1. INTRODUCTION

1.1 General Background

Population is defined as a group of individuals of the same species occupying a particular geographic area. Populations may be relatively small and closed, as on an island or in a valley, or they may be more diffused and without a clear boundary between them and a neighboring population of the same species. For species that reproduce sexually, the members of a population interbreed either exclusively with members of their own population or, where populations intergraded, to a greater degree than with members of other populations (www.en.wikipedia.org).

The muntjak or barking deer (*Muntiacus muntjak)* is a small, solitary, forest dwelling ruminants (Teng et al. 2004, Shrestha 1997, Oli and Jacobson 1995). Muntjak deer are classified into 9 known species: *Muntiacus crinifrons, M. feae, M. gongshanensis, M. muntjak, M. putaoensis, M. reevesi, M. roosevelorum, M. truongsonensis and M. vuquangensis* (Shi and Ma 1988, Amato et al. 1991, Nowak 1991, Giao et al. 1998, Wang and Lan 2000). There are 15 subspecies of the *Muntiacus muntjak* in the world (Ohataishi and Gao 1990). The species found in Nepal, Bhutan and Northern India is *M. muntjak vaginalis* (Tamang 1982).

The barking deer is potential prey for large carnivores such as tiger (*Panthera tigris*) and leopard (*Panthera pardus).* However several studies showed that the barking deer is not preferred as prey by tigers (Schaller 1967, Stoen 1994, Stoen 1996,Heggdal 1999). Muntjaks are hunted for their meat and skins. In China, estimated that 140,000-150,000 Indian muntjaks are hunted for their meat throughout their range (Teng et al. 2004).

Muntjaks are the oldest known deer, appearing 15-35 million years ago, with remains found in Miocene deposits in France and Germany (www.en.wikipedia.org).

1.2 Distribution

Barking deer ranged over the greater part of the Indo-Malayan countries and also found in China, Formosa, Japan, Sri Lanka, North India and Nepal (Shrestha 2003). Reeves' muntjak (*M. reevesi*) introduced to Britain and the United states where in some areas they are well established (Chapman et al. 1993). They are found in altitude from sea level to 3000 meters in the Himalayas (Oli 1986, Mishra 1982). According to Shrestha (1997), barking deer are widespread in oak and lower conifer forest up to about 3500m elevations in Nepal. The species prefers gently sloping terrain and also occurs in the steeper hills. The deer is common in Bhabar and its distribution in Tarai is largely restricted to areas receiving to good protection (WII 2004). In Nepal, it is common in almost all dense forest and protected areas. It is distributed in Sagarmatha National Park, Makalu Barun National Park, Shivapuri Nagarjun National Park, Langtang National Park, Annapurna Conservation Area, Dhorpatan Hunting Reserve, Rara National Park, Khaptad National Park, Shuklaphata Wildlife Reserve, Parsa Wildlife Reserve and Koshi Tappu Wildlife Reserve. It is reported from district of Taplejung, Ilam, Panchther, Shankhuwasabha, Ramechhap, Sindhupalchowk, Kailali, Kanchanpur, Bhajang, Kalikot and Jumla (Majupuria and Majupuria 2006).

1.3 Classification

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Artiodactyla

Suborder: Ruminantia

Family: Cervidae

Subfamily: Cervinae

Genus*:* *Muntiacus*

Species: *muntjak*

(Sources: www.iucnredlist.org)

1.4 Morphology

The barking deer is also called Rib-Faced deer, as the antlers grow in male from a pair of elongated skin covered pedicles that is an extension of two raised bony tissues and females have small bony knobs and tufts of hairs (Shrestha 1997). The colour of coat varies from dark brown to chestnut brown, hence the local name "Raate" or "Ratuwa" (Yonzon 1978, Chalise 2013). The males have short antlers, which are carried on long, bony, hair-covered structures and are shed annually. Males also have tusk-like upper canine teeth, which curve strongly outward from the lips (Shrestha 1997). The Head Rump length is 89-135cm, the tail length is 13-23cm, the body height is 40-65cm and weight is 15-35kg.

1.5 Habit and Habitat

A habitat is an ecological or environmental area that is inhabited by a particular species of animal, plant, or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds a species population. A habitat is made up of physical factors such as soil, moisture, range of temperature, and availability of light as well as biotic factors such as the availability of food and the presence of predators. A habitat is not necessarily a geographic area for a parasitic organism it is the body of its host, part of the host's body such as the digestive tract, or a cell within the host's body (www.en.wikipedia.org).

Barking deer is primarily a solitary species (Kurt 1981, Heggdal 1999) and can be seen occasionally in a group of four or five animals (Kurup 1971). They are shy and secretive creatures (Kurt 1981). Well-developed scent glands are typical of species adopting a territorial system, since the animals are able to advertise their status by scent marking within territories (Gosling 1986). Besides the scent Glands, which lie below each eye, the male muntjaks have a frontal gland on forehead (Prater 1980). There scent glands also occur between the hooves, which leave a trail of scent behind (Yonzon 1978). The average home range size determined by Heggdal (1999) in Bardia National Park was 34.3ha whereas Mosand (2001) found that the average home range size for females and males was 40ha and 77ha respectively. Furthermore, Shrestha (1997) claims that males like a solitary existence but become more aggressive during onset of the rut. But in

female territory more inclusive and most likely females are not territorial as males (Heggdal 1999, Mosand 2001). Barking deer is difficult to discover in wild forest. It will sneak away or “freeze” as soon as disturbance is detected (Mishra 1982, Mathilde and Andersen 1993).

The barking deer inhabited in rain forest, areas of dense vegetation, hilly countries and monsoon forests. Studies in Hainan Island, China, muntjak avoided woods, cultivated grassplots and deciduous monsoon forests. Comparing forage sites with bed sites, food availability was greater at forest sites, taller trees with larger canopies, taller and denser shrubs canopy covers and concealment covers were essential factors (Teng et al. 2004). Heggdal (1999) found that the riverine forest is a more preferable habitat or the barking deer than Sal forest in BNP. Nagarkoti (2006) found that barking deer prefers mixed broadleaved forest and pine forest in spring and rainy season respectively.

Muntjaks exhibit two patterns of defecation in captivity and even in wild. They defecate through their enclosure without regard to existing pellet groups, and they repeatedly use specific areas, which are called latrines (Dubost 1970). By camera trapping (Mosand 2001) found that both males and females were using the same latrine. On some occasion more than one female were detected to use the same latrine area. Also several males used the same latrine.

The animal browses at early dawns and in the evening; mid-day is spent resting under cover of a bush or under a rock. It also used to bark in the morning and evening, sometimes after dark (Shrestha 1997). They drink water at least once a day, mainly in the morning or at noon hours (Yonzon 1978). Muntjaks are virtually omnivorous in habit (Kurt 1981) and are primarily ‘nibblers’ feed on tender leaves, twigs, seed pods and shrub fruits (Barrette 1977). Mainly, their diet comprises herbs, sprouts, fruits, seeds, bird’s eggs, small animals and carrion. Muntjaks are capable of breeding all year around. They become sexually mature in six to twelve months and gestation period is approximately six months.

1.6 Statement of Problem

Shivapuri Nagarjun National Park is least touched by researcher for faunal study although it lies in the central region of Nepal. A few studies in the forest are focused mainly on the flora: and birds and bat among fauna (Kanai and Shakya 1970, Rana 1979, Chitrakar 1982, Shrestha 1997 and Shrestha 2003). However, information on most of the fauna is still lacking. The barking deer is common species in Nepal but it is threatened by habitat loss, degradation and pouching throughout the country except in protected areas. In addition, studies on barking deer (*Muntiacus muntjak*) have been concentrated in lowlands of Nepal (Yonzon 1978, Shrestha 1984, Heggdal 1999 and Mosand 2001). Only limited studies have been carried out about population status, distribution and habitat pattern of barking deer in Nepal. It is very difficult to say anything strongly about the long term survival. This study extrapolates population status, distribution and habitat of barking deer which provide baseline information for effective conservation and management thereby enhancing long survival of ungulates in Shivapuri Nagarjun area.

1.7 Conservation Status

Fortunately barking deer are not listed in the IUCN Red List of Threatened Species. In Nepal, wildlife management practice confined to National Parks and Wildlife Reserve. However, there are many biologically potential habitat closed to the protected areas, which face problems of habitat degradation due to human pressure. Increasing demand of local people on forest resources for fodder, grass, timber and firewood heightens the pressure on dwindling resources (Thapa 2003). Maintaining prey bio-mass above a certain threshold level in important for the conservation of both endangered carnivores like leopards and the prey species themselves (Wegge et al. 2000). For that it is important to determine the habitat requirements for a given prey species (Scotter 1980).

Any Researcher for any biological study does not touch Sikre VDC, a probable area of Shivapuri Nagarjun National Park. So information on flora and fauna found in Sikre VDC is still lacking. The barking deer is common species in Nepal but it is threatened by habitat loss, degradation and poaching throughout the country except in protected areas.

1.8 Objectives

The main objective of the study is to present the population status of barking deer at Shivapuri Nagarjun National Park. Specially this study would attempt to deal with following specific objectives-

1. To determine the population status and distribution of barking deer at Shivapuri Nagarjun National Park (Sikre VDC).
2. To determine the habitat utilization by barking deer.
3. To determine the anthropogenic impact on the habitat of barking deer.

1.9 Rationale

The intensive studies focusing on barking deer in Nepal are few. A study on attitude of local people is also essential for the conservation of the barking deer. It is hoped that the information generated by this study will be useful for the management of barking deer in Sikre VDC as well as other parts of central hills of the country, furthermore, the study will be helpful for proper management of Sikre VDC for wild animals.

2.0 Limitation of the Study

The present study was without any sponsorship so financial and technical constraint was the major limitation of the study. Shy, solitary and crepuscular habit of barking deer limits the study work that is intended for the short period. In addition steep topography and less information of the study area were other problems during this study.

2. LITERATURE REVIEW

A total of 12 individuals (5 adult males, 4 adult females, 2 sub-adult females and 1 infant), 178 pellet groups, 13 latrines and one hunting spot were recorded inside three different blocks of the Hemja VDC, Kaski District. A study was carried out to know the status and distribution of barking deer found in the forested mountains of Hemja VDC, Kaski District. The study was done by direct observation method with indirect counting of fecal pellets while walking systematically in total 11 line transects covering 6.64 km in length (Pokhrel and Chalise 2010).

The distribution pattern and habitat preference of barking deer (*Muntiacus muntjak*) were analyzed during spring and rainy seasons of 2005 in Nagarjun Forest, Kathmandu. A total of 14 observations (seven males and seven females), 247 pellets and 118 footprints of barking deer were recorded in the spring and 14 observations (nine males and five females), 151 pellets and 140 footprints were recorded during the rainy season (Nagarkoti 2006). The food habits of the barking deer (*Muntiacus muntjak*) were studied and analyzing fresh pellets collected in spring (N=247) and the rainy season (N=151). Fresh pellet groups were sampled along line transects and analysed using microhistological techniques.

The distribution patterns and relative abundance of mountain ungulates in *Prek Chu* catchment of Khangchendzonga Biosphere Reserve (BR) during 2008-2009 by sampling trails/ transect and using camera traps. Presence of goral (*Naemorhaedus goral*), barking deer (*Muntiacus muntjak*), serow (*Naemorhaedus sumatraensis*), musk deer (*Moschus sp.*) and blue sheep (*Pseudois nayaur*) was confirmed through direct and indirect evidence (Bhattachaya 2010).

The current population and conservation status of barking deer *(Muntiacus muntjak)* in Pir Lasorha National Park (PLNP) and surrounding areas of District Kotli, a study was carried out from April to December 2009. During the survey, direct (physical observations and signs) and indirect (information through questionnaires) methods were used to collect information about the population of barking deer (Zulfiqar et al. 2011).

Observations on barking deer (*Muntiacus muntjak*) in Nepal suggest this solitary forest dweller may be the most communicative of all deer. A total of 147 h of visual observations on 9 captive and 110 wild barking deer were recorded (Oli and Jacobson 1995).

An expedition into northern Myanmar obtained detailed descriptive data on a new species of muntjak called the leaf deer. Weights, measurements, and physical data were obtained from 12 freshly killed leaf deer, along with partial measurements from 90 head pieces of leaf deer found in village huts (Amato et al. 1991).

Belt transect (71 km) sampling of population of barking deer (*Muntiacus muntjak*) in Margalla Hills National Park, Pakistan (western extremities of Lesser Himalayas), conducted during winter March-April 2005 suggested a population of 86 individuals distributed in southern slopes with an average density of 1.21±0.14/ km^2 (range 0.80 - 1.45) (Hameed et al 2009). Habitat preference of five herbivores in the Chimmony Wildlife Sancturary (Jayson 1999).

More than 75.5% of the economically active population of the park and its buffer zone is engaged in agriculture as primary occupation and 45% of the total population working as labor. The younger generation prefers off-farm employment opportunities rather than the traditional occupation of subsistence farming (Khatri-Chhetri 1993).

Livestock rearing is an integral part in the hill farming system. It is an important component of the Nepalese farming system providing food for humans, manure for plants, and draft powers for farms and cash income for farm families. Generally poor people prefer to collect firewood rather than buying and they have a tendency to exploit the forest near to settlements rather than to think about sustainable use. Firewood is the major source of energy for mountain people because it is easily and freely accessible (Blaikie 1992) and also used by local people where they have no alternative source.

People living in and around the ShNNP depend mainly on the park forests for firewood, leaf litter, and timber. Firewood composed of trees, brushwood including green conifer bushes and other example crop residues is the main source of energy for cooking and heating (KMTNC 2004). In the Sagarmatha National Park (SNP), there was heavy

demand on forest areas for firewood use, both by local inhabitants and the visitors (Sherpa 1979). The firewood demand from growing population in and around the Chitwan National Park (CNP) was a major cause of park/people conflicts in Old Padmapur (Sharma and Pukkla 1990). In the Bhandara Buffer Zone in Chitwan, only 2.50% of the green fodder and 26.0% of the firewood demand can be fulfilled by the buffer zone community forests and the rest was met from the CNP and neighboring forests (Ghimire 2007).

The continuous illegal collection of firewood, fodder, grazing of livestock, and other activities inside the forest causes depletion of resources that cause adverse effect on biodiversity (Rai and Sharma 1998). Due to increase human population and to meet their needs, large scale habitat changes are occurring globally (Khan et al. 1993) and site which is rich in diversity is also facing threat due to increased tourist movement (Chettri et al. 2001). Due to rapid human population growth, grazing areas have shrunk. Farmers selectively stall feed their animals that include milking cows, buffaloes and grasses for these animals are brought from the forests, plantation areas, and farmland (Jnawali 1994). The growing rates of deforestation in many developing countries have been linked to the growing scarcity of firewood but in most situations the underlying cause of deforestation is the conversion of land to farming (Eckholm et al. 1984).

3. MATERIALS AND METHODS

3.1 Materials

The scientific instruments used during the field study are:

1. Camera	2. Measuring tape	3. GPS
4. Binocular	5. Map of study area	6. Compass

3.2 Study Area

3.2.1 Location

Shivapuri Nagarjun National Park (ShNNP) is situated on the northern fringe of Kathmandu valley and lies about 12 km away from capital city. It is major watershed providing drinking water to Kathmandu's burgeoning urban population. The area was gazette as the country's ninth national park in 2002 A.D. The extension touches the boarder of four districts i.e. Kathmandu, Nuwakot, Sindhupalchwok and Dhading. Shivapuri Nagarjun National Park (ShNNP), initially established as Shivapuri Watershed Reserve in 1976 and Shivapuri Watershed and Wildlife Reserve in 1984, was gazetted as a National Park in 2002. The park is located on the northern edge of Kathmandu valley between 27°45' and 27°52' North latitude and 85°15' and85°30' East longitude. Covering an area about 144 km^2 of the twelve Village Development Committees (VDCs) at the northern part of Kathmandu District, nine VDCs at the southern part of Nuwakot, and two VDCs at the western part of Sindhupalchowk of Central Development Region, it stretches about eight to ten kilometers from North to South and about 20 to 24 km from East to West. It represents a typical mid hill physiographic zone of Nepal. Two villages Mulkharka and Okhreni are located within the park. The park boundary is well demarcated with a 111 km long wall around the park (NTNC 2004). It is the main source of the river Bagmati and Vishnumati that flow the southern slopes of the mountain. The highest point is the Shivapuri Peak with 2732m altitude that represents the second highest mountain surrounding the Kathmandu valley.

Actual study was conducted in the Sikre VDC in ShNNP. The soils of the area range from loamy sand on northern side to sandy loam on the southern slope (Baniya 1998). Entire area is characterized by its steep topography. The distance of Sikre from Panimuhan is 12 km. Sikre VDC comes under the Nuwakot district with the hilly ecological zone (Figure1).

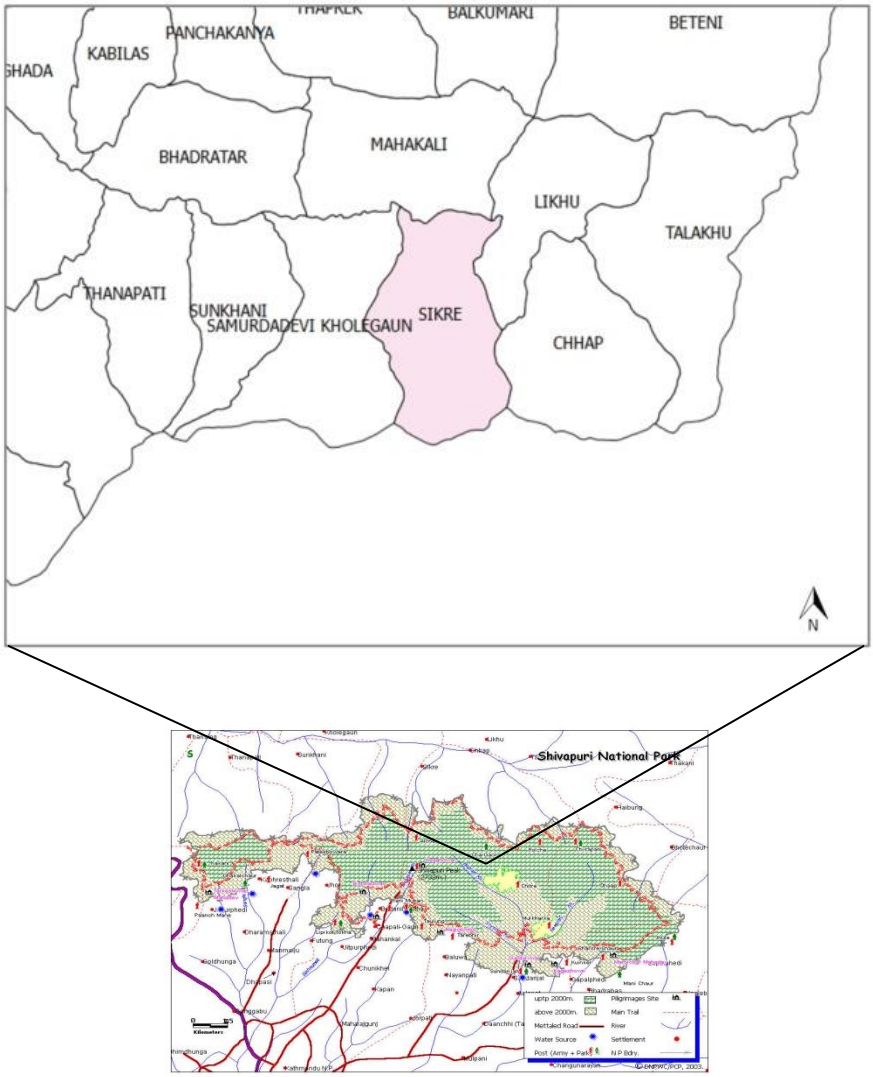

Figure 1: Adjoining the VDC of ShNNP with Sikre VDC

(Source: NTNC 2004)

3.2.2 Climate

The climate of the ShNNP area ranges from sub-tropical and warm temperature. It has relatively high humidity all throughout the year. There is a high variation in the annual temperature and precipitation. According to the climate data (for the period of 2005–2013) of Department of Hydrology and Metrology, Babarmahal, the mean monthly maximum temperature at Panimuhan was 29.8°C in May and June (summer) and minimum temperature was 1.7°C in January. The mean annual rainfall was 716.5 mm occurs in July and the amount of rainfall decreases considerably in winter (DHM) and the average monthly relative humidity reaches up to 96.2% (morning) and 93.9% (evening) (APPENDIX II).

3.2.3 Land use Pattern

The land use pattern in and around SNNP is predominated by forest (40.7%) followed by agriculture (35.3%), shrubs (14.8%), grassland (2.9%), grassland and shrubs (2.6%), landslides (0.5%), settlements (0.9%), riverine feature (0.2%) and abandoned lands (2.0%) (NTNC 2004).

3.2.4 Buffer Zone Community Forest

The Sikre community forests were managed by six community forest user communities namely Basin Danda, Syalpin Danda Pakha, Syawrithan Ghakhai Pakha, Chyan Danda, Deurali Mahila and Simpakha Mahila respectively. The forest is upper mixed hardwood with lower mixed hardwood forest, chirpine forest and oak forest (Amatya 1993, Kattel 1993, NTNC 2004). Major species were *Schima wallichii, Castanopsis indica, Alnus nepalensis, Rhododendron arboresum, Pinus roxburgii, Quercus* sp. Some of the wildlifes found in the forest were common leopard (*Panthera pardus*), langur (*Semnopithecus entellus)*, rhesus monkey (*Macacca mulatta)* and jungle cat (*Felis chaus)*. The forest is also the home to 177 species of birds, 102 species of butterflies and 129 species of mushroom (Pandey 2010, ShNNP 2010). It is estimated that more than 200 Rhesus monkeys inhabits around ShNNP and with a maximum number of 64 individuals in a troop of Sundarijal (Nepal 2005, Chalise et al. 2013). Some of the community forest were properly managed and open once a month for fodder and firewood collection.

3.3 Preliminary Field Survey

A preliminary field survey was made to find out the population status, distribution and habitat of barking deer in Shivapuri Nagarjun National Park before the intensive study was made.The preliminary survey in the area for the research was carried out during the month of June 2013 to collect general information and to identify the potential area of barking deer. For more information, discussion was made with local people, community forest users members and forest office staff.

3.4 Field Survey

The field survey was carried out to collect data on individuals, fecal matter and foot prints of barking deer from November 2013 to June 2014.

3.4.1 Direct Observation

The population status, distribution pattern and habitat use of barking deer in Sikre VDC was determined by direcct observation and was carried out from 6.00 am to 6.50 pm. Comparatively similar amount of time was spent in area for the data collection. Monitoring of barking deer was done through transects. The line transects of 100m in length were laid out with the interval of 5m corresponding contour lines of topographic maps. The study site was designated into Plot A, Plot B, Plot C, Plot D contained 20, 15, 10, and 5 transects respectively according to feasibility of topography. The animals and evidences of presence such as footprints (hoofmark) and pellets sighted within 5m in each side of transect were recorded. At each sign location, data on GPS coordinates; altitude and habitat type were recorded. On these transects ten meter square plots were randomly laid down to record the habitat type, plant species present , fecal deposits and footprints of animal according to the habitat type available. Habitat use and preference were determined by a method used by Jayson (1999) for herbivores.

3.4.2 Indirect Observation

In ecological research, the direct observation is not a research tool to complete. Indirect method was also used to find the research goals. In indirect methods, pellets, antler, hoofmarks, barking sounds etc were used as a tool to identify the animals. If these materials were found in the field then it was supposed that the animal was residing in the

place. This method used for distribution pattern and habitat use and preference for barking deer.

3.4.2.1 Age group and sex

Age group of barking deer was distinguished by their body proportion, height and size. Since horns are found only in male , age estimation of male was on the basis of size of horn.

Infant: Very small body size, and remained associated with their mother.

Juvenile: Small body size moved around their mother or might be solitary and not more than 1 year in age.

Sub-adult: Individuals with 1-2 years of age and estimated height at shoulder was not more than 45 cm. Similarly, individuals with noticeable horns were considered as sub-adult male and without horns at that height were considered as sub- adult female.

Adult: Adults of both sexes were estimated to be over 2 years of age and more than 45cm in height. Males had well developed bifurcated horns with approximately 10cm or more in length.

3.4.2.2 Pellets counts

All these fecal deposits categorized into Very Fresh (F_2), Fresh (F_1), Old (O_1), and Very Old (O_2), according to their status and external properties.

Very Fresh (F2): Shiny black and great amount of moisture content fecal pellets, which seemed to be defecated just before 2-3 hours.

Fresh (F1): Shiny black but less amount of moisture content and seemed to be defecated with in 24 hours.

Old (O1): No shine but grayish black, feces have normal shape without moisture content.

Very Old (O2): Losing shine at all and some of the pellets lost their normal form and shape.

3.5 Questionnaire Survey

A set of questionnaire was prepared and interviewed with local people within the study area to know the perspective of villagers about barking deer and other associated mammalian fauna. Questionnaire mainly deals with the barking deer status, distribution pattern and habitat use. Survey also deals with the information on the resource use and dependency was collected through the source of energy use, daily need or demand of resources and availability of the resources they actually depend on (APPENDIX I).

3.6 Data Analysis

All the collected information were categorized and tabulated according to the objective of the study to determine population status, distribution pattern and habitat preference. Data were manually processed and analyzed in descriptive way as well as by statistical measure.

3.6.1 Population Density

Population density is defined as total number of animals per unit area they occupy. It is necessarily a positive number, but it may be a fraction. The generalized definition density of population is:

$$D = N/A$$

$$\text{Density} = \frac{\text{Total Number of Animals in an Area}}{\text{Total Area}}$$

3.6.2 Distribution pattern

3.6.2.1 Variance-to-mean ratio ($S^2/\bar{x}$): Data on animal location such as number of individuals, footprints and pellets recorded in each habitat type were used to determine distribution pattern. The distribution pattern of the deer was calculated by variance-to-mean ratio (Odum1971) which is based on the fact that is Poisson distribution, the variance (S^2) is equal to the mean.

If $S^2/\overline{X} > 1$; Distribution is clumped

If $S^2/\overline{X} < 1$; Distribution is uniformed

If $S^2/\overline{X} = 1$; Distribution is random

3.6.2.2 Chi-square test for goodness-of–fit (x^2 – test): A chi-square goodness-of-fit test was carried out to determine whether the individuals, footprints and pellets of the barking deer were distributed according to the availability of habitat types. The test was performed by setting hypothesis that the deer was uniformly distributed in all habitat type in Shivapuri forest. The hypothesis was tested at 1% and 5% level of significance.

Under H_0, the test statistic is given by:

$$x^2 = \sum \frac{(O-E)^2}{E} \qquad \text{(n-1) df.....(I)}$$

Where, O = observed frequency

E = Expected frequency

3.6.3 Habitat preference

3.6.3.1 Relative preference index (RPI): Relative preference index had been calculated by using methods of Stinnet and Klebenow (1986) to determine habitat preference of the barking deer.

$$\text{Relative preference index(RPI)} = \frac{\text{percentage utilization}}{\text{percentage avilability of the habitat}} - 1$$

Positive values of RPI indicates preference, negative values between 0 and -1 indicate no preference, and -1 indicates no use. Area estimates of different vegetation types obtained from topographic map had been used to calculate percentage availability of habitats.

3.6.3.2 Analysis of variance (ANOVA): The two way ANOVA was used to determine significance of any difference in distribution of different types of fecal category in different habitat types available for the barking deer. The hypothesis was tested at 5% level of significance.

Under $H_{o,}$ the test statistic is:

$$F = \frac{MSC}{MSE} \sim [(k-1)(N-1)] \text{ d.f.} \ldots\ldots\ldots\ldots\ldots\ldots \text{ (II)}$$

$$F = \frac{MSR}{MSE} \sim [(r-1)(N-1)] \text{ d.f.} \ldots\ldots\ldots\ldots\ldots\ldots \text{ (III)}$$

Where,

MSC = Mean sum of squares of Variations due to columns

MSR = Mean sum of squares of Variations due to rows

MSE = Mean sum of squares of residual due to errors

k-1 = Degree of freedom (d.f) between columns

r-1 = d.f between rows

N-1 = Total d.f

4. RESULTS

4.1 Population status

A total of seven individuals were recorded in the survey area during the study period. The density of the barking deer was 1.4 individual per square kilometer. Out of seven individuals observed in the study area 57.14% were males including male infant, 42.85% were females (Table 1).

Among all sex and age groups male to female sex ratio was computed at 0.57:0.42 that is four males and three females. Upper mixed hardwood forest was the most suitable habitat for the barking deer (n=5), where as in chirpine forest and oak forest only single species were encountered (n=1) and no individual was recorded in lower mixed hardwood forest of Sikre VDC (Table 2).

Table 1 : Sex and age composition of barking deer (*Muntiacus muntjak)* in Sikre VDC ShNNP (2014)

Sex	Age	Number	Percentage
Male	Adult, Sub-Adult and Infant	4	57.14
Female	Sub-Adult	3	42.85
Total		7	

4.2 Distribution Pattern

A total of the seven individuals (four males and three females), 138 pellets groups and 94 footprints of barking deer were recorded from the study area (Table 1). Among these, five individual (two males and three females), 120 pellets groups and 84 footprints were found in upper mixed hardwood forest, one male with 11 pellets groups and five footprints were recorded in chirpine forest, one male with four pellets groups and three footprints were recorded in oak forest and however no individual were recorded except three pellets and two footprints of deer in lower mixed hardwood forest (Table 2).

Table 2: Total Number of individuals, pellets groups and footprints of barking deer observed in Sikre VDC ShNNP (2014)

Number	Lower mixed hardwood forest	Chirpine forest	Upper mixed hardwood forest	Oak forest	Total
Number of individuals	-	1	5	1	7
Number of Pellets	3	11	120	4	138
Number of Footprints	2	5	84	3	94
Total	5	17	209	8	239

Different categories of fecal pellets were recorded from all the habitat type available for barking deer. Out of 138 fecal pellets, highest frequency of pellets was recorded in upper mixed hardwood forest which is found to be 120 (86.9%), chirpine forest 11 (7.9%), oak forest consist 4 (2.8%) and lowest frequency was observed in lower mixed hardwood forest 3 (2.1%) respectively in Sikre VDC (Table 2) (Figure 2).

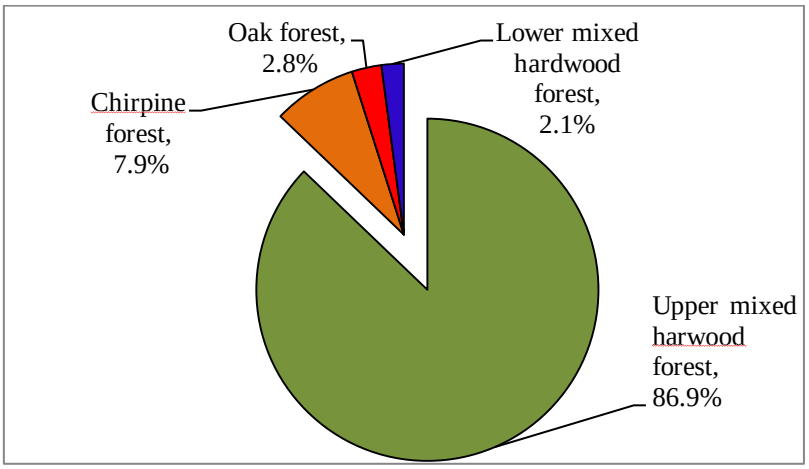

Figure 2: Percentage distribution of pellets in different habitat type in Sikre VDC

The results showed clumped distribution pattern of the deer ($S^2/\overline{X}$ = 2.80>1). Similarly, the distribution pattern of fecal pellets is also clumped ($S^2/\overline{X}$ = 94.53>1) and uneven ($x^2 = 283.61 > x^2_{0.05}$ at 3 d.f).

4.3 Habitat use and preference

4.3.1 Habitat classification

Four types of forests – Lower mixed hardwood forest, Chirpine forest, Upper mixed hardwood forest and Oak forest were recognized in the study area as described by Amatya (1995) and Kattel (1993).

a) Lower mixed hardwood forests: It was found up to nearly 1000-1500 altitude and the dominant tree species are *Schima wallichii, Castanopsis indica, Alnus nepalensis, Anthosaphalus cadamba, Prunus cerasoides* and shrubs like *Sarcococca coriacea, Smilax aspera, Arundinaria falcate, Eriobotrya hookeriana, Desmodium oxyphyllum* etc (APPENDIX III).

b) Chirpine forest: Pine forests were found in patches at lower altitude 1000-1600 and the dominant tree species are *Pinus roxburghii, Castanopsis indica, Myrica esculenta, Pyrus pashia* and shrubs like *Sarcococca coriacea, Berberis asiatica, Myrsine semiserrata, Colebrookia oppositifolia, Rubus ellipticus* etc (APPENDIX III).

c) Upper mixed hardwood forest: The forest was found at an altitude (1500-2700) and the dominant tree species are *Acer spp., Aesculus spp., Juglans regia, Betula spp., Fraxinus spp., Salix spp., Quercus spp., Celtis spp., Alnus nepalensis* whereas common shrubs included *Camellia kissi, Caryopteris grata, Dodecadenia grandiflora, Lindera pulcherrima, Sarcococca hookeriana* etc (APPENDIX III).

d) Oak forest : It was Found to occur at the steep rocky at an altitude 2300-2700 and the dominant tree species are *Quercus semecarpifolia, Eurya acuminate , Ilex dipyrens, Michelia champaca, Rhododendron arboreum, Symplocus spp.* With common shrubs like *Berberis asiatica, Arundinella nepalensis, Caryopteris grata, Desmodium floribundum, Gaultheria fragrantissima, Inula cappa, Phylanthus parvifolius, Rubus ellipticus* etc (APPENDIX III).

The recent study of forest and GIS analysis showed that the percentage availability of upper mixed hardwood forest, chirpine forest, lower mixed hardwood and oak forest were 40.14, 25.7, 20 and 14, respectively (Figure 3).

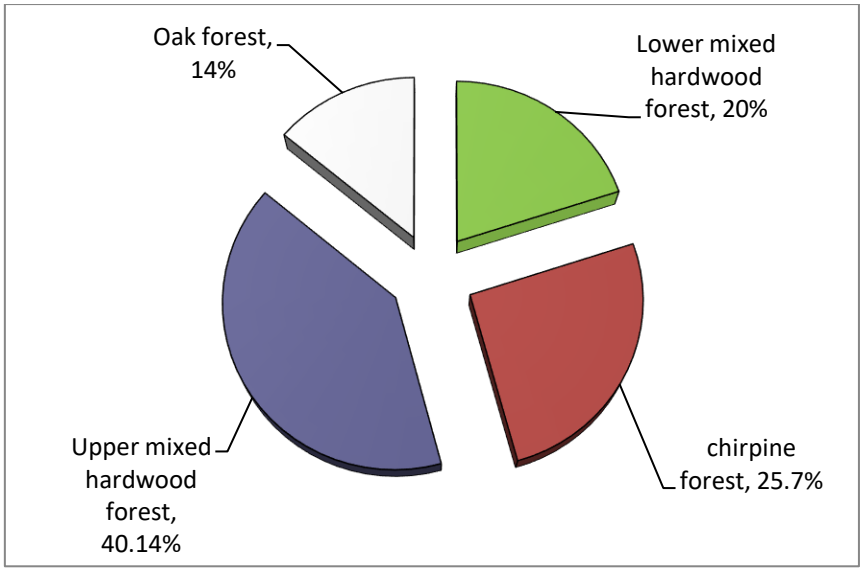

Figure 3: Percentage of availability of different habitat types in Sikre VDC ShNNP (2014)

4.3.2 Habitat use and preference

The upper mixed hardwood forest was most preferred (RPI = 1.17) by barking deer while, pine forest (RPI = -0.72) and oak forest (RPI = -0.76) and lower mixed hardwood forest (RPI = -0.89) was totally avoided (Figure 4).

Analysis of Variance (Two-way ANOVA) showed that there was no significant difference in distribution of pellets groups in different habitat types ($F=0.812<F_{0.05}$at (3,9) d.f) but there was significant difference in distribution of different category of pellets ($F=7.54>F_{0.05}$at (3,9) d.f).

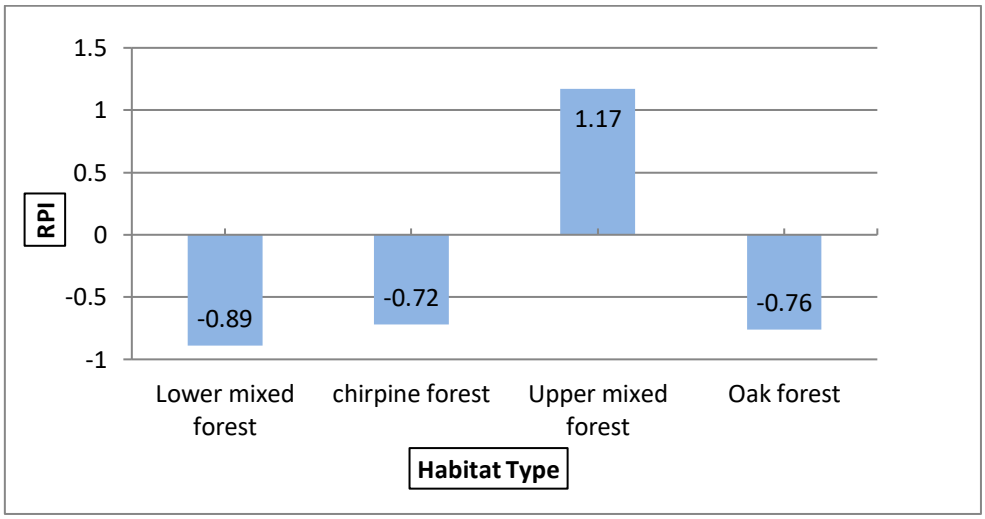

Figure 4: Relative preference Index of different habitat types in Sikre VDC ShNNP (2014)

4.3.3 Fecal pellets categorization

A total of 138 fecal pellets were recorded in the study area. Depending on the freshness, four categories of fecal pellets were distinguished. Among them old (O_1), fecal pellets had highest frequency 42.05% while very old (O_2) 28.98%, fresh (F_1) 18.11% and that of very fresh (F_2), has lowest 10.86%, respectively (APPENDIX V) (Figure 5).

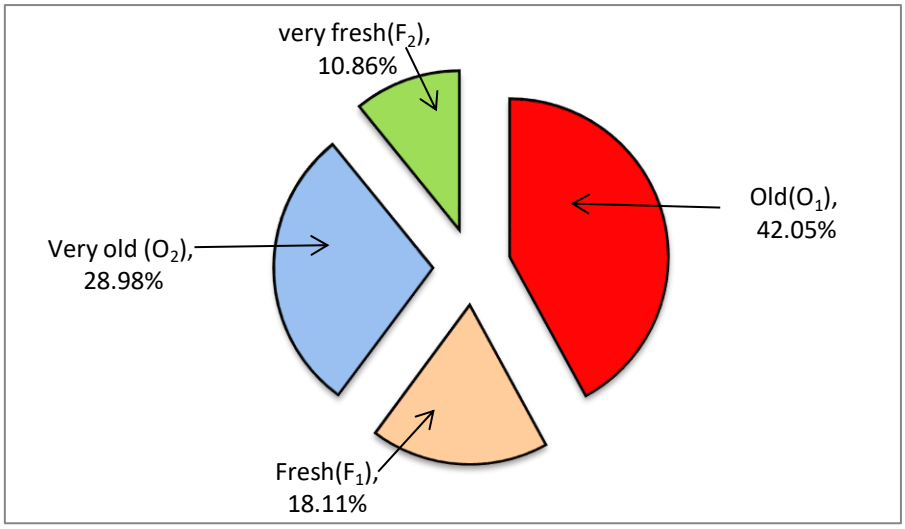

Figure 5: Fecal pellets categorization found in Sikre VDC ShNNP (2014)

4.4 Indirect evidence of other mammals

Indirect evidence of presence of other mammalian fauna was noticed. Loud noise made by common leopard (*Panther pardus*), was heard during night time. Moreover, a total of 15 scats of leopard were also recorded from the different habitat in the area. A total of four pugmarks of leopard were also recorded. During data collection dropping (rhesus monkey and wild boar) and pugmarks of mammals (jungle cat and bear) were also recorded. Some rodentia species were also recorded (Table 3) (APPENDIX IV).

During field survey, vocalization of bear was heard two times during the line transect and the presence of fresh fecal and pugmarks also confirmed the presence of Himalayan bear in Sikre VDC. Similarly the vocalization of leopard was also heard during the night time near the study area. Pangolian burrow was also recorded during line transect and two marten species were also observed.

Table3: List of animals encountered during the study period (Direct/Indirect Sign).

S.No	Common/Scientific name	Order	Family	Altitudinal Range (m)
1	Wild boar (*Sus scrofa*)	Artiodactyla	Suidae	1700-2700
2	Barking deer(*Muntiacu muntjak*)	Artiodactyla	Cervidae	1700-2700
3	Himalayan ghoral (*Nemorhaedus goral*)	Artiodactyla	Bovidae	2500-2700
4	Common leopard (*Panther pardus*)	Carnivore	Felidae	1740-2600
5	Jungle cat(*Felis chaus*)	Carnivore	Felidae	1719-2155
6	Himalayan black bear (*Selenarctos thibetanus*)	Carnivore	Ursidae	At 2517
7	Yellow-throated marten (*Martes flavigula*)	Carnivore	Mustelidae	1850-2400
8	Rhesus monkey (*Macaca mulatta*)	Primate	Cercopithecida	1670-2100
9	Himalayan squirrel (*Dremomys lokriah*)	Rodentia	Sciuridae	1900-2700

4.5 People's Impact on habitat

Most of the households practiced subsistence farming. Among them 63% respondents were engaged in agriculture as primary occupation and rest of respondent were involved in business, housework's, skilled labor and unskilled labor. The younger generation prefers off-farm employment opportunities rather than the traditional occupation of subsistence farming. Livestock rearing is an integral part in the hill farming system. The majority of people were Tamang, Rai, Limbu, Gurung and Newar ethnic groups in Sikre VDC. Livestock keeping and alcohol making were the main alternative sources of income generation. Generally poor people prefer to collect firewood rather than buying and they have a tendency to exploit the forest near to settlements rather than to think about sustainable use (Figure 6). Average amount of firewood consumption was about six to ten kilogram per day for each household. The demand of firewood was found to be maximum in winter season in Sikre VDC followed by monsoon, autumn, spring and summer, respectively.

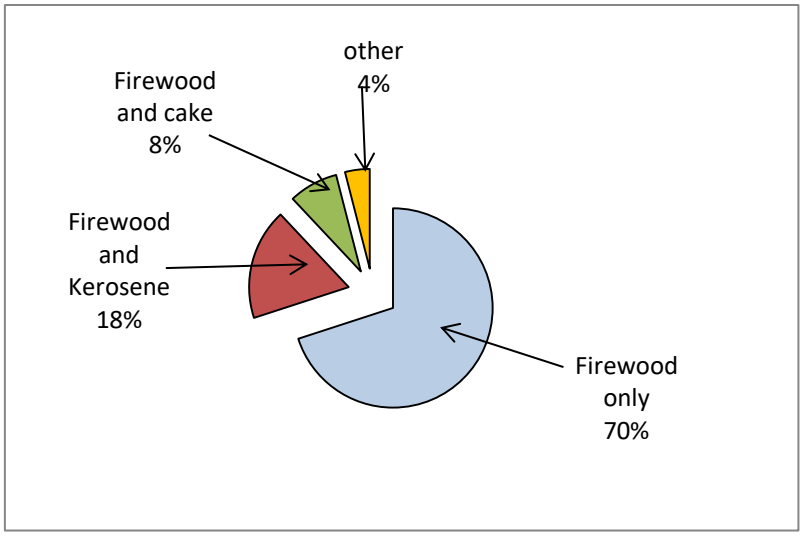

Figure 6: Type of fuel used in Sikre VDC ShNNP

People were getting benefits from the park such as income from tourism and resource utilization including water, firewood, fodder, and leaf litter fall. Firewood and fodder collection is illegal. Trees such as *Alnus nepalensis, Castanopsis spp.*, *Myrica esculenta, Myrsine capitellata, Myrsine semiserrata, Schima wallichii* and *Quercus spp*. were mostly used as firewood and fodder. Firewood is main source of energy and mostly used in alcohol production. The firewood consumption pattern was different in the household

making alcohol and household not making alcohol and was about 26 kg and six to ten kg per day. These firewood were collected from the National Park as well as private land (Figure 7). Wildlife habitat is regularly disturbed by local people by collecting firewood, fodder, and livestock bedding materials. The human activities within the forest also disturbed the wildlife's seasonal and daily activities including breeding.

People living in and around the ShNNP depend mainly on the park forests for firewood, leaf litter, and timber. Firewood composed of trees, brushwood including green conifer bushes and other example crop residues is the main source of energy for cooking and heating. Firewood was used as major source for preparing alcohol (Figure 6). It was observed that 60% of the people from Sikre VDC preferred the national park as the source of firewood, 23% both national park and private land and 17% private land, respectively (Figure 7).

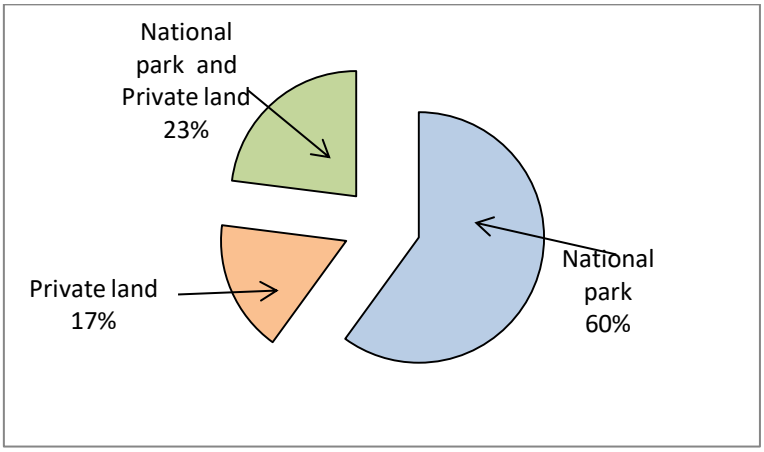

Figure 7: Source of firewood in Sikre VDC ShNNP

The continuous illegal collection of firewood, fodder, grazing of livestock, and other activities inside the forest causes depletion of resources that cause adverse effect on biodiversity. Due to increase human population and to meet their needs, large scale habitat changes are occurring globally and site which is rich in diversity is also facing threat due to increased tourist movement and according to local people 52% of tourist visited the area per year for trekking purpose. Due to rapid human population growth, grazing areas have shrunk. Farmers selectively stall feed their animals that include milking cows, buffaloes and grasses for these animals are brought from the forests, plantation areas, and farm land. Many trees about 57% were found cut and 52% lopped.

None of the hunting and poaching wildlife activities were recorded in the area. People collected firewood, fodder, and leaf litter fall, and grazed livestock inside the park. Other impacts such as unmanaged garbage and trails inside the park directly or indirectly influenced the biodiversity. Motor road at Tokha entry point to Alche where two buses entry and two buses left everyday and pilgrims like Bagdwar also generated significant disturbance to wildlife and their habitats. Trails to the other village (Panimuhan to Sikre) were also major cause of habitat disturbance. Inside the park directly or indirectly disturbing the wildlife habitat creating water pollution, land (garbage) pollution, air pollution, and noise pollution.

5. DISCUSSION

5.1 Population Status

A total of seven individuals were observed in the survey area during the study period. The density of the barking deer was 1.4 individual per square kilometer. The field survey is mainly carried in the northern side of the Sikre VDC of Shivapuri forest. Out of seven individuals observed in the study area 57.14% were males including male infant, 42.85% were females (Table 1). A total of 12 individuals (5 adult males, 4 adult females, 2 sub-adult females and 1 infant) were recorded inside three different blocks of the Hemja VDC, Kaski District (Pokhrel 2006). The density of barking deer was highest in upper mixed hardwood forest and lowest in lower mixed hardwood forest because of the availability of cover, food and water (Henry 1981), similar with the finding of Nagarkoti (2006) in Nagarjun forest. In Shivapuri forest coverage of shrub and surface layers were relatively dense in mixed hardwood forest, as compared to those of other forest types (Kanai and Shakya 1970), causing concentration of deer in this habitat. As Upper mixed hardwood forest was the most suitable habitat for the barking deer (n=5), where as in chirpine forest and oak forest only single species were encountered (n=1) and no individual was recorded in lower mixed hardwood forest of Sikre VDC (Table 2).

5.2 Distribution Pattern

In Sikre VDC, the barking deer distribution pattern in different habitat types available were found to be clumped and unenven, that is ($S^2/\overline{X}$ = 94.53>1) and ($x^2 = 283.61 > x^2_{0.05}$ at 3 d.f) respectively**,** which is similar with finding of Pokhrel (2005) in Suklaphanta wildlife Reserve and Nagarkoti (2006) in Nagarjun almost in rule, when individuals are considered. Random distribution, relatively rare in nature, occurs where the environment is very uniform where as uniform distribution occurs where competition between individuals is serve or where there is positive antagonism which promotes even spacing (Odum 1971). In the forest of Sikre VDC the resources such as food, water resources and cover are not distributed uniformly leading to the uneven distribution of the species.

Increasing human pressure to the forest resources might be another reason of uneven distribution of the species.

Similarly, in Sikre VDC, middle range of the mountain is widely used by barking deer. It might be due to that the base of the mountain is excessively used by local people. Most of the area at the base is utilized by local people for animal grazing. So this is the area of high human disturbance. Similarly, somewhere, there is very Steep Mountain with very less vegetation cover in the upper range of the mountain and there is scarcity of water also. However, middle is least disturbed by human being and has high vegetation cover with natural resources as water sources that is why middle range is more suitable for the barking deer in Sikre VDC.

5.3 Habitat use and preference

Muntiacus muntjak was generalist in habitat use. However the deer showed difference in habitat preferences in different habitat type. Upper mixed hardwood forest showed high preference (RPI = 1.17) and avoid lower mixed hardwood forest (RPI = -0.89). Both food availability and vegetation cover are very important for Indian muntjak habitat selection (Teng et al. 2004). Habitat utilization is determined by the availability of cover, food (Henry 1981, Mysterud and Ostbye 1995, Bernice and David 2002) and water. The feeding habitats of *muntjaks* corresponded to that of small African forest ruminants that are 'selector of juicy' concentrated herbage (Hofmann and Stewart 1972). These kinds of food items are more abundant in shrub habitat (Song and Li 1994).

Dense canopy is another important factor in habitat selection of muntjaks (Teng et al, 2004). Selection of a high percentage of ground cover is also a strategy defending against predators for ungulate calves (Gerlach and Vaughan 1991, Bowyer *et al.* 1998, Bowyer *et al.*1999). For Indian muntjak, use of a high percentage of canopy closure could be an anti-predatory strategy: in a forest or woodland, inhabiting dense cover can minimize visual detection (Geist 1974) and scent might not spread so much because of less wind in the closed micro site (Mysterud and Ostbye 1995). Shy nature along with anti-predator strategy of being inconspicuous makes it concentrated more in dense forest than in open and disturbed area (Thapa 2003). In Bardia National Park, Heggdal (1999) found that barking deer preferred riverine forest followed by *Mallotus* dominated Sal forest for

foraging habitat and night- time habitat but did not prefer the Sal dominated forest as foraging habitat, bushy grassland and open Sal grassland as shelter and day time habitat, and bushy Sal, Sal grassland and Sal dominated forest as night time habitat.

In the Sikre VDC, coverage of shrub and surface layers were relatively dense in mixed broadleaved forest, as compared to those of other forest types (Kanai and Shakya 1970). Water is important factor in determining the distribution of animal species. The barking deer usually drink water at least once a day, mainly in the morning or at noon hours (Yonzon 1978, Shrestha 1997), thus they like to remain closer to a water source to fulfill their demands (Yonzon 1978).

5.4 Human Impacts

More than 75.5% of the total populations of Nepal depend on firewood as the main source of energy. The main source of energy in Sikre VDC was firewood, which was fulfilled from the park's forest. In Sikre VDC 63% respondents were engaged in agriculture as primary occupation and rest of respondent were involved in business, housework's, skilled labor and unskilled labor. Agricultural residues e.g., straw fulfilled a little of the total firewood and fodder requirements. According to the park authority, the local people were cutting and lopping off green branches of trees, bushes, and grasses for firewood and fodder, which is illegal. But respondents claimed that they collected dry and fallen branches, as it was their traditional right. Firewood is the major source of energy for mountain people (Figure 6) because it is easily and freely accessible (Blaikie 1985) and also used by local people where they have no alternative source. The firewood consumption was different according to their profession. Average amount of firewood consumption was about six to ten kilogram per day for each household in Sikre VDC. In the Sagarmatha National Park (SNP), there was heavy demand on forest areas for firewood use, both by local inhabitants and the visitors (Sherpa 1979). The demand of firewood was found to be maximum in winter season in Sikre VDC followed by monsoon, autumn, spring and summer, respectively.

The main threat to biodiversity was influenced by human activities. Firewood, fodder, leaf litter fall and grass were extracted throughout the year mainly during winter because firewood was used for cooking, food heating, and for cowshed (feeder boiling and

heating) as different energy sources and fodder and leaf litter for manure making, insulator, and bed for livestock which created wildlife habitat disturb, scarcity of food, nutrient cycle unbalanced as well as some species of wildlife may become extinct. The continuous illegal collection of firewood, fodder, grazing of livestock, and other activities inside the forest causes depletion of resources that cause adverse effect on biodiversity (Rai and Sharma 1998). Due to increase human population and to meet their needs, large scale habitat changes are occurring globally (Khan et al. 1993) and site which is rich in diversity is also facing threat due to increased tourist movement (Chettri et al. 2001). Due to rapid human population growth, grazing areas have shrunk. Farmers selectively stall feed their animals that include milking cows, buffaloes and grasses for these animals are brought from the forests, plantation areas, and farmland (Jnawali 1994). The growing rates of deforestation in many developing countries have been linked to the growing scarcity of firewood but in most situations the underlying cause of deforestation is the conversion of land to farming (Eckholm et al. 1984).

Wildlife habitat is regularly disturbed by local people by collecting firewood, fodder, and livestock bedding materials. The human activities within the forest also disturbed the wildlife's seasonal and daily activities including breeding. Moreover, the Park Forest consists of trees species such as *Castanopsis spp.*, *Rhododendron spp.*, *Alnus nepalensis* where barking deer, jackal, jungle cat, monkey, porcupine, and wild boar were found. The wildlife depredation was increasing due to collection of firewood, fodder, grasses, leaf litter collection, livestock grazing, food scarcity inside the park, and broken of wall boundary.

6. CONCLUSION

A total of seven individuals were recorded from different sites in Sikre VDC .The density of the barking deer was 1.4 individual per square kilometer. Among them, four were males and three were females. Out of seven individuals observed in the study area 57.14% were males including male infant, 42.85% were females. They are unevenly distributed and clumped distribution pattern were exhibited in Sikre VDC. The results showed clumped distribution pattern of the deer ($S^2/\overline{X}$ = 2.80>1). Similarly, the distribution pattern of fecal pellets is also clumped ($S^2/\overline{X}$ = 94.53>1) and uneven ($x^2 = 283.61 > x^2_{0.05}$ at 3 d.f), respectively.

The barking deer prefers area of their home range with dense forest. They prefer mixed forests of *schima wallichi* and *castanopsis indica*, pine and oak forest. The upper mixed hardwood forest was most preferred (RPI = 1.17) by barking deer while, pine forest (RPI = -0.72) and oak forest (RPI = -0.76) and lower mixed hardwood forest (RPI = -0.89) was totally avoided. The result showed that barking deer utilize the area even around the human trail less used by human inside the dense forest. It also confirmed from the study that the barking deer prefers middle range of the mountain which has dense canopy cover, proper water resources and less human disturbances. Similarly it prefers vegetated moist northern face of the mountain than southern face which is more arid.

Habitat degradation is the major problem faced by barking deer. Local people collect firewood, timber and grass from the forest. Livestock keeping and alcohol making were the main alternative sources of income generation. The firewood was the basic need of local people (Figure 6) residing around the park, which was fulfilled from the park as well as private land (Figure 7). Average amount of firewood consumption was about six to ten kilogram per day for each household. The main issues of anthropogenic impact on habitat of barking deer included: scarcity of fodder/ firewood/alternative energy sources, lack of alternative sources of income generation and lack of awareness. The wildlife habitat was disturbed by trail used by park staff, tourist, villagers and vehicles, fodder collection, firewood collection, livestock grazing, and unmanaged garbage.

7. RECOMMENDATION

The following are the some of the recommendation arisen from the study which will help to conserve barking deer as well as other flora and fauna of the forests.

- The forests authorities should be more attentive in protecting the forest as illegal and unmanaged collection of fodder and cutting of trees is going on in the area.
- Regular census should be carried out every year. This will help to reveal population trends and make necessary intervention for management and conservation of barking deer population.
- Vegetation should be conserved to meet the requirements of the population of barking deer.
- Alternative energy source should be promoted to meet the fuel wood demand of local households.
- Awareness program should be launched about the national park and wildlife conservation and training should be initiated on resource management for the local people as well as park visitor a part of the park management.
- The broken park boundary should be maintained to protect water bodies, flora, and fauna, and their habitats, and also to minimize conflict.
- Development of patchy, peripheral forest areas as nurseries for herbal plants, species, commercial plants, and local tree varieties, which will help to fulfill the people's economic and firewood needs.
- Training should be conducted on improved cooking stove and biogas in order to reduce the existing pressure on forests.

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APPENDICES

APPENDIX I: QUESTIONNAIRE SURVEY

Serial no.: …… Date: ……

Name: ……..

Sex: …….. Age: …… VDC: ……

Ward no. : ..... Education: …… Occupation: …….

Family member……

1. What wild mammals have you seen in Shivapuri Nagarjun National Park?

S.N.	Name of mammal species	Abundance	Frequency of encounter	Location	Date of last sighting	Time	Remark
1	Barking deer						
2	Wild boar						
3	Common leopard						
4	Clouded leopard						
5	Jungle cat						
6	Leopard cat						
7	Large civet						
8	Himalayan black bear						
9	Hanuman languor						
10	Rhesus monkey						
11	Himalayan ghoral						
12	Brown-toothed shrew						
13	Chinese pangolin						
14	Fawn colored mouse						
15	Golden jackal						
16	Himalayan squirrel						
17	House rat						
18	Indian hare						
19	Porcupine						
20	Small Indian Mongoose						
21	Yellow throated Marten						

Code:

Abundance: L = low, M = Medium, H = High

Frequency: R = Rare, S = Sometime, F = Frequently

2. Which mountain range is widely used by barking deer?

a. Lower range b. middle range c. upper range

3. Describe distinctive physical features?

……

4. How big was it? (Indicate height as shoulder)

……..

5. Can you estimate, how many barking deer use this area?

……

6. What are the predators of barking deer?

……...

7. Should barking deer be protected or not?

……

8. Is there any poaching in your areas?

a. Yes b. no c. Don't know

If yes, which wild life species?

……..

9. Do barking deer destruct your crop/ agriculture field?

…….

10. If yes, then which crop is widely destructed?

a. Paddy b. Millet c. Wheat d. Maize e. Other

11. How far is your home from the park?

.....

12. Do you have any problem from the park? Yes / No. If yes, which problem

i. Crop depredation ii. Human harassment

iii. Livestock depredation iv. Others

13. Have you seen any wild mammals species graze or visit in the same area where the livestock graze? Yes / No.

If yes, in which month? ……

14. Why you abandoned the land?

i. Low soil fertility ii. Poor irrigation iii. Wildlife damage iv. Drought v. Others

15. Do you raise livestock? Yes / No, If yes

Type of livestock	Numbers(M/F)		How you raise them?	Source(NP/CF/PL/others)
Goat				
Sheep				
Buffalo				
Cow				
Pig				
Chicken				
Duck				

a. Stall feeding (SF) b. Dhuto (DU) c. Open grazing with attendant (OG/A)

d. Open grazing without attendant (OG/NA) e. Dana (D) f. Pitho (P)

Note :-{ NP: National Park, CF: Community Forest, PL: Private Land}

16. Do the wildlife raid crop in your land? Yes / No. If yes

S.N.	Wildlife	Raid crops	Most preferred crop	Time of raiding	Unpreferred crops	Frequency of visit	Number of time
1	Wild boar						
2	Monkey						
3	Bear						
4	Deer						
5	Others						

{Frequency: R = Rare, S = Sometime, F = Frequent}

17. Is your cattle been killed recently by any predator of the national park? Yes/No,

If yes,

S.No	Name of livestock	Number	Killed month	Name of predator	Time (morn/aft/nights)
1					
2					
3					

18. Where did the wildlife kill your livestock?

i. Shed ii. Meadow iii. Road iv. Agricultural land

19. Have the wildlife attacked human? Yes/No. If yes

S.N.	Where	Who	Remarks(dead/live)
1			
2			
3			

20. What is the main energy source for cooking and other purposes?

i. Firewood ii. Electricity ii. Biogas iv. Kerosene/LP gas v. Cake vi. Mixed

21. What benefit do you have from the Park?

i. Resource utilization ii.Economic benefit from tourisms iii. Training iv. Others

22. Do the tourist visit your village? Yes/No

If yes, mention the number of tourist ……..

23. Did tourism enhance your economy? Yes/No

…….

24. What are the main reasons for visiting this area?

i Trekking ii Religious iii Research iv Don't know

25. Do the park management involve you in managing park? Yes / No. If yes,

i. Information about hunting poaching ii. Information about inconvenience

iii. Meeting iv. Awareness program. v. Others

26. What kind of support you want from the national park?

…….

27. Do you think these animals should be protected?

i. Strongly positive ii. Positive iii. Negative iv. Strongly negative

28. Do you think protection and conservation of NP is good? Yes/no. If yes, what do you do to help to conserve the NP?

i. Reporting ii. Protection of trees and their seedlings

iii. Protection of NTFPs iv. Protection from fire

v. Protection from poaching hunting and felling of trees vi. Others

29. Would you like to tell your suggestion for the conservation and management of the park?

……..

APPENDIX II: Rainfall, Temperature and Humidity in Sikre VDC ShNNP

a. Rainfall (mm) in Sikre VDC ShNNP

Year / Months	2005	2006	2007	2008	2009	2010	2011	2012
January	61.2	0	0	4.5	0	0	3.7	0
February	17.8	0	91.2	0	1.5	24	37	75.4
March	63.4	59.8	36.4	23	4	20.5	30.6	0
April	30.8	161	86.3	165.5	17	32.5	123.7	0
May	64.2	252.2	244.3	0	232.1	155.5	298.4	0
June	257.8	334	0	424.5	98.3	298.2	363.7	0
July	406.8	417.2	466.5	410.2	716.5	394.2	414.1	0
August	440.4	359.2	360.5	507.2	411	628.8	371.3	678.5
September	211.2	287.4	509.5	330.2	179.5	386.7	0	311.3
October	124.8	29.6	17	38.1	118	5	0	0
November	0	3.2	2.2	0	1.5	0	0	0
December	0	22.6	0	6	3	0	0	0

(Source: DHM/GON)

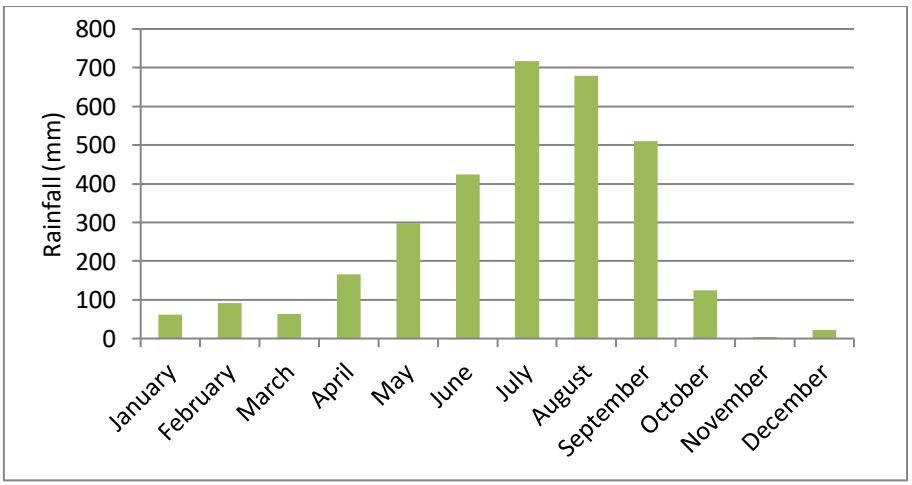


Figure a: Average rainfall (mm) at Panimuhan (2005-2013)

b. Monthly Mean Air Maximum Temperature (°C)

Year / Months	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	16.3	19.9	19.4	17.4	19.4	20.4	17.3	15	19
February	19.2	21.5	17.1	18.4	23.1	20.6	20.7	20.8	NA
March	23	23.2	22	23.4	25.2	27	25.8	NA	NA
April	26.4	25.7	26.3	25.9	28.4	28.2	28.4	NA	NA
May	26.7	26.5	26.7	29.8	27.8	28.5	27.7	NA	NA
June	28.8	27.6	27.7	28.3	29.8	28.8	28.4	NA	NA
July	27.2	27.4	26.5	27.1	28.9	27.9	28	NA	NA
August	26.3	26.1	27.5	27.1	28.1	28	28.6	27.6	NA
September	27.5	24.8	26.3	27.6	27.1	27.9	NA	28.1	NA
October	24.2	21.2	25.4	25.1	25.6	27.6	NA	NA	NA
November	21.2	17	21.6	23.7	22.5	23.9	NA	NA	NA
December	18.9	NA	18.3	20.7	19.5	20	NA	19.7	NA

c. Monthly Mean Air Minimum Temperature (°C)

Year / Months	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	2.6	3.2	3.6	2.7	4.1	2.5	2.8	2.3	1.7
February	5.7	7.9	6.4	3.9	6.3	3.9	7.3	4.6	NA
March	9.5	8.9	9.4	9.7	8.1	7.5	8.3	NA	NA
April	10.5	11.1	14.2	14.5	12.8	13.2	10.5	NA	NA
May	14.3	15.9	16.9	14.7	14.7	16.9	13.9	NA	NA
June	18.9	18.7	19	18	17.8	18.8	14.4	NA	NA
July	19.9	19.9	19.9	19.1	19.5	20.2	19.5	NA	NA
August	19.5	18.3	20	18.9	19.1	20.2	18.8	19.4	NA
September	19.1	17.4	18.7	16.9	17.7	19	NA	18.4	NA
October	13.3	13.5	14.6	14.4	13.9	15.7	NA	NA	NA
November	8.7	9.5	11.5	9.1	7.8	12.7	NA	NA	NA
December	4.1	5.9	3.9	5.5	5	3.9	NA	4.9	NA

(Source: DHM/GON)

NA= Not available

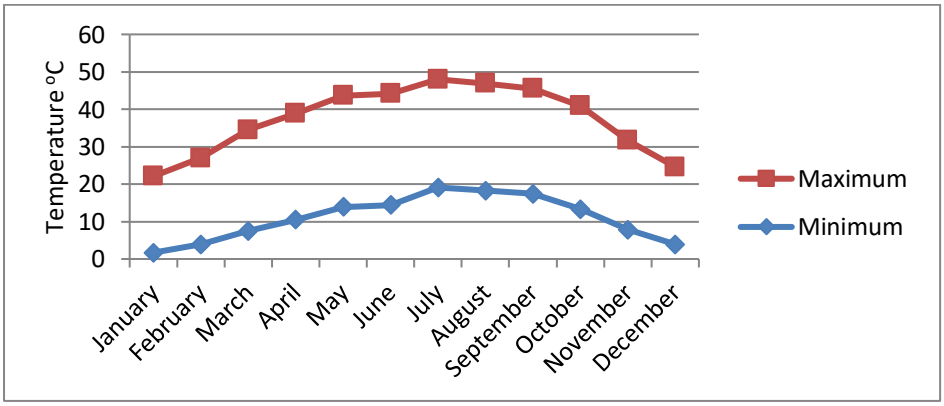


Figure b: Average Maximum and Minimum Temperature (°C) of Panimuhan (2005-2013)

d. Monthly Mean Relative Humidity (%) (Morning)

Year / Months	2005	2006	2007	2008	2009	2010	2011	2012	2013
Januaery	90.7	75.3	80.1	83.2	91	90.9	84.5	92.9	74.2
February	83.7	85.7	91.9	84.4	871	87.6	73.1	92.2	NA
March	81	75	81.5	79.7	88.4	78.1	76.6	NA	NA
April	70.4	73.3	74.6	75.6	63.4	76.4	84.8	NA	NA
May	75.3	84	81.7	75.1	71.8	75.3	82.2	NA	NA
June	79.1	87	85.5	85.4	76.1	82.1	83.3	NA	NA
July	83.6	88.6	87.2	NA	88.9	88.1	93.6	NA	NA
August	90.6	86	88.1	87.4	88.7	88.1	94.5	94.9	NA
September	90	86.1	88.8	82.7	88.4	86	NA	94	NA
October	87.6	88	84.7	80.9	85.6	59	NA	NA	NA
November	93	86.6	88.3	87.1	90.6	80.4	NA	NA	NA
December	87.4	92.7	85.9	87.6	96.2	82.8	NA	86.8	NA

e. Monthly Mean Relative Humidity (%) (Evening)

Year / Months	2005	2006	2007	2008	2009	2010	2011	2012	2013
January	75.1	51.8	56.3	63.5	65.8	78.7	46.6	93.9	46.6
February	74	62	76.1	54.9	53.1	74.7	71.4	87.7	NA
March	63.7	64.4	64.8	68.2	72.4	70.2	69.6	NA	NA
April	53.4	59.5	63.7	81.1	47.5	78.4	78.9	NA	NA
May	68	65.1	74.8	70.6	63.5	69.3	75.9	NA	NA
June	73.8	78.7	80.9	82.4	66.1	74.9	91.3	NA	NA
July	82.1	86.6	87.1	84.9	80.9	85.7	84.4	NA	NA
August	85.6	87.4	87.1	86.8	83	88.1	90.8	85	NA
September	86.5	81.8	85.9	81.8	81.3	84.4	NA	83.1	NA
October	78.8	72	77.3	82.2	79.7	79.5	NA	NA	NA
November	70.5	66.2	68.3	71.5	82.3	77.5	NA	NA	NA
December	66.7	77.8	71.5	74.7	78.8	76.8	NA	57.7	NA

(Source: DHM/GON)

NA= Not available

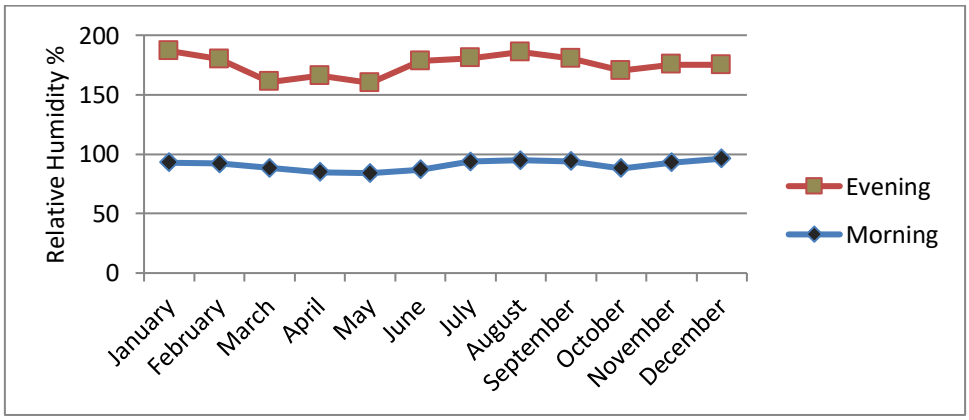


Figure c: Average Relative Humidity Morning and Evening (%) at Panimuhan (2005-2013)

APPENDIX III: List of Tree, Shrub and Herbs species recorded in Sikre VDC ShNNP

Species	Local Name	Type
Aesculus spp.	Babool	Tree
Albizia mollis	Siris	Tree
Alnus nepalensis	Utis	Tree
Anthosaphalus cadamba	Kadam	Tree
Betula alnoides	Saur	Tree
Betula utilis	Bhojpatra	Tree
Castanopsis tribuloides	Musurekatus	Tree
Castanopsis indica	Dhalekatus	Tree
Choerospondias axillaris	Lapsi	Tree
Engelhardia spicata	Mahuwa	Tree
Eurya cerasifolia	Jhingane	Tree
Ficus semicordata	Khanio	Tree
Ilex dipyrens		Tree
Juglans regia	Okhar	Tree
Luculia grantissima		Tree
Lyonia ovalifolia		Tree
Meliosma simplicifolia	KodeKhavade	Tree
Michelia champaca		Tree
Myrica esculenta	Kaphal	Tree
Myrsin ecapitellata	Setikath	Tree
Myrsine semiserrata	Kali kath	Tree
Pinus roxburghii	Ranisalla	Tree
Pinus wallichiana		Tree
Prunus cerasoides	Paiyun	Tree
Pyrus pashia	Mayel	Tree
Quercus lanuginose	Banjh	Tree
Quercus spicata	Arkhola	Tree
Rhododendron arboreum	Laliguras	Tree
Schima wallichii	Chilaune	Tree
Symplocus spp.		Tree

Syzygium cumini	Jamun	Tree
Shrub species		
Amomum subulatum		Shrub
Ardisia macrocarpa	Damaiphool	Shrub
Arundinaria falcate	Nigalo	Shrub
Berberis asiatica	Chutro	Shrub
Camellia kissi	Chiya pate	Shrub
Caryopteris odorata	Niloghusure	Shrub
Colebrookia oppositifolia	Dhusure	Shrub
Daphne bholua	Kagat pate	Shrub
Dichroa repens		Shrub
Duranata repens		Shrub
Eriobotrya hookeriana		Shrub
Gaultheria fragrantissima	Dhasingarae	Shrub
Hypericum uralum	Areli	Shrub
Indigofera pulchella	Mirmire	Shrub
Lindera nacusua	Pahelokhapate	Shrub
Ligustrum indicum	Kanikephool	Shrub
Moghania strobilifera	Chunetroghans	Shrub
Osbeckia stellata	Ratochulsi	Shrub
Osyris wightiana	Nun dhiki	Shrub
Oxyspora paniculata		Shrub
Phragmites karka	Narkat	Shrub
Phyllanthus parvifolius	Khareto	Shrub
Rubu sellipticus	Ainselu	Shrub
Sacrcococca coriacea	Kush	Shrub
Smilax aspera	Kukurdaino	Climbing shrub
Urtica dioca	Sisnu	Shrub
Xylosoma controversum	Dandekanda	Shrub
Herb species		
Achvranthes bidentata	Datiun / Ratoapmarga	Herb
Ageratum conyzoides	Gandhe	Herb

Anaphalis busua	Buki Phool	Herb
Barleria cristata	Bhende kuro	Herb
Biden pilosa	Tikhe kuro	Herb
Cyperus compressus		Herb
Dryoatherium boryanum		Herb
Eulaliopsis binata		Herb
Hibiscus manihot	Ban nalu	Herb
Imperata cylindrical	Siru	Herb
Medicago lupulina		Herb
Saccharum spontaneum	Kush	Herb
Themeda triandra		Herb
Viola serpens	Ghatte ghans	Herb

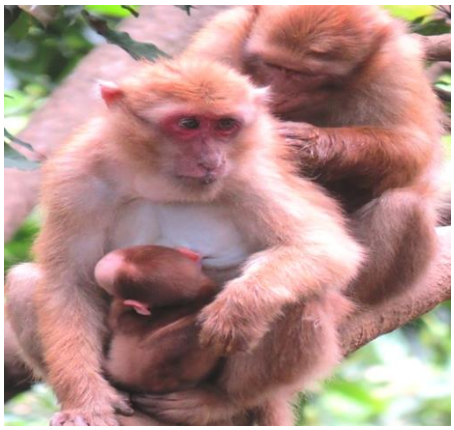
Data were collected by quadrate method during field work.

APPENDIX IV: Photographs of Direct and indirect evidences of animal during field survey (Photo: Chalise 2014)

Himalayan Ghoral

Barking Deer

Rhesus monkey



Assamese monkey

Yellow-throated Marten

Wild Boar

Pugmark of Jungle cat

Scat of Leopard

Hoofmark of Barking deer

Pellets of Barking deer

APPENDIX V: Photographs of pellets of barking deer recorded in Sikre VDC

Very Fresh Pellets

Very Fresh Pellets

Fresh Pellets

Fresh Pellets

Old Pellets

Very Old Pellets

APPENDIX VI: Photographs of field survey

a. Peoples taking their livestocks for grazing

b. Chopped trees inside national park

c. Pellets collection

d. Interviewing house owner

e. Collection of firewood

f. Piles of firewood inside the house