

**POPULATION STATUS AND CONSERVATION THREATS TO ASSAMESE  
MACAQUE (*Macaca assamensis* M'Clelland, 1840) IN SHIVAPURI  
NAGARJUN NATIONAL PARK, NEPAL**



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In partial fulfillment of the requirement for the award of the degree of Master of  
Science in Zoology with especial paper Ecology**

**Submitted to**

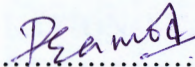
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**November 2018**

## DECLARATION

I hereby declare that the work presented in this thesis entitled “**POPULATION STATUS AND CONSERVATION THREATS TO ASSAMESE MONKEY (*Macaca assamensis* McClelland, 1840) IN SHIVAPURI NAGARJUN NATIONAL PARK, NEPAL**” has been done by myself, and has not been submitted elsewhere for the award of any degree. All the sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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This is to recommend that the thesis entitled “**POPULATION STATUS AND CONSERVATION THREATS TO ASSAMESE MONKEY (*Macaca assamensis* McClelland, 1840) IN SHIVAPURI NAGARJUN NATIONAL PARK, NEPAL**” has been carried out by Mr. Pramod Thapa for partial fulfillment of the requirement for Master’s Degree in Zoology with the special paper of Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this work has not been submitted for any other degree in any institutions.

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## LIST OF ABBREVIATIONS/ACRONYMS

<b>Abbreviated form</b>	<b>Details of Abbreviation</b>
asl	Above sea level
CAMP	Conservation Assessment and Management plan
CBS	Central Bureau of Statistics
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
Cm	Centimeter
GIS	Geographic Information System
GPS	Global Positioning System
IUCN	International Union for the Conservation of Nature and Natural Resources
HH	Households
Kg	Kilogram
Km <sup>2</sup>	Square Kilometer
LNP	Langtang National Park
Max./ Min.	Maximum/Minimum
MBNP	Makalu Barun Conservation Area
NG/RDHM	Nepal Government/ Regional Depart of Hydrology and Meteorology
%	Percentage
T/HB	Tail to Head Body Ratio
ShNP	Shivapuri National Park
SNNP	Shivapuri Nagarjun National Park
T.U.	Tribhuvan University
VDCs	Village Development Committees

## ABSTRACT

Systematic studies of less common primate species Assamese macaque is rare in Nepal, so to explore the population dynamics and threats to the macaque this study was carried out in the Nagarjun Forest of Shivapuri Nagarjun National Park (SNNP) from August 2017 to July 2018. A total of 145 Assamese macaques (*Macaca assamensis*) were encountered in 7 groups within the total area surveyed of 16 km<sup>2</sup> in Nagarjun Forest of SNNP by head count or direct count method. The group density was found to be 0.4375 groups/km<sup>2</sup> with a crude (population) density of 9.0625 individuals/ km<sup>2</sup> and a mean group size of 20.7142 individuals, range 11-41 individuals. Age-sex composition of macaque comprised 18.621% adult males, 24.138% adult females, 13.793% sub adult male, 11.034% young female, 9.655% Juvenile male, 11.724% juvenile female and 11.034% were infants in the study area. The adult sex ratio and the recruitment rate were found to be 0.771:100 (77male per 100 females) and 2.187:1 (218 female per 100 infant) respectively. Total 16 Quadrate of 20x20m, 44 plant species with 376 number were recorded from Nagarjun forest. This study revealed that Chilaune (*Schima wallichii*) is the dominant plant species with relative density 10.37% and relative frequency 8.27% followed by Musure kattus (*Castanopsis tribuloides*) with relative density 9.30% and relative frequency 7.51%. In the two buffer zone VDCs of Nagarjun forest, questionnaire survey was conducted to the local people who are directly involved in agriculture and reported crop raiding as the major problem. Crop mostly preferred includes maize (53.17%), Wheat (15.6%), Millet (7.33%), Paddy (11.93%), Vegetables (7.56%) and Fruits (4.41%). To protect crop fields, local peoples used patrolling and guarding the fields (42%), Tin-box and throwing stone with “Catapult” (13%), using dogs (11%), shouting and chasing (24%), and other methods like fencing with thorny twigs, trapping and caging, scarecrows etc. (10%) were used. Only 15% of the respondents approved that monkeys should be conserved, a majority of 85% don't feel that it is necessary to conserve the animal. Majority, 52% of local respondent agreed with retaliatory killing was the major threats to monkey, meanwhile 13% agreed with encroachment, 12% habitat destruction, 6% forest fire, 8% disease and 9% respondents stated they have no idea about the threats to monkey. Most of the local peoples (49%), suggested proper monetary compensation is appropriate for the reduction of intensity of conflict, 21% of people said that they should be killed, 19% of total respondents stated that translocation of monkey is another remedial measure. Patrolling and guarding of the crop field by security personnel (Army, Armed Police force) on the regular basis, was suggested by 6% and 5% of respondents didn't have any suggestion to give.

**Key words:** Assamese monkey, Crop damage, Nagarjun forest, Population distribution, Threats, Vegetation.

# 1. INTRODUCTION

## 1.1 General Background

The most glaciated area outside the polar realm, the Himalayan range (Owen, 2009), is enrich with unique geographic, topographic and climatic regions, and as a result has a high level of endemism and globally important ecoregions (Myers *et al.*, 2000). Approximately, the Himalayas run 2,400 km from east to west, with the Nepal Himalaya (NH) region extending along 800 km of its central section (ICIMOD, 2011). Nepal's biodiversity is a reflection of its unique geographic position, altitudinal, and climatic variations. NH places in the transitional zone between the eastern and western Himalayas, it incorporates the Palearctic and the Indo-Malayan biogeographical regions and the major floristic provinces of Asia (the Sino-Japanese, Indian, western and central Asiatic, Southeast Asiatic, and African Indian desert), creating a unique and rich terrestrial biodiversity (Chalise, 2013).

### 1.1.1 Historic Primate Research in Nepal

Primate research in Nepal was started in the 1970s on Rhesus monkeys (*Macaca mulatta*) in urban areas mostly near religious places and later, on the langurs. The first study on monkey was conducted by Southwick and Siddique in 1974. The research on the *Presbytis entellus* in Nepal was accomplished by American primatologists (Chalise, 1995; Bishop, 1975; Curtin, 1975; Boggess, 1976) studying on langurs of high altitude areas of Melamchi and Solukhumbu, Nepal. In 1990, Dr. Paul Winkler (Institute of Anthropology, University of Gottingen, Germany) started research on the Hanuman langur monkeys (*Semnopithecus entellus*) living around Ramnagar village of Chitwan, Nepal. This preliminary research led to the establishment of the Ramnagar Monkey Research Project (RMRP) in 1991 by Prof. Dr. Christian Vogel (Institute of Anthropology, University of Gottingen, Germany) in collaboration with the Natural History Museum, Tribhuvan University, Nepal. One Nepali (Dr. Chalise) joined this project in March 1992, to collect the data on langurs' sex differences in feeding behavior for his Ph. D degree (Chalise, 1995). Behavioral study and assessment of conservation status was started early on the 1980s by various biologists (Bishop, 1979; Chalise, 1995; Chalise, 2013). The study on Assamese monkey in Shivapuri Nagarjun National Park was initiated by Dr. Kazuo Wada around the 70s and it was followed later on by others (Wada, 2005; Chalise *et al.*, 2013b).

### 1.1.2 Primates

Among mammals, primates, viz., Prosimii (primitive primates such as lemurs, tarsiers and lorises) and Anthropoidea (new world monkeys, old world monkeys and hominids) are the most complex creatures which appeared on the planet Earth around 63 million years ago in Eocene period of Coenozoic Era (Drapper, 2000). The order Primates is one of the most species-rich groups of mammals, surpassed only by the orders Chiroptera (bats, 1151 species) and Rodentia (rodents, 2256 species). The most recent taxonomic

compilation lists 701 extant taxa belonging to 504 species from 79 genera and 16 families. Primates occur in four regions, the Neotropics (171 species), mainland Africa (111 species), Madagascar (103 species), and Asia (119 species) and are present naturally in 90 countries. However, two-thirds of all species occur in just four countries, Brazil, Madagascar, Indonesia, and the Democratic Republic of the Congo (DRC). Nonhuman primates, our closest biological relatives, play important roles in the livelihoods, cultures, and religions of many societies and offer unique insights into human evolution, biology, behavior, and the threat of emerging diseases. They are an essential component of tropical biodiversity, contributing to forest regeneration and ecosystem health. Alarming, about 60% of primate species are now threatened with extinction and about 75% have declining populations. This situation is the result of escalating anthropogenic pressures on primates and their habitats, mainly global and local market demands, leading to extensive habitat loss through the expansion of industrial agriculture, large-scale cattle ranching, logging, oil and gas drilling, mining, dam building, and the construction of new road networks in primate range regions. Other important drivers are increased bush meat hunting and the illegal trade of primates as pets and primate body parts, along with emerging threats, such as climate change and anthroponotic diseases. Often, these pressures act in synergy, exacerbating primate population declines (Estrada *et al.*, 2017).

### **1.1.3 Macaque/Monkey**

Macaques (genus *Macaca*; Primates: Cercopithecidae) are an ecologically extremely adaptive primate taxon that is distributed more widely than any other non-human primate genus. After a split-off from the baboons, mandrills, drills and mangabeys the macaques moved out of Africa and today only the Barbary macaque (*Macaca sylvanus*) is still found in Africa. All other extant macaque species occur in Asia, ranging from Pakistan, India and Tibet in the West to the Northeastern tip of Japan in the North and just south of the Wallace line in the Southeast (Thierry *et al.*, 2004). Two species of macaques have been reported from Nepal, the Rhesus macaque (*M. mulatta*) and the Assamese macaque (*M. assamensis*), the latter is the least known non-human primate of Nepal. They are diurnal animals found along the hills, valleys and upland river basin along the east-west mountainous range with diversified ecological zones (Wada, 2005). They are arboreal, terrestrial and omnivorous animals which are seen doing their social and other activities in the ground with sluggish movement (Chalise, 2005b).

### **1.1.4 Assamese macaque**

After the CAMP (Conservation Assessment and Management Plan) Workshop 2002 held in India, the Assamese macaque of Nepal was postulated as (*M. assamensis* ‘Nepal Population’) due to its morphological characters that differ from the currently recognized subspecies i.e. Eastern Assamese macaque (*M. a. assamensis*) and Western Assamese macaque (*M. a. pelops*), the ‘Nepal Population’ differs in pelage and facial color (darker

fur with purple snout), relative tail length, body weight and elevational distribution range to their nearest conspecific populations (*M. a. pelops*) from adjacent countries such as India and Bhutan, this macaque also considered as a new subspecies endemic to Nepal (Chalise, 2003; Molur *et al.*, 2003). This species inhabiting subtropical hills in Sal forests, mixed deciduous forests, temperate broadleaved forests with rocky outcrops, and steeply sloped riverside forests at high altitudes, they are endangered because of their restricted distribution, the small number of individuals in fragmented patches, and the reductions in their habitats and population caused by human activities (Molur *et al.*, 2003; Boonratana *et al.*, 2008). The species belongs to the polytypic Sinica-group of macaques with a fragmented distribution in South and South-east Asian countries (Fan *et al.*, 2017).

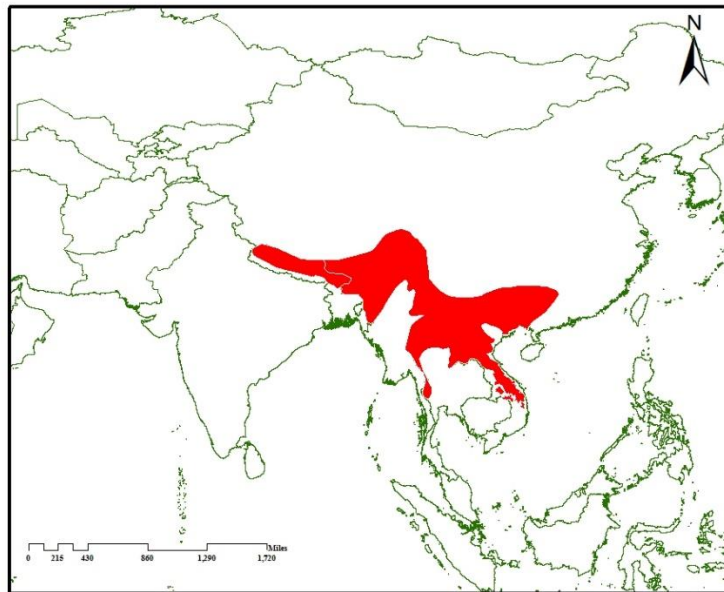
There are two known subspecies, eastern Assamese macaque (*M. a. assamensis* and western Assamese macaque (*M. a. pelops*), whose distribution ranges are demarcated by the Brahmaputra River (Roos *et al.*, 2014). It is a medium-sized, arboreal, diurnal, and omnivorous cercopithecine primate that lives in multi male multi-female social groups (Chalise, 1999; Molur *et al.*, 2003). It has been reported from the mid-hills and high montane forests within Nepal, but aspects of its socio-ecology remain poorly understood. Some studies have been conducted on population, distribution, behavior and conservation of Assamese macaque at different forest fragments (Chalise, 2013). In many parts of Nepal, it has been observed as one of the major crop raiders and in some areas even retaliatory killings have been reported (Chalise, 2010).

#### **1.1.5 Population status of Assamese macaque**

A population is defined as any group of organism 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). 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). The population recorded in Nepal during first decade of 2000 from different sites showed altogether 282 mature individuals while total population with different age and sex comprises up to 525 (Chalise, 2004a, 2004b; Chalise, 2005a). The most recent Assamese macaque population survey of Nepal counted a total of only 1,099 individuals in 51troops from 380 masl to 2,350 masl (Chalise, 2013). 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. To know and understand the interactions of the endangered animals with other species is also important for a successful conservation program (Fleming, 1973).

### 1.1.6 Distribution

Assamese macaque (*M. assamensis*) occurs from central Nepal east through the Himalaya to southernmost China and north and central South-east Asia (Fooden, 1982b). This Assamese macaque occurs in Bangladesh, Bhutan, southwestern China (Guangxi, Guizhou, Tibet and Yunnan), northeastern India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttar Pradesh, and West Bengal), Lao PDR, Myanmar, Nepal, northwestern Thailand, and northern Viet Nam. It is found from central Nepal east into northern Myanmar and southeast through southernmost China to the upper Mekong in Tibet, and in the east into southern Guizhou to Hoi Xuan in Viet Nam and Thateng in Lao PDR; the range continues south through the Myanmar/Thailand border ranges as far as Chongkrong, as well as to the Sunderbans in Bangladesh. There is a gap in northeastern India between the two main population pockets, specifically between central Bhutan and the south side of the Brahmaputra; the east bank of its upper course, the Dhibang, marks the division between the two subspecies (Groves, 2001).



Map 1: Global distribution of Assamese monkey (*Macaca assamensis*) (IUCN, 2018).

Wada (2005) and Chalise (2013) documented the distribution pattern of Assamese macaques along the Himalayan foothills within a narrow altitudinal range and forest fragments in Nepal. The current distribution of the Assamese macaque is fragmented and isolated due to physiographic barriers such as rivers and mountains, resulting in the morphological variation. Mostly found in mid hills (warm temperate monsoon; cool



temperate monsoon, 1000-3000 masl) (Chalise, 2013). In Nepal, recently Assamese macaque recorded from 130 m asl to 2,650 m asl (Khanal *et al.*, 2018).

### **1.1.7 Conservation status**

The Assamese macaque is categorized as “Near Threatened” by the IUCN and its Nepalese population, is nationally listed as “Endangered” due to its restricted distribution, population threats, and small numbers in fragmented patches of remaining habitat. Thus, the species is protected by the National Park and Wildlife Protection Act-1973 of Nepal (Boonratana *et al.*, 2008; Chalise, 2013; Chalise *et al.*, 2013a).

### **1.1.8 Threats**

Habitat loss and degradation, especially driven by agricultural expansion and intensification, are major threats to biodiversity (Maxwell *et al.*, 2016). Over the last two decades, about one-tenth (~3.3 million km<sup>2</sup>) of all wilderness areas worldwide were converted to anthropogenic land uses, with South America and Africa being the most affected regions (Watson *et al.*, 2016). Conflicts between humans and non-human primates are recognized as major issues in conservation of primates. Crop damage caused by primates is one of the most wide spread and common examples of human-non-human primate conflicts in areas where local people are mainly subsistence farmers (Hill, 1998). Monkeys destroy home gardens, fruit trees and crops. On the other hand, monkeys are also beaten, injured and killed by the local people. These interactions may increase the risk of bidirectional disease transmission (Jones-Engel *et al.*, 2008). Due to the narrow habitat range, Assamese macaque are facing strong negative impacts on their survival and the population is decreasing in many parts. Anthropogenic activities like deforestation, agricultural expansion, development projects of roads and hydroelectric power generation are reported as the major threats to this species (Chalise, 2013; Molur *et al.*, 2003).

## **1.2 Objectives of the study**

### **1.2.1 General objectives**

The main objective of the study was to investigate the population status, distribution and threats to the Assamese macaque in Nagarjun forest of Shivapuri Nagarjun National park (SNNP).

### **1.2.2 Specific objectives**

Specific objectives of the study are as follows

1. To determine the population status, their distribution and age- sex composition of Assamese macaque in Nagarjun forest of SNNP.
2. To explore the habitat characteristics utilized by Assamese macaque.

3. To assess the crop raiding and related threats to the Assamese macaque.

### **1.3 Rationale of the study**

Assamese macaque are rarely studied and documented throughout in its range countries (Kawamoto *et al.*, 2006; Timmins and Duckworth, 2013). Assamese macaque censuses were never thoroughly conducted in Nepal. The biggest threat to all of the primates in Nepal is persistent human encroachment. Deforestation drives the dispersal of primates increasingly into areas of human settlement and agricultural lands, and ultimately leads into conflict. The intact wild areas of Nepal are fragmented due to physical infrastructure with highway and human settlements poured around and through the forests, further exacerbated by extreme fuelwood and timber extraction (Chalise, 2013). The protected species are the great wealth of any country. This protected species Assamese macaque found in this location (Nagarjun forest of SNNP) is significant for wildlife study. It is further important that the Assamese macaque are residing very close to capital city and University, Colleges of the Kathmandu valley. It provides a high opportunity to study them in their natural setting and could be an easy access to formulate their management planning for countrywide. This study will be helpful to document the population status of Assamese macaque, associated habitat characteristics and any natural or anthropogenic threats that influences on the population growth and their distribution for proper conservation of the protected species and management of the human- macaque conflict which is likely to be increased in near future. So this study will definitely contribute to update information on above mentioned issues.

### **1.4 Limitation of the study**

Some of the limitations felt during field study are as follows

1. Steep sloppy forest of the study area created difficulties to follow the animal continuously for long period of time.
2. Lacked of sophisticated scientific equipment limit the finding of study.
3. Respondents may give biased answer.
4. Some individuals could not be found because of dense vegetation at some places and also difficult to identify their sex because of fast moving nature.

## 2. LITERATURE REVIEW

### 2.1. Population status and age-sex composition

Khanal *et al.* (2018) studied mitochondrial DNA analyses and ecological niche modeling of the Assam macaque (*Macaca assamensis*) in the foothills of Nepal Himalaya reported fine-scale sampling of the Assam macaque populations of Nepal has low nucleotide diversity but high haplotype diversity of mtDNA. They also reported that isolation by distance had a stronger influence on population genetic structuring than the riverine barrier effects and suggested that conservation efforts in the mid-hills and lower Himalayas to maintain the genetic viability of the endangered Assam macaques in Nepal.

Adhikari, Khanal and Chalise (2018) studied status and effects of food provisioning on ecology of Assamese macaque in Ramdi area, Palpa, Nepal. They reported two troops of Assamese macaque having total population of 48 with the mean troop size of 24 individuals. The group density was 0.33 group/km<sup>2</sup> with a population density of 6 individual/km<sup>2</sup>. The male to female adult sex ratio was 1:1.75 and the infant to female ratio was 0.85.

Upadhyay (2018) studied mother-infant relationships among Assamese monkey and Rhesus monkey in Shivapuri Nagarjun National Park, reported that one Assamese macaque troop consisted of 47 individuals, of which 6 were adult males, 14 adult females, 2 sub-adults male, 10 juveniles male, 2 juveniles female, 7 female infants and 6 male infants. Likewise, one Rhesus monkeys troop consisted of 37 individuals, of which 4 were adult males, 13 adult females, 4 young females, 4 female infants, one juvenile male and 11 male infants, in her selected two focal troops.

Poudel and Chalise (2017) studied on *Macaca assamensis* general behavior and vegetation associated with their habitats in Kaligandaki River Basin at Baglung and Parbat Districts of Nepal. They reported total 47 individuals of Assamese Macaques (*Macaca assamensis*) in four different troops.

Sarania *et al.* (2017) studied population status of the endangered *Macaca munzala* in Arunachal Pradesh, India, they reported that total number of 971 individuals (including two solitary males) comprising 41 troops of *M. munzala* during the population survey. The mean troop size was  $23.63 \pm 1.21$  individuals per troop ranging from 12 to 44 individuals. On average, *M. munzala* troops were comprised of juveniles (30.37%), adult females (23.83%), infants (18.22%), adult males (11.53%), sub-adult females (9.81%), and sub-adult males (6.23%).

Rijal (2015) studied Ecological study of Rhesus and Assamese macaque and their conflict with humans in Nagarjun forest Kathmandu, Nepal reported the distribution of the monkeys was found 270 and 166 numbers of Rhesus macaques and Assamese macaques in 7 different blocks respectively.

Koirala and Chalise (2014) studied general behavior and feeding ecology of Assamese macaque in Shivapuri Nagarjun National Park, reported that a total of 137 Assamese macaque of different five troops, in which mean troop size was 27.4 individuals with group density 0.31 groups/km<sup>2</sup> and 8.56 individuals/km<sup>2</sup> population density. Age- sex composition of macaque comprised 22.45% infants, 18.37% juveniles, 13.26% young, 19.39 % adult male and 26.53% adult female, having adult sex ratio of 0.73.

Adhikari and Chalise (2014) studied general behavior of Assamese macaque (*Macaca assamensis*, McClelland, 1840) in upper Marsyangdi area, Lamjung, Nepal, reported total of 53 individuals of Assamese macaques (*Macaca assamensis*) in the study area. Among them 13, 15 and 25 individuals were recorded in blocks A, B and C respectively. The minimum of Assamese macaque were reported from the Jagat and Paune of Taghring VDC whereas maximum numbers of Assamese were reported in Chipla of Ghermu VDC.

Aryal and Chalise (2013) studied the ecology of existing monkey species in Arkhale and Nayagaun VDC of Gulmi district Nepal. Four troops of Rhesus monkey with a population of 128 and a troop of Hanuman Langur with 14 individuals were recorded.

Chalise *et al.* (2013a) studied Ecology and Behavior of Assamese macaque in Shivapuri Nagarjun National Park (SNNP), Nepal and reported seven troops (166) of different population sizes in six potential sites. Three age groups were identified as infants, young, and mature. There are 14.46 %, 42.17 %, and 40.96 % infants, young/juvenile, and mature simultaneously. 21.08 % are male, 21.69% female, and 57.23 are of unknown sex.

Chalise *et al.* (2013b) studied the Population Distribution of Assamese macaque (*Macaca assamensis*) in Nagarjun forest of Shivapuri Nagarjun National Park, Nepal. Seven bisexual troops (144) were observed in subtropical/lower temperate forest of Nagarjun forest especially around Raniban forest area. The observed smallest troop was with 9 individuals while the largest troop had 37 (41) individuals of different age. The average troop size is 20.57. Out of three broad age groups adults were 56.31% and immature 43.06% while infant alone were 18.06%. The sex ratio between male and female was 1:1.34.

Schulke (2011) studied ecology of Assamese macaques (*Macaca assamensis*) at Phu- phieo wildlife sanctuary, Thailand reported that group composition of study group was 18 adult, 11 sub-adult, 18 juvenile, 7 infants, all total 54 individuals.

Chalise (2010) studied the Assamese macaque in Sebrubeshi of Langtang National Park, Nepal. He reported that total 77 Assamese macaque in two troops, in Pahirol and Dovan area, they are named as Pahirol and Dovan troops. Pahirol troop consists of 42 members with 6 adult male, 8 adult female 10 sub-adult male, 8 young female, 4 juveniles and 6 infants and in Dovan troop, 35 members with 5 adult male, 6 adult female, 8 sub-adult male, 7 young female, 4 juveniles and 5 infants.

Regmi (2008) studied the status and threats of Assamese Macaque in Langtang National Park. He reported total of 213 Assamese Macaques were encountered in 9 groups of 113 km<sup>2</sup> in which the group density is found to be 0.0791 groups /km<sup>2</sup> with a population density of 1.8691 individuals /km<sup>2</sup> and a mean group size of 23.66 individuals. He also reported, Age-sex composition of macaque, comprised 31% adult females, 16% adult males, 18% young, 16% juveniles and 19% were infants, having adult sex ratio 1: 1.92.

Kumar and Solanki (2008) studied the distribution and population status of the capped langur (*Trachypithecus pileatus*) in and around the Pakke Wildlife Sanctuary in Arunachal Pradesh, India. They surveyed ten selected localities, recording 26 groups and a total of 195 individuals. The data was obtained using line transect surveys and total count methods. Of the 195 individuals registered, 14% were adult males, 52% adult females, 2% unidentified adults, 7% sub-adults, 11% juveniles and 15% infants. The smallest group numbered 3, and the largest 13, with an average group size of 7.5 individuals. The male-female ratio was 1:3.6. The most common size class of the group was of 7–9 individuals.

Chetry *et al.* (2003) studied Non-human Primates in Namdapha National Park, Arunachal Pradesh, India and surveyed the primates to assess their status. They directly sighted, 5 species of diurnal primates, 10 groups of Hoolock Gibbons (33 individuals), 9 troops of Capped Langurs (61 individuals), 15 groups of Assamese macaque (209 individuals), 6 groups of Rhesus macaques (74 individuals) and one unidentified group of Macaques.

Chalise (1999) surveyed some Behavioral and Ecological Aspects of Assamese macaque (*Macaca assamensis*) in Makalu-Barun Area, Nepal and reported 83 individuals of Assamese Monkeys in five troops with 12 adult males, 23 adult females, 4 sub-adult males, 4 young adult females, 12 juveniles and 17 infants. No solitary males were reported.

## **2.2 Distribution**

Timmins and Duckworth (2013) studied distribution and habitat of Assamese Macaque in Lao PDR, including its use of low altitude Karsts. They reported that the distribution and ecology of Assamese macaque remains little studied in South-East Asia. He stated that most records are from hill evergreen forest above 500 m and ecological overlap with Northern pig tailed macaque (*Macaca leonina*) and with Rhesus macaque (*Macaca mulatta*) is very limited in Lao PDR.

Chalise *et al.* (2013a) studied ecology and behavior of Assamese macaque in Shivapuri Nagarjun National Park (SNNP), Nepal reported Altitudinal distribution covers from 1440 masl in Nagarjun Fulbari gate to Rholche/Cha-Gaun troop at an elevation of 1949 masl. All the troops found confined around the park boundary frequently interacting with crop-field of nearby villages.

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.

Wada (2005) studied on distribution patterns of Assamese macaque and Rhesus macaque in Nepal in 1984. During his survey he found that Rhesus macaque dominated the tropical, subtropical and temperate forests below 3,000 masl all over Nepal, Assamese macaques were patchily distributed along rivers in the tropical and subtropical areas and both species principally utilized forest parapatrically. Discontinuous distribution of Assamese macaque was as a result of expansion of Rhesus monkey distribution in mid- and late Pleistocene.

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

Singh (2001) reported that *Macaca assamensis* the second most common primate species, next to Rhesus, in Arunachal Pradesh, it found in all types of forest including bamboo forest starting from the foothills to an altitude of 2000m.

Choudhary (2001) reported an overview on primates of Northeast India, showed that *Macaca assamensis* is distributed in all the northeast states, on both banks of the Brahmaputra River, it was the most abundant primate in the mountains of Arunachal Pradesh. This species occurred from the floodplains (Dibru-Saikhowa National Park) to the high mountains (Dibang Sanctuary, Arunachal Pradesh), up to 2,800 m (rarely to 3,000 m, especially in summer) in Arunachal Pradesh, and prefers dense forests.

### **2.3 Vegetation associated with habitat**

Poudel and Chalise (2017) studied vegetation associated with *Macaca assamensis* habitats in Kaligandaki River Basin at Baglung and Parbat districts of Nepal, they reported that by quadrat sampling, 58 plant species with 716 number were recorded, whereas Sal (*Sorea robusta*) was the dominant plant species with relative density 31.42% and relative frequency 8.376% which was followed by Tiju (*Diospyros malabarica*) with relative density 10.93% and relative frequency 8.376%.

Chalise (2010) studied the Assamese macaque in Sebrubeshi of Langtang National Park, Nepal, habitat was explored by plotting the botanical quadrates in different elevation. Preliminary investigation showed that altogether 18 species of plants were found in the home range of focal Assamese macaque troop.

Chalise (1999) surveyed ecological aspects of Assamese macaque (*Macaca assamensis*) in Makalu-Barun Area, Nepal, reported that vegetation composition was 23 plant species were fodder plants, among the fodder plants the *Schima wallichii* was the predominant species.

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 dynamic resting for the Assamese Monkeys. She also reported the Kaulo and *Schima wallachi* are the most exploited tree species and Bilaune was the most common plant among the ground vegetation of the macaque's habitat. She concluded that the way in which Primate use time and organize activity pattern is an important aspect of behavioral ecology.

#### **2.4 Human- monkey conflict and threats**

Adhikari, Khanal and Chalise (2018) studied status and effects of food provisioning on ecology of Assamese macaque in Ramdi area of Palpa, Nepal. He reported human- monkey conflict was high in Ramdi area, primarily due to the crop-raiding from fields and even the storage, the major crops raided are maize, vegetables, pulses and fruits.

Poudel (2016) conducted research on conflict due to Assamese macaques (*Macaca assamensis*) and crop protection strategies in Kaligandaki river basin, Baglung and Parbat districts, western Nepal. He reported maize was the highest raided crop 46.95% followed by 15.91% paddy, 15.11% potato, 10.84% millet, 6.88% wheat, 2.05% pulses, 1.59% fruits and 0.66% vegetables. The most commonly used crop protection strategy in guarding their field were by constant vigilance 50%, 25% of field owner use "scarecrows" 20% used dogs, and 5% farmers used tin-box and catapult to chase the macaques from the crop fields.

Rijal (2015) studied ecological study of Rhesus and Assamese macaques and their conflict with humans in Nagarjun forest, Kathmandu, Nepal. He reported crop raiding was the main cause of conflict to human beings, Maize 57% and wheat 28% were reported to be the worst affected crops, whereas pulses 1% were the least. Shouting and following 31% as well as using stone and catapult 25% were the common methods of deterrent against the macaques. His findings further showed that the macaque problem has increased from <50% in 2011 to 92% currently.

Aryal and Chalise (2013) studied the ecology of existing monkey species in Arkhale and Nayagaun Village Development Committee of Gulmi district Nepal Rhesus monkey was considered most crops damaging, 65% respondents while physical hurt and harassment 27%. Shouting and chasing 30%, using stone and catapult 24% were the common local deterrent method against monkeys.

Khatun *et al.* (2013) from Bangladesh reported that when the supply of natural food is not enough, high quality and easily digested human food is a good alternative form of nutrition for primates, which could be the most important cause of the intensity of crop raiding.

Timmins and Duckworth (2013) studied distribution and habitat of Assamese Macaque in Lao PDR, including its use of low altitude Karsts. They reported that hunting and forest encroachment are threats to Assamese macaque in Lao PDR.

Priston *et al.* (2012) reported in many parts of the distribution range, anthropogenic habitat alteration has forced the non- human primates into conflict interactions with humans and their livelihood activities, especially through crop raiding.

Zhou *et al.* (2011) studied on diet of Assamese Macaque in limestone seasonal rain forests at Nonggang Nature Reserve, China. They found that Assamese Macaque are highly folivorous, where young leaf were staple food items (74.1% of the diet) and fruit accounted for only 17.4% of the diet.

Monkeys living in the habitat with fewer wild food resources are more likely to utilize human settlements and areas around them with dependence on crop foods (Yamada and Muroyama, 2010).

Chalise (2010) reported that crop damage problem in lower part of Langtang, the crop losses due to the monkey species were heavy to the maize fields, then potatoes (tubers also), rice, fruits and millets.

Regmi (2008) studied the status and threats of Assamese Macaque in Langtang National Park, he reported that maize, potato, wheat, buck wheat and millet were the crop raided by Assamese macaque. Negative attitude of the farmers with respect to food security and habitat encroachment were the main threats to the species.

Mc. Court (2005) stated that 92% respondents of Hetauda were found to suffer from crop damage from monkeys. 87% of respondents complained the harassment by monkey by taking food spilling or eating from the kitchen, porch or roof, whereas in his study 53.67% respondents stated crop raiding and 24.13% human attack and harassment as a major problem.

Persistent conflict with human- wildlife may have significant impacts on natural ecosystems and may cause even local extinction of wildlife populations (Woodroffe *et al.*, 2005).

Chhangani and Mohnot (2004) studied in and around Aravallis of India, Calculated the percentage of crop protection methods by farmers said that the most commonly used crop protection strategy is guarding the fields by constant vigilance during crop seasons, as 60%, 20% throwing stones, 15% using dogs and 5% others including dangerous method like single shot gun, potash bomb and high voltage electric current in which animals are usually killed or seriously injured.

Chetry *et al.* (2003) studied Nonhuman Primates in Namdapha National Park, Arunachal Pradesh, India, hunting, rather than habitat destruction, was the chief potential threat for primates in the park.



Sillero and Switzer (2001) reported that across the globe, primates are the most frequently identified crop-raiding animals, from Africa to the Arabian Peninsula to Southeast Asia to Japan, primates come into conflict with humans due to the renowned crop raiding behavior of many species.

Singh (2001) reported that the population of the macaque species in the state is under threat due to destruction and damage being caused to its habitat, the macaque is being hunted by the tribal people of the state for food and for medicinal purpose.

Chalise (1999) reported that both Rhesus and Assamese macaque raided field crops. Among the crop losses due to wild animals, 55% damage occurred through monkeys. They raid maize fields heavily in Lakuwa village of Makalu-Barun Area, Nepal.

Crop damage caused by raiding primates is one of the most widespread and common examples of human-primate conflicts in the areas where local people are mainly subsistence farmers (Hill,1998).

Choice of crops is a sort of compromise between the costs and benefits associated with crop type, the factors such as labor requirements for cultivation, harvesting, storage, food preparation and food preferences and traditions affects the type of crop grown (Hill, 1997).

Strum (1994) assumed that crop raiding is the foraging strategy with specific cost and benefits in the case of Olive baboons (*Papio anubis*) in Kenya.

Prater (1993) reported maize was highly raided crop by Assamese macaques at Tarkhola, Darjeeling, India. There the local Lepcha tribe hunted them for food and medicinal purposes.

### 3. MATERIALS AND METHODS

#### 3.1 Materials

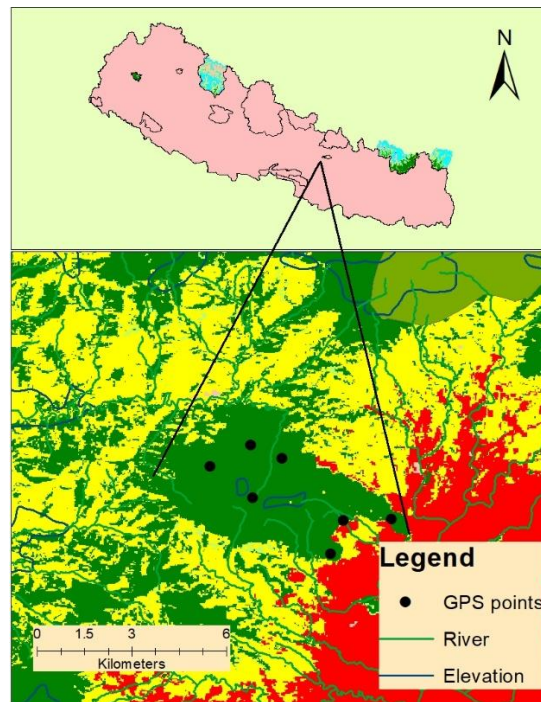
Following equipment were used during the field study.

- |                                      |                   |                   |               |
|--------------------------------------|-------------------|-------------------|---------------|
| a) Binoculars                        | b) Measuring tape | c) Digital Camera | d) Data sheet |
| e) Topographic map of the study area | f) GPS            | g) Stationary     |               |

#### 3.2 Study Area

##### 3.2.1 Location

Geographically Shivapuri forest located within 27°45' to 27°52' N latitude and 85°16' to 85°45' E longitude and Nagarjun forest is located within 27°43' to 27°46' N latitude and 85°13' to 85°18' E longitude. It covers parts of Kathmandu, Nuwakot, Sindhupalchowk and Dhading districts of central Nepal and elevation range from 1350 to 2732 masl. It is the only protected area that falls entirely within the middle mountain range of Nepal and represents its flora, fauna and ecosystem (SNNP, 2017).



Map 2: Nagarjun forest and GPS points of recorded Macaque troop.

Shivapuri Nagarjun National Park (SNNP) initially established as Shivapuri Watershed Conservation Area in 1976, Shivapuri Protected Watershed Area in 1978 as Shivapuri Watershed and Wildlife Reserve in 1983, as Shivapuri National Park (144 km<sup>2</sup>) gazette in 2002 and Nagarjun forest area (16 km<sup>2</sup>) was added and renamed as SNNP in 2009. It is

situated on the Northern fringe of Kathmandu valley, and the Park headquarters (Panimuhan) is just 12 km away from the centre of Kathmandu city (Sundharaa). The Park is a true representation of the mid hills in the protected area system of Nepal (SNNP, 2017).

### **3.2.2 Boundaries**

Covering an area of 159 km<sup>2</sup> of Kathmandu, Nuwakot, Dhading and Sindhupalchok district of central Nepal, the park stretches about 20-24 km East-West and about 8-10 km North-South and separate patch of Nagarjun forest of 16 km<sup>2</sup>. The park boundary is well demarcated with a 111 km long stone wall around the Park. The boundary wall runs along number of Village Development committees (VDCs) that include Talakhu, Chhap, Likhu, Sikere, Samundradevi, Sunkhani, Thanapati of Nuwakot District in the North and Jitpurphedi, Kavresthali, Sangla, Jhormahankal, Tokha Chndeshori, Bisnu-Budhanilkantha, Chapali Bhadrakali, Baluwa, Nayapati, Sundarijal, Gagalphedi, Bajrayogini, Lapsiphedi of Kathmandu district in the South. Bhotechaur, Haibung of Sindhupalchok district lies in the Eastern boundary while Okharpauwa and Kakani of Nuwakot district lies in the Western boundary of the Park. Similarly, the Nagarjun patch is also well demarked by boundary wall and runs along Bhimdhunga, Ramkot, Ichangunarayan, Goldhunga, Jitpurphedi and Chhatredeurali VDCs (SNNP, 2017).

### **3.2.3 Some of the significant highlights of SNNP**

#### **3.2.3.1 Source of Fresh Water**

Bagmati, Syalmati, Bishnumati, Rudramati, Sangala, Tusal Khola, Salinadi Mahadev Khola, Nagmati and their tributaries of SNNP are the prime source of drinking water for Kathmandu valley (SNNP, 2017).

#### **3.2.3.2 Sink for air pollution**

Kathmandu city is under catastrophic threat of environmental degradation primarily due to air pollution, which has caused significance cases of respiratory related illnesses in the valley's resident population. In this scenario, SNNP plays a vital role as a carbon sink hence the valley's entire population shares sequestering CO<sub>2</sub> by SNNP as an ancillary benefit (SNNP, 2017).

#### **3.2.3.3 Cultural heritage and tourist destination**

Shivapuri peak and Jamacho are the holy places for both Hindus and Buddhists and source of holy rivers Bagmati and Bishnumati. Jamacho, Buddha Gumba, Pachali Bhairab at Nagarjun is the popular tourist destinations which also provide opportunities for recreation, rock climbing, hiking and wilderness. Baghdhowar, Bishnudhowar, Sundarimai, Manichud, Tarakeshowr are the popular religious tourist destination in Shivapuri area (SNNP, 2017).

### 3.2.3.4 Climate

SNNP has subtropical to warm temperate climate. There is a high variation in annual temperature and precipitation. The weather station at Kakani (altitude 2066 m), has record of average maximum temperature of 22.7<sup>0</sup> C in mid - May/June and that of average minimum temperature of 0.30<sup>0</sup> C in December/January. The mean annual precipitation was 2727 mm mostly occurring during monsoon period (SNNP, 2017).

### 3.2.4 Biodiversity Status

#### 3.2.4.1 Floral Diversity

Floral diversity is quite high in SNNP due to its location, altitudinal and climatic variations. The elevation of this national park ranged between 1000 m to 2732 m asl within 10 km north-south aerial distances. The park is located in sub-tropical and lower temperate zone of Nepal. It harbors a total of 2,821 plant species. About 129 species of mushrooms and nearly 50 species of macro fungi have been reported. There are more than 1250 flowering plants including 16 endemic species (SNNP 2017). Forests in Nagarjun can be categorized into four types: *Schima wallichii* forest, pine forest, mixed broadleaved forest (*Phoebe lanceolate*, *Machilus duthiei*, *Michelia kisopa* as major species) and dry oak forest, which support rich faunal and floral diversity with a number of protected, threatened and endemic wildlife species (Kanai and Shakya 1970). Among the four types of forests recognized in Nagarjun hill, the *Schima wallichii*, forest constituted nearly 2/3rd of the total forest cover. GIS analysis has shown that coverage of *Schima wallichii* forest, mixed broadleaved forest, pine forest and dry oak forest in Nagarjun hill was 61.29%, 27.91%, 9.08% and 1.72%, respectively (Nagarkoti, 2006).

#### 3.2.4.2 Faunal diversity

Faunal diversity of the park includes 30 species of mammals including nine threatened species. Clouded leopard (*Pardofelis nebulosa*), two species of pangolin (*Manis spp.*) Assamese macaque (*Macaca assamensis*), Leopard cat (*Prionailurus bengalensis*) are the protected mammals found in SNNP. Common mammals include Common Leopard (*Panthera pardus*), Himalayan Black Bear (*Ursus thibetanus*), Goral (*Naemorhedus goral*), Jungle Cat (*Felis chaus*), Wild Boar (*Sus scrofa*), Barking Deer (*Muntiacus muntijack*), Sambar (*Cervus unicolor*), Rhesus monkey (*Macaca mulata*), Porcupine (*Hystrix indica*), Himalayan Serrow (*Capricornis thar*), Yellow Throated Marten (*Martes flavigula*), Large Indian Civet (*Viverra zibetha*), masked palm civet (*Pagumalar vata*), Flying Squirrel (*Petaurista spp.*), mongooses and bats. SNNP is one of the most popular areas for watching birds and butterflies. It is home to 106 species of butterflies and 318 species of birds, 14 of them are threatened including Spiny Babbler (*Turdoides nepalensis*), which is an endemic species. Eighteen species of Herpetofauna found in Nagarjun forest, Frogs, Toads, King Cobra, Green Pit Viper, Rat Snake, Skink, Lizards and Geckos are

common reptiles found in SNNP. Rhesus monkeys are very common and widespread, cause tremendous crop damage. The Nagarjun area of the park is one of the best locality to observe the Assamese macaque (SNNP 2017). It is estimated that more than 200 Rhesus monkeys inhabit around SNNP and with a maximum number of 64 individuals in a troop of Sundarijal (Chalise, 2013; Chalise *et al.*, 2013a).

### **3.2.5 Threats**

#### **3.2.5.1 Hunting**

Poaching of wildlife is another issue of great concern especially within the BZ areas. Respondents from most of the villages claimed that hunting occurs everywhere, however it takes place as a retaliation against crop damage or to control further loss of the crops (SNNP, 2017).

#### **3.2.5.2 Habitat degradation**

The major problem confronted by wildlife in the area is degradation of their habitats by humans through several activities. Deliberate as well as accidental forest fire, tourism and contagions livestock diseases is serious problem of great concern in the area (SNNP, 2017).

### **3.3 Methodology**

#### **3.3.1 Preliminary Survey**

The areas with steep cliff and deep gorges were the preferred habitat for Assamese macaque (Chalise, 2003), such areas are considered as focal areas to find the species (Chalise, 2010). To identify the focal area, all the possible forest trail of Nagarjun forest were surveyed, prior to commencement of fieldwork, in the month of August 2017.

#### **3.3.2 Direct/head count**

##### **3.3.2.1 Population census**

All the focal area were repeatedly visited by walking through forest trail. The trails were walked slowly at 1 km/ hr., covering the 6 km/day. Observers were placed along trails stopping every 1000 meters to search the area for ½ hour by applying both visual and auditory cues simultaneously as described by Altman (1974) and practiced by Chalise (2003). Whenever the macaques were encountered (considered as focal troop), the following data were recorded detection time, locality, its coordinates, habitat type and age-sex composition. Repeated observation was made to identify individually and to recognize their home range. A regular watching was conducted without disturbing natural setting. The head count of the particular troop was done by visual inspection aided with binoculars (10x40 mm). Counting was repeated three times in an observation session to minimize the bias in distinguishing troop composition.

### 3.3.2.2 Age- sex composition

The composition of the troop was differentiated into seven different categories of Age and sex, according to their body size, coloration and behaviors as described by (Chalise, 1995).

**Adults** were those attained the maximum height and body maturity. Adult males were distinguished by large and hanging scrotal sacs, prominent sitting pads, large skull and a bit flat head, Adult females were distinguished with small dome shaped head, protruded nipple and sexual swelling in estrus period.

**Sub Adults and Young** were those who attained the height of adulthood however not matured enough in body fitness and sexual activities. They were grown up and independent, without hanging scrotal sac in male and no protruded nipple in female.

**Juveniles** are the individuals that are left nipple contact (weaned) and depend on natural foods and they play a lot between the same age groups, mostly following their kin. Male try to stay far from mother while female follow her mostly.

**Infants** are those stage individual they still depends on nipple feeding for their main food. The very young infants are always clinging on breast while a little grown up are frequently clinging to their mothers for movement and security.

### 3.3.2.3 Population Density

Population density defined as total number of animals per unit area they occupy. It is necessarily a positive number, but may be a whole number or a fraction. The generalized formula to obtain the crude density is:

$$\text{Crude Density (C. D)} = \text{Total number of individuals (N)} / \text{Total Area (A)}$$

$$\text{Group density (G. D.)} = \text{Total Number of troop} / \text{Total Area (A)}$$

### 3.3.2.4 Sex ratio

Male to female sex ratio was taken as the number of males per 100 females.

### 3.3.2.5 Range

It is difference between minimum numbers of individuals of one troop to other troop which was of maximum numbers of individuals.

### 3.3.2.6 Average troop size

It is the ratio of total numbers of individuals (N) to total numbers of troop recorded.

### 3.3.2.7 Recruitment rate

It is the ratio of total numbers of female to infant.

### **3.3.3 Distribution of Assamese Macaque**

Assamese Macaque distribution in the study area was determined by categorizing age-sex composition of each troops recorded in study area.

### **3.3.4 Habitat Analysis**

Due to presence of mountainous topography that precludes the most of the systemic survey methods impractical (Rose and Reeve, 2003) so the quadrates of 20×20 m sized were used to analyze vegetation of Assamese macaque habitat. Total 16 quadrates were laid down attitudinally in the possible habitat of macaques. The collected vegetation data were quantitatively analyzed. To understand characteristics and productivity of the habitat, different parameters like density, relative density, frequency, relative frequency and dominance, were determined (Zobel *et al.*, 1987). Local name of the plant was identified by the experienced local persons. Unidentified plants in the field were prepared herbarium and were identified at National Herbarium Center, Godawori, Lalitpur.

#### **Density of species**

$$= \text{Total No. of individual of a species} / (\text{Total No. of quadrate} \times \text{Area of quadrate})$$

#### **Relative Density of a species**

$$= (\text{Density of a species} / \text{Total density of all species}) \times 100$$

Frequency of a species is the percentage of quadrates in which the particular species occurs. It gives an index on the spatial distribution of a species and is a measure of relative abundance (Krebs, 1978).

#### **Frequency of a species**

$$= (\text{No. of quadrate in which a species occur} / \text{Total No. of quadrate}) \times 100$$

#### **Relative frequency of a species**

$$= (\text{Frequency value of a species} / \text{Total frequency value of all species}) \times 100$$

### **3.3.5 Questionnaire Survey**

Questionnaire survey was conducted with the local inhabitants (respondents) in the buffer zone VDCs of Nagarjun Forest. Each VDCs households (HH) and human population (HP) are as follows Chhatreaurali (1655 HH, 7687 HP) from Dhading district, Bhimdhunga (619 HH, 2915 HP), Ramkot (1937 HH, 8759 HP), Ichungu Narayan (6288 HH, 24,425 HP), Goldhunga (3806 HH, 16174 HP) and Jitpurphedi (1103 HH, 5135 HP) from Kathmandu district (CBS, 2011). Information on various aspect of problematic issues and threats to Assamese macaque was gathered using semi-structured questionnaires. Household survey was conducted and individuals were interviewed randomly. Details regarding their landholdings, crop loss due to macaque raiding, retaliatory killings, crop protection strategies (adopted by the local peoples), their perception towards monkey conservation etc. were collected. The interviewees were the household head, the wife of

the household head or with resident adults (>18 years), who were willing to participate in the interview as a representative of the family. Each interview was conducted in Nepali. It took 15-30 minutes to complete one questionnaire.

**Sample size and sampling method:**

Random sampling method was used to select respondent for the questionnaire survey. The intensive crop raiding and conflict issues were in Chhatreurali VDC (Dhading) and Bhimdhunga VDC (Kathmandu) according to local people, so questionnaire survey was mainly focused in such 2 area, out of 1655 households in Chhatreurali, 65 respondents and out of 619 household in Bhimdhunga 35 respondents, altogether 100 respondents (4.4%) were selected as sample size from the study area.

**3.3.6 Data analysis and presentation**

The collected data was edited and tabulated for analysis and interpretation with the use of MS EXCEL 2013. Arc GIS 10.1 was also used to map out the distribution of Assamese Macaque in the study area. Mainly descriptive statistics (percentages, frequencies) were used to analyze the data. Charts, table, graphs, and bar diagrams were used to present the data in most simplified and understandable form.



## 4. RESULTS

### 4.1 Population status of Assamese macaque

#### 4.1.1 Total population

A total of 145 individuals of Assamese macaque (*Macaca assamensis*) were recorded from seven different troops during the field study. The minimum of Assamese macaque were recorded from Jamacho troop 11 individuals and maximum 41 individuals were recorded from Army barrack troop (Table 1).



Photo 1: Adult female Assamese macaque. Photo 2: Observing macaque into the forest.

Table 1: Population status of Assamese macaque in each 7 different troops, in Nagarjun forest, 2017/18.

S.N	Location/ Troop	GPS Coordinates		Altitude (M)	Troop Size	Aspect
		Latitude (N)	Longitude (E)			
1	Raniban	27.73981	85.28225	1376	28	Southern
2	Ichungu	27.73025	85.27868	1515	22	Southern
3	Army barrack	27.74012	85.29601	1404	41	Southern
4	Jamacho	27.74621	85.25638	1901	11	Northern
5	Mudkhu	27.75759	85.26464	1526	16	Northern
6	Sanagau	27.76139	85.25566	1522	12	Northern
7	Ain dada	27.75514	85.24404	1674	15	Western
Total					145	

#### 4.1.2 Density, Range and Average troop size

Total area of study area was 16 km<sup>2</sup>, therefore the crude density in the study area was calculated to be 9.0625 individual/km<sup>2</sup>. Group density was found to be 0.4375 group/km<sup>2</sup>. The mean troop (group) size of Assamese macaque in the study area was found to be 20.7142. Range was (11-41) individuals.

### 4.1.3 Age- sex structure

Troop composition was categorized into 7 age- sex group, such as adult male 18.621%, adult female 24.138%, sub-adult male 13.793%, young female 11.034%, juvenile male 9.655%, juvenile female 11.724% and infants (unidentified sex) 11.034% (Fig 4).

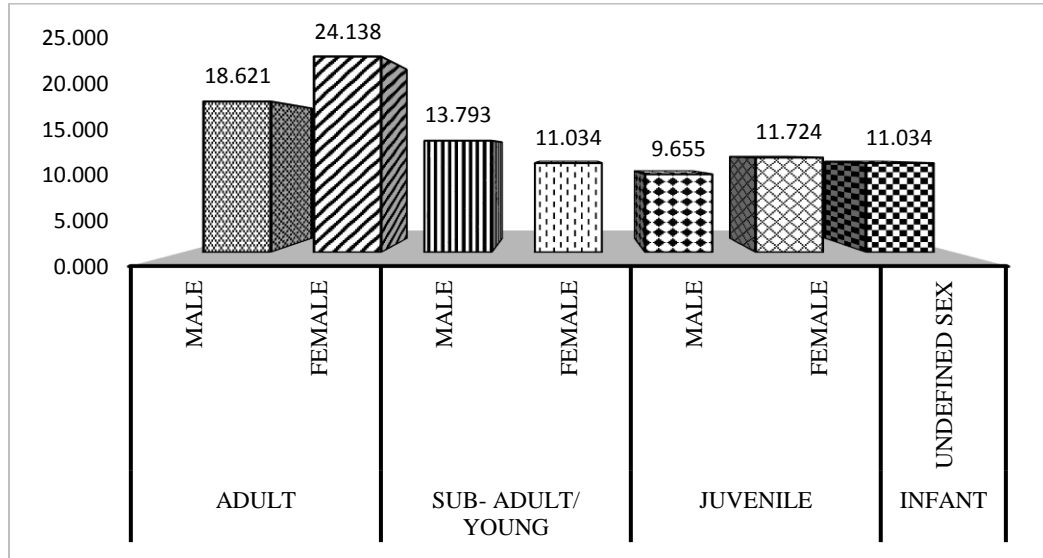


Fig 1: Overall Age-Sex composition, 2017/18

### 4.1.4 Sex Ratio

Among Adult, out of 62 individuals male to female ratio was 0.771:100 (77male per 100 females).

### 4.1.5 Recruitment rate

Female to infant ratio observed in the study area was 2.187:1 (218 female per 100 infant).

### 4.1.4 Forest type of each Assamese monkey troop recorded

Most of the troops were recorded from *Schima- Castanopsis* forest (5 troops). Single troop



Photo 3: Nagarjun forest from view tower. Photo 4: Nagarjun forest from Jamacho Gumba. recorded from chirpine forest and mixed broadleaved forest and dry oak forest, where no any troop recorded (Fig 5).

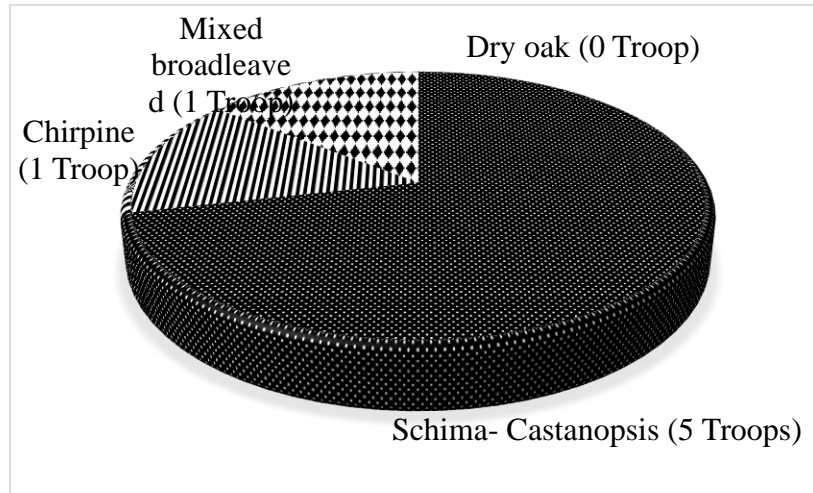


Fig 2: Forest type and corresponding number of troops occupied.

#### 4.2 Population distribution

Among 7 different troops, largest troop was Army barrack troop composed of total 41 number of individuals, in which 6 were adult male, 7 adult female, 5 sub-adult male, 6 young female, 4 juvenile male, 5 juvenile female, 8 infants.

Smallest troop was Jamacho troop composed of total 11 number of individuals, in which 2 were adult male, 3 adult female, 2 sub-adult male, 1 young female, 1 juvenile male, 2 juvenile female, 0 infants (Fig 6).

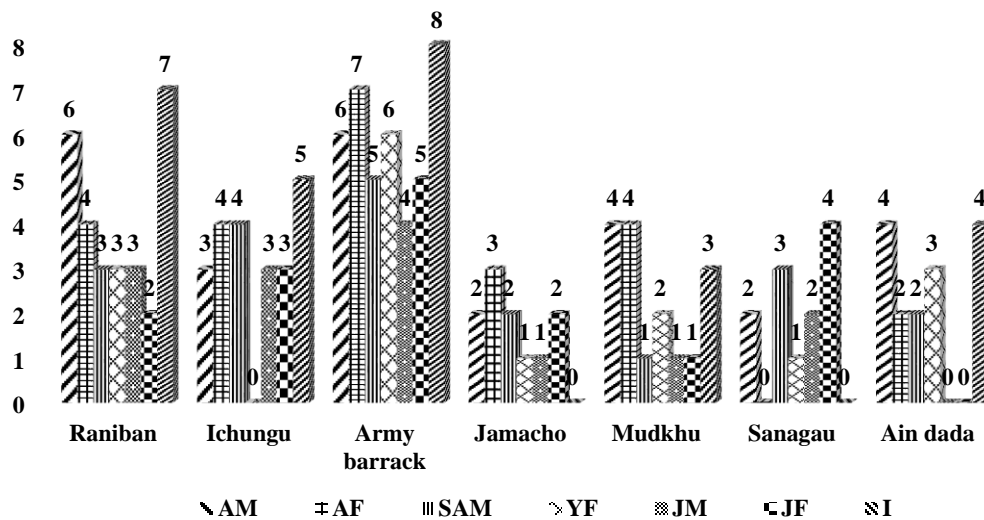


Fig 3: Troop wise distribution of Assamese monkey, 2017/18.

Where AM= Adult male, AF= Adult female, SAM= Sub adult male, YF= Young female, JM= Juvenile male, JF= Juvenile female and I= Infant

### 4.3 Vegetation Analysis

By quadrat sampling, 44 plant species with 376 number were recorded. This study revealed that Chilaune (*Schima wallichii*) is the dominant plant species with relative density 10.37% and relative frequency 8.27% which is followed by Musure kattu (*Castanopsis tribuloides*) with relative density 9.30% and relative frequency 7.51%. The detail list of vegetation is given in (Appendix-II).



Photo 5: Tree composition in quadrat sampling. Photo 6: Recording of trees species.

### 4.4 Threats Assessment

#### 4.4.1 Crop raiding

In the buffer zone of Nagarjun forest, the major crops are maize wheat, millet etc. People who are directly involved in agriculture reported crop raiding as the major problem. Monkey damage crop by different ways, sometimes eating the harvestable part, sometimes premature dropping of fruits and flower buds and sometimes uprooting the whole plants.



Photo 7: Macaque raiding the maize field.

Photo 8: Eating maize.

Crop mostly preferred includes Maize (53.17%), Wheat (15.6%), Millet (7.33%), Paddy (11.93%), Vegetables (7.56%) and Fruits (4.41%). Vegetables such as beans, cabbage, cauliflower, potato etc. and fruits such as banana, mango, litchi, nuts, guava etc. are reported to be worst affected, by the monkey in the study site (Fig 7 and Appendix IV).

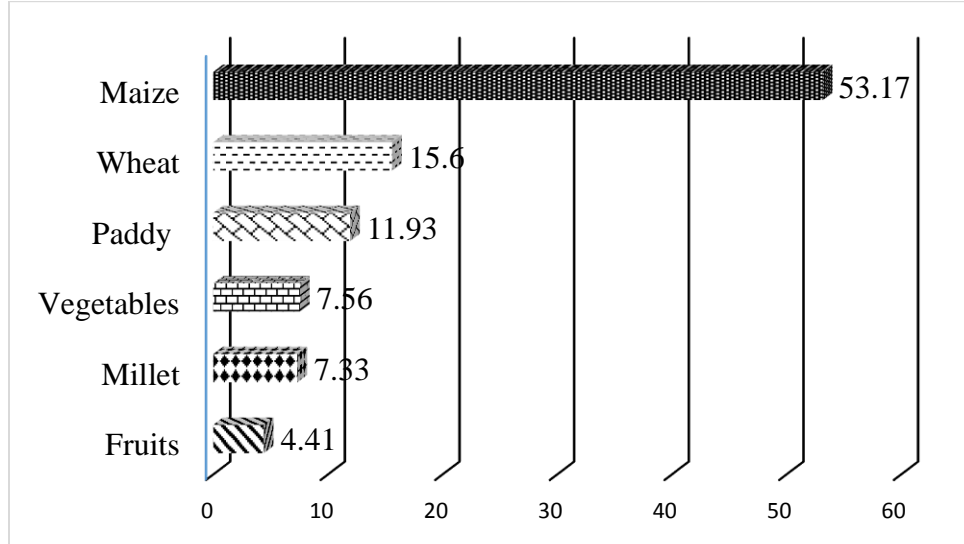


Fig 4: Crop damage (%) by Assamese Macaques in buffer zone VDCs of Nagarjun forest.

#### 4.4.2 Deterrent methods against monkey

To protect crop fields, from monkey species local peoples used various methods, these methods include patrolling and guarding the fields (42%), Tin-box and throwing stone with “Catapult” (13%), using dogs (11%), shouting and chasing (24%), and other methods like fencing with thorny twigs, trapping and caging, scarecrows etc. (10%) were used (Fig 8).

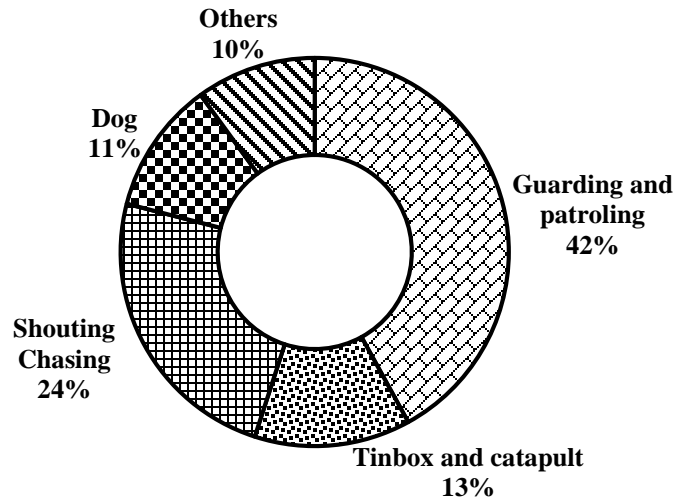


Fig 5: Different crop protection strategies used by farmers in buffer zone VDCs of Nagarjun forest.

### 4.4.3 People's Perception and Attitude towards Monkeys

Only 15% of the respondents approved that monkeys should be conserved, among them 20% thought that, they are animal lover, 53.33% thought that, all animal have right to live, and 26.66% were convinced to both factors.



Photo 9: Interviewing with the local people. Photo 10: Interviewing with the local people.

A majority of 85% don't feel that it is necessary to conserve the animal, among them 56.47%, thought that they are crop raider, 23.53% thought that human attack and harassment and remaining 20% claimed both above factors are responsible to dislike of monkey (Fig 9).

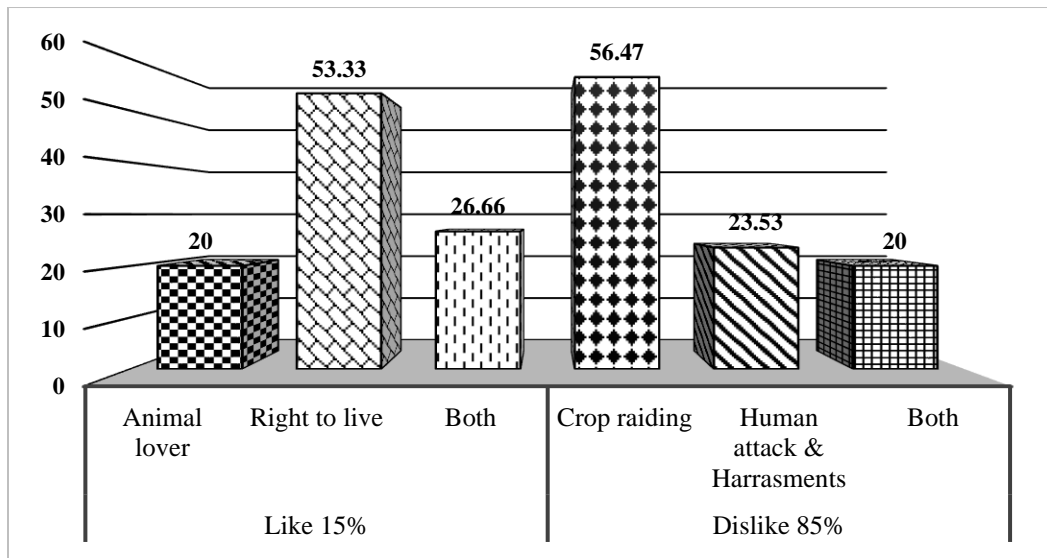


Fig 6: People's Perception and Attitude towards Monkey.

### 4.4.4 Threats to the species

In the buffer zone, 52% of local respondent agreed with retaliatory killing was the major threats to monkey, meanwhile 13% agreed with encroachment, 12% habitat destruction, 6% forest fire, 8% disease and 9% respondents stated they have no idea about the threats to monkey (Fig 10).

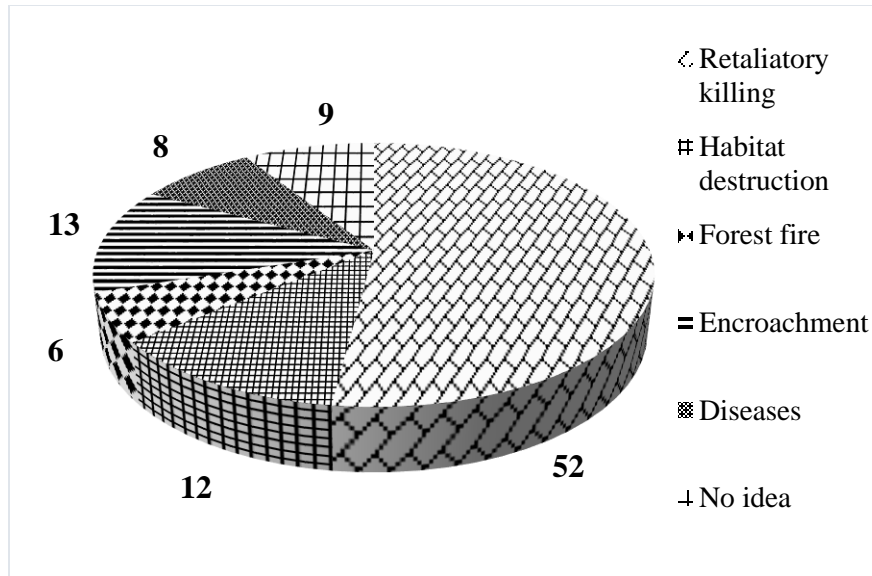


Fig 7: Major threats associated with monkey.

#### 4.4.5 Remedial measures

Most of the local peoples (49%) were suggested proper monetary compensation is appropriate for the reduction of intensity of conflict. 21% of people were more aggressive to monkey and said that they should be killed. Translocation of monkey is another remedial measure suggested by 19% of total respondents. Patrolling and guarding of the crop field by security personnel (Army, Armed Police force) on the regular basis, was suggested by 6% and 5% of respondents didn't have any suggestion to give (Fig 11).

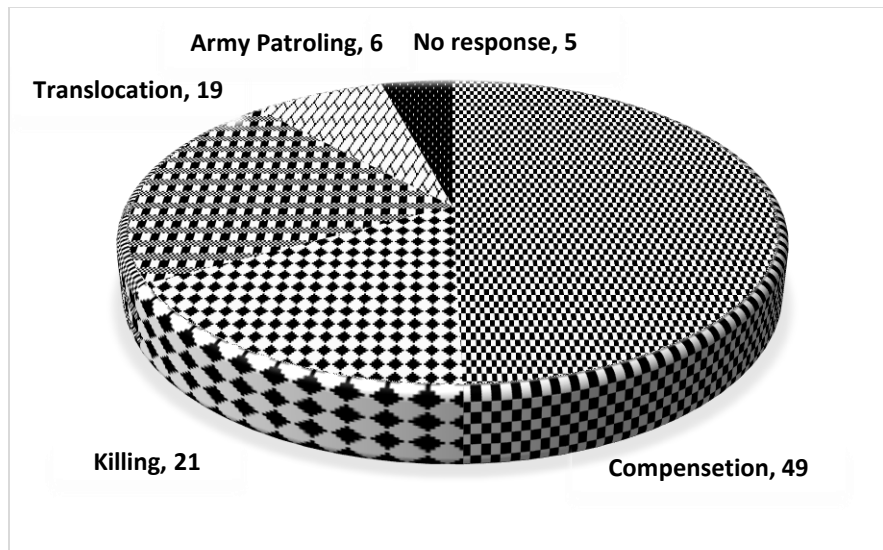


Fig 8: Remedial measure suggested by local people.

## 5. DISCUSSION

### 5.1 Population Status and Density

The macaques groups in Nagarjun forest of SNNP were comparatively more stable and less persecuted by human beings, made the recording of group size and their composition more accurate. Environmental constrains and human interference might affect group composition and group size of the macaques (Machairas *et al.*, 2003). In fact there are demographic differences between the encountered populations in Nagarjun forest, large group size (41) observed in Army barrack might be attributed to provision of food from canteen, which maximize the availability of food. The research conducted on population status in Nagarjun forest of SNNP, it was found that 7 troops of Assamese macaque with 145 total number of individuals at 7 different sites, whereas Wada (2005) had recorded Assamese macaque in Nagarjun for the first time and total number of individual was 98. While in same study site Chalise *et al.* (2013a) had recorded three troop having 83 individuals in Nagarjun forest, however Koirala (2014) reported that five troop with total number of 137, in 5 different sites, at the same time Chalise *et al.* (2013b) reported 7 troops with 144 total number of individuals, which shows the macaques' groups in Nagarjun forest were comparatively more stable, consistent and less persecuted by human beings, easily available of food resources might be the reason for constant stable rate of population of Assamese macaque in the study area.

This research revealed the average troop 20.714 and range 11-41, while in the same study area Chalise *et al.* (2013b) reported smallest troop was with 9 individuals while the largest troop had 37 individuals, the average troop size was 20.57 also Koirala (2014) reported mean troop size 27.4 (Range 17-43) and Wada 2005, with range 5-34 (mean 19.1) these findings are highly consistent with this research findings this might be due to insignificant disturbance of habitat as protected area. The group density and population density of this study was found to be 0.4375 group/km<sup>2</sup> and 9.0625 individual/km<sup>2</sup> and mean group size as 20.714, however Poudel (2017) reported total of 47 individuals in 4 different troops in Baglung and Parbat district, group density was 0.038 groups/km<sup>2</sup> and population density of 0.44 individuals/km<sup>2</sup> and mean group size of 11.75 (range 3-16) individuals, whereas Adhikari (2014) reported three troops of Assamese Macaques in Lamjung and estimated group size 13-25, having total 53 individuals from three different blocks and population density 0.28 individuals/km<sup>2</sup>, with the mean group size of 17.66 in Lamjung. While Adhikari (2018) reported from Ramdi area, Palpa found total two troops of Assamese macaque with the mean troop size of 24 (Range 21-27), the group density of 0.33 groups /km<sup>2</sup> and a population density of 6 individuals/ km<sup>2</sup>. Though these all above mentioned study were from mid hills, the current finding was contradict to above three study, there might be the reason of non-protected habitat where lots of human disturbance were prevailed. Sarania *et al.* (2017) reported a total number of 971 individuals (including two solitary males) in 41 troops, mean troop size was 23.63 ± 1.21 individuals per troop ranging from 12 to 44 individuals of *M. munzala* in Arunachal Pradesh, India, which was



inconsistent with the present finding, that is quite higher the values of population parameters, it might be the reason of better habitat condition and low human pressure to exploit the habitat, which enhance the reproductive success as well.

In contrast to this research, Chalise (2000a) reported seven troops of Assamese Macaques in Makalu-Barun area in 1997 and estimated group size of 7-50 and again, in 1998 from the same study area, he reported group size in range of 3-27 of 4 troops. Whereas Regmi (2008) also recorded 9 Assamese Macaques troops in LNP and observed troop size ranges from 13-23 individuals, group density and population density 0.0790 group/km<sup>2</sup> and 1.8691 individuals /km<sup>2</sup> respectively in LNP within a census of 183 km<sup>2</sup>. As well as Kumar and Solanki (2008) reported 26 groups total of 195 individuals, range was 3-11, with an average group size of 7.5 individuals. Possible reason behind this lowering the values of population parameters, might be high altitude habitat (study area), for Assamese macaque, where different harsh environmental condition, inappropriate forest type, topography and lack of awareness, higher degree of human- monkey conflict were existed. Environmental constrains and human interference might affect group composition and group size of the macaques (Machairas *et al.*, 2003).

## **5.2 Vegetation associated with habitat**

This study revealed that Chilaune (*Schima wallichii*) is the dominant plant species with relative density 10.37% and relative frequency 8.27%, followed by Musure kattu (*Castanopsis tribuloides*) with relative density 9.30% and relative frequency 7.51%, whereas Rijal (2014) and Chalise (1999) also reported that Chilaune (*Schima wallichii*) was the dominant plant species, this result highly supports the findings of this study, might be of the similar types of vegetation, same sub-tropical temperate type of vegetation. Whereas Poudel (2016) reported that Sal (*Sorea robusta*) is the dominant plant species, while Aryal (2013) reported that Khote Salla (*Pinus ruxberghii*) was the dominant plant species, whereas Chalise *et al.* (2001) reported *Lyonia ovalifolia* was the dominant species, this might be due to different type of vegetation, altitude range, topological features.

## **5.3 Threats Assessments**

### **5.3.1 Crop raiding status**

Crop raiding is an essential component of the ecology of primates inhabiting human settlements (Naughton-Treves *et al.*, 1998), as per the buffer zone of Nagarjun forest, also there is two VDCs Chhatreaurali (Dhading) and Bhimdhunga (Kathmandu) highly affected. The amount and types of raided crops could also be depending upon the types of cultivated crops, availability of natural food, distance of cropland from the forest and number of individual in the monkey troop. Most of the people prefer maize to grow in the farm because the return from maize is more in comparison to the labor cost used to cultivate them. Other crops such as Wheat (*Triticum aestivum*), Rice (*Oryza sativa*), Potato (*Solanum tuberosum*) and Millet (*Pennisetum glaucum*) are also important crops in the

area, but they need more labor so they are less preferred to grow by farmers. Maize is one of the most important crops for the livelihood in Asia. So raiding of maize results to develop negative attitudes towards wildlife (Warren *et al.*, 2007). Fallowing of land to get rid from the problem of monkey was in high intensity, local people could not yield sufficient food to fulfill their family need as raided by monkeys and fallowing of land. As perceived by local farmers, lack of natural food in the forest was the major cause compelling monkey to raid the crop. Most of the local people (56.47%) reported crop raiding as the major problem. Whereas Khatri (2006) found that 76% of the respondents of Dharan, 92% respondents of Hetauda Mc. Court (2005), 80% of respondents from Kali-Gandaki River Basin Poudel (2016), 66% respondents (N= 100) from Ramdi area, Palpa Adhikari (2018), reported the crop raiding as the major problem.

Crop mostly preferred includes Maize (53.17%), Wheat (15.6%), Millet (7.33%), Paddy (11.93%), Vegetables (7.56%), and Fruits (4.41%). Vegetables such as beans, cabbage, cauliflower, potato etc. and fruits such as banana, mango, litchi, nuts, guava etc. are reported to be worst affected, by the monkey in the study site. Whereas highest proportion of maize damaged (57%) from from Nagarjun (Rijal, 2015), whereas Poudel (2016) Major crops raided by monkeys included maize was the highest raided crop, 46.95%, loss of maize (21%) Aryal (2013) in Gulmi, as well as highest loss of maize (35%) Nepal (2005) in SNNP, also maize damage was in highest extent (44%) Adhikari (2014) in Lamjung, loss of maize was found highest in most of mountainous areas might be the reason of maize is more palatable, easy to raid and mostly grown in every hill parts of Nepal in summer and rainy season when natural fruits are not plenty enough in the forest areas. Chalise (2000b), Hill (1997), Khatri (2006) and Regmi *et al.* (2008) reported that maize is a staple and preferred crop prominently vulnerable for raiding by primates. Artificial provisioning causes changes in the diet, home range and habitat and even the behavior of the monkey (Southwick *et al.*, 1976). In Nagarjun area, Army barrack troop is habituated to human because of provisioning of foods, therefore their diet, home range, habitat and behavior are susceptible to changed.

### **5.3.2 Deterrent methods adopted by farmers**

To protect crop fields, in Nagarjun's buffer zone, local peoples used various Indigenous techniques for driving off crop raiders. These methods include patrolling and guarding the fields by farmers including their children (42%), Tin-box and throwing stone with "Catapult" (13%), using Dogs (11%), Shouting and Chasing (24%), and other methods like fencing with thorny twigs, trapping & caging, scarecrows etc. (10%) were common procedures used to save crops. In 1998, some of the farmers sprayed crops in marginal farming areas with a chili solution that caused irritating effects and frightened of potential crop raiding wild animals (Chalise 2001). In this study guarding the fields by farmers including their children (42%), whereas Regmi (2008) showed 60 % of the farmers guard the fields, Adhikari (2014) reported 68%, Poudel (2016) 50%, Chhangani and Mohnot (2004) 60% guarding fields, which is highly consistent with this finding, might be attributed by similar deterrent methods practiced accordingly. Chhangani and Mohnot

(2004) also reported that dangerous method like single shot gun, potash bomb and high voltage electric current in which animals are usually killed or seriously injured but the farmers of this study areas were not used cruel type of crop protection strategies might be due to illegal or band of these techniques. Among the different preventive methods, use of catapult ((97% respondents) to frighten the monkeys was found to be most effective in Ramdi area (Adhikari, 2018) whereas from Hetauda also reported the use of stone throw with catapult (84 respondents) as a main deterrent methods (Mc Court, 2005), these are contradictory with this research might be due to variation in experience and practices adopted.

### **5.3.3 Attitudes and perception**

Attitudes are determined in terms of like or dislike of respondents and the reasons associated with it. In the study area most of the respondents had more negative attitudes. The reasons associated with them are also different. Most respondents said the crop raiding was the first reason to dislike, the people living nearby the protected area have less willingness to conserve them while the people living far from the protected area prefer them and have positive attitudes (Roskaft *et al.*, 2007). Only 15% of the respondents approved that monkeys should be conserved, among them (53.33%) thought that, monkeys as one of the nature's creations as human beings having right to existence in nature, they think that they help disperse seeds, and their number is declining, also (20%) said that they are animal lover and remaining (26.66%), they convinced to both factors. A majority 85% don't feel that it is necessary to conserve the animal and some (56.47%) assert that they should be eliminated as they depredate crops, 23.53% thought human attack and harassment, and remaining 20% claimed both above factors are responsible to dislike of monkey. Air (2015) study reported that people had more negative attitudes, with high crop raiding in comparison to the area with less crop raiding in buffer zone village of Shivapuri Nagarjun national park, also reported that respondents wanted to kill Rhesus macaques in response to crop raiding. Whereas Southwick and Siddiqi (1961) believed that the Rhesus macaque populations of northern India were declining because of changing attitudes of the villagers of India toward Rhesus macaques. A monoculture of unattractive crops might act as a buffer to discourage primate crop raiding (Naughton-Treves, 1998). Alternative buffer crops could also be medicinal plant not raided by wildlife (Rao *et al.*, 2002). Chalise (2001) reported that farmer's suffering from monkey crop damage in eastern Nepal was considering planting chili, garlic and tobacco. From this study, some unpalatable crops for monkey were planted by farmers, so as to minimize the crop raiding problems. Ginger, garlic, chili, pidalu etc. were the major alternative crops planted by the local people.

## 6. CONCLUSION AND RECOMMENDATION

### 6.1 Conclusion

The research conducted on population status, distribution and threats assessment of Assamese macaque in Nagarjun forest, showed that total 7 troops of Assamese macaque with 145 total number of individuals, at 7 different sites with group density and population density of 0.4375 group/km<sup>2</sup> and 9.0625 individual/km<sup>2</sup> respectively. Macaque's troop size varies from 11 to 41 individuals, with altitudinal range from 1376 masl to 1901 masl. Total 16 quadrat sampling revealed 44 plant species with 376 number. Dominant species was found to be Chilaune (*Schima wallichii*) (Appendix-II).

Major crops raided was Maize (53.17%) however crops like lady's finger, peas, soya beans, coriander, ginger, turmeric and chilly were less preferred by the monkey (Appendix IV). To protect crop fields, most of the local people (42%) used Patrolling and guarding method. Only 15% of the respondents have positive attitudes mean while majority (85%) don't feel that it is necessary to conserve the animal.

Biodiversity conservation becomes a big challenge due to various factor (anthropogenic as well as natural). In the buffer zone, most of the (52%) local respondent agreed with retaliatory killing was the major threats to monkey. Most of the local peoples (49%), suggested proper monetary compensation is appropriate remedial measures for the reduction of intensity of conflict.

### 6.2 Recommendations

For the protection of Assamese macaque population in Nagarjun forest and minimize its buffer zone human- macaque conflict, following recommendations can be made

- Sources of drinking water in natural habitat should be properly used and managed.
- Local people collect fodder for their cattle and illegal destruction of palatable plants of monkey causes lack of food, so, this activity should be checked and minimize.
- People should give priority for alternative farming, like mushroom cultivation, monkey unpalatable crops such as spinach, lady's finger, winter beans, coriander, ginger, turmeric, chili, garlic etc.
- The antagonism between people and animals makes wildlife conservation efforts more difficult. So awareness program should be conducted.
- Need more researches on the ecology and behavior of Assamese monkey, that should be carried out through Universities, research agencies and wildlife experts.

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**Appendix I: List of tree species according to altitudinal gradient in Nagarjun forest.**

Q. no 1(1300-1350m)	Local name	Scientific name	Total no.
1	Chilaune	<i>Schima wallichii</i>	5
2	Uttis	<i>Alnus nepalensis</i>	3
3	Firfire	<i>Acer oblongum</i>	2
4	Mauwa	<i>Englehardtia spicata</i>	3
5	Setikath	<i>Myrsine capitellata</i>	2
6	Musure kattus	<i>Castanopsis tribuloides</i>	2
7	Falat	<i>Cyclobalanopsis glauca</i>	3
8	Nasi	<i>Stranvaesia nussia</i>	2
Total	8		22
Q. no 2(1350-1400m)			
1	Rani salla	<i>Pinus roxburghii</i>	7
2	Chilaune	<i>Schima wallichii</i>	4
3	Kafal	<i>Myrica esculanta</i>	2
4	Hade bayar	<i>Zizyphus mauritiana</i>	3
5	Banpipal	<i>Ficus religiosa</i>	2
6	Siris	<i>Albizia bellek</i>	2
Total	6		20
Q. no 3(1400-1450m)			
1	Musure kattus	<i>Castanopsis tribuloides</i>	7
2	Simal	<i>Bombax ceiba</i>	2
3	Mauwa	<i>Englehardtia spicata</i>	3
4	Chilaune	<i>Schima wallichii</i>	5
5	Haluwabed	<i>Diospyros virginiana</i>	1
6	Hade bayar	<i>Zizyphus mauritiana</i>	1
7	Ranisalla	<i>Pinus roxburghii</i>	4
Total	7		23
Q. no 4(1450-1500m)			
1	Falat	<i>Cyclobalanopsis glauca</i>	6
2	Kaulo	<i>Persea odoratissima</i>	2
3	Mauwa	<i>Englehardtia spicata</i>	4
4	Saur	<i>Betula alnoides</i>	2
5	Chilaune	<i>Schima wallichii</i>	3
7	Dale kattus	<i>Castanopsis indica</i>	2
8	Hade bayar	<i>Zizyphus mauritiana</i>	2
9	Amala	<i>Phyllanthus emblica</i>	1
Total	9		22
Q. no 5(1500-1550m)			

1	Baaj	<i>Quercus lanuginosa</i>	2
2	Chilaune	<i>Schima wallichii</i>	3
3	Mauwa	<i>Englehardtia spicata</i>	1
4	Mayel	<i>Pyrus pashia</i>	1
5	Musure kattus	<i>Castonopsis tribuloides</i>	3
6	Falame	<i>Flacourtia spp.</i>	1
7	Ban pipal	<i>Ficus religiosa</i>	2
8	Saur	<i>Betula alnoides</i>	2
9	Hade bayar	<i>Zizyphus mauritiana</i>	3
10	Paiyu	<i>Prunus cerasoides</i>	6
11	Gogan	<i>Saurauia napaulensis</i>	3
Total	11		27
Q no 6(1550-1600m)			
1	Saur	<i>Betula alnoides</i>	7
2	Paiyu	<i>Prunus cerasoides</i>	2
3	Musure kattus	<i>Castonopsis tribuloides</i>	4
4	Chilaune	<i>Schima wallichii</i>	3
5	Falame	<i>Flacourtia spp.</i>	3
6	Nasi	<i>Stranvaesia nussia</i>	2
7	Jamun	<i>Syzygium cumini</i>	2
8	Koiralo	<i>Bauhinia variegata</i>	1
9	Haluwabed	<i>Diospyros virginiana</i>	1
Total	9		25
Q. no 7(1600-1650m)			
1	Banpipal	<i>Ficus religiosa</i>	6
2	Kafal	<i>Myrica esculanta</i>	4
3	Paiyu	<i>Prunus cerasoides</i>	3
4	Musure kattus	<i>Castonopsis tribuloides</i>	3
5	Hade bayar	<i>Zizyphus mauritiana</i>	3
6	Uttis	<i>Alnus nepalensis</i>	3
7	Lapsi	<i>Choerospondias axillaris</i>	1
8	Khari	<i>Celtis australia</i>	2
Total	8		25
Q. no 8(1650-1700m)			
1	Banpipal	<i>Ficus religiosa</i>	5
2	Hade bayar	<i>Zizyphus mauritiana</i>	2
3	Jhingane	<i>Eurya acuminata</i>	2
4	Jhakri kath	<i>Litsea doshia</i>	3
5	Kaulo	<i>Persea odoratissima</i>	2
6	Mauwa	<i>Englehardtia spicata</i>	3
7	Guras	<i>Rhododendron arboretum</i>	2

8	Gogan	<i>Saurauia napaulensis</i>	3
9	Firfire	<i>Acer oblongum</i>	2
10	Falat	<i>Cyclobalanopsis glauca</i>	2
Total	10		26
Q. no 9(1700-1750m)			
1	Kaulo	<i>Persea odoratissima</i>	2
2	Dale kattus	<i>Castanopsis indica</i>	2
3	Musure kattus	<i>Castanopsis tribuloides</i>	3
4	Paiyu	<i>Prunus cerasoides</i>	2
5	Chilaune	<i>Schima wallichii</i>	5
6	Jhingane	<i>Eurya acuminata</i>	2
7	Gogan	<i>Saurauia napaulensis</i>	3
8	Dudhilo	<i>Ficus nerifolia</i>	2
9	Kafal	<i>Myrica esculanta</i>	1
10	Guras	<i>Rhododendron arboretum</i>	2
11	Angeri	<i>Lyonia ovalifolia</i>	1
12	Lapsi	<i>Choerospondias axillaris</i>	1
Total	12		26
Q. no 10(1750-1800m)			
1	Hade bayar	<i>Zizyphus mauritiana</i>	3
2	Saur	<i>Betula alnoides</i>	8
3	Musure kattus	<i>Castanopsis tribuloides</i>	4
4	Setikath	<i>Myrsine capitellata</i>	3
5	Rani salla	<i>Pinus roxburghii</i>	3
6	Dhare kanda	<i>Xylosoma controversum</i>	3
7	Okhar	<i>Juglans regia</i>	2
8	Khari	<i>Celtis australia</i>	1
Total	8		27
Q. no 11(1800-1850m)			
1	Gobre salla	<i>Pinus Wallichiana</i>	11
2	Chilaune	<i>Schima wallichii</i>	3
3	Kafal	<i>Myrica esculanta</i>	1
4	Mauwa	<i>Englehardtia spicata</i>	2
5	Musure kattus	<i>Castanopsis tribuloides</i>	3
6	Baaj	<i>Quercus lanuginosa</i>	2
7	Tanki	<i>Bauhinia purpurea</i>	2
8	Jungali aru	<i>Prunus napaulensis</i>	1
Total	8		25
Q. no 12(1850-1900m)			
1	Chilaune	<i>Schima wallichii</i>	3
2	Hade bayar	<i>Zizyphus mauritiana</i>	1

3	Jhingane	<i>Eurya acuminata</i>	3
4	Gobre salla	<i>Pinus wallichiana</i>	9
5	Kali kath	<i>Myrsine semiserrata</i>	2
6	Kafal	<i>Myrica esculanta</i>	3
7	Mayal	<i>Pyrus pashia</i>	2
8	Angeri	<i>Lyonia ovalifolia</i>	2
9	Mauwa	<i>Englehardtia spicata</i>	1
10	Falame	<i>Flacourtia spp.</i>	2
Total	10		28
Q. no 13(1900-1950m)			
1	Baaj	<i>Quercus lanuginosa</i>	5
2	Chilaune	<i>Schima wallichii</i>	3
3	Banpipal	<i>Ficus religiosa</i>	1
4	Musure kattus	<i>Castonopsis tribuloides</i>	2
5	Hade bayer	<i>Zizyphus mauritiana</i>	1
6	Angeri	<i>Lyonia ovalifolia</i>	2
7	Falame	<i>Flacourtia spp.</i>	2
8	Saur	<i>Betula alnoides</i>	3
9	Guras	<i>Rhododendron arboretum</i>	3
10	Kafal	<i>Myrica esculanta</i>	2
Total	10		24
Q. no 14(1950-2000m)			
1	Musure kattus	<i>Castonopsis tribuloides</i>	4
2	Guras	<i>Rhododendron arboretum</i>	3
3	Banpipal	<i>Ficus religiosa</i>	3
4	Uttis	<i>Alnus nepalensis</i>	4
5	Arkhalo	<i>Lithocarpus sp.</i>	3
6	Tanki	<i>Bauhinia purpurea</i>	2
7	Kalikath	<i>Myrsine semiserrata</i>	3
Total	7		22
Q. no 15(2000-2050m)			
1	Baaj	<i>Quercus lanuginosa</i>	9
2	Guras	<i>Rhododendron arboretum</i>	4
3	Chilaune	<i>Schima wallichii</i>	2
4	Falame	<i>Flacourtia spp.</i>	3
5	Angeri	<i>Lyonia ovalifolia</i>	1
Total	5		19
Q. no 16(2050-2100m)			
1	Tej pat	<i>Cinnamomum tamala</i>	2
2	Khasru	<i>Quercus semecarpifolia</i>	4
3	Guras	<i>Rhododendron arboretum</i>	3



4	Bhayalo	<i>Semecarpus anacardium</i>	2
5	Baaj	<i>Quercus lanuginosa</i>	3
6	Dhupi	<i>Cryptomeria joaponika</i>	3
Total	6		17
Grand Total			376

**Appendix II: Value of different parameters for tree species in Nagarjun forest.**

S. N	Local Name	Scientific Name	Total	Den. (D)	R. D.	Freq. (F)	R. F.
1	Chilaune	<i>Schima wallichii</i>	39	0.00609	10.3723	68.75	8.27068
2	Musure kattus	<i>Castanopsis tribuloides</i>	35	0.00547	9.30851	62.50	7.51880
3	Saur	<i>Betula alnoides</i>	22	0.00344	5.85106	31.25	3.75940
4	Baaj	<i>Quercus lanuginosa</i>	21	0.00328	5.58511	31.25	3.75940
5	Gobre salla	<i>Pinus wallichiana</i>	20	0.00313	5.31915	12.50	1.50376
6	Banpipal	<i>Ficus religiosa</i>	19	0.00297	5.05319	37.50	4.51128
7	Hade bayar	<i>Zizyphus mauritiana</i>	17	0.00266	4.52128	56.25	6.76692
8	Guras	<i>Rhododendron arboretum</i>	17	0.00266	4.52128	37.50	4.51128
9	Mauwa	<i>Englehardtia spicata</i>	17	0.00266	4.52128	43.75	5.26316
10	Rani salla	<i>Pinus roxburghii</i>	14	0.00219	3.72340	18.75	2.25564
11	Paiyu	<i>Prunus cerasoides</i>	13	0.00203	3.45745	25.00	3.00752
12	Kafal	<i>Myrica esculanta</i>	13	0.00203	3.45745	37.50	4.51128
13	Falame	<i>Flacourtia spp.</i>	11	0.00172	2.92553	31.25	3.75940
14	Falat	<i>Cyclobalanopsis glauca</i>	11	0.00172	2.92553	18.75	2.25564
15	Uttis	<i>Alnus nepalensis</i>	10	0.00156	2.65957	18.75	2.25564
16	Gogan	<i>Saurauia napaulensis</i>	9	0.00141	2.39362	18.75	2.25564
17	Jhingane	<i>Eurya acuminata</i>	7	0.00109	1.86170	18.75	2.25564
18	Kaulo	<i>Persea odoratissima</i>	6	0.00094	1.59574	18.75	2.25564
19	Angeri	<i>Lyonia ovalifolia</i>	6	0.00094	1.59574	25.00	3.00752
20	Kalikath	<i>Myrsine semiserrata</i>	5	0.00078	1.32979	12.50	1.50376
21	Setikath	<i>Myrsine capitellata</i>	5	0.00078	1.32979	12.50	1.50376
22	Tanki	<i>Bauhinia purpurea</i>	4	0.00063	1.06383	12.50	1.50376
23	Nasi	<i>Stranvaesia nussia</i>	4	0.00063	1.06383	12.50	1.50376
24	Dale kattus	<i>Castanopsis indica</i>	4	0.00063	1.06383	12.50	1.50376
25	Firfire	<i>Acer oblongum</i>	4	0.00063	1.06383	12.50	1.50376
26	Khasru	<i>Quercus semecarpifolia</i>	4	0.00063	1.06383	6.25	0.75188
27	Dhupi	<i>Cryptomeria joaponika</i>	3	0.00047	0.79787	6.25	0.75188
28	Dhare kanda	<i>Xylosoma controversum</i>	3	0.00047	0.79787	6.25	0.75188
29	Arkhalo	<i>Lithocarpus sp.</i>	3	0.00047	0.79787	6.25	0.75188

30	Jhakri kath	<i>Litsea doshia</i>	3	0.00047	0.79787	6.25	0.75188
31	Khari	<i>Celtis australia</i>	3	0.00047	0.79787	12.50	1.50376
32	Mayel	<i>Pyrus pashia</i>	3	0.00047	0.79787	12.50	1.50376
33	Dudhilo	<i>Ficus nerifolia</i>	2	0.00031	0.53191	6.25	0.75188
34	Bhalayo	<i>Semecarpus anacardium</i>	2	0.00031	0.53191	6.25	0.75188
35	Haluwabed	<i>Diospyros virginiana</i>	2	0.00031	0.53191	12.50	1.50376
36	Lapsi	<i>Choerospondias axillaris</i>	2	0.00031	0.53191	12.50	1.50376
37	Simal	<i>Bombax ceiba</i>	2	0.00031	0.53191	6.25	0.75188
38	Siris	<i>Albizia bellek</i>	2	0.00031	0.53191	6.25	0.75188
39	Tej pat	<i>Cinnamomum tamala</i>	2	0.00031	0.53191	6.25	0.75188
40	Okhar	<i>Juglans regia</i>	2	0.00031	0.53191	6.25	0.75188
41	Jamun	<i>Syzygium cumini</i>	2	0.00031	0.53191	6.25	0.75188
42	Amala	<i>Phyllanthus emblica</i>	1	0.00016	0.26596	6.25	0.75188
43	Jungali aru	<i>Prunus napaulensis</i>	1	0.00016	0.26596	6.25	0.75188
44	Koiralo	<i>Bauhinia variegata</i>	1	0.00016	0.26596	6.25	0.75188
	Total		376	0.05875	100.0000 0	831.25	100.0000 0

Den: Density, Freq.: Frequency, R.D: Relative Density and R.F: Relative Frequency

**Appendix III: Pre- structured questionnaire for locals of buffer zone VDCs.**

**QUESTIONNAIRE SURVEY FOR THREAT ASSESSMENT OF ASSAMESE  
MACAQUE IN BUFFER ZONE OF NAGARJUN FOREST, NEPAL**

Respondent No..... Date: .....

Name of respondent: ..... Age: ..... Sex: .....

Address: ..... Occupation: .....

**IDENTIFICATION OF MONKEY SPECIES**

1. Can you identify how many species of monkey present in your locality?
 

i) Two	ii) Three	iii) Four	iv) No idea
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**PEOPLE PERCEPTION ON PAST AND PRESENT POPULATION STATUS**

2. What do you think about population status?
 

i) Increasing	iii) Same
ii) Decreasing	iv) No idea

**THREATS TO ASSAMESE MACAQUE**

**A. HABITAT ISSUES:**

3. What do you think about forest condition?
 

i) Growing	iii) Same
ii) Degrading	iv) No idea
4. How frequently does forest fire happened?
 

i) Regularly	iii) No
ii) Occasionally	iv) No idea
5. Have Logging and Firewood Collection prevail in your locality?
 

i) Yes	ii) No
--------	--------
6. What are Possible Development Related Threats existed in your locality?
 

i) Road	iii) Other
ii) Infrastructure	iv) No idea

**B. CONFLICT ISSUES:**

**Economic loss**

7. How much land you have owned?
 

i) Khet .....	iii) Pakho .....
ii) Bari .....	iv) Total .....
8. Do Animal/ birds damaged your crops?
 

i) Yes (??)	ii) No
-------------	--------
9. Do Monkey Raid your Crops?
 

i) Yes (? Spp.)	ii) No
-----------------	--------
10. Which time does they mostly raid?
 

i) Early morning	iii) Evening
ii) Noon	iv) Night

11. Proximity of damaged field to the jungle?

- i) Below 100 meter
- ii) 100-200 meter
- iii) 200-500 meter
- iv) Above 500 meter

12. Net yield with crop raiding loss? (KG)

S.N	Crops Name	Land use (Ropani)	Loss (KG)	Net gain (KG)
1	Maize			
2	Wheat			
3	Millet			
4	Paddy			
5	Fruits			
6	Vegetables			

13. Any land left fallow because of crop raiding by monkey?

- i) Khet .....
- ii) Bari.....
- iii) Pakho .....
- iv) Total .....

14. Which crops are not raided by monkeys?

- i) .....
- ii) .....
- iii) .....
- iv) .....

**Crop protection strategy**

15. Which methods do you often used?

- i) Guarding and patrolling
- ii) Shouting and chasing
- iii) Dog
- iv) Tin box and catapult
- v) Others

**Attitudes/ perception**

16. What is your reaction towards monkey?

- i) Like, why?
- ii) Dislike, why?

**Threats to Monkey**

17. What is the major threats to the monkey?

- i) Retaliatory killing
- ii) Habitat destruction
- iii) Forest fire
- iv) Encroachment
- v) Disease
- vi) No idea

**Remedial measures**

18. What are your expectation/suggestion to the park authority, with regards to crop raiding?

- i) Monetary compensation
- ii) Translocation
- iii) No idea
- iv) Killing
- v) Armed patrolling

19. Have you asked to forest officials for compensation or other solution?

- i) Yes
- ii) No
- iii) No idea

**Appendix IV: Crop raiding rate of Assamese Macaque in Buffer zone VDCs.**

S. N	Crops	Total land (Ropani)	Expected Yield (Quintal)	Observed Yield (Quintal)	Loss (Quintal)	Loss %
1	Maize	46.25	115.63	38.80	76.83	53.17
2	Wheat	25.90	64.75	42.21	22.54	15.60
3	Paddy	20.35	50.88	33.64	17.24	11.93
4	Vegetables	44.40	111.00	100.08	10.92	7.56
5	Millet	29.60	74.00	63.41	10.59	7.33
6	Fruits	18.50	46.25	39.88	6.37	4.41
		185.00	462.50	318.00	144.50	100.00

## PHOTOPLATES



1. Adult male Assame macaque.



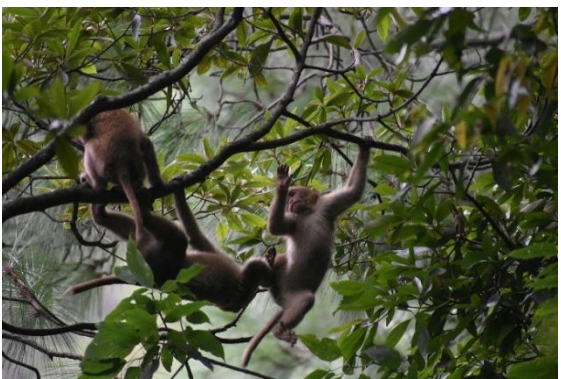
2. Observing trail map to the next focal site.



3. Macaque feeding rice near to canteen.



4. Macaque feeding cucumber.



5. Juvenile macaque playing to each other.



6. Macaque feeding banana near to canteen.



7. Crop land in buffer zone VDC.



8. Plantation of crops, vegetables etc.



9. Local's cottage and their crop land.



10. Dog chasing the macaque.



11. Waste thrown by visitors into the park.



12. Inadequate space for waste to be thrown.