ACTIVITY PATTERNS AND HABITAT OF HANUMAN LANGUR (*Semnopithecus entellus* Dufresne, 1779) IN SAHID LAKHAN RURAL MUNICIPALITY, GORKHA, NEPAL

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DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the authors or institution(s).

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RECOMMENDATION

This is to recommend that the thesis entitled, **"ACTIVITY PATTERNS AND HABITAT OF HANUMAN LANGUR (*Semnopithecus entellus* Dufresne, 1779) IN SAHID LAKHAN RURAL MUNICIPALITY, GORKHA NEPAL"** has been carried out by **Manish Paudel** for the partial fulfillment of Master's Degree of Science in Zoology with special paper Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

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On the recommendation of supervisor "Prof. Mukesh Kumar Chalise, PhD" this thesis submitted by Manish Paudel entitle **"ACTIVITY PATTERNS AND HABITAT OF HANUMAN LANGUR (*Semnopithecus entellus* Dufresne, 1779) IN SAHID LAKHAN RURAL MUNICIPALITY, GORKHA, NEPAL"** is approved for the examination for partial fulfillment of the requirements for the Master's Degree of Science in Zoology with special paper Ecology and Environment.

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Manish Paudel entitled "**ACTIVITY PATTERNS AND HABITAT OF HANUMAN LANGUR (*Semnopithecus entellus* Dufresne, 1779) IN SAHID LAKHAN RURAL MUNICIPALITY, GORKHA, NEPAL**" has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Ecology.

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LIST OF ABBREVATONS

Abbreviated from	Details of abbreviations
%	Percentage
^{0}C	Degree Celsius
asl	Above the sea level
cm	Centimeter
Kg	Kilogram
km	Kilometer
m	Meter
mm	millimeter

ABSTRACT

Study on the population and behaviour of animals help us to conserve the population of species. This study aims to study the population, behaviour and habitat of langur monkey with relation to human beings on the bank of Marsyandi River of Sahid Lakhan Rural municipality, Gorkha. Field survey was carried out only in one season (May 17 to 1 July, 2019). Instantaneous focal animal sampling method was used to observe the animal and individual observed for 10 minutes. Time was classified into four phases i.e. morning [7:00 to 9:40], late morning [9:45 to 12:25], day [12:30 to 15:10] and evening [15:15 to 18:10]. Langur monkey spent more time on foraging (45.99%), inactive (17.67%), locomotion (14.12%), grooming (9.15%) and sleeping (9.11%). The Chi-square test revealed that there was significance difference between all behaviour in different phase of day Similarly, total 32 quadrates having 10m radius were laid down to find the plant diversity of habitat and found that the species diversity was 2.66 with the dominant of Sal (*Shorea robusta*) followed by Botdhayero (*Largerstromia parviflora*) and Chilaune (*Schima wallichii*). Semi structured question were asked with 37 local people having age more than 20 years. Maize (14.6%) is mostly raided crop by langur which is followed by daal (9.71%), millet (9.32%) and vegetables (7.11%) and local people apply different strategies to chase out the langur from agricultural field. Shouting and following was the most common strategy applied by local while throwing stones ranked the second. Few invasive species as well as anthropogenic effects to the natural forest were experienced in the study area. To conserve the species, further study will be required, and relation between assamese monkey as well to reduce the conflicts between human and primate's should be found on local level.

Keywords: Behaviour, crop raiding, instantaneous sampling, langur monkey.

1. INTRODUCTION

1.1 General Background

The natural environment where a particular species lives and can find food, shelter, protection as well as mate for reproduction are known as habitat of species (Rayan 2019). The local environment has great role and cause fluctuations in the quality of habitat of species and species changes their activity patterns to survive in the habitat (Borries et al. 1993, Ashan and Khan 2006, Caselli et al. 2013, Li et al. 2013).

Primate is an order of mammals including the monkeys, apes, humans and other similar forms typically having dexterous hands and feet, binocular vision and well-developed brain. Of all the primates, monkeys, next to human have adapted best to widely diverse environmental conditions which are found in tropical forests, dry savannas, mountains, villages and temples and even in large cities (Van Hoff 1990). Monkeys are included under the sub order of Simiiformes of order Primates. According to geographical distribution, monkeys are categorized into two types, new- world monkeys and old- world monkeys. The new world monkeys lack cheeks pouches and nostrils open two sides rather than down. Area between the nostrils is wide and flat. Most have long prehensile tail and non-have callous pads on the buttocks, e.g. Spider monkeys, Capuchins etc. The old-world monkeys have protruded muzzle and well-developed check pouches; nostril set close together facing forward and downward. The tail is never prehensile and some species are tail less. Both the hands and feet are adapted for grasping, callous pads on the buttocks are often bright and in case of females swollen during estrus period (Walker 1968). Macaques (Primates: Cercopithecidae) are an ecologically extremely adaptive primate taxon that is distributed more widely than any other non-human primate genus (Schulke et al. 2011).

Hanuman langurs (family Cercopithecidae, subfamily Colobinae) are the most widely distributed nonhuman primates in South Asia (Napier and Napier 1967, Choudhury 2007). They are dispersed throughout most of India and Sri Lanka (Ellerman and MorrisonScott1966, Oates et al. 1994), and are also established in parts of Pakistan, Nepal (Roonwal 1984, Oates et al. 1994), Bhutan, and Bangladesh (Choudhury 2007). They occur in a wide range of habitats from arid regions on the edge of the desert in Rajasthan to the rain forests of Western Ghats and at altitudes of 100–4270 m above

mean the sea level (Asl) in the Himalayas (Hrdyn 1977, Bishop 1978) and they are found in area with high temperature upto 46^0C (Channgani 2002) as well as in cold temperature upto -7^0C (Bishop 1979, Curtin 1982).

In Nepal, three species of non-human Primates (Hanuman Langur, Rhesus and Assamese Monkeys) are recorded from Tarai plain to the valleys of high mountains (Chalise et al. 2005). Himalayan Langur (*Semnopithecus ajax*), the Lesser Hill Langur (*Semnopithecus hector*) and the Nepal Grey Langur (*Semnopithecus schistaceus*) are the three subspecies of langur which are identified by Conservation Assessment and management plan (CAMP) workshop 2003 for Nepal (Chalise 2013) and Rhesus has only one sub species but Assamese have two sub species but one only sub species was recorded in Nepal (Chalise 2003).

In Nepal they are found in diverse habitat ranging from low land tropical forest to highland (4000m asl.) subalpine forest covering multiple vegetative and climatic zones (Shrestha 2011, Chalise 2013). Hanuman Langurs are arboreal and occasionally descends on ground. They are herbivores and feed almost all parts of plants (Patil and Modse, 2019) but sometimes they feed on insects, gum and lick soils (Chalise 1995, Chalise et al. 2005).

Life span of the langur is about 12 years and average age at first reproduction is about three and half year. Breeding season varies with location and they give a baby at once after 190- 210 days of gastrulation period (Roonwal and Mohnot, 1977). Birth occurs in most month of year (Bishop, 1979) but concentrated between January and March (Roonwal and Mohnot, 1977) until June (Minha et al. 2010). The sex ratio is 2.3 to 2.5 female per male (Curtin, 1982), two female per male (Khanal et al. 2018): four female per male (Laws and Laws 1982).

Social interactions of Hanuman langur are displayed through grooming, aggression, playing, mating, and parental care (Alan et al. 2014). Male shows more aggressive interaction during the mating season as compare to other season (Laws and Laws, 1982) but individual primates can occasionally alter their usual pattern of interacting capacity when the social or ecological environment makes such advantageous behavioral flexibility (Cheney and Seyfarth, 1990).

S. ajax has a yellowish white coloration, especially on the ventrum and some brown on the dorsum and limbs with fore limbs darkest. Similarly, *S. hector* has a white head and is overall grayish yellow, yellowish- white or pale yellow with brownish limbs with pale paws and *Semnopithecus schistaceus* has dark brownish with a whitish head, ventrum, upper hindquarters and tip of the tail. They have a larger body size than others among grey langurs (Roonwal et al. 1977, Grooves 2001, Brandon- Jones 2004). The combined head and body lengths of both sexes of *Semnopithecus schistaceous* average 68.9 cm and average weight is 17.7kg while *S. ajax* averages 67.1cm and weight is about 17.7 kg and average length of both sesxes of S. *entellus* has 63.9cm length with 12.5 kg weight on average (Roonwal 1979) but females are typically somehow smaller than males (Roonwal 1979, Shrestha 2011). The heaviest Himalayan Langur is 26kg was recorded from Nepal (Choudhury et al. 2007). Locally Hanuman langur is known by different names like Langoor, Kalomukhe Bandar, Lampuchre Bandar, Phetawal Bandhar, Kaldhaure and Guna in Nepal and commonly known as Hanuman Langur (Chalise 2013).

1.2 Objectives

The general objective of this study was to explore the general behaviour of Hanuman langur.

The specific objectives were:

i. Find out the population of langur
ii. To investigate the behaviour of Langur
iii. To explore the habitat characteristics of species.
iv. To explore the Human-Langur conflicts

1.3 Rationale of the study

The research on monkey population, status behaviour will assess to run the conservation program as well as increase the knowledge of monkey and their behavior. Population distribution of monkey could be great importance in regards to species conservation and management (Chalise 2003).

The Study of primate ecology, behaviour and its interaction with human will enable us to understand the problem encounter by these species (Masi et al. 2009). The results obtained from this study will assess to government of Nepal to make effective decision to protect the species with their habitat and also help make plan to reduce the human primate conflicts.

1.4 Hypothesis

There is no significant difference in Behaviour of Langur in different time phase of the day.

1.5 Limitation of the study

The major limitations of the study were as follows:

1. Movement of monkey under the higher density of plant like *Lantana camara, Mikania micrantha*, *Agerstina adonophora* caused difficulty to record its behavior.
2. Langur could not be followed continuously during the study period due to steepness of the study site.

2. LITRERATURE REVIEW

2.1 Habitat and habitat

Basically, colobine monkey were regarded as folivore indeed, because off their multi chambered stomach they are able to rely diet containing high amount of leaves. They also prefer seeds/fruits rather than leaf but eat leaves more in amount when seeds or fruits are unavailable (Stanford 1991). Hanuman langurs are highly adaptive species that occur in various habitats like different types of forest, agricultural area, in and around the human habitation. They are herbivorous and eat most part such as leaves, fruit, flowers and seed of the plant but leaves are the major source of food throughout the year (Chalise 1995, Alam et al. 2014, Patil and Modse 2019). Hanuman langur mostly depends on leaves (more than 50%) for food followed by fruits and flower and rarely feeds on insects (Chalise 1995) but feeding of primate is dependent on habitat quality, such as dietary quality, food abundance, distribution pattern of food plant and seasonal availability of food (Chalise 2000, Jaman and Huffman 2012). The distribution of food resources in time and space may affect the social organization of primates (Chalise 2000, Engel et al. 2010, Li et al. 2010).

Ecological conditions cause high fluctuation of food throughout the year and but food is sufficient to cover the basic needs of langurs except in late pregnancy and early lactation period (Borries et al. 1993). Food and shelter of monkey are the reason for competition and dominance between the groups and usually occur in unfavorable conditions. The higher ranked individual threat or attack to displace other individuals from food patch and avert access of food as well as good place for rest or sitting for monitoring purpose (Minhas et al. 2010). Similarly, higher ranked male involved in monitoring, vocalization, fighting for dominance and maintain the territory (Ashan and Khan 2006).

Home range size of animal is different according to seasons (Koeing et al. 1997, Sarkar et al. 2013). Home range size of Langur is influence by availability and abundance of food, group size and composition, agricultural activities and human interference. Langur use large tree for sleep in a limited portion of home range. Langurs travel most when there is shortage of food (Chhangani and Mohnot, 2006). Habitat fragmentation changes the social organization and behaviour of howler monkey such as change in group size, social interaction and activities pattern. The number of male decrease and unimale increase on

increasing the habitat fragmentation by natural and anthropogenic activities (Arryo-RodrAguez and Dias 2010) and most member of monkey occur in high quality habitat (Li et al. 2003, Caselli et al. 2011). Monkey spends less time moving and more time feeding and playing behaviour in more habitat fragments area (Huang et al. 2017) but another study suggest that there is no relationship between home range size and fragments of habitat (Wong and Sicotte 2007). In Nepal, one of the invasive plant species named *Mikania micrantha* covers the 50% habitat of rhinoceros and also decrease the food of rhinoceros (Sapkota 2009) and it also decrease the productivity by reducing the number of herbs, the water holding capacity of soil (Karki and Paudel 2013).

2.2 Population status of monkey

In Nepal, the latest primate census was done by Chalise (2013) and he reported that 67 troops of Hanuman Langurs which includes 1113 individuals from different part of Nepal. Khanal et al (2018) studied the Himalayan langur in southern flank of Nepal and found that troop size of langur varies in between 19.41 individuals per troop (from Gandaki River System) to 14 individuals per troop (from Koshi River system). Similarly the study revealed the adult sex ratio is 2 female per male and the ratio of adult to young is 1:1.01 but different results was found in group of Langur from Langtang National Park, where the sex ratio is 4 female per male and the ratio of sub adult to adult is 1:1.94 (Ale 2010). When population (density) increase female rhesus monkey significantly increases the aggressive behaviour against the kin and non kin but male doesn't show the density related aggression (Judge and De Waal 1997).

2.3 Behaviour of monkey

From the study of langur's behavior, langur changes behaviour according to seasons and food available (Chalise 1995, Koeing et al. 1997, Huang et al. 2017). Langur mostly feed on leaves which accounts more than half of their diets, followed by fruits and flower but they rarely feeds on insects and regularly licks stone as well as hard calcium carbonate to obtain their requirements of salts and minerals (Chalise 1995). Hanuman langur (*Semnopithecus entellus*) from Langtang National Park spends most of the time in feeding (39.8%) which is followed by resting (29.2%), locomotion (17.5%) and grooming ia about 9.5% (Sayer and Norconk 200) but they spends most time in resting (41.04%) which is followed by feeding (33.75%), grooming (11.73%) and locomotion (4.87%) in urban area (Alam et al. 2014). Back-fronted titi monkeys spends most time on feeding (35%) followed resting (30%) and traveling (24%) (Caselli et al. 2011). Blue monkey

spends most of their time on resting (42%) while feeding (33%) and locomotion (11%) comes second and third position respectively which is followed by social interaction (Pazol and Cords 2005) and similar pattern was seen in Francon's langur (Yang et al. 2007). In Kaligandaki area assaemese monkey spend smost of their time on foraging (47.25%) which is followed by moving (27.25%) and resting which constitute about 14% of total time (Paudel and Chalise 2017) but assamese from Shivapuri Nagarjun National Park spends almost equal time on resting (25.2%) and feeding (28%) which is followed by grooming (16.5%) and locomotion (11.95%) (Upadhaya et al. 2018) but rhesus spends most of their time (around half of their behavior) on foraging (44%) and followed by moving (26%) and grooming (11%) (Upadhaya et al. 2018). In early morning, late morning as well as early evening langur spends most of their time on feeding. They spend most of their time on tree rather than ground and only down to ground in drought season as well as when they went to crops fields (Subedi 2007). Female monkey groomed each other more often than male groomed to another male as well as a female groomed a male was greater and vice versa (Cooper and Bernstein 2000). Female langurs spend their 9% day time in grooming. The length of time for auto grooming and allo- grooming is different i.e 2.3 minutes and 4.1 minutes respectively. Female to female grooming bout occurred after 5.7 hours on average while female to male grooming episode occurred after 39.4 hours on average but male to female grooming is rare and expected after 900 hours (Borries et al. 1994). Monkey significantly decrease the social interaction and time spend on resting but spend more time on feeding and traveling to different places and spent less time on feeding and spent more time on playing and other activities when they are in highest quality of habitat (Arryo- RodrAguez and Dias 2010, Li and Roger 2004).

Rank hierarchy plays important roles in monkey's behaviour (Borries et al. 1994, Cooper and Bernstein 2000, Upadhya et al. 2018). Males groomed to dominant male but less to dominant female (Cooper and Bernstein 2000), higher ranked individuals gets good quality of food (Jaman and Huffman 2012), gets better place for resting as well as monitoring purpose (Minhas et al. 2010), higher ranked individuals spends much more time foraging and spends less time on locomotion (Upadhaya et al. 2018) and young and highest ranked individuals give and receive more grooming than old and lowest ranked individuals in langur troops (Borries et al. 1994).

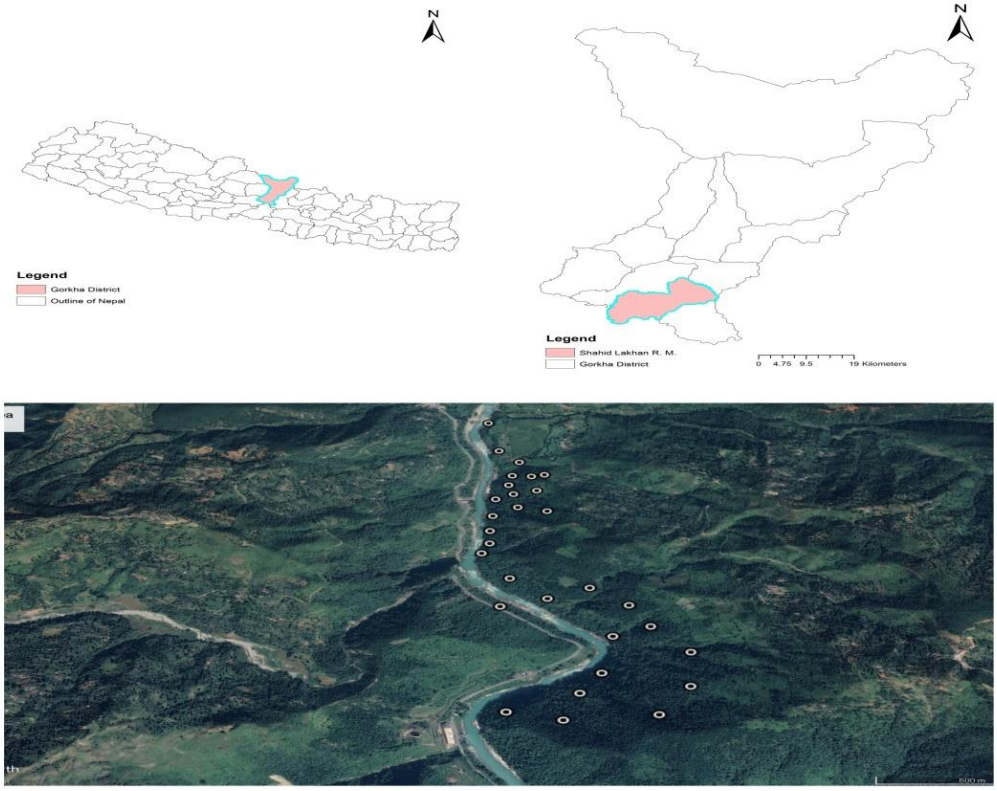
2.4 Human monkey conflicts

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-nonhuman primate conflicts in areas where local people are mainly subsistence farmers (Hill 1999). Crop raiding, property damage, livestock depredation and human casualties are most common form of human wild life conflicts (Chalise 2001, Adhikari et al. 2018). The conflict between human and macaques is increasing in Nepal due to habitat loss by agricultural expansion, logging and shifting cultivation followed by the revenge feeling of farmers due to their crops loss (Chalise 2003). Wild animal monkey, deer, porcupines, squirrels, wild boar, Indian hare are responsible for the crop loss among them maize ranked first (Chalise 2001, Adhikari et al. 2018, Ghimire and Chalise 2019). Pandey and Bajracharya (2015) studied about crop protection and its effectiveness against wildlife in two villages from Shivapuri Nagarjun National park and results reveled that local people use both traditional and new preventive methods to minimize the crop loss. They also found that people are using bio-fencing (using *Euphorbia species* and *Jatropa species)* and construction of wall like structure to prevent the entry of animals. Similarly they use tin hitting, shouting in group are other some methods to reduce the crop loss by animals.

3. MATERIALS AND METHODS

3.1 Study area

This study was conducted in Sahid Lakhan Rural Municipality of Gorkha district, Gandaki Provenance of Nepal. The total area of this rural municipality is 149.03 $km^{2.}$ According to the Nepal census 2011 AD, the total population of this rural municipality is 27,555 (Government of Nepal). Marsyangdi, Daraudi are the largest river around the area. Purposively, the study was conducted in Salleri Community Forest and Darsing Community forest which lies on the bank of Marsayandi River. The total area of Salleri community forest is 34.42 hectors and 85 households depend on the forest while the area of Darsing Community forest is 123.75 hector and 39 households depend on this forest to fulfill their basic needs (Department of forest, Gorkha).



Source: Google Earth (January 15, 2020)

Fig. 1: Map of Study area in Shahid Lakhan Rural Municipality, Gorkha

3.1.1 Flora and Fauna

There were diverse plant species in study area and most common species were, Sal (*Shorea robusta*), Khirro (*Sapium insigne*), Chilaune (*Schima wallichii*), Sindhure (*Mallotus philipinancis*), Karam (*Adina cordifolia*), Chatiwan (*Alstonia scholaris*), Botdhayero (*Lagerstromia parviflora*), Bel (*Aegle marmelos*). There is presence of some invasive species like *Mikania micrantha, Lantana camara, Ageratina adenophora* etc.

In the study area, some faunal species like Assamese monkey (*Macaca assamensis*), Barking deer (*Muntiacus muntjak),* Rhesus monkey (*Macaca mulatta),* Oriental turtle dove (*Streptopelia orientalis*), Common green magpie (*Cissa chinensis),* White-throated kingfisher (*Halcyon smyrnensis*), Red Jungle fowl (*Gallus gallus*) etc were found.

3.1.2 Tourism

This rural municipality is promoting eco-tourism. The area becomes one of the principal tourist destinations in recent days. Manakamana Temple, Triveni Temple, Sidhha Lakhan Cave, Santaneswor Madhev Temple are the significant historical and religious site inside the rural municipality (http://shahidlakhanmun.gov.np).

3.1.3 Climatic conditions

The metrological data of last 5 years (2013 AD to 2018 AD) shows that the highest temperature occurred in June and the maximum temperature rise above the 30^0C between April to August while there is much more cold in December and January when average minimum temperature lies below to 10^0C. The maximum rainfall occurs in July which is followed by August and June but low rain occurs in November and December.

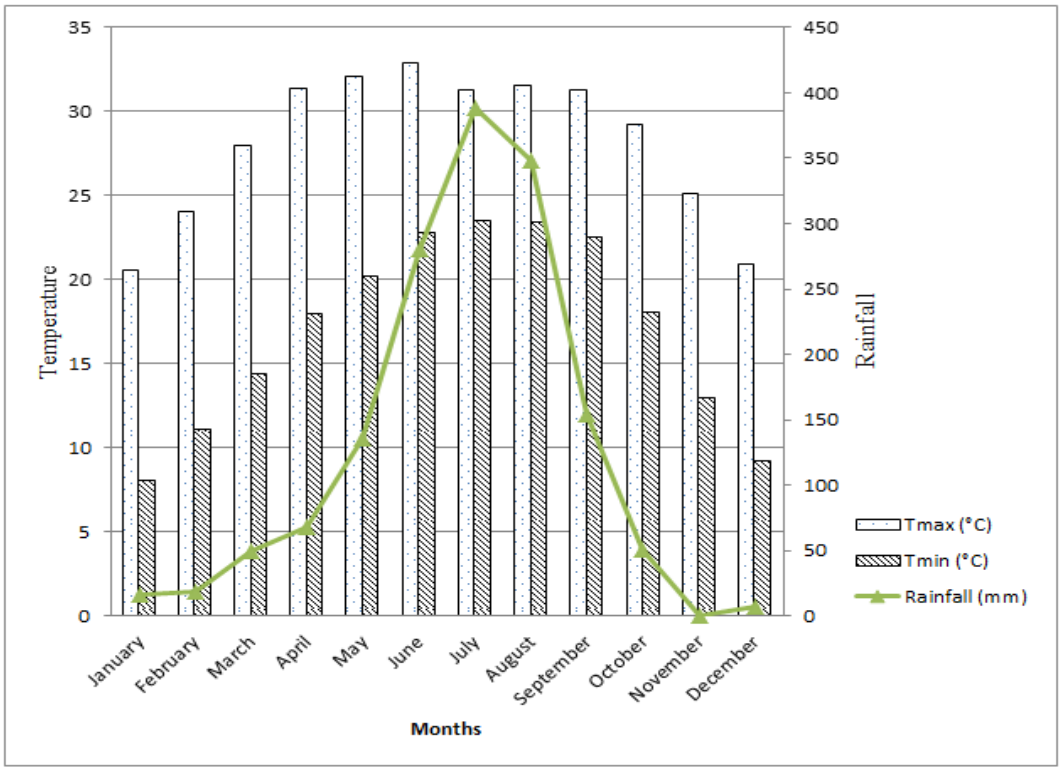


Fig. 2: Monthly average maximum and minimum temperature and rainfall

(Source: Department of Hydrology and Meteorology, Gorkha station) (Appendix 1)

3.2 Materials used

Following materials were used during the study:

1. Measuring Tape (50m)
2. Global Positioning System
3. Stop Watch
4. Camera (750D with 75 to 300 mm lens)
5. Binocular (Kylitech 12x42)
6. Data sheets and Stationary
7. Plastic bags

3.3 Methods

Following methods were applied for the determination of ecological behaviour of monkey and vegetation analysis:

3.3.1 Preliminary survey

In order to detect the likely areas of monkey troops and their each individual, Salleri community forest was walked to acquaint the forced existing primates. Preliminary

survey was conducted from 17-24 May, 2019 following 8 days. A total of 48 individuals of focal troop representing various age and sex groups were observed. Various information of monkey and their behaviours were collected through the interaction with local people.

3.3.2 Population Count Method

Line transect method was used to walk in the forest. Monkey population was counted by direct counting method. In this method each head of langur was counted with binocular aid. The composition of the troop was differentiated into Adult males, Adult females, Sub adult males, young adult females, Juveniles and infants according to their body size, coloration and behaviours as described by Chalise (1995) as shown in appendix II.

Adults were those attained the maximum height and body maturity. Females were distinguished with small head and protruded nipple.

Sub adults were those who attained the height however not matured in body fitness and sexual activities. They were grown up one and independent.

Juveniles are the individuals that left nipple contact (weaned) and depend on natural foods and mostly following their kin.

Infants are those who still suck the nipple as their main food and following mother.

3.3.3 Behavioural Sampling

Instantaneous focal animal sampling method was used to observe the monkey behaviour. In this method, one individuals of langur was observed for 10 minutes and after 5 minutes another individual was observed and so on (Altmann 1974). Various behaviors like foraging, locomotion, grooming, inactive, sleeping and agnostic were noticed and recorded. The total instantaneous sampling per day was 11 hour (7 to 18:05). For this sampling, stop watch/timer and binocular were used to observe the langur in far sight. Data were collected from May 25 to June 28, 2019.

Behaviour of monkey were classified into following types

a. Locomotion

The behavioral phenomenon in which monkey produce motion displacing from one place to another (Picture 3).

b**. Foraging**

The behavioral activities shown by macaques to search for food or eating something, licking stone and drinking water (Picture 4).

c. Grooming

The behavioral activity in which monkey search their own fur or the fur of other for lice, bugs or diet which include rubbing and scratching (Picture 12).

d. Inactive

The state when langur rests with the body supporting upon the buttocks with hind quarts lowered on to a supporting surface without closing their eyes. In this behaviour no displacements occur (Picture 13).

e. Sleeping

The state when langur rests with the body supporting upon the buttocks with hind quarts lowered on to a supporting surface by closing their eyes (Picture 14).

3.3.4 Vegetation Sampling

For the vegetation composition of langur's habitat, altogether 32 random quadrates were established among them 27 are in jungle while 5 were on the edge of agricultural field (Appendix III). Two different types of circular quadrates were established i.e. quadrates having radius 10 m was established in forest area while quadrates having 5m radius was established on the edge of the agricultural field.

The tree species having circumference at breast height (CBH) more than 10cm was noted as well as some dominant ground vegetation also noted. The plant local name was identified by the experience local person while for unidentified plant photographs was taken simultaneously and asked with expert.

3.3.5 Questionnaire Survey

Semi structured questionnaire was asked with randomly selected 37 (25 male and 12 female) respondents (17.29% of peripheral households). A questionnaire containing information like monkey related problem, preventing methods used by the locals as well as their perception towards langurs etc. was used to collect the information from the respondents. Most questions were fixed and asked with the people having age more than 20 years. The question format is given in appendix VI.

3.4 Experimental design

Among total 48 individuals of langur, only 14 individuals were chosen for behaviour observation. Among them 2 were adult male, 4 were adult female, 3 sub-adult male and 5 sub adult female. These numbers represent around 40% of their population. Behaviour of monkey was recorded from May 25, to June 28, 2019 and the total contact hour with monkey was 143 hour and 55 minutes. Similarly, the time period of day was classified into four parts i.e. morning (7:00 to 9:40), late morning (9:45 to 12:25), day (12:30 to 15:10) and evening (15:15 to 18:00).

3.5 Data analysis and presentation

The obtained data were analyzed by Microsoft excel (2010) and Arc GIS version 10.4 was used to construct the geographical map. Chi- square test was done to test the similarity of behaviour in different time period of day.

3.5.1 Chi-square test

Chi-square test was used to test whether there is significance difference in foraging, inactive, locomotion, grooming and sleeping behaviour of langur in different phase of a day. P<0.05 was considered for significant results.

$$\text{Chi-square } \mathbf{X^2} = \frac{(\mathbf{Observed - Expected})\,(\mathbf{Observed - Expected})}{\mathbf{Expected}}$$

3.5.2 Shannon-Weiner diversity index

Biodiversity index (H) was calculated by using Shannon- Weiner Function. Shannon Weiner index assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample (Appendix IV).

Similarly Shannon and Weavor's formula was used to calculate the plant species diversity.

$$H = \sum_{\mathbf{i=1}}^{\mathbf{s}} \mathbf{Pi} * \mathbf{lnPi}$$

Where Pi = the proportion of species i relative to the total number of species.

3.5.3 Density and relative density

Density refers to the total number of individuals per unit area. Density is usually used for large plants that have discrete individuals (Zobel et al. 1987).

$$Density\ of\ species = \frac{Total\ number\ of\ individuals\ of\ species}{Total\ number\ of\ quadrates\ sampled\ X\ size\ of\ quadrates}$$

$$Relative\ density = \frac{Density\ of\ a\ species}{Total\ density\ of\ all\ species}\ X\ 100$$

4. RESULTS

4.1 Population Status

4.1.1 Population of monkeys

Total 48 individuals of langur were found in study area among them 14 (5 male and 9 female) were adult individuals, 20 (6 male and 14 female) were sub-adult individuals, 8 were juvenile and 6 were infants. At beginning of the study there were 4 infants and during the study period 2 new infants were born. Similarly 45 individuals of Assamese monkey *(Macaca assamensis*) were observed in one troop with adult male 7, adult female 12, Sub-adult 9, juvenile 11 and infants 6.

4.1.2 Age, Sex composition of langur

The sex composition of studied *Semnopithecus entellus* troop constitute adult male monkey by 10.42% while that of the adult female monkey by 18.75%, Young-adult male monkey by 12.5%, sub-adult female by 29.17%, juvenile by 16.67% and infants by 12.5% (Figure 3). The population of studied langur's troop clearly reflects that this troop was dominated by female individuals.

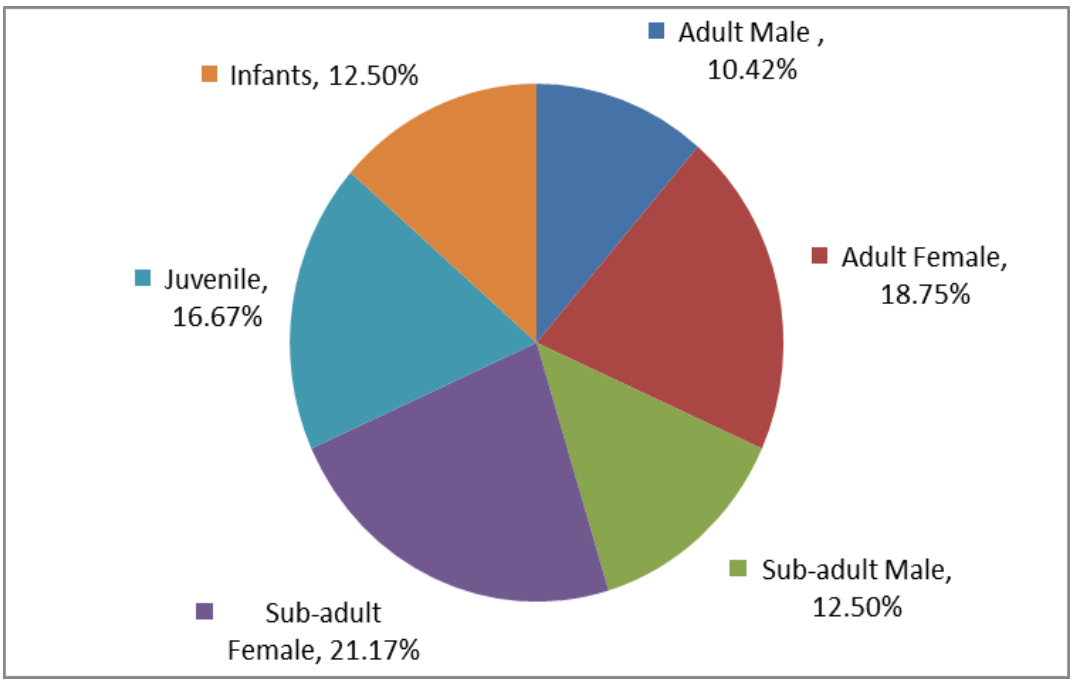


Fig. 3: Age and sex composition of Langur

4.1.3 Sex Ratio

The observed sex ratio between adult male to adult female is 1:1.8 and the sex ratio between sub-adult male to sub-adult female is 1:2.33. The ratio of total male to female is 1:2.27 and ratio of adult langur to sub-adult langur is 1:1.43.

4.2 Behaviour Observation

4.2.1 Behaviour of langur of total time

Langur spends more time on foraging behaviour which occupies 45.99% of total behaviour of langur. Similarly this study found that langur macaques spend 17.67% time on inactive behavior, 14.12% in locomotion. They spend quite similar time for grooming and sleeping behavior which accounts 9.14% and 9.11% of total time (Figure 4) while they spent less time on other behaviour (Agnostic, play, excretion etc).

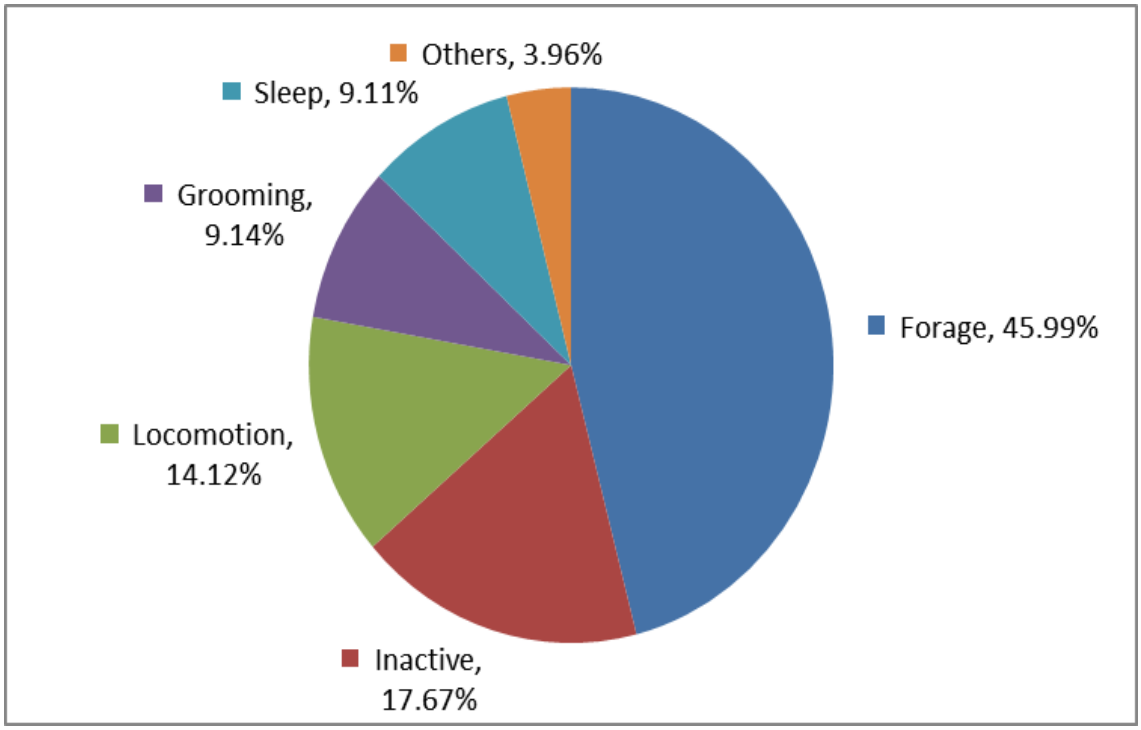


Fig.4: Percentage of time spent in major activities by langur macaques

4.2.2 Behaviour of langur in different phase of day

Forage is the highest behaviour shown by langur in morning (7:00 to 9:40) which accounts for nearly 60.4%. Langur spent 16.45% time on locomotion, 10.7% on inactive, 4.22% on grooming and spends less time on sleeping behaviour (0.71%).

In late morning (9:45 to 12:25) foraging is highest behaviour shown by langur and accounts for 49.78% and followed by inactive, locomotion and grooming which accounts

17.57%, 12.38% and 11.2% respectively. Langur spent nearly 6.6% time on sleeping behaviour and less time on other behaviour (like play, agnostic, excretion etc).

In day time (12:30 to 15:10), langur spent more time on inactive behaviour (nearly 27.5%) which is followed by sleep (26.27%), forage (18.15%) and grooming (14.75%). They spents less time locomotion (10.51%) and other behaviour (2.82%)

Similarly, in evening (15:15 to 15:55) langur spent more time in foraging (nearly 55%) followed by locomotion behaviour (nearly17%) and inactive (nearly 15.42%) and. They spent 6.87% time for grooming and nearly 3.36% time for sleeping and 2.68% on others behaviour (Figure 5).

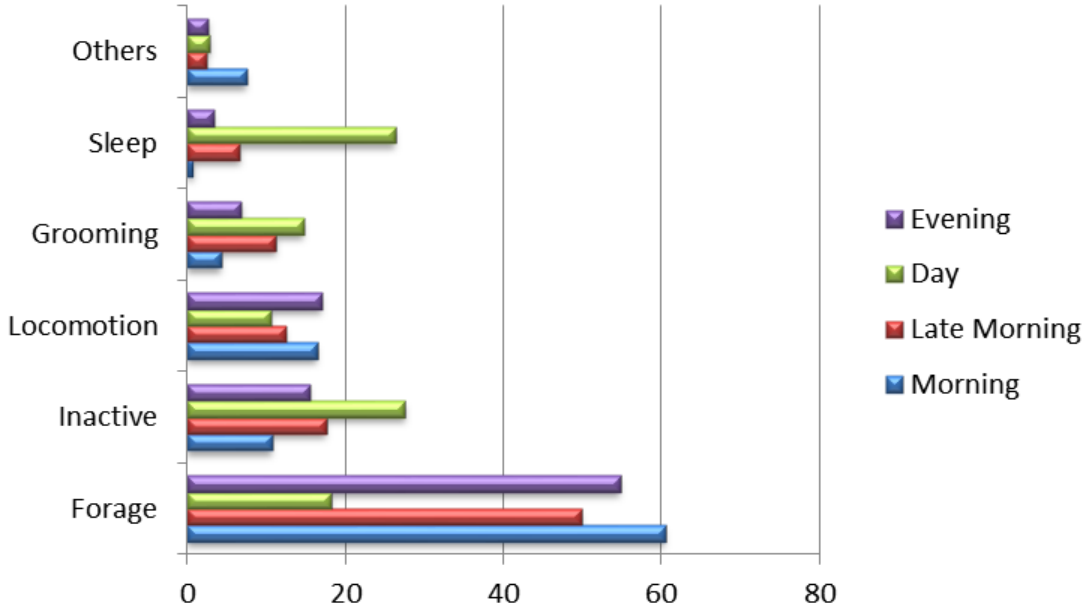


Fig. 5: Percentage behaviour of langur in different periods of day

This result was tested by Pearson's Chi-Square test and found that there is significant difference between the behaviors (for example, forage to forage and so on) in different phase of time at 95% confidence level (i.e. null hypothesis rejected). At 95% confidence level with 3 degree of freedom, the chi- square value of foraging is 584.09, inactive is 175.62, groom is 146.42, sleep is 980.41 and locomotion is 58.98.

4.3 Vegetation

In the study area, altogether 39 tree species were recorded and Sal (*Shorea robusta*) as dominant species with relative density of 31.17% which is followed by Botdhayero (*Lagerstromia parviflora*) with 11% relative density, Chilaune (*Schima wallichii*) with

9%, Madhise khirro (*Holarrhena pubescens*) with 6.68% relative density. The species diversity was 2.66 which mean there is presence of diverse plant species. Some dominant herbs, shrub were also noted in the area among them Asura (*Justicia adhatoda*) is dominant shrubs while, Banmara (*Chromolaena odorata*), Kirne kada (*Lantana camara*) and Lahare banmara *(Micania micarantha*) were dominant invasive species.

4.4 Conflicts between Human and Langur

In the study site, most of the respondent reported that langur come in farm land to forage on plant species like Tanki (*Bauhinia purpura*), Epil (*Leucacaena leucocephala*), Gidhauri (*Premmna integrifolia*) etc. as well as crop raiding.

4.4.1 Crop raiding

According to the respondent, Maize is most vulnerable crop which is followed by daal and millet. The loss of maize accounts of 14.6% of its production followed by daal accounts 9.71% and millet 9.32%. Local people loss 7.11% vegetables, 5.53% fruits and 4.61% rice but none of the respondent left agricultural land due to crop raided by monkey.

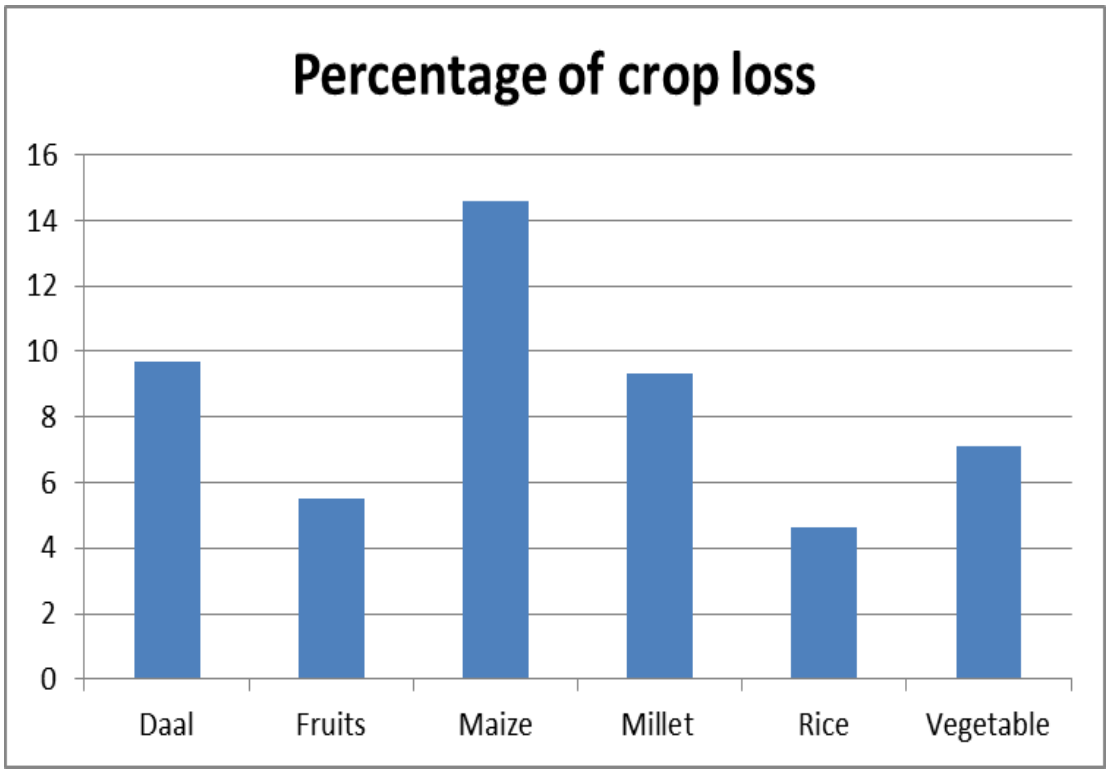


Fig. 6: Percentage of respondent reporting crop loss.

4.4.2 Crop protection strategies

To protect crop fields from Macaque, farmers used many methods. These methods include patrolling and guarding the fields by farmers including their children, throwing stone with "Catapult", keeping Dogs, fencing with thorny twigs etc (Figure 7). The most commonly used crop protection strategy was shouting and throwing stone as well as using catapult.

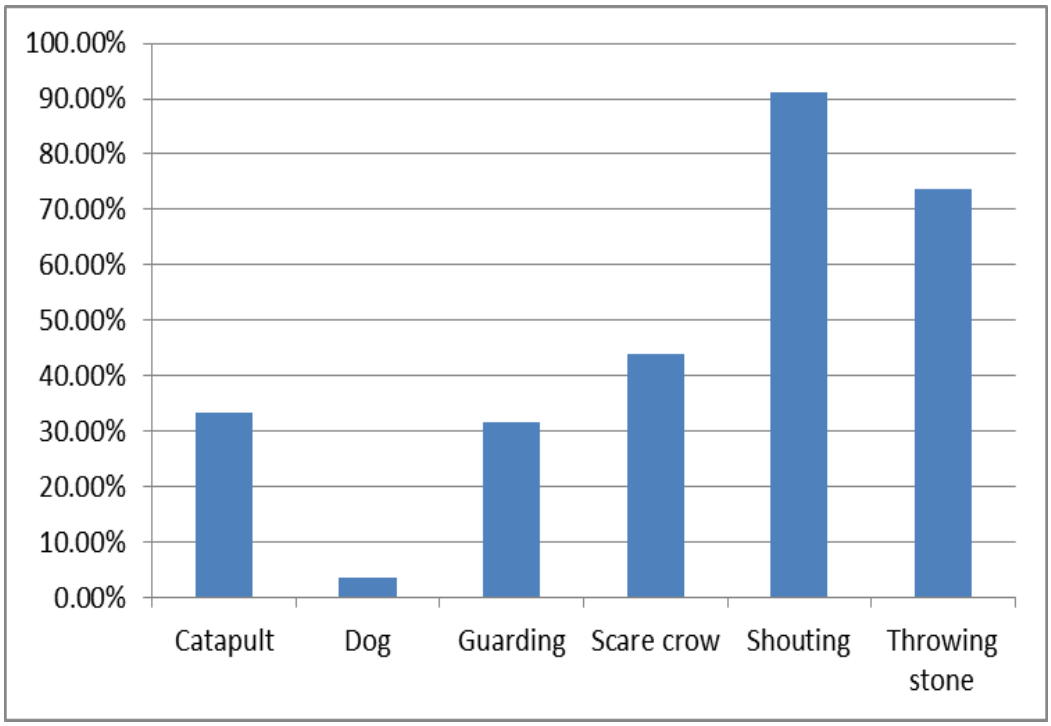


Fig. 7: Crop protection strategies applied by respondent.

5. DISCUSSION

5.1 Age, Sex composition

The study of population of any species is important to maintain or re-establishment the species and we must know the required space, shelter and food as well as their population to conserve them (Flemming 1973). A head count method was carried out from all the accessible trails present in the study area and followed Chalise (1995) to distinguish the age, sex of the langur monkey. Two species of monkeys were found i.e. Hanuman langur (*Semnopithecus entellus*) and Assamese monkey (*Macaca assamensis).* There was almost equal number of langur and assamese with total head count of 48 and 45 respectively. The sex ratio of overall male to female langur is 1:2.27 which is similar to study conducted by Bishop (1979), Boggers (1980), Newton (1988) and Khanal et al. (2018).

5.2 Behaviour of monkey

The percentage of time allocated to resting, moving and feeding in different hour of the day showed significant variation. This study concluded that *Semnopithecus entellus* have a typical activity patterns in morning (7:00 to 9:40), late morning (9:45 to 12:25), day (12:30 to 15:10) and evening (15:15 to 18:05) with foraging peaks in three phases which is followed by locomotion in morning and evening while locomotion is followed by inactive in morning and evening. In day inactive phase is peak which is followed by sleeping behaviour and it is similar to findings of Zhou et al. (2007) which may be an adaptation to variation in the temperature (Ripley 1970). In overall observation, langur spent nearly half of their time in foraging followed by resting/inactive and locomotion. Same patterns were seen in another study conducted by Sayer and Norconk (2008). The time spent in the feeding behaviour and locomotion was different because of many factors. It may be due to effect of season because my study was only conducted in one season and primate's behaviour is different according to seasons (Huang et al. 2003) or may be high temperature because, langur stays inactive during high temperature and negatively correlated with locomotion (Ripley 1970, Zhou et al. 2007) or may be habitat quality. In poor habitat quality langur spent more time on foraging (Koenig et al. 1997, Alam et al. 2014), locomotion (Sommer and Mendoza-Granados 2010) and less time in playing behavior (Li and Rogers 2004) as well as less time on grooming (Alam et al. 2014) but these results contrast with the results concluded by Oates (1977) . In my study area, local people daily visit the forest for daily needs as well they allow domestic

animals in forest for grazing and in some place evidence of jungle fire as well as some invasive plant species were seen. These anthropogenic activities may decrease the quality of habitat of langur monkey. The population of monkey effects in behaviour of monkey, monkey try to ingest more and travel less in high individuals conditions (Judge and De Wall 1997) and this might be the another factor responsible for less locomotion and high foraging which was found in my study. Langur spends much more time on foraging and less time on locomotion, it may be the response towards the reduced food resource because Langur spends more time on feeding to maximize their energy intake as a response to reduced food resources area because increasing the feeding and decreasing the locomotion could set of the energy expenditure in such area (Huang et al. 2003, Wong and Sicotte 2007). In study time, langur troop and assamese troop are in same tree or within close range with almost equal number of individuals. During such conditions assamese seems dominant and show may activities while langur remains inactive or close to another individuals of lagur. Further investigation required to find out the relation between two sympatric species.

5.3 Habitat of monkey

Primate distribution is adversely affected by the distribution of food resources caused by spatial and temporal variation in their locality (Li et al. 2010). Assamese macaques prefer the habitat near to water resource Regmi (2008) which was also applicable for Langur monkey (Ale 2010) and similar to present study that the langur encountered near to Marsyangdi River in the study area. Total 39 species of tree were found on present study sites with dominance of sal *(Shorea robusta)* followed by Bot dhayero (*Lagerstromia parviflora*) but higher plant species i.e. 58 species were recorded by Paudel and Chalise (2017) on the bank of Kaligandaki river with the dominance of Sal (*Shorea robusta)* followed by tiju *(Diospyros malabarica*) with almost equal area covered in both study. Langur usually prefer higher tree for resting (Ramakishan and Coss 2001) which is similar to my findings. When langur are under the high canopy of invasive species like *Lanatana camara, Ageratina adenophora* they stay on ground this may be the adaptation of langur (Sapkota 2007, Magar 2018).

5.4 Crop raiding by monkey

Among the most widely distributed non- human primates in South Asia, Himlayan langur is common in diverse habitat but they are vulnerable due to habitat loss by anthropogenic activities (Chalise 2013, Nag et al. 2014). Present study reported that crop raiding was

reported major problem caused by langur and this is supported by different study conducted on rhesus by and Khatri (2006) and study conducted by Ghimire and Chalise (2016, 2019) on assamese monkey.

Different crop were raided by monkey Chalise (1997, 2001, 2002) and he also recorded that highest loss of maize (32%), followed by potato (24%), rice (14%) and fruits12%) in Makalu Barun National Park area. Ghimire and Chlaise (2016) concluded that maize (58.43%) is highest raided crop by Assamese monkey and maize is followed by Rice (11.34%), lentil (8.74%), peanuts (4.35%) and soybean (4.18%) on side of Budhigandaki River. Similarly, Maize (47.14%), fruits (16.43%), wheat (11.13%), millet (5.72%) are the highest crops raided by Assamese in Palpa and Syangja districts (Ghimire and Chalise 2019). Aryal (2012) found that the damage of maize is highest extend which is followed by wheat (23%), paddy (16%) in Gulmi. Adhikari (2013) found that 78% of respondent of Lamjung area reported that crop raiding as a major problem caused by assumes monkey which is similar finding of Paudel (2016) in Baglung. The amount of raided crops could also be depending upon the types of cultivated crops, availability of natural food, distance to crop land from the forest area and number of individuals in the monkey troops and these are related with mine findings. My study concluded that there was a crop raiding problem which accounts 14.6% of maize production, 9.71% of daal, 9.32% millet, and 7.11% vegetables but no one left crop land due to crop raiding problems. This shows that there is less crop raiding problem as compare to other studies conducted by Chalise (1997,2001,2002), Ghimire and Chalise (2016, 2019) and Aryal (2012).

Due to heavy crop raiding habit of these monkey, locals farmer have tried various method to chase out the monkey from the crop land. The most followed method was shouting and following the macaques. Use of catapult and stone, guarding the crop field, use of dog are other common method to protect the crops and these results were similar to Khatri (2006), Aryal (2012) and Adhikari (2013). Chalise (2001) reported that farmer's suffering from monkey crop damage in eastern Nepal was considering planting chili, garlic and tobacco.

6. CONCLUSION AND RECOMMENDATIONS

The study of population and behaviour of any species is important to maintain the number or re-introduction of species. From the study area, two species o monkey i.e. langur (*Semnopithecus entellus*) and Assamese monkey (*Macaca assamensis*) are found in study area and classified them with their age structure. Only 14 langurs were chosen for behavioural observation of monkey and instantaneous focal animal method was used to observe the behaviour. This study conclude that langur spent much more time in foraging behaviour (45.99%), followed by inactive (17.67%), Locomotion (14.12%). The behaviour of langur was observed in different time phase of day and phase of classified into morning, late morning, day and evening. Chi- square test was applied to test the difference between behaviours in different phase of time and null hypothesis was rejected at 95% confidence level.

The plant species was counted in study area by random quadrate sampling method, altogether 32 circular quadrates having radius 10m were laid down among them, 27 were in forest area and 5 were in edge of agricultural area. Total 39 species of plant excluding some invasive species like *Mikania micrantha*, *Lantana camara*, *Ageratina adenophora* and among them, Sal (*Shorea robusta*) is most dominant species which was followed by Botdhayero (*lagrestromia parviflora*), Chilaune (*Schima wallichii*), Madhise Khirro (*Holarrhea pubescens)*and Sindhure *(Mallofus philipinanus*.

Semi structured question was asked with 37 local people and most of them reported that crop raiding was major problem caused by Langur. Maize, millet, daal and vegetable were some major crops raided by langur and local people applied various methods to chase out the monkey from agricultural fields among them shouting and following and throwing stone are the methods that come on ranked first and second respectively.

To conserve the habitat of monkey, following are some of the recommendation drawn from the study which will be helpful in conservation of primates as well as habitat of primates.

a. In study area, Assamese monkey and Langur were found in same habitat as well as their troop frequently meet to each other. In future, the behaviour of sympatric species should be compared in that area which will help us to conserve both species.
b. Jungle fire as well invasive plant species must be control.

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APPENDICES

Appendix I

Average Climatic parameter in the year 2013 to 2018 at Gorkha station

Gorkha Station			
Months	**Maximum Temperature (°C)**	**Minimum Temperature (°C)**	**Rainfall (mm)**
January	20.58	8.12	16.56
February	24.06	11.1	19.16
March	27.98	14.38	49.26
April	31.34	17.96	68.24
May	32.12	20.2	136
June	32.86	22.78	280.74
July	31.32	23.56	388.42
August	31.54	23.48	347.78
September	31.26	22.5	154.68
October	29.2	18.04	50.78
November	25.12	12.98	0
December	20.92	9.28	7.26

(Department of Meteorology, Gorkha Station)

Appendix II

Data sheet to count population of encountered troops

Place	GPS location	Time	Age sex composition of macaque						Total	Remarks
			AM	AF	SAM	SAF	J	I		

AM= Adult male, AF= Adult female, SAM= Sub-adult male, SAF= Sub-adult female, J= Juvenile and I= Infants

Appendix III

Location of Quadrates

1	27.89393	84.54218
2	27.88339	84.54145
3	27.89280	84.54188
4	27.89203	84.54173
5	27.89131	84.54193
6	27.89028	84.54211
7	27.89275	84.54269
8	27.89289	84.54324
9	27.89741	84.54081
10	27.89490	84.54130
11	27.89090	84.54121
12	27.88961	84.54110
13	27.89010	84.54331
14	27.89160	84.54290
15	27.88851	84.54101
16	27.88760	84.54110
17	27.88690	84.54071
18	27.88521	84.54180
19	27.88390	84.54321
20	27.88461	84.54480
21	27.88350	84.54620
22	27.88160	84.54551
23	27.88220	84.54690
24	27.87740	84.54170
25	27.87710	84.54360
26	27.87840	84.54420
27	27.87950	84.54501
28	27.87731	84.54680
29	27.87880	84.54801
30	27.88071	84.54821
31	27.87470	84.54431
32	27.8760	84.5449

Appendix IV

Species diversity calculation of plant in study area

S. N.	Local Name	Scientific name	Number of individuals	Pi	LnPi	Pi*LnPi
1	Khirro	*Sapium insigne*	39	0.03775411	-3.2767	-0.12371
2	Sindhure	*Mallotus philipinancis*	65	0.06292352	-2.7658	-0.17404
3	Bot Dhayero	*Lagerstromia parviflora*	116	0.11229429	-2.1866	-0.24555
4	Epil	*Leucacaena leucocephala*	13	0.0125847	-4.3753	-0.05506
5	Madise Khirro	*Holarrhena pubescens*	69	0.06679574	-2.7061	-0.18076
6	Thotne	*Aconogonum molle*	17	0.01645692	-4.107	-0.06759
7	RaaTpate		19	0.01839303	-3.9958	-0.07349
8	Chatiwan	*Alstonia scholaris*	3	0.00290416	-5.8416	-0.01696
9	Mayal	*Pyrus pashia*	15	0.01452081	-4.2322	-0.06145
10	Paakmaro		41	0.03969022	-3.2267	-0.12807
11	Simal	*Bombax ceiba*	2	0.00193611	-6.2471	-0.0121
12	Bhorla	*Bauhnia vahlii*	14	0.01355276	-4.3012	-0.05829
13	Karam	*Adina cordifolia*	38	0.03678606	-3.3026	-0.12149
14	Chilaune	*Schima wallichii*	93	0.09002904	-2.4076	-0.21676
15	Kamuna	*Cleistocalyx operculata*	6	0.00580833	-5.1485	-0.0299
16	Guyalo	*Elaeagnus parviflora*	17	0.01645692	-4.107	-0.06759
17	Sal	*Shorea robusta*	322	0.31171346	-1.1657	-0.36336
18	Bhellor	*Trewia nudiflora*	6	0.00580833	-5.1485	-0.0299
19	Gidhauri	*Premmna integrifolia*	4	0.00387222	-5.5539	-0.02151
20	Sisau	*Dalbergia sissoo*	3	0.00290416	-5.8416	-0.01696
21	Bel	*Aegle marmelos*	21	0.02032914	-3.8957	-0.0792
22	Dabdabe	*Garuga pinnata*	5	0.00484027	-5.3308	-0.0258
23	Pipal	*Ficus religiosa*	11	0.0106486	-4.5423	-0.04837
24	Aamala	*Phyllanthus emblica*	2	0.00193611	-6.2471	-0.0121
25	Katahar	*Artocarpus*	3	0.00290416	-5.8416	-0.01696
26	Tanki	*Bauhinia purpura*	7	0.00677638	-4.9943	-0.03384
27	Khanayo	*Ficus semicordata*	4	0.00387222	-5.5539	-0.02151
28	Kavro	*Ficus lacor*	9	0.00871249	-4.743	-0.04132
29	Saj	*Terminalia alata*	3	0.00290416	-5.8416	-0.01696

30	Padke		16	0.01548887	-4.1676	-0.06455
31	Dumri	*Ficus racemosa*	3	0.00290416	-5.8416	-0.01696
32	Pakhuri	*Ficus glabernima*	1	0.00096805	-6.9402	-0.00672
33	Bakenu	*Melia azederach*	14	0.01355276	-4.3012	-0.05829
34	Mango	*Mangifera indica*	16	0.01548887	-4.1676	-0.06455
35	Khayer	*Acacia catecho*	5	0.00484027	-5.3308	-0.0258
36	Chitu	*Diospyrus malabarica*	4	0.00387222	-5.5539	-0.02151
37	Kadam	*Anthocephalus chinesis*	2	0.00193611	-6.2471	-0.0121
38	Gayo	*Bridelia retusa*	2	0.00193611	-6.2471	-0.0121
39	Bar	*Ficus banghalensis*	3	0.00290416	-5.8416	-0.01696
			1033			-2.66014

Appendix V

Plant frequency, relative frequency, density and relative density in study area.

Local Name	Scientific name	No. of I	No of Q	D	RD
Khirro	*Sapium insigne*	39	11	0.00381369	3.78
Sindhure	*Mallotus philipinancis*	65	14	0.00646894	6.29
Bot Dhayero	*Lagerstromia parviflora*	116	19	0.01154458	11.2
Epil	*Leucacaena leucocephala*	13	3	0.00129379	1.26
Madise Khirro	*Holarrhena pubescens*	69	14	0.00686704	6.68
Thotne	*Aconogonum molle*	17	6	0.00169188	1.65
RaaTpate		19	7	0.00189092	1.84
Chatiwan	*Alstonia scholaris*	3	1	0.00029857	0.29
Mayal	*Pyrus pashia*	15	4	0.00149283	1.45
Paakmaro		41	13	0.00408041	3.97
Simal	*Bombax ceiba*	2	2	0.00019905	0.19
Bhorla	*Bauhnia vahlii*	14	4	0.00139331	1.36
Karam	*Adina cordifolia*	38	9	0.00378185	3.68
Chilaune	*Schima wallichii*	93	12	0.00925557	9
Kamuna	*Cleistocalyx operculata*	6	3	0.00059713	0.58
Guyalo	*Elaeagnus parviflora*	17	5	0.00169188	1.65
Sal	*Shorea robusta*	322	21	0.03204618	31.2
Bhellor	*Trewia nudiflora*	6	2	0.00059713	0.58
Gidhauri	*Premmna integrifolia*	4	2	0.00039809	0.39
Sisau	*Dalbergia sissoo*	3	2	0.00029857	0.29
Bel	*Aegle marmelos*	21	5	0.00208997	2.03
Dabdabe	*Garuga pinnata*	5	3	0.00049761	0.48
Pipal	*Ficus religiosa*	11	4	0.00109475	1.06
Aamala	*Phyllanthus emblica*	2	1	0.00019905	0.19
Katahar	*Artocarpus*	3	1	0.00029857	0.29
Tanki	*Bauhinia purpura*	7	3	00.0006966	0.68
Khanayo	*Ficus semicordata*	4	3	0.00039809	0.39
Kavro	*Ficus lacor*	9	5	0.00089570	0.87
Saj	*Terminalia alata*	3	2	0.0002857	0.29
Padke		16	4	0.00159236	1.55
Dumri	*Ficus racemosa*	3	2	0.00029857	0.29
Pakhuri	*Ficus glabernima*	1	1	0.0000995	0.1
Bakenu	*Melia azederach*	14	4	0.00139331	1.36
Mango	*Mangifera indica*	16	6	0.00159236	1.55
Khayer	*Acacia catecho*	5	3	0.00049761	0.48
Chitu	*Diospyrus malabarica*	4	2	0.00039809	0.39
Kadam	*Anthocephalu schinesis*	2	1	0.00019905	0.19
Gayo	*Bridelia retusa*	2	1	0.00019905	0.19
Bar	*Ficus banghalensis*	3	2	0.00019905	0.29
		1033	32	0	100

Here, No of I = Number of Individuals, No of Q= Number of quadrates in which species occurred F= Frequency, RF= relative frequency, D= Density and RD= Relative density

Appendix VI

Questionnaire format for respondents

Date: …….

Name …….. Age: ……. Sex: M/F

Occupation: ……. Family member: …….. Address:

……..

1. How many family members are there in your family? …….
2. How much land do you own? …… Ropani/ Hal
3. Which Crops do you grow in your field?

   a. b. c.

   d. e. f.

   g. h. i.

4. Did you see langur around your house? Yes [ ] No [ ]

If yes, how many times in a day/week? ……

5. Does langur/dheduwa raid crop? Yes [ ] No [ ]

   If yes, name the crops

   a. b. c. d.

   e. f. g. h.

6. Proximity of damage field to jungle? 100m/200m/300m/500m

7. What is the frequency of monkey interference in crops?

Name of crops	Frequency per day/week/months
Maize	
Millet	
Vegetables	
Fruits	
Rice	

8. Any land left fellow because of the crop raiding of monkey? Yes [ ] No [ ]

If yes, then ……Ropani/hal

9. Any kind of nuisance activities/ harassment besides crop raiding? ……

10. What are the preventive methods that you are using to control?

a. Guarded by human b. Shouting and follow c. Throw stone

d. Guarded by dog f. Fire cracker g. Hunting

h. Others ……..

11. What will be the suggestive solution?

……

12. Remaining any suggestions and problem?

PHOTOPLATES

Picture: 1 Troop of langur monkey

Picture: 2 Troop of assamese monkey

Picture: 3 Locomotion of adult male langur

Picture: 4 Forage by sub-adult female

Picture: 5 Ault-male langur in crop land

Picture: 6 Local people in forest for fodder

Picture: 7 Footage of jungle fire collection

Figure:8Cattle grazing in Jungle for fodder

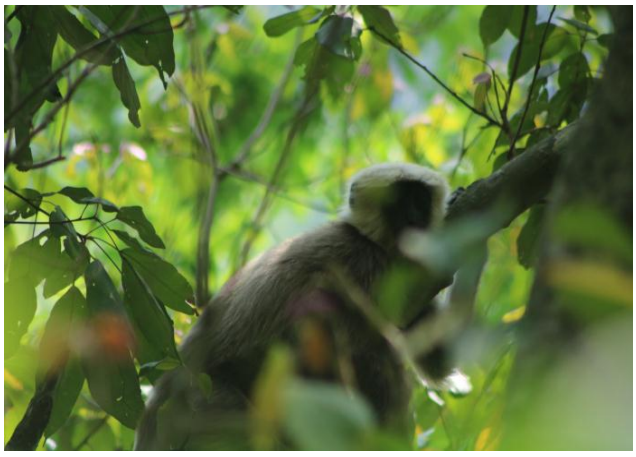
Picture: 9 Defecation of male langur

Picture: 10 Langur and assamese monkey on Same tree

Picture 11: Questionnaire with local people by researcher in Sahid Lakhan Rural Municipality

Picture 12: Grooming behaviour of Langur

Picture 13: Inactive behaviour of Langur



Picture 14: Sleeping behaviour of Langur