1. INTRODUCTION

1.1. Species introduction

Spotted Deer (*Axis axis* Elxreben, 1777) is one of the six deer species found in Nepal. It is locally known as chital in Nepal (Shrestha 2003). It belongs to the order Artiodactyla and the family Cervidae. Artiodactyla appears in the age of mammals in the Eocene epoch (57 to 37 MYA) and flourished during the middle of Tertiary. Cervids appeared in Eocene epoch of Tertiary period (Grzimek 1976). It has been considered as the most primitive of Cervids and was presenting during Pliocene and Pleistocene in Europe and Asia (Schaller 1998).

Ellerman and Morrison-Scott (1966) recognized following two sub-species of *Axis axis*. Which are as follow:-

*Axis axis axis,*native to Nepal, India, and Sri-Lanka.

Axis axis ceylonensis, native to Sri-Lanka (Ceylon).

1.2. Status of Spotted Deer

According to IUCN Red List Category it is listed as Least Concern because it occurs over a very wide range with large populations (Duckworth et al. 2008).

1.3. Distribution

It is indigenous to Sri Lanka, India, Bangladesh and Nepal (Mishra 1982). In India it is found in the forest at the base of Himalaya and practically throughout the Peninsula and Ceylon where there is jungle combined with good grazing and a plentiful supply of water. It is found in Assam in the Goal Park, Kamrup and Darrang district (Prater 1993).

This species is widely distributed along the Terai-Bhabar region of Nepal and within all the protected areas of the low land, Bardiya National Park, Chitwan National Park, Parsa Wildlife Reserve, Suklaphanta Wildlife Reserve and adjoining forest. It is also reported from the districts of Bara, Bardiya, Kailali, Jhapa, Sunsari, Saptari, Nawalparasi, Rupandehi, Chitwan, Mahottari, Kapilvastu, Dang, Banke and Kanchanpur (Majupuria and Majupuria

2006). They are found scattered in lower number in the mid-hill, warmer valleys and forest areas (Chalise 2001, 2013).

Spotted Deer (Axis axis) inhabit scrubs, forests and grasslands along the forest edges bordering on cultivation and grassland below the altitude of 1000m (Majupuriya and Majupuriya 2006). It is rarely found above an altitude of 1100m in their native Asian habitat, including Nepal. Four factors appear to have limited the Spotted Deer to these vegetation type 1) need of water, 2) the need for shade, 3)avoidance of high and rugged terrain and 4) preference for grass as forage (Schaller 1967).
In this reference at least 2,000 Spotted Deer (*Axis axis*) might possibly be distributed in Tarai area (Chalise 2001, 2013). The present distribution of the Chital has been greatly affected by the elimination of its habitat for agricultural purpose.

1.4. Morphology

The Spotted Deer (*Axis axis)* is perhaps the most beautiful deer species. Its coat is rufous brown and covered with white spots. A dark stripe runs down the back from the nape to the tip of the tail. The other parts of the body such as abdomen, rump, throat and inside of the legs, tail and ear are white. Old buck is more brownish in colour and darker than does. There is no seasonal difference in the colour of the coat, except that during the cool season it is somewhat glassier darker and thicker than during the hot and wet season (Prater 1993, Schaller 1998, Shrestha 2003).

The head is short, the body is compact and tail varies from long to medium long. These animals have longer legs and body respectively. The eyes are large and the upper lids have long lashes. The weight is 75-100 kg (Grzimek 1972). An average size stands 60cm to 100cm at the shoulder height. The antlers are reddish brown. The beam curves backward and outward in the lyre-shaped formation which is usually 60cm (Brander 1982). The first set of antler in yearling consists of simple spikes less than 5 inches long.

1.5. Ecology and behavior

Spotted Deer *(Axis axis*) occur more commonly in Sub- tropical grassland and forest. It prefers riverine forest during the hot and dry season. In monsoon, it mostly prefers Sal forest.

It occupies grassland habitat more in the weeks following cutting and burning grassed in January to February due to new grass growth. It feed mainly in fruit, browse and grasses. It is never found too far from the water (Ranjitsinh 1991).

They are less nocturnal than any other deer (Brander 1982). They spend a major portion of their life in foraging, resting and wandering within their range (Schaller 1998). It usually starts feeding in early morning and eats about mid morning. It feeds both on grasses and browse but it prefers green vegetation and cultivated crops such as mustard and wheat (Shaha and Richard 2001).

Mating is throughout the year (Waring 1996) with two peak rutting season (December – January and April – May) (Shah and Richard 2001). Female becomes able to give birth to a fawn at the age of 14 to 17 months (Ables 1974) with the clutch size of one or two after the gestation period of approximately 7 – 7.5 month (Mitra 1990).

Spotted Deer spends most of time in social contact with other. The average herd size was varied with season with a range of 5 and 10 individuals per herd but as many as 50 to 70 individual are also found occasionally. Herd size is influenced by the availability of food and water. In November and December they are scattered in small herd and when green shoots of grass appears in February, animal tended to form large herd. Most leaders of herds are adult female. Bucks in velvet are very passive which display aggressive behavior also when their antlers becomes hard (Schaller 1998).

Spotted Deer is peacefully associated with most of the animal. Langur monkey and Spotted Deer are frequently associated having symbiotic relationship with each other. It congregates beneath the feeding monkey for picking falling to the ground Primates have been seen riding the back of Spottted Deer. Langurs are the first notifier of presence of predator (Ranjitsinh 1991).

1.6. Conservation Threats

Major threats to Spotted Deer in Nepal are habitat loss and degradation due to the human encroachment, poaching, forest fire and fragmentation of forest (Chalise 2013). Competition with domestic livestock is another threat in Nepal (Duckworth et al. 2013).

1.7. Rationale of the study

Many works have been carried out about this species for proper management and conservation by many researchers (De and Spillet 1966, Tamang et al. 1976, Naess and Andersen 1993, Biswas and Sankar 2001, Srinivasula 2001, Pokhrel 2005, Dar et al. 2012) in different parts of world. Many conservation and research programme have been conducted throughout the World on this species but these animals facing the problem due to different anthropogenic and natural causes like poaching, habitat loss and degradation due to human encroachment, forest fire. No any studied have been carried out in GBZCF. This study helps to trace out the population status and habitat of the Spotted Deer along with people's perception on present scenario of the species status which provides baseline information for effective conservation and management to enhance long-term survival of the Spotted Deer in the study area.

1.8. Research objective

The main goal of this study was to collect information of Spotted Deer and their habitat in Ghailaghari Buffer Zone Community Forest (GBZCF), Chitwan, Nepal.

The specific objectives were

- To estimate the population status and density of Spotted Deer.
- To study the habitat preference of Spotted Deer.
- To determine the crop damage by Spotted Deer in Ghailaghari Buffer Zone Community Forest, Chitwan, Nepal.

1.9. Limitation of the study

- The population was estimated on the basis of direct observation.
- Night observation could not be made.
- Schedule of university (1 year for theory and thesis completion) and time for exam preparation could not allow the regularity in the field.

2. LITERATURE REVIEW

De and Spillet (1966) estimated the population of Spotted Deer in Corbett National Park. They found 1906 individual of Spotted Deer in 520.8 km^2 area.

Spillet et al. (1967) estimated only 200 individual of Spotted Deer in Keoladeo Ghana Sanctuary in February 1965. They reported that the large herd consists of 44 individual and the ratio of female: young was 1.6: 1.

Sharatchandra and Gadgil (1975) reported 800 Spotted Deer in Bandipur National Park in Karnataka in 874 km^2 area. They also mentioned that May to August was the main rutting season. They also noticed that large herd of more than 100 individuals was formed in monsoon season but it was break up into smaller herd at dry season.

Tamang et al. (1976) estimated the sex ratio of Spotted Deer in Chitwan National Park. The sex ratio of male: female was 59:100.

Schaller and Spillet (1986) estimated the density of Spotted Deer in Keoladeo Ghana Sanctuary, Rajasthan as 45 individual per $mile^2$.

Choudhary (1987) estimated 1,246, 1,027 and 1,602 head of Spotted Deer in 165.50 km^2 area in the year of 1984, 1985 and 1986 respectively in Tadoba National Park, India.

Naess and Andersen (1993) estimated the density of Spotted Deer in Bardiya National Park. It was found to be 225.3-384.5 individual per km^2.

Verman and Sukumar (1995) observes that the density of Spotted Deer along road were significantly different from those of interior of the forest in Tropical deciduous forest in India.

Raman (1998) investigated that the most of the birth (49%) Was occurred between December and March in Guindy National Park in Southern India.

Biswas and Sankar (2001) estimated 80.7 individual per km^2 density of Spotted Deer in Pench National Park in Central India.

Silva and Silva (2001) estimated that the average group size of Spotted Deer was 10.99and it was varied with season. According to them the herd size of Spotted Deer was 15.36 in rainy season, 7.76 in wet season and5.76 in dry season. They also noticed one largest group of Spotted Deer having 179 individual. They also reported that the male: female ratio was 0.59:1 and the ratio of young and female was 0.47:1.

Srinivasulu (2001) recorded only 383 individual of Spotted Deer in Nallamala hills of Eastern Ghats, India. He recorded 32 herds with maximum herd size of 12. According to him the sex ratio varied seasonally and more bucks were associated with group during season.

Verma and Asokan (2001) reported that the density of Spotted Deer was higher along road side than the dry deciduous forest in Mudumalai Wildlife Sanctuary, India. They also reported that the density of Spotted Deer was very low in riverine forest.

Jathanna et al. (2003) estimated the ecological density of large herbivore including Spotted Deer, Sambar deer, Muntjac, Gour and Hanuman Langur in Tropical forest of India. They estimated the mean density of Spotted Deer was 451±1.5 individual per km^2. According to them, estimated density of Spotted Deer was extremely low in comparison to other large herbivore due to the cause of poaching and livestock grazing.

Bagchi et al. (2008) reported that the mean and typical size of Spotted Deer were 4.7 to 9.2 in winter and 4.5 to 7.9 in summer respectively in Tropical forest in Western India. According to him the ratio of male and female was 86.4:100 and the ratio of young to adult Spotted Deer was 28: 100. He also reported that the grouping pattern was differentiated according to the habitat.

Dave and Jhala (2011) estimate the density of Spotted Deer in Gir forest India. It was found to be 44.8±7.1 individual per km^2.

Ganguly et al. (2011) observed the activity schedule and herd formation of Spotted Deer at Zoological garden. They found that the average mixed herd size was 10.36, average female – young herd size was 7.56, average male herd size was 7.37 and average herd size of yearling was 3.13. He also reported that the Spotted Deer spent a major portion of time on feeding and

it was inversely proportional to the daily temperature where as resting was directly proportional to the daily temperature.

Ramesh et al. (2011) reported that the mean group size and crowding for Spotted Deer was 13.1±0.50 (n=1020) and 33.3 respectively. The average adult male: female mean group size of Spotted Deer varied significantly between season in Western Ghats, India.

Dar et al. (2012) estimated that the highest mean group size of Spotted Deer was 7.74±1.19 in Shivalik ecosystem Uttarakhanda. They also reported that the group size was varied significantly across season in comparison to the other ungulates.

Johnsingh and Sankar (1991) reported that Spotted Deer fed on 162 plant species consisting various plant type such as trees, shrubs, creepers, climber, herbs and grasses in Mundanthurai platue, Tamilnadu. They also conclude that the diet of the Spotted Deer varied from month to month.

Moe and Wegge (1994) reported that the Spotted Deer preferred riverine forest during the hot dry- season where as they preferred Sal forest during monsoon season in Lowland of Nepal. They also noticed that grassland was preferentially utilized by female at night during the hot-dry season.

Raman et al. (1996) studied the seasonal habitat utilization of Spotted Deer in Guindy National Park and found that wood land was highly used in dry season where as scrubland and grassland was used in monsoon season. They also mentioned that maximum birth was occurred in January- February.

Pokhrel (2005) reported that the sal forest was highly preferred habitat for Spotted Deer in Suklaphanta Wildlife Reserve, Nepal.

Kushwaha et al. (2012) reported that the Spotted Deer preferred open mixed forest with high density of grass in Kuno Wildlife Sanctuary.

Gautam (2013) reported that hardwood forest was mostly preferred and Flood plain was least preferred habitat of Spotted Deer in Karnali flood plain on Bardiya National Park, Nepal.

Noor et al. (2013) reported that wood land was highly preferred habitat for Spotted Deer because of good availability of shrub and other ground vegetation in Keoladeo National Park, Rajasthan, India.

3. MATERIALS AND METHODS

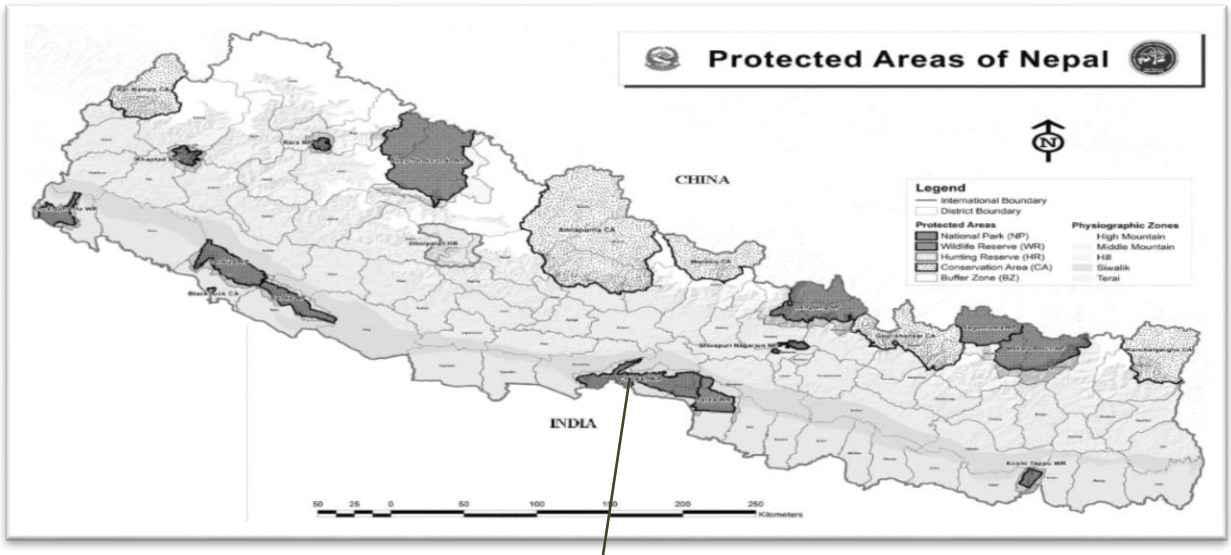
3.1. Study Area

3.1.1. Location

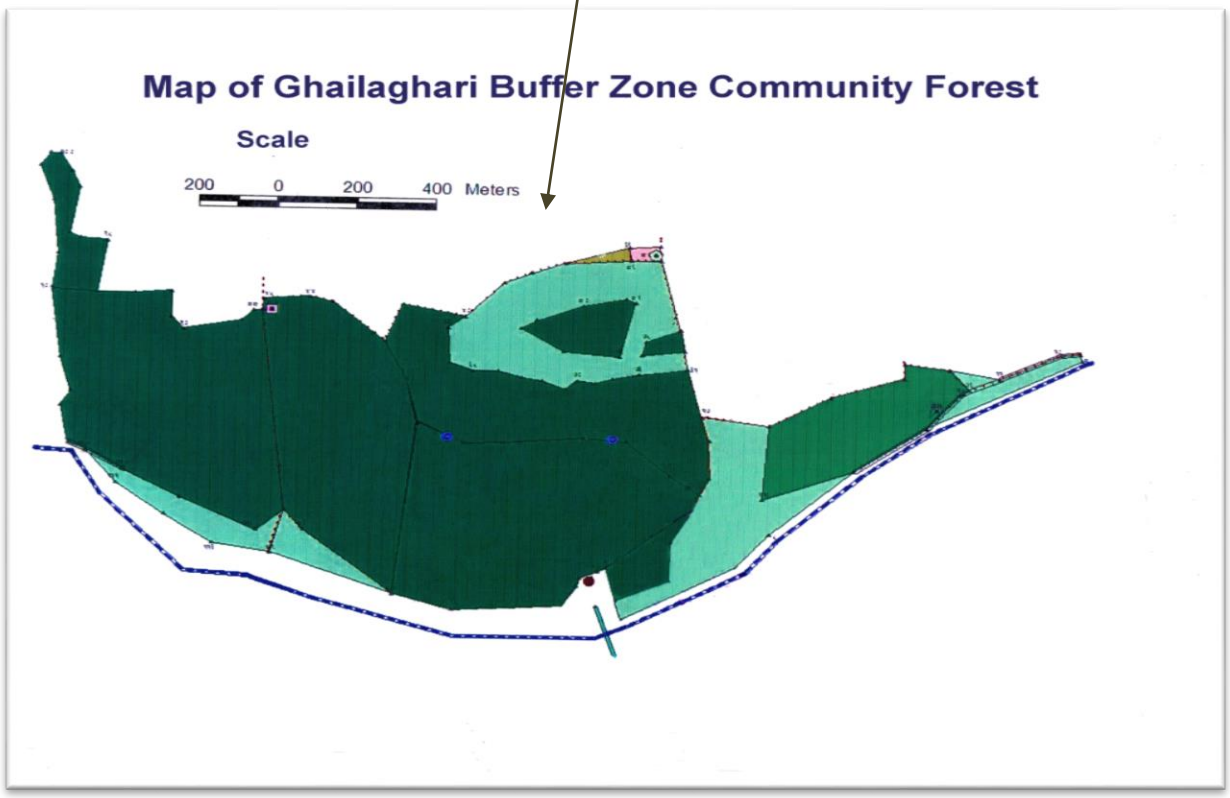
Ghailaghari Buffer Zone Community Forest (GBZCF) is located in ward number 1 and 2 of Jagatpur VDC in Chitwan District of Central Nepal. It is situated approximately in between $27^0$33'05.3" to $27^0$33'33.5'' North latitude and $84^0$18'50.7'' to $84^0$19'45.6'' East longitude. It is located at a distance of 19km west from Bharatpur. It was established in 2052BS (1996 AD) with an area of .56 km^2. Topography of the study area is more or less flat with an elevation of 150m above mean sea level. It is contiguous with CNP in South. Rapti River separates the study area from CNP (Map 1and 2).

3.1.2. Climate

According to the altitudinal zonation, the Chitwan valley falls in Sub tropical zone. However based on temperature and vegetation characteristic this area falls under tropical to sub-tropical monsoon climate with relatively high humidity throughout the year and characterized by three main seasons. Summer (hottest and driest) season extending from March to early June with temperature rising progressively. Monsoon season occurring from June to late September and Winter season starts from October to the end of February (Sharma 1997). The mean annual climate of Chitwan district for the year 2001 to 2010 was described below (Appendix I: Table 8-10).



Map 1: Map of Nepal showing protected area of Nepal.



Map 2: Map of Ghailaghari Buffer Zone Community Forest (GBZCF).

(Source: Buffer Zone Community Forestry Operation Plan, 2068)

According to Department of Hydrology and Meteorology, the mean annual rainfall of the year between 2001- 2010 was 1520 mm with about 90% of the total rainfall occurring from May to September (Figure: 1). Heavy flooding occurs during the monsoon that changes the characters and courses of the river. Spring starts from March and is immediately followed with summer that ends in June. The annual average minimum temperature in ten years (2001-2010) was recorded to be 17.6º C; likewise the maximum temperature was 31.1º C (Figure: 2). Winter temperature falls almost to freezing point, whereas from March to June it can reach as high as 43º C (DNPWC 2010). The relative humidity was recorded maximum 96.9% in the month of January and minimum 67.2% in the month of March between 2001- 2010 (Figure: 3).

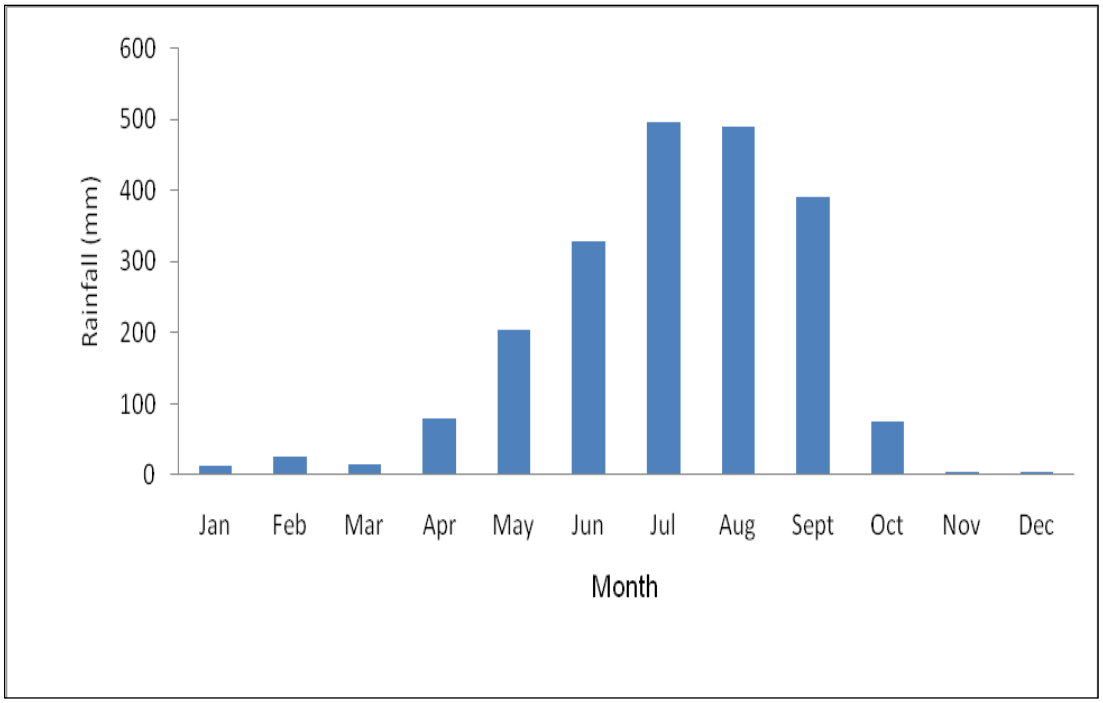


Figure 1: Mean monthly Rainfall (mm) (2001 to 2010) recorded at Meteorological Station at Bharatpur, Chitwan. (Source: Nepal Government, Department of Hydrology and Meteorology).

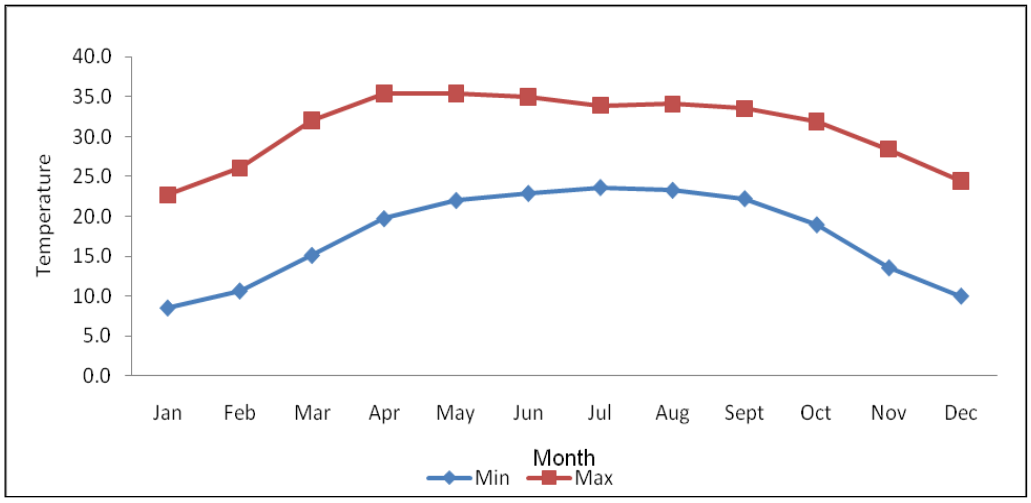


Figure 2: Mean monthly Temperature (º C) (2001 to 2010) recorded at Meteorological Station at Bharatpur, Chitwan. (Source: Nepal Government, Department of Hydrology and Meteorology).

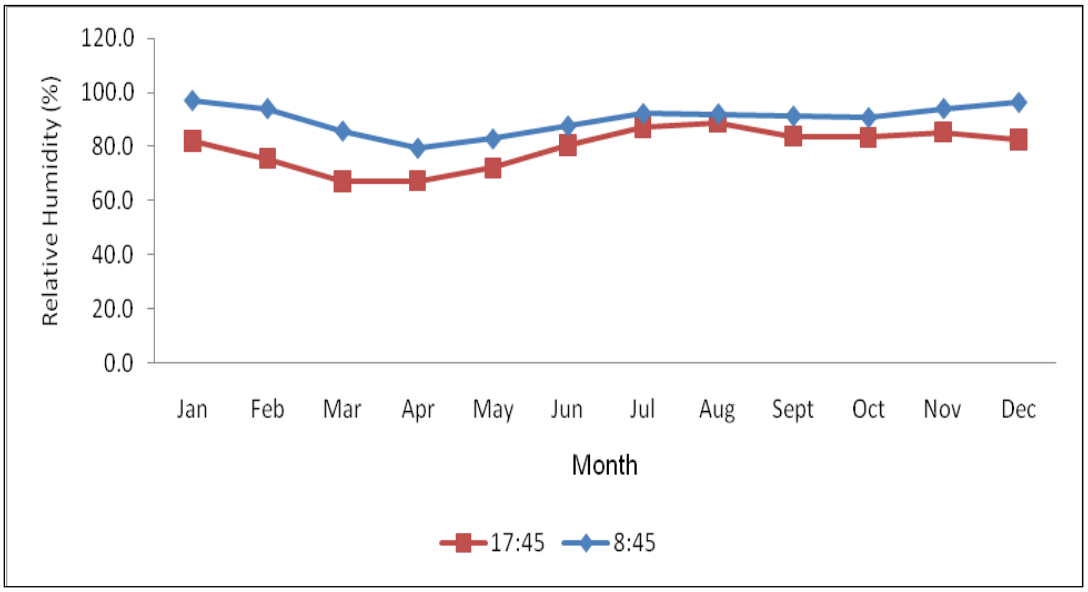


Figure 3: Mean monthly Relative Humidity (%) (2001 to 2010) recorded at Meteorological Station at Bharatpur, Chitwan. (Source: Nepal Government, Department of Hydrology and Meteorology).

3.1.3. Flora and Fauna

This area consist of tree species like Bhellar *(Trewia nudiflora*), Simal *(Bombax ceiba)*, Sisoo (*Dalbergia sisoo*), Chhatiwan (*Alstonia scholaris*), Kutmero *(Litsea monopetala*), kalikath (*Aporusa octondra*), Banbhogate *(Citrus maxima*) etc. Different types of shrubs species such as Datiwan (*Achyranthes bidentata*), Titepati (*Artemisia indica*), Vansilam (*Elsholtzia flava*), Banmara (*Eupatorium adenophorum*), Sisnoo (*Urtica dioica*), Daichamre (*Maesu macrophylla*) etc are also found in this area. It consist of different types of herbs such as Dubo (*Cynodon dactylon*), Pipla (*Piper langum*), Lahare banmara *(Mikania micrantha*), Mothe (*Cyperus rotundua*), Gholtapre (*Hydrocotyle asiatica*), Kash *(Saccharum spontaneum*), Siru *(Imperata cylindrical*), Chari amilo (*Oxalis corniculata*), Nilo gande *(Ageratum houstonianum*), Banso *(Digitaria sp*), Kalo Kuro (*Bidens polisa*), etc (BZCFOP 2068).

The fauna of this area consist of Rhino *(Rhinoceros unicornis*), Wildboar (*Sus scrofa*), Barking deer (*Muntiacus muntjak*), Sambar deer (*Rusa unicolor*), Hare *(Lepus nigricollis*), Jackal (*Canis aureus*). Large carnivore like Tiger (*Panthera tigris tigris*), Leopard *(Panthera pardus*) are occasionally visited in this area. Birds like Red jungle fowl (*Gallus gallus*), Common Peafowl (*Pavo cristatus*), Blue rock pigeon *(Columba livia*), Spotted dove (*Streptopelia chinensis*), Jungle crow *(Corvus macrorhynchus*), Red vented Bulbul (*Pycnonotus cafer*), Parakeet (*Psittacula cyanocephala*) etc are common. It consist of Reptiles like Ghariyal (*Gavials gangaticus*), Mugger (*Crorodiles palustris*), Common Python *(Python morulus*) etc (BZCFOP 2068).

3.1.4Socio- cultural and economy

GBZCF includes total 946 households of ward number 1, 2, 3 and 4 of Jagatpur VDC. The total human population is about 4,950 among which 2,457 are female and 2,493 are male. Among the total population 49.63% are female and 50.37% are female. Indigenous people such as Darai and Tharu are living in this area followed by Brahman, Chhettri, Newar, Giris, etc. People are basically depends on the agricultural activities for their livelihood (BZCFOP 2068).

3.2. Research Methods

A preliminary field survey was done on 11th- 15th April, 2012 in Ghailaghari Buffer Zone Community Forest. The total study period was around the year from 11th May, 2012 to 18th February, 2013. The 1st field study was conducted from May, 2012 during summer season, 2nd field study was on July – August, 2012 during rainy season, 3rd field study was on November, 2012 during autumn and finally 4th field study was conducted on February, 2013. The field was studied on foot. The study was conducted on different four seasons to collect the seasonal population data of Spotted Deer while the data of habitat preference as well as vegetation was collected on the Spring season.

3.2.1. Population Status

After preliminary survey the whole study area was divided in to 3 habitat types i.e. Grassland, Bhellar (*Trewia nudiflora*) - Sisoo (*Dalbergia sisoo*) mixed forest and Simal (*Bombax ceiba*) dominated forest. Among these 3 habitat types Bhellar (*Trewia nudiflora*) - Sisoo (*Dalbergia sisoo*) mixed forest has larger area. So to make the counting easier, the whole study area was divided in to 9 blocks. Bhellar (*Trewia nudiflora*) - Sisoo (*Dalbergia sisoo*) mixed forest was divided in to 7 blocks and Grassland and Simal (*Bombax ceiba*) dominated forest was considered as 1, 1 block respectively. Then population was recorded by direct count method. It was done with the help of binoculars (10×50) and age and sex composition was identified. The counting was done from 7:00am -9:00am in the morning and 3:00pm -6:00pm in the evening. Repeated regular counting was carried out in each session and in all seasons along the line transect. During the total count, the exact total numbers were different at the same place in different replication. So first and second highest numbers of species were recorded. During day to day direct observation, the herd size and total herd number was finalized and the total individuals were counted and noted down.

3.2.1.1. Age and sex composition

The age and sex composition was determined by using binoculars (10×50). To facilitate the counting the animal was divided into 3 categories based on (Sapkota 1999) as:

Male: The adult male more than 60cm body height with characteristic antlers.

Female: The female animal with above 60cm in height without antlers.

Young: Individual with an age of less than one year, smaller in size and always remain with their mothers. When standing they reach up to central body line of adult female roughly less than 60cm.

3.2.2. Vegetation Study

The quadrate sampling method was used for the sampling of vegetation in different habitat type of the study area. First of all the North to South line transect were made then the quadrate was laid down 10m far from the main line transect on both side alternatively left and right of the line. The second quadrate was placed 50m apart from the previous one. For the study of trees, shrubs and herbs, $20\times20m^2$, $5\times5m^2$ and $1\times1m^2$ quadrates were used respectively. A total of 143 quadrates of size 20×20 m^2, 157quadrats of size $5\times5m^2$ and 157 quadrates of size $1\times1m^2$ were used to study the vegetation on the study area. The local name and their presence number of the plant species were recorded. In case of the tree, circumference of the tree was also measured at1.35m height. All the trees which have the circumference of 12cm and more were recorded. The vegetation were studied and recorded based on the local name and unknown species were collected and preserved as herbarium and taken to the National Herbarium and Botanical Laboratory, Godawari for taxonomic identification.

3.2.3. Habitat Preference

After the study of vegetation structure, three representative habitat types were broadly identified. The selected habitats were:

- Grassland (Open land either none or few trees and Shrubs)
- Bhellar (*Trewia nudiflora)* - Sisoo (*Dalbergia sisoo)* mixed forest
- Simal (*Bombax ceiba*) dominated forest

The habitat preference was examined by the faecal pellet observation through the line transect method (Wegge 1976). In each type of habitat North – South line transect was made with the help of the compass and measuring tape spacing 100m between the line transect. GPS point of starting and ending point of transect line was recorded (Appendix II, Table: 11). A circular plot with radius 1.78m was made at every point of 50m interval along line transect and the pellet of the Spotted Deer was observed within the circular plot.

3.2.4. Questionnaire survey

A set of questionnaire was prepared (Appendix III). The main aspect of the questionnaire survey was to collect the information about the crop damage by Spotted Deer. Another main aspect was to know the attitude toward the conservation of the Spotted Deer, to know the local method which was used to reduce the crop loss and to collect people's recommendation to minimize the conflict. The questionnaire survey was conducted in 100 household including 10.57% of total household (946) of GBZCF peripheral area. It was basically intended to collect the representative feeling of family. The questionnaire survey was conducted during the month of February, 2013. The household were selected by the random sampling method. Before taking interview people were briefed about study and tried to interview with the head of the household. In the absence of the head of the household the person next to the head was interviewed.

3.3. Data analysis

3.3.1. Population estimation

During total count, the total numbers of the Spotted Deer were different in different time at the same place. So to reduce the biasness, total population was estimated by using the statistical formula given by (Quenouille 1956).

$$N_0 = 2N_k - N_{k-1}$$

Where, N_0= Population estimate.

N_k= highest count.

N_{k-1}= next highest count.

3.3.1.1. Population Density

The total number of individual of a species per unit area is known as population density. Crude density refers to the total number of individuals present in the total area of the habitat and is given by the formula:

$$\text{Density} = \frac{Total\ number\ of\ animal\ in\ an\ area\ (N)}{Total\ Area\ (A)}$$

3.3.1.2. Herd characteristic

The average herd size of the Spotted Deer was calculated as:

$$\text{Average herd size} = \frac{Total\ number\ of\ individual\ observed}{Total\ Number\ of\ herds\ observed}$$

3.3.1.3. Population variation with blocks and seasons

3.3.1.3.1. Parametric test

The one way ANOVA test was used to analyze the variation in population of Spotted Deer in different block and different season. SPSS version16 was used for statistical analysis.

For direct count methods

Null hypothesis:

H_0: There is no significant difference in the population of Spotted Deer in different season due to block.

Alternative hypothesis:

H_1: There is significant difference in the population of Spotted Deer in different season due to block.

Null hypothesis:

H_0: There is no significant difference in the population of Spotted Deer in different block due to season.

Alternative hypothesis:

H_1: There is significant difference in the population of Spotted Deer in different block due to season.

3.3.2. Vegetation Analysis

The vegetation data were analyzed by using Zobel et al.1987 as following methods:

$$\text{Frequency} = \frac{Total\ number\ of\ quadrat\ in\ which\ species\ has\ occured}{Total\ number\ of\ quadrat\ studied}$$

Relative Frequency (RF) = $\frac{Frequency\ of\ individual\ species}{Total\ frequency\ of\ all\ species} \times 100$

Density= $\frac{Total\ number\ of\ individual\ species}{Total\ number\ of\ quadrats\ studied \times area\ of\ quadrat}$

Relative Density (RD) = $\frac{Density\ of\ individual\ species}{Total\ density\ of\ all\ species} \times 100$

Basal Area= $\frac{C^2}{4\pi}$

Where, C= Circumference of the tree

Relative Basal Area (RBA) =$\frac{Basal\ area\ of\ species}{Total\ basal\ area\ of\ all\ speciea} \times 100$

IVI= RD +RF +RBA

In case of herbs and shrubs relative frequency and relative density were calculated while in case of tree Important Value Index (IVI) was calculated.

3.3.3. Habitat preferences:

Habitat preference was calculated by using formula (Wegge 1976).

Habitat Preference $= \frac{PPE}{TPP} \times 100$

Where,

PPE= Pellet present percent (%) in each habitat type.

TPP= Total pellet present (%) in all habitat type.

A chi-square test for goodness of fit (Elliott 1971) was used to test whether the use of different habitat were statistically significant or not.

3.3.4. Crop Damage

The collected data from the questionnaire survey were quantitatively analyzed. The objectives behind this are to calculate the total loss of different crop.

For this purpose various statistical methods were applied. The following formulas are used to calculate the loss per unit area (Poudel 2007).

$$X = \frac{XE - XA}{XLC}$$

Where, X= Loss per unit land

XE= Expected yield before crop loss

XA= Actual value after crop depredation

XLC= Total cropping land of that field

XL= XE- XA

Where, XL= Total crop loss

Total economic = price of crop× total crop loss in the village

4. RESULTS

4.1. Population Status of Spotted Deer

4.1.1. Population Estimation

The total estimated population of Spotted Deer was 72, 79, 85, 96 in Spring, Rainy, Autumn and Winter seasons respectively. The highest recorded population was 95 individuals in winter while lowest was 70 individuals in Spring. However statistically 96 and 72 were found to be the highest and lowest estimated population (Table- 1).

Table 1: Population status of Spotted Deer in four different seasons of GBZCF.

S.N	Season	Population of Spotted Deer observed		Estimated population $N= 2N_k – N_{k-1}$
		Maximum(N_k)	**Second maximum(N_{k-1})**	
1	Spring	70	68	72
2	Rainy	77	75	79
3	Autumn	84	83	85
4	Winter	95	94	96
Average population		**81.5**	**80**	**83**

The total number was found to be different in different seasons. During field study minimum population was 70 in May 2012 and the maximum population was 95 in February 2013 (Figure- 4).

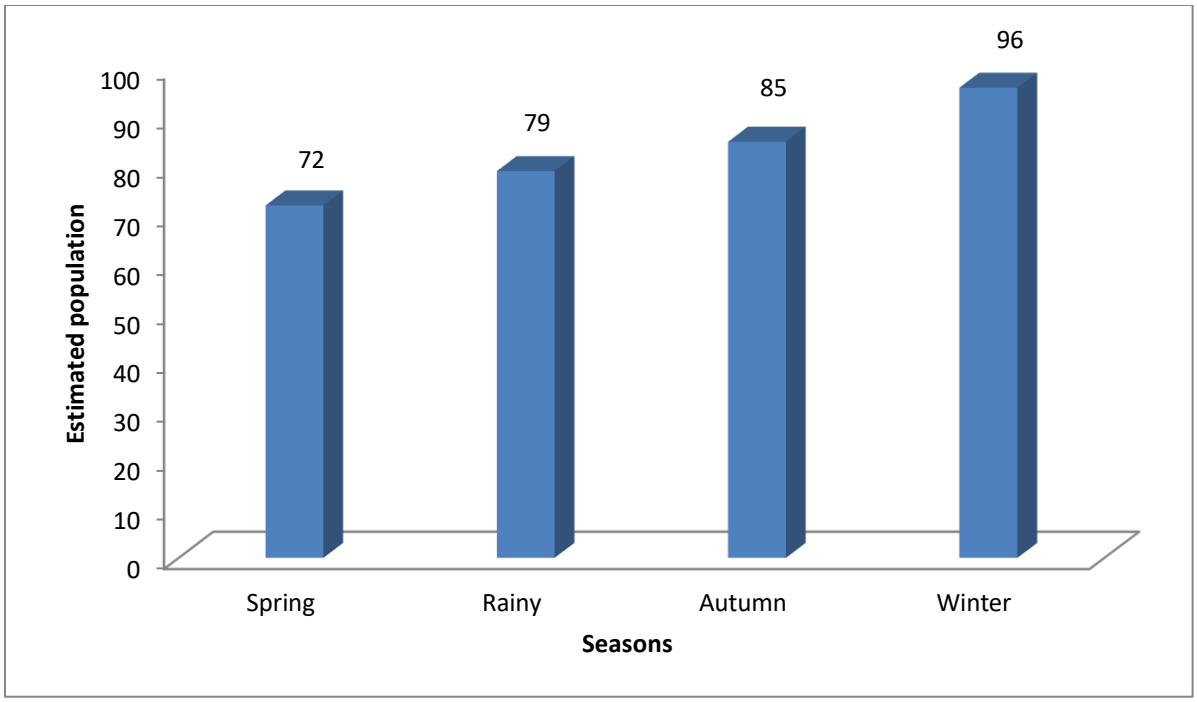


Figure 4: Estimated population of Spotted Deer in four seasons in GBZCF.

4.1.2. Population Density

The observed maximum numbers of the Spotted Deer were used to find out the crude density in different season of the study area. The crude density were 44.87 individuals/km^2, 49.36individuals/km^2,53.84individuals/km^2 and 60.89 individuals/km^2 in Spring, Rainy, Autumn and Winter season respectively. The maximum crude density was estimated in Winter season where as minimum crude density was estimated in Spring season. In average the crude density was 81.5 individual/km^2 (Table- 2).

Table 2: Crude density of Spotted Deer in four different season of GBZCF.

S.N	Season	Total populations	Area in km^2.	Density(individuals/km^2)
1	Spring	70	1.56	44.87
2	Rainy	77	1.56	49.35
3	Autumn	84	1.56	53.84
4	Winter	95	1.56	60.89
Average		81.5	1.56	52.24

4.1.3. Age and Sex composition

The number of Spotted Deer observed in four different seasons was used to find out the age and sex ratio for each season.

In Spring season the number of Spotted Deer observed was 70. Among them 24 (34.28%) were male, 31 (44.28%) were female and 15 (21.43%) were young. The male to female ratio was 1:1.29 showing a sex ratio of 77.41 bucks to 100 does. The young to female ratio was 1:2.06 showing the ratio of 48.3 young to 100 does (Figure- 5).

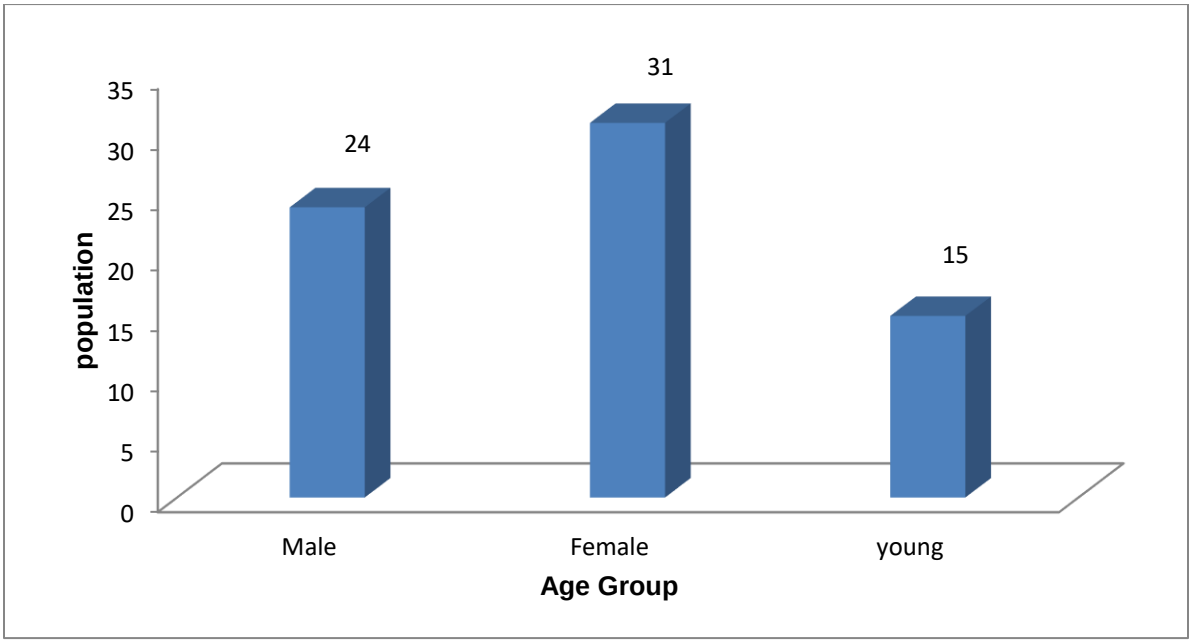


Figure 5: Age and sex composition of Spotted Deer in Spring season of GBZCF in 2012.

In Rainy season the maximum number of Spotted Deer observed was 77. Among them 25 (32.46%) were male, 35 (45.46%) were female and 17 (22.08%) were young. The male to female ratio was 1:1.4 showing a sex ratio of 71.42 buck to 100 does. The young to female ratio was 1:2.44 showing the ratio 41.03 young to 100 does (Figure- 6).

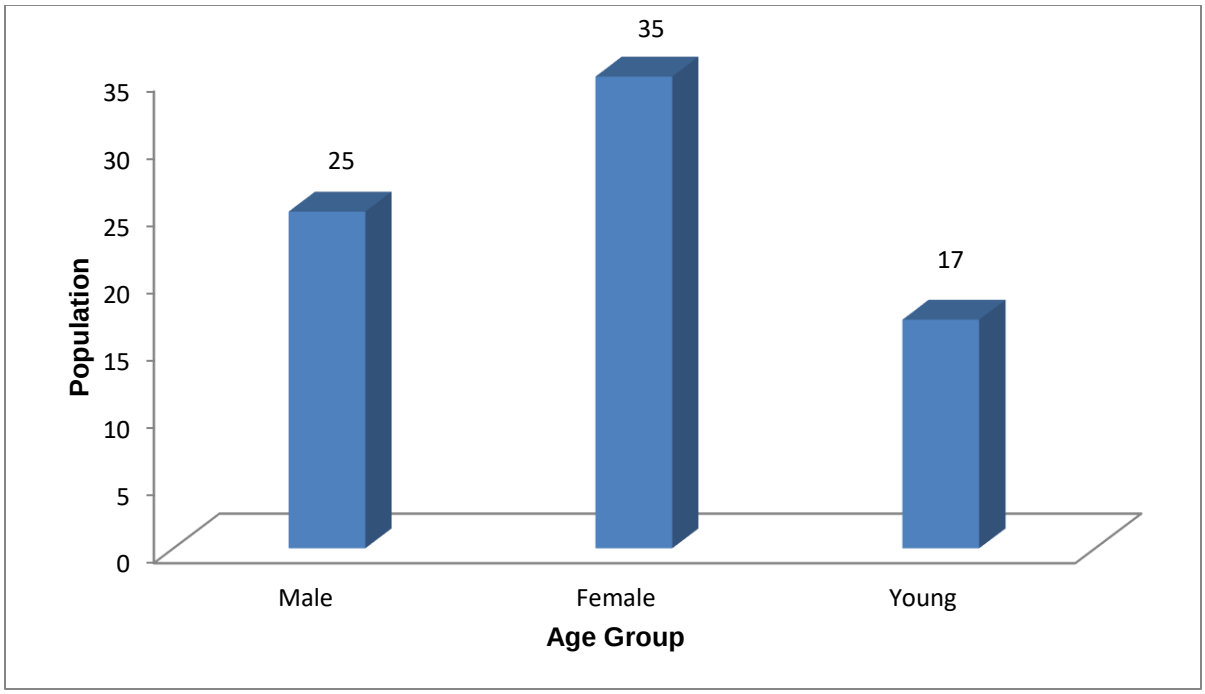


Figure 6: Age and sex composition of Spotted Deer in Rainy season of GBZCF in 2012.

In Autumn season the maximum number of Spotted Deer observed was 84. Among them 29 (34.59%) were male, 39 (46.43%) were female and 16 (19.05%) were young. The male to female ratio was 1:1.344 showing the ration 74.36 buck to 100 does. The young to female ratio was 1:2.44 showing the ratio of 41.03 young to 100 does (Figure- 7).

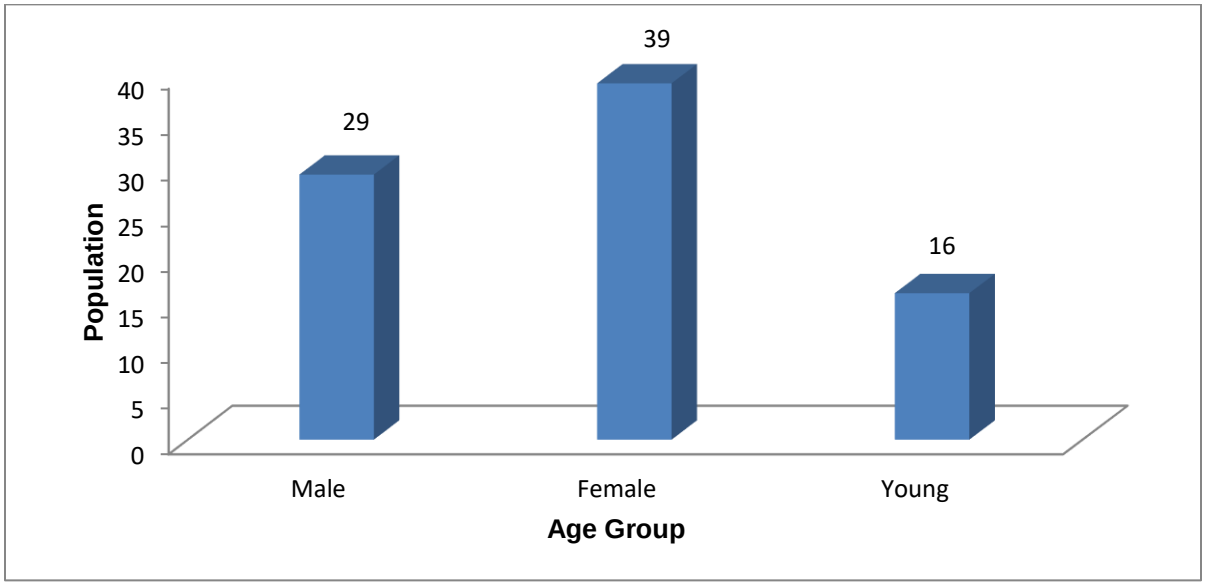


Figure 7: Age and Sex composition of Spotted Deer in Autumn season of GBZCF in 2012.

In Winter season the maximum number of Spotted Deer was 94. Among them 32 (33.69%) were male, 43 (45.26%) were female and 20 (21.05%) were young. So the male to female ratio was 1:1.344 showing a se ratio of 74.3 buck to 100 does. The young to female ratio was 1:2.15 showing the ratio of 46.51 young to 100 does (Figure- 8).

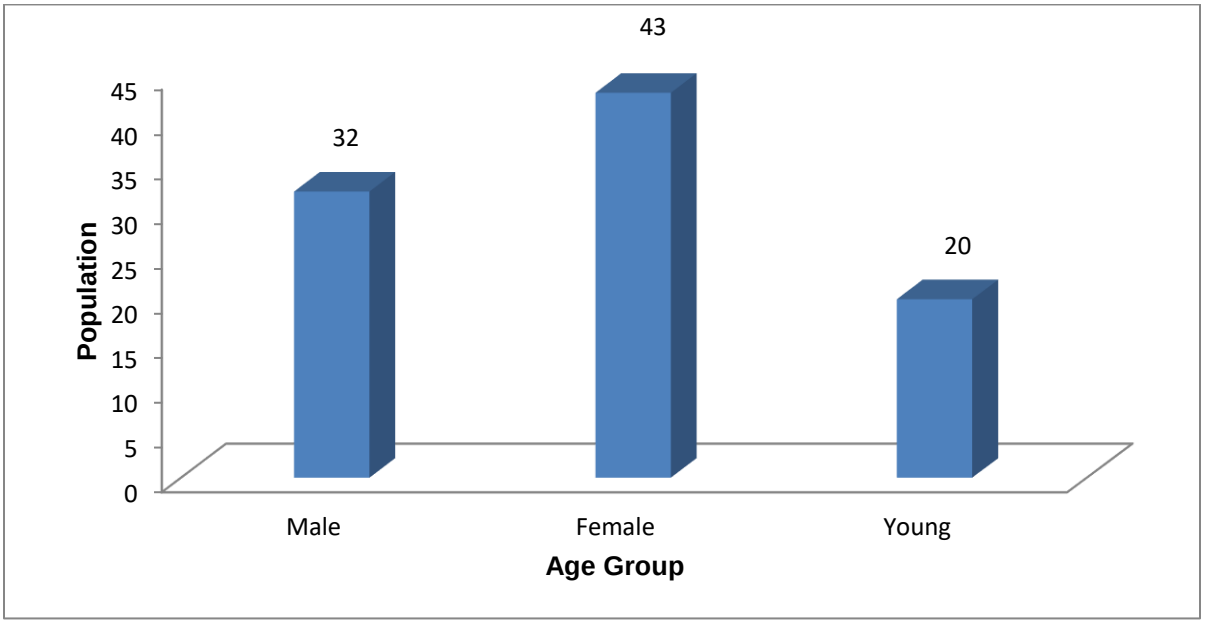


Figure 8: Age and sex composition of Spotted Deer in Winter season of GBZCF in 2013.

4.1.4. Herd Size

A maximum individual number and number of herds in 4 different seasons were used to estimate the herd size. A total 326 individuals of Spotted Deer in 22 herds were counted during the study period. The average herd size was 14.8.

4.1.5. Population variation with blocks and seasons

4.1.5.1. Parametric Test

The maximum numbers of Spotted Deer counted in nine blocks in four seasons were used to compute the ANOVA test. Total number in different 9 blocks in 4 seasons was given below (Table- 3).

Table 3: Maximum number of Spotted Deer in nine blocks in four seasons by direct count method.

Season / Block	Spring	Rainy	Autumn	Winter	Total
1	5	0	0	0	5
2	6	5	0	9	20
3	15	14	14	19	62
4	5	6	0	21	32
5	0	13	23	0	36
6	23	0	23	0	46
7	0	0	19	23	42
8	0	23	0	0	23
9	16	16	5	23	60
Total	**70**	**77**	**84**	**95**	**326**

From the One way ANOVA test it was concluded that there was no significant difference of number of Spotted Deer in 4 seasons due to block because the calculated value of ANOVA test was 0.139 while the tabulated value with df (3, 32) at 95% level of confidence was 2.9. So null hypothesis was accepted (Table- 4).

Table 4: Summary of population of Spotted Deer in four seasons due to block (One way ANOVA).

Source of Variance	Sum of Square	df	Mean square	F-ratio	Remark
Between Group	37.889	3	12.630	0.139	No significant
Within Group	2898.000	32	90.562		
Total	2935.889	35			

The one way ANOVA test concluded that there was no significant difference of number of Spotted Deer in 9 blocks due to seasons. The calculated value of ANOVA test was 1.051 while the tabulated value was 2.24 at df (8, 27) at 95% level of confidence i.e. null hypothesis was accepted (Table-5).

Table 5: Summary of population of Spotted Deer in nine blocks due to seasons (One way ANOVA).

Source of Varience	Sum of Square	df	Mean Square	F-ratio	Remark
Between Groups	697.389	8	87.174	1.051	No significant
Within Groups	2238.500	27	82.907		
Total	2935.889	35			

4.2. Vegetation Analysis

The total number of the line transect laid down were 34 and total length of the line transect was 7.85km. A total of 143 quadrates of size 20×20 m^2 for trees, 157quadrats of size 5×5m^2 for shrubs and 157 quadrates of size 1×1m^2 for herbs were used to know the vegetation pattern and floral diversity in the study area. It is reflected that there were 11 species of trees, 23 species of shrubs and 54 species of herbs were recorded in the habitat (Appendix IV; Table 12 -14). Among tree, *Trewia nudiflora* (IVI= 75.83) was the dominated tree species. It was followed by *Bombax ceiba* (IVI= 58.92) and *Dalbergia sisoo* (IVI= 47.24).

Among shrubs, *Urtica dioica* had high relative density (RD = 36.77032) which was followed by *Pogostemon benghalensis* (RD= 13.69) *Eupatorium odoratum* (RD= 11.129) and *Callicarpa macrophylla* (RD= 10.53). In case of relative frequency *Pogostemon benghalensis* had high relative frequency (RF= 16.78) which was followed by *Urtica dioica* (RF= 16.31), *Callicarpa macrophylla* (RF= 16.06) and *Colebrookea oppositifolia* (RF= 15.11).

Among herbs, *Mikania micrantha* had high relative density (RD= 13.181) which was followed by *Imperata cylindrical* (RD= 9.314), *Ageratum houstonianuk* (RD= 8.0843), *Cynodon doctylon (*RD= 6.326) and *Saccharum spontaneum* (RD= 6.151). Relative frequency was high in *Imperata cylindrical* (RF= 33.832) which was followed by *Mikania micrantha* (RF= 10.135), *Saccharum spontaneum* (RF= 9.617) *Cynodon doctylon* (RF= 7.304) and *Cyperus rotundus* (RF=19.49).

4.3. Habitat Preference

From the study of vegetation structure, 3 different habitats were broadly identified. They were Grassland, Bhellar (*Trewia nudiflora*) - Sisoo *(Dalbergia sisoo*) mixed forest and Simal (*Bombax ceiba*) dominated forest.

All together 157 plots were placed in 7.85km of line transect. Out of 157 plots, 36 were in grassland, 70 were in Bhellar (*Trewia nudiflora*) and Sisoo (*Dalbergia sisoo*) mixed forest and 51 were in Simal *(Bombax ceiba*) dominated forest habitat type. From the examination on the habitat preference in different habitat type, it was found that Spotted Deer mostly preferred grassland which carried the habitat preference value of 38.879% which was followed by Bhellar (*Trewia nudiflora)*–Sisoo (*Dalbergia sisoo*) mixed forest with habitat preference value 33.676. However Simal (*Bombax ceiba)* dominated forest was recorded as least preferred as it had 27.44% habitat preference value (Table-6).

Table 6: Number of plots in each habitat type, plots with pellets and habitat preference (HP) value.

S.N	Habitat Type	Total plot	Plot with pellet	PPE%	HP%
1	Grassland	36	19	52.77	38.879
2	Bhellar (*Trewia nudiflora*) - Sisoo (*Dalbergia sisoo)* mixed forest	70	32	45.71	33.676
3	Simal (*Bombax ceiba)* dominated forest	51	19	37.25	27.444
Total pellets present % of the all habitat types				135.747	

From chi- square contingency test, it was observed that there was no significant (χ^2= 0.475, P<0.05, df = 1) difference between Grassland and Bhellar (*Trewia nudiflora*) - Sisoo (*Dalbergia sisoo)* mixed forest. There was no significant (χ^2= 0.865, P<0.05, df= 1) difference between Bhellar (*Trewia nudiflora*)-Sisoo (*Dalbergia sisoo)* mixed forest and Simal (*Bombax ceiba)* dominated forest. Similarly in between Grassland and Simal (*Bombax ceiba)* dominated forest, no significant difference (χ^2= 2.0670, P< 0.05, df =1) was observed.

4.4. Crop Damage

Total 100 households were interviewed from GBZCF peripheral area. It was Ghailaghari village, Hittan Bagaichha, Madhyabarti Chowk, Kashara Chowk, Jagatpur, Khadgauli, Belhatta, Dhruba,Madhupuri and Sital pani. Among them 62 (62%) household suffered crop loss while 38 (38%) household did not suffer from crop loss. Altogether the crop loss was estimated to be 205.85 quintals of different crops and vegetable. Which has the monetary value of NRs 6,00,090 in those area. The crop loss per household in the area was estimated to be NRs 9,678.87 (Table- 7). However there was no record of loss of fruit and orchard invasion.

Table 7: Overall crop loss in user group of GBZCF.

S.N	Type of Crop	Total Expected Yield (Quintals)	Total observed Yield (Quintals)	Total Crop loss (Quintals)	Loss in NRs
1	Pulses	78.95	54.51	24.44	1,58,860
2	Paddy	703.65	646.5	57.25	1,37,400
3	Maize	313.65	242.2	71.45	1,35,755
4	Wheat	123.10	82.35	40.75	1,01,875
5	Vegetable	29.37	20.61	8.76	43,800
6	Mustard	36.70	33.5	3.20	22,400
	Total	**1,285.52**	**1,079.67**	**205.85**	**6,00,090**

Price of different crops was obtained from the local people and local market of Jagatpur (Appendix V, Table 15). The rate of crop damage per unit area was also computed. The rate of damage to Maize was 2.54 quintal/ha, which was followed by Paddy (1.93 quintal/ha), Wheat (1.90 quintal/ha), Pulses (1.045 quintal/ha), Vegetable (0.79 quintal/ha) and Mustard (0.411 quintal per ha) respectively (Appendix VI, Table 16).Paddy, maize, wheat, mustard and vegetable were main crops destroyed by Spotted Deer. Maize was heavily destroyed followed by paddy. Mustard was least destroyed (Figure - 9). In Monetarily value the loss of pulses was highest although its value is low (24.44 quintal/ 1,56,860 NRs).

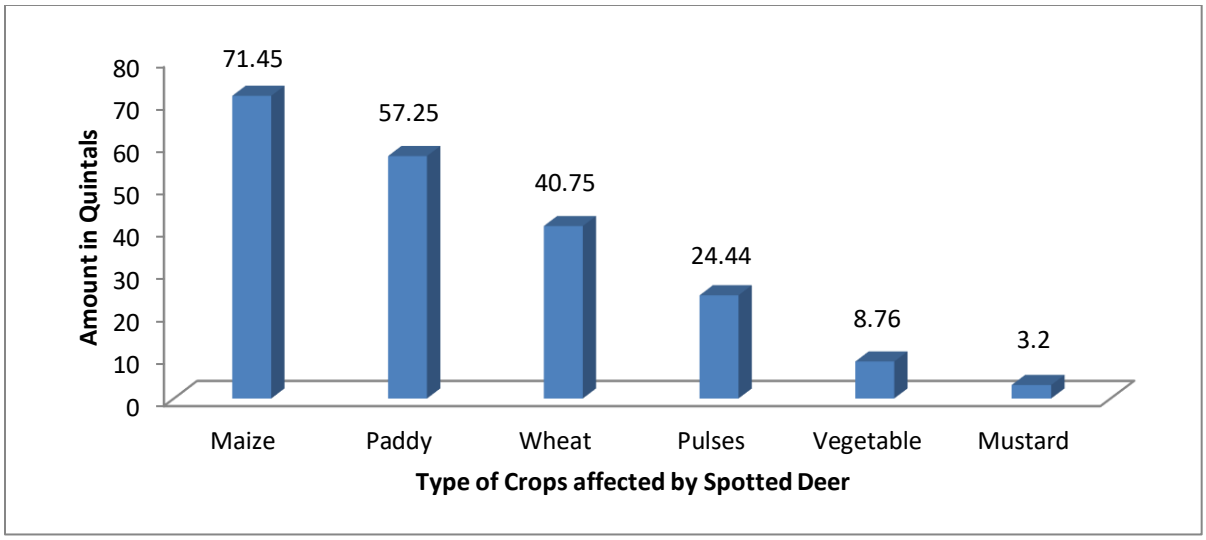


Figure 9: Types and amount of Crop loss by Spotted Deer in GBZCF.

Among the affected user committees it was found that ward number 1 was more affected in Crop loss than ward number 2. No any crop loss was reported from ward number 3 and 4. In ward number 1 and 2 there was crop loss of 108.4 and 97.45quintals respectively (Figure-10)

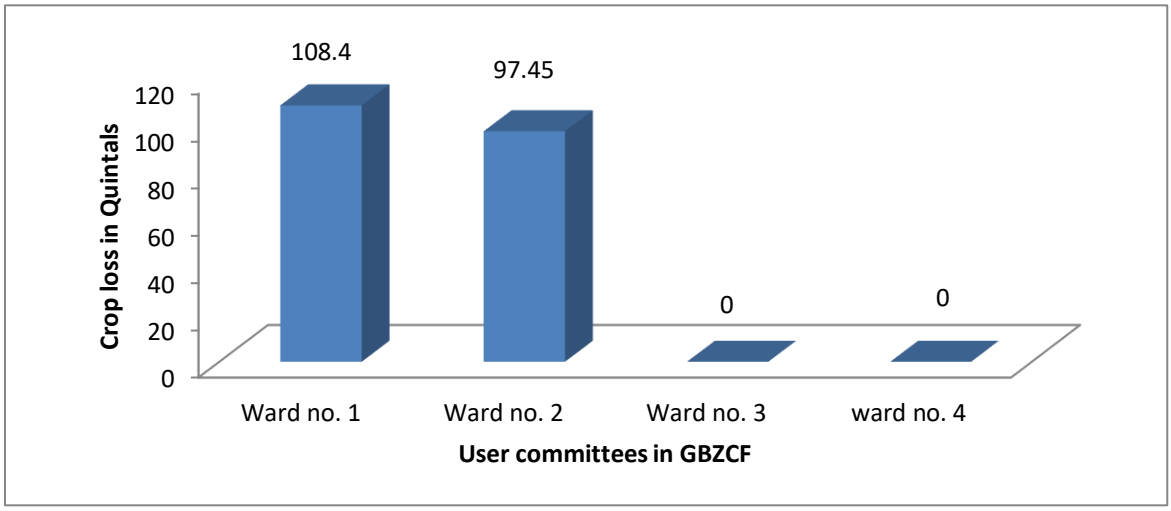


Figure 10: Crop loss in the user committees of GBZCF.

59% respondent said that the rate of crop damage is in increasing trend. Most of the respondent concluded that the rate was increased due to the unavailability of enough grass in comparison to their number. 41% respondent said that the rate of damage was decreased due to well manage electric wire in the boundary of the forest (Figure-11).

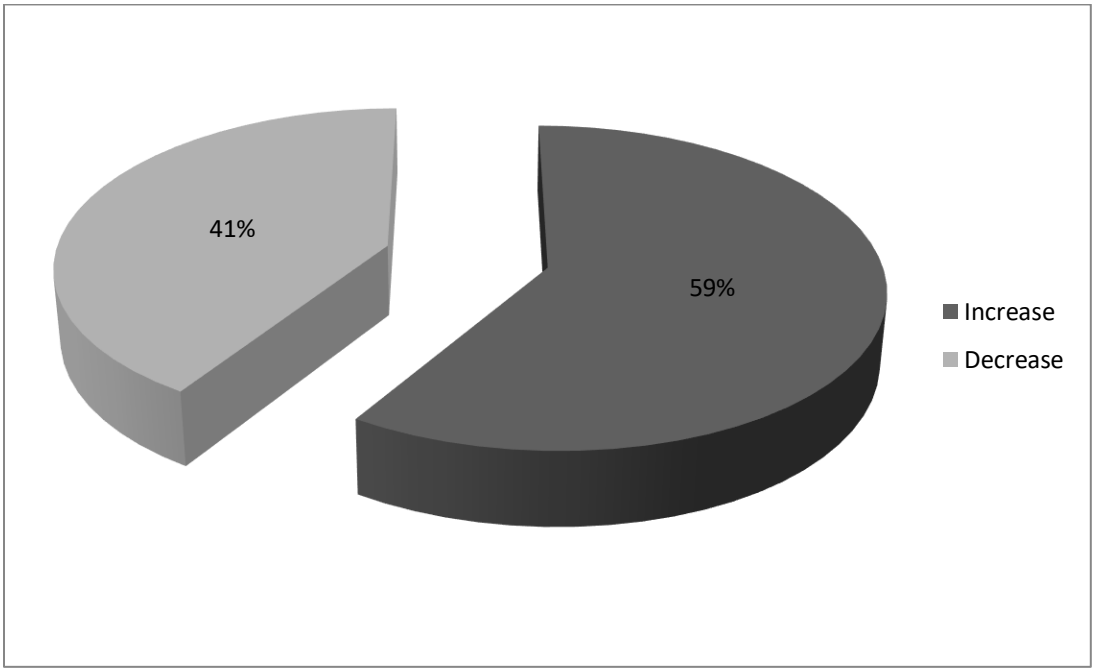


Figure 11: Trend of Crop damage in GBZCF.

Local people of study area usually practice different types of indigenous methods for the purposed of crop prevention from the Spotted Deer. Such as shouting, overnight guarding, making scarecrow and beating drum. Out of these methods shouting was highly used (32.25%) which was followed by making scarecrow (19.35%), both shouting and making scarecrow (16.12%), beating drum (12.90%), guarding in the field (8.06%), both shouting and beating drum (6.45%) and both shouting and guarding in the field (1.6%) respectively. (Figure: 12).

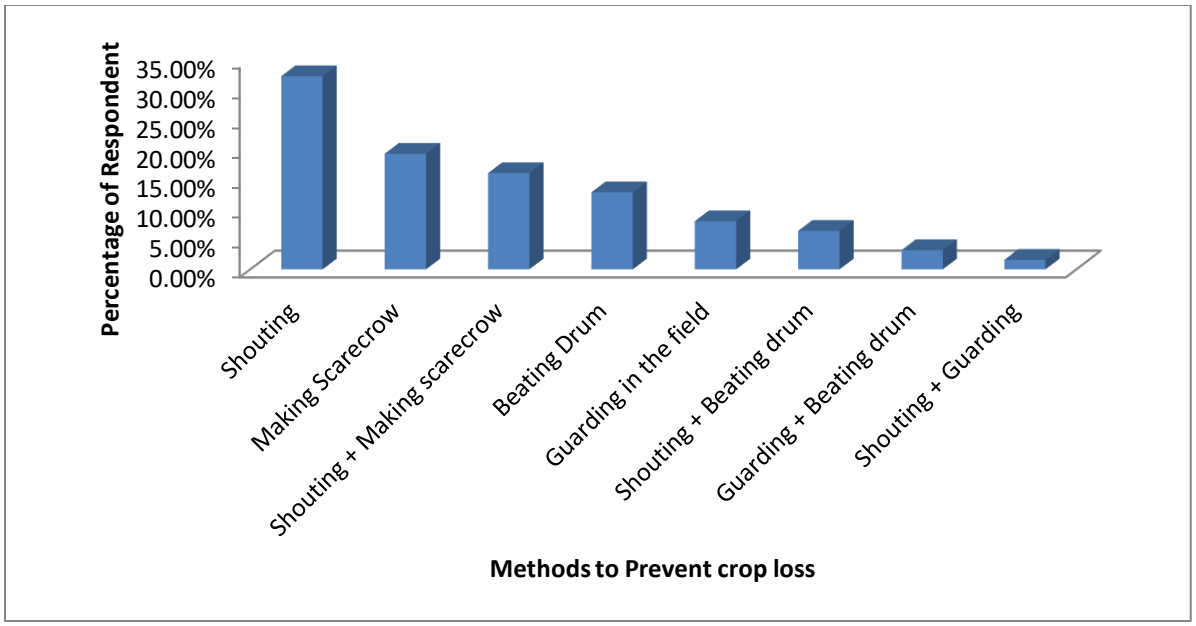


Figure 12: Percentage of respondents using different methods to prevent crop loss in GBZCF.

71% respondent had positive attitude toward the conservation of Spotted Deer. 18% respondent had negative attitude and 11% respondent were neutral toward the conservation of Spotted Deer (Figure: 13).

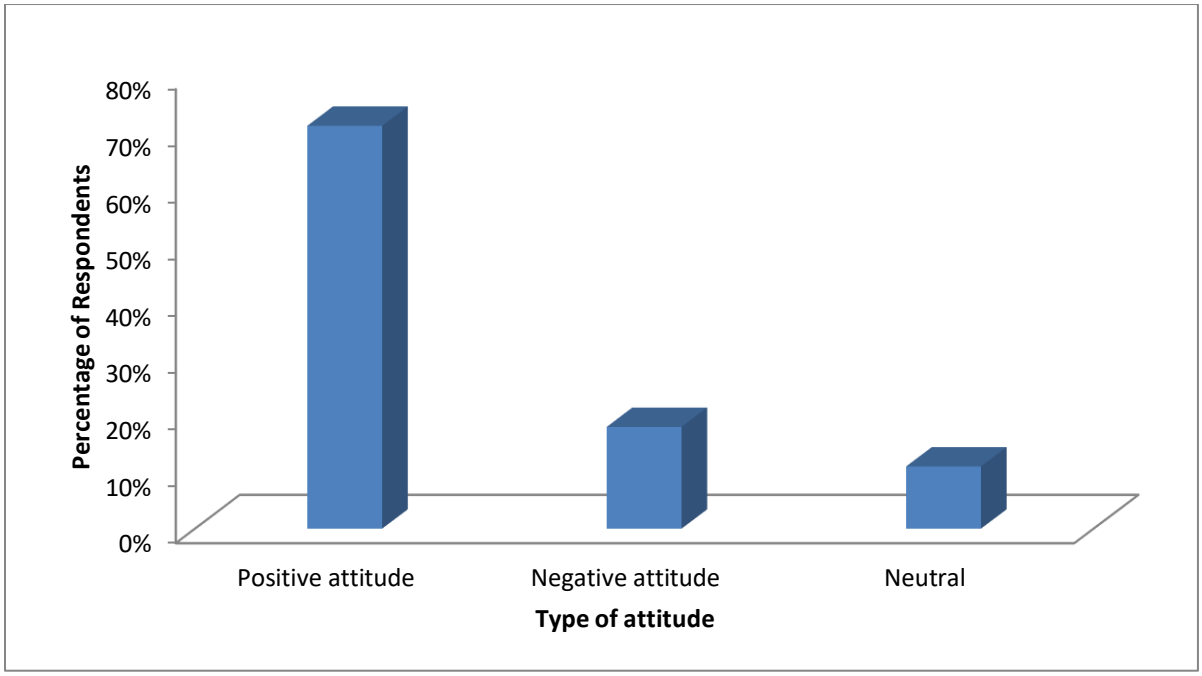


Figure 13: Attitude of local people towards the conservation of Spotted Deer.

5. DISCUSSION

5.1. Population Status

The total population of Spotted Deer was found to be varied in different season. Maximum observed population was 70, 77, 84 and 95 in Spring, Rainy, Autumn and Winter season respectively in 1.56 km^2 area. This number was higher than the estimated by Choudhary (1987) in Tadoba National Park, India. He estimated 1246, 1027 and 1602 head of this species in 116.54km^2 area in the year of 1984, 1985 and 1986 respectively. De and Spillet (1996) estimated only 1906 individual in 520.8 km^2 area in Corbett National Park. Parajuli (2007) counted total of 832 individuals from different location from about 30 km^2 area of North- western corner of Bardiya National Park, Nepal. This estimated Population was less than the total population found in the study area. The actual census of Spotted Deer was not done before this study in GBZCF. From the seasonal data it can concluded that the population is in increasing pattern.

Present study shows the crude density of Spotted deer to be 44.87, 49.35, 53.84 and 60.87 individual per km^2 in Spring, Rainy Autumn and Winter season respectively which was similar to the estimated by Schaller and Spillet (1986) in Keoladeo Ghana Sanctuary, by Dave and Jhala (2011) in Gir Forest, India, who record the crude density 45individual per km^2 and 44.8 ± 1.5 individual per km^2. But it was less than the estimated by Naess and Andersen (1993) in Bardiya National Park, Nepal, by Biswas and Sankar (2001) in Pench National Park in Central India and by Jathanna et al. (2003) in Tropical forest of India which was 225.3-384.5 individuals per km^2, 80.7 individuals per km^2 and 451± 1.5 individuals per km^2. The population as well as crude density was lowest in Spring season. It may be due to the unavailability of palatable grass because the forest committee had opened the forest for grass cutting for user committee. The density was found to be highest in winter season which may be due to the newly grown shoot of grass after ground fire. The ground fire was generally done by people during early winter season.

The sex ratio is defined as the population of males in population. The sex ratio of Spotted Deer in GBZCF was 1:1.29 showing 77.41 antlers to 100 does in Season. In rainy season the sex ratio was 1:1.344 showing the sex ratio of 71.42 antlers to 100 does. In Autumn season the sex ratio was 1:1.344 showing the ratio of 74.36 antlers to 100 does. In winter season the sex ratio was 1:1.343 showing the sex ratio of 74.30 antlers to 100 does. The ratio of male to female was slightly same in Autumn and winter season. The ratio of male to female was less than the ratio which was estimated by Nichols (1960). He reported that the sex ratio of adult male to female was 77:100 in Hawaii. The sex ratio of the species in study area was higher than the estimated by Tamang et al. (1976) at Chitwan National Park, Nepal (59:100), by Parajuli (2007) in Bardiya National Park, Nepal (49:100) and by Schaller (1967) in Corbett National park (70:100). This ratio was also higher than the estimated by Dinerstein (1980) in Royal-Karnali Bardia, Nepal and by Johnsingh (1983) in Bandipur, India, which was 0.5 males: 1 female and 0.6male: 1female The sex ratio of GBZCF was comparatively high than the Bardiya National Park and Chitwan National Park, it may be due to the proper management of habitat by buffer zone committee and availability of water inside it. Absence of regular large carnivore like Tiger, Leopard and Wild dog was another factor for higher sex ratio because large carnivores are occasionally visited in this area.

The average herd size was found to be 14.8. It is far less than the estimated by Sapkota (1999) in Parsa Wildlife Reserve and by Parajuli (2007) in Bardiya National Park which was 20 and 16.67 individual in one herd. The herd size is higher than the herd size which was estimated by Ganguly et al. (2011) in Zoological garden of India, Ramesh et al. (2011) in Western Ghat , India and Srinivasulu (2001) in Eastern Ghat India, which was 10.36, 13.1±0.50 and 12 respectively. According to Dinerstein (1980), chital group size in Karnali-Bardia (Nepal) varied from one to 91 individuals with a mean group size of 10.7. Barrette (1991) reported 2 to 125 individuals in Wilpattu (Sri Lanka) with a mean group size of 12 which was lower than the present study.

The hypothesis on direct count methods used to study the significant difference in number of Spotted Deer in four different seasons due to block was tested by statistical analysis (one-way ANOVA). The ANOVA test was also used to find out the significant different in number of Spotted Deer in Nine blocks due to season. In both test null hypothesis was

accepted at 95% confidence level. It may be due to the immigration and emigration of Spotted Deer from GBZCF to nearby Chitwan National Park and Hariyali Buffer Zone Community forest and vice versa.

5.2. Vegetation Analysis

The total number of floral species that occurred in the present study area was 88. Out of which 11 species were trees, 23 species were shrubs and 54 species were herbs. Among tree species *Trewia nudiflora* (IVI= 75.83) was the dominated tree species in the study area. In shrubs *Urtica diaica* had high relative density (RD = 36.77032) and *Pogostemon benghalensis* had high relative frequency (RF= 16.78). In herbs, *Mikania micrantha* had high relative density (RD= 13.181) and *Imperata cylindrical* had high relative frequency (RF= 33.832). The high density of *Urtica diacia* and *Mikania micrantha* shows that the other shrubs and herbs of this forest will be highly affected in few years because of their ability to change and destroy habitats and ecosystem.

5.3. Habitat Preference

Spotted deer mostly preferred grassland habitat with habitat preference value 39.03 and least preferred habitat was Simal (*Bombax ceiba*) dominated forest habitat with habitat preference value 27.55. Similar result was found in Parsa Wildlife Reserve, Nepal by (Sapkota 1999). Grassland was preferentially utilized by female at night during hot season in low land of Nepal (Moe and Wegge 1994). The grassland habitat was mostly used by Spotted Deer; it may be due to the availability of grass species such as *Imperata cylindrical, Saccharum spontaneum, Cynodon dactylon,* as well as *Digitaria* species. The Bhellar(*Trewia nudiflora*) – Sisoo (*Dalbergia sisoo*) mixed forest was least preferred than grassland with habitat preference value 33.8. The Bhellar (*Trewia nudiflora*) –Sisoo (*Dalbergia sisoo*) mixed forest was mainly used for resting during day time. Simal (*Bombax ceiba*) dominated forest was least preferred. It may be due to unavailability of grass species for grazing. But dissimilar result was found in different area. Moe and Wegge (1994) reported that riverine forest was mostly preferred habitat in hot-dry season and Sal forest was preferred in monsoon season in low land of Nepal. Sal forest was highly preferred habitat in Sukla Phanta Wildlife Reserve,

Nepal (Pokhrel 2005). Mixed forest habitat with high density of grass was mostly preferred habitat in Kuno Wildlife Sanctuary (Kushwah et al. 2012) and hardwood forest was mostly preferred and flood plain was least preferred habitat Karnali flood plain on Bardiya National Park, Nepal (Gautam 2013).

5.4. Crop Damage

During the study period, 205.85 quintals of crops was lost which has market value of about NRs 6,00,090. Crop loss per household was estimated to be NRs 9,678.87. Maize was heavily destroyed with the rate of damage 2.54 quintal/ha. Crop depredation was found high in those wards of study area which lies closer to forest boundary. Area which lies between 0-500m distances from the forest were must vulnerable area for crop. In may be due to the lack of food and low area of grassland followed by overcrowding of Spotted Deer in their habitat. Among the user committee, crop loss was observed from ward number 1 and 2 of Jagatpur VDC. No any crop loss was recorded in Ward number 3 and 4. Crop loss was high in Ward no. 1 than in ward no. 2. Paddy Maize, Wheat, Mustard, Pulses and Vegetable were main crop destroyed by Spotted Deer. It was found that local people use different indigenous means as controlling methods for the purpose of Crop prevention from Spotted Deer. They adopted shouting, over night guarding, making scarecrow and beating drum. Among them shouting (32.25%) was highly used method for prevention of crop from Spotted Deer. 71% respondent were positive toward the conservation of Spotted Deer. So it can be concluded that crop loss did not affect the conservation attitude of local people.

6. CONCLUSION AND RECOMMENDATIONS

From the study it has been concluded that good number of Spotted Deer was found in GBZCF in four seasons (May, 2012 to February, 2013). The population of Spotted Deer was ranging from 70-95 throughout the year. Their number did not remain constant. The average density was 52.24 individuals/km^2.The maximum male to female ratio was 1:1.29 showing the sex ratio 77.41 buck to 100 does in spring season. The maximum female to young ratio was 1:2.06 showing the result of 48.3 young to 100 does in spring season. The average herd size of Spotted Deer was 14.8. There is no significant difference in number of Spotted Deer in different seasons and in different blocks. In GBZCF it was found that Spotted Deer mostly preferred grassland habitat and Simal (*Bombax ceiba*) dominated forest habitat was least preferred.

GBZCF is Bhellar (*Trewia nudiflora*) dominated forest. Heavy crop loss was initiated by Spotted Deer which was more in ward number 1 than in ward number 2 of Jagatpur VDC. The crop loss by Spotted Deer per household was estimated to be NRs 9,678.87.

Based on the study, following recommendation can be made for the management, monitoring and conservation of Spotted Deer in GBZCF.

- Regular census should be carried out every year. This will help to reveal population trends and make necessary intervention for management of Spotted Deer population in long term.
- Grassland expansion and management intervention should be operated regularly so as to increase the movement of Spotted Deer in Grassland.
- The encroaching species like Sisnoo (*Urtica dioica*) and invasive alien species like Lahare banmara *(Mikania micrantha*) should be control to save the habitat for wildlife.
- Effective physical barrier like fencing and trenching around GBZCF should be done to lessened crop loss.

- Crops which are least damaged or disliked by Spotted Deer should be introduced in affected area to minimize the level of conflict due to crop loss.
- A well planned compensation scheme should be executed for the crop damage to promote sustainable conservation of animal and to add the harmony between park official and local communities.

7. REFERENCES

Ables, E. D. 1974. The *Axis* Deer in Texas. The Caeser Kleberg Research Programme. The Texas Agricultural Experiment Station. A & M University System. Texas. 86 pp.

Bagchi, S. P., Goyal, S. P. and Sankar, K. 2008. Social organization and population structure of ungulates in a dry tropical forest in Western India (Mammalia, Artiodactylla). Mammalia **17**(1): 44- 49.

Barrette , C. 1991. The size of Axis Deer fluid groups in Wilpattu National Park , Sri Lanka . *Mammalia* **55**:207-220.

Biswas, S. and Sankar, K. 2002. Prey abundance and food habit of Tiger (*Panthera tigris tigris*) in Pench National Park, Madhya Pradesh. Indian Journal of Zoology **256**(3): 411-420.

Brander, A. D. 1982. Wildlife in Central India. Natraj Publication, India.

BZCFOP 2068. Buffer Zone Community Forestry Operation Plan 2068 serial no: CNP/KAS/JAG/21 CA/SEC/POS/VDC/ Reg.No.

Chalise, M. K. 2001. Wildlife of Nepal (Part – 2). Nepal Natural History Society. Kathmandu, Nepal. Pp: 67.

Chalise, M. K. 2013. Nepal ka Mrigaharu. Revoscience **3**(2): 19-20.

Choudhary, R. 1987. Methodology for population estimate of Herbivore: A Statistical Approach in Indian Condition. Tiger Paper, July- sep. **14**(3):11-17.

Dar, T. A., Habib, B. and Khan, J. A. 2012. Group size, habitat use and overlap analysis of four sympatric Ungulates species in Shivalik Ecosystem, Uttarakhanda, India. Mammalai **76**(1): 31-41.

Dave, C. and Jhala, Y. 2011. Is competition with livestock detrimental for Native wild Ungulates? A case study of Chital (*Axis axis)* in Gir Forest, India. Journal of Tropical Ecology **27**(3): 239-247.

De, R. C. and Spillet, J. J. 1966. A study of Chital or Spotted Deer in Corbett National Park, U. P. Journal of Bombay Natural History Society **63**(3): 576-598.

Dinerstein, E. 1980. An ecological survey of the Royal Karnali-Bardia wildlife Reserve, Nepal. Part III: Ungulate populations. Biol. Conserv. **16**:5-38.

DHM, 2010. Climatological Records of Nepal (issues from 2001-2010). Department of Hydrology and Meterology, Kathmandu, Nepal.

DNPWC, 2010. Annual Report. DNPWC. Nepal.

Duckworth, J.W., Kumar, N.S., Islam, A. Md., Baral, H. S & Timmins, R.J. 2008. Axis axis. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 16 July 2013.

Ellerman, J. and Morrison- Scott, T. 1966. Checklist of Palaeartic and Indian Mammals Second Edition., Aldex, Oxfored. pp 86.

Elliiott, J. M. 1971. Some methods for the statistical analysis of benthic Invertebrates.F. B – A Sci- Pub. No. 25.

Ganguly, K., Quasin, S., Roy, A. K.,Mahato, R. and De, J. K. 2011. Activity schedule, herd dynamic and management of Spotted Deer (*Axis axis* Erexleben 1977*)*. A case study in Zoological Garden, Alipore, Kalkata, Indian Forestor **137**(4): 439-446.

Gautam, D. N. 2013. Assessment of Wild Ungulates in Karnali flood plain of Bardiya National Park, Nepal. International Journal of Conservation Science **4**(1): 87-94.

Grzimek, B. 1972. Grzimek Animal Life Encyclopedia. Van Nostrand Reinhold Company, Newyork. **13**: 167-168.

Grizmik, B. 1976. Grzimek Animal Life Encyclopedia. Van Nostrand Reinhold Compani, Newyork. **13**.

Jathanna, D., Karanatha, K. V. and Johnsingh, A. J. T. 2003. Estimation of large Herbivore density in the Tropical forest of Southern India using distance sampling. Journal of Zoology **261**(3): 285-290.

Jnawali, S. R., Baral, H. M., Lee, S., Acharya, K. P., Upadhyay, G. P., Pandey, M., Shrestha, R., Joshi, D., Lamichhane, B. R., Griffiths, J., Khatiwada, A. P., Subedi, N. and Amone, R. (Compiler) 2011. The status of Nepal's Mammals: The National Redlist series published by Department of National Park and Wildlife Reserve, Nepal. pp: 36-37.

Johnsingh, A. J. T. 1983. Large Mammalian prey-predators in Bandipur. Journal of Bombay Natural History Society. **80**(1): 1-57.

Johnsingh, A. J. T. and Sankar, K. 1991. Food plant of Chital, Sambar and Cattle on Mundanthurai Plateau, Tamil Nadu, Southern India. Mammalia **55**(1): 55-65.

Kushwah, H., Rao, R. J. and Phurailatpam, B. 2012. Geospatial modeling of habitat suitability of Wild species of Kuno Wildlife Sanctuary. Journal of Environmental Science, Toxicology and Food Technology **1**(14): 12-19.

Majupuria. T. C. and Majupuria, R. K. 2006. Wildlife and Protected area of Nepal. Published by S. Devi, Saharanpur, India. pp -150.

Mishra, H. R. 1982. The Ecological and Behaviour of Chital (*Axis axis)* in the RCNP, Nepal. Ph. D. Thesis. Univ- Edinburg.

Mitra, T. R. 1990. Ecology of Wild and captive Chital (Axis axis Erxleben) In: Majupuria, T.C. (ed): Wildlife health of India, Tecpress Service Bankok, Thailand.

Moe, S. R. and Wegge, P. 1994. Spacing behavior and habitat use of Axis Deer (Axis axis) in Low Land Nepal. Canadian Journal of Zoology **72**(10): 1735-1744.

Naess, K. M. and Andersen, H.J. 1993. Assessing census Technique for Wild Ungulates in RBNP, Nepal. M. Sc Thesis. Agricultural University of Norway.

Nichols, L. 1960. Ecology of Axis deer. Job completion report, September 1, 1957 to September 1, 1960. Mimeographed manuscripts from the Division of Fish and Games of Hawaii.

Noor, A., Habib, B. and Kumar, S. 2013. Habitat selection and niche segregation between Chital and Nilgai in Keoladeo National Park, India. European Journal of Zoological Research **2**(2): 1-9.

Parajuli, D. P. 2007. Population status, distribution and general behavior of Spotted Deer (*Axis axis* Erxleben 1777) in Bardiya National park Bardiya Nepal. M. Sc Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Pokhrel, S. 2005. Distribution and abundance of Wild Ungulates in Royal Suklaphanta Wildlife Reserve, Nepal. M.Sc. Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Poudel, B. 2007. An assessment of crop depredation due to Wild animals in this adjoining VDCs of Shivapuri National Park at Kathmandu, Nepal. M. Sc Thesis. Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

Prater, S. H. 1993. The book of Indian animals, Bombay Natural History Society. Bombay. Oxford university press.

Quenouille, M. H. 1956. Notes on Bias in Estimation. Biometrika **43**(3-4): 353-360

Raman, T. R. S. 1998. Antler cycle and breeding season of Chital (*Axis axis* Erxleben*)* in Southern India. Journal of Bombay Natural History Society **95**(3): 377-391.

Raman, T. R. S., Menon, R. K. G, and Sukumar, R. 1996. Ecology and management of Chital and Blackbuck in Guindy National Park, Madras. Journal of Natural History Society **93**: 178-192.

Ramesh, T., Sankar, K., Qureshai, Q. and Kalle, R. 2011. Group size, sex and age composition of Chital (*Axis axis)* and Sambar (*Rusa unicolor)* in Deciduous forest of Western Ghats, India. Mammalian Biology **84**(7): 404-414.

Ranjitsinh, M.K. 1991. Deer Antelope and Bovines In: Iserial, S. and Toby, S. Indian wildlife Apa publication (HK). LTD. pp 93- 94.

Sapkota, J. 1999. Study of status, habitat utilization, and management of Chital (*Axis axis*) in Parsa Wildlife Reserve Nepal. M. Sc Thesis. Central Department of Zoology, TU.

Schaller, G. B. 1967. The Deer and Tiger. A study of Wildlife in India. Natraj Publisher Dehradun. pp 37-92.

Schaller, G. B. 1998. The Deer and Tiger. A study of Wildlife in India. Natraj Publisher Dehradun. pp 37-92.

Schaller, G. B. and Spillet, J. 1966. The status of big game species in the Keoladeo Ghana Sanctuary, Rajasthan. Wildlife Preservation Society **8**(2): 12-16.

Shaha, R. and Richard, M. M. 2001. Wildlife in Nepal. Nirala Publication, New Delhi. pp 76-77.

Sharatchandra, H. C. and Gadgil, M. 1975. A year of Bandipur. A Journal of Natural History Society **7**(3): 623-647.

Sharma, U. R. 1997. A study of Park People interaction in RCNP. Report submitted to World Wildlife Fund, USA.

Shrestha, T. K. 2003. Wildlife of Nepal. Published by Mrs. Bimala Shrestha. Kathmandu, Nepal. pp 223-226.

Silva, M. D. and Silva, P. K. 2001. Group composition, sex ratio and seasonality of Spottted Deer (*Axis axis)* in the Yala Protected Area Complex, Srilanka. Journal of South Asian Natural History **5**(2): 135-141.

Spillet, J. J., Cohen, J. E. and De, R. C. 1967. The large mammal of Keoladeo Ghana Sanctuary, Rajasthan. Journal of Bombay Natural History Society **63**(3): 602-607.

Srinivasulu, C. 2001. Chital (*Axis axis* Erxleben 1777), Herd composition and sex ratio on the Nallamala Hills of Eastern Ghats, Andhra Pradesh, India. Zoo's Print Journal **16**(12): 655-658.

Tamang, K. M., Troth, R. G. and Sunquist, M. E. 1967. Smithsonian Tiger Ecology Project, Report No. 11: 1-15.

Verma, S. and Asokan, S. 2001. A study on census of large herbivore Mammal during dry season in Mudumalai Wildlife Sanctuary, Southern India. Indian Institute of Science **16**(6): 516-520.

Waring, G. H. 1996. Preliminary study of the Behaviour and Ecology of *Axis* Deer on Maui, Hawaii. Department of Zoology, Southern Illinois University, Carbondale, U.S.A. Online version presentedby the Hawaii Ecosystem at Risk (HEAR) project.

Wegge, P. 1976. National Park and Wildlife conservation Nepal. Terai Shikar Reserves: Survey and Management proposals. FAO/NEP/72/002, Field document No. 4: 78pp.

Zobel, D. B., Jha, P. K., Behan, M. J. and Yadav. U. K. R. 1987. A practical manual for Ecology.Ratna Book Distrobutors, Bagbajaar, Kathmandu, Nepal.

8. APPENDICES

Appendix I. Meteorological Data of Chitwan, 2001 to 2010 AD

Table 8: Monthly Average Maximum Temperature (°C) and Average Minimum Temperature (°C) of Chitwan District (2001-2010).

Month	Temp	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Average
Jan	Max	24.5	22.8	DNA	22.6	22.8	DNA	21.4	22.0	24.5	21.0	181.6	22.7
	Min	7.5	8.8	DNA	9.7	5.5	DNA	7.8	9.0	10.5	9.5	68.3	8.5
Feb	Max	26.3	26.5	DNA	26.3	25	DNA	23.9	25.2	29.6	25.8	208.6	26.07
	Min	10.9	12.2	DNA	11.2	6.7	DNA	12.2	9.2	11.9	11.0	85.3	10.6
Mar	Max	32.4	31.5	DNA	33.7	31.5	DNA	29.7	31.9	32.8	32.8	256.3	32.03
	Min	14.4	16.3	DNA	14.2	12.1	DNA	14.7	15.9	15.5	17.9	121.0	15.12
April	Max	35.6	34.1	35.3	34.0	33.4	DNA	34.9	36.3	37.5	37.6	318.7	35.41
	Min	20.0	21.1	22.0	14.2	15.4	DNA	21.3	19.7	21.7	22.2	177.6	19.7
May	Max	33.8	33.6	35.8	37.1	35.5	DNA	35.8	35.5	35.5	35.8	318.4	35.3
	Min	23.0	23.3	22.2	17.7	19.4	DNA	23.6	23.0	22.5	23.5	198.2	22.02
June	Max	33.8	34.8	33.8	34.4	38.1	35.0	34.2	34.1	36.1	35.8	350.1	35.01
	Min	24.8	24.8	24.3	17.0	20.9	18.0	24.7	25.0	25.0	4.6	209.1	20.9
July	Max	34.4	33.2	33.6	35.0	36.6	34.1	31.7	34.1	34.0	33.5	340.2	34.02
	Min	25.5	25.4	25.2	18.0	20.1	20.4	25.0	25.5	25.9	25.5	236.5	23.65
Aug	Max	34.0	33.5	34.1	35.6	36.9	33.8	33.4	33.8	33.0	32.7	340.8	34.08
	Min	25.1	25.2	25.3	19.2	19.7	19.0	24.8	25.3	25.2	24.2	233	23.3
Sept	Max	33.1	33.2	33.1	34.4	35.6	32.7	31.9	34.1	34.3	32.7	335.1	33.51
	Min	24	23.7	24.3	18.2	18.5	17.3	23.5	24.2	24.6	24.2	222.5	22.25
Oct	Max	32.4	32.0	32.3	32.2	31.4	31.6	31.0	32.8	31.7	31.5	318.9	31.89
	Min	21.4	19.9	20.7	16.1	14.4	14.5	21.4	200	20.5	20.8	189.7	18.97
Nov	Max	28.1	28.7	28.2	29.0	27.9	29.3	28.3	29.1	27.5	28.1	284.2	28.42
	Min	15.4	14.7	15.0	9.2	9.1	10.9	15.6	14.7	14.6	16.5	135.7	13.57
Dec	Max	22.9	24.1	25.4	25.9	DNA	DNA	23.2	25.3	DNA	24.3	171.1	24.44
	Min	9.7	10.8	11.2	7.1	DNA	DNA	9.8	12.3	DNA	9.2	70.1	10.01

Source: Department of Hydrology and Meteorology, Nepal Government.

Table 9: Average monthly Humidity % at 8:45 and 17:45 (2001- 2010)

Month	Humidity	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	8:45	97.2	100.0	DNA	98.9	97.7	DNA	93.9	94.8	97.1	95.9
	17:45	77.7	96.4	DNA	69.3	87.4	DNA	89.9	88.4	74.2	73.4
Feb	8:45	99.8	98.8	DNA	97.8	97.7	DNA	92.5	89.0	88.1	88.2
	17:45	95.7	86.9	DNA	74.5	88.8	DNA	87.2	64.4	51.0	55.8
Mar	8:45	100	99.8	DNA	96.0	97.9	DNA	87.2	71.6	63.0	70.4
	17:45	97.3	77.6	DNA	70.0	93.9	DNA	59.7	61.1	35.4	42.9
Apr	8:45	100	87.4	90.6	94.3	91.5	DNA	73.4	65.2	53.5	59.2
	17:45	97.8	67.9	69.5	74.7	87.6	DNA	63.3	68.0	34.8	42.5
May	8:45	100	81.0	85.8	95.1	93.0	DNA	77.8	70.2	70.4	72.5
	17:45	92.9	62.9	64.4	92.4	81.7	DNA	73.0	66.6	57.0	57.3
Jun	8:45	100	87.4	90.9	97.8	88.3	95.8	83.4	82.5	76.2	73.9
	17:45	97.8	78.8	77.3	84.7	80.3	97.4	75.9	81.1	63.9	66.8
Jul	8:45	99.7	95.6	93.1	97.1	89.2	96.3	89.6	86.9	86.8	87.1
	17:45	95.7	86.3	82.8	90.0	83.1	95.2	89.4	90.8	80.1	78.2
Aug	8:45	100	92.3	93.9	95.5	89.0	96.4	90.4	87.7	85.1	90.2
	17:45	98.2	89.2	86.4	93.9	84.2	95.1	87.9	90.7	82.2	81.3
Sep	8:45	100	91.5	95.6	91.3	89.6	94.1	90.8	84.9	84.6	90.2
	17:45	87.2	87.1	83.3	82.6	82.2	91.9	85.1	85.7	71.5	80.9
Oct	8:45	100	92.8	96.7	88.0	93.7	95.6	88.4	81.9	85.3	84.5
	17:45	80.1	81.1	90.6	80.2	88.1	96.2	83.6	86.2	75.9	72.2
Nov	8:45	100	97.6	96.0	96.4	97.7	96.8	86.3	86.7	90.5	92.1
	17:45	91.9	80.1	90.6	90.5	94.2	95.1	84.7	81.2	73.4	71.6
Dec	8:45	99.9	98.6	99.4	94.3	DNA	DNA	93.3	95.8	DNA	92.5
	17:45	97.7	80.4	75.5	79.0	DNA	DNA	90.8	86.2	DNA	67.9

Table 10: Monthly Rainfall (MM) in Chitwan district (2001-2010).

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2001	DNA	6.8	0.0	113.3	283.4	380.9	DN	DNA	293.7	DNA	23	0.0
2002	0.0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
2003	0.0	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA	DNA
2004	58.8	DNA	9	184.4	145.8	603.7	336.3	293.4	443.9	92.9	9.1	DNA
2005	41.7	6.0	24.1	24	218.9	215.6	479	532.2	115.5	192.7	0	DNA
2006	DNA	DNA	DNA	DNA	DNA	DNA	436.5	429.0	643.7	DNA	5.5	19
2007	0	141.5	27.5	155.5	228.4	408.4	635	576.4	1002.3	60.4	0.0	0.0
2008	4.6	2.8	43.6	23.3	122.9	267.4	422.9	374.2	179.0	44.5	0.0	0.0
2009	0.0	0.0	0.0	0	172.7	144.1	454.5	736.6	107.0	0.0	0.0	DNA
2010	5	18	0.0	55.9	254.7	282.6	704.3	484	342.5	63.1	0.0	0.0
Total	110.1	175.1	104.2	556.4	1426.8	2302.7	3468.5	3425.8	3127.6	453.6	37.6	19.0
Avg	13.76	29.18	14.88	79.48	203.82	328.95	495.5	489.4	390.95	75.60	4.70	3.80

DNA= Data not available

Source: Department of Hydrology and Meteorology, Nepal Government.

Appendix II. GPS points of field.

Table 11: GPS point of Starting and Ending Point of line transect in UTM system in GBZCF

Transect	Habitat	Starting point of transect(UTM)		Ending point of transect(UTM)	
		Easting	Northing	Easting	Northing
1	Bhellar-Sisoo mixed forest	0236534	3050403	0236600	3050241
2	Bhellar-Sisoo mixed forest	0236385	3050346	0236471	3050146
3	Bhellar-Sisoo mixed forest	0236269	3050299	0236386	3050079
4	Bhellar-Sisoo mixed forest	0236166	3050238	0236257	3049992
5	Bhellar-Sisoo mixed forest	0236098	3050255	0236046	3049996
6	Bhellar-Sisoo mixed forest	0235956	3049970	0236019	3049830
7	Bhellar-Sisoo mixed forest	0235841	3049875	0235925	3049735
8	Grassland	0235407	3050548	0235488	3050399
9	Grassland	0235466	3050645	0235599	3050373
10	Grassland	0235576	3050685	0235675	3050380
11	Grassland	0235677	3050733	0235762	3050335
12	Grassland	0235761	3050403	0235711	3050219
13	Grassland	0235423	3050410	0235341	3050208
14	Grassland	0235621	3050333	0235592	3050201
15	Grassland	0235480	3050171	0235566	3049699
16	Bhellar-Sisoo mixed forest	0235860	3050398	0235733	3050203
17	Bhellar-Sisoo mixed forest	0235944	3050407	0235992	3050185
18	Bhellar-Sisoo mixed forest	0235320	3050557	0235282	3050262
19	Bhellar-Sisoo mixed forest	0235734	3050210	0235712	3049813
20	Bhellar-Sisoo mixed forest	0235815	3050157	0235847	3049881
21	Bhellar-Sisoo mixed forest	0234996	3050598	0235065	3050139
22	Bhellar-Sisoo mixed forest	0235088	3050539	0235123	3050111
23	Bhellar-Sisoo mixed forest	0235179	3050467	0235200	3050099
24	Bhellar-Sisoo mixed forest	0235065	3050139	0234973	3049921

25	Bhellar-Sisoo mixed forest	0235123	3050097	0235033	3049864
26	Bhellar-Sisoo mixed forest	0235212	3050078	0235106	3049810
27	Simal dominated forest	0234368	3050748	0234449	3050131
28	Simal dominated forest	0234523	3050560	0234640	3050004
29	Simal dominated forest	0234524	3050559	0234684	3050186
30	Simal dominated forest	0234653	3050480	0234775	3050199
31	Simal dominated forest	0234764	3050511	0234804	3050343
32	Simal dominated forest	0234736	3049946	0234684	3050186
33	Simal dominated forest	0234755	3050199	0234835	3049877
34	Simal dominated forest	0234822	3050327	0234894	3049944

Bhellar: - *Trewia nudiflora*

Sisoo: - *Dalbergia Sisoo*

Simal: - *Bombax ceiba*

Appendix III. Questionnaire for Household Survey

Form no:- Date:-

District …….Vdc…….Village …… Ward no……..

1. Name of respondent……

   Age …… Sex……. Education……..

2. How many members do you have in your family?

   Male…….. Female…….. Total…….

3. How much land do you have?

   Bigha …… Kattha ……. Dhur……..

4. For how many years have you been living in this area? .....

5. What are the summer crops that you grow in your field?

   a)…… b)…… c)……..

   d)…… e)…… f)……

6. What are the winter crops that you grow in your field?

   a) …….. b)……. c)…….

   d)……. e)……. f)……

7. Does Chital damage your crop?

   a)Yes b) No

8. At what time they visited your crop field?

   a) Morning b) Afternoon c) Evening d) Night

9. Which season mostly? .....

10. Which crop do you grow in your field? How much did you harvest and lost last year?

Name of crop	Total expected yield in Quintal or Kg	Total observed yield in Quintal or Kg	Loss due to Chital in Quintal or Kg
Maize			
Paddy			
Wheat			
Millet			
Mustard			

Potato			
Vegetables			
Fruit			
Other			

11. Do you think that the rate of damage?

a) Increasing a) Decreasing

If increase what is the cause…….

If decrease what is the cause ……

12. What method do you adopt to prevent the crop damage by chital?

a) Chasing b) Shouting c) Guarding field at night d) Fencing

e) Making scarecrow in the field f) beating Drum g) other

13. What is your attitude toward Chital?

a) Positive b) Negative c) Neutral

14. In your opinion what is the general herd size?

a) 1-5 b)5-10 c)10-15 d)15- 20 e) > 20

15. What kind of habitat do they prefer?

a) Open grassland b) Grassland with adjoining forest c) Forest

d) River bed forest with flowing water e) River bed forest without water

16. What is your opinion about number of chital?

a) Number increase b) Number decrease c) Not quite known

17. Are Chital chased or killed by people?

a) Yes b) No c) Don't know

18. What are the major threats of Chital?

……

……

……

19. What are your views about Chital conservation?

a) Should be protected b) Should not be protected

20. What are the problem in the conservation of Chital ?

……

……

21. What are the measures to solve the conservation problem? Any recommendation.....

.....

22. Does this forest hold enough area preferred by Chital?

a) Yes b) No

If no ,why…….

23. What do you use to cook food?

a) Fire wood b) Fuel wood c) Bio gas d) Gas/ Stove e) Other

24. Do you have any livestock?

Name	Number
Cow/bull	
Buffalo	
Goat	
Sheep	
Other	

25. Why should you conserve the forest?

……

……

…….

26. Is there any benefit from the Buffer zone area?

a) Yes b) No

If yes what are they?

a)……..

b)……..

c)……..

d)…….

28. What are the common invasive species in this forest?

a)…….. b)…… c)…….. d)…….

29. Do you think that the invasive species degrading the habitat of Chital?

a) Yes b) No c) Don't know

30. What can be done to minimize the growth of such species?

a)……. b)……. c)…….. d)……..

Thank you on behalf of my supervisor and myself for your co- operation!

Appendix IV. Floristic composition of GBZCF

Table 12: Relative Density and Relative Frequency of herbs in GBZCF

S.N	Scientific Name	Local Name	Frquency	R.F	Density	R.D
1	*Ageratum houstonianum*	Nilo gandhe	28.93082	8.084359	132.0755	4.996431
2	*Alternanthera paronychioides*	Bhiringi jhar	1.257862	0.351494	3.144654	0.118963
3	*Alternanthera sessilis*		0.628931	0.175747	1.257862	0.047585
4	*Amaranthera spinosus*	Kande lunde	2.515723	0.702988	7.54717	0.28551
5	*Athyrium sp*		3.773585	1.054482	8.805031	0.333095
6	*Bidens polisa*	Kalo kuro	1.257862	0.351494	5.031447	0.19034
7	*Boehmeria rotundifolia*		4.402516	1.230228	19.49686	0.737568
8	*Bothriospermum tenellum*		0.628931	0.175747	0.628931	0.023793
9	*Chamaesyce hitra*		5.660377	1.581722	14.46541	0.547228
10	*Chrysopogon zizanioides*		2.515723	0.702988	50.31447	1.903402
11	*Colocasia antiquorum*	Karkalo	0.628931	0.175747	0.628931	0.023793
12	*Commelina benghalensis*	Bankane	5.660377	1.581722	15.09434	0.571021
13	*Conyza japonica*	Salaha jhar	0.628931	0.175747	1.886792	0.071378
14	*Curcuma aromatic*	Ban haledo	0.628931	0.175747	3.144654	0.118963
15	*Cynodon doctylon*	Dubo	22.64151	6.326889	193.0818	7.304306
16	*Cyperus rotundus*	Mothe	19.49686	5.448155	134.5912	5.091601
17	*Digitaria ciliaris*	Chitre banso	2.515723	0.702988	4.402516	0.166548
18	*Digitaria sanguinalis*	Banso	7.54717	2.108963	30.81761	1.165834
19	*Dioscorea bulbifera*	Bantarul	5.031447	1.405975	10.06289	0.38068
20	*Diplocyclos palmatum*	Sava	1.886792	0.527241	5.031447	0.19034
21	*Drymaria diandra*	Janai Laharo	1.886792	0.527241	11.32075	0.428266
22	*Dryopteris cochleata*	Neuro	7.54717	2.108963	18.86792	0.713776
23	*Equisetum arvanse*	Ankhle	2.515723	0.702988	4.402516	0.166548
24	*Euphorbia hirta*	Dudhe Jhar	5.660377	1.581722	14.46541	0.547228
25	*Fimbristylis dichotoma*	Pani Mothe	0.628931	0.175747	1.257862	0.047585
26	*Flemingia chappar*	Bhatmas Jhar	0.628931	0.175747	3.144654	0.118963

27	*Gonostegia pentandra*	Chiple jhar	10.06289	2.811951	25.15723	0.951701
28	*Hemarthria compressa*	Ghode Dubo	18.23899	5.096661	119.4969	4.520581
29	*Hydrocotyle sibthorpioides*	Gholtapre	1.886792	0.527241	6.289308	0.237925
30	*Imperata cylindrical*	Siru	33.33333	9.314587	894.3396	33.83298
31	*Justica sp*	Bisaune jhar	0.628931	0.175747	13.20755	0.499643
32	*Lablab purpureus*		1.257862	0.351494	5.031447	0.19034
33	*Lantana camera*	Vanpanda kanda	1.257862	0.351494	2.515723	0.09517
34	*Martynia annua*	Gridhamkki	1.257862	0.351494	2.515723	0.09517
35	*Mazus pumilus*	malati jhar	0.628931	0.175747	1.257862	0.047585
36	*Medicago denticulate*	Chari amilo	2.515723	0.702988	6.918239	0.261718
37	*Microstegium nudum*		0.628931	0.175747	1.886792	0.071378
38	*Mikania micrantha*	Lahare banmara	47.16981	13.18102	267.9245	10.13562
39	*Mimosa pudica*	Lajawati	0.628931	0.175747	3.144654	0.118963
40	*Oplismenus composites*		1.886792	0.527241	13.20755	0.499643
41	*Oxalis corniculata*	Chari amilo	8.805031	2.460457	35.84906	1.356174
42	*Panicum antidotale*		4.402516	1.230228	10.69182	0.404473
43	*Passiflora foetida*		1.886792	0.527241	6.289308	0.237925
44	*Phaseolus mungo*	Ban marsang	3.144654	0.878735	6.918239	0.261718
45	*Piper longum*	Pipla	13.20755	3.690685	50.9434	1.927195
46	*Plectranthus mollis*		2.515723	0.702988	8.805031	0.333095
47	*Polygonum plebeium*	Sukul jhar	1.886792	0.527241	6.918239	0.261718
48	*Pteris Sp*		8.176101	2.28471	29.55975	1.118249
49	*Saccharum spontaneum*	Kash	22.01258	6.151142	238.3648	9.017369
50	*Strobilanthes sp*	Kibbu	2.515723	0.702988	25.15723	0.951701
51	*Taraxacum sp*	Tuki Ful	1.257862	0.351494	6.289308	0.237925
52	*Thelypteris auriculata*	Bishkoche	3.144654	0.878735	8.176101	0.309303
53	*Thelypteris sp*		20.75472	5.799649	132.0755	4.996431
54	*Urena lobata*	Chyarchyare	5.660377	1.581722	19.49686	0.737568

Table 13: Relative density and Relative frequency of Shrubs in GBZCF

S.N	Scientific Name	Common Name	Density	R.D	Frequency	R.F
1	*Achyranthes aspera*	Dattiun	1.121019	2.400436	8.8050314	3.357314
2	*Artemisia dubia*	Patti	2.496815	5.346426	6.918239	2.63789
3	*Artemisia sp*		0.050955	0.109111	1.2578616	0.479616
4	*Callicarpa macrophylla*	Daichamre	4.917197	10.52919	42.138365	16.06715
5	*Calotropis gigantean*	Aakh	0.407643	0.872886	4.4025157	1.678657
6	*Clerodendrom viscosum*		0.178344	0.381888	4.4025157	1.678657
7	*Colebrookea oppositifolia*	Dhursilo	2.267516	4.855428	39.622642	15.10791
8	*Didymocarpus albicalyx*	Kumkum	0.356688	0.763775	0.6289308	0.239808
9	*Eupatorium capilifolia*		0.050955	0.109111	1.2578616	0.479616
10	*Eupatorium odoratum*	Banmara	5.197452	11.1293	25.157233	9.592326
11	*Hyptis suaveolens*	Jungali silam	0.152866	0.327332	1.8867925	0.719424
12	*Ipomoea carnea*		0.050955	0.109111	0.6289308	0.239808
13	*Marthynia annua*		0.178344	0.381888	4.4025157	1.678657
14	*Phragmites karka*	Narkat	0.305732	0.654664	3.1446541	1.199041
15	*Pogostemon benghalensis*	Rudhilo	6.394904	13.6934	44.025157	16.78657
16	*Ricicus communis*	Areth	0.076433	0.163666	0.6289308	0.239808
17	*Solanum aculeatissimum*		0.356688	0.763775	5.0314465	1.918465
18	*Solanum xanthocarpum*		0.076433	0.163666	0.6289308	0.239808
19	*Thysanolaena maxima*	Amriso	0.127389	0.272777	0.6289308	0.239808
20	*Urtica dioica*	Sisnoo	17.17197	36.77032	42.767296	16.30695
21	*Zizyphus mauritiana*	Bayar	1.375796	2.94599	10.691824	4.076739
22		Barful	0.509554	1.091107	3.7735849	1.438849
23		Bhati	2.878981	6.164757	9.4339623	3.597122

Table 14: IVI of Trees in GBZCF

S.N	Scientific *Name*	Local Name	RD	RF	RBA	IVI
1	*Adina cordifolia*	Karam	0.070671	0.348432	0.068207	0.138878
2	*Alstonia scholaris*	Chhatiwan	0.282685	0.696864	0.160003	0.442689
3	*Aporusa octondra*	Kalikath	0.989399	1.742161	0.171129	1.160528
4	*Bombax ceiba*	Simal	25.22968	18.81534	33.68338	58.91306
5	*Citrus maxima*	Ban bhogate	0.212014	1.045296	0.114643	0.326657
6	*Dalbergia sisoo*	Sisoo	21.34275	26.13241	25.89192	47.23468
7	*Ficus benghalensis*	Bar	0.070671	0.348432	0.014854	0.085525
8	*Ficus religiosa*	Pipal	0.070671	0.348432	0.015715	0.086386
9	*Litsea monopetala*	Kutmero	10.53003	16.37631	5.004038	15.53407
10	*Melia azederach*	Bakaina	0.141343	0.348432	0.115848	0.257191
11	*Trewia nudiflora*	Bhellar	41.06007	33.79792	34.76026	75.82033

Appendix V. Local market price of crops at Jagatpur

Table 15: Local market price of crop at Jagatpur

S.N	Crops	Average Monetary value in NRs per Quintal in local market
1	Rice	2,400
2	Maize	1,900
3	Wheat	2,500
4	Mustard	7,000
5	Pulses	6,500
6	Vegetable	5,000

Appendix VI. Rate of crop loss by Spotted Deer in user committee GBZCF

Table 16: Rate of crop loss by Spotted Deer in user committee GBZCF.

Cultivated crop	Total Land (ha)	Expected Yield (quintal)	Observed Yield (quintal)	Loss (Quintal)	Loss (NRs)	Loss Quintal/ Ha
Maize	28.033	313.65	242.2	71.45	135755	2.54
Paddy	29.631	703.75	646.5	57.25	137400	1.93
Wheat	21.437	123.1	82.35	40.75	101875	1.90
Pulses	23.3852	78.95	54.51	24.44	158860	1.045
Vegetable	11.0262	29.37	20.61	8.76	43800	0.79
Mustard	7.82	36.7	33.5	3.2	22400	0.411
Total ⟶	121.3324	1285.52	1079.67	205.85	6,00,090	8.616

APPENDIX VII. Some Photographs of the Field

Herd of Spotted Deer

Female Spotted Deer

Male Spotted Deer

Questionnaire

Man made waterhole inside the GBZCF.

Flower of *Mikania Micrantha in Study Area*