1. INTRODUCTION

1.1 Background

A population is defined as any group of organisms of the same species occupying a particular space at a particular time (Krebs, 1994) and functioning as a part of a biotic community (Odum and Barret, 2005). The ultimate constituents of the population are individual organisms that can potentially interbreed (Krebs, 1994). The population becomes an important study level when a species is nearing extinction. In order to maintain or re-establish the species; one need to know what space, shelter and food the population requires. To know and understand the interactions of the endangered animals with other species is also important for a successful conservation programme (Fleming, 1973). Animal behaviour is the means of functional importance by which an animal maintains its relation with the environment. To the wildlife biologist, precise knowledge of population composition with regard to age and sex structure and animal behaviour is a basic necessity for intelligent conservation and management (Benton and Werner, 1966).

Conservation, in contrast to the preservation, means the utilization of renewable natural resources in such a way that they are not destroyed but are to be used latter. Wildlife management which is an important branch of conservation is concerned with assuring the maximum possible populations of the game animals consistent with other land uses in the same area and with the number that the given habitat will support. This is attained by manipulating the balance of nature in such a way that the desired game species are favoured (Verma and Agrawal, 1998). The aim of wildlife management can range from conservation of endangered species, through exploitation of a resource species to extermination of pest (Farland, 1981). The basic role of wildlife management is to keep the wild animal population optimal, diversified and harmonized with the environment in order to satisfy the economic, recreational, scientific, educational and social needs of man (Shrestha, 2003). The wildlife manager often has to strike a compromise between many conflicting interests. These may include the future viability of the habitat, the population size of the species within the particular area, the welfare of individual animals, the economic impacts of management practices, the traditional interests of the local human population etc. Research into ethology and ecology can do much to provide this knowledge and to safeguard the interests of animal and plant communities in the world (Farland, 1981).

Within a population, all the individuals capable of reproduction have the opportunity to reproduce with other mature members of the group. Age and sex-wise population composition of an area indicates the viability and the growing trend of the population of that species, which is one of the main indicators of its management. Behaviour includes all those processes by which an animal senses the external world and the internal state of its body and responds accordingly. Behaviour involved in contest competition for limiting resources is important in population regulation. Most of the researches on the role of behaviour in population regulation have focused on self-regulatory mechanisms, in which increase in intraspecific competition produce behavioural or physiological changes. The result of these changes is that population is regulated below the carrying capacity; and over population of the species is avoided. By territorial behaviour or dominance hierarchies, sub-ordinate individuals are less successful in obtaining mates or rearing offspring. Birthrates are lowered due to interference in courtship or copulation or by in-adequate maternal care and agnostic behaviour increase death rates and decrease birth rates in field population (Drickamer and Vessey, 1986). The study of animal behaviour is of great practical importance for the conservation of wild animals in their natural habitats (Manning and Dawkins, 1998).

1.2 Conservation Efforts in Nepal

Nepal, the Himalayan Kingdom is the trans-boundary of different five sub-realms of the Oriental and Palearctic realm. Nepal is endowed with vast array of biological resources, which are now in critical condition due to exploitation and degradation (Shrestha, 2003). Among 181 mammal species recorded from Nepal, three species are extinct and 56 species are considered threatened (Khanal, 2002). The National Park and Wildlife Conservation Act 1973, has listed 26 species of protected mammals, and, Blackbuck is one of them. Blackbuck is considered ‘Vulnerable’ as per IUCN categories, facing a high risk of extinction in the wild in medium term, and CITES has listed this species in Category III (Chapagain and Dhakal, 2005) indicating the need of regulatory measures for preventing or restricting exploitation and seeking co-operation of other parties in the control of trade.

Blackbuck, locally known as Krishnasar / Sasin was once found in large areas of India, Pakistan, Bangladesh and Nepal, is now an endangered species. In Nepal,

Blackbucks are now restricted to Khairapur of Gulariya Municipality of Bardia district of Western Nepal in a small number and is in the verge of extinction. HMGN, in State-Minister level declared 481.97 hectares area of the ward number 1, 5 and 9 of Khairapur VDC and ward number 7 of Gulariya VDC as the Proposed Blackbuck Conservation Area (Pokharel, 2002). Increased human pressure on its natural habitat since the onset of Malaria Eradication Programme with high rate of immigration of people to Terai and isolation of fragmented habitat has lead to decrease Blackbuck population in Nepal (Bhandari, 1994).

1.3 Blackbuck

1.3.1 Evolution and Systematic Position

The artiodactyls appeared in the age of mammals in the Eocene Epoch (57 to 37 millions years ago) as small forest adopted omnivorous. They were barely the size of rabbits and like them apparently depended for survival on hiding plus a swift gateway by hopping rapidly. The artiodactyls flourished during the middle of Tertiary when savannah and steppe replaced much of the earlier forest. The artiodactyls now had access to grasslands which unlike tall forests, could be totally exploited for food. With that arose a multitude of highly gregarious, large bodied runners. Some species become short legged runners and other the long legged runners (Grzimek, 1976).

The bovids are comparatively young group under artiodactyla that first appeared fully developed, in the Miocene epoch, 20 millions years ago. These were characterized by bearing horns, consisting of a simple unbranched core of bone and covered with a heavy sheath. Remains of these were found in Eotragus, Libya and Namibia (Grzimek, 1976). Bovids were believed to be developed in Asia, with Eurassia as the centre of their dispersal (Matthews, 1969). Many primitive genera have been described from the Pliocene beds of the Siwalik Hills in India which were more resembling to those from Africa than they do to Eurassian forms. By the time of Pleistocene epoch most of the bovids had disappeared from Europe due to the increasing cold, which the deer were able to withstand. Africa and Asia were thus became major refuges, particularly the former which had seven times the land area of the Indian sub-continent at the bovids dispersal (Ranjitsinh, 1989).

The word ‘antelope’ was originally used by the Greek Eustathius in the fourth century AD to describe a marvelous animal which lived on the banks of the river Euphrates and which horns got entangled in trees and bushes. When the Blackbuck came to be

described in recent times, the name ‘antelope’ was ascribed to it by the French naturalist Buffon (1764) and some English writers. In common parlance, the word antelope is now used to describe a number of species of the Bovidae family, but the scientific name *Antelope* is restricted only to the Blackbuck (Ranjitsinh, 1989).

Geographical variations and classification of Blackbuck into different forms was first studied by Zukowsky. Ellerman and Morrison – Scott (1951) accept the classification with the substitution of the nomenclature *Antelope cervicapra* in place of *A. hagenbecki*, and the identification of the four forms as sub-species instead of full species (Ranjitsinh, 1989).

1.3.2. Taxonomy

Class: Mammalia

Order: Artiodactyla

Family: Bovidae

Sub-family: Antilopinae

Genus: *Antilope*

Species: *cervicapra*

Blackbuck (*Antilope cervicapra*) is an elegant, gazelle-like animal, regarded as the most handsome member of the ‘Bovidae’ family. It is uniquely indigenous to the South Asian sub-continent where it is the sole representative of the genus “*Antilope*’ and was once the most ubiquitous of the larger wild animals of this region (Majupuria and Majupuria, 2006 and Ranjitsinh, 1989). It belongs to the sub-family ‘Antilopinae’, order ‘Artiodactyla’ which are clover-hoofed mammals or ungulates having two or four weight bearing toes on each foot, hence the name even toed ungulates.

Ellerman and Morrison –Scott (1951) and Corbet and Hill (1977) recognized four sub-species of Blackbuck according to the coat colour, length and shape of the horn. They are:

Antelope cervicapra centralis in Central India

Antelope cervicapra cervicapra in Southern India

Antelope cervicapra rajputane in Rajasthan and Punjab of India and Pakistan

Antelope cervicapra rupicapra in Nepal and Northern India eastward of Uttar Pradesh.

1.3.3 Physical Characteristics

The Blackbucks are the medium sized, slender antelopes. The bucks stand about 29 to 33 inches high at the shoulder and their total length is 49 to 58 inches (Schaller, 1998). Its weight varies between 34 to 45 kilograms while that of the females varies between 31 to 39 kilograms (Ranjitsinh, 1989). The Blackbuck is one of the few antelopes in which the coat colour of the bucks and the does differs strikingly (Schaller, 1998). Females are having light brownish tan on the upper parts of the body, tail, outer flanks of the legs, face and neck with a similar colour, stripe running down the foreleg. The under parts of the body, tail and the remainders of the legs are white, with a similar colour patch around each eye. Males are similar to females in colouration when immature, and assume a darken pelage with black in sharp contrast to the white on the nose and lower muzzle, eyes, chest, bellies and legs. The patch on the nape, between the horns, behind the ears and the upper portion of the neck remains fawnish tan, but in certain elder males, a sprinkling of dark, slate grey hair develops in this area (Ranjitsinh, 1989). Adult bucks undergo a conspicuous change of pelage colour during the molt, they begin to lose their dark colour in January and become quite brown by late March. By early July their neck and shoulder are blackened, and in August they have their full black pelage once more (Schaller, 1998). The long narrow ears are thickly fringed with white hairs on the inside. The tail is relatively short and naked on its ventral surface, when excited the tail is carried curled over the back (Roberts, 1997).

The distinctive feature of the adult male is the straight shallow spiral horns. These horns are non-deciduous that grow from an ossicone on the fore head. The ossicone is formed in the skin of the frontal bone. It is largely hollow inside, designating bovids as hollowed-horn ruminants. The diversity of the horn shape and size is striking (Grzimek, 1976). In the antelopes with spirally twisted horns the right horn has a left handed spiral and vice versa, whether the spiral is an open or a tight one (Matthews, 1969). The horns of the males are marked throughout with prominent rings or ridges which are closer together towards their base. In addition to their annulations the entire horn curves through three or four complete spirals and exceptionally even up to five spirals. An average horn length measured straight is 50 to 61 cm. The record horn from a specimen killed near Delhi measured 71.5 cm in straight line with a spread of 45 cm between the tips (Roberts, 1997). The number of spirals is not always

commensurate with the length of the horn (Matthews, 1969 and Ranjitsinh, 1989). The females are hornless but in exceptional case, Ranjitsinh (1989) recorded two females in Wakaner with respective horn length of approximately 4.5 cm and 6.3 cm. Male Blackbuck have a particularly conspicuous sub-orbital gland. In both sexes there is generally a tuft of longer black hairs on the knee (Roberts, 1997).

1.3.4 Habitat and Food Habit

Blackbucks are primarily grazing animals and avoid forest areas, but will survive in semi-desert regions as long as there is sufficient scattered vegetation (Roberts, 1997) and also in cultivated land (Majupuria and Majupuria, 2006). It is an animal of the open flat to slightly undulating terrain reaching its greatest abundance in areas covered with thorn and dry deciduous forest. It is readily adaptable to the wastelands, marginal agricultural land and cultivated areas. It lives in open plains and avoids hilly and dense forested areas (Walther, 1964). These herbivores prefer open habitats with low growing grasses rather than tall grasses. Seasonally Blackbuck is primarily a grazer when succulent grasses are available during the monsoon and resorts to browse when depletion of grasses forces a greater dependency on leaf litter, flowers and fruits (Berwick, 1976). In areas of severe habitat decline, Blackbuck depends on cereal crops (Walther, 1964). A preference of early successional stages is an important consideration for Blackbuck habitat management (Schaller, 1998).

1.3.5 Social Structure

The social structure of the Blackbuck population changes with the seasons. The social organization in Blackbuck consists of harems, normally with one male and a large number of females and fawns forming herds during breeding seasons and a mixed herd at other times (Shrestha, 1997). Schaller (1998) refer: (1) mixed herds, consisting of a loose aggregation of bucks and does, (2) breeding herds, consisting of a buck and several does confined to territory at the time of rut and (3) buck herds, consisting solely of bucks. The territorial scrape consists of shallow depression dug by the alpha male by means of hooves of forelegs where the animal urinates and defecates with characteristic body posture. Generally fecal pellets spread around the scrape show that scraping act is the indicator of territorial response (Shrestha, 1997).

1.3.6 Reproduction and Life Span

Males engage in rutting throughout the year. Fawns are born throughout the year; however, more fawns were reportedly born in January to April at Khairapur, Bardia (Tamang and Shrestha, 1998). Gestation period of the Blackbuck is six month and litter size is one or two (Ranjitsinh, 1989 and Shrestha, 1997). Schaller (1998) in Kanha National Park, India reported no twins in his study duration nor did Crandall (1964) report any in 97 births at the New York Zoological Garden. Mortality is higher between the ages 7 to 9 years. The maximum age recorded for the male was between 12 and 13 years and for female 16 years. The median age for adult death is 7.92 years (Jhala, 1991).

1.3.7 Defensive Features

Keen eyesight and high speed are the primary defensive characteristics of Blackbuck against predators. When alarmed the herd moves off a quick gallop (Ranjitsinh, 1989). When disturbed Blackbuck usually trot or gallop. This evokes the attention of the members of the group and elicits the spronk response among all members in a single file of galloping movements (Shrestha, 1997). Schaller (1967) gives the probable benefits of the Spronking behaviour as follows; (i) the noise of the thudding hooves may be an auditory signal to others, near by, indicating danger, (ii) High leaps, which are accompanied by white flashes from the abdomen and rump, make the animal visible at great distance may be successful to elicit the visual signal, (iii) Leaps may help the animals keep the source of the disturbance in view and spot a lurking enemy ahead in the grass and (iv) scent may be deposited from the inter-digital scent gland present in all the feet, leaving an olfactory signal for others passing latter. Since the extinction of Cheetah, Blackbucks are the fastest moving of all wildlife of Indian subcontinent (Seshadri, 1969). Ranjitsinh (1989) recorded a speed of over 80 km/hr for a distance of over 1.5 kilometers, almost 90 km/hr over a distance of 600 meters, and a leap over a 4 meter high Cactus fence.

1.4 Distribution and Status of Blackbuck

The Blackbuck is typically Indian in distribution having once occurred from what is now West Pakistan along the foot of the Himalayas from Punjab through Uttar Pradesh and Nepal to West Bengal and East Pakistan, as well as through out drier parts of the peninsular India, but not in Ceylon (Schaller, 1998). Once there were four

millions Blackbuck in India and were hunted by Maharajas with tamed Cheetah (*Acinonyx jubatus venaticus*). Herds of 10,000 or more used to assemble during dry seasons. But once the most abundant antelope (Blackbuck) in India and Pakistan has now become rare and is now more abundant in Texas and Argentina where it was introduced. As early as 1947, the Blackbuck population was estimated approximately as 80,000 but by the end of 1964, only 8,000 remained (Rao and Prasad, 1982). Ranjitsinh (1989) estimated a total of 45, 000 Blackbuck in India corresponding to the rough estimation of Rahmani (1991), which was between 19,000 to 38,000. They are most common in Maharashtra and Rajasthan. The Blackbuck has become extinct in Bangladesh. They became extinct in Pakistan in 1970s but have been reintroduced to Shandra and Kalabagh National Park while re-introduce of 10 animals obtained from Texas; USA was done in Lal Sunahara National Park of Sindh province of Pakistan (Burton, 1987). Blackbucks were introduced in Texas and North America in 1932, where a census in 1974 estimated a population of 7,339 Blackbuck (Ranjitsinh, 1989). Blackbucks were also introduced in Argentina since 1906 and in Australia since 1912. In Argentina they were first released on the Southern Pampas Grasslands, where more than 10,000 herds were counted in 1980s. In Argentina they have assumed pest proportion and have had to be culled by the hundreds. A few survive in New South Wales, Australia where they are farmed for meat.

According to Ranjitsinh (1989) the Blackbucks are surviving in 13 different states of India, the number of the animals recorded is listed below (Table 1).

Table 1. Blackbuck Population of India in Different States

S. N.	**State**	**Population**	**S. N.**	**State**	**Population**
1.	Maharashtra	8,200	8.	Tamilnadu	2,325
2.	Rajasthan	8,178	9.	Uttar Pradesh	1,480
3.	Haryana	4,852	10.	Orissa	1,250
4.	Gujarat	4,300	11.	Andhra Pradesh	11,38
5.	Madhya Pradesh	4.110	12.	Bihar	40
6.	Karnataka	4,000	13.	West Bengal	26
7.	Panjab	3,530		**Total**	**43,429**

The total population of Blackbuck in India may therefore be estimated around 43,500 animals approximately. In 1982 it had estimated the Blackbuck population between 22,500 and 24,500 (Ranjitsinh, 1989). But, Schaller (1998) mentions that, the states of Assam, West Bengal and Kerala contain no Blackbuck.

Within Pakistan territory, there is no evidence that Blackbuck ever extended west of Indus and they were most numerous in the semi-desert tracts on the borders of Rajasthan. The main stronghold of the Blackbuck population within Pakistan territory used to be around Bahawalnagar and Fort Abbas in northern part of Cholistan district. Blackbuck has been reintroduced into many parks of Pakistan from captive herds in Denmark, Texas and Holland (Roberts, 1997).

Figure 1. Present Distribution of Blackbuck in India, Nepal and Pakistan.

Prepared By: Laxman Khanal, TU, 2006.

(With Support of Rahmani, 1989, Roberts, 1997 and Field Visit, 2006.

In western Nepal, Scattered population of Blackbuck occurred in the districts of Kanchanpur, Bardia and Banke as late as 1960s (Tamang and Shrestha, 1998). In 1967-68, two populations were sighted, one in Banke district close to Rapti river and the other in Mainapokhar area, about 15 km east of the present habitat of Blackbuck at Khairapur, Bardia. Dinerstein (1975) and Wegge and Wilson (1976) observed two small separate herds of Blackbuck, one in Bhagawanpur and Jamuni of Banke and the other at Khairapur, Bardia. According to Bouer (1988) population raised to a maximum of 190 individuals and then a decline in population starts as the counts were 162 (Subedi, 1991), and 92 in 1993 (Nepal, 1994). The chaotic fluctuation in the population of the Blackbuck at Khairapur continued, population increased to 102 in 1995 and 111 individuals in 1996 (Tamang and Shrestha, 1998) that again declined to 94 in 1998 (Chand, 1999), 40 in 2000 (Khanal, 2000). The population then started to increase at slow rate and became 53 in 2001 (Khanal, 2002) and 109 in 2005, November (Field visit, 2005).

At present, 133 Blackbucks inhabit the natural habitat at Khairapur, Bardia and about 90 Blackbucks are present in captive (Central Zoo, and Mahendra Park) and semi-captive enclosure (Mrigasthali) of Nepal (Figure, 2).

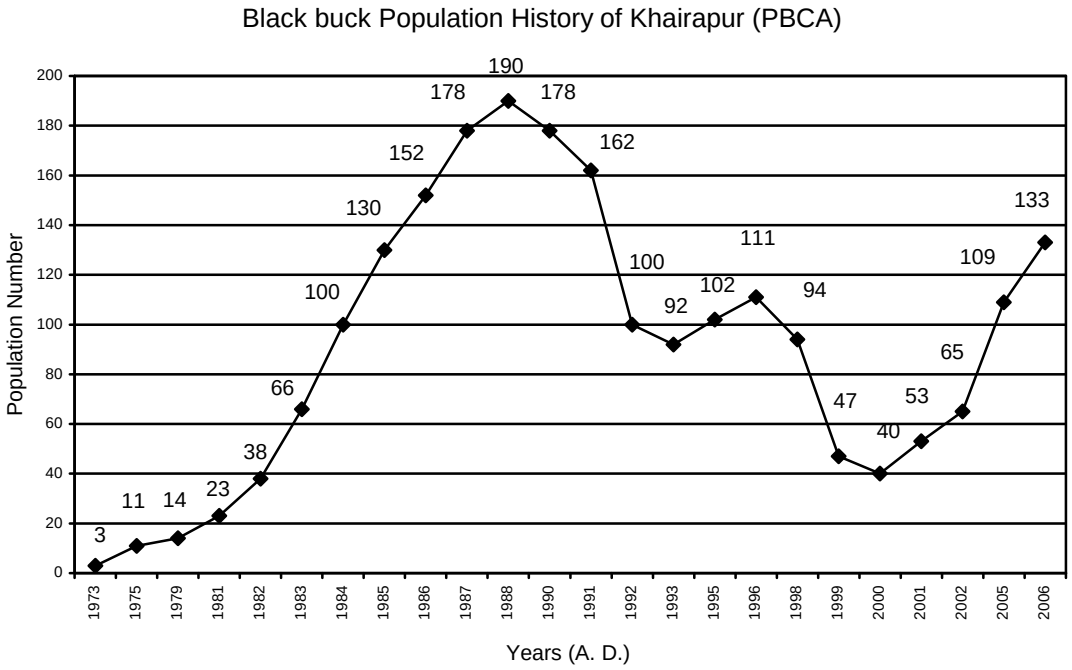


Figure 2. Blackbuck Population History of PBCA (Source: Khanal, 2002 and Field Survey 2005 and 2006).

1.5 Value of Blackbuck

As other wildlife Blackbuck has biological, genetic, ecological and economical importance; beside these the Blackbuck has cultural value in Hinduism and Buddhism. It is the symbol of purity, prosperity and peace and regarded as the chariot of Moon. Manu Maharaja, the religious teacher and law giver of Hindus, also has permitted Brahmans to eat the flesh of this holy animal. Blackbucks were often tamed by Hindu Fakirs in the ancient past (Shrestha, 1997). Its skin is used during the worship and at the time of taking secret thread (Mitzvah / Bratabandha) in Hindu culture. A pair of buck symbolizes Buddha when he turned to the Sarnath, India (Khanal, 2002). Blackbuck in fascinating head-up display has been pictured in Ajanta Cave, India which dates back to the sixteenth century (Shrestha, 1997).

1.6 Rationale of the Study

Present habitat of the Blackbuck is isolated and densely encroached by human (Tamang and Shrestha, 1998, Pradhan, Bhatta and Jnawali, 1999). At present suitable habitat for Blackbuck at Proposed Blackbuck Conservation Area (PBCA) is only 1.77 km^2 which is heavily grazed by livestock and additionally disturbed by human (Field visit, 2006). Floristic composition of the Blackbuck habitat, population dynamics of the Blackbuck and the land use of the area is not documented scientifically. Socio-economic condition of local people and their perception and attitude towards the Blackbuck and proposed Blackbuck Conservation Area is also unknown. The chaotic fluctuation of the population from 3 individuals in 1973 to 190 individuals in 1990 and then to 64 individuals in 2002 is a subject for an ecological study. Behavioural study play very important role for the conservation of any species (Jhala, 1991, Manning and Dawkins, 1998).

Considering limited resources and multiplying needs with growing human population, management based on holistic research approach is essential and appropriate. To conserve the endangered species like Blackbuck, such research identifies the key process for conservation by effective management strategies. Biological data, which includes the current population status and understanding of behaviour, are vital for in-situ conservation of any endangered species. This study extrapolates the population characteristics, daily activity pattern, general behaviour, survival threats and conservation strategies for the endangered species of Blackbuck in Nepal.

1.7 Research Objectives

The main objective of the study was to assess the general behaviour and conservation status of endangered and protected species of Blackbuck (*Antilope cervicapra*) in 'Proposed Blackbuck Conservation Area' at Khairapur, Bardia. The specific objectives of the present research were:

1. To determine the total population, age and sex ratio and to review gross natality and mortality of Blackbuck at Khairapur.
2. To document the general behaviour and diurnal activity pattern of different age group of Blackbuck.
3. To determine the conservation threats of Blackbuck in PBCA, Khairapur.
4. To investigate the conservation practices of Blackbuck in PBCA, Khairapur.

1.8 Limitations

Present research work is meant for Master Level Dissertation and following limitations were felt during the study.

- Duration of the study was only 9 months, so study for all the seasons could not be made.
- Night observation could not be made due to security and technical problems.
- Sophisticated scientific equipments could not be used for the study.
- Budget constraint was the prime limitation for the field research.

2. STUDY AREA

2.1. Location and Topography

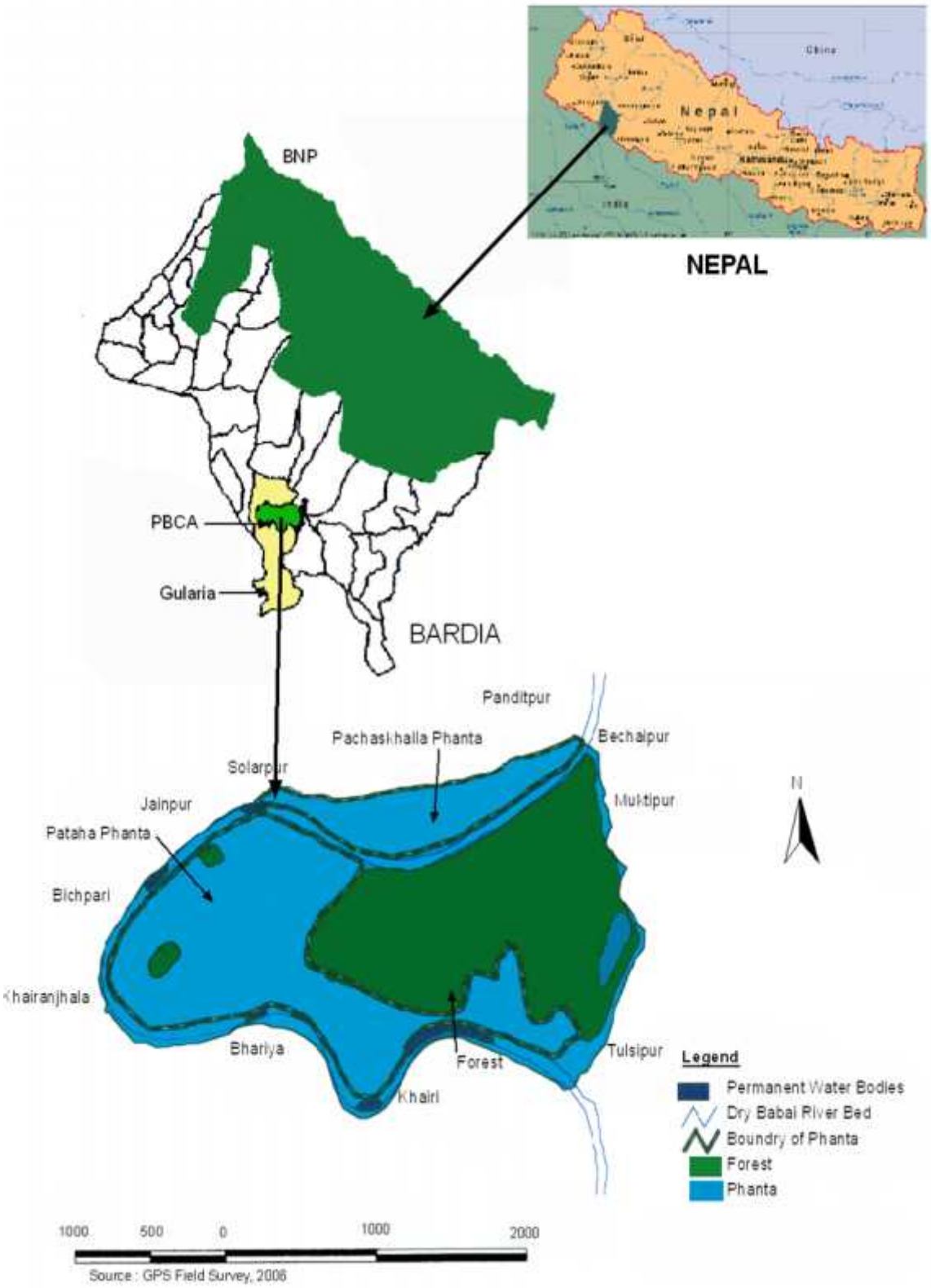
This study was conducted in Bardia district of western lowland Terai of Nepal. The study site was Khairapur and surrounding areas of Gularia Municipality (GM), Ward Number 2, 3, 4 and 5 which is 35 km west of Nepalgunj. Gularia Municipality is situated between 20^0 07' 54" to 28^0 17' 22" N and 81^0 16' 48" to 81^0 22' 54" E with total area of 19.19 square kilometer (GM, 2001).

The core study area at Khairapur is situated 5 kilometers north west of main city Gularia, the head quarter of Bardia district and about 42 kilometer south east from the headquarter Thakurdwara, of Bardia National Park (BNP). The Blackbuck habitat is situated on a left flood plain of old Babai riverbed known as Pataha Phanta. The area constituted mostly marginal agricultural land and grazing land bordered on the west, south and north by agricultural land and on the east by Khair-Simal (*Acacia- Bombax*) and scrub forest. Old Babai riverbed, locally known as 'Sarju Nadi', runs along north, west and south boundary of the study area. The Proposed Blackbuck Conservation Area (PBCA) shares its boundary in north with Panditpur, Solarpur and Jainpur village and in south with Bhariya, Turantpur and Khairi village of the ward number two. Eastern boundary of the PBCA is with Tulsipur and Bechaipur village of ward number 5 and 2 respectively and the western boundary is connected to the Khairanjhala and Chaudharipur village of ward number 2. Topography of the study area is more or less flat land, sloping towards the south with an elevation of average 146m above mean sea level.

2.2. Geology and Soil

The study area falls on the northern extension of the Gangetic plains. It contains the older deposits of Gangetic alluvium consisting of beds of silt, clay, sand, pebbles and gravel. Soils of the flat land are gently sloping and are generally well drained and quite deep. Brown or yellow brown sandy loam predominates in the area and is mostly calcareous and slightly alkaline in nature. It is very dry due to its slight slope with sandy and porous soil (Bolton, 1976). The sandy slopes are heavily leached, whereas the lowland plains are more fertile consisting of finer sand and clay loams (Wegge, 1991). Towards the north lies the Siwalik range, which is of the late tertiary in origin and contains fine grained sand stones with deposits of clay, shale, conglomerate and fresh water limestone (Tamang and Shrestha, 1998).

STUDY AREA



Proposed Blackbuck Conservation Area [PBCA]

Prepared By: Laxman Khanal, TU, Kirtipur

2.3. Hydrology and Drainage

The study area is more or less flat land gently sloping towards the south with the altitudinal variation of 8 to 10 meter only. Stagnant water is available around the year in the old river bed of Babai River (Sarju Nadi) but is dried out in many places during the hot season from March to June (Shrestha, 1997, Tamang and Shrestha, 1998). The present Babai River is about 1.5 km far from the east boundary of the Proposed Blackbuck Conservation Area (PBCA).

2.4 Climate

The study area has tropical monsoon climate. The rain-bearing wind from the Bay of Bengal blows from the east towards west of Nepal during the rainy season (June to September).However western Terai generally receives less rain and tends to have a shorter monsoon. Three distinct seasons were identified in this area as hot season (mid-February to mid-June), monsoon (mid-June to late September) and cool, dry season (early October to mid-February) (Khanal, 2002). Average annual mean rainfall recorded during 1994 to 2004 was 1307.1 mm. Minimum rainfall was recorded in 2004 (830mm) and maximum in 1995 (1659mm) at Rani Jaruwa Nursery, Bardia (Figure: 3).

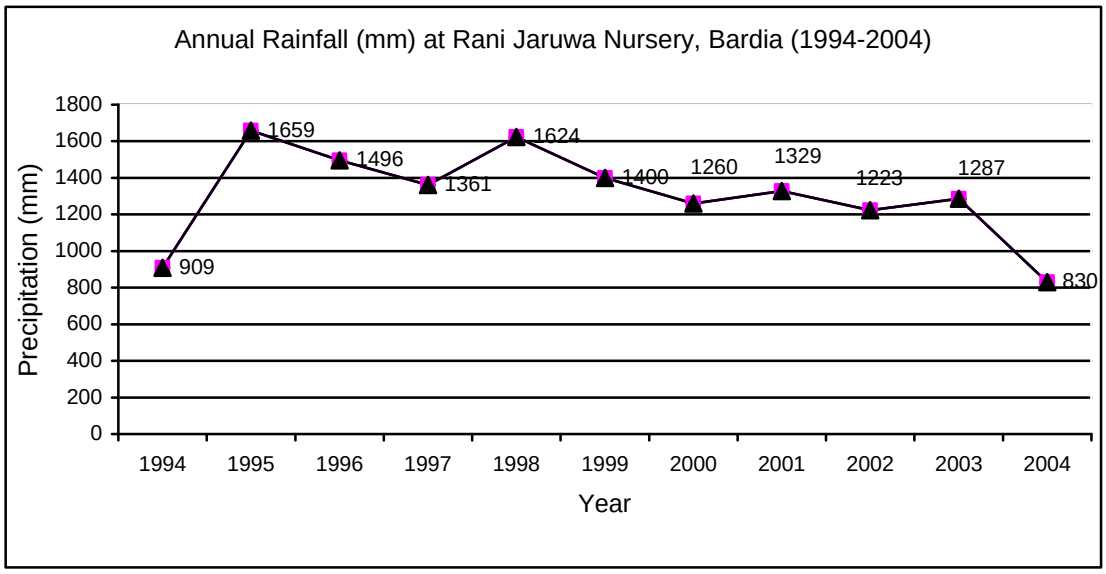


Figure 3. Annual Rainfall at Rani Jaruwa Nursery, Bardia (Source: Department of Hydrology and Meteorology, NG, 2006).

Almost 90% of the rainfall occurs at June to September during the Rainy season of this area. Bardia district, being in western Nepal receives less rainfall than the eastern Terai during the rainy season, the rainfall during which occurs from the monsoon

coming from the Bay of Bengal. The average monthly rainfall as recorded in the Rani Jaruwa Nursery of Bardia District is as follows (Figure 4).

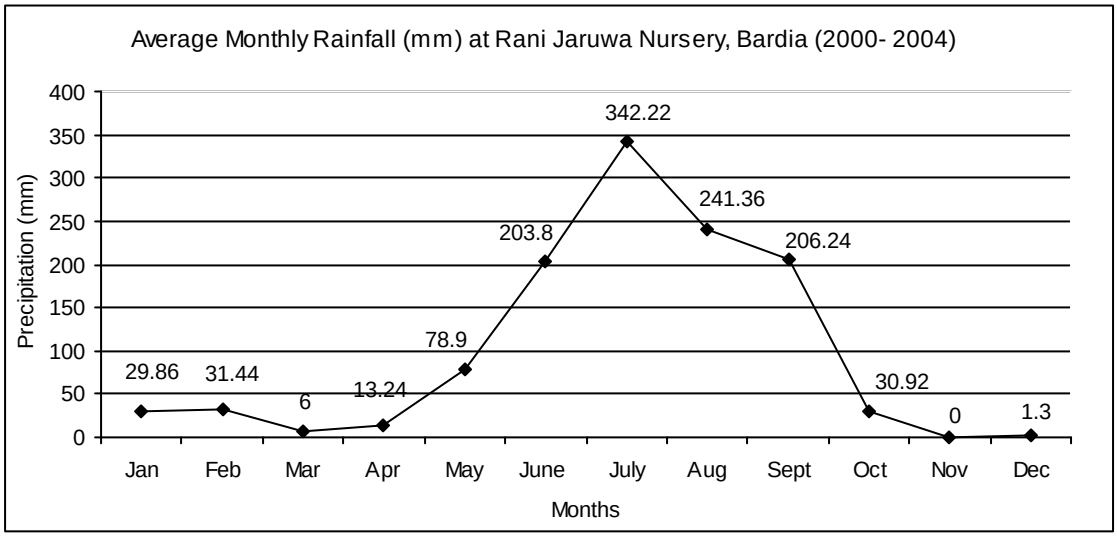


Figure 4. Average Monthly Rainfall at Rani Jaruwa Nursery, Bardia (Source: Department of Hydrology and Meteorology, NG, 2006).

The Maximum and minimum temperature recorded in Gularia Municipality is 42 ^{0}C and 7.7 ^{0}C respectively (GM, 2001). The average annual mean maximum and minimum temperatures recorded at Rani Jaruwa Nursery from 1994 to 2004 were 30.86 ^{0}C and 17.89 ^{0}C respectively (Figure 5).

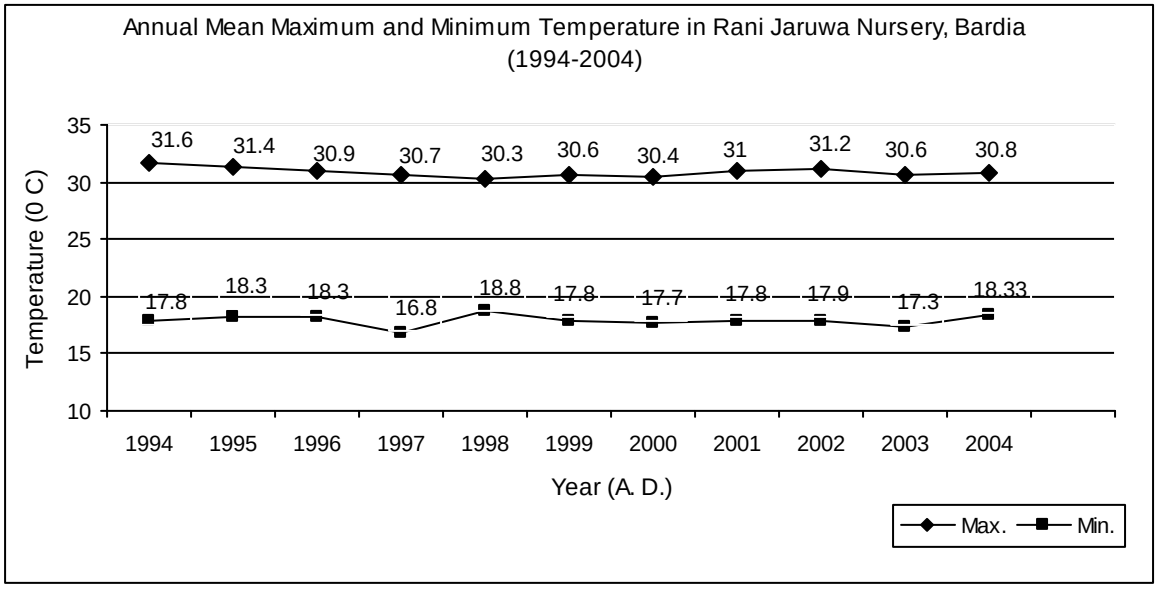


Figure 5. Annual mean Maximum and Minimum Temperature in Rani Jaruwa Nursery 1994-2004 (Source: Department of Hydrology and Meteorology, NG, 2006).

The average maximum temperature of the area is highest in the month of April, May and June while the average minimum temperature of the Rani Jaruwa Nursery recorded is in December, January and February. The average maximum temperature recorded is 36.96 in May (Figure 2.4)

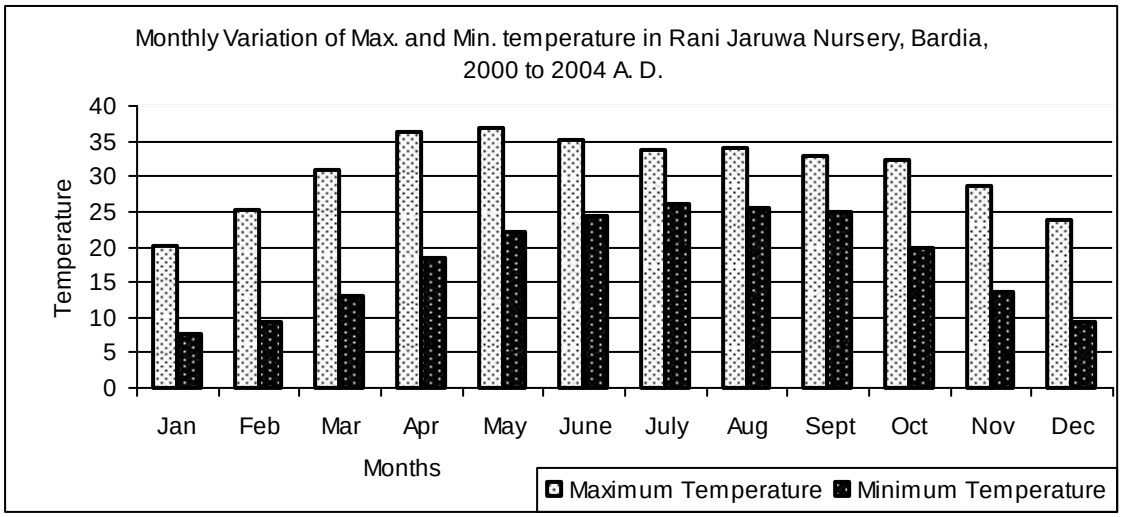


Figure 6. Monthly Variation of Maximum and Minimum Temperature in Rani Jaruwa Nursery, Bardia, 2000 - 2004. (Source: Department of Hydrology and Meteorology, NG, 2006).

The western Terai of Nepal is relatively drier area. The average annual Relative Humidity measured at Rani Jaruwa Nursery (2000-2004) is found lowest (80.79) in 2002 while others are above 83 (Figure 7).

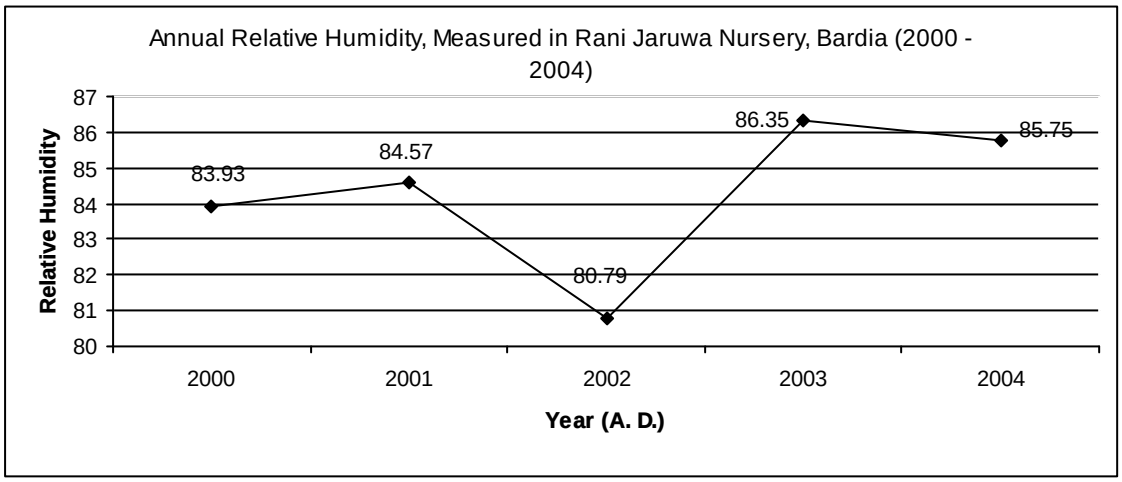


Figure 7. Annual Relative Humidity in Rani Jaruwa Nursery, Bardia (2000 – 2004). (Source: Department of Hydrology and Meteorology, NG, 2006).

2.5 Flora of the Study Area

Most of the part of PBCA land consists of over grazed open wasteland. Degraded patches of Khair-Simal forest consists of scattered Khair (*Acacia catechu*), Sissoo (*Dalbergia sissoo*), Simal (*Bombax malabaricum*), Babool (*Acacia nilotica*) and Karma (*Adina cordifolia*) trees with *Mallotus philippenansis, Bixa orelana, Murraya koenigi, Glycosmis pentaphylla, Zizyphus cylind, Colebrookia oppposititifolia, Clerodendron oppposititifolia, Clerodendron viscoxum, Zizyphus mauritiana, Eupatosium odoratum, Adhatoda vasica, Cassia tora* prevails (Field visit, 2006).

Vegetation of the fallow fields varies with the intensity of the livestock grazing regime, which is determined by the size of area and the nearness of the standing crops that may be damaged by livestock. There are sizable fallow fields which are generally more productive and less heavily grazed than the larger fields and are interspersed in patchwork fashion with standing crops (Shrestha, 1997).The grass species in heavily grazed land of the study area are Dubo grass (*Cynodon dactylon*), Chamcham (*Cassia tora*) and Ganja (*Cannabis sativa*). The graminoids dominating are *Eragrostis coecta, Panicum sp. Paspalum distichum, Eleusine indica, Setaria glauca, Thylactodenia aegyptum, Cyperus rotundus, Crysopogon assiculatus, Saccharum munj, Sporobolus diander, Fimbristylis sp.* (Dinerstein, 1975). Other species prevailing are *Phyllanthus virgatus, Euphorbia hirta, Imperata cylindrica, Cyperous cephalotus, Echinocloa colonum Saccharum spontaneum, Artemisia vulgaris, Oxalis corniculata,* etc.

2.6 Fauna of the Study Area

Major wild fauna besides Blackbuck reported in and around the study area are considered such as: palm squirrel (*Funambulus pennati*), Brown-hare (*Lepus nigricollis*), Common mongoose (*Herpestes edwardsi*), Rodents etc. Visiting animals include Rhesus monkey (*Macaca mullata*), Common langur (*Siemnopithecus entellus*), Indian fox (*Vulps bengalensis*), Spotted deer (*Axis axis*), Jungle cat (*Felis chaus*), stripped Hyena (*Hyaena hyaena*), Wild boar (*Sus scrofa*), Porcupine (*Hystrix indica*), Blue bull (*Boselaphus tragocamelus*), Barking deer (*Muntiacus muntjak*), Jackal (*Canis aureus*), Common leopard (*Panthera pardus*), and sometimes Tiger (*Panthera tigris*), etc.

Some bird species recorded are Common Mynah (*Acridotheres tristis*), Black ibis (*Pseudoidis papillosa*), Cattle egret (*Bubulcus ibis*), Pond heron (*Ardeola grayii*), White necked stork (*Ciconia episcopus*), Little egret (*Egretta garzetta*), Common peafowl (*Pavo cristatus*), House crow (*Corvus splendens*), Jungle crow (*Corvus macrorhynchus*), White wag tail (*Motacilla alba*), House sparrow (*Passer domesticus*), Black drongo (*Dicrurus adsimilis*), Red-vented bulbul (*Pycnonotus cafer*), common Grey Hornbill (*Tokus birostris*), white-breasted kingfisher (*Halcyon smyrnensis*), Blue jay (*Coracias bengalensis*), Bengal green pigeon (*Treron phoenicoptera*), Blue rock pigeon (*Columba livia*), Spotted dove (*Streptopelia chinensis*), Ring dove (*Streptopelia decaocto*) Rose-ringed parakeet (*Psittacula krameri*), Crow-pheasant or Coucal (*Centeropus sinensis*), Indian robbin (*Saxicoloides fulicata*), etc.

2.7. Settlement and Land Use

The core study area is located in ward number - 2 of Gulariya Municipality. Total population of the Gularia Municipality is 46,011 from 7,939 house holds out of which 646 households with a total population of 3,876 reside in ward number -2, in which males were 51.71%. Population above 18 years of age was 51.10% (GM, 2001). Main occupation of the people is agriculture, and few were found employed in government offices and others in private services.

Table 2. Population Compositions, Cast-wise, in Ward No- 2 of Gulariya Municipality.

S. N.	Cast	Population %	S. N.	Cast	Population %
1	Tharu	26.96	13	Loniya	1.47
2	Yadav	9.64	14	Dhobi	1.10
3	Brahmin	9.46	15	Newar	1.05
4	Magar	8.10	16	Teli	0.87
5	Chhetri	7.43	17	Paasi	0.85
6	Muslim	7.01	18	Gaine	0.56
7	Khairaha	6.43	19	Gurung	0.51
8	Kami	6.39	20	Tamang	0.41
9	Godiya	4.51	21	Kalwar	0.25
10	Damai	2.50	22	Sarki	0.23
11	Lodha	2.08	23	Thakuri	0.12
12	Chamar	1.88	24	Das	0.07

(Source: G.M., 2001).

Ethnic community of Gulariya Municipality is diverse, dominated by 19.76% of Tharus, followed by 11.40% of Brahmin, 8.91% of Yadav and 8.64% of Godiya, others occupying the minor percentage. Ethnic composition of Ward No- 2 is diverse (Table 2.1), dominated by Tharu (26.96%), and followed by Yadav 9.64%, Brahmin 9.46%, Magar (8.10%) respectively (Table 2). Majority of peoples, mostly Brahmins, Chhetri and Magar were immigrated from Dang, Jajarkot, Pyuthan, Arghakhanchi, Baglung, Syangja, Parbat and Kaski districts.

A secondary school (Nepal Rashtriya Shamvu Sharan Ma. Vi.) and a primary school is present in Ward Number -2 in which almost 45.75% students are females. Among 6 to 15 year age group, only 26.67% of population was found admitted in the school, of which 45.75 were females (Khanal, 2002).

Most households of Ward No – 2 have tube-wells for water supply, but only few households have toilets. Open space defecation is a common practice, signifying poor sanitary situation. Khairapur Health Post located in Ward Number 3 in Chauraha is the nearest health facility for the people of Ward Number 2 also. One health assistant, two nurses and one health worker are providing health services in the post. Most common health problems of this area are common cold, gastrointestinal diseases, fever, scabies and chest infections as informed by the local health assistant (Khanal, 2002).

Common livestock possessed by the residents of this area include cattle, buffaloes, goats, etc. These livestock share the same pastureland in which remaining population of Blackbuck depends. Land use of Ward Number -2 includes 38.18% of Blackbuck Conservation Area followed by 29.99% agriculture land and 27.62% of the forest (Figure 8).

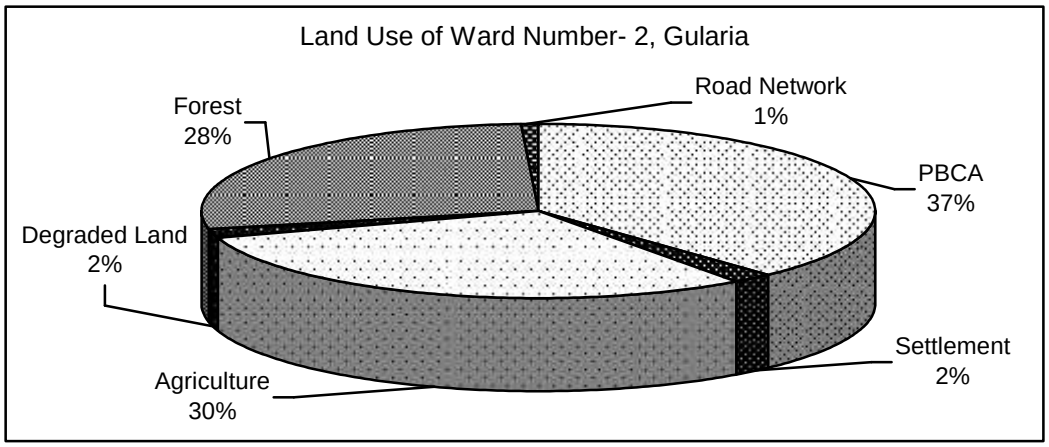


Figure 8. Land Use Pattern of Ward No -2, Gularia Municipality. (Source: GM, 2001)

2.8. Socio-economic Status of Local People

2.8.1 Demography:

Prior to malaria eradication, only a few scattered populations of indigenous Tharu people immune to this disease were living in Terai (Shrestha, 1996). Lehmkul (1979) reported PBCA is bordered with marginal agricultural land and grazing land and scrub jungle on three sides. Agriculture supported by the livestock is the most common way of livelihood in this area. Major crops farmed are wheat (*Triticum aestivum*), Rahar dal (*Lens esculenta*), Mashoor (*Phaseolus mungo*), mustard (*Brassica compestris*), chilly (*Capsicum annum*), peanut (*Arachis hypogea*), cotton (*Gossypium asboluium*), pigeon pea (*Cajanus cajan*) etc (Nepal 1994, Bhandari 1994, Kafle, 1998, Pradhan *et al.* 1999).

A total of 812 people from 132 households are found inside the PBCA residing permanently with the mean household size of 6 and male to female ratio 1: 1.07. All of these residents are the migrants and 39% of them were migrated between 1985 to 1995, 21% between 1965 to 1975, 20% between 1975 to 1985 and remaining 20% between 1995 to 2001 (Khanal, 2002).

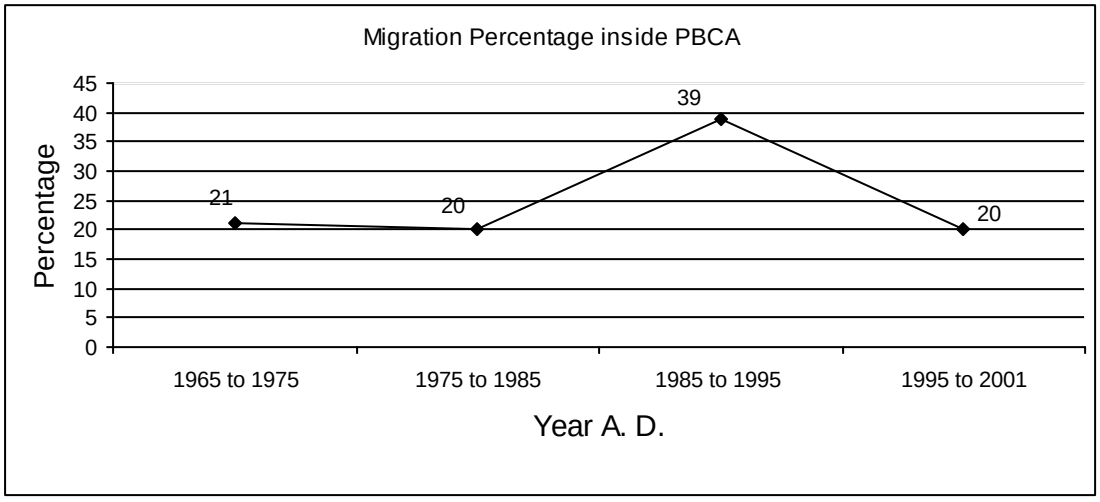


Figure 9. Migration Trend inside PBCA in Percentage (Source: Khanal, 2002).

Recently, more than 90 hectares scrub jungle area of PBCA east ward of the Pataha Phanta has been illegally used up by the landless (Sukumbasi) peoples with the installment of 550 scattered huts residence with agricultural field operation.

2.8.2 Education and Income

The average total literacy is 54.59% (female = 23.41% and male =31.17%). Literacy rate among females is 48.65% and among male is 60.09% (Khanal, 2002). Most of the school admitted students leave the school within primary level, very few persons give continuity to their education up to Matriculation. Literacy rate among age group between 6 to 15 is seen higher that is followed by between 16 to 25, which indicates the young generations are towards education.

The main source of income of the local people is agriculture. The annual income of the 34.35% of the households residing in Ward Number -2 is less than 10,000 and only 9.4% of the households earn more than 31,000 annually (Figure 10). Almost 77.77% of the people suffer from food deficiency; only 22.23% of them get year round food from their own production (Field Survey, 2006).

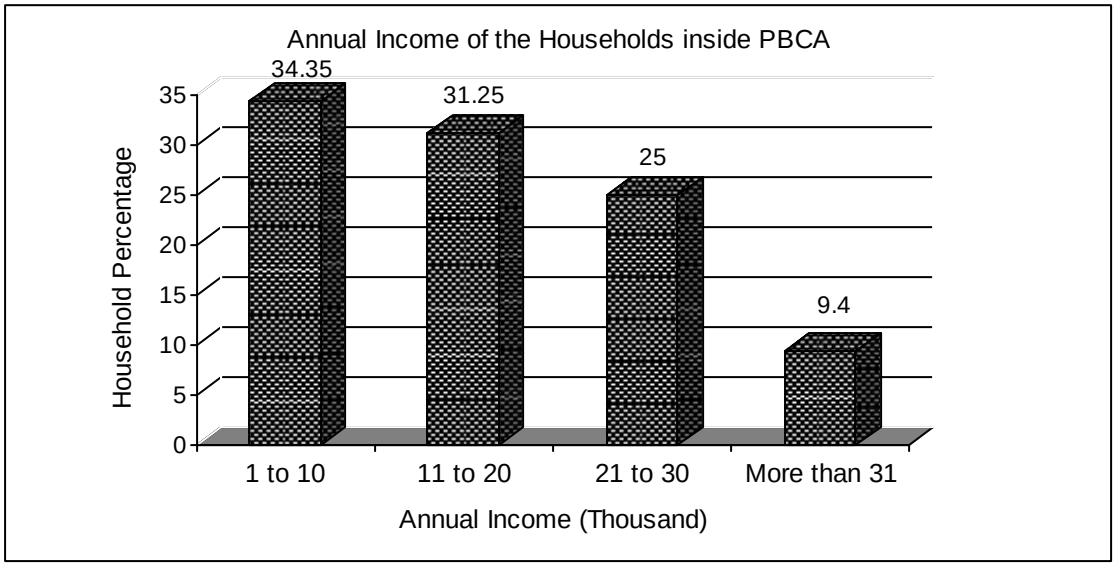


Figure 10. Annual Income of the Households Residing inside PBCA (Source: Field Survey, 2006).

2.8.3 Land Holding and Occupation

Among 132 households residing inside the PBCA, 108 (81.81%) households have Ailani (land without ownership certificate) land, 50 (37.87%) have Numbari land (land having ownership certificate) and 26 (19.69%) households have both Ailani and Numbari land. All households are dependent on agriculture followed by labor (12.31%) and 1.47% engaged in governmental and non-governmental services. Major

crops cultivated are corn, wheat, rice, mustard, peas, beans, gram, tomato, chilly, potato etc. Livestock mainly raised are buffalo, cow and goat. Only 14.89% of the local people practice the stall feeding for their livestock. The livestock holding of local people is found to be high in permanently residing Yadav, Godiya and Chamar community than in those households which were immigrated to this area.

2.8.4 Social Groups, Health and Sanitation

18.84% of the population is involved in different associations of which 58.82% are in community forest user group, 28.75% in farmer's association, 3.92% in saving groups and 8.94% in other groups. Integrated Conservation and Development Centre (ICDC), a local NGO, has formed 'Blackbuck Conservation Groups' among the residents of the ward no. 2 (18 groups), 3 (6 groups), 4 (13 groups) and 5 (6 groups) which are adjacent to the PBCA. ICDC has also formed co-clubs in two secondary and three primary schools involving altogether 318 students from different grades (ICDC, 2006).

Fire wood is used by almost all of the local people as the source of energy and kerosene is used for the lighting purpose as there is no electrification in those households which are residing in the Ailani land and the fuel wood is commonly collected from community forest and PBCA, which is one of the major causes of deforestation. The water supply for the entire household is from tube-wells. The level of sanitation is very poor, none of the households have modern toilets, and going to an open space for defecation is common practice.

3. METHODOLOGY

3.1 Preliminary Field Survey

A preliminary field survey was done with Research Supervisor from 31st October to 5th November 2005, to estimate the population status of Blackbuck together with the general behaviour and conservation practices of Blackbuck at Khairapur, Bardia and to understand the geophysical and climatic conditions. Survey process included the collection of information by the discussion with park authorities (Warden, Rangers and Game-scouts) of Bardia National Park (BNP), local peoples and officials of INGOs and NGOs (including CCEW, ICDC and TAL) working for Blackbuck conservation. Study area was visited on foot, animals were observed using 12 x 50 mm binoculars and behavioural data collection methods were practiced.

3.2. Population Status

3.2.1 Population Census

Direct count of the animals with the help of binoculars was carried out and total population, age and sex composition was recorded and determined in April 20 by the observation of 25 days for spring season and again in 4th July, 2006 in another field visit by the observation of 10 days. Four knowledgeable persons were included for thorough counting in one session to avoid the double count of animals. The maximum concurrent count was taken as total population of the Blackbuck in PBCA.

3.2.2 Population Density

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

$$\text{Crude Density (D)} = \frac{\text{Total Number of Individual in an Area (N)}}{\text{Total Area (A)}}$$

Ecological or Realized density is the total number of individuals present in the actual area of habitat available to the species and is given by:

$$\text{Ecological Density (E.D.)} = \frac{\text{Total Number of Individual (N)}}{\text{Area of the Actual Habitat (A)}}$$

3.2.3 Natality and Mortality

Natality is the number of organisms born per female of child bearing age per unit time. The crude natality rate of population can be expressed as follows:

$$\text{Natality (Birth) Rate (b)} = \frac{\text{Number of Births per Unit Time}}{\text{Average Population of Females}}$$

Mortality is the population decline factor and is defined as the number of deaths per unit time out of the average population. Mortality is given by:

$$\text{Mortality (Death) Rate (d)} = \frac{\text{Number of Deaths per Unit Time}}{\text{Average Population}}$$

The distribution of deaths in different months of the year was tested for statistical significance by the G- Test (Sokal and Rohlf, 1994), to see whether the risk of Blackbuck mortality was higher during any month.

$$G = 2 \sum_i O_i . \ln\left(\frac{O_i}{E_i}\right)$$

Where, O_i = Observed number of deaths in different months

E_i = Expected number of deaths in different months

3.2.4 Age and Sex Composition

Blackbucks were observed every day for classifying different age and sex composition. Binoculars (12 x 50 mm) were used to observe animals from a distance. Age and sex classes were determined according to Jhala (1991). Mature male and females were differentiated from their body colour and horn and immature were differentiated with keen observation on the belly to examine Urethra. Strikingly different posture of male and female during urination and the place of licking of the doe after suckling of the neonate were the main aid to identify the sex of fawns and neonate.

Age classes were limited to four groups discernible in the field by mere observation. The following description from Jhala (1991) was used to distinguish among groups.

a) Fawn (Less than 6 months)

This category was further divided into two groups, viz. (1) Neonate or brown fawn (< 2 weeks of age) and (2) Older fawn (>2 weeks but less than 6 months). The neonate Blackbuck is brown over the pigmented areas without orange-tan colour like the adult female. The fawn in the second week of life is still shorter at the withers than the bottom line of the mother's belly; bears long legs, thin and short body and short neck.

By two weeks, the older fawn loses its neonate proportion and is well coordinated; the fawn's coat changes approximately the colour of its mother by one month. The one month old fawn's withers overlap its mother's side. Light creamy-yellow colour changes into typical orange-tan and buds which will latter develop into horns can be discerned at about 4 months age. Urination posture is basically used for the identification of sex classes among fawns. The area that is licked by the doe after suckling the neonate is another key to identify the sex of neonate.

b) Adolescent (6 to 12 months)

Adolescent has lost the body proportion of the fawn, has a longer, deeper body which makes the legs appear relatively shorter and the neck longer than in the fawn stage. The withers come up to an adult female's side with typically orange-tan coat. Male continue to grow more robust horns which curve forward, grow rings and develop spirals.

c) Sub-adults (1 to 2 years)

Sub-adults are as tall as adults and as long but not as deep through the body. Thus, they are lighter in built than the adult. The white along the ventro-lateral side of female is comparatively less wide than the pigmented area and bear shorter face. The sub-adult male has horns with 2 spirals with the tips pointing in; they still bear orange-tan pelage.

d) Adults (Greater than 2 years)

Adults are deep through the body and the face is longer than that of the sub-adults. The width of the white on the side approximates that of the pigmented area. Females

often have some darkening on the lower shoulder where the pigmented area borders on the white, on the upper forelegs and on the stifle. Males may be orange-tan, black or any colour in between; black colour starts to develop after the age of 3 years, the darkness of which varies in different seasons. The horns have 3 to 5 spirals.

3.2.5 Herd Size and Number

A group or herd consisted of one or more Blackbucks which were together at the time of observation. Herd size was estimated by using the methods given by Martin (1977). Total number of the Blackbuck observed was divided by the total number of herds observed, to determine the average herd size. Herd types were identified as the mixed herd (consisting males, females and fawns with loose aggregations), breeding herd 9with a single alpha male and breeding females), male band (a group of males of similar age), single male, a male and a female (in breeding season), a female and a fawn, females and fawn and the group of fawns.

$$\text{Average Herd Size } X \frac{\text{Total Number of Individuals Counted}}{\text{Total Number of Herds Observed}}$$

3.3 Diurnal Activity Pattern and General Behaviour

The Blackbucks were observed daily from 06.00 A.M. to 18.00 P. M. The daily observation schedule was divided into four shifts; early morning shift: 06.00 – 09.00 hr. late morning shift: 09.00 – 12.00 hr. afternoon shift: 12.00 – 15.00 hr. and evening shift 15.00 – 18.00 hr. Once in a week continuous 12 hourly observations was undertaken with the help of a ranger of BNP. Night observation was not conducted considering the security and technical problems. Direct ocular observation method was employed for cataloguing the behaviour and monitoring the activities. The ocular observation was aided with 12 x 50 mm binoculars.

Behavioural data were obtained by the 'Focal Animal Sampling' and 'Scan Sampling' methods as described by Altman (1974). The data of event and state behaviour were obtained by focal animal sampling. A well identified animal (focal animal) was observed for an observational shift of three hours as mentioned above and all interactions involving that animal were recorded. The quantitative data on the frequency, temporal sequence and duration of behaviour was obtained by this method.

To obtain the amount or percentage of time used for an event; scan sampling of different herds was done. Time was considered as a descrete variable in the analysis of behavioural data. Blackbuck activities were divided into following state and events and at the interval of each five minutes the number of individuals engaged on respective events were noted.

- Feeding (grazing, browsing)
- Resting (sitting, lying on the ground)
- Standing
- Alert (Standing, ears raised to perceive some external stimuli)
- Moving (locomotion of different type and purpose)
- Others (drinking, sparring, chasing, courtship, mating, suckling)

Any remarkable events noticed during the observation were noted, the behaviours shown were correlated with the vegetation composition of the area being observed and interactions among the individuals of different age and sex group were noted to analyze the general behaviour. Careful note was made of the activity of the animals, the structure of the herd, the number of animals per herd, the location of the sighting and any habitat factor affecting their behaviour during the field visit. Movements of the herds were also noted.

3.4 Habitat Mapping

Survey of PBCA was done with the help of Geographic Positioning System (GPS). GPSmart Fortuna was used to note the position of the reference and demarcation pillars. Latitude, longitude, distances and bearing of the each pillar was recorded and the household, cultivated land, water holes, jungle area, Phanta, road, foot trail were surveyed by GPS and data were transferred to 'Arc View GIS 3.2 and land use map, road network map and habitat subtypes in Pataha Phanta of PBCA were developed. The digitizing was aided with the Topo-map of scale 1: 50,000 produced by the Survey Department of His Majesty's Government of Nepal in 1996/97.

3.5 Vegetation Analysis and Habitat Classification

Quadrates were randomly laid on different parts of the PBCA. 4 quadrates of 60 x 60 m^2, 8 quadrates of 20 x 20 m^2 and 35 quadrates of 1 x 1 m^2 were used for tree, understory and ground vegetation respectively. The vegetation data was quantitatively

analyzed for species frequency and relative density. Stems of grasses, forbs and other flora inside the 1 x 1 m^2 quadrates were counted. As it was difficult to recognize individual grass stems each tiller of a grass was counted as one individual. Unidentified grass species were collected and preserved as Herbarium and was identified at the Central Department of Botany, Tribhuvan University; Kirtipur. The grasses and forbs from the 10 quadrates of ploughed field, 10 quadrates of grass cut fields, 10 quadrates of heavily livestock grazed fields and 10 quadrates of normal fields were removed and were dried in sun for two days and transferred to Kathmandu. The sampled biomass from the quadrates was kept in an incubator at 75 ^{0}C for 24 hours and was weighed in digital balance to measure the dry weight. The significance in the difference of biomass from the different types of plots was tested with one way Analysis of Variance (ANOVA).

$$\text{F Z Ratio X} \frac{\text{Sum of the Square between the Samples /}_{\text{k Z1}}}{\text{Sum of the Square within the Samples /}_{\text{n Z k}}}$$

On the basis of the relative density of the dominant plant species, demarcation by the road and foot trails and intensity of the livestock grazing the Pataha Phanta was divided into different blocks for this study. The number of livestock grazing in different blocks was counted and average was taken. Those blocks with higher livestock grazing pressure (Block F and Block H) were observed to count the average number of livestock grazed within the block and number of Blackbuck present within the same block. Karl-Pearson correlation coefficient was calculated between the number of livestock grazing and the number of Blackbuck present in the same block to assess the interference competition between them.

$$r \text{ X } \frac{(X_1 \text{ Z } \overline{X}_1)(X_2 \text{ Z } \overline{X}_2)}{\sqrt{(X_1 \text{ Z } \overline{X}_1)^2 (X_2 \text{ Z } \overline{X}_2)^2}}$$

Where, r = Karl-Pearson's Correlation Coefficient

X_1 = Number of livestock grazing in a block

X_2 = Number of Blackbuck grazing in the same block

3.6 Study of Health Status

The prevalence of gastro-intestinal parasites in the Blackbuck and domestic livestock grazed in PBCA was conducted twice, once in April and next in July/August. Fresh

fecal samples of different age and sex group of Blackbuck and domestic livestock that were grazed in Pataha Phanta of PBCA were collected in sterilized plastic sample tubes and were preserved using 10% Formalin as preservative. The stool samples were examined with both direct smear and concentration methods. Wet mount preparations were made in normal saline and iodine and observed under a light-microscope with 10X objectives. The suspected objects were confirmed by observing with 40X objectives. Parasite identification was based upon the size and appearance of cysts, eggs and larvae of parasites. The gastro-intestinal parasites were examined in the lab of Nepal Agricultural Research Council, National Animal Science Research Institute; Animal Health Research Division at Khumaltar, Lalitpur.

3.7 Questionnaire Survey

To explore the conservation threats of the Blackbuck in PBCA, questionnaire survey was conducted with the local inhabitants in the vicinity of PBCA. Questionnaires cover following main aspects:

- Socio-economic conditions of the local inhabitants.
- Agricultural practices of the local people and crop damage by the Blackbuck.
- The sources of conflicts between the local people and the Blackbuck.
- Perspectives/attitudes of local people towards the declaration of Khairapur Area as 'Blackbuck Conservation Area'.

Most of the questions were closed type, but some open ended questions were also included to get more explorative approach from the respondents. The respondents from the different wards were chosen at random but proportionately, based on the distance of their settlement from the core Blackbuck area.

3.8 Interviews and Discussions

Interviews and discussions were made with the park authorities of the BNP, the officials of District Forest Office of Bardia, officials of the Gulariya Municipality who were directly involved in the conservation practices of Blackbuck at Khairapur. The discussions were also made with the officials of the locally working related NGOs and INGOs. The discussions were made with the members of the 'Local Blackbuck Conservation Committee' and Eco clubs.

4. RESULT

4.1 Population Status of Blackbuck

4.1.1 Total Population

The counting of Blackbuck was done when the animals were grazing at Pataha Phanta. The population count of Blackbuck in PBCA on 5th November, 2005 was 109, on April 20, 2006 was 131 and on 4th July 2006 with the birth of two new fawns became 133.

The total population of the Blackbuck in Nepal including natural habitat, captive and semi-captive enclosures is 223 in aggregate in 2006 (Table 3).

Table 3. Population Status of Blackbuck in Nepal in 2006.

S.N.	Area	Blackbuck Population			
		Male	Female	Fawn	Total
1.	PBCA, Gulariya	52	66	15 (6 males and 9 females)	133
2.	Central Zoo, Jawalakhel	16	23	8	47
3.	Mrigasthali, Kathmandu	4	16	3	23
4.	Mahendra Park, Nepalgunj	8	11	1	20
Total		80	116	27	223

(Source: Field Visit, 2006).

4.1.2 Population Density

Total population counted on 4th July 2006 was 133 and total area of study area in the PBCA is 5.25 km^2, therefore the crude density in the study area was calculated to be 25.33 individuals / km^2. However, the area of realized habitat of Blackbuck in Pataha Phanta excluding the encroached residential and cultivated area and the eastern forest with no access of Blackbuck is only 1.77 km^2; therefore the ecological density of Blackbuck population in the study area was calculated to be 75.14 individuals / km^2.

4.1.3. Age and Sex structure

Total population of Blackbuck observed in PBCA during the terminal period of the study was 133, out of which total males were 58 (43.6%) and females were 75

(56.4%), thus male to female ratio was computed to be 1:1.29 showing a sex ratio of 77.3 bucks to 100 does.

Among adults, out of 82 individuals, male to female ratio was computed at 1:1.28 indicating 78.26 adult males to 100 adult females.

Among sub adults, out of 21 individuals, male to female ratio was obtained to be 1:1.33 indicating 75 sub-adult males to 100 sub adult females.

Among the 15 individuals of adolescent age group, the sex ratio was computed at 1:1.14 that indicated 87.5 adolescent males to 100 females.

Among 15 fawns of age group below six months, the sex ratio was computed at 1:1.5 that indicated the 66.7 male fawns to 100 female fawns (Figure 11).

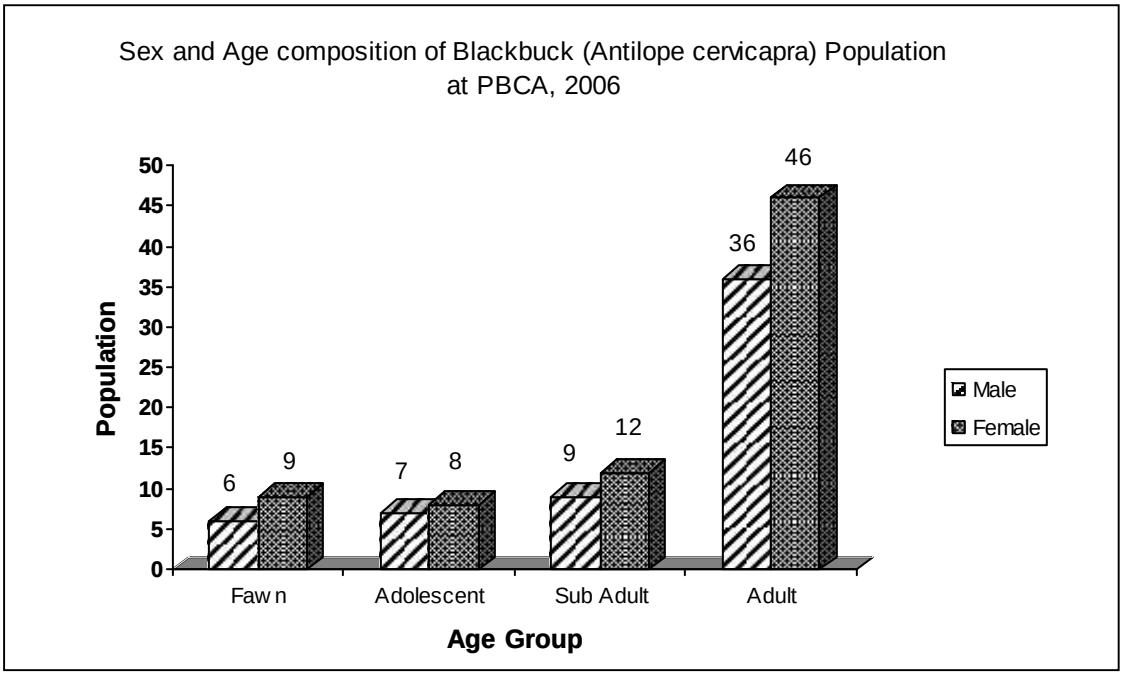


Figure 11. Sex and Age Composition of Blackbuck in the PBCA in 2006 (Source: Field Visit, 2006).

In all the age groups of wild population of Blackbuck in PBCA, there were more females than males, but, in no age group did this depart significantly from a 1:1 sex ratio ($\chi^2 = 2.16$, d. f. = 1, $P < 0.05$).

4.1.4 Natality and Mortality

Total number of live births from 5th July, 2005 to 4th July, 2006 was recorded to be 36 and the average number of females of age of reproduction was 43 for that time period. Hence, the natality rate of Blackbuck population in PBCA is computed to be 0.84 per matured female per year.

The average population of Blackbuck in PBCA from 5th July 2005 to 4th July 2006 was 120 (107 individuals in 5th July 2005 and 133 individuals in 4th July 2006). The total number of death within that one year period including one pre-natal death was recorded 11 (Table 4) and the mortality rate was computed to be 0.091 per individuals per year (i.e. 9.1%).

Table 4. Frequency Distribution of Deaths of Blackbuck in Different Months in PBCA

Year ⟶	2005						2006					
Month ⟶	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
No. of Deaths	1	0	0	1	0	1	1	3	0	2	1	1

(Source: Record from Khairapur Post and Field Visit, 2006)

The distribution of deaths was tested for statistical significance by the G-Test to see whether the risk of mortality was higher during any month. The frequency distribution does not deviate from an even distribution ($G = 11.27$, d. $f = 11$, $P < 0.05$).

4.1.5 Herd size

The continuous changes undergone in composition and social structure of the herds were noticed during the study period. Herd size varied considerably with the season, time of the day, availability of the grazing fallow, and disturbances from the humans and grazing livestock on the same grazing land. The average herd size of 7.64 individuals was computed from 4,920 individuals counted during the study period on 644 groups or herds during the study period. Almost one-third (32.34 percent) were observed as single individuals of which 82% of the individuals were single isolated male. The largest herd size of 59 individuals including both sexes and of all the age groups was observed in the early morning of 20th April 2006, the day followed by the heavy rainfall with hailstone 7.5cm thickness on the ground at 19:30 hour on 19th April 2006. 34 percent of the herds were observed in the groups of six to ten individuals.

PHOTO PLATES

Photo 1. A Neonate hiding on the grass just after30 minutes of its birth

Photo 2. A Fawn of Blackbuck in alert posture

Photo 3. An Adolescent male Blackbuck standing on grazing fallow

Photo 4. A sub-adult female Blackbuck in alert posture

Photo 5. An adult female Blackbuck in alert posture

Photo 6. An adult male Blackbuck showing the inner white rump of its tail

Photo 7. A breeding herd with alpha male and adult females

Photo 8. Two mother Blackbucks with their fawns

4.2 General Behaviour and Daily Activity Pattern:

4.2.1 General Behaviour

4.2.1.1 Social behaviour:

The social structure of the Blackbuck population was found to change with various climatic, environmental and disturbance factors. Mixed herds, consisting of loose aggregation of bucks and does, breeding herds consisting of an alpha male and several does at the time of rut, buck herds (male band) consisting solely of bucks and single isolated adult males were the major herd types recorded from blackbuck population in the PBCA.

Occasionally seen were the herd of a male and a female in courtship, a female and a neonate on nursing it, many females and fawns and the group of resting neonates.

A mixed herd comprised a matured male, many females, sub adult and adolescent males and fawns. The aggregation of the individuals in the mixed herd was found to be very loose that was broken even with slight disturbance, into different herds. A breeding herd comprised of an alpha male with many females during breeding season within well demarcated territory. The territory of Blackbuck comprised 'Scrape' consisting of shallow depression of about 6 cm on depth, 80cm in length and 30cm in width. The scrape was made by the alpha male by means of hooves of forelegs. In such freshly excavated depression, the alpha male urinated and then defecated with characteristic crouching posture. The alpha male vocalized and chased other males approaching its territory. It carried the tail curled over its back and stepped with a rather high mincing gait. The nose and neck were stretched out, horns were carried horizontally over the back and the sub-orbital pit glands were everted. After excluding the invaded male from its territory the alpha male thrushed its everted sub-orbital pit glands on the twig of bush or grasses. The dominant male (alpha male) prevented the movement of the females in such a direction by approaching them obliquely with a head up display and warding them off.

A male band (buck herd) comprised of a group of males of almost similar age group. Three buck herds, one of 15 adult males, second of 9 sub-adult males and third of 5 adolescent males were observed in PBCA. The individuals of the buck herd were seen

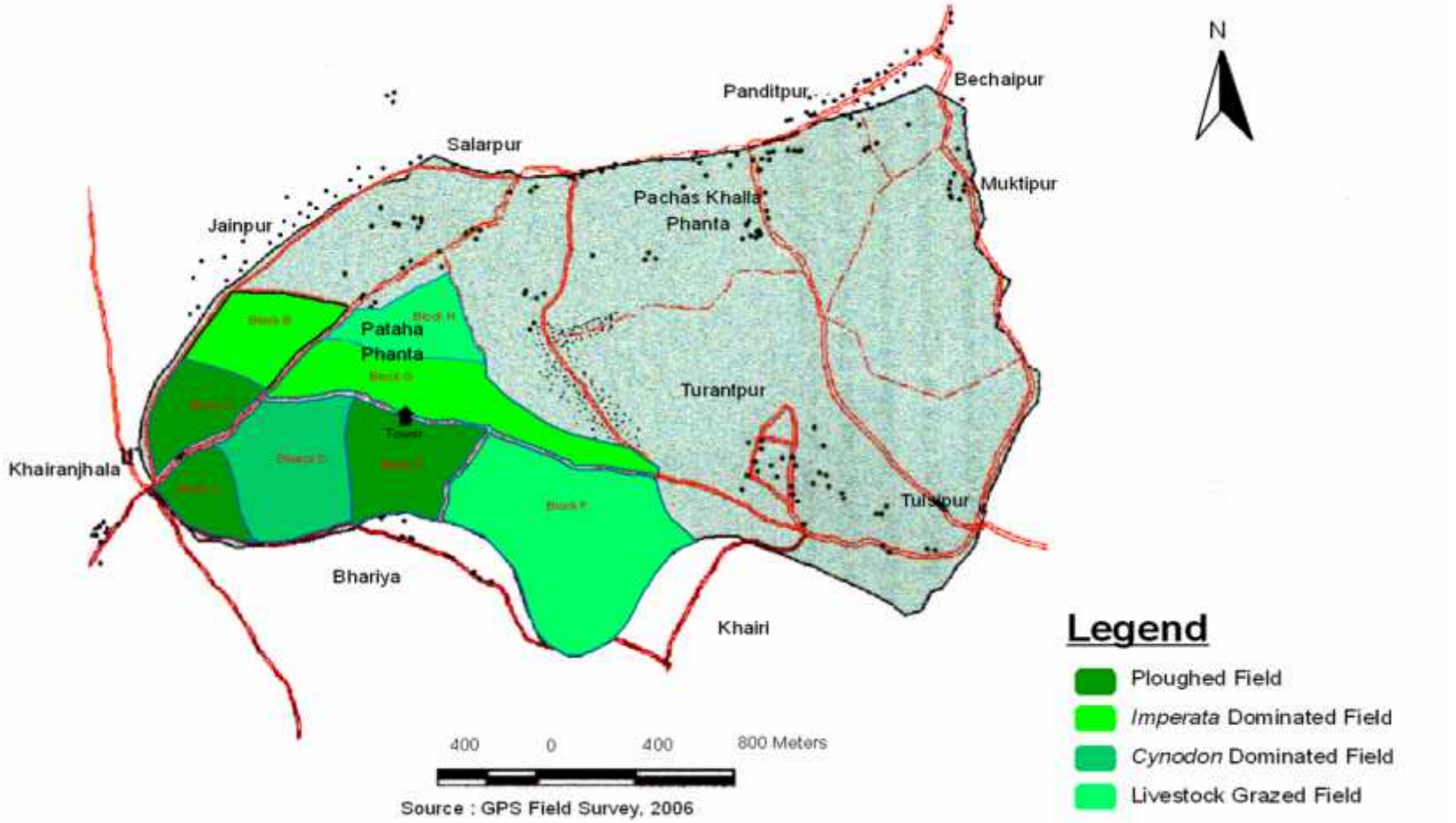
engaged in playing and sparring activities for comparatively longer time than those individuals of the mixed herds and breeding herds. When the males were indulged in sparring, chasing and even displaying for long time, the superior males came to the spot, interrupted the game with head and nose up display. Play was found to be restricted to the playful interactions and was different from its agnostic behaviour. Play was seen mostly in the morning from 7:00 to 8:00 AM and they were seen playing and less resting even at noon on the cloudy day. While playing the youngsters were seen trying to mount which is partly play behaviour and partly sexual attempting for the sneaking copulation.

After playful time, Blackbuck started to feed upon the grasses and forbs. After 9.00 AM, they rested upon the plain area basking on the sunlight. During peak hours of grazing no individual was seen resting whereas during low period of activity and grazing, many were seen lying down. Standing, lying and alert as static activities, characteristically shown just the reverse relation with grazing and moving in seasonal pattern. While resting, legs were brought close to the belly and neck either stretched forward or turned back over the trunk. Though, they seem sleepy, they jumped into standing alert position within a second when disturbed by any source of the disturbance. Both the males and females urinate 3-4 times a day but the volume of urine was less and highly concentrated with pungent smell. While urinating the males stretched the hind legs backward, the body was also stretched back and the urine passed out; while in females, the posterior legs were curved forward and fixed on the ground, body became slightly folded and the urine was passed out. Defecation was in the form of pellets of black colour, small seed-like, and oval in shape with pungent smell.

4.2.1.2 Feeding Behaviour

On the basis of the relative density of the dominant plant species, livestock grazing intensity and habitat manipulation practices in the Pataha Phanta of PBCA, the Pataha Phanta was classified into 8 blocks, namely: Block-A, Block-B, Block-C, Block-D, Block-E, Block-F, Block-G and Block-H (Table 5).

Habitat Classification inside Pataha Phanta



Source : GPS Field Survey, 2006

Prepared By : Laxman Khanal, TU, Kirtipur

Table 5. Classification of Pataha Phanta into different blocks for this Study.

Study Block	**Habitat Sub-type**
Block- A	Ploughed (P)
Block- B	*Imperata* Dominated (I)
Block- C	Ploughed (P)
Block- D	*Cynodon* Dominated (C)
Block- E	Ploughed (P)
Block- F	Heavily Grazed (G)
Block- G	*Imperata* Dominated (I)
Block- H	*Imperata* Dominated, Heavily Grazed (IG)

(Source: Field Survey, 2006).

Blackbucks, the true grazers preferred to graze in the vast area from dawn to dusk and took rest on the scorching sun. The Blackbucks were seen feeding on the grazing fallow of 'Pataha Phanta' mostly in the Block 'A', 'C' and 'D', which were the ploughed blocks dominated by the *Cynodon dactylon,* and *Saccharum spontaneum*. Other plants preferred by the Blackbuck were *Euphorbia hirta, Phyllanthus virgatus*, *Medicago denticulre*, *Cyperus cepalotus*, *Zizyphus mauritiana* etc (Table 6).

Table 6. Number of Blackbuck Herds Sighting in Different Study Plots in 2006.

Study Block	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Total Sighting**
Habitat Subtype	**Ploughed**	***Imperata* Dominated**	**Ploughed**	***Cynodon* Dominated**	**Ploughed**	**Heavily Grazed**	***Imperata* Dominated**	**Heavily Grazed**	
No. of herds sighted	113	35	125	157	94	27	49	44	644
Percentage	17.54	5.43	19.4	24.53	14.60	4.19	7.6	6.83	100

Source: Field Visit, 2006.

Grazing population peaked (83%) around 8.00 hours and lowest (32%) at 11.00 hours. Less than 50% of the animals were engaged in grazing between 11.00 to 14.00 hours, and then the grazing percentage increased and continued till the evening. However more than 50% of animals were found busy in grazing around 10.00 hours in morning and after 14.00 hours in afternoon (Figure 12).

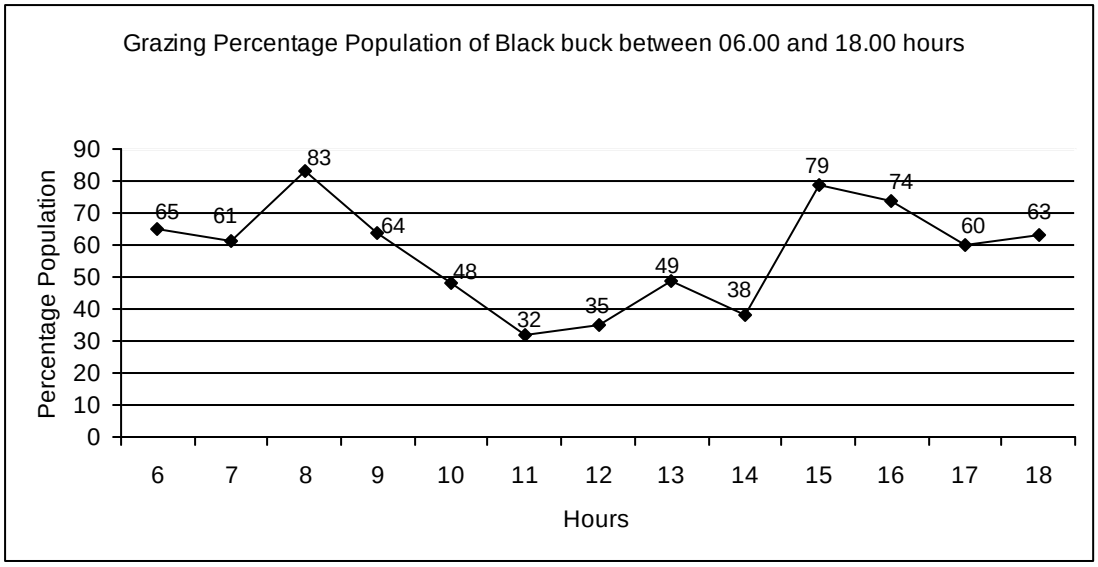


Figure12. Grazing Percentage Population of Blackbuck between 06:00 and 18:00 Hours in PBCA (Source: Field visit, 2006).

Blackbucks were reported to raid the agricultural field of local farmers at night time. Questionnaire survey was carried out in ward no. 2, 3, 4 and 5 of Gulariya Municipality. The majority of (76.4%) the respondents reported the crop damage by the Blackbuck in their field. Crop preferences varied in different growing stages and seasons and the loss was in inverse proportion with the distance from the main habitat of Blackbuck. Pulses like lentil and black gram were the first choice of the Blackbucks, second choice being the wheat, mustard, pea and corn. Rahar and paddy were reported to be less raided by the Blackbuck. Most of the respondents reported that the crop damage is more in winter than in the summer season. The preferred plants lentil and black gram are cultivated in winter season in extended areas in the vicinity of PBCA.

Blackbucks were seen drinking water from the artificial water holes 2 to 3 times a day in April-May when there was no naturally occurring water in the old Babai river beds. The drinking hour was about 9.00 am and 2.30 pm. While drinking the water, forelegs fixed on the border of the water hole, hind legs stretched slightly backward, body stretched back and the head was lowered to the surface of the water. The animal spent about 45 seconds to drink water interrupting 2-3 times, scanning on all the direction on each interruption.

4.2.1.3 Anti-predatory Behaviour

The sharp eye-sight and high speed are major component for the natural defense against the enemies. The flat and open grazing land of Pataha Phanta provide suitable habitat to them for their long range vision. Some of the anti-predatory behaviours of the Blackbuck observed in PBCA were as follows:

4.2.1.3.1 Alert Posture: Alert posture of Blackbuck was noticed when they were disturbed, in which the animals stand erect with neck hold almost vertically, pinnae and tail raised erect displaying the white fur of the inner layer.

4.2.1.3.2 Alarm Posture: The disturbance caused the members of the herd to crowd together in alert posture before they started to run.

4.2.1.3.3 Foot Stamping: When the animals were alarmed they gave sign of danger to other members by stamping their feet on the ground, so that the noises of thudding hooves became the auditory signal and led to take precautions.

4.2.1.3.4 Alert Flight: When the animals were disturbed suddenly and violently, the group members frequently took a series of high leaps with head high, they jumped stiff-legged, all the four legs moving and striking the ground in unison.

Auditory signals from vocalization were not found in Blackbuck as anti-predatory behaviour. The grunting sound was heard from male while chasing other male or displaying in front of an oestrous female, the call (ghuk-ghuk) sound was heard from the recently delivered doe to call her neonate.

During the field visit in PBCA, 3 cases of the delivery of neonate were observed by the researcher. In these three cases, female gave birth inside the tall grasses. She licked the neonate completely just after the delivery within 8-10 minutes. The neonate could stand and was found walking side by to its mother within 15 minutes of birth. The neonate was licked by the mother doe while nursing them and the doe stimulated the urination and defecation of the neonate by massaging its ano-genital region with her tongue. During the first-second days, the mother of the neonate ate the feces and drank the urine of the neonate. Thus the neonate was made completely odourless and

the neonate itself moved some distance apart to hide. The female was seen never approached to the hiding place of the neonate, instead she used to call the neonate at the time of nursing and after nursing, it went back to its hiding place itself. In some cases the mother was seen being unable to locate the hiding place of her neonate at the next nursing period and she was seen searching with her call sound even for hours. Remaining completely odourless would be one of the best defensive natures for the neonate which yet to attain its full running speed.

4.2.1.4 Aggressive Behaviour

The buck raised its muzzle high, the horns made parallel to the back exposing the white inner part and tail raised, curved over the back making the white rump patch conspicuous. The buck approached his opponent at a prancing walk on that posture, bobbing the head up and down flashing his white chin. He bound forward in a stiff legged gallop, uttering a series of harsh grunts and jerking up his head with each sound. The chased animals used to trot, gallop or spronk about 50 m away and often circled back to the periphery of the herd. Two bucks usually sparred, jerked their heads down, locked horns sometimes with a crash and then pushed and twist their heads until one turned aside. The winner male often followed the looser in the head-up display for a short distance. An alpha male of breeding herd chased the intruder males in head-up display and advanced at a fast walk, which changed into a run if the intruders hesitate to leave the herd. The alpha male drove the intruders, occasionally grunting while threatening them until they either left the area or hovered around the periphery. The does remained in the territory of the buck largely of their own accord. The buck sometimes drove a straying doe back to the herd by nudging her shoulder with the base of his neck, then following her back by zigzagging back and forth over her trail.

4.2.1.5 Sexual Behaviour

The dominant male use similar display postures for dominance and for courtship. The male sniffed the ano-genital area or the fresh urine of the doe, exhibited flehmen with curled lip and then took quick steps behind her with pre-orbital glands everted and nuzzle raised in a typical head-up display. He chased the female uttering harsh grunts. The chased doe circled back to the herd where the buck continued to follow her and stood parallel to her in the head up display. He placed his chin on her rump, licked her

genitalia, and blocked her movement and attempt for copulation. The female remain in slow motion; the male raised his forelegs and jumped over the receptive female. The tail of the female was raised up, the thrust after the genital contact pushed the female forward and she bowed her body in a characteristic loop. Then the female ran away and played, the male licked its genitalia and followed her. The same process continued for 1 or 2 days.

4.2.2 Diurnal Activity Pattern

Field work was conducted from April to July, 2006. Total jungle time was of 375 hours and animal contact time was 190 hours. The daily observation schedule was divided into four shifts; early morning shift: 06.00 – 09.00 hr. late morning shift: 09.00 – 12.00 hr. afternoon shift: 12.00 – 15.00 hr. and evening shift 15.00 – 18.00 hr. Once in a week, continuous 12 hour observation was undertaken with the help of a trained ranger of BNP. Total 3,942 individuals of different sex and age group were observed. Direct ocular observation aided with 12 x 50 mm binoculars was employed for cataloguing the behaviour and monitoring the activities. The percentages of the time invested by different herds were obtained from the focal animal sampling and scan sampling method.

4.2.2.1 Diurnal Activities of Mixed Herds

A total of 1,419 individuals of the mixed herds were observed for this study. Mixed herds were found to invest more time on feeding (57%) followed by resting (26%), walking (6%), alert (4%), standing (4%) and others (3%) of the day time (Figure 13).

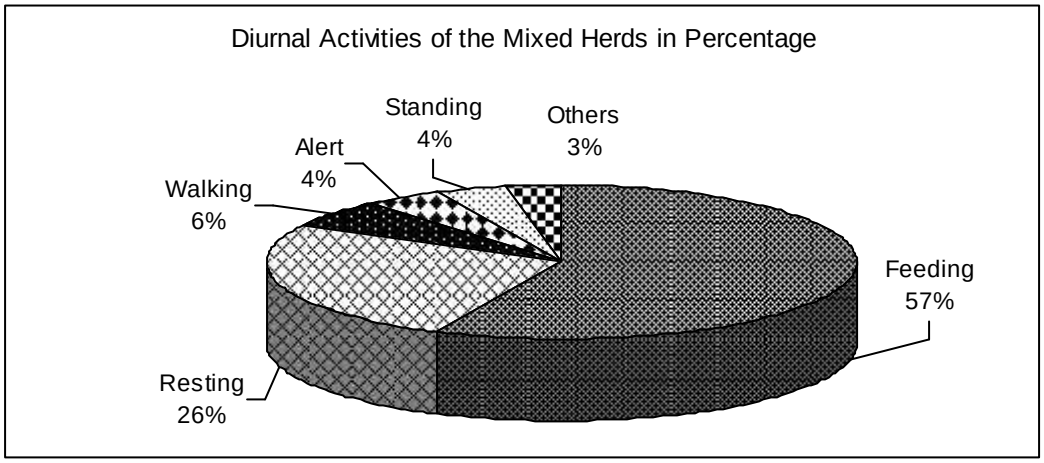


Figure 13. Diurnal Activities Percentages of Mixed Herds of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.2 Diurnal Activities of Breeding Herds

A total of 1,195 individuals were scanned for obtaining the diurnal activities of breeding herds. Breeding herds invested more time on feeding (48%) followed by resting (33%), others (7%), walking (6%), alert (3%) and standing (3%) of the day (Figure 14).

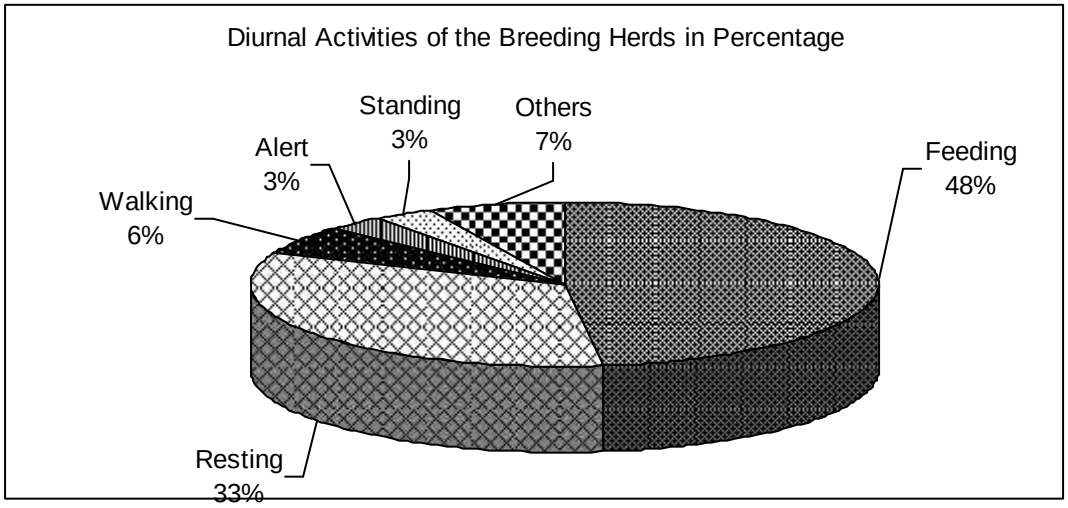


Figure 14. Diurnal Activities Percentages of Breeding Herds of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.3 Diurnal Activities of Adult Buck Herds

649 individuals of adult buck herds were observed for this study. Adult bucks spent almost 39% of time on feeding, followed by resting (18%), walking (16%), others (16%), standing (8%) and alert (3%) in a day. Walking and other activities like sparring, displaying, etc. were also the remarkable events shown by them (Figure 15).

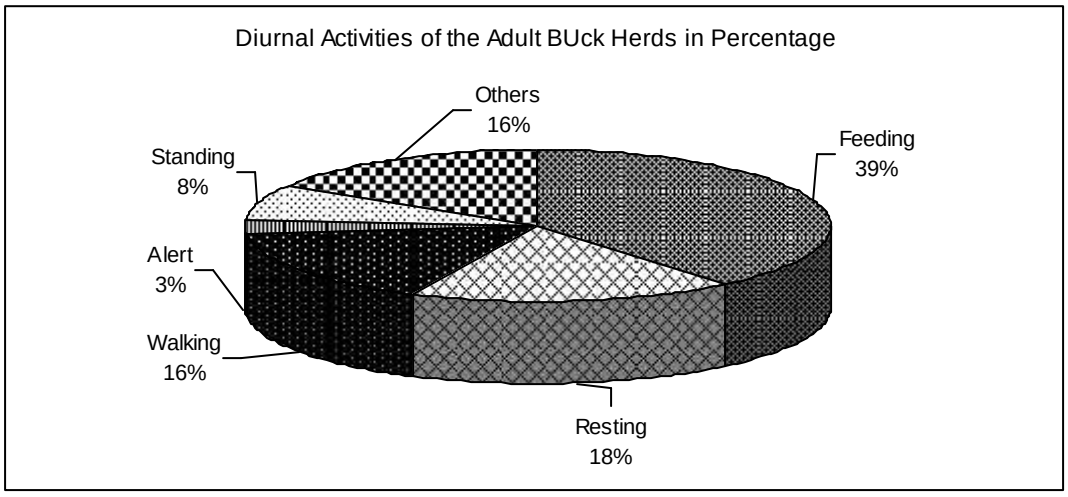


Figure 15. Diurnal Activities Percentages of Adult Buck Herds of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.4 Diurnal Activities of Sub-adult Buck Herds.

A total of 513 individuals of sub-adult and adolescent buck herds were scanned for this study. The buck herds were found to spend more time on feeding (42%) followed by walking (17%), resting (14%), others (12%), standing (10%) and alert (5%) of the day time. Sub-adult bucks also spent comparatively more time in other activities like playing, sparring, etc. than other groups (Figure 16).

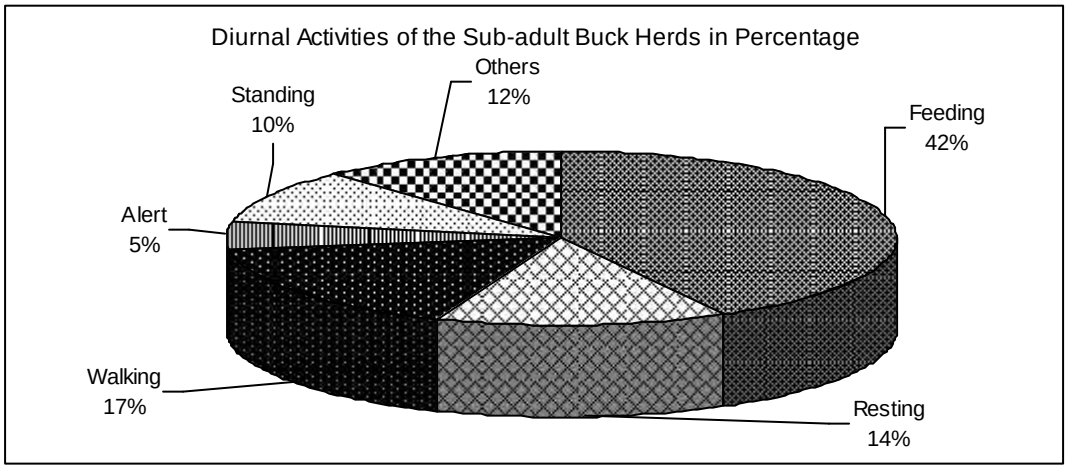


Figure 16. Diurnal Activities Percentages of Sub-adult Buck Herds of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.5 Diurnal Activities of Single Male

42 individuals of single male herds were observed by focal animal sampling technique for this study. The single male was found to spend maximum time on feeding (51%) followed by resting (35%), walking (5%), alert (3%), standing (3%) and others (3%) of the day. They were the second to spend more time on resting after the neonate (Figure 17).

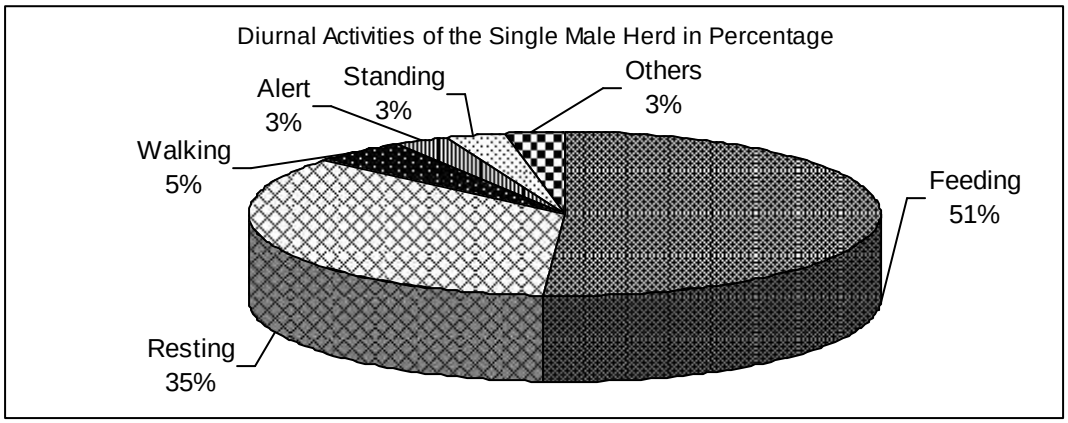


Figure 17. Diurnal Activities Percentages of Single Male Herds of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.6 Diurnal Activities of Neonates

33 individuals of newly born neonates were repeatedly observed. Neonates were found to spend maximum time on resting followed by walking (14%), others (8%), standing (4%) and alert (2%) of the day time. Suckling by the female was considered as other activities, hence, feeding percentage is nill and resting percentage(72%) is the highest (Figure 18).

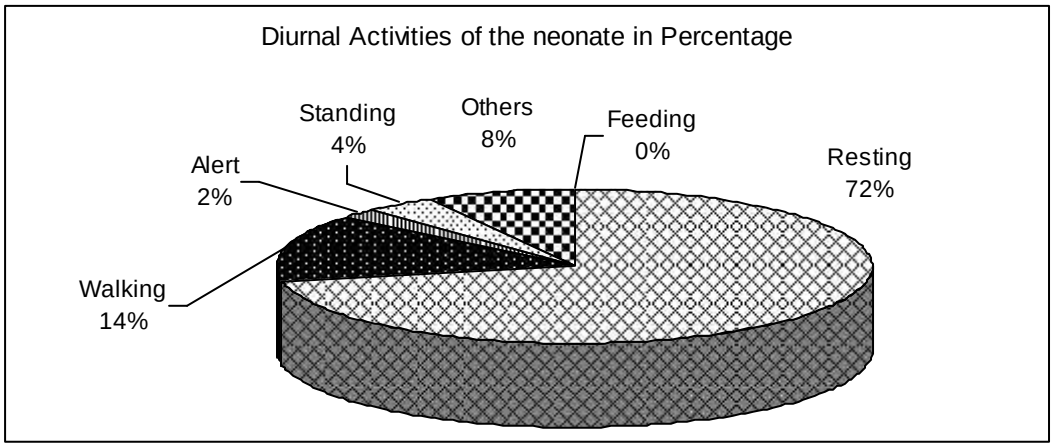


Figure 18. Diurnal Activities Percentages of Neonate of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.7 Diurnal Activities of Alpha Male

A total of 47 alpha males of different mixed herds and breeding herds were repeatedly observed for this study. The alpha males were found to spend their more time on feeding (39%) followed by resting (27%), others (14%), walking (11%), standing (5%) and alert (4%) of the day time (Figure 19).

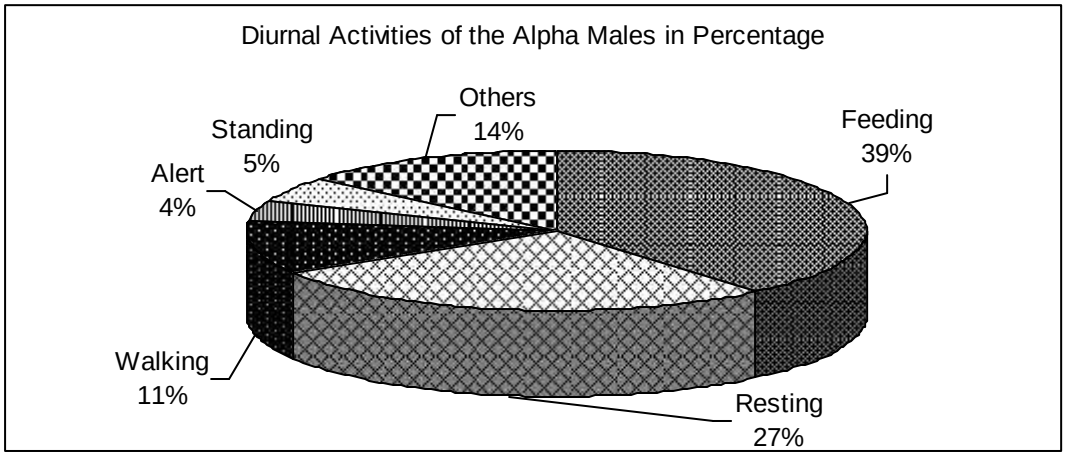


Figure 19. Diurnal Activities Percentages of Alpha Males of Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.8 Diurnal Activities of Mother Blackbuck

A total of 44 individuals of Blackbuck females having the fawns of different age were observed for this study. The mother Blackbucks were found to invest more time on feeding (46%) followed by walking (17%), alert (16%), other (11%), resting (4%) and standing (4%) of the day. She used to remain in more alert looking for the safe of her neonate (Figure 20).

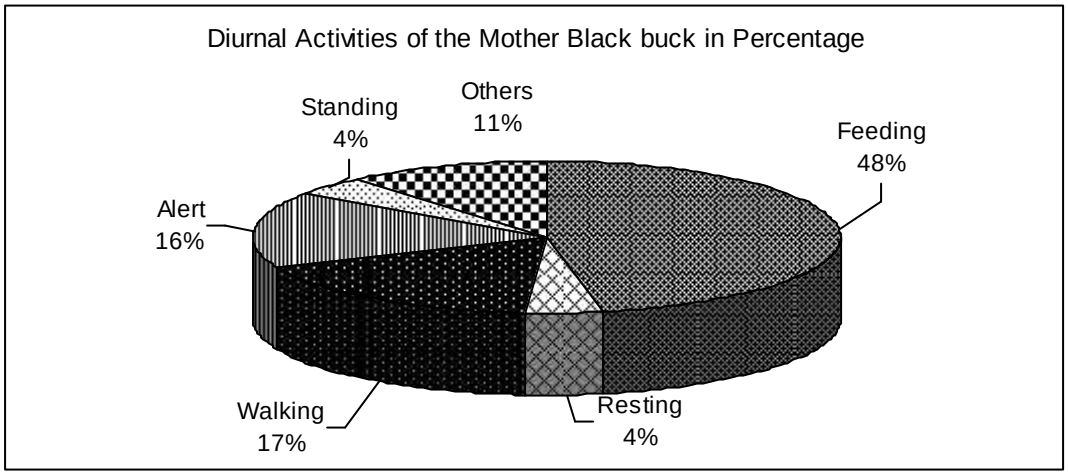


Figure 20. Diurnal Activities Percentages of Mother Blackbuck in PBCA (Source: Field Survey, 2006).

4.2.2.9 Diurnal Activities of Blackbuck in PBCA

Grazing time of the Blackbuck was found to be highest (71%) in 15.00 to 18.00 observational phase followed by 69.66% in the morning from 06.00 to 09.00 observational phase, 48% in 09.00 to 12.00 observational phase and 40.66% in the observational phase of 12.00 to 15.00 hours. Resting time of Blackbuck was found to be highest (36.21%) in 12.00 to 15.00 observational phase followed by 27.65% in 09.00 to 12.00 observational phase, 11.23% in 06.00 to 09.00 observational phase and 7.36% in 15.00 to 18.00 observational phase. Walking percentage was found to be highest (14.43%) in 09.00 to 12.00 hours followed by 12.92% in 15.00 to 18.00 hours, 11.94% in 12.00 to 15.00 hours and 10.45% in 06.00 to 09.00 hours. Blackbucks were seen mostly alert (4.34%) in 12.00 to 15.00 observational phase followed by 4.25% in 09.00 to 12.00 observational phase, 3.40% in 06.00 to 09.00 observational phase and 1.35% in 15.00 to 18.00 observational phase (Figure 21).

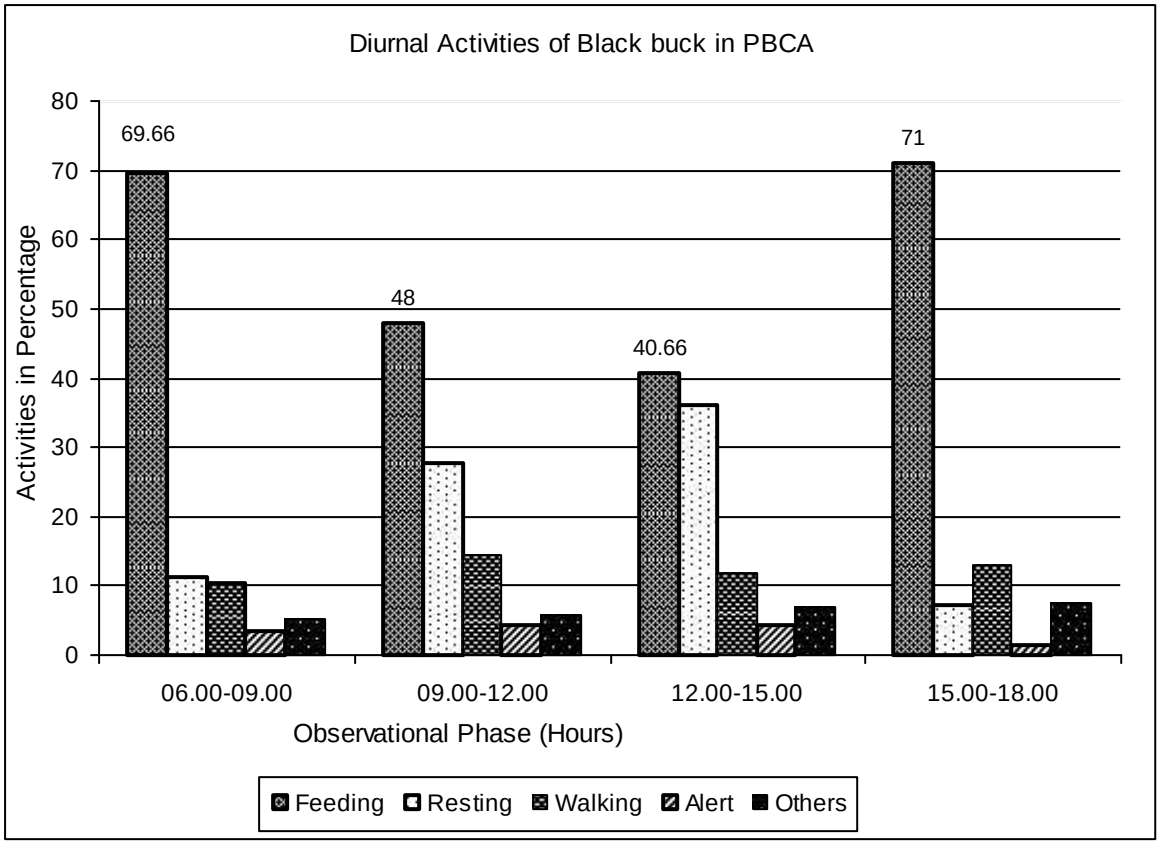


Figure 21. Diurnal Activities Percentage of Blackbuck in PBCA (Source: Field Survey, 2006).

PHOTO PLATES

Photo 9. A practice to note the behavioural data, guided by the Supervisor in the field

Photo 10. Two adult males sparring on the ploughed field of Pataha Phanta

Photo 11. A mixed herd of Blackbuck grazing on grass

Photo 12. The dominant male of Blackbuck defending its territory in head-up display

Photo 12. The winner male Blackbuck chasing the loser after sparring

Photo 13. The dominant male attempting an oestrous female standing side by her in head-up display

Photo 14. An adult Blackbuck male in urinating posture

Photo 15. An adult female Blackbuck in urinating posture

4.3 Survival Threats of Blackbuck

4.3.1 Habitat Encroachment

The boundary of the PBCA was delineated with 12 reference pillars and 171 demarcation pillars. The total area delineated for the PBCA is 5.25 square kilometer (525 hectares) with a perimeter of 10.25 kilometer. The area was found to be heavily encroached by the local people. 137 households were permanently residing in Pataha Phanta, Pachas Khalla Phanta, Tharu basti, Tulsipur and Muktipur area of PBCA, of which 55 households were Numberi (registered) land owners, 110 households were Ailani (non-registered) land owners and 26 households were both Ailani and Numberi land owners. Total area occupied by the permanently residing people inside the PBCA was found 1.35 square kilometer. About 550 huts of Sukumbasi (land less) people were found recently installed after clearing the forest area of eastern boundary of Pataha Phanta with the forest. About 0.22 square kilometers of the area is estimated to be encroached by the Sukumbasi people at present in PBCA.

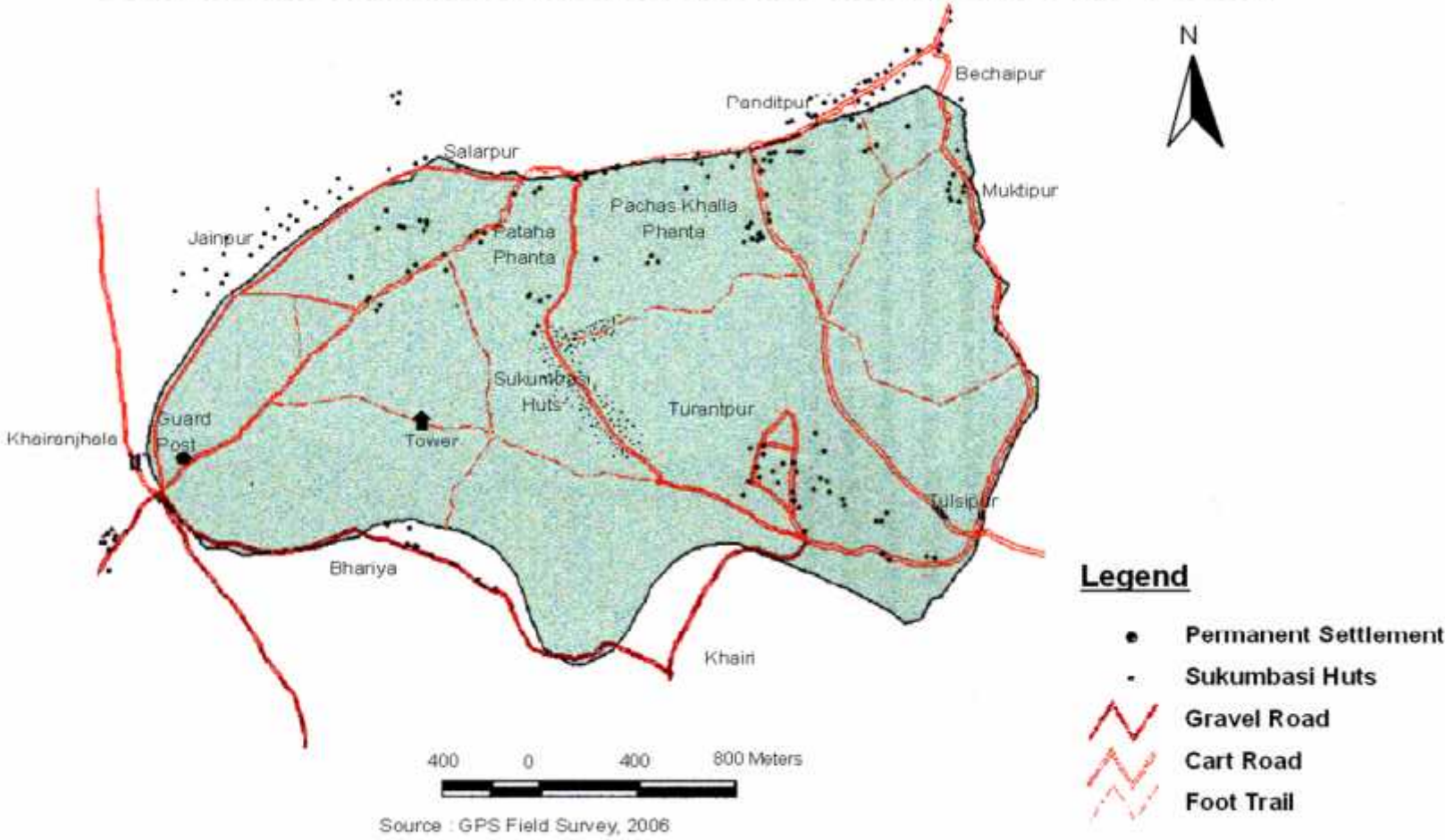
Out of total area of 5.25 square kilometer of PBCA, 1.90 square kilometer is forest, 1.35 square kilometer is permanently settled by the local people, and 0.23 square kilometer of the area is encroached by the Sukumbasi people. So, only 1.77 square kilometer of the Pataha Phanta is available to the Blackbuck to use for habitat and their survival (Table 7).

Table 7. Land Use pattern in and around the Pataha Phanta of PBCA

Land Use Type	**Area in Square kilometer**	**Remarks**
Forest	1.90	*Acacia-Bombax* Forest
Permanent Settlement	1.35	PachasKhalla, Pataha, Muktipur, Tharu Basti and Tulsipur.
Sukumbasi Area	0.23	Eastern Boundary of Pataha Phanta
Pataha Phanta	1.77	Core Blackbuck habitat
Total	**5.25**	

Source: Field Survey, 2006.

Settlement and Road Network inside and around the PBCA



Source : GPS Field Survey, 2006

Prepared By : Laxman Khanal, TU, Kirtipur

4.3.2 Habitat Fragmentation

The Proposed Blackbuck Conservation Area (PBCA) is fragmented into very small land pieces due to the easy access of the local people and lack of proper rules and regulations. The Blackbuck habitat is fragmented by the gravel road, cart road and foot trails. Total length of 5 to 6 meter wide motorable road inside the PBCA is about 15 kilometer and the foot trail is almost 17 kilometer long (Table 8).

Table 8. Existing Motor Road and Foot Trails inside PBCA during the Study Period

S. N.	Name of the Road or Trails	Type	Length (Km)
1	Khairan Jhala to Panditpur (Boundary Road)	Motor Road	4.5
2	Khairan Jhala to Salarpur	Motor Road	2.0
3	Muktipur to Turantpur (Boundary Road)	Motor Road	2.5
4	Salarpur to Tulsipur	Motor Road	4.5
5	Panditpur to Tulsipur	Motor Road	1.5
6	Khairanjhala to Bhariya	Foot Trail	3.0
7	Tower to Bhariya	Foot Trail	1.5
8	Guard Post, Tower to Tharubasti	Foot Trail	1.5
9	Salarpur to Bhariya	Foot Trail	2.0
10	Pachaskhalla to Turantpur	Foot Trail	2.5
11	Pachaskhalla to TUrantpur (Jungle Route)	Foot Trail	1.5
12	Muktipur to Tharubasti	Foot Trail	1.5
13	Others	Foot Trail	4.5

Source: Field Visit, 2006

4.3.3 Livestock Grazing and Biomass Removal

Livestock raising was found to be one of the main occupations of the local people at Khairapur. Due to the dense settlement and thorough use of land for cultivation, no open space for livestock grazing is left around the Blackbuck area except the Phanta of PBCA. The number and types of livestock grazed in different blocks of PBCA were noted and the block F and block H were found more heavily grazed than other blocks (Figure: 22). Block F is far from the guard post in eastern side, so illegal livestock grazing from the grazers of Khairi, Bhariya and Khairanjhala was intense and the intense grazing in Block H and Block B was from the grazers of Khairanjhala, Pataha Phanta and Jainpur.

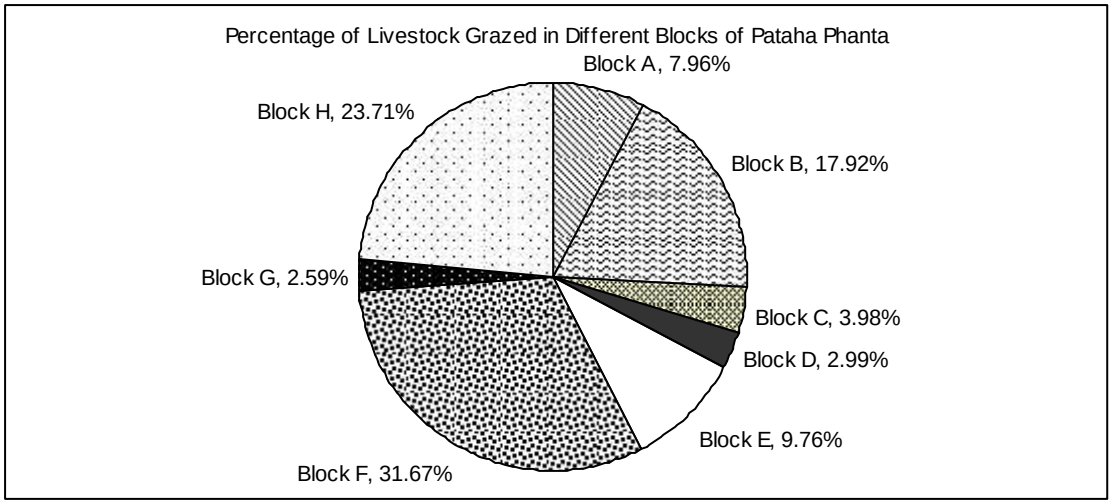


Figure 22. Percentage of Livestock Grazed in Different Blocks of Pataha Phanta (Source: Field Survey, 2006).

Average number of livestock grazed in PBCA was found to be 976 per day. The night grazing practice of buffalo and cow was also reported but could not be assessed. The livestock grazed were commonly buffalo, cows and goat. The percentage of buffalo grazing in PBCA is highest (44.46%) while the goats are least (12.81%) (Figure 23).

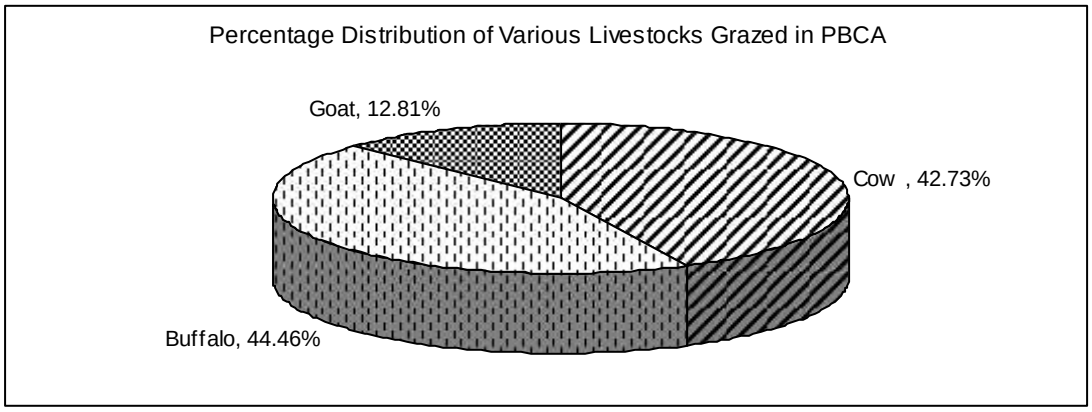


Figure 23. Percentage Distribution of Various Livestock Grazed in PBCA (Source: Field Survey, 2006).

The interspecific competition between the Blackbuck and livestock that were grazed in PBCA was noticed. The number of livestock grazed and the number of Blackbuck present in the respective block were counted for heavily grazed blocks F and H. Karl-Pearson's correlation coefficient (r) was calculated between the number of livestock grazed and the Blackbuck present in the same block. It was found to be r = - 0.562 at 0.05 level of significance (N = 22) that indicated a high degree of negative correlation. This indicated the interference competition between the livestock and Blackbuck in PBCA.

Biomass removal from the Pataha Phanta was one of the great threats in Blackbuck survival. Every day in an average about 65 grass cutters were seen removing the grass in two methods of grass cutting. Cutting with sickle and uprooting with the 'Khurpi'. The average amount of fresh biomass removed by each grass cutter per 'Bhari' was estimated to be 11.5 kg. The traditional method of grass cutting with 'Khurpi' removed the grass from top soil and the ground became cover less. It took almost two months for the herbs and forbs to re-grow on such areas if the season is favourable. This reduces the greenery of PBCA resulting less foraging habitat to Blackbuck.

The vegetation within the sampled $1x1m^2$ quadrates from the normal fields which were not manipulated and were grazed by the Blackbuck only, ploughed fields for habitat manipulation, grass cut fields with sickle and Khurpi; and the livestock grazed fields were removed and dried in incubator. The dry weights of biomass from 10 quadrates of each type were measured by digital balance and the significance difference in the biomass among the four types of field was tested with One Way ANOVA Test. There was the significant difference in the biomass of normal, ploughed, grass cut and livestock grazed fields of Pataha Phanta, PBCA (Calculated F-ratio = 9.44, Tabulated F-ratio = 2.88, d. f. = 3 and 36; $p < 0.05$). The biomass difference in different types of field indicated the significant effect in foraging habit of Blackbuck.

4.3.4 Health Hazards

The threat of gastrointestinal parasites and other diseases was also noticed in Blackbuck population in the PBCA from the common grazing fallow of Blackbuck and livestock, the chances of transmission of parasites and diseases was seen higher. Two does were seen suffered from foot and mouth disease and a buck was dead from suspected diphtheria during the study period. The gastro-intestinal parasite investigation report indicated that almost 100% of the livestock grazed in Pataha Phanta were infected from at least one protozoan or helminthes parasite. The common parasites from livestock were *Coccidia*, *Ascaris*, *Paramphistomum, Strongyles* and *Fasciola*. 93.33% of the observed samples of Blackbuck population were suffered from at least one of the protozoan or helminthes parasite. The common occurrence were *Paramphistomum* (83.33% samples were positive), Strongyles (86.67% samples were positive to the test) and *Ascaris* (36.67%). The common parasites of livestock and Blackbuck were *Paranphistomum, Strogyles* and *Ascaris* (Appendix VII).

4.3.5. Domestic and Stray Dogs

Dogs were reared by the local people to chase Blackbuck from their crop fields. Number of stray dogs found around the villages is also high. They were found to be one of the threats to the Blackbuck survival. No cases of death and casualties of Blackbuck due to the dog were observed during the study period but frequent attempts were noticed. Domestic dogs were seen in the groups while attempting to the Blackbuck area. Average number of individuals in a dog group was calculated to be 3.65 dogs per group from 23 observations. Out of the observed 23 attempts of the domestic dogs, 10 attempts (43.47%) were on single male, 7 attempts were on the mixed herd (17.39%) and 2 attempts were on the resting fawn (8.69%). Block-C, which is adjacent to the Khairan Jhala Village, is experienced to have highest dog attempts (69.56%). The groups of dogs were seen attempting at any time of the day. The morning observational phase of 06:00 hours to 09:00 hours is found with highest number (56.25%) of dog nuisance.

4.3.6. Crop Depredation

The conflict between the Blackbuck and local people was found to be one of the survival threats for Blackbuck. Some of the legislative measures against the activities of local people inside PBCA and the crop depredation by the Blackbuck in the crop field of local people, who are not compensated, were the main sources of conflicts arousal. The questionnaire survey and discussions were carried out with the local people and members of local Blackbuck Conservation Committee of ward number 2, 3, 4 and 5. Out of 86 respondents, 57.5% reported the loss of their crop due to Blackbuck. According to the respondents the extent of crop damage varied with seasons, growing stages of the crop and distance from the main core habitat of Blackbuck at Pataha Phanta to agricultural land.

4.3.6.1 Crop Depredation at Different Distances

The respondents were divided into three groups: less than 0.5 km, 0.5 to 1 km, and 1 to 2 km on the basis of distance between the Pataha Phanta and their crop fields. Turantpur, Panditpur, Pataha Phanta (Ailani land) and Khairi villages located at the distance of less than 0.5 Km were highly affected. The respondents of those areas reported the regular visit of Blackbuck to their crop fields at night time. The

frequency of Blackbuck visit and percentage of crop damage was found to be in inverse proportion with the distance (Table 9).

Table 9. Frequency of Blackbuck Visit in Different Distances for Crop Depredation

Distance from Pataha Phanta	Percentage Frequency			
	Frequently	Occasionally	Never	Total
Up to 0.5 km	91	9	-	100
0.5 to 1 km	67	19	14	100
1 to 2 km	31	33	36	100

The highest (81%) damage of crops was found in nearest distance within 0.5 Km while only 4% damage was reported in the distance of 2 Km from the Core Blackbuck habitat (Figure 24).

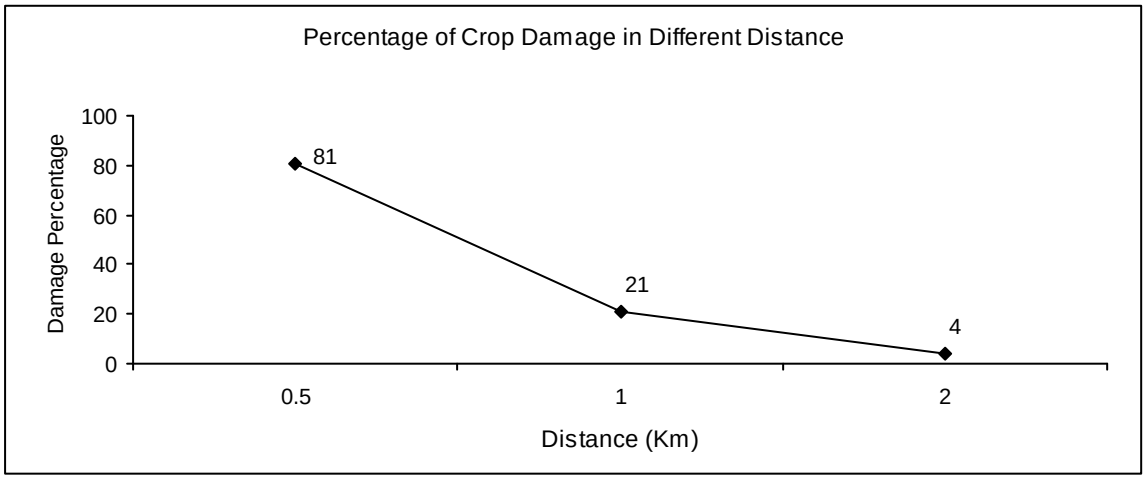


Figure 24. Percentage of Crop Damage in Three Category Distance from Core Blackbuck Area (Source: Field Survey, 2006).

The frequency of visit of Blackbuck and percentage of crop damage was based on questionnaire survey. Crop damage in some of the fields was recorded and some of the fields were even left barren without cultivation. Though, loss was recorded, people tend to exaggerate the damage amount of their crops.

4.3.6.2 Crop Preference and Seasonality of Damage

Crop damage of Blackbuck was excessive during the early stages of growth in most of the crops. The first choice of the Blackbuck were pulses including lentil, black gram, pigeon pea, beans, etc while the second preference was in wheat and mustard. Both the first and second preferences of Blackbucks are grown in winter season. So, crop

damage seems extensive in winter than in summer. Cotton, potato, paddy, etc. were the last choice of Blackbuck (Table 10).

Table 10. Percentage of Crop Damage by Blackbuck and Seasonality

Name of Crop	English/Botanical Name	Season of Growth	Respondent
Pulses	Lentil, Black gram, Beans, Pea etc.	Winter	92.40%
Wheat	*Triticum aestievum*	Winter	82.00%
Mustard	*Brassica Compestris*	Winter	80.50%
Pigeon Pea	*Cajanus Cajan*	Winter	35.50%
Corn	*Zea mays*	Summer	32.40%
Chilly	*Capsicum annum*	Winter	31.20%
Gram	*Cicer arietiunum*	Winter	28.40%
Cotton	*Gossypium arborium*	Winter	23.50%
Potato	*Solanum tuberosum*	Winter	15.00%
Alas	*Linum usitatissium*	Winter	14.50%
Paddy	*Oryza sativa*	Summer	7.50%
Groundnut	*Arachis hypogea*	Summer	4.25%
Lin seed	*Sesamum indicum*	Summer	-
Radish	*Raphanus sativus*	Winter	-

Source: Field Survey, 2006

4.3.6.3 Methods Adopted to Prevent Crop Damage

Different methods were adopted by the local people to prevent the crop damage from Blackbuck. Among them, making loud noise, chasing animals away, fencing the crop field, making effigy of different shapes and guarding the crop field staying in a hut made inside the field were common methods. Among these different guarding methods, more than one third (34.65%) of the respondents adopted the shouting and making noise to deter the Blackbuck before they enter the crop field and one third (33.2%) of the respondents adopted chasing the animals away by using dogs or themselves. Similarly, 23.4% of respondents adopted fencing on their crop field and 8.75% of respondents adopted hut guarding and effigy methods (Figure 25).

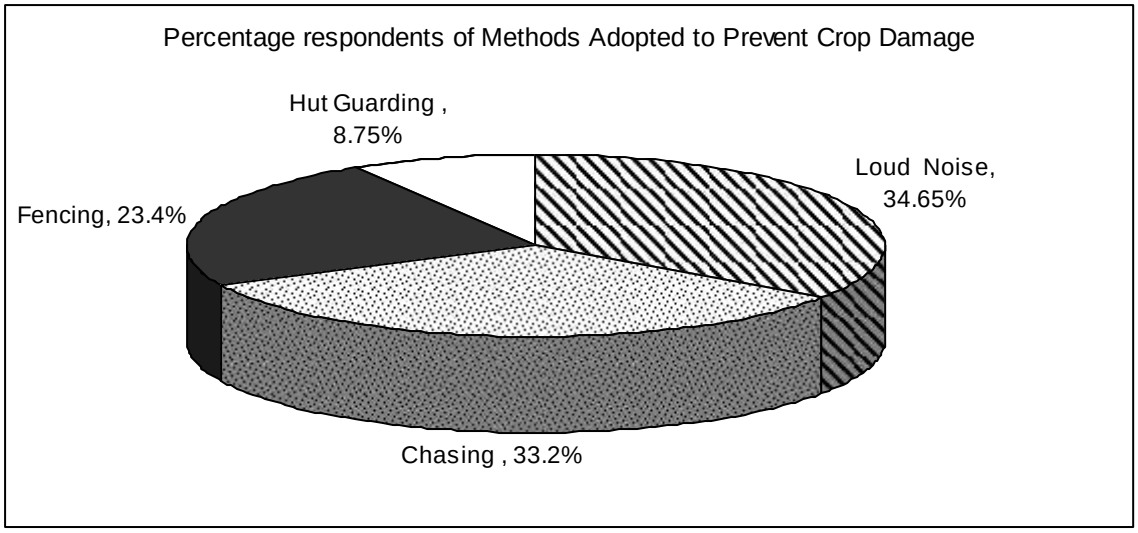


Figure 25. Percentage Respondents of Adopted Methods to Prevent Crop Damage (Source: Field Survey, 2006).

More than half of the respondents mentioned that the methods they adopted to prevent crop damage were partly successful, while other replied that the methods were useless at all.

4.4. Management Practices

A number of management practices were observed in the management of the PBCA at Khairapur with the involvement of governmental, non-governmental organization and local people.

4.4.1 Habitat Manipulation

Some of the methods of manipulating the PBCA in the favour of Blackbucks were practiced.

4.4.1.1 Fencing

3.5 km of the western boundary of PBCA is fenced with the metallic net, 1.5 km in the border with Bhariya in South and 2 km in the border with Khairan Jhala and Jainpur in North-West. But, the metallic fence was cut at more than 18 points from where free entrance and exit of Blackbuck as well as livestock was possible. Blackbucks were seen going out from such points even at the daytime in the month of April-May.

4.4.1.2 Water Holes Construction

Seven water holes were constructed and water was supplied with underground plastic pipes. Only three of such water spouts were seen working during the observation period. Blackbuck used such spouts for drinking in summer season when there was no water in standing water sources of old Babai river beds.

4.4.1.3 Ploughing and Seedling Growth

Under the financial support of Terai Arc Landscape Programme (TAL Programme), about 25 hectors of the Pataha Phanta was ploughed twice a year in different blocks with a diesel tractor that digs below to 1 foot depth. The seasonal crops are sown in the ploughed field. In winter, pigeon pea, lentil, black gram, bean and wheat seeds were sown and in summer corn and black gram seeds were sown. In June/July 2006, 26.47 hector of the field area from different blocks was ploughed and seeds were sown to provide supplement diet of the Blackbuck and to prevent going out of habitat (Table11).

Table 11. The Blocks and Area of Ploughing and Seedling Growth in June/July, 2006

S.N.	Blocks in Pataha Phanta	Ploughed Area (Hector)
1	A	3.29
2	B	6.44
3	C	9.33
4	D	7.41
Total		**26.47**

Source: Field Survey, 2006.

Species diversity of the herbs in ploughed area was found higher than in the non-ploughed area of the same block of Pataha Phanta. The maximum numbers of herds were observed in the ploughed blocks grazing on the field during the observation.

4.4.1.4 Non-Palatable Species Removal

Non-palatable species like Pirrhe (*Cymbopogon cirtatus*), Besharma (*Ipomoea, fistulata*), Shiru (*Imperata cylindria*) etc. that were invading in many area of Pataha Phanta were removed. The *Cymbopogon* and *Ipomoea* were dug out from their root; they were dried and burnt on fire.

4.4.2 Local Blackbuck Conservation Committees and Eco-Clubs:

There are 43 Conservation Committees formed among the local people from Ward Number 2, 3, 4 and 5 of the Gulariya municipality (Figure 26).

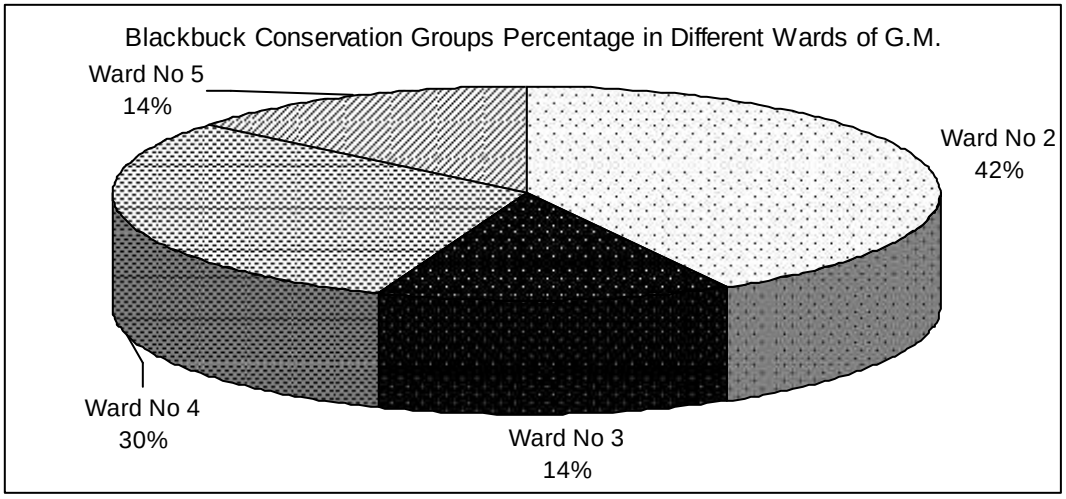


Figure 26. Blackbuck conservation groups Percentage in different wards of Gulariya Municipality (Source: Field Visit, 2006)

From 2 secondary schools and 3 primary schools 318 students are the members of Eco-Clubs in Gulariya Municipality. Shree Nepal Rastriya Shambhusaran Secondary School of ward no 2 and Dhruba Secondary school ward no 5, Tulsipur comprises of the 36.16% of the Eco-club members. 63.84% of the Eco-club members were from 3 primary schools (Saraswoti Primary School, ward no. 2, Bhanodaya Primary School, ward no. 3 and Krishnasar Primary School, ward no. 4, Khairi) of Gulariya Municipality. The members of the working committees of Blackbuck Conservation Groups and Eco-clubs used to have regular monthly meeting. Various discussions, interaction and training programmes were also organized in the coordination of local NGO named ICDC.

4.4.3. Involvement of Local NGOs and INGOs

CCEW and ICDC were the local NGOs directly involved in the Blackbuck Conservation Programme. CCEW in the past conducted many training programmes, mobilized the local people in conservation and killed 400 stray and domestic dogs with poison from the areas which were adjacent to the PBCA. CCEW conducted non-formal education programme to illiterate adults of the Gulariya Municipality, removed the *Ipomoea fistulata* with the mobilization of volunteers and initiated the award to those persons who gave the secret information about the Blackbuck poachers and hunters.

ICDC is another non-governmental organization working in the field of biodiversity conservation and local development in Bardia district. Blackbuck Conservation Groups and Eco-clubs were formed under the initiation of ICDC that regularly conducted the awareness raising programmes in Bardia district by means of training and seminars.

Terai Arc Landscape (TAL) Programme under WWF is working for the conservation of Blackbuck and management of the PBCA. It provided the funds for the ploughing and seedling growth in PBCA, twice annually. The fencing in the PBCA, removal of *Ipomoea fistulata*, and *Cymbopogon citratus*, construction of a viewing tower, guard post, trench around the Pataha Phanta, and water holes etc. were some of the mentionable events carried out under TAL programme in PBCA.

4.4.4. Perception of Local People

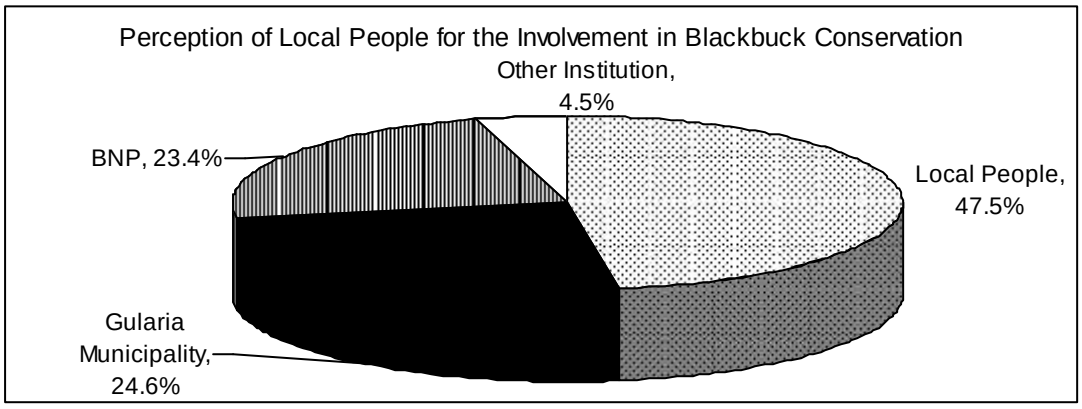


Figure 27. Perception of Local People for the Institutional Involvement in Blackbuck Conservation (Source: Field Survey, 2006)

Most of the respondents expressed importance of Blackbuck for its religious, tourism and ecological value. 100% of the respondents said that the Blackbuck should be conserved and 94.14% of the respondents said that the Blackbuck area should be declared as "Blackbuck Conservation Area" by the government. 86.5% of Ailani land owners mentioned that they were ready to be shifted from their present area if the government provides them suitable alternatives for their settlements. 47.67% of the 86 respondents expressed that Blackbuck should be conserved by local communities themselves with technical assistance from government and NGOs / INGOs; 24.6% expressed that Gulariaya Municipality should conserve it. 23.4% recommended the role of BNP and remaining 4.5% recommended for some other institution (Figure 27).

PHOTO PLATES

Photo 17. Grass cutting inside PBCA with the 'Khurpi' leaves the ground bare for long time

Photo 18. Livestock pressure on the Pataha Phanta, a serious threat in Blackbuck survival

Photo 19. The victim of natural calamity, the fawn dead on Phanta after hailstorm

Photo 20. A group of females crossing the road inside their fragmented habitat.

Photo 21. Ploughing and seedling growth is the management practice at Khairapur

Photo 22. Two bucks of different age grazing on the ploughed field

Photo 23. A buck herd in the ploughed field at Khairapur

Photo 24. Frequent disturbances in habitat cause Blackbuck to run along the field at Khairapur

5. DISCUSSION

5.1 Population Status at Khairapur

The total counted population of Blackbuck during this study was 133, showing an increase of two fold in population since 2002. It was only 65 individuals at that period (Khanal, 2002). The Blackbuck population in Bardia was found never exceeding 190 individuals that were reported by Bauer and Ellenberg (1988). Dinnerstein (1975) and Wegge and Wilson (1976) reported two separate population of Blackbuck existed in Banke and Bardia districts of Western Terai region. Lehmkul (1979) reported 11 Blackbucks in Khairi Panditpur area of Bardia and 7 in Jamuni and Bhagawanpur of Banke. There is no other Blackbuck population recorded at wild in Nepal except that of Khairapur, Bardia.

Starting from three Blackbucks in 1973 (Shrestha, 1973), the population increased steadily to 190 individuals until 1988. The population decreased to 162 in 1991 (Subedi, 1991) while drastic decline below to 92 in 1993 (Nepal, 1994). Tamang and Shrestha (1998) reported 102 individuals in 1995 and 111 individuals in 1996. The population of Blackbuck decreased again to 94 in 1998 (Chand, 1999), even below to 47 in 1999 (Pradhan, Bhatta and Jnawali, 1999) and 40 in 2000 (Khanal, 2000). Chand (1998) reported the declination of population could be due to predation by village dogs, early mortality of fawns and ever going interspecific competition with domestic livestock for forage. He reported the observation of strong evidences of predation by village dogs and fawn mortality due to severe cold in the winter. The extreme reduction of Blackbuck has been attributed to the habitat destruction and excessive killings (Bista, 1981). The population of Blackbuck may have decreased from 190 individuals in 1988 to 40 in 2000 because of inbreeding of localized population, hunting and poaching, predation by the wild predators and domestic dogs and paralyzing effect of poisonous plant Besharma (*Ipomoea fistulata*) which were browsed by Blackbuck during scarce period. Khanal (2002) reported 65 Blackbucks in 2002, there were 107 Blackbucks in November, 2005 and 133 individuals were counted in the July, 2006 during this study. The apparent 21.67% increase in population occurred from 2005 to 2006. The increase in population was may be due to the improvement of habitat through habitat manipulation, increased awareness of

local people and emergency and curfew may have lowered poaching activities and increased the free crop raiding facilities for the Blackbuck at night time.

The smaller the population size the more vulnerable it is to extinction due to demographic, environmental and genetic stochasticity. The smaller population may become extinct through chance fluctuations in fertility and mortality of individuals or a peculiar age structure (Sukumar, 1992 and Chapman and Reiss, 2005). The small population of Blackbuck in the isolated and fragmented small habitat in PBCA is prone to extinction because of environmental stochasticity that may result from a disease epidemic or adverse climate such as a severe drought, flood, fire etc. In 1991, several Blackbuck (*Antilope cervicapra*) were killed in Bardia district by a heavy hailstorm (Majupuria and Majupuria, 2006). In a small population gene frequencies change from one generation to another with the loss of some alleles which is known as genetic drift that leads into genetic uniformity. Such genetic uniformity is not better in evolutionary point of view for the continuity of generation of wildlife population. Sukumar (1992) mentions that about 500 effective breeding individuals are must to counter the genetic drift through natural selection or by gain from mutation, the population maintaining this effective size can be expected to remain viable from an evolutionary viewpoint. .

Nepal (1994) reported the density of Blackbuck population at Khairapur to be 17.52 individuals per square kilometer. Chand (1998) found it to be 17.90 individuals per square kilometer and Khanal (2002) found the Blackbuck population density to be 12.38 individuals per square kilometer. 62.5 individuals per square kilometer was the density of Blackbuck in Rehekuri Sanctuary, India in 1986 (Bharucha and Asher, 1993). The crude density of Blackbuck in present study was found to be 25.33 individuals per square kilometer and the ecological density, considering only the Pataha Phanta as the useful habitat for the Blackbuck, was 75.14 individuals per square kilometer.

The sex ratio is defined as the population of males in population. In population of many (perhaps most) diocious organisms there are approximately equal numbers of males and females (Pianka, 1974). The sex ratio of Blackbuck in the present study was found to be 1:1.29 indicating 77.3 males per 100 females. Nepal (1994) recorded

30 males per 100 females indicating male to female ratio was 1: 2.9. Chand (1999) gave the male to female ratio of 1:4 indicating 25 males per 100 females and Khanal (2002) gave the sex ratio of 1:1.95 indicating 51.26 males per 100 females in the same study area. The male to female ratio seems to be decreased since 1998 indicating the close approach of 1:1 sex ratio of diocious animal, Blackbuck in PBCA. Mungall (1978) came across a sex ratio of 1:1.5 in Texas Pasture and Ranjitsinh (1989) in India accounted a sex ratio of 1:2.8. Nair (1976) gave the sex ratio of 1:4.7 from the Point Calimere Sanctuary, Tamilnadu. Bharucha and Asher (1993) recorded the sex ratio of 1:1.37 for male to female population of Blackbuck at Rehekuri Blackbuck Sanctuary, Maharashtra and the sex ratio of 1:4.76 was recorded for the Blackbuck population of Guindy National Park, Madras (Shankar Raman *et al.* 1995). Hence, the present Blackbuck population of PBCA seems to have similar sex ratio with that of Texas Pasture as accounted by Mungall (1978). The diocious animals theoretically have the male to female sex ratio of 1:1 that is rarely found in the wild population. If the sex ratio is closer to 1:1, there are fewer chances of genetic uniformity and genetic loss. More unequal the sex ratio, the higher is the rate of genetic drift (Sukumar, 1992).

During this study period, the adult male to female sex ratio was found to be 1:1.28 indicating 78.26 males to 100 females while Chand (1999) got 20 adult males to 100 adult females and Khanal (2002) got 43.47 adult males to 100 adult females in the same study area. Among sub-adult, male to female ratio was found to be 75 males to 100 females but Chand (1999) accounted 43 sub-adult males to 100 sub-adult females and 96 sub-adult male to 100 sub-adult female was the ratio computed by Nepal (1994) in PBCA. The adult females were found to be highest with 34.58% followed by adult males 27.06%. Nepal (1994) in the same study area recorded 56.11% females followed by 14.38% adult males, Chand (1999) recorded 58.5% females followed by 11.70% adult males and Khanal (2002) recorded 35.38% adult females followed by 15.38% adult males. The fawns comprised 11.28% of the population in the present study that was recorded to be 9.57% by Chand (1999). Sub-adult males and sub-adult females were 6.77% and 9.02% respectively. Adolescent males and females comprised 5.26% and 6.01% of the total population in PBCA. The population of Blackbuck in different age group when plotted in graph; the curve obtained is skewed towards the left. Knight (1966) mentioned: a population curve skewed to the left

indicates a greater number of mature individuals existing within the population with little reproductive activity or success, as in evidenced by the small number of immature size classes.

Schaller (1967) defined two fawning peaks of Blackbuck in India, one in March-April and next in August-October. Tamang and Shrestha (1998) suggested that more fawns were born in the month of January to April and with a gestation period of around six and half months, this may perhaps indicate a peak rutting season in July-October for Khairapur population. In the present study, most of the cases of fawning were noticed in March and April.

The average herd size of the Blackbuck in the PBCA was recorded to be of 7.64 individuals. 34% of the total herds were observed in the groups of 6 to 10 individuals. The herd size never remained constant indicating a weak social relationship among individuals. Tamang and Shrestha (1998) accounted a mean herd size ranging from 4.4 to 6.9 animals and Chand (1999) recorded the average herd size of 9.8 to 10.55 individuals in the same study area. Nair (1975) accounted the average herd size of 23 individuals of Blackbuck in Point Calimere Sanctuary, Tamilnadu; and Bharucha and Asher (1993) recorded the average herd size of 21 animals from Rehekuri Blackbuck Sanctuary, Maharashtra. Among the herds observed during this study almost one-third (32.34%) of the herds were single individuals of which 82% were single males. The largest herd recorded was of 59 individuals which was seen on the 20th April morning when heavy wind and rainfall with hailstone occurred at the evening of 19th April, 2006. Tamang and Shrestha (1998) observed 34% of the herds as the single individuals of which over 80% were males and Chand (1999) observed 29.58% of the herds as single individuals. Herd size varied considerably with the season, time of the day, availability of food and nature of disturbances from activities of visitors, tear passers, livestock and livestock grazers.

The birth rate of Blackbuck in PBCA was found to be 0.84 per mature female per year and the death rate was calculated to be 0.091 per individual per year. The birth rate was computed to be higher than the death rate indicating the apparent population growth rate of 21.67% for the year 2005 to 2006.

5.2 General Behaviour and Diurnal Activities

During this study period, four main types of social groups were found in Blackbuck in the PBCA: mixed herds, breeding herds, male band and single adult male. A male and a female in courtship, a female and a neonate on nursing period, group of resting neonates and group of females and fawns were also occasionally seen. Schaller (1998) at Kanha National Park, India reported only three types of herds in Blackbuck: mixed herds, breeding herds and buck herds. The social organization of Blackbuck in the PBCA was found loose because of frequent disturbance from the visitors, tear passers, livestock, dogs and livestock grazers. The territory marking by the mature male with a number of visual and olfactory signs serve to delineate the boundary. The most conspicuous territorial marker is the buck himself with his striking black and white pelage and long horns, standing, as he often does in a prominent place (Schaller, 1998). Fecal deposits on certain locations and secretions from pre-orbital glands deposited on grass and bushes serve to mark the territory (Prasad, 1987). Exhibition of territory by the mature male were observed in PBCA but the territories were not maintained for long time as mentioned by Schaller (1998) in Guindy National Park, India. The reason behind the poor territorial marking may be as explained by Tamang and Shrestha (1998), the small size of the core habitat at Pataha Phanta, constant daily disturbance from people and livestock activities, year round sexual activities, continuous harassment and chasing by dogs etc. Many dung piles of territorial males were seen in April-May but with the onset of rainy season such dung piles and definite sequence of actions of territorial male while defecating there, were not observed. When chasing an intruding buck or when driving a doe, the territorial male often produced grunting sound and chased with halts and head-up display. The buck raises his muzzle so high that the horns lie almost alongside the neck; the ears are folded back, lowered and held somewhat laterally exposing the white insides and the stubby tail is raised and curved up over the back, making the white patch on the rump conspicuous (Schaller, 1998). The territorial male was seen approaching the opponent in head-up display, flashing his white chin. Uttering a series of harsh grunts and jerking up his head with each sound. Sparring was seen common among individuals of buck herds, the continuous sparring for long time was separated by a superior male.

Blackbucks are almost exclusively grazers (Schaller, 1998) as most of the ruminants they are non-selective feeders. During this study period Blackbuck was seen preferring *Cynodon dactylon, Medicago denticulre, Echinocloa colonum, Euphorbia hirta, Zizyphus mauritiana* etc. Bhandari (1994) accounted the preference of *Cynodon dactylon, Imperata cylindrica, Saccharum spontaneum, Desmostachia bipinnata* and *Vitiveria zyzanoides* from the same study area. Lehmkul (1979) reported the Blackbucks were dependent heavily on agricultural crops in Banke and Bardia districts. Bharucha and Asher (1993) accounted the preference of Blackbuck in modified habitat where the successional stages are set back. Blackbuck at Guindy National Park prefer *Carissa spinarum, Randia dumetorum* etc. in dry season and *Aristida setacea, Cynodon barberi, Cymbopogon flexuosus, Chrysopogon fulvus, Indigofera linnaei* etc. in wet season (Shankar Raman *et al.* 1995). Roberts (1997) observed the preference of Blackbuck in fallen flowers of *Tecomella undulata*, leaves of *Prosopis* spp., *Zizyphus numularia. Aristidia mutabilis, Cymbopogon jwarancusa* etc. in Pakistan. Blackbucks are generally found in areas with such low growing grasses as *Andropogon brevifolius* and *Echinocloa colona* avoiding *Themeda* and other tall grasses (Schaller, 1998). The Blackbucks are sprout feeders; they preferred the *Cynodon* dominated blocks of Pataha Phanta. They spent most of their time in ploughed areas and almost 51.55% of the herds were observed in ploughed fields during this study period. They spent most of the early morning and late afternoon time on feeding.

Many zoologists are of the opinion that Blackbuck seldom drinks (Shrestha, 1997). It has been reliably established that they do not drink water even when it is available (Roberts, 1997) and Schaller (1998) mentions he had never seen Blackbuck drink and even during the hottest months of the year, the animals failed to make obvious trek to water at dawn and dusk like Chital and Barasingha. Khanal *et al.* (2005) reported the drinking habit of Blackbuck in artificial ponds of semi-captive enclosure at Mrigasthali, Kathmandu. During this study at the hot season of April-May when the grasses and forbs on the ground were withered, Blackbucks were seen drinking water 2 to 3 times a day in artificial water holes at about 09.00 AM in the morning and at the noon in PBCA. Krishnan (1972) reported that Blackbuck drink regularly in Guindy National Park, India and he mentioned the Blackbuck scraping at soft soil with their muzzle. The Blackbucks of PBCA were also seen licking the soil, probably

to maintain the minerals and salts in their body. They regurgitate their food while resting, chew thoroughly and re-swallow (Gelder, 1969).

Keen eye-sight and high speed were observed as the natural defense of Blackbuck against predators. Their group living habit was seen beneficial for them as many eyes could locate the threat easily than the few ones. The flat grass land of PBCA was seen suitable for the Blackbuck for their long range of vision. Though, being fast of foot few adult animals even fall to carnivores (Shrestha, 1997). The alert posture, which as in common deer consists of standing erect with the neck held almost vertically, is the most frequently employed visual signal in response to an alarm call. Blackbuck appears to have a good sense of smell (Schaller, 1998). Spronking was seen when the animals were disturbed, in which all the four feet are bunched together and the animal lands on the hooves simultaneously producing an audible 'thump' (Nair, 1975). This leaping may serve to increase the field of vision for a plain-dweller for whom death may lurk behind any clump of grass, or to alert conspecifics through visual, auditory or olfactory signals or may serve to deflect the aim of a pursuing enemy (Nair, 1975 and Schaller, 1998).

The dominant male displayed similar posture in dominance and courtship. With the onset of rutting season, courtship displays were observed. The male sniffed the ano-genital region of the oestrous female and displayed the characteristic head-up display. The male chased the female and she circled back to the herd. Several attempts of mounting were observed. Schaller (1998) observed several occasion of mounting, one buck mounted four does in succession but no successful copulation was seen. The receptive female raised her tail curved up; the male jumped over her, hold her body with his forelegs and jerked forward with the genital contact. The female bowed her body and ran away; the male licked its genitalia and followed her. Schaller (1998) reported the animals sometimes copulate while walking or trotting. During the study period in PBCA, many cases of successful copulation were observed but no receptive females were seen standing erect firmly during copulation. They were at the same position seen with slow motion during copulation.

The parturition in Blackbuck was observed in the tall grass field unlike as it was mentioned by Tamang and Shretstha (1998) in *Zizyphus* bush. The doe after delivery

licked the placental covering of the neonate thoroughly. After 8-10 minutes the neonate was seen standing, the doe suckled the neonate and the neonate shifted few meters away and remained at rest. The doe was seen grazing nearby the area of her neonate with frequent alert posture. Grzimek (1990) explains the maternal behaviour of the Blackbuck as 'staying put' in which the mother licks the body of its neonate, stimulates the urination and defecation of the neonate by massaging on its ano-genital region by her tongue and drinks and feeds upon the urine and feces of neonate making it completely odourless, at the time of suckling and nursing. Then the neonate rests in the hiding place till the next nursing period, the mother Blackbuck never approaches the hiding place of the neonate, it just calls the neonate at the time of next nursing. The neonate of antelope is able to stand within few minutes and to run efficiently within 2 days (Carrington, 1963 and Chalise, 2004).

Diurnal activities were recorded during April to July 2006. A total of 3942 individuals representing different age groups of both the sexes were observed. Most common activity in a characteristic day was feeding (57.33%) followed by resting (20.61%), walking (12.44%), others (6.29%) and alert (3.34%). Khanal (2002) accounted that Blackbuck spent 38.56% of the day time on feeding followed by resting (32%), walking (14.2%), others (8.32%) and alert (6.92%) in the same study area. The higher percentage of feeding during my study period was may be due to the lack of sufficient grass on the ground. Due to extreme hot and drought most of the herbs and forbs of the Pataha Phanta were withered during April-May. Blackbuck spend 40% of the day light for grazing in Texas (Mungall, 1978) and 36% spending during summer from India was reported by Ranjitsinh (1989). However on yearly basis only 11-25% of feeding and 37-57% for rest time was reported by Rao and Prasad (1982). Chattopadhyay and Bhattacharya (1983) reported 50% of the day light was used by Blackbuck for grazing. Schaller (1998) accounted the grazing percentage of Blackbuck to be 62.5% from November to February.

Blackbuck in the PBCA are in sub-optimal habitat condition, so that they spent most of their time on grazing. The animal mostly remained active in the day time except a brief spell around noon when less than 50% of the population was seen to be active. The activities reached to their peaks once in morning at 08.00 hour and again during afternoon at 15.00 hour. During the peak hours of grazing no individual was seen

resting whereas, during low period of activity and grazing many were seen resting on the ground. Standing, resting and alert as static activities, characteristically show just the reverse relation with grazing and walking.

Dhakal (1994), reported that Blackbuck at Khairapur were grazing during morning was the most dominant activity and Khanal (2002) reported that resting was the main dominant activity during the morning. During this study period Blackbucks were seen actively grazing in the morning and late afternoon as similar to Dhakal (1994). Khanal (2002) reported crop raiding by the Blackbuck at night time and resting at the morning but during my observation, no crops were cultivated in the fields except few, may be because of that Blackbucks were grazing since early morning. The grazing percentage of the Blackbuck increased up to 08.00 hour and they started to rest till the day, again from 15.00 hour till the evening they were seen actively engaged in grazing.

Among different herd types, time spent in feeding was found highly dominant than other activities, followed by resting and walking. Mixed herds spent maximum day time on grazing than others. Single males were found next to the neonates to rest more in the day light. The individuals of the sub-adult buck herds were the most walking group members in PBCA. Among different age and sex groups, mother female remained in alert posture in highest percentage. Such an alert posture of the mother female is for guarding and looking after at her neonate. The individuals of buck herds and the alpha males of breeding herds spent more time on other activities like sparring, chasing, display, etc. than others. As in present observation, it was also reported by Schaller (1967) and Nair (1975) that in Blackbuck grazing is more frequent in females than males. On the other hand resting was more frequent in males than in the females as observed by Schaller (1967). The neonates spent much of the day lying quietly hidden in a patch of the grass, being visited only at the intervals by its mother. The neonate was observed crouched with neck and head extended along the ground. Schaller (1998) reported a doe suckled its doe for 50 seconds, licking its rump; one day old neonate was suckled several times, totaling about 250 seconds in 15 minutes. Similar cases were observed in Blackbuck population in the PBCA during this study.

5.3 Survival Threats of Blackbuck

Loss and alteration of habitat is considered to be the greatest indirect threat to the wildlife of Nepal (Majupuria and Majupuria, 2006). Loss of habitat has been one of the principal reasons for the decline in the number and distribution of important population in most places. We are facing similar problems related to wild buffalo (*Bubalus bubalis*), rhino (*Rhinoceros unicornis*), tiger (*Panthera tigris*), elephant (*Elephas maximus*), swamp deer (*Cervus duvauceli*), gaur (*Bos gaurus*) and Blackbuck, just to name a few important species in Nepal due to loss of habitat (Tamang and Shrestha, 1998). Habitat encroachment and fragmentation are seen as the main threats to the Blackbuck survival in Bardia (Chalise, 2004). Out of the total delineated area of 5.25 square kilometer of PBCA, excluding the forest, settlement and agricultural field; only 1.77 square kilometer of Pataha Phanta is the suitable habitat for Blackbuck. The 1.77 square kilometer area of the Pataha Phanta is also fragmented into dozens of fragments by motor road and foot trails. The sizes of the home-range of Blackbuck vary with the size of the herd, availability of food, topography of the terrain and intraspecific competition. A herd of 12 individuals in Kanha National Park, India had home range of about 0.4 Km^2 and a herd of 28 individuals in Wankaner National Park, India had a range of approximately 2.5 Km^2 (Ranjitsinh, 1989). Simulating 133 individuals of PBCA with range of 12 individuals in Kanha National Park shows that they need 4.43 square kilometer area where as comparing with the Wankaner National Park needed the home range of 11.88 square kilometer. This clearly indicates that the habitat used by the Blackbuck at Pataha Phanta is not enough for long term survival. Provided that obvious requirements such as food, space and water are available, a major requirement for free ranging Blackbuck is the opportunity for the males to express territorial behaviour. Non-territorial males rarely reproduce (Walther *et al.* 1983).The fragmentation of habitat in Guindy National Park, India is likely to have mainly affected the spatial distribution of Blackbuck territories (Shankar Raman *et al.* 1995). The area of PBCA useful for Blackbuck population is very small, isolated and fragmented, where the males are unable to maintain territory; so the viability of the males may have decreased that may result into long term problem in the survival of Blackbuck population.

Livestock encroachment is an acute problem in the protected areas of Nepal (Majupuria and Majupuria, 2006). Illegal grazing of livestock inside the PBCA was a part of regular observation during the study period. The livestock grazing in the field of PBCA not only removed the biomass of grass but also harassed and disturbed the Blackbuck activities. The probability of the disease transmission while sharing the same grazing fallow was seen high; the health condition of most of the livestock grazing at Pataha Phanta was seen very poor. *Paramphistomum*, *Strongyles* and *Ascaris* were the common gastro-intestinal parasites in the livestock and Blackbuck. Baur and Ellenberg (1988) reported a total of 811 livestock utilizing the Blackbuck habitat and Bhandari (1994) estimated livestock number in between 1100-1200 in 1994. Khanal (2002) reported substantial decrease in the livestock grazing inside the PBCA. During this study period the average number of the livestock grazed inside the Pataha Phanta in a characteristic day excluding the night grazers was found to be 976 per day; almost 7.34 times more than the Blackbuck population. Considering an adult male goat or *Antilope* equivalent to 0.23 livestock unit (Majupuria and Majupuria, 2006) the livestock grazing in Pataha Phanta is equivalent to 31.91 times more than the Blackbuck population in terms of biomass removal. Blackbuck prefers sprouting shoots of grass therefore mild grazing is useful for the Blackbuck (Khanal, 2002). At present, excessive and uncontrolled livestock grazing at day as well as at night leaves no time for the growth of sprout and its consumption by the Blackbuck. Biomass from the Pataha Phanta was seen removed in large amount by grass cutters also for stall feeding that seems better than the livestock grazing in Phanta for Blackbuck as there will be less chances of disease transmission and interference. But, illegal method of grass cutting by 'Khurpi' left the ground bare for long time, grass cutting with sickle was seen beneficial for Blackbuck. Significant difference in the biomass of normal field, ploughed field, overgrazed field and grass cut field of Pataha Phanta was obtained when tested with One Way ANOVA.

Tamang and Shrestha (1998) reported nine Blackbucks killed by dogs in 1995/1996; the most vulnerable were the young and the pregnant females. Pregnant females may abort from such harassment and have serious adverse effects on reproduction. Chand (1999) reported the local village dogs were the serious cause for high mortality on fawn and pregnant females. During this study period several unsuccessful attempts of dogs in group towards Blackbucks were observed but no case of casualty or deaths were noticed.

Crop damage by the Blackbuck in the agricultural field of local people was one of the main causes of conflict between the Blackbuck Post authorities and local people. If the livestock of local people were caught inside the Pataha Phanta they were penalized but no compensation was given when the Blackbuck damaged their crops. The crop damage by the Blackbuck was found to be higher in winter than in other seasons and the intensity of the damage decreased with increase in distance of crop field from Pataha Phanta. Most of the crops were damaged extensively in the early stages of their growth. Kafle (1998) reported grazing of domestic animals during winter in Blackbuck habitat is the main reason of lack of food thereby forcing the Blackbuck to enter the cultivated areas. Chandra (1997) observed that the intensity of crop damage was directly proportional to an increase in the animal population, with more crops damaged in the high intensity Blackbuck areas. He also noted that the Blackbuck preferred the tender shoots and blades of succulent plants. Several methods were adopted by the local people to prevent from the crop damage by Blackbuck. Most of the local people practiced making noises and chasing animals; hut guarding was reported to be difficult and fencing was complained to be less effective due to high jumping habit of Blackbuck that could cross the fence easily.

5.4 Conservation Practices of Blackbuck

Various management practices of Blackbuck and its habitat were seen in PBCA. Habitat manipulation was done by fencing about 3.5 Km of the perimeter of PBCA, artificial water holes were made and supplied with water in dry seasons. About 25 hectare of the Pataha Phanta was ploughed twice a year in different locations alternately and seedlings of seasonal crops were grown. The seedlings were used up by the Blackbuck in their early stage of growth. The ploughing and firing leaves the ground bald for some time therefore it needs to be done in suitable season. The ploughing and firing being practiced in PBCA at the dry season should be done before the onset of spring season. The fence was seen of no use for Blackbuck protection as it had many holes through which easy passage of Blackbuck and livestock was possible, but some cases of Blackbuck death after striking on the fence while escaping from the chase of dogs and hyenas were reported by the local people and game scouts. Non-palatable plant species like *Ipomoea fistulata, Cymbopogon citratus* etc. were dug out, dried and burnt. *Ipomoea fistulata* was reported to be poisonous to

Blackbuck by Khanal (2002) and the game scouts of PBCA complained the paralysis in Blackbuck after consuming large amount of *Ipomoea* in dry season. Bharucha and Asher (1993) explained that rangeland management within and outside the sanctuary, fodder supplement, plantation of lure crops, change in cropping pattern and land use pattern were the methods practiced in Rehekuri Blackbuck Sanctuary, Maharashtra (India). Habitat manipulation, control of exotic plants like *Acacia auriculiformis, Prosopis juliflora*, *Antigonon leptopus* and *Cereus peruviana*; introduction of a few Blackbuck from other areas and regular long term monitoring were the recommendations made for the management of Blackbuck population in Guindy National Park, Madras (Shankar Raman *et al.* 1995).

Local peoples of Gularia Municipality were involved in the conservation of Blackbuck at Khairapur. Local Conservation Committees and Eco-clubs members were engaged in conservation programmes with active participation in various discussions, interactions and training programmes organized by the local NGOs involved in Blackbuck conservation. Ironically, some of the members of conservation committees were themselves grazing their livestock inside the PBCA field. One of the main reasons behind this situation may be the lack of awareness in wildlife conservation, the next being their poor economic condition with no alternative grazing land for their livestock and no alternative profession for their survival. Most of the local people said that the government should initiate the effective measures to conserve Blackbuck at Khairapur. They pointed the conservation of Blackbuck at Khairapur for religious, tourism, economic and ecological importance. Almost all the local people said that the Khairapur area should be declared as the “Blackbuck Conservation Area” with legislative measures as soon as possible.

6. CONCLUSION

Total population of Blackbuck in PBCA during the terminal period of this study was 133, showing an increase of 216.28% since 2000 AD and 18.04% than that of 2005 AD. The crude density of Blackbuck in PBCA was 25.33 individuals/ km^2 while the ecological density in core habitat was 75.14 individuals/ km^2. The sex ratio was 77.3 bucks to 100 does. Female population in all the age group was more than male population but in no group this departed from 1:1 sex ratio ($\chi^2 = 2.16$, $p>0.05$). The highest population percentage was of adult female (34.58%) and 11.28% of total population were the fawns. The crude birth rate was 0.84 per matured female per year and mortality rate was 0.091 per individual per year. Mean herd size recorded during the study period was of 7.64 individuals.

The social groups were mainly mixed herds, breeding herds, buck herds and isolated males; the aggregations were loose which could be changed by climatic and disturbance factors. Territoriality marking by adult male with dung pile and secretion of sub-orbital pit glands on grasses and bushes were observed. The grasses preferred by Blackbuck were *Cynodon dactylon*, *Saccharum spontaneum* and *Medicago denticulre* on feeding. The feeding reached to the peak (83%) at 08.00 hours in the morning and least (32%) at 11.00 hours. Less than 50% of Blackbucks were engaged in feeding from 10.00 to 14.00 hours; that again peaked up and continued till the evening. Drinking of water in artificial water holes was observed 2 to 3 times a day in April and May. Sharp eye sight, long range of vision in flat land and high speed are the natural defence measures of Blackbuck against predators. The mother Blackbuck licked the neonate thoroughly while nursing, making it odourless as the means of defence before hiding it alone in the bush or grasses. Sparring was observed mostly among the individuals of the same age group in which two males jerked their head down, locked horns with crash and then pushed and twisted their head until one turned aside. The winner often followed the loser in head up display. The dominant male exhibited similar head up display for dominance and for courtship. The male could recognize the oestrous female by sniffing her ano-genital area or urine. He continued to follow her in head up display placing his chin on her rump, licking genitalia and blocking her movement with the attempt of copulation. The copulation occurred in slow movement of the female when the male jumped over the receptive female and gave the thrust after genital contact.

Most common activity in day time was feeding (57.33%) followed by resting (20.61%), walking (12.44%), others (6.29%) (Sparring, chasing, courtship, mating,

etc) and alert (3.34%). Among different age and sex groups, the mixed herds spent maximum percentage (57%) of time on feeding while the alpha male of the breeding herd was the least feeder (39%).

The total 5.25 square kilometer of the PBCA is heavily encroached by the local people. Only 1.77 square kilometer of Pataha Phanta is being used by 133 Blackbuck which is even highly fragmented into small pieces by motor roads and foot trails. Blackbucks in confined area of Pataha Phanta are disturbed by visitors, village dogs and livestock. Livestock interfered the Blackbuck in grazing fallow and exploited them by removing the biomass from their foraging field. The threat of disease transmission between the livestock and Blackbuck was also high. Crop depredation by Blackbuck was mainly in the winter season in lentil, black gram, beans, etc. The frequency of Blackbuck visit and percentage of crop damage is found inversely proportional to the distance of crop field from Pataha Phanta. Local people prevent crop raiding by chasing Blackbuck, making loud noise and installing fence around the crop field.

Fencing 3.5 km of western boundary, supplying water in artificial water holes, ploughing and growing seedlings of pigeon pea, lentil, black gram, wheat, etc and the removal of non-palatable invasive species *Ipomoea* and *Cymbopogon* are some of the habitat manipulation practices of PBCA. 'Blackbuck Conservation Committees' of local people, Eco-clubs of primary and secondary level students around PBCA and local NGOs like ICDC and CCEW work in the field of Blackbuck conservation. TAL Programme under WWF provides financial support in ploughing and seedling growth. 94.14% of the respondents said that Khairapur area should be declared as 'Blackbuck Conservation Area' and 47.67% people said that conservation of Blackbuck should be done by the local people.

The population of Blackbuck at Khairapur is increasing. Even with the frequent anthropogenic disturbance they exhibit their characteristic social, feeding, aggressive, anti-predatory and sexual behaviour. Encroachment and fragmentation of habitat, excessive interference and exploitation by the livestock, frequent disturbance by the village dogs, possibilities of epidemic and parasitic diseases transmission and their crop raiding nuisance in the scarcity of forage in the habitat are the survival threats of Blackbuck at Khairapur. A few management practices for Blackbuck habitat at Khairapur area are deemed over by the strong survival threats. So, in the continuity of present situation, the long-term survival and population flourish of the Blackbuck at Khairapur does not seem to be expected.

7. RECCOMENDATIONS

Blackbucks are now restricted to Khairapur and is least remaining population of Nepal, where they are facing many problems. The continuity of such threats for long time may result into their extermination from wild habitat very soon. The degradation of habitat quality and loss of space is not supporting the viable self-sustaining population of Blackbuck at natural condition. For in-situ conservation of Blackbuck, restoration, maintenance and extension of existing habitat at Khairapur is important. From the conclusion drawn of the present research, in order to maintain the habitat and increase the population of Blackbuck; following recommendations are made for consideration by concerned authorities.

1. Acquisition of Registered Land. 19 Bigha of non-registered land from Pataha Phanta and Pachaskhalla Phanta was converted into registered land by the decision of the Supreme Court of Nepal. The registered land inside the PBCA should be completely acquisited.

2. Relocation of Non-registered Land Owners. The non registered land owners residing inside the PBCA, mainly from Pataha Phanta and Pachaskhalla Phanta should be shifted and relocated in suitable place. The eastern side of PBCA at Tulsipur could be the suitable alternative in the absence of other places out side the PBCA.

3. Declaration of Khairapur Area as 'Blackbuck Conservation Area'. The present Blackbuck area at Khairapur was set apart by the decision of State-Minister level as 'Proposed Blackbuck Conservation Area'. It should be declared as the 'Blackbuck Conservation Area' or 'Blackbuck Sanctuary' with the essential legislative measures.

4. Blackbucks are sprout feeders which prefer the fresh low growing herbs and forbs, so alternate ploughing on the different blocks of Phanta and controlled firing at the end of winter season should be done.

5. Blackbucks are habituated to the agricultural crops and the crop raiding by them is a cause of conflict with local people and the cause of their survival threats. So, seedling growth of palatable crops like lentils, black gram, wheat, maize, etc in respective seasons should be done.

6. Non-palatable and invasive species like *Ipomoea fistulata*, *Cymbopogon citratus*, etc should be dug out, dried and burnt on fire before their flowering for their control and eradication.

7. The regular disturbance in the daily activities of Blackbuck by the tear passers, vehicles, bullock carts etc through the road and foot trails inside the Pataha Phanta needs to be checked. Instead of the medial road of Phanta, the border road from Khairanjhala to Salarpur should be used.

8. Existing artificial water holes were not much useful and not sufficient too. So, 3 to 4 other water holes should be made in Pataha Phanta.

9. Grass cutting in Pataha Phanta in dry season during the scarcity of forage for Blackbuck should be checked and collection of grass with 'Khurpi' should be strictly prohibited.

10. Livestock grazing inside the PBCA should be regulated; controlled number of livestock grazing in different blocks alternately could be done. Livestock grazing should be avoided in dry season when there is scarcity of forage for Blackbuck.

11. The efforts to control village dog population from the local areas of PBCA should be continued and strengthened.

12. For the regulation of livestock grazing and visitor's activities one guard post needs to be established on the eastern side of Pataha Phanta towards Turantpur with the added number of Game Scouts.

13. Awareness raising programme among the local people in and around the 'Blackbuck Area' should be given higher priority for the minimization of poaching and promotion of their attitude towards conservation.

14. The responsibility of regulating livestock grazing and grass cutting inside PBCA should be given to the 'Local Conservation Committees' with the direct involvement of Game Scouts.

15. For the livelihood options for local people promotion of nearby community forest, implementation of modern agricultural techniques and promotion of alternative economic sources instead of livestock rearing should be given higher priority.

16. Starting from 3 individuals in 1973 AD the Blackbuck population at Khairapur is now 133. The genetic uniformity and inbreeding are some non-ocular problems in Blackbuck population. So, exchange of Blackbuck among the captive Central Zoo, semi-captive Mrigasthali and wild habitat of Khairapur should be done to counteract the inbreeding problem.

17. The suitable habitat for Blackbuck survival at Khairapur is insufficient to sustain the existing population in sound condition. So, either the area should be extended very soon or some Blackbuck should be translocated to the next suitable area with detailed ecological study.

18. Captive breeding of the Blackbuck and farming for the population boost up should be done.

19. Research and study about endangered species of Blackbuck should be given higher priority because a very limited research paper is published about Blackbuck in Nepal till date. So, detailed study on ecological, behavioural and genetic aspects of Blackbuck should be given higher priority.

REFERENCES

Altman J. 1974. Observational Study of Behaviour; Sampling Methods. Behaviors, 49. 227-265.

Bauer, J. J. and Ellenberg, H. 1988. Status and Management of Blackbuck (*Antilope cervicapra*) in Nepal- with observations on Behaviour and Factors Affecting its Population Size. DNPWC/FAO Project in Nepal. Report No. 85/011.

Benton A. H and Werner, W. E. 1966. Field Biology and Ecology, Second Edition. McGraw-Hill Book Company, New York.

Berwick, S. 1976. The Gir Forest: An Endangered Ecosystem. American Scientist 64, pp. 28-40.

Bhandari K. 1994. An Assessment of Food Habit and Habitat Utilization of Blackbuck (*Antilope cervicapra*) in Bardia. A Dissertation Submitted to Central Department of Zoology, T. U. Kirtipur.

Bhandari, K. 2005. Current Status and Conservation Efforts of Blackbuck (*Antilope cervicapra*) in Nepal. B. Sc. Dissertation Submitted to Pokhara University.

Bharucha E. and Asher K. 1993. Behaviour Patterns of the Blackbuck (*Antilope cervicapra*) under suboptimal Habitat Conditions. Journal of Bombay Natural History Society, Volume 90. pp. 371-390.

Bhatta, S. R. 1987. Study of Blackbuck Population at Khairapur, Bardia. B. Sc. Dissertation Submitted to Institute of Forestry, Tribhuvan University.

Bista, R. 1981. Blackbuck (*Antilope cervicapra*) in Wild is Beautiful (Edited By: Trilok Chandra Mjupuria). Craftsman Press, Bangkok.

Bolton, M. 1976. Management Plan, 1976-1981. HMGN / UNDP / FAO, National Park and Wildlife Conservation Projects. Project Working Document No. 6, Kathmandu.

Bolton, M. 1976. Royal Karnali Wildlife Reserve Management Plan 1976-1981. UNDP/FAO Project in Nepal. Report No. 72/002, Field Document No. 6.

Brander, A. 1923. The Wild Animals in Central India. British Museum, London.

Brander, A. D. 1982. Wild Animals in Central India. Nataraj Publishers Deharadun; India.

Burton, J. A. 1987. Collins Guide to Rare Mammals of the World. New York, U. S. A.

Carrington, R. 1963. Life Nature Library, The Mammals. The Life Books, New York.

Chalise, M. K. 2004. Wildlife of Nepal (Part – 3). Nepal Natural History Society. Kathmandu, Nepal. Pp: 77.

Chand G. B. 1999. Status and Distribution of Blackbuck (*Antilope cervicapra*) Population at Khairapur, Bardia, Nepal. M. Sc. Dissertation submitted to Central Department of Zoology, T.U. Kirtipur.

Chandra, J. 1997. Crop Damage Caused by Blackbucks at Karera Great Indian Bustard Sanctuary and its Possible Remedial Solutions. Tiger paper, Volume 24:No.3 July-September, 1997. India.

Chapagain, D. and Dhakal, J. 2002. CITES Implementation in Nepal. DNPWC Babarmahal and WWF Nepal Programme.

Chapman J. L. and Reiss M. J. 2005. Ecology: Principles and Applications. Cambridge University Press. Cambridge, U. K.

Chattopadhyay B. and Bhattacharya T. 1983. Basic Diurnal Activity Pattern of Blackbuck (Antilope cervicapra) of Ballavpur Wildlife Sanctuary, W. B. and its Seasonal Variations. Journal of Bombay Natural History Society, Volume 83. pp. 553-561.

Corbet G. B. and Hill, J. E. 1992. The Mammals of Indo-Malayan Region: A Systematic Review. Natural History Museum Publications. Oxford University Press. New York, USA.

Crandell, L. 1964. The Management of Wild Animals in Captivity, Chicago.

Dhakal, A. 1994. Behavioural Study of the Blackbuck (*Antilope cervicapra*) in Bardia. M. Sc. Dissertation Submitted to Central Department of Zoology, T. U. Kirtipur.

Dinerstein, E. 1975. A status Report on the Blackbuck of Bardia District. Report of DNPWC / HMG Nepal, Kathmandu; Nepal.

Drickamer, L. C. and Vessy, S. H. 1986. Animal Behaviour: Concepts, Processes and Methods. Wadsworth Publishing Company.

Ellerman J. and Morrison-Scott T. 1951. Checklist of Palearctic and Indian Mammals, 1758 to 1946. British Museum, London.

Farland D. 1981. The Oxford Companion to Animal Behaviour. Oxford University Press, Oxford.

Fleming, R. L. 1973. The General Ecology, Flora and Fauna of Midland Nepal. United states Agency for International Development (USAID). Kathmandu. Nepal.

Gelder, R. G. V. 1969. Biology of Mammals. George Allen and Unwin Ltd. London

Grzimek, B. 1972. Grzimek's Animal Life Encyclopedia, Mammals-IV. Van Nostrad Reinhold. New York.

Grzimek, B. 1990. Grzimek's Encyclopedia of Mammals, Volume 5. McGraw-Hill Publishing Company, New York.

Jahala, Y. V. 1991. Habitat and Population of Wolves and Blackbuck in Velavadar National Park, Gujarat, India. A Dissertation Submitted to Faculty of the Virginia Polytechnic Institute and State University in Partial Fulfillment of the Requirement for the Degree of Doctor of Philosophy in Fisheries and Wildlife Science, Blacksburg, Virginia.

Kafle, A.1998. Conservation Strategies of Blackbuck (*Antelope cervicapra*): Necessity, Impact and Result. M. Sc. Dissertation Submitted to Central Department of Zoology, T. U. Kirtipur.

Khanal, L., Khatry P., Parajuli S. and Shrestha B. 2005. Mammals of Mrigasthali Area and Their Problems. A Project Report Submitted to Pashupati Area Development Trust, Gaushala, Kathmandu.

Khanal, P. 2000. Blackbuck: Current Population Status and Conservation Issues; A Case Study from Khairapur, Bardia. A Project Report Submitted for Partial Fulfillment for B. Sc. in Environmental Science to Kathmandu University, Dhulikhel.

Khanal, P. 2002. Study on Ecology, Behaviour and Habitat Options for Conservation of Last Remaining Blackbuck Population in Nepal by Using GIS. M. Sc. Dissertation Submitted to Kathmandu University, Dhulikkhel.

Knight C. B. 1966. Basic Concepts of Ecology. The MacMilan Company, New York U. S. A.

Krebs, C. J. 1994. Ecology: The Experimental Analysis of Distribution and Abundance. Addision-Wesely Educational Publishers, USA.

Krishnan, M. 1972. An Ecological Survey of the Larger Mammals of Peninsular India. Journal of Bombay Natural History Society, Volume 69. pp. 469-473.

Lehmkul, J. F. 1979. Some Aspects of the Life History of Blackbuck in Nepal. Journal of Bombay Natural History Society, Volume 77. pp. 444-449.

Lydekker, R. 1924. The Game Animals of India, Burma, Malaya and Tibet. British Museum, London.

Majupuria, T. C. and Majupuria, R. K. 2006. Wildlife and Protected Areas of Nepal. Published by: S. Devi, Saharanpur, India. Pp.163, 508.

Manning A. and Dawkins, M. S. 1998. An Introduction to Animal Behaviour. Cambridge University Press, Cambridge.

Martin, P. and Bateson P. 1993. Measuring Behaviour. Cambridge University Press, Cambridge.

Matthews, L. H. 1969. The Life of Mammals, Volume 1. Widenfeld and Nicolson, Winsley Street, London.

Mungall, E. C. 1978. The Indian Blackbuck (*Antilope cervicapra*): A Texas View. Kleberg Studies in Natural Resources. No.3. pp. 184.

Nair, S. S. 1975. A Population Survey and Observations on the Behaviour of the Blackbuck in the Point Calimere Sanctuary, Tamilnadu. Journal of Bombay Natural History Society, Volume 73. pp. 304-310.

Nepal, R. P. 1994. The Status of Blackbuck (*Antelope cervicapra*) Population in Bardia. M Sc. Dissertation Submitted to Central Department of Zoology, T. U. Kirtipur.

Odum E. P. and Barret G. W. 2005. Fundamentals of Ecology. East West Press Pvt. Ltd. Daryaganj, New Delhi.

Pianka, E. C. 1974. Evolutionary Ecology. Harper and Row Publishers, New York.

Pokharel, B. K. 2002. Blackbuck: Conservation or Politics! CCEW Commemorative Volume- 2059. Gulariya, Bardia.

Pradhan, N. M., Bhatta, S. R. and Jnawali, S. R. 1999. Blackbuck Conservation Study Report. RBNP, Bardia, Nepal (Script in Nepali).

Prasad N. L. N. S. 1987. Territoriality in Indian Blackbuck (*Antilope cervicapra*) Journal of Bombay Natural History Society, Volume 86. pp. 187-193.

Prater, S. 1948. The Book of Indian Animals. Bombay Natural History Society. Bombay.

Rahmani, A. R. 1989. Present Distribution of the Blackbuck (*Antilope cervicapra*) in India, with Special Emphasis on the Lesser Known Populations. Journal of Bombay Natural History Society, Volume 73. pp. 35-45

Ranjitsinh, M. K. 1989. The Indian Blackbuck. Nataraj Publishers, Dehradun; India.

Rao, R. J. V. and Prasad, N. L. N. S. 1982. Management and Husbandry of Blackbuck. FAO, RAPA Publication No. 53.

Roberts, T. J. 1997. The Mammals of Pakistan. Oxford University Press, Walton Street, New York.

Schaller G. B. 1967. The Deer and the Tiger. The University of Chicago Press, Chicago.

Schaller G. B. 1998. The Deer and the Tiger, A Study of Wildlife in India. Nataraj Publishers, Dehradun; India.

Seshadri, B. K. 1969. The Twilight of India's Wildlife. Oxford University Press. Bombay, India.

Shankar Raman, T. R., Menon, R. K. and Sukumar, R. 1996. Ecology and Management of Chital and Blackbuck in Guindy National Park, Madras. Journal of Bombay Natural History Society, Volume 93.

Shrestha, M. K. 1996. Socio-economics of the People and Extinction of Species in Protected Areas of Nepal (Report on Wildlife Week, April 13-19, 1996) WWF Kathmandu.

Shrestha, T. K. 1997. Mammals of Nepal. Publisher: Mrs. Bimala Shrestha, Kathmandu, Nepal. Pp. 190-195

Shrestha, T. K. 2003. Wildlife of Nepal. Publisher: Mrs. Bimala Shrestha. Kathmandu, Nepal. Pp. 223-228.

Sokal, R. R. and Rohlf, F. J. 1994. Biometry: The Principles and Practice of Statistics in Biological Research; 3rd Edition. New York. www.wikipedia.org/w/index.php

Subedi, B. R. 1991. Problems and Prospects of Blackbuck Population at Khairapur, Bardia. A Project Paper Submitted in Partial Fulfillment for B. Sc. Forestry at Institute of Forestry, T. U. Pokhara.

Sukumar, R. 1992. The Asian Elephant, Ecology and Management. Cambridge University Press, Cambridge.

Tamang K. M. and Shrestha S. K. 1998. Study of Blackbuck (*Antilope cervicapra*) at Khairapur, Bardia; Nepal. Case Study of Endangered on the Verge of Extinction. Institute of Forestry, International Tropical Timber Organization, Pokhara.

Tapol, R. 2001. Behavioural Study of Blackbuck (*Antelope cervicapra*) in Captivity. M. Sc. Dissertation Submitted to Central Department of Zoology, T. U. Kirtipur.

Verma, P. S. and Agrawal, V. K. 1998. Environmental Biology (Principles of Ecology). S. Chand and Company Ltd. Ram Nagar, New Delhi.

Wallace, R. A. 1979. Animal Behaviour, Its Development, Ecology and Evolution. Good Year Publishing Company, California.

Walther, F. R. 1964. Gazelles and their Relatives. A Study in Territorial Behaviour. Noyes Publication, New Jersy. U. S. A.

Wegge, P. 1991. The Bardia Conservation Research Programme Progress Report. November 1990, Department of Biology and Nature Conservation. Agricultural University of Norway.

Wegge, P. and Wilson P. 1976. The Blackbuck in Banke District. Report to HMGN, Kathmandu.

APPENDIXES

Appendix I. Floristic Composition of PBCA, 2006.

S. N.	Form	Botanical Name	Local Name	Remarks
1.	Forb	*Alysicarpus vaginalis*	Titilo	
2.	Forb	*Convolvulus numularis*	Thulo Dudhiya	
3.	Forb	*Euphorbia hirta*	Dudhe Jhar	
4.	Forb	*Hemigraphis hirta*	Rudhilo Jhar	
5.	Forb	*Lindenbergia indica*	Kanchan	
6.	Forb	*Lippia nudiflora*	Vagadiya	
7.	Forb	*Medicago denticulre*	Chari Amilo	Preferred by Blackbuck
8.	Forb	*Medicago lupulina*	Kalo Jhar	
9.	Forb	*Phyllanthus virgatus*	Ameli	
10.	Forb	*Rungia parviflora*	Titilo	
11.	Forb	*Sida cordata*	Pan pate	
12.	Forb	*Tamarindus indica*	Tin Pate	
13.	Grass	*Bothriochloa ischaemum*	Dube Banso	
14.	Grass	*Cynodon dactylon*	Dubo	Preferred by Blackbuck
15.	Grass	*Cyperus cephalotus*	Mothe	
16.	Grass	*Desmostachya bipinnata*	Kush	
17.	Grass	*Digitaria ciliaris*	Banso	
18.	Grass	*Digitaria ciliaris*	Chitre Banso	
19.	Grass	*Echinocloa colonum*	Moto Banso	
20.	Grass	*Eleusine indica*	Kode Banso	
21.	Grass	*Imperata cylindrica*	Siru	
22.	Grass	*Parthenocissus semicordata*	Charchare	
23.	Grass	*Saccharum munja*	Munja	
24.	Grass	*Saccharum spontaneum*	Kaas	
25.	Grass	*Sporobolus diander*	Masino dubo	
26.	Grass	*Vetiveria zizanioides*	Jove	
27.	Shrub	*Anagallis arvensis*	Kuro	
28.	Shrub	*Canabis sativa*	Bhang	
29.	Shrub	*Carissa carandus*	Karaunda	
30.	Shrub	*Cassia sophera*	Tapre	
31.	Shrub	*Cassia tora*	Tapre	
32.	Shrub	*Clerodendrum infortunatum*	Bhanti	
33.	Shrub	*Cymbopogon citratus*	Pirrhe Ghans	Non-palatable to Blackbuck
34.	Shrub	*Glycosmis pentaphylla*	Gutuhuro	
35.	Shrub	*Ipomoea fistulata*	Besharma	Non-palatable to Blackbuck
36.	Shrub	*Murraya koenigii*	Nim Kothia	
37.	Shrub	*Zizyphus mauritiana*	Bayar	
38.	Climber	*Acacia pennata*	Arphu	
39.	Tree	*Acacia catechu*	Khayar	
40.	Tree	*Acacia nilotica*	Babur/Babool	
41.	Tree	*Azadirachta Indica*	Nim	
42.	Tree	*Bombax ceiba*	Simal	
43.	Tree	*Dalbergia sissoo*	Sisoo	
44.	Tree	*Mallotus philippensis*	Sindhure	
45.	Tree	*Quercus floribunda*	More Kath/Chiloun	
46.	Tree	*Syzygium cumini*	Jamun	

Appendix – II. Questionnaire Survey

Date:……..…

1. Name of Respondent……. Age……Sex……
   Cast……. Village:…….....…Ward No.....
   Occupation……..
2. Are you the permanent resident of Khairapur or Migrated to here? …….
   If Migrated, When?..... From where? ……..
3. How many members do you have in your family?
   Male:……. Female:……. Total:…….
4. How far is your crop field from Blackbuck post at Khairapur?
   a. Less than 0.5 Km b. 0.5 to 1.0 Km
   c. 1.0 to 2.0 Km c. More then 2.0 Km
5. How much land do you have?
   ……. Bigha ……Kattha …… Dhur.
6. What type of land do you have?
   a. Ailani land (Total……) b. Registered/ Numberi land (Total……..)
7. Which type of crop do you grow in your crop field?

General Crops		**Cash Crops**	
Crops	**Month**	**Crops**	**Month**
Gram		Brinjal	
Maize		Cabbage/Cauliflower	
Mustard		Chilly	
Pea		Green Vegetables	
Wheat		Tomato	
Paddy		Carrot/ Turnip/ Radish	
Any Other		Any Other	

8. What are the main problems that you face in agriculture?
   a. Irrigation b. Insects/Diseases
   c. Animals/Blackbuck d. Any Other (Please specify :…….)
9. A. Does Blackbuck damage your crops?
   a. Yes b. No
   B. How often does the Blackbuck visit your crop field?
   a. Daily b. Once/Twice in a week
   c. Once/Twice in a month d. Occasionally

C. At what time does the Blackbuck enter your crop field?

a. Morning b. At Noon

c. Evening d. At Night

D. Does Blackbuck feed on all the types of crops?

a. Feeds on all types b. Feeds selectively

E. Please specify the crops according to the extent of crop damaged by Blackbuck.

Highest Damage	High Damage	Little Damage	No damage

F. At which stage of the plant does the Blackbuck damage the crop?

a. Just after germination b. While growing

c. Flowering Stage d. Fruiting Stage

G. How much percentage of your crop is damaged by the Blackbuck?

a. Less than 10% b. 10 to 20%

c. About 50% d. More than 50% (About……. %)

H. Which method do you adopt to prevent crop damage from Blackbuck?

a. By chasing with dogs and self b. By making loud noise

c. By fencing the crop field d. By guarding the field

e. If any other……

I. Are the methods that you have adopted successful?

a. Yes b. No c. Partially

J. Do you cultivate the crops that are not damaged by Blackbuck?

i) If yes, please specify the crops ……

ii) If not, why?

a. Lack of irrigation b. Soil is not better

c. Less production d. Any other…….

K. Do you leave the field bare because of the damage made by Blackbuck?

a. Yes, I did in the past b. Yes, I do c. No

L. Whether the crop damage by Blackbuck is in increasing or decreasing order?

a. Increasing b. Decreasing

M. What can be the better solution of crop damage by Blackbuck? …….

N. Is there any other problem by Blackbuck except crop damage?

10. Do you have any livestock?

    a. Yes b. No

    If yes,

Livestock	**Number**
Cow/Bull	
Buffalo	
Goat	
Sheep	
Any other	

11. Where do you graze your livestock?

    a. Community Forest b. Jungle of PBCA

    c. Phanta of PBCA d. Private land

    e. Stall feeding

12. In your opinion, what can be the reason of excessive livestock grazing in PBCA?
13. Do you think that excessive grazing should be stopped?

    a. Yes b. No

14. What are the ways to prevent excessive grazing?
15. What are the problems in the conservation and management of Blackbuck?
16. What should be done in the conservation and management of Blackbuck at Khairapur?
17. Which institution do you think better for the conservation of Blackbuck?

    a. Bardia National Park

    b. Gulariya Municipality

    c. Local Conservation committees

    d. Any Other

18. Should Khairapur be declared as 'Blackbuck Conservation Area'?

    a. Yes b. No

19. What can be your role in the conservation of Blackbuck at Khairapur?

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Appendix – III: Population History of Blackbuck at Khairapur

Year	Blackbuck Population	Source
1973	3	Shrestha, 1973
1975	11	Lehmkul, 1979
1979	14	Bista, 1987
1981	23	RBNP
1982	38	RBNP
1983	66	RBNP
1984	100	RBNP
1985	130	RBNP
1986	152	RBNP
1987	178	Bhatta, 1987
1988	190	Bauer, 1989
1990	178	RBNP
1991	162	Subedi, 1991
1992	100	RBNP
1993	92	Nepal, 1994
1995	102	Tamang and Shrestha, 1998
1996	111	Tamang and Shrestha, 1998
1998	94	Chand, 1998
1999	47	Pradhan, Bhatta and Jnawali, 1999
2000	40	Khanal, 2000
2001	53	Khanal, 2001
2002	65	Khanal, 2002
2003	78	RBNP
2004	99	RBNP
2005	109	Present Study
2006	133	Present Study

Appendix– IV: Biomass of Different Fields of Pataha Phanta in 1x1 m^2 quadrates

Block Type → / Quadrate Number ↓	Biomass / Dry Weight in Grams			
	Normal Field	Livestock Grazed Field	Ploughed Field	Grass Cut Field
1	169.9	216.5	203.3	84.5
2	275.6	171.2	115.6	80.7
3	248.0	147.0	84.5	103.2
4	144.0	167.3	378.0	56.3
5	225.4	205.7	151.2	62.5
6	212.0	104.7	132.4	48.0
7	168.0	163.2	271.5	48.7
8	197.6	212.4	315.6	65.4
9	213.7	201.5	287.4	91.0
10	161.0	161.0	299.5	83.1

Appendix – V: Monthly Maximum Temperature of Rani Jaruwa Nursery, 2000-2004 AD.

Year / Months	Maximum Temperature (^{0} C)					
	2000 AD	**2001 AD**	**2002 AD**	**2003 AD**	**2004 AD**	**Average**
January	20.1	19.9	22.9	18.2	20.1	20.24
February	23.2	27.1	25.9	24.8	25.1	25.22
March	30.0	31.6	31.3	29.6	32.2	30.94
April	36.0	36.5	35.2	37.2	36.6	36.30
May	36.9	36.0	36.9	37.9	37.1	36.96
June	33.7	34.0	36.6	36.5	35.7	35.30
July	32.5	33.7	34.4	34.5	33.3	33.68
August	35.6	34.8	33.3	33.2	33.7	34.12
September	32.6	33.8	32.7	32.0	33.0	32.82
October	32.4	32.5	32.2	32.2	31.9	32.24
November	28.1	29.3	29.2	28.5	27.6	28.54
December	24.2	23.8	24.0	23.1	23.4	23.70

Appendix – VI: Monthly Minimum Temperature of Rani Jaruwa Nursery, 2000- 2004 AD.

Year / Months	Minimum Temperature (^{0} C)					
	2000 AD	**2001 AD**	**2002 AD**	**2003 AD**	**2004 AD**	**Average**
January	7.8	6.9	8.1	7.5	8.2	7.70
February	8.5	9.1	10.2	8.3	10.0	9.22
March	12.4	11.7	12.9	12.7	15.0	12.94
April	18.5	17.0	18.5	17.6	20.8	18.48
May	23.0	21.9	23.0	19.6	23.0	22.10
June	24.8	24.5	25.2	24.0	23.3	24.36
July	25.2	26.5	26.5	25.9	26.1	26.04
August	24.0	26.3	25.5	25.9	26.0	25.54
September	25.0	25.3	24.2	24.7	25.1	24.86
October	20.3	20.2	19.3	18.8	20.1	19.74
November	15.0	13.9	12.7	13.3	12.5	13.48
December	7.8	10.5	9.4	9.0	9.5	9.24

Appendix – VII: Report of Gastro-intestinal Parasites of Blackbuck

Nepal Agricultural Research Council
National Animal Science Research Institute
Animal Health Research Division
Khumaltar, Lalitpur, Nepal

Letter No.
Register No.

Blackbuck (Bardia)

Sample No	Type of Animal	*Paramphistomum*	*Strongyles*	*Ascaris*	*Coccidia*
1	Male	++	++	-	-
2	Male	++	+++	+	-
3	Male	+	++	-	-
4	Male	++	+	-	-
5	Male	++	++	-	-
6	Male	+	+	-	-
7	Male	+++	+++	+	-
8	Male	+++	++	-	-
9	Male	++	+	++	+
10	Male	++	+++	-	-
11	Male	+++	+	+	-
12	Male	++	++	-	-
13	Female	+	+	-	-
14	Female	+	++	-	-
15	Female	+	+	-	-
16	Female	+++	+	+	-
17	Female	++	+	+	-
18	Female	-	+	-	-
19	Female	+	+++	-	+
20	Female	-	++	+	-
21	Female	++	+++	-	-
22	Female	++	+++	++	+
23	Female	+++	+++	-	-
24	Female	++	+	-	-
25	Female	++	+	+	-
26	Female	+	+	-	-
27	Fawn	-	-	-	-
28	Fawn	+	+	+	-
29	Fawn	-	-	-	-
30	Fawn	-	-	+	-
Total		**25**	**26**	**11**	**3**

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