper and Bernstein (1999) studied the Dominance in Assamese macaques at a temple site in Assam, India and constructed rank hierarchies for agonistic, grooming and mounting matrices. They found a nearly linear agonistic dominance hierarchy does not correlate with the directionality of mounting or grooming.

Subba (1998) studied the ecology and habitat of *Macaca assamensis* in Makalu Barun Conservation Area, Nepal. She found that trees with lesser height are not suitable for the night halt and daytime resting for the macaques. She also reported that Kaulo and *Schima wallichi* are the most exploited tree species and Bilaune was the most common plant among the ground vegetation of the macaques' habiat. She concluded that the way in which primates use time and organize activity patterns is an important aspect of behavioral ecology.

CHAPTER 3 RESEARCH METHODS

3.1 Research Site

Source: BCN

Map 1: Langtang National Park showing the Assamese macaque survey trails.

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. LNP is the second largest Mountain National Park of Nepal, which covers 1710 km^2 in three districts: Rasuwa, Nuwakot and Sindhupalchock of Bagmati Zone of Nepal (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. 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. 1, see also Appendix. 2).

Fig. 1 Temperature (max. and min.) recorded in the year 2006 at Dhunche Station.

Relative humidity is recorded maximum (89.7%) in the month of June and minimun (58.2%) in November 2006. The average relative humidity is recorded 74.08% (Fig. 2).

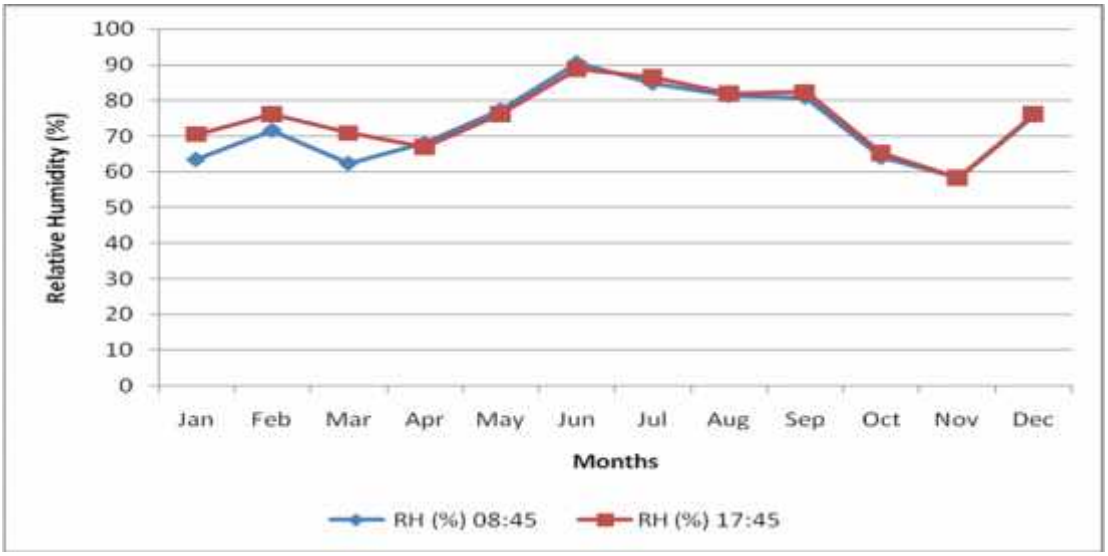
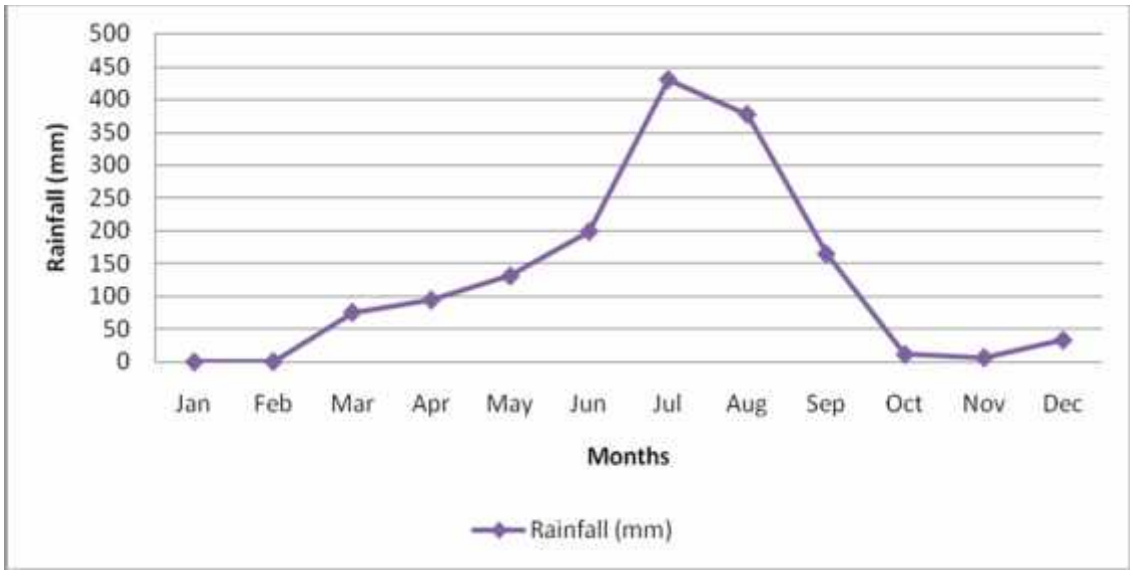


Fig. 2 Relative Humidity recorded in the year 2006 at Dhunche Station.

The seasonal climate is dominated by the southerly monsoon which occurs June to September (Fig. 3). The incidence and type of precipitation is mainly related to aspect, altitude and the presence of rain shadow effect.



Source: Department of Hydrology and Meteorology/GoN

Fig. 3 Rainfall (mm) recorded in the year 2006 at Dhunche Station.

3.1.4 Soil

Although no economically viable mineral concentrations are reported to occur in Langtang, the park may be considerably affected, indirectly, once the lead-zinc deposits of Ganesh Himal beings to operate. An Indian company (Hyderabad Asbestos Cement Products Ltd.) has held the permission of mining rights from the HMG. For this purpose, a road has been constructed to transport ore from the mining site, Ganesh Himal to India. For such a dissected area, where topography, vegetation and aspect severely affect local soil pattern, it is difficult to generalize. Mature, mainly fertile loams soil occurs in the lower forested regions. In the upper Langtang valley, the most common textural component is sandy-loam with a large proportion of rocks. The mean proportion of sand decreases with elevation and loamy sands become predominant below 2,440 m. Where the practice of pasture burning occurs, the top soil layers often comprise alternating darks and pale horizons due to ash accumulation, and the pH is more homogenous between them. Soils are generally fairly acidic, pH 5-6 (Maire, 1973: Cited in Pandey, 2006).

Consideration for park management associating all the different aspects of climate, topography, hydrology, geology and soils is the incidence of erosion, both natural and accelerated. The sub and alpine environments are affected by livestock and grazing prevailing shorter growth periods. Cattle’s, grazing for much of the days of year on the higher slopes, frequently create soil 'baths' in which they rest and roll. Trails suffer from margin collapse each year, particularly at the time of mass transhumance before and after the monsoon. At lower forested elevations foraging and wood-cutting activities, together with heavy rains, high run off and low evaporation during the monsoon, cause considerable soil transportation. Resultant land, debris and mud slides cover extensive tracts of land in low basins. Gully and landslides erosion was formerly concentrated in Nuwakot District, in area of increasing population pressures and associated deforestation (Tautscher, 1970: Cited in Pandey, 2006).

3.1.5 Flora

The greater altitudinal variation has caused the park's climatic and geological variation and consequently the variation in vegetation type. The description and classification of the vegetation in the park has been described in detail in the management plan (DNPWC/DUHE, 1977).

3.1.6 Fauna

Because of the altitudinal variation, Langtang National Park has an abundant faunal species. These are recorded more than 46 mammal species, 345 bird species, 11 species of herpeto-fauna, 30 species of fishes, 70 species of butterflies and 10 species of spiders (Chaudhary, 1998; Karki *et al.*, 2002).

Langtang's expansive high meadow provide summer habitat for numbers of ungulate species such as musk deer and Himalayan tahr. Three species of monkeys are also found here - Rhesus monkeys, Hanuman langur and Assamese monkeys (Chalise *et al.*, 2001; Chalise, 2003). Some of the endangered/threatened species found in the park are: Snow leopard (*Uncia uncia*), Clouded leopard (*Neofelis nebulosa*), Musk deer (*Moschus chryrogaster*), and Red panda (*Ailurus fulgens*). The ungulate prey species such as the Himalayan Tahr (*Hemitragus jemlahicus*), Ghoral (*Nemorhaedus goral*) also present in the area. The park is also well known for the Red fox (*Vulpes vulpes*), Common leopard (*Panthera Pardus*), Yellow throated marten (*Martes flavigula*), Himalayan black bear (*Selenarctos thibetanus*), Large Indian Civet (*Viverra zibetha*), Barking Deer (*Muntiacus muntjac*) etc. (Khatiwada, 2004).

3.1.7 Socio-Economy

There are 15 VDCs within the Buffer Zone covering 11 of Rasuwa, 3 of Nuwakot and Sindhupalchok-1. It comprises 10,509 household. Presently study is focused on the Langtang VDC that consists of 521 total human populations with 143 households (CBS, 2002). The people from Langtang speak Kerung dialect. It seems that the Langtang was settled by families from Kerung Tibet (China). However, there is intermingling of local Tamangs and refugees from Tibet. Although, they call themselves Tamangs but they don't speak common Tamang dialect. They also celebrate Tibetan Buddhist festivals such as Loshar. The inhabitants inside the Langtang National Park depend mainly upon tourism industry and agriculture for their livelihood. Five thousand trekkers some with porters and guides and Nine thousands pilgrims visit the park annually. The distribution of human population and livestock are governed by vertical stratification of the environment. Vertical strata are characterized by altitude, slope, ecology and availability of water. A general pattern of such utilization is high pasture zone (3,800-4,700m), forest (2,600-3800m) and cultivated zone (1600-2600m). Tourism is the primary source of income and

agriculture is the secondary in terms of costs and benefits because of low crop production. Most people buy food grains by using earned money from various other activities. Popular crop combinations being buckwheat, potato and barley, cropping pattern is set in alternative way or one crop each year. Rearing of animals is a very important aspect of the people of Langtang. Livestock is seasonally shifted for the litter fodder and pasture land. They are carried to upper elevation (3000-5000 m) from May-September and they come down to lower elevation at 2,000 m in winter. However, high altitude Yak and Nak don't come below 2,500m. Sheep and goats are grouped into several herds for the summer grazing. These animals usually graze in meadows not accessible by Yaks and in area where there is not enough fodder for larger livestock. Animals are allowed to graze freely in the valleys of park. Chauris and Nak are milked once a day and usually in the morning. Dairy Development Corporation opened the first cheese factory in Langtang in 1953. There are two cheese factories which has an ambitious target to produce 20,000 kilograms of cheese a year. Farmers also receives loan from cheese factory. Each cheese factory collects milk from 50 sq km of grazing areas by setting up more than half a dozen collection and processing depots (Gurung, 1988).

3.1.8 Tourism

Tourism industry is the major income source of Langtang people. Langtang trekking is popular tourist destination. With the construction of road to Dhunche and Syafrubensi from Kathmandu, Langtang National Park has become the shortest trek in the Himalayas (Gurung, 1988). Panoramic natural scenery of snow claded Himalayas, shrines and unpolluted environment has helped to attract international tourism. More than 59 hotels and tea stalls are present along the trail from Syafrubensi to Kyanjing Gumba. In the entire Langtang Valley, there are 63 lodges, 19 tea stalls with camping sites and some restaurants run by local people. It indicates that tourism has a positive impact on the economy of the creating various employment opportunities for the local people and providing substantial contribution in improving the local economy. It has been reported unofficially that more than 200 children from the Langtang have been studying in Kathmandu by the donation from the tourists. The large and increasing number of tourist in a small area might have some negative impact on the local environment. Due to high tourist pressure, the environment could easily degrade. The more trekkers in the valley, the more requirement of energy, which is based on fuel

wood from local forests. The forest deterioration can reduce soil fertility and enhance erosion and ultimately can also be disturbance to wildlife (Pandey, 2006).

3. 2 Research procedures

3.2.1 Preliminary Field Survey and Block Design

A preliminary field survey was done from 12 February to 25 February 2006, 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 113 km² was selected in two dimensions with help of topomaps (scale: 1:50 000) without taking contours into account for the survey and divided into three blocks namely: Block A (Ramche-Syafrubensi, 53 km²), Block B (Syafrubensi-Langtang, 25 km²) and Block C (Syafrubensi-Rasuwagadhi, 35 km²).

3.2.2 Total Count

Population surveys throughout the study area (113 km²) were carried out from all the accessible trails. The trails were walked slowly at c. 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 (See also Appendix 3). 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: $D_2 = D_1 \times$ 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.

3.2.3 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.

3.2.4 Questionnaire Survey

Direct questionnaires were used because the mountainous topography and the land use patterns of the study area made alternative methods impractical. After visiting the 120 farms in the study area, 75 households were surveyed in Ramche, Syafru and Timure VDC of Rasuwa district whose farms were found to be damaged by the macaques (See Appendix 4). The survey focused in estimating the crop damage per household yearly and getting the information on the methods of deterrence applied by the farmers in the area (See Photo plate 1 and Photo plate 2).

3.3 Data Analysis and Interpretation

Chi-square (χ^2) Test

Chi-square test (χ^2) was used to test whether there was prevalence of the significant relation of presence and absence of macaque damage to the distance of farms from the forest.

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

Where, Oi = Observed values, Ei =Expected values and k = Number of categories

CHAPTER-4 RESULTS

4.1 Population Status and distribution of Assamese macaque in LNP

4.1.1 Group and Population density

A total of 213 Assamese macaques were encountered which were living in 9 groups (Appendix 1). The mean group size was found to be 23.66 (Range 13-35) individuals. The group density was found to be 0.0790 groups / km² with a population density of 1.8691 individuals/ km².

4.1.2 Age-sex composition

Among the total counted monkeys, 31% were adult female, 16% adult male, 18% young, 16% Juvenile and 19% infant during the study period (Fig. 4).

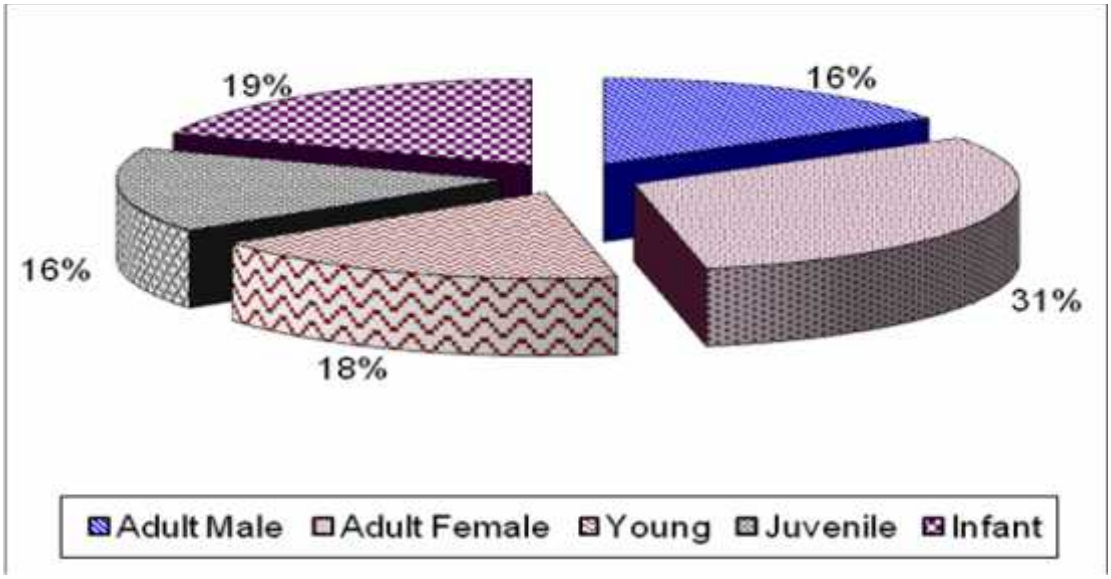


Fig. 4 Age-sex structure in the study area.

The study area was categorized as block A, B and C for more specific data collection in different sites. Block A consisted of 33% adult female, 15% adult male, 18% young, 13% juvenile and 21% infants. Block B had 27% adult female, 14% adult male, 25% young, 18% juvenile and 16% infant. Block C comprised of 32% adult female, 19% adult male, 13% young, 17% juvenile and 19% infant (Fig. 5).

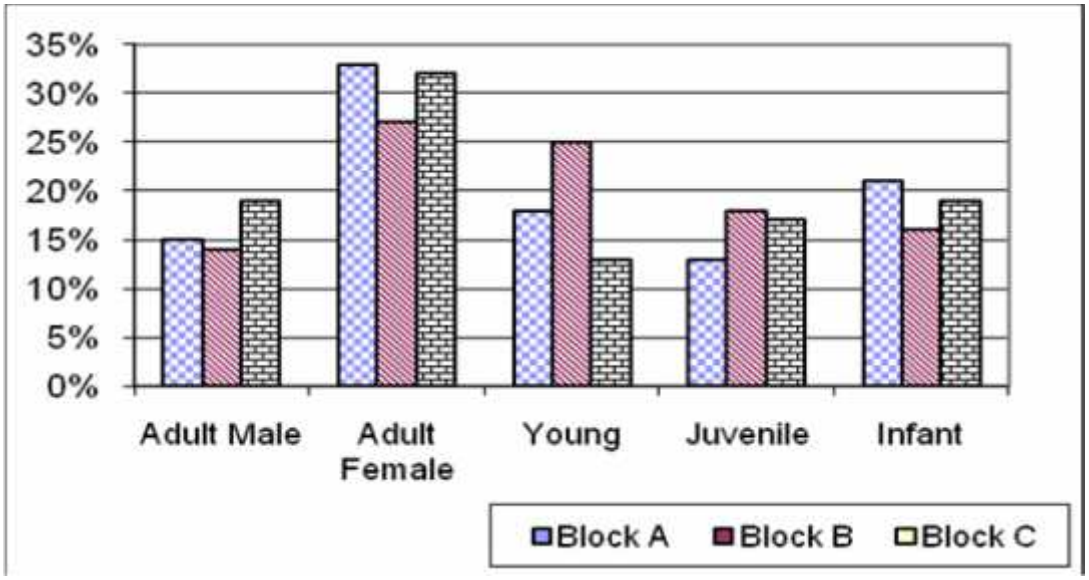


Fig. 5 Age-sex structure in different blocks.

4.1.3 Adult Sex Ratio

The adult sex ratio (male to female) observed during the entire survey block was 0.52 (52 males per 100 females) i.e. 1:1.92.

The adult sex ratio was 0.46 (46 males per 100 females) i.e. 1:2.17 in block A, 0.50 (50 males per 100 females) i.e. 1:2 in block B and 0.60 (60 males per 100 females) i.e. 1:1.66 in Block C (Fig. 6).

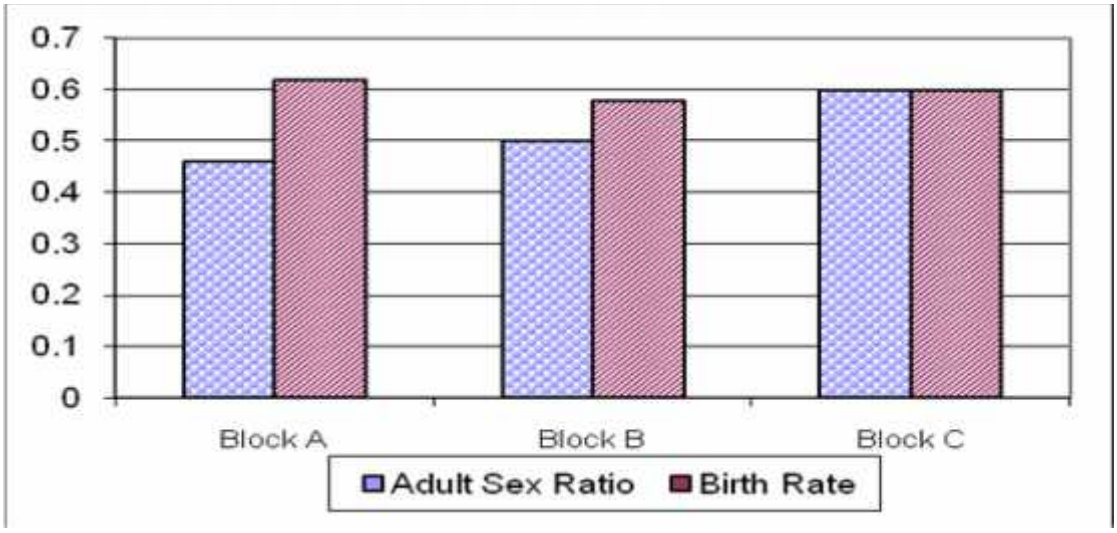


Fig. 6 Adult sex ratio and birth rate in different blocks.

4.1.4 Recruitment Rate (Birth Rate)

Recruitment rate (female to infant ratio) was found 0.61 (61 infants per 100 females) in the entire study with the recruitment rate of 0.62 (62 infants per 100 female), 0.58 (58 infants per 100 females) and 0.60 (60 infants per 100 females) in the Block A, Block B and Block C respectively (Fig. 6).

4.1.5 Group size and distribution

The average group size was 23.66 (Range 13-35) in the study area. The group size recorded at highest elevation of 2420 m asl in Lama Hotel consisted of 13 individuals. The group size recorded at lowest elevation of 1,300 m asl in Ghurtabensi consisted of 23 individual. The largest group size was recorded at an elevation of 1,710 m asl at the bank of Bhotekoshi river near Timure that consisted of 35 individuals of Assamese macaques. The smallest group size was recorded in Lama Hotel at an elevation of 2420 m asl that consisted of 13 individuals of Macaques (Fig. 7).

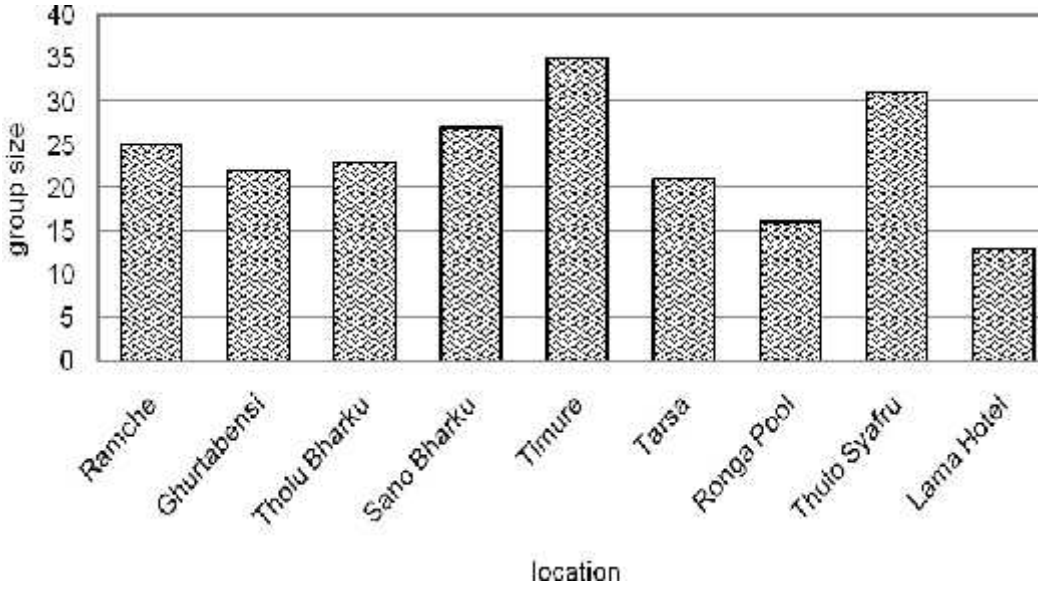


Fig. 7 The group size of Assamese macaque in different locations of LNP, 2007.

The group size was varied in different block. The average group size was 24.25 in the Block A, 22 in Block B and 24 in the Block C (Fig. 8).

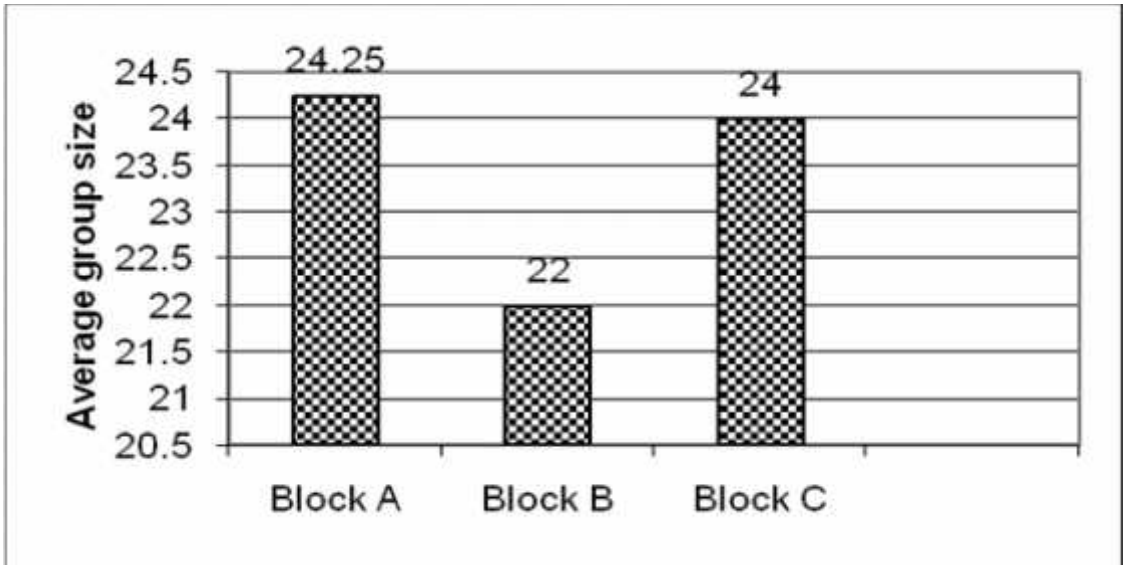


Fig. 8 Average group size recorded at different blocks in 2007.

4.2 General behaviour

The Assamese group of size of 16 individuals of Ronga Pool was selected for the scan sampling to measure the general behaviour of Assamese macaque. Four major behaviors were recorded during the study period. The focal group revealed that foraging was 49%, moving 26%, resting 16%, and grooming 9% (Fig. 9).

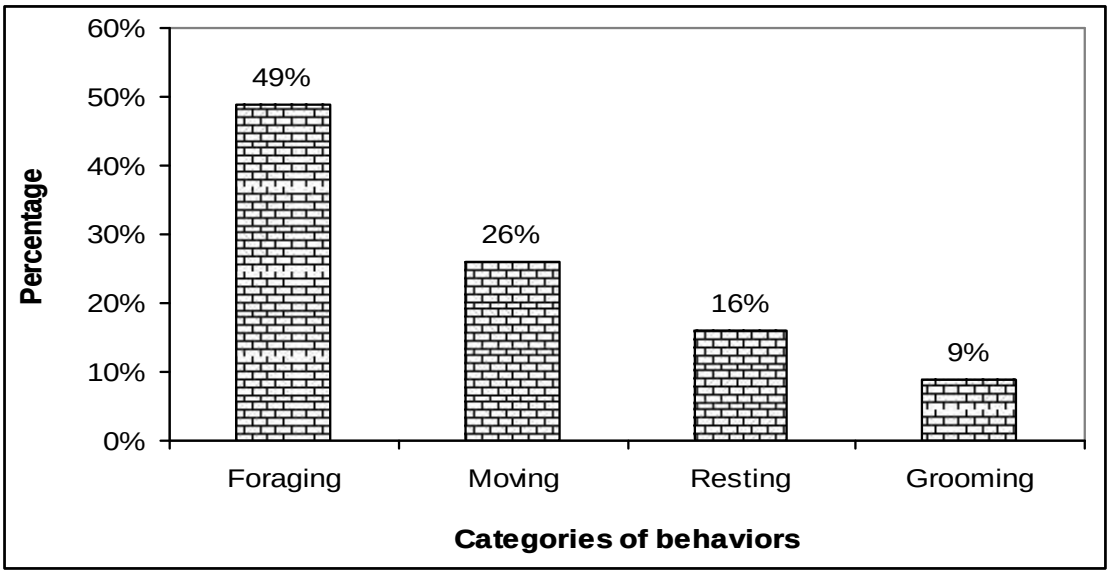


Fig. 9 Major behaviors of Assamese macaque in Langtang during 2007.

4.3 Threats to Monkeys

4.3.1 Crop-raiding and its consequences

4.3.1.1 Presence and Absence of macaque damage (crop vulnerability)

One of the factors likely to affect vulnerability to crop raiding by wildlife includes the distance from farm to forest edge. Macaque damage scores from the 120 farms were recorded as present or absent to see if there was significant difference between farms with distance from forest (Near <100m, Average 101m-500m and Far >501m) using Chi Square test. Presence or absence of macaque damage is significantly related to the distance of the farm from the forest (¡ ^{2} = 30.9, df = 2, *P* << 0.05). Damage is present in more farms near to the forest than for those average distances or far from the forest (Table 1). Thus macaque damage is more likely to occur in farms closer to the forest.

Table 1 Cross tabulation for presence of macaque damage against distance of farm to forest

		Distance to Forest			**Total**
		Near <100m	Average 101-500m	Far >501m	
Macaque Damage Absent	Observed	12	15	18	**45**
	Expected	24	13.1	7.8	
Macaque Damage Present	Observed	52	20	3	**75**
	Expected	40	21.8	13.1	
Total	Observed	**64**	**35**	**21**	**120**

4.3.1.2 Economic loss

In this study, the kind of loss, direct or indirect brought about by Assamese macaque raids were estimated. It was found that they damaged most agricultural crops to a considerable extent. It was found that Assamese Macaques spoiled more crops than they actually eat; juveniles and infants in particular brought about damage during play on the ground. The estimate of damage was assessed on the basis of the information gathered from the owners (households) of 75 farms where there were the presence of macaque damage out of 120 farms. The calculated crop damage from those 75 households was about Rs. 150,000 per annum with the average of Rs. 2,000 per household. The costs of crop protection ranged between Rs.500-1500 per household

per year, which comes to Rs. 37,500- 112,500 for 75 households. Besides this direct loss, they also caused indirect loss by feeding upon the flowering and fruiting trees, which reduces the fruit production considerably.

4.3.1.3 Crop Preference

The major crops Maize, Potato, Wheat, Buck wheat, Millet were found to be raided by Assamese macaque in the area. Among those maize cobs were found to be highly preferred (62%) followed by potato tubers (23%), millet (7%) buck wheat (6%) and others 2% by macaques (Fig. 10).

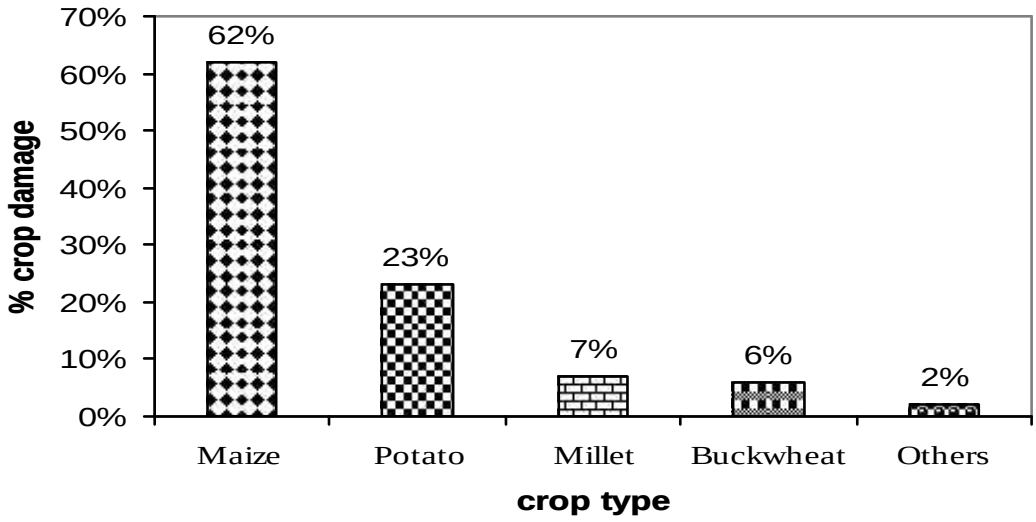


Fig. 10 Percentage crop damage by Assamese macaque in LNP

4.3.1.4 Crop protection strategies and management

To protect crop fields and orchards from wildlife including Assamese macaque, farmers use many methods. These methods include patrolling and guarding the fields by farmers including their children, Scarecrows, Tin-box, throwing stone with "Catapult", keeping dogs, fencing with thorny twigs etc. The most commonly used crop protection strategy in guarding their fields by constant vigilance during crop seasons. This method was used by 60 % of the farmers in the study area. 20 % of field owners use "Scarecrows", a device to scare the animals from the field. Few farmers (about 15 %) using dogs for crop protection to chase the macaques away, While the remaining 5 % of farmers used tin-box and catapult (a device made with rubber to

throw the stone to hit the distant objects) to chase the macaques from the crop fields (Fig. 11).

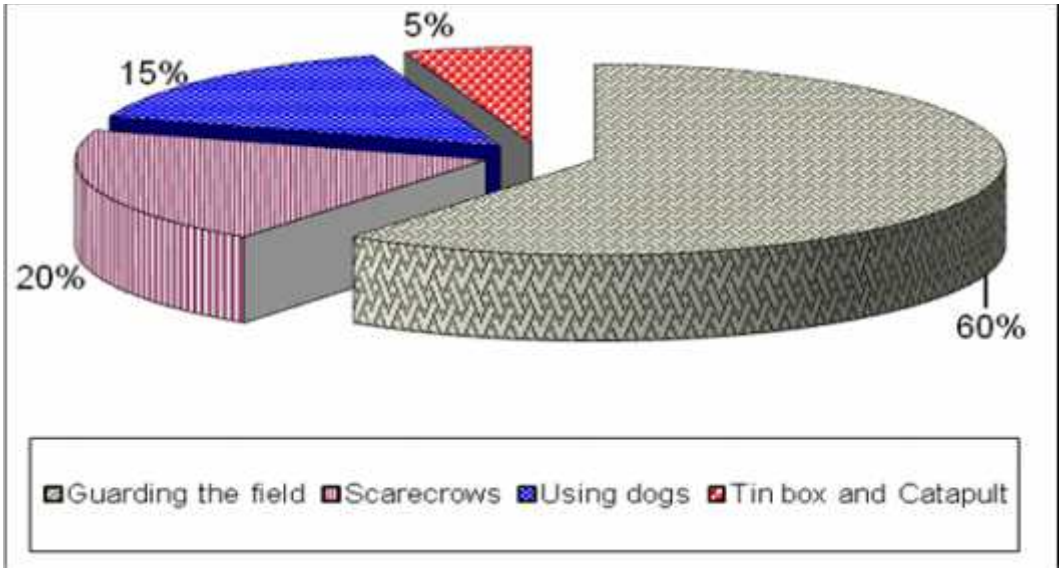


Fig. 11 Different crop protection strategies used by farmers

Along with above methods all the farmers commonly fence their farm using thorny twigs and branches of different trees and shrubs as protective measures. Despite all these measures of crop protection, macaques do manage to invade the crops.

CHAPTER-5 DISCUSSION

5.1 Population Status and distribution

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 (1997) to distinguish the age and sex of the macaques 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 macaques' groups in LNP were comparatively more stable and less persecuted by human beings made the group size estimation and composition more accurate.

Hanya *et al.* (2003) stated that a "group" should be modified to reflect the normal group spread of the species and defined a group only by distance, and did not distinguish situations when macaques belonging to different social units (troop) stayed within 500m each other. I also followed Hanya *et al.* (2003) for defining the group to estimate the group density though this shortcoming may have caused an underestimation. Intensive study may be required to avoid this underestimation.

The group density of Japanese macaques estimated as 1.43 and 0.737 groups/ km² in the disturbed area and undisturbed area by the method of combining point census and group follows within a census area of 7 km² in the western area of Yakushima, an island in southern Japan (Hanya *et al.*, 2003) whereas in the present study the group density of Assamese macaque was found to be 0.0790 groups / km² by applying a method of total population count within a census area of 113 km². Hanya *et al.*, in the same study, population density was calculated to be 22.9 and 11.8 macaques/ km² in the disturbed and undisturbed areas respectively with the mean group size of 16 whereas in the present study, the population density of Assamese macaques was found to be 1.8691 macaques/ km² with the mean group size of 23.66. The altitude of census area was 700-1300 m asl in the study of Hanya *et al.* (2003) and 900-2500 in the study of Chalise (1997) whereas the altitude of census area was 1200-3300 m asl in the present study. Mehlman (1989) reported a semiisolated study population of 162 Barbary macaques (six groups) inhabiting the Ghomaran fir forests of the Moroccan Rif mountains had a density of 6.73 individuals/ km². The adult sex ratio was O. 725, and immature comprise 46.9% of the population. Group size ranged from 12 to 59 individuals, with a median value of 24.

Southwick *et al.* (1964) reported two troops of Assamese monkeys in Darjeeling and estimated group size of 10-25 and the adult sex ratio 1:1.7. Foden (1982a) recorded 11 Assamese monkeys' troops and observed troop size varies from 10 to 50 individuals in Kanchanaburi, Thailand whereas I recorded 9 Assamese monkeys' troops and observed troop size varies from 13 to 35 individuals in Langtang National Park. Aggimarangsee (1992) observed two semi-tame colony of this species with 29 and 27 individuals and the adult sex ratios of those colonies were about 1:1.7. The adult sex ratio of Assamese macaques' troops observed in this study i.e. 1:1.92 is apparently similar to that of the above stated in the study of Southwick *et al.* (1964) and Aggimarangsee (1992) i.e. 1:1.7 and in the study of Chalise (2000) i.e. 1:1.9. Macaques live in multi-male, female-kin bonded groups and ratios of males to females range from 1:1.2 (*Macaca radiata*) to 1:9 (*Macaca nemestrina*) (Feeroz, 1996) which is also justified with my present study in which the adult sex ratio was found as 1:1.92 with the reasonable recruitment rate of females though slightly more than half i.e. 0.61 (61 infants per 100 females). These findings support that the

Macaca assamensis also live in multi-male and female-kin bonded groups like as other macaques.

Barbary macaques in the Djebela, Morocco were extremely wary of humans and generally fled once sighted (Waters *et al.*, 2007). They sighted a total of nine groups and 89 different individuals counted and the overall average group size was 9.9 (range 3–19). Wangchuk (1995) calculated the population density of Golden langurs using line transect method covering the area of 58.5 km² was found to be 2.1 langurs/ km² and in the present study, the population density of Assamese macaque was found to be 1.8 individuals/ km². Environmental constrains and human interference might affect group composition and group size of the macaques (Machairas *et al*., 2003). In fact there are altitudinal demographic differences between the encountered populations in Langtang National Park. Small group size (13) observed in Lama Hotel (2420m 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 as in *Macaca sylvanus,* then group size can be kept small to comfort food availability (Van Shaik and Van Noordwijk, 1983) as in the Assamese macaque in this study which was found in the group size of 13 individuals at 2420m altitude where they have to face with sparsely distributed and low quality feeding resources and no alternatives (crop-raiding) as in lower altitudes. It could be argued that the presence of Himalayan *Semnopithecus entellus* in the area might be another reason for squeezing the group size in the area because neither it can expand its upper limit of altitudinal distribution as by Himalyan *Semnopithecus entellus* (which is found up to 3800m in Langtang National Park: Pers. Comm. with Prof. Dr. Randall C. Kyes and Assoc. Prof. Dr. Mukesh K. Chalise in 2007 during field study) nor can adapt with lower inter and inter specific groups in terms of foraging competition.

The Assamese macaques were distributed between the altitudes of 1300m-2420m asl in LNP in contrast with the Arunachal macaque which is unique in its altitudinal distribution, occurring largely at altitudes between 2000 and 3500m asl (Kawamoto *et al*., 2006) whereas Fa (1984) recorded the distribution of the Barbary macaques within the altitudinal range of 600m-2300m in Morocco and Algeria with the population density of 2-36 individuals/ km². Previously Assamese monkeys were reported in Nepal ranged from 200–1,800m asl (Wada, 2005) which corresponds to forest zones between tropical and subtropical. Neither Assamese monkeys nor had positive information of the monkeys were found in the areas west of Kaligandaki Valley. Assamese monkey populations were separated compared to those of rhesus monkeys, and had limited distribution along rivers and valleys at some locations in tropical and subtropical forests (Wada, 2005). The primate species Assamese and langur are dwellers of riverside forest area as it provides succulent herbs and other food items including insect larva (Chalise, 2007) which is consistent to the present study since most of the groups of macaques encountered near the trail route along the water resources Trisuli, Langtang Khola and Bhotekoshi river. Possibly, they prefer the open area with fewer disturbances for either precluding or minimizing the predator pressure during their activity period though it has to be confirmed in the future study. Animals will choose to live in those places where they will have the maximum chance of survival or reproductive success (Partridge, 1978). Distribution of species in different habitats may not follow directly from habitat preference or choice; inter- and intraspecific competition can exclude animals from preferred habitats and force them into less suitable areas (Partridge, 1978). Barbary macaques remain in zones which humans have been unable to use or reach (Fa, 1984) in contrast with the Assamese macaque in Langtang National Park but are not provisioned by locals and tourists.

5.2 General Behavior

During this study period, nine groups of Assamese macaque were recorded in pre-designed three blocks of LNP among those the group of Ronga pool of group size 16 was selected for exploring the general behavior of the Assamese macaque in LNP in 2007. That sizable group was easy to follow and individuals were easily and clearly identified within this group, one adult male had very short tail due to which the group could be easily identified for recording behaviors. Four major behaviors were recorded during the study period as foraging 49%, moving 26%, resting 16%, and

grooming 9% whereas Chalise *et al.* (2005b) recorded foraging 43.4%, moving 31.7%, sitting 18.5%, grooming 3.4% and stone licking 1.7% and Bhattarai 2002 recorded sitting 33%, eating 29.20%, walking 28.20 %, grooming 6.40%, mating 1.10%, aggression 0.71% and play 0.40% in the same study area but in different troop.

Chalise (2003) carried out observations on a macaque group in Langtang National Park in October –November 2000 and April-May 2001. Differences in time budget were noticeable. In 2000, the macaques foraged less (20% as opposed to 37% in 2001) and moved more (30% compared to 24% of their daily activity) than in 2001. They also groomed less (12% compared to 20% in 2001) and rested (sitting) more (38% compare to 19% in 2001). Chalise (2000) recorded four major behaviors during the study in both expeditions (1997/98) in Makalu-Barun National Park taking geophagy into separate account and found 3 to 4% difference in either cases of feeding, walking, grooming and resting (1997/98 invested percentages: feeding, 47/44; walking, 29/25; grooming, 9/13 and resting, 15/18) which is consistent to this present study in Langtang National Park. Aggimaragsee (1992) categorized the behaviors of all age sex class of Assamese monkeys into seven activities, where monkeys spent 31.2 % in rest, 27.2% travel, 16.8% feeding, 15.4% playing, 8% grooming, 1.1% aggression and 0.3% sexual activities. Khanal (2006) recorded similar type of diurnal behaviors in the mixed herds of Black Buck in Khairapur were found to invest more time on feeding (57%) followed by resting (26%), walking (6%), alert (4%), standing (4%) and others (3%) of the day time.

5.3 Threats to Monkeys (Crop-raiding and its consequences)

I found that presence of macaque damage was associated with the distance to farm from the forest which is similar to the study of Priston (2005) who had studied crop-raiding by *Macaca ochreata brunnescens* in Sulawesi, Indonesia. When farmers have opportunities to claim financial compensation for crop damage, there is the potential for primates to be 'blamed' for damage that may be over and above the damage these species actually inflicts (Chalise, 2000; Naughton Treves, 1997; Siex and Struhsaker 1999). Therefore, in this study, I had given no signs for compensation to the farmers from the concerned authorities before taking the response about crop loss from them; their estimation about crop damage may be somewhat reliable. In this study, the loss

was directly converted into Nepalese Rupees which was equivalent to about Rs. 2000 per household in the study area. The costs of crop protection ranged between Rs.500-1500 per household per year, which comes to Rs. 37,500- 112,500 for 75 households. Besides this direct loss, they also caused indirect loss by feeding upon the flowering and fruiting trees, which reduces the fruit production considerably.

Chalise (2000) collected the information of crop raiding by the interviews with the villagers in Lakuwa village of MBCA and reported that Rhesus and Assamese macaques were the most crop raiders and langurs visited the fields least and the villagers blamed that among the two species, Assamese monkeys were the terrible than rhesus. He estimated 39696.65 kg of the agricultural product in Lakuwa village with 80 households, was lost by the wild animals with 496.21 kg for each household; that is, 67.38% of cereals and 32.62% of tubers and fruits and among the crop losses due to the wild animals, monkey species took part in 55% damage. He stated that out of it they raid heavily to the maize fields- 29%, then potatoes- 23% (tubers also), rice-13%, fruits- 12% and kodo- 12%. The tubers and fruits come to 35% of the total loss and all the cereals combinely made 65% loss in Lakuwa village.

The most heavily damaged crops were maize, potato, wheat, buck wheat and millet, in common with other studies. Farmers were accurate in their reports of preferred crops by macaques. It was found that they persisted in growing maize, despite its vulnerability to crop damage. Hill (1997) reported that maize was a staple and preferred crop and was less vulnerable to other forms of damage. Chalise (2000) reported that cereals, fruits and tubers are the most preferred and vulnerable for raiding by macaques in MBCA which is similar to this study. Khatry (2006) also supports that maize is the prominently vulnerable crops for raiding by primates. Unlike macaques, Slender lorises ignore a year-round availability of wild and domestic flowers and fruits, including mangoes and bananas which lorises eat readily in captivity and are almost exclusively insectivorous (Nekaris and Rasmussen, 2003; Nekaris and Jayewardene, 2003; Nekaris *et al.*, 2005) though the herbivory is very common among primates (Fleagle, 1999).

Human activity on the farm, including regular patrols, caused monkeys to spend more time loitering on the boundaries of farms and reduced party sizes. Of the deterrents

used a combination of ‘physical and noise’ methods proved most likely to prevent further raiding, when carried out by men (Priston, 2005). Studies of elephant have shown that if the risks to elephants of raiding can be increased from the moment that they come near the farm, they are less likely to raid. Thus as soon as elephants are sighted people shout, whistle, and chase them to deter them (Hill, 1998). The same kind of activities was successful against macaques in LNP. This study showed that 60 % of the farmers were found to guard the fields by themselves, 20 % were using "Scarecrows", and 15 % were using dogs and remaining 5 % using tin-box and catapult for scaring and driving the macaques from the crop fields. Often farmers would wait until macaques were actually in their farm before they did anything to try to deter them. If, on first sighting the macaques, farmers made noises, threw stones and chased them away from the surrounding area it may prove successful in deterring them.

Chhangani and Mohnot (2004), in a study in and around Aravallis of India, calculated the percentage of crop protection methods by farmers as 60% guarding fields, 20% throwing stones, 15% using dogs and 5% others including dangerous methods like single shot gun, potash bomb and high voltage electric current in which animals are usually killed or seriously injured. But the farmers of Langtang National Park were not using cruel types of crop protection strategies like shot guns and potash bomb though the first three methods were also applied by them and guarding is found in both studies as the most effective one.

Bagale (2003) found guarding overnights as an effective crop protection technique in Lumbini area in order to protect their crops from Nilgai *Boselaphus tragocamelus, a* nocturnal crop raider. In this study, I found guarding field as most employed crop protection technique in Langtang from Assamese macaque, a diurnal crop raider. Though the Guarding/Chasing is the most effective method of deterrence in which mainly the women and children engage, it is time expensive and keeps people away from other activities (Bell, 1984; Hill, 2000; King and Lee 1987; Knight, 1999; Pirta *et al*., 1997; Sekhar, 1998; Southwick and Lindburgh, 1986; Southwick and Siddiqi, 1977) especially consumes the time of educational activities of children in such remote areas which further move the poor people backwards through long lasting impacts. So the loss is invaluable in comparison with time rather than economy.

Farmers in LNP reported that loss of crops, loss of food, loss of money and loss of time (via time spent guarding fields) were problems associated with crop-raiding by macaques. Loss of time was the most frequently cited problem, followed by crop loss. Crop loss, of course, actually encompasses two of the other problems, money and food.

CHAPTER-6 CONCLUSION

This study indicates that Langtang National Park is the prime habitat of Assamese macaque but the eco-war with local farmers in the form of unacceptable crop-raiding has been made this animal more vulnerable. The monkeys inhabiting forests were remarkably disturbed by the overutilization of forests by humans who cultivated crops in fields, cut tree branches as fodder for domestic animals and collected firewood. Monkey distribution has become fragmented and shrunken by the forest deterioration. Because of their distribution patterns, Assamese monkey populations would have been more influenced by forest habitat deterioration compared with other monkey populations. The isolated distribution of the Assamese seems insufficient for maintaining a viable population in Nepal. There have been few studies to determine the minimal viable population size necessary for the conservation of not only Assamese monkeys, but also *Macaca* in general. A species' viability must be measured by evaluating population dynamics and environmental effects.

Damage is present in more farms near to the forest than for those average distances or far from the forest. Thus macaque damage is more likely to occur in farms closer to the forest. Among the major crops found to be raided by Assamese macaque in the area, maize cobs are highly preferred followed by potato tubers. The most effective crop protection strategies adopted by the farmers is guarding their fields by constant vigilance during crop seasons. The crop loss has the potential to be a significant problem for subsistence farmers. Without an appreciation of the human dimension to problems of conflict with primate populations, sustaining primates not only outside but also inside protected areas may be impossible. However, for future generations of both nonhuman primates and humans, strategies to manage and contain conflict are urgently needed. These strategies must relate to human needs as well as primate needs in order to be effective over the long term. The Assamese macaque involved in crop-raiding is of major conservation concern, being vulnerable. Management of conflict thus needs to ensure that this species is not subjected to greater pressures leading to local extinction.

CHAPTER-7 RECOMMENDATIONS

1. The crop raiding by Assamese macaque is the major cause of conflict between Assamese macaque and human. For species and habitats to be conserved effectively, this conflict must be addressed. Developing a management plan needs to be done in the context of direct interaction and engagement with farmers and not in academic isolation.
2. Locals should be encouraged for the replacement of other suitable crops that likely not preferred (repellent crops) by primates. Future study should be focused on the identification of these repellent crops for monkeys.
3. The locals should be encouraged for the proper guarding of crop fields without persecuting the macaques.
4. Further study should be focused on inter-specific resource competition and spatial analysis between Himalayan *Semnopithecus entellus* and Assamese macaque as they occupy the same habitat.
5. Future study should also be focused on the effect of both within and between the group competition since they shape the group size and their fission and fusion with respect to seasonal availability of feeding resources and social behavior as in most of the macaques.
6. Locals should be awared about the role of primates in the ecosystem and the possibility of primate tourism as in the most of the African countries which may be the alternate income source for the subsistence farmers.

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PHOTO PLATE 1

A. Adult male of Assamese macaque **B. Juveniles of Assamese macaque**

C. Local women with raided maize cobs

D. Researcher (left) with raided maize cobs

E. Observation of crop-raiding field

F. Interviewing local people

PHOTO PLATE 2

G. Common place: crop field, village houses and the macaque habitat

H. Macaque entering the local

I. Children guarding their crop fields

J. Scarecrows on the fields

K. Discussion with local people **L. Conservation education for students**

APPENDICES

Appendix: 1 Group size of macaques encountered in different locations of the study area

SN	Location	Group Size	Co-ordinates	Elevation (asl)
1.	Ramche	25	N 28° 02' 21.6" E 085° 12' 31.9"	1719 m
2.	Ghurtabensi	22	N 28° 0' 48.2" E 085° 16' 02.3"	1300 m
3.	Thulo Bharku	23	N 28° 07' 47.0" E 085° 18' 22.9"	1860 m
4.	Sano Bharku	27	N 28° 09' 01.5" E 085° 19' 33.4"	1520 m
5.	Timure	35	N 28° 15' 49.0" E 085° 22' 23.0"	1710 m

6.	Tarsa	21	N 28° 11' 49.5" E 085° 20' 54.1"	1690 m
7.	Ronga Pool	16	N 28° 10' 56.0" E 085° 20' 22.2"	1455 m
8.	Thulo Syafru	31	N 28° 09' 23.9" E 085° 20' 57.0"	1640 m
9.	Lama Hotel	13	N 28° 09' 40.6" E 28° 25' 46.0"	2420 m

Appendix: 2 Climatic parameters recorded at Dhunche Station in the year 2006

Months	**Temperature (°C)**		**Humidity (%)**		**Rainfall**
	Maximum	**Minimum**	**8:45**	**17:45**	**(mm)**
January	17.7	3.9	63.4	70.5	0.0
February	18.2	6.4	71.6	76.1	0.6
March	18.8	7.2	62.3	70.8	75.6
April	22.0	10.1	68.0	66.9	94.4
May	24.2	14.2	77.3	76.2	130.9
June	25.2	15.9	90.5	88.9	199.0

July	25.6	17.0	84.8	86.6	430.2
August	26.7	16.7	81.3	81.9	377.2
September	24.9	15.5	80.8	82.4	164.6
October	23.2	11.2	64.0	65.2	11.4
November	18.7	6.8	58.2	58.2	6.6
December	14.6	4.3	75.9	76.2	33.4
Average	21.6	10.7	73.1	74.9	126.9

Appendix: 3 Pre-structured population survey form

Date: **Time:** **Primate Species:**

Location: **Troop/group size:**

Co-ordinates: **Total duration of observation:**

Altitude:

TALLY I

AM	AF	SAM	SAF	J	I	UI	Total

TALLY II

AM	AF	SAM	SAF	J	I	UI	Total

TALLY III

AM	AF	SAM	SAF	J	I	UI	Total

AM= Adult male AF= Adult female SAM= Sub-adult male SAF= Sub-adult female J= Juvenile I= Infant UI= Unidentified

Appendix: 4 Pre-structured Questionnaire for crop raiding

Q. N. **Date:**

Name: Age: Sex: M/F

District: VDC: Village:

Ward no:

Crop raider: Local name

Crop: Maize KG (=Rs…….) Rice KG (=Rs…….) Wheat KG (Rs…….)

Millets KG (Rs……...) Potato KG (Rs……...) Fruits KG (RS……)

Others:

Time of raid:

A. Dawn B. Late morning C. Afternoon D. Dusk

Crop affected part:

A. Eaten…… B. Destroyed……

Proximity of damage field to the jungle:

A. Near <100m B. Average 101-500m C. Far >501m

Action taken against the damage:

A. Guarded by Man/Woman/Young/Children B. Using dogs C. Scarecrows

D. Tinbox/Poison/Firecrackers/Shotguns E. Others

What do you expect from the park authorities?

……
……

……
……

……