Estimating the Status and Impact of Hunting on Tiger Prey in Bardia National Park, Nepal

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By

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CERTIFICATE

This is to certify that this dissertation entitled *"Estimating the Status and Impact of Hunting on Tiger Prey in Bardia National Park"* consists of original research carried out by Miss Sabita Malla for the partial fulfillment of **Master of Science** degree in **Wildlife Science** from Saurashtra University, Rajkot. The research was carried out under our supervision at the Wildlife Institute of India between November 2008 and June 2009. We also certify that this work has not been submitted for any degree from any other university.

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ABSTRACT

One of the serious threats to wildlife is illegal hunting for wildmeat. A study was undertaken to understand the status of tiger prey species in relation to the hunting pressure in Bardia NP(28° 15' to 28° 40'N Lat and 81° 15'to 81°40'E Long) from November 2008 to April 2009. Tiger prey density and hunting pressures between Babai valley and Karnali with varying levels of protection measures was compared. Detailed interviews were carried out with the active hunters (hunt atleast once a month) and occasional-opportunistic hunters (n=94) in the surrounding villages to understand the hunting intensity, hunting patterns and factors governing the wildmeat hunting. Impacts of hunting were assessed by comparing the densities of the prey species present in both the areas. Choosing Chital (*Axis axis*) as the model species, demographic parameters (group size, age-sex composition) and it's behavior (flight distance) was compared for two study areas.

The prey densities were estimated using Distance sampling. A total of 83.34 km was covered for Babai valley (N=48) and 64.96 km for Karnali (N= 35). The prey density in Babai valley was estimated to be (28.75±5.54) animals/km^2 which is only one-third of prey density estimates of Karnali (91.52±26.50) animals/ km^2. Chital density was significantly lower 25.47 animals/km^2 in Babai as compared to 85.47 animals/km^2 in Karnali. Significant differences were also found in chital group sizes, group composition and sex-ratio between the two study areas. The greater sex- ratio in Babai valley is explained by the fact that hunters operating in the area were not selective of the sex as is the case with trophy hunting. Though the flight distance of Chital did vary, the greater flight distance was found in Karnali which relates to the greater amount of human disturbance such as tourism.

The hunting intensity varied significantly in all the villages' surveyed and was higher in the hill villages. The intensity was found to be highest in Taranga with the estimated hunter days of 143.78 days/month followed by Haripur with 91.71 hunter days/month. Respondents (N=94) had killed 17 species of mammals>3kg in weight for wildmeat using a maximum of 13 different methods. The frequency of hunting, the wildmeat consumption and the sale was governed by the income level of the hunters. The dependency to wildmeat also increased with increasing level of poverty.

The results of the study suggest that observed differences in prey density between Babai and Karnali are an indication of the prevailing hunting pressure in the area and more research work needs to be carried out in demography and behavior for concrete conclusion.

1. INTRODUCTION

Anthropogenic pressure is one of the world's overriding challenges to the goal of conservation. Approximately 11.63% (WDPA 2007) of the world's total landmass is set aside as Protected Areas (PAs) however, most of them are not able to provide adequate protection to the biodiversity due to the lack in enforcement of protection measures. This is the combined effect of inadequate investments in reserve acquisition and management (James *et al.* 2001) and uncertainty about when and where the conservation investments may arise. Nepal is not an exception to the global scenario. Though Nepal government has established an impressive network of PAs covering about 18.33% of the total area of the country, (DNPWC 2003) human impacts in PAs are still prevalent and are further exacerbated owing to political unrest and situation of insurgency occurring from 1996 to 2006 (Budhathoki 2003). More than 70% of army posts were removed from PAs due to security reasons (Yonzon 2002). As a result traditionally employed protection efforts in some parts of PAs have been compromised thereby threatening the effectiveness of preservation measures and creating conditions conducive for opportunistic resource exploitation.

It is axiomatic that better protected areas are relatively beneficial than the ones with lesser degrees of protection. Nevertheless, some species may be unaffected by protection practices and others may even be adversely affected. For example, some generalists thrive in anthropogenically altered habitats (Meffe & Carroll 1997) and competition within protected areas may depress abundance of certain species (Creel & Creel 1996). However, it is difficult to predict how protection will affect most species because our knowledge of the ecological processes that limit most populations is incomplete.

The basic interest here is to understand the status of the ungulates in areas where they have been subjected to direct persecution. For this, different sites were compared that were subjected to varying levels of hunting intensity. Prey density, demography and FD were used as a measure of hunting intensity and compared for two sites within Bardia NP but varying in protection level. Frequency of hunting, hunting methods, socio-economic factors in relation to consumption and sale of wild meat in surrounding villages were also documented.

1.1 Review of Literature

1.1.1 Importance of prey to predator

Prosecution of ungulates adversely affects dependent predators such as tigers and other carnivores that directly depend on large ungulates for their energy needs. It has been well established that for a carnivore like tiger, besides requiring large undisturbed habitats, prey-base is a key factor determining their viability (Jhala *et al.* 2008; Sunquist & Sunquist, 1989; Karanth & Sunquist 1995; Karanth & Nichols 2002,). Distribution and abundance of carnivores is closely related to the biomass and densities of prey species (Carbone & Gittleman 2002; Karanth *et al.* 2004, Karanth & Stith 1999). Though tigers have been known to feed on a wide variety of animals (Schaller 1976) a marked preference for medium (31-175 Kg) to large (>176 Kg) sized ungulates has been documented by studies in different habitats. Schaller (1967), Karanth & Sunquist (1995), Bagchi *et al.* (2003) Johnsingh *et al.* (2004) have all found that medium to large sized ungulates comprise the bulk of the tiger's diet, of which Chital and Sambar constitute approximately 55% – 65%. Medium sized prey includes chital and wild boar, while large prey includes sambar, swamp deer and nilgai. However, they do go for the smaller sized animals (<30kg) such as langur, barking deer, hog deer and four-horned antelope. The average kill rate is about 50 ungulates/adult tiger/ year, while a tigress with large cubs require 60-73 ungulates year. They crop at the rate of about ~10% of the standing ungulate biomass annually (Sunquist 1981).

Low prey population manifests as a strong negative impact on tiger populations by reducing the carrying capacity of breeding adults, decreasing cub survival and diminished resilience (Karanth & Stith 1999; Sunquist & Sunquist 1989). In the harsh environmental conditions of the Russian Far EAst, mean litter size of tigers 2.4 was decreased to 1.3 by the time cubs were 12 months old (Kerley et al. 2003). But unlike in Chitwan, where the mean litter size was 2.98, it decreased to 2.45 by year one, and 2.22 by year two. (Smith and McDougal 1991).This indicates that while tigers do live where prey densities are low, as in the Russian Far East, low prey densities manifests in low tiger reproductive output and a greatly diminished resilience in the tiger meta population. The low prey density within the habitat leads to lower encounter rates of tigers with their prey resulting in greater search effort to find prey, and much higher energy expenditures per kill (Sunquist & Sunquist 2001). Hence, prey depletion should be explicitly recognized as a threat to persistence of tigers apart from habitat loss, structural degradation of habitat and tiger poaching. Monitoring prey population is therefore important for conservation of vulnerable predator populations.

1.1.2 Prey habitat relationship

Prey species vary in their habitat requirement. For example, Sambar is a generalist grazer/browser (Schaller 1976, Johnsingh 1983) and is known to have significant dependency on shrubs and water. Chital on the other hand, is known to have significant dependency on surface water and partial cover (Schaller 1967, Johnsingh 1983). They prefer open grasslands during winter and more forested patch during summer when grass is low in abundance (Schaller 1967, Bhat 1993). Hog deer is a true grazer and prefers tall grassland (Wegge 2009). Similarly, Barasingha is also a true grazer and prefers the riverine habitats (Dinerstein, 1979b, Khatri 1993, Pokharel 1996 and Wegge *et al.* 2006). On the other hand Barking deer and Four-horned antelope are truly a forest dweller and browsers. Wild ungulates across the Terai, follow a gradient, with highest densities in riverine forest and tall-grass interspersed with shorter-grass grazing areas on newly recovering flooded sites and lower densities in *sal* forest clad hills but near permanent water(Seidensticker 1976).

1.1.3 Effect of hunting pressures on Prey

Habitat loss and degradation are such massive and visible threats to the depletion of prey species in tropical Asia that the impact of hunting is sometimes considered secondary, at least in comparison with Africa and the Neotropics (Primack & Corlett 2005, Sodhi & Brook 2006). However, hunting by humans is believed to have been among the most significant factors driving the extinction of large wildlife species. All of these prey species yield high amount of meat and most of them are preferred for wild meat consumption. This makes them very vulnerable to hunting. At the same time their biological traits such as inherently low densities, large dietary requirements and home ranges, slow rates of growth and maturation, small litter sizes, long lifespans and generation times also render them vulnerable to extinction from stochastic factors related to demography, environment, and genetics (Madhusudan & Karanth 2002). Thus, understanding the impacts of human hunting on exploited species is of critical importance in planning realistic strategies for their conservation.

So far no study on the intensity and impact of hunting has been carried out in Nepal except for the anecdotal records maintained on the yearly report on poaching control (2062/63) (Shrestha & Thapa 2063). In India, few studies of similar type have been undertaken. These studies have looked at the extent and impacts of hunting on wildlife populations in India (Madhusudan & Karanth 2000, Kaul *et al.* 2004), while hunting's eco-social history has been examined in central India (Rangarajan 1996). There have been only two short-term studies that discuss extent of hunting on wildlife in North-east India (Mishra *et al.* 1998, Datta 2002), apart from incidental documentation in anthropological studies (Elwin 1959, von Furer-Haimendorf 1955) or anecdotal observations from faunal surveys and other studies (Katti *et al.* 1992, Datta *et al.* 2003, Mishra *et al.* 2004).

Local hunting of wild animals is widely prevalent especially in developing countries of Africa and South-east Asia and Africa where it is driven by poverty (Wilkie & Carpenter 1999, Peres 2000, Madhusudhan & Karanth 2002, Datta *et al.* 2008, Asibey 1977, ma Mbalele 1978, Martin 1983, Anadu *et al.* 1988, Geist 1988, King 1994, Juste *et al.* 1995). It is known to pose far greater threat as it targets wide variety of species since it is carried out by a greater number of people (Madhusudan & Karanth 2002). In such a scenario, it is necessary to understand whether the people are merely using the resource, truly depending upon it for subsistence or is it beyond subsistence?

In case people are truly dependent on wild meat for protein it has to be managed with alternative livelihood resources. If it is beyond subsistence driven by market demands, the challenge is even greater and the problem should be addressed by looking at the wider economic and institutional context within which hunting occurs, from household economies to trade (Milner-Gulland & Bennett 2003).

1.1.4 Index of hunting pressures

A number of studies in Africa have indicated that exploitation of wildlife alter population densities as well as behavior and population dynamics (Caro 1999, Fischer & Linsemair 2001; Milner-Gulland *et al.* 2001). Similar study in India has shown that areas with little or no antipoaching efforts tend to have lesser densities of wild animals (Madhusudan & Karanth, 2002). Comparative studies in African subcontinent (Setsaas *et al.* 2007) between protected and partially PAs have shown animals to have lower density, skewed sex ratio and a longer flight distance in partially PAs. No studies of this type has been attempted in Indian subcontinent probably because the very existence of hunting is often discounted or even denied and broad generalization may not be applicable unless area specific researches are carried out. Flight distance (FD), the distance between the predator and the prey when the prey flees or the distance between animals and the disturbance when the animals take flight in response to that disturbance (Altmann 1958, Hediger 1968) are useful in the assessment of an animal's welfare state. Animals are generally known to be more wary and show a greater FD in areas with greater degree of human pressure. These changes in behavior can have damaging effects on food intake trading off the benefits of reduced predation risk against the cost of foraging time (Frid & Dill 2002; Blumstein *et al.* 2005). Detailed studies document a lower proportion of younger females breeding when sex ratios are heavily skewed (Ginsberg & Milner-Gulland 1994; Solberg *et al.* 2002). Studies also suggest that male capacity to inseminate females can be limiting when the adult sex ratio is severely skewed (Gruver *et al.* 1984; Ginsberg and Milner-Gulland 1994). Thus the skewed sex-ratio can negatively affect population dynamics of the species (Ginsberg 1994) thereby disrupting the entire balance of the ecosystem.

1.2 Objectives

In the above context, the study was carried out with the following objectives:

I. To study the status of Tiger prey species in areas with different intensity of hunting pressure.

II. To assess the level of hunting pressures in the study sites by doing field sampling and village survey.

Research questions

i) Do the prey species densities differ between study areas with respect to hunting pressure?

ii) Is there a difference in demography (group sizes, age-sex composition) and behavior (flight distance) of Chital between the two study sites?

iii) What is local people's dependency on wild meat?

iv) What are the major drivers that govern consumption of wild meat? Is wild meat a genuine subsistence need of the local communities or are there market forces that drive this trade for enhancing economies beyond subsistence?

2. STUDY AREA

2.1 Location and Boundaries

Bardia National Park, is the second largest national park lying in the low land of southern Terai in the mid western region (one of the five country's administrative division) of Nepal. It is situated in Bardia and Banke districts in the Bheri zone of Nepal. It occupies an area of 968 km^2 between 28° 15' to 28° 40'N and 81° 15'to 81°40'E (Fig2.1). In the western boundary of the park is the Geruwa river which is the eastern most branch of the longest perennial river of Nepal, known as Karnali. Surkhet-Kohalpur road forms the eastern boundary whereas the park runs all along the crest of Churia to the north. In the south, most of the boundary follows the local limits of cultivation and human settlements.

2.2 Topography

Unlike the mountainous terrain of the large parts of the Kingdom of Nepal, the Bardia NP covers an area of Siwaliks and flat floodplains, an extension of the Gangetic plain. The landscape of the National park is dominated by the wide, braided Karnali and Babai rivers. The park can be categorized into five distinct land types namely the Churia (Siwaliks), the Bhabar foot-hills, the alluvial Terai flat lands, the riverine floodplains, and the Babai valley where the Siwalik splits into a set of parallel ridges. Large part of the park is composed of the southern slopes of the Churia hills and the gravelly foot hills called the Bhabar belt. An altitudinal gradient prevails over the park ranging from 152m (msl) at the south-western corner of the reserve to the elevation of 1441 m at Sukurmala to the crest of Churia ridge (Dinerstein, 1979b).

Location map of Study Area

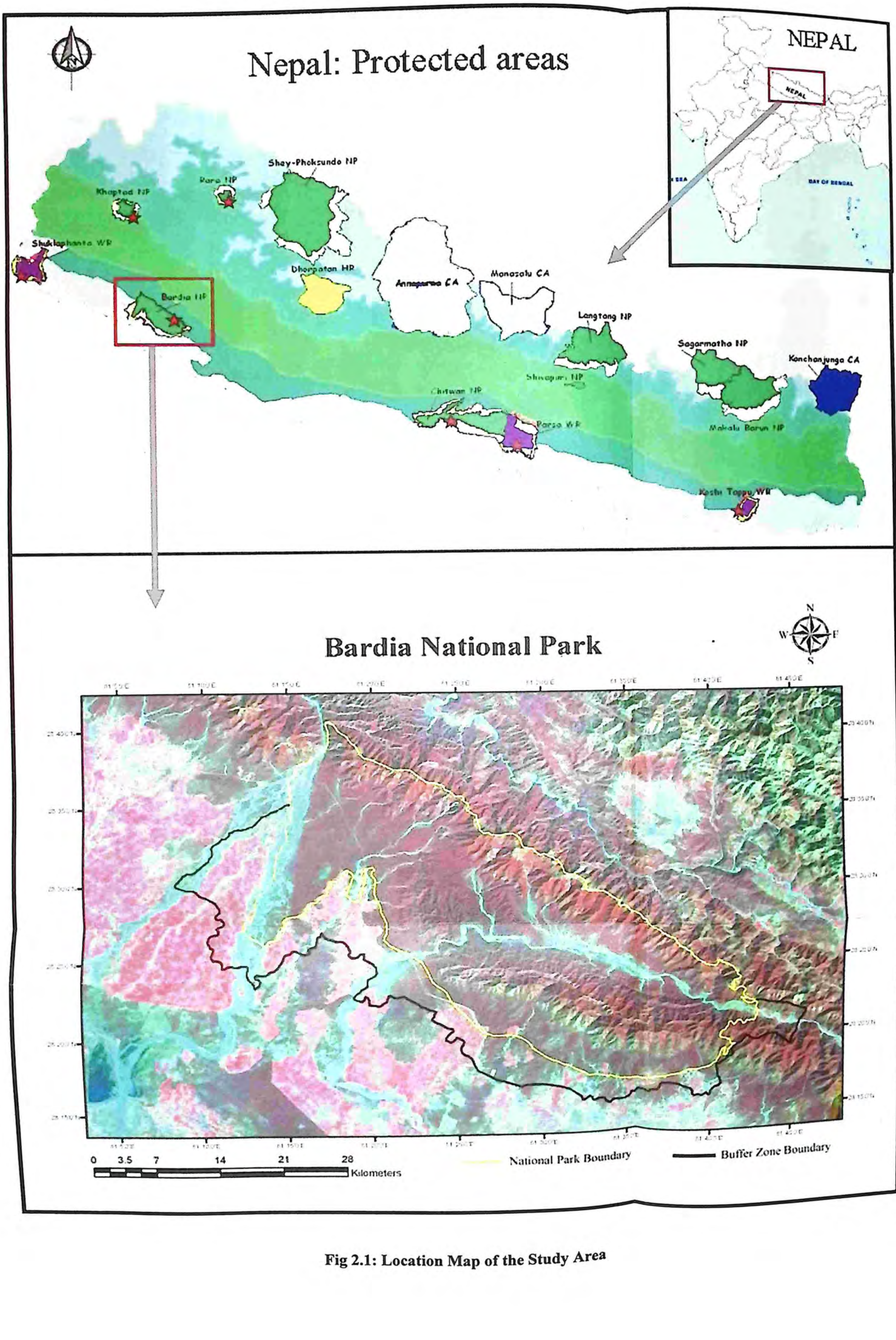

Fig 2.1: Location Map of the Study Area

2.3 Climate

The climate is subtropical monsoonal with most precipitation occurring between June and September. The mean annual rainfall range between 1550-2310mm with three distinct seasons existing in the area. Following the monsoon is a cool period lasting from November until mid February. The lowest temperatures of the year occur in December and January. The temperature ranges from a minimum of 10°C in January to a maximum of 41°C in May (Bolton 1976, Dinerstein 1979b). The relative humidity remains low through out most of the season, and increases with the onset of the pre-monsoon rains.

2.4 Vegetation

The vegetation is sub-tropical type, with a mosaic of early successional flood plain communities in alluvial floodplains to climax sal community in the relatively dry flat lands. Bardia NP holds two major eco-regions, namely the Tarai-duar Savannas and grasslands, and the Himalayan Sub-tropical broadleaf forests. The savanna and phanta grasslands harbour a large number of ungulate species and their predators. Dinerstein (1979) classified the vegetation of the park into six major types and was later modified by Jnawali & Wegge (1993) into seven types. The major vegetation types are Sal forest, Riverine forest, Mixed hardwood forest, Wooded grasslands, Phantas and Tall alluvial floodplain grassland. Similarly during the present study, the vegetation of Bardia National Park was classified into 6 major vegetation types using (Two-Way Indicator Species Analysis) TWINSPAN (HillS 1979) in PCord (Fig:2.3).

The forest cover within the park area comes to some 76 percent of the total park area. Bhuju (2003) indicated that 52% of the plant species are trees, while the shrub species amounts to 20% and the herbs make 19% in total.

2.4.1 Sal forests

More than 70% of the park area is dominated by Sal in the alluvial flood plain, and in the parts of the south- facing slopes of the Siwaliks to the north. The Sal forests in Bardia NP can be distinctly differentiated on the basis of their association. One of the most common associations of Sal encountered in the park is the *Shorea robusta-Buchnania latifolia* forest. The second type of association is the *Shorea robusta-Terminalia latifolia and Lagerstromia parviflora* forest. And finally the third type of association is the hill sal forest which occurs along the southern flanks of Churia ridge. Several other tree species such as *Terminalia alata, Careya arborea, Buchanania latifolia, Lagerostroemia parviflora, Semicarpus anacardium* and *Syzygium cumini* become dominant in these areas.

2.4.2 Riverine forests

Forests along flood plains and riverine alluviums are occupied by *Acacia catechu* and *Dalbergia sisso*. These two species have long been known to form the first seral stand of trees along the major river courses of the Terai belt because they are able to withstand flooding. Within the park this association is mostly prevalent along the banks of Karnali river, on the island within its flood plain and some parts of Babai river. Moist riverine forest is characterized by evergreen species such as *Ficus racemosa, Syzigium cumimi,* and *Mallotus phillipinensis*. Other tree species associated in the riverine vegetation include *Ehretia laevis, Trewia nudiflora along with the ground layer of Murraya koenigii, Callicarpa macrophylla and Colebrookia oppositifolia.*

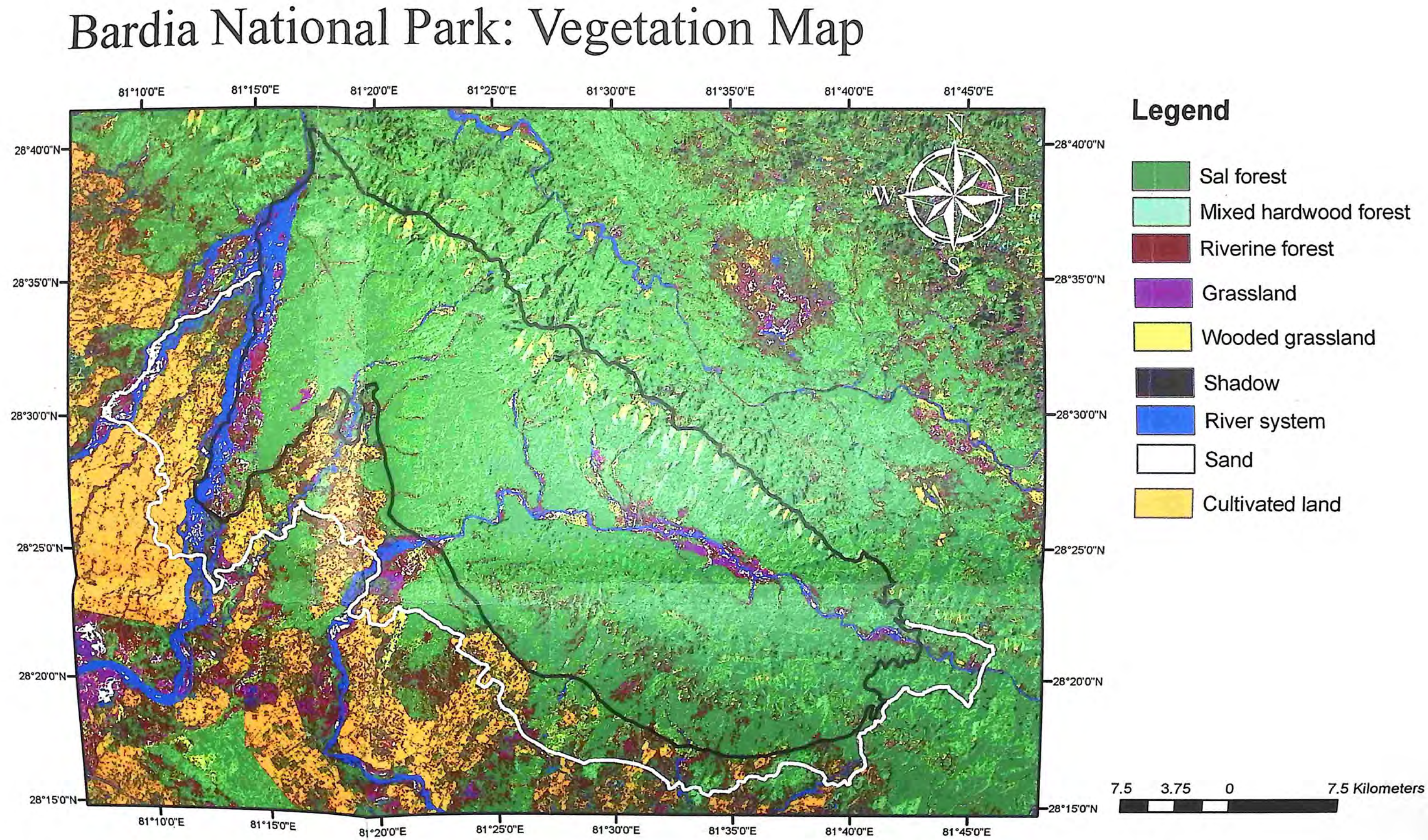

Fig 2.3: Vegetation Map of Bardia National Park

2.4.3 Mixed hardwood forests

The marked similarity is found between the wooded grassland and the mixed hardwood type of forest. But this vegetation differentiates from the former one on the basis of the remarkable tree density and the conspicuous shrub layer dominated by *Colebrookia oppositifolia, Pogostemon plectranthoides, Clerodendron viscosum* and *Murraya koenegii* (Dinerstein 1979b).

2.4.4 Grasslands and Phantas

Three categories of grasslands are found in Bardia NP namely wooded grassland, open grassland and the tall riparian grassland. These vegetation types are in the successional stage and are therefore, progressively changed into shrublands and woodlands.

2.4.4.1 Wooded grassland

This type of vegetation is dotted by the *Bombax ceiba* trees and supports a greater diversity of tree species. The role of *Bombax ceiba* in the successional pattern of this particular habitat is of utmost importance since it is resistant to fire, grazing and flooding, the three important factors which play the role in shaping the vegetation composition in Bardia NP (Dinerstein 1979b). The other tree species are composed of sparsely distributed trees such as *Shorea robusta, Bombax ceiba, Mallotus philippinensis, Adina cordifolia, Lagerstroemia parviflora* and *Dalbergia sisso*. The understorey layer is dominated by the coarse grasses such as *Imperata cylindrica, Erianthus ravennae* and *Vetiveria zizanoides*.

2.4.4.2 Open grasslands

Similarly, previous cultivated fields have contributed in the formation of "Phanta" grasslands such as Baghaura and Lamkauli in the southern section of Karnali and Guthi, Shivpur, Sanosiri, Thulosiri and Chepang Phantas in Babai area. The dominant grass species are *Impereta cylindrica*, *Desmostachya bipinnata*, *Arundo donax*, *Phragmites karka*, *Cymbopogon spp*, *Eragrostis species* and *Sporobolus sp.* (Smith and Brown 1973, Dinerstein 1979b).

2.4.4.3 Riparian tall grasslands

The floodplain grasslands are established and are maintained in the form of secondary seral stage as a result of monsoon flooding and other fluvial actions (Dinerstein 1979b). Main component of the tall grasses are *Saccharam spontaneum*, *Narenga porphyrocoma*, *Themeda arundinacea* and *Phragmitis karka*. These riparian grasslands provide the promising habitats for hogdeer.

2.4.5 Fauna

Bardia NP supports a diverse range of faunal groups. It harbors 59 species of mammals including 5 species of deer, approximately 407 species of birds, 42 species of reptiles and amphibians, 124 species of fishes (BPP 1995 & DNPWC 2001). The mosaics of habitat types support a high density of ungulates (Dinerstein 1979b). Besides, some 70-80 Asian elephants (*Elephas maximus)* have now become resident to the park (Steinheim *et al.* 2005). The globally endangered faunal group comprises of tiger (*Panthera tigris*), Asian one horned rhinoceros (*Rhinoceros unicornis*), hispid hare (*Aprophagus hispidus*), Gangetic dolphins (*Platanista gangetica*), Bengal florican (*Houbaropsis bengalensis* (Baral *et al.* 2002) and Great hornbill (*Buceros* *bicornis*) (HMGN 2001). Similarly co-existing ungulate community comprises of sambar (*Cervus unicolar*), wildboar (*Sus scrofa*), spotted deer (*Axis axis*), swamp deer (*Cervus duvauceli*) barking deer (*Muntiacus muntjack*), hog deer (*Axis porcinus*) and four horned antelope (*Tetracerus quadricornis*). Tiger is the largest predator (*Panthera tigris*) supplemented by other predators such as leopard (*Panthera pardus*), leopard cat (*Prionailurus bengalensis*), fishing cat(*Prionailurus bengalensis*), jungle cat (*Felis chaus*), jackal (*Canis aureus*), hyena (*Hyaena hyaena*), large indian civet(*Viverra zibetha*), small indian civet (*Viverricula indica*), common palm civet (*Paradoxurus hermaphroditus*) and Ratel (*Mellivora capensis*). Other than this, park also supports goral (*Naemorhedus goral*), serow (*Capricornis tahr*), sloth bear (*Melursus ursinus*), yellow throated marten (*Martes flavigula*), pangolin (*Manis pentadactyla*) and river otter (*Lutra canadensis*). It is also home to endangered species like gharial (*Gavialus gangeticus*) and mugger crocodile (*Crocodylus palustris*).

2.4.6 Intensive study area

The intensive study area was the Karnali flood plain and the Babai valley both of which are the two crucial habitats of wildlife. **Karnali area** is situated on the western part of the park and extends from Chisapani to Thakurdwara. The Karnali flood plain and adjoining strip of Terai alluvium covers some 114 sq. km and has a direct link with the Katarniaghat Wildlife Sanctury of India. **Babai valley** extends from Parewaodar to Chepang (bridge) and covers over 50% of the park area. It consists of a riverine flood plain of 131km^2 and the valley slope covering 373 km^2. It is saddled in the north-eastern section of the park and represents a typical example of an inner terai dun ecosystem. The Babai valley was named after river Babai which flows from east to west about 40 km from inside the park between two parallel ridges of the Siwaliks. This valley is contiguous towards the Lamahi bottleneck through the proposed Bardia extension area.

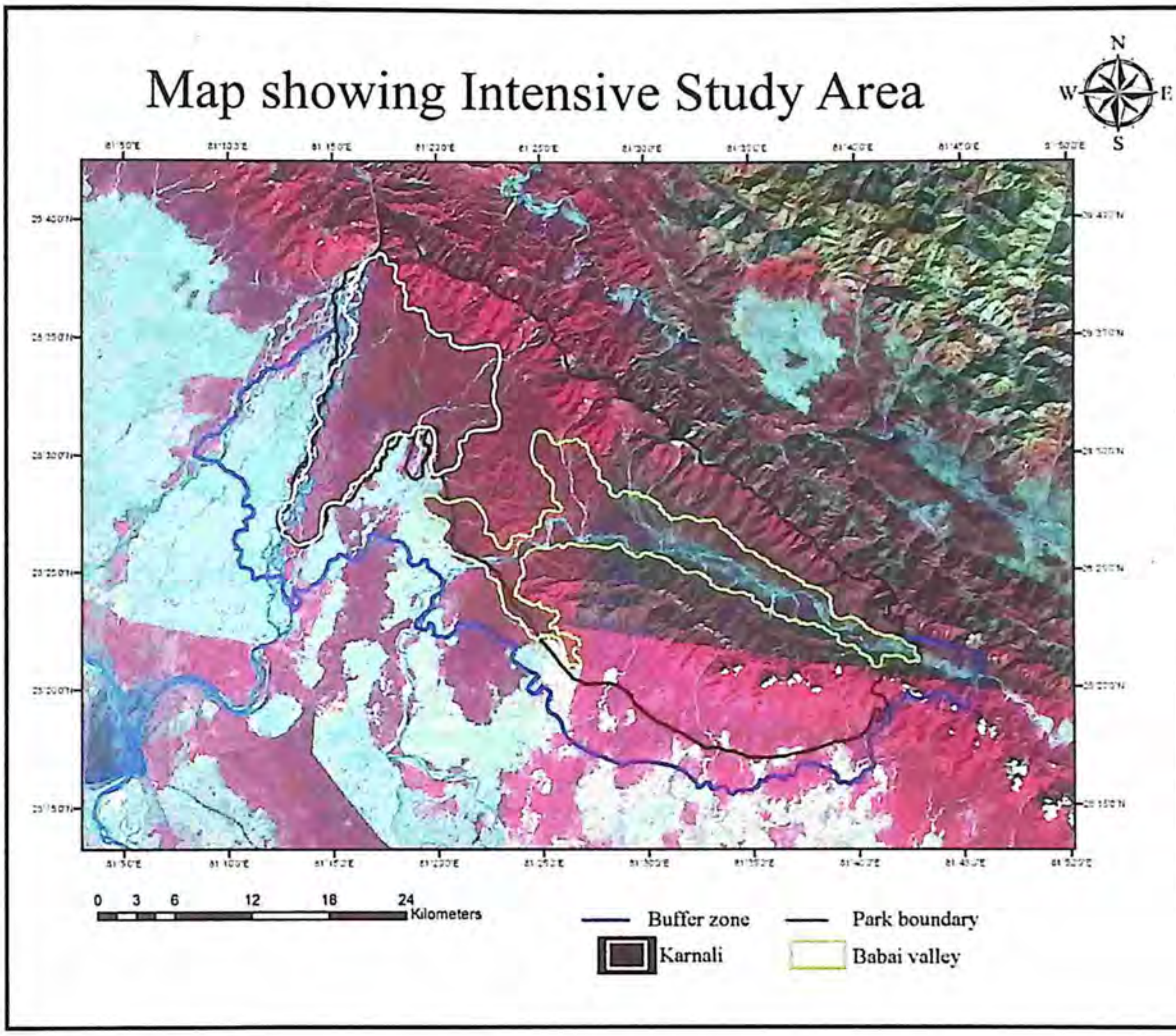

Fig 2.3.6 Map of the Intensive Study Area

And on the west this valley has a direct connectivity to the northern extension of Shuklaphanta wildlife Reserve and then to the tiger habitats in eastern part of Indian Terai Arclandscape across Mahakali river through Brahmadev corridor.

2.4.7 Conservation History of Bardia National Park

History of Bardia NP dates back to as early as 1950. Until 1950s, forests were protected as the property of the Rana rulers, which got nationalized in 1956 (Upreti

1994). In 1969, the area was declared a Royal Hunting Reserve, although local people had free access to the forest and to graze their livestock. Following this in the year 1976, the area covering 386km^2 was officially gazetted as the Royal Karnali Wildlife Reserve (Dinerstein 1979) which was renamed to Royal Bardia Wildlife Reserve in 1988. More detailed explanation of different conservation classifications and legislation, are available in Heinen & Kattel (1992) and Heinen & Yonzon (1994).

Prior to 1984, there were village settlements both in Karnali and in Babai valley (Brown 1995). The grasslands existing today in Baghauraphanta, Lamkauliphanta, Thuloshree, Sanoshree, Shivapur and Chepang are the result of the human settlements existing in the past. The villages located in the Baghaura phanta and the Lamkauli Phanta was relocated outside the reserve boundary (Upreti 1994). A total of 1572 families comprising 9500 individuals were displaced from the Babai Valley and resettled in the district near Gularia in the Taratal area in the year 1984 (Resources Nepal 1994). However, some 220 families did not want to leave their homesteads but they were forcibly relocated. The total population from the 20 villages had left 1200 ha of farmland, 1096 permanent houses and 1793 semi-permanent structures behind (Brown 1995). In the same year the area was extended and was upgraded to a national park in 1988.

2.4.8 Human ecology

Relatively little documentary evidence exists detailing the human use of the area prior to its designation as a National Park. Bardia NP is surrounded by 20 Village Development Centre (VDCs) of which 17 falls under the buffer zone leaving behind 3 VDCs lying in the north of Siwalik range namely Hariharpur, Lekhparajul and

Taranga. These 20 VDCs hold the total household number of 32753 with a population of 199694 (CBS 2001). But Buffer zone (BZ) comprises of only 15290 households with 101,000 resident population (BZ Management Plan 2057 B.S.). The population density is 308 persons per $km.^2$ Four VDCs (Manau, Pasupatinagar, Gola and Patabhar) lie to the west of the park boundary in the Karnali flood plain while three VDCs (Belwa, Chisapani & Chhinchu) border the eastern boundary. Like wise ten VDCs (Suryapatuwa, Thakurdwara, Shivapur, Neulapur, Bagnaha, Motipur, Baniyabhar, Magaragadi, Dhadabar and Deudkala) are located on southern border (Fig 2.1.2).

People in BZ belong to a number of ethnic groups with indigenous Tharu community claiming over 60% of the total population. A range of different ethnic and caste groups now inhabit the Terai and this has changed considerably over time. Migration and land colonization occurred to a minor extent from the second half of the 19th century, but since 1960, land shortages in the uplands and a malaria eradication programme led to a rapid expansion in the human population of the area. By 1990 more than 50% of Nepal's population resided in the Terai. The ethnic mix of the population is changing due to migration from the Hills and uplands; Tharu consisted 75 percent of population of Bardia in 1971 (Pokharel 1993), but now account for less than 52 percent (CBS 1993).

They are the oldest and original inhabitants of the Karnali region(Cox, 1990) and have been living here for more than 600 years. They migrated from Rajasthan during the 15th and 16th centuries (Ghimire 1992); indeed their dress and customs are very similar to tribals of Rajasthan. They are traditionally dependent on the forest for timber, thatch grass and fodder, and also collect fibres, leaves, canes and reeds, mushrooms, honey, vegetables, medicinal herbs and fruits (Dasmann & and Gadgil 1993). Fish, snails, crabs and rodents are considered delicacy in their diets.

While in the hills majority of the people are Chettri (37%) followed by Magar (18%) and Kami (14%) (CBS 2001). Ethnicity is extremely diverse representing castes such as Sonar, Brahmin, Sanyasi, Badi, Raji, Kumal, Tharu, Gurung, Thakuri,Newar, Damai, Koiri, Rai, Sherpa, Gaine and others. These people are the aborigines of the area and some of the families have moved down to the plains and some are in a process (Field survey, 2009). The hill villages however distinctly differ from the ones in the plains though there may be exception of the people living below the poverty line in the plains too.

Despite holding conservation history of almost 40 years Bardia NP still faces several challenges of which illegal hunting for wildmeat is of major concern. Dinerstein (1979) mentioned about the continued unrestricted poaching in the park. Similarly, Brown (1995) has mentioned the snaring of the pigs and deer by the Tharu communities. However, this kind of subsistence and/or local hunting has not received as much attention as poaching for trade. Currently, Bardia NP is practicing anti poaching operation through a network of local informants, park staff, Nepal Army and park elephants yet implementation of law is a failure in many parts of the park. Although it is acknowledged that hunting occurs, this is hardly ever openly highlighted or debated.

3. METHODOLOGY

3.1 Density estimation using Line Transect Method

Densities of the prey species was estimated using the line transect method (Anderson *et al.* 1979, Burnham *et al.* 1980 and Buckland *et al.* 1993). Line transects have been found to be very effective and reliable in estimating densities of ungulates in the Indian Subcontinent (Sunquist 1981, Johnsingh 1983, Karanth & Sunquist 1992, 1995, Karanth & Nichols 1998, Varman & Sukumar 1995, Biswas & Sankar 2002, Sankar & Johnsingh 2002, Bagchi *et al* 2003, David *et al.* 2005, Harihar *et al.* 2007).

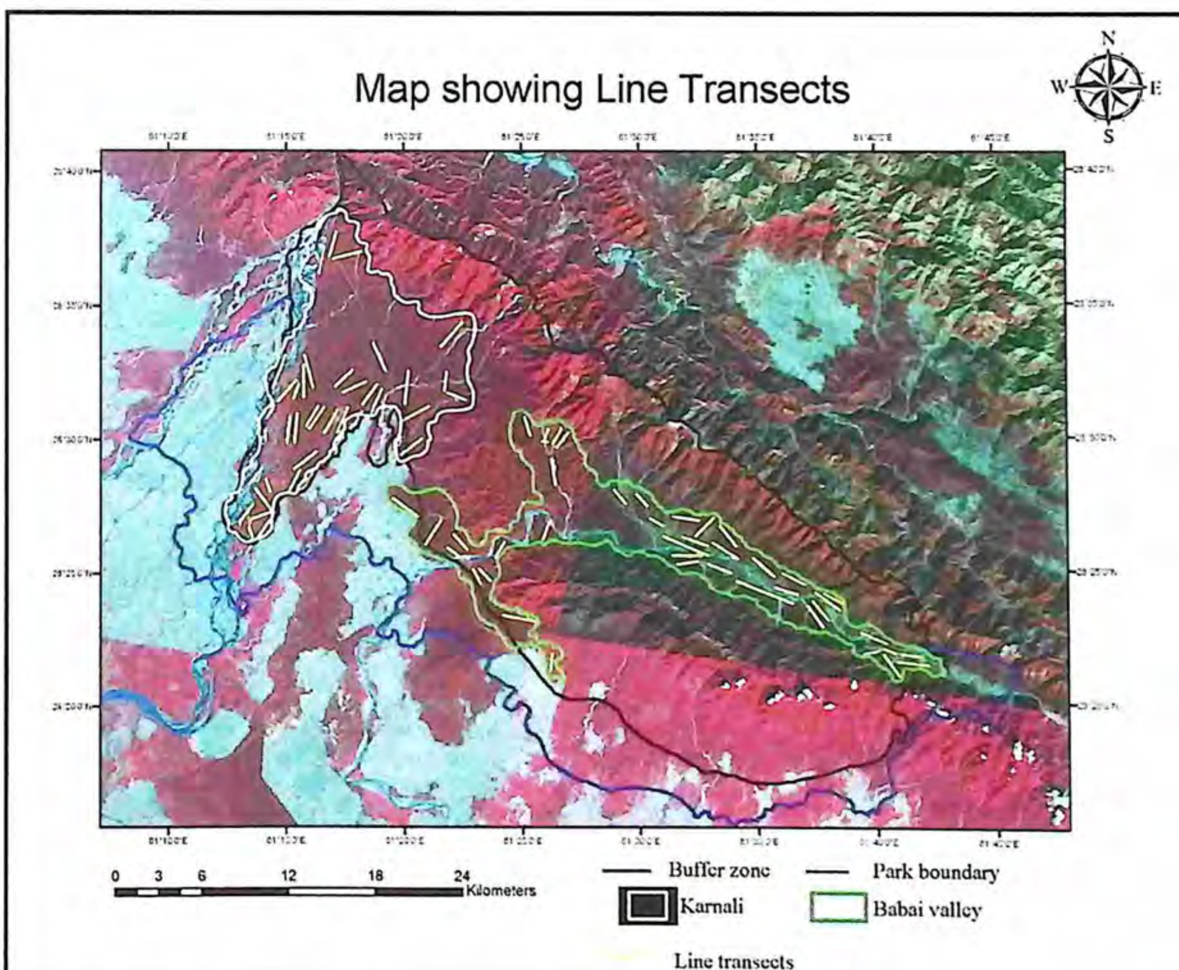

Fig 3.1: Map showing Line transects in the Intensive Study Area

The study area was stratified into 6 different vegetation types *viz*: Mixed Sal forest, Hill Sal forest, Riverine forest, Mixed hardwood forest, Wooded grassland and grassland combined and the Tall riparian grassland. A total of 48 line transects were walked in Babai valley, with lengths varying from 1km to 3.64 km making a total effort of 83.34km. Similarly, 35 transects were walked in Karnali, with lengths varying from 1km to 2.68km which made the total effort of 64.96km covering all vegetation types in the study area (Appendix I and II and Fig 3.1). Coordinates of the start and end points of these transect were recorded using a GPS (Appendix I and II). Each transect was considered independent and were sampled only once. A fixed bearing was followed until the termination of transect, distance was measured both using the range finder and the GPS. Line transect data was collected between 0630 hrs and 0930 hrs by three observers. Both foot transect and elephant transects were used for the purpose but elephant use was restricted to the tall and wooded grasslands.

On each detection the following informations were recorded:

- Species and group size: The identity of the species was noted along with their group size.
- Sighting distance: Distance of animal clusters or individuals from observer was noted using a laser range finder (Bushnell *Yardage Pro 400,* Overland Park, Kansas USA)..
- Sighting angle: Using a hand held compass (SUNNTO, Vantaa, Finland), the bearing of the animal clusters or individuals was taken. Since the bearing of walk was determined the angle of sighting was calculated.

The line transect data was analysed using program DISTANCE 4.1 (Buckland *et al.* 1993, Laake *et al.* 1993 and Burnham *et al.* 1980).

3.2 Demography

3.2.1 Demographic parameters

As per the previous studies by Dinerstein 1980, Eisenberg & Lockhardt 1972, Johnsingh 1983, Mishra 1982, Schaller 1967, Sukumar 1990 and Tamang 1982, Karanth & sunquist 1982; the proportion of age- sex classes in the population do not differ between different localities within same habitat type. Therefore, line transects counts were supplemented with the adlib records of animals sightings to determine the group sizes and to estimate the different age-sex categories.

3.2.1.1 Group sizes

Groups were defined as individuals being within 50 m of their nearest neighbors. Each detection was placed to a following category:

Group size range	**(%) in size range category**					
1	2-3.0	4-6.0	7-10.0	11-16.0	16-30	30+
(Solitary animals)	Family association	Small groups	Moderately small groups	Mediu m group	Large group	Very large group

3.2.1.2 Age and Sex-composition

I used physical characteristics and the size criteria described in the literature (Eisenberg & Lockhart 1972, Mishra 1982 and Schaller 1967) to age and sex the animal. The animals were classified as adult, sub-adult, yearling and fawn.

3.3 Behavior: Flight distance (FD)

Flight distance (FD) was calculated as the distance to which a person can approach an animal without causing it to flee (Miller *et al.* 2006).

On detection of an individual or a group we slowly walked toward the animal and the distance at which the animal took flight was recorded as flight distance.

3. 4 Habitat comparison

Data on following vegetation and disturbance parameters were collected for habitat comparison.

3.4.1 Vegetation parameters

A nested design circular plots were laid systematically at every 200m on transect. For each plot GPS coordinates was noted down.

3.4.1.1 Tree abundance

Tree species were quantified within 10m circular plots. A tree is defined as any plant with GBH (girth at breast height) ≥ 20cm).

3.4.1.2 Shrub and sapling abundance

Shrub and saplings of the tree species were quantified within 5m circular plots. Weed density were also recorded separately within the same plot. Saplings were combined with the shrub layer since they have a structural contribution to the shrub cover and density.

3.4.1.3 Grass, herb and seedling

Herbs and seedlings were also quantified species wise within 1m radius plot nested within 5 m radius plot. Grass cover was estimated as the % of grass from visual estimation of the area.

3.5 Impacts of Hunting

3.5.1 Secondary information

Information regarding hunting was collected from the known informants, wildlife department staffs, offence record and intelligence network (Appendix-3). Detailed household survey was carried out in the villages around Bardia National Park (Fig 3.5)

3.5.2 Household Survey

3.5.1.1 Selection of the Villages and interviewee

Villages to be surveyed were chosen on the basis of discussions regarding the poaching pressure with the park officials and the NGO staffs and my personal experience in the field during the past 4 months. The information was cross- checked with the park records to get the in-depth reality. "Snowball" method (Patton 1990) was followed to get to the next interviewee. In this method people are asked to suggest other informants who might provide us the best possible information.

3.5.2.2 Survey Methods

Before proceeding on to the village prior contacts in each of the villages were made. Questionnaires were different for the hunters and key informers. All the questions were set in mind and Pen Recorder was used to record the interviews to avoid possible suspicion since the nature of work was such that people would be reluctant to discuss the matter if the answers were noted on the questionnaires. People were interviewed in wide array of topics so as to gain their confidence and finally got on to the point of interest. Emphasis was placed on the intensity of hunting, species being killed, methods used and the proportion in subsistence and sold (Appendix-3).

The recorded interviews were later listened and the questionnaires sets filled up.

Table 3.5:1 Surveyed villages around Bardia National Park

VDC	Village Enclaves	N (Respondents)
Hariharpur	Telpani.Harrekanda, Lekgaun, Sungurkhal	26
Taranga	Narsinmkanda	12
Shivapur	Mohanpur	31
Pashupatinagar	Banjaria and Syaulibazar	16
Gola	Rajipur and Jodhipur	8
Manau	Parsenipur and Saijana	8
Total		101

3.5.3 Categories of hunters

Hunters were classified on the basis of their frequency of hunting.

- Active hunters are the ones who hunt at least once in a month.
- Occasional (lean period) hunters take part in hunting during festivals and the hardships.
- Opportunistic hunters are active during the political instability of the area when patrolling is less or whenever the animals are in easy access to poach.

Location map of Surveyed villages

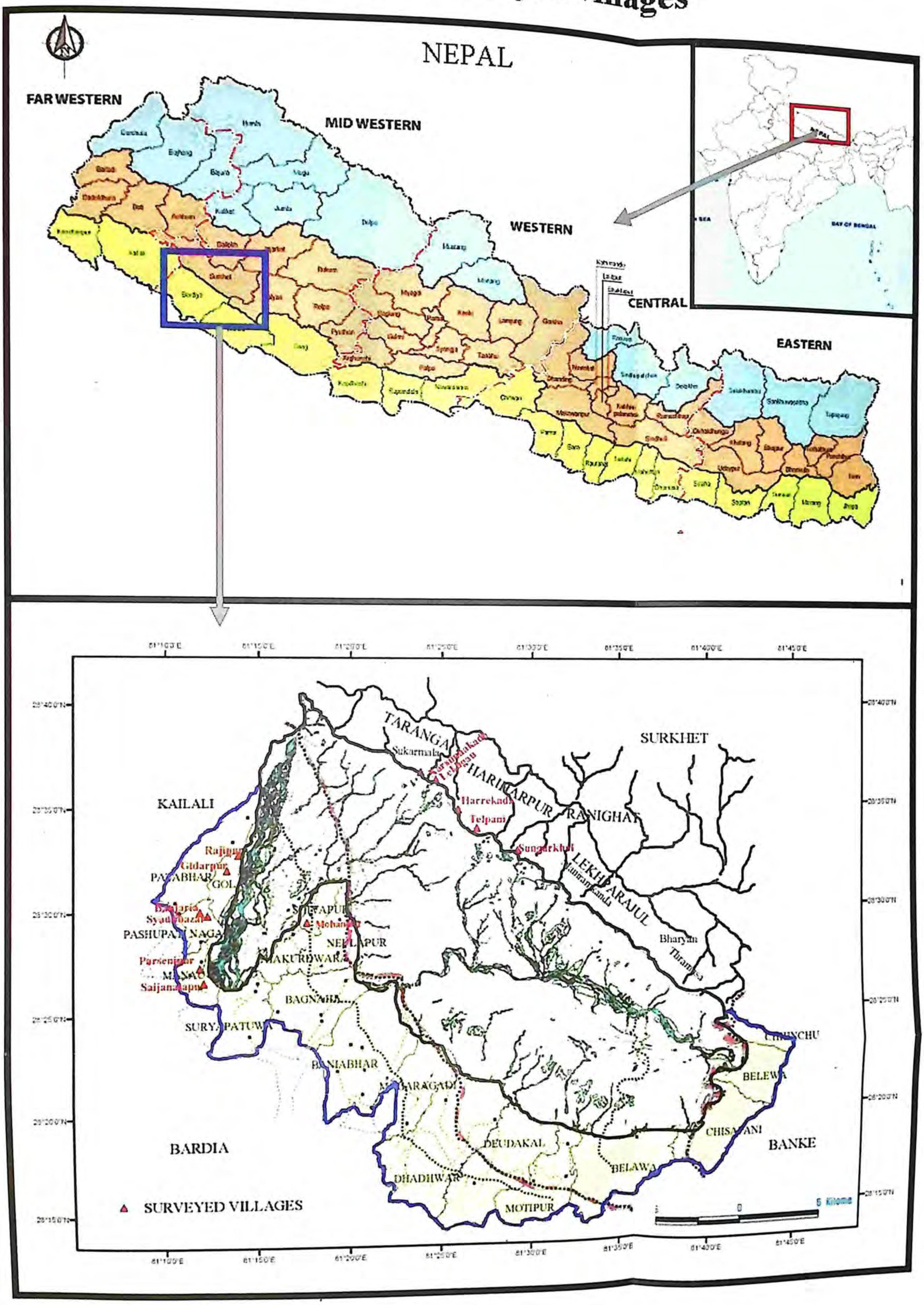

Fig 3.5 Location Map of the Surveyed Villages

4. STATISTICAL ANALYSIS

4.1 Density Estimation

Population density of principal prey species was estimated using program DISTANCE 5 Release 2 (Thomas *et al.* 2006). In order to model detection functions so as to estimate species density, the data for each species per survey was examined for signs of evasive movement and peaking at great distance from the line of walk. Following this, suitable modifications were made so as to ensure a reliable fit of key functions and adjustment terms to the data in order to arrive at density estimates. Akaike Information Criterion (AIC) and goodness-of-fit (GOF-p) tests were used to judge the fit of the model. Using the selected model, estimates of group density (*DS*), group size (GS) and individual density (*Di*) were derived.

4.2 Prey species biomass

Using the estimates of prey species densities derived from transects prey biomass was calculated by multiplying the average weight (kg) of the prey species as reported by Wegge (2009) and Karanth & Sunquist (1992).

4.3 Habitat comparison

Vegetation parameters collected during the line transect survey *i.e.* trees, shrubs, and herbs' species composition along with their densities was sorted with their corresponding plots of Babai and Karnali. These plots were grouped on the basis of their vegetation type, and analyzed for Analysis of similarities (ANOSIM) by using Program: PRIMER 6.1. The data was normalized, resembled and D1 Euclidean distance measures were selected for the further analysis. We performed Analysis of Similarities (ANOSIM) using programme PRIMER 6.1 to show the similarity between the habitat types.

4.4 Demography and Behavior

Demographic and behavioral parameters were analyzed using MS Excel 2003 and SPSS 16.0. All the data set were subjected to One Sample Kolmogorov-Sminorov Test to check the normality.

4.4.1 Group size

Mann- Whitney Test was used to test the group size differences between Babai valley and Karnali.

4.4.2 Age composition and Sex-ratio

Chi-Square Test was used to test the differences in age composition and Sex-ratio between the two study sites.

4.4.3 Behavior (Flight distance)

Mann-Whitney Test was used to compare the flight distance of Chital between the two study areas.

4.5 Hunting data

For hunting data basic statistical analysis was done using graphs and scatterplots of MS Excel and SPSS 16.0 (Zar 1984). Correlation matrices were made to see association between variables. Independent Sample Kolmogorov- Sminorov Test was used to see whether the hill or the plain villages varied in hunting intensity. Kruskal-Wallis Test was done to check the differences in hunting methods. Pearson's co-relation coefficient and regression was used to test the relationship between the hunting frequency, consumption and sale of the wild meat and the socio-economic factors. Similarly, Kruskal- Wallis Test was used to see the differences in villages' dependency on wild meat.

5. RESULTS

5.1 Density Estimation

Densities were estimated and compared for the prey species as a whole between the two study sites. However out of the 11 species that were detected on transects estimates for the density could be computed only for the 7 species due to sample size constraints (Buckland *et al.* 1993). The swamp deer density could not be compared since it was virtually absent from Babai whereas we got very low sightings of hog deer in Babai and low sambar sightings in Karanali.

Table 5.1: Species wise summary of detections from all line transects.

	Babai		Karnali		Pooled	
Species	**Detections**	**Number**	**Detections**	**Number**	**Detections**	**Number**
Chital	78	240	98	721	176	961
Sambar	24	42	5	7	29	49
Barking deer	17	17	7	7	24	24
Hog deer	2	2	24	59	26	61
Swamp deer	6	86	0	0	6	86
Four horned antelope	2	2	0	0	2	2
Wildpig	4	9	7	18	11	27
Langur	6	19	12	88	18	107
Rhesus	3	22	0	0	3	22
Porcupine	2	2	0	0	2	2
Hispid hare	1	1	0	0	1	1
Black naped hare	1	1	0	0	1	1
Total	146	443	153	900	299	1343

Chital was detected in 30 out of 47 transects in Babai valley while in Karnali it was detected on 29 out of 35 transects. The detection probability was 0.42 with a density estimate of 25.68 individuals/km^2 (Fig 5.1.1, Table 5.2).

In Karnali area (Fig 5.1.2) detection probability was estimated as 0.35, the coefficient of variation on the estimate of density was high compared to Babai (Table 5.2).

Barking deer detection probability was 0.71 with a density estimate of 2.45/km^2 in Babai (Fig 5.1.3 and Table 5.2). I couldn't get a good fit for the Karnali transects due to limited sightings.

Sambar detection was extremely low in Karnali (4) hence no model fit was possible. In Babai detection probability of 0.39 (Fig 5.1.5) and the density estimates was 4.14 animals/km^2 (Table 5.2).

Langur and Rhesus data were pooled together and the result was best explained (Fig 5.1.6) with an overall detection probability of 0.34 (Table 5.2).

Hog deer density (Fig 5.1.7) estimate has high coefficient of variation with detection probability 0.40 (Table 5.2).

We couldn't get the good fit for the wildpig sightings due to sample size constraints (Table 5.2)

The overall prey base density of Babai was estimated 28.75 animals/Km^2 (Table 5.2) with an overall detection probability of 0.44 (Fig 5.1.8).

In Karnali area the overall detection probability was 0.35 and density was 91.52/km2(Table 5.2) (Fig 5.1.9).

Table 5.2: Density of wild ungulate prey species obtained from program DISTANCE

Species	Species Model	p – hat	ESW (SE)	Cluster	DS	CV% (DS)	D	CV% (D	95%CI
Chital (Babai)	Half Normal-Cosine	0.42	50.73(4.3)	2.89(0.34)	9.31	17.89	25.47	21.16	16-38
Chital(Karnal)	Half Normal-Cosine	0.35	56.79(6)	7.42(0.94)	12.33	25.99	85.32	29.29	48-151
Barking deer (Babai)	Uniform-Simple Polynomial	0.71	41.52(6.7)	1	2.45	34.10	2.45	34.1	1.2-4.7
Barking deer(Karnali)	Neg Exp/ Polynomial	0.39	41.52(6.7)	1	3.08	62.2	3.08	62.2	0.92-10
Sambar	Half Normal-Cosine	0.34	39.98(5.7)	1.77(0.2)	2.33	26.63	4.14	28.96	2-7
Langur/ Rhesus	Negative exponential Cosine	0.34	26.57(7.24)	6.23(0.91)	2.68	37	16.73	39.82	7-35
Hogdeer	Half	0.40	28.53(5.4)	2.47(0.74)	2	86.7	4.96	88.84	1-22

	Normal-Cosine								
Wildpig(Babai)	Uniform-Cosine	1	45(0)	2.25(0.75)	0.53	55	1.19	64	0.35-4.02
Wildpig(Karnali)	Uniform - Cosine	1	45(0)	2.57(0.94)	1.19	33	3.07	49	1.14-8.27
Entire (Babai)	Half Normal-Cosine	0.44	53.12(4.6)	3.21	8.94	15.91	28.75	19.29	19-41
Entire(Karnali)	Half Normal-Cosine	0.35	56.79(6.3)	7.42	12.33	25.99	91.52	28.96	51-161

p – *hat* = Detection probability, ESW = Effective strip width, Cluster = average cluster size, *DS* = group density, *D* = individual density, CV%(*DS*) and CV% (*D*) = coefficient of variation on estimate of *Ds* and *D* respectively and the 95% Confidence Interval (95%CI) on the estimates of individual density.

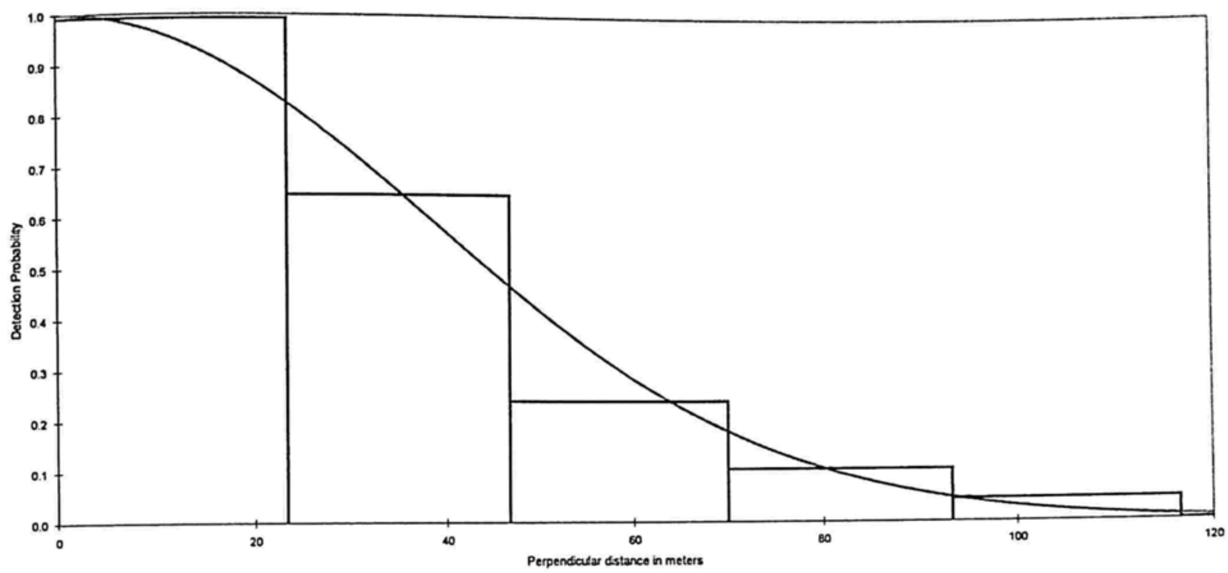

Figure 5.1.1: Detection probability curve (Half normal cosine) for Chital across all habitat types in Babai valley

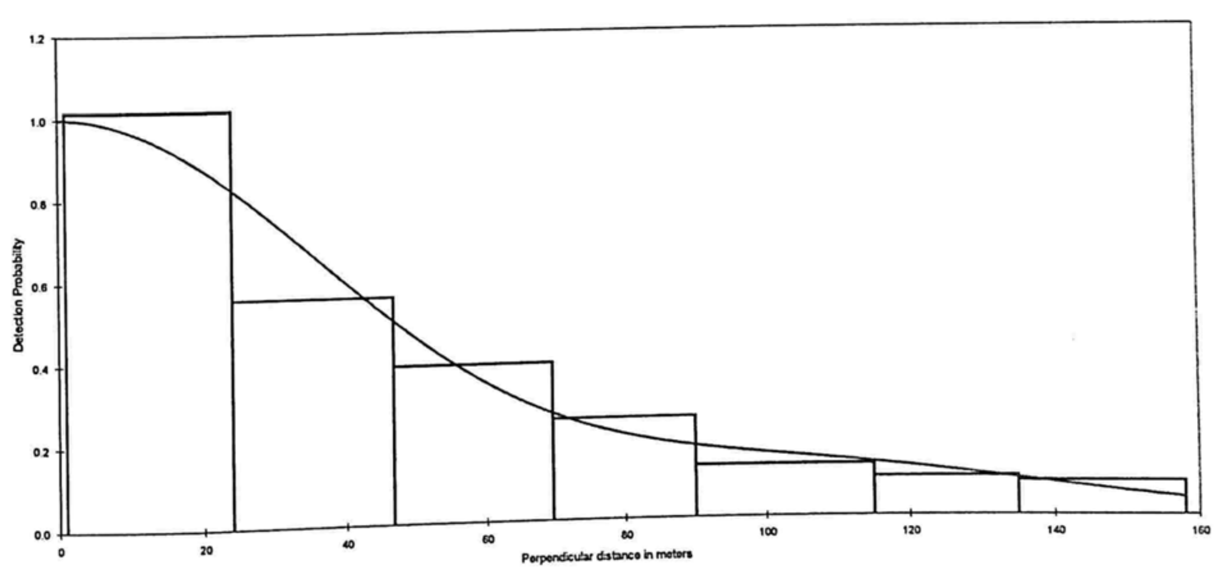

Figure 5.1.2: Detection probability curve (Half normal cosine) for Chital across all habitat types in Karnali

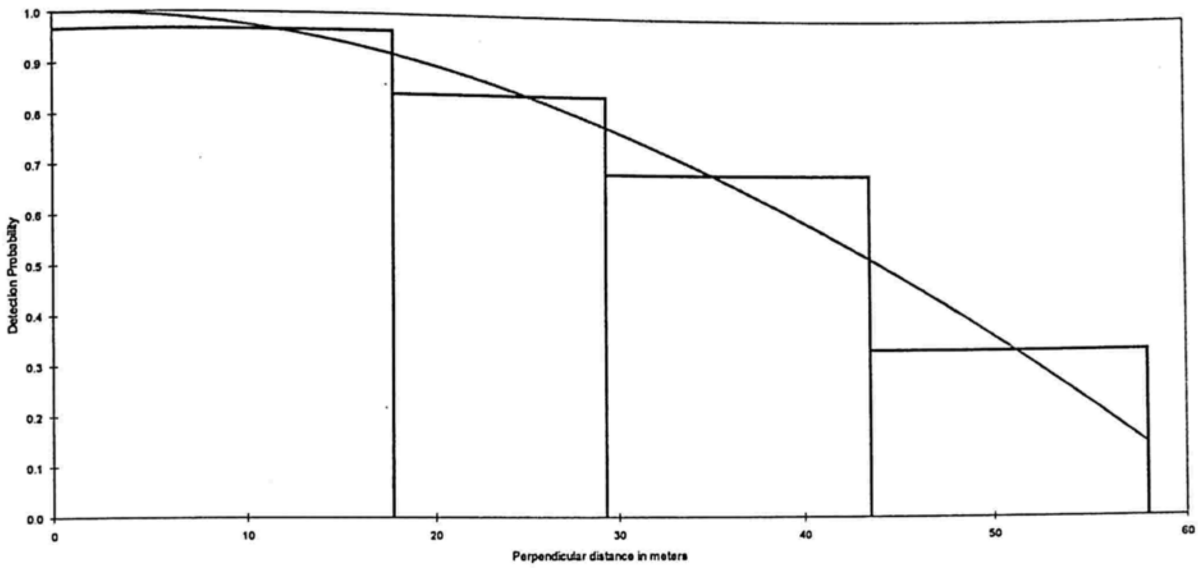

Figure 5.1.3: Detection probability curve (Uniform-Cosine) for Barking deer across all habitat types in Babai valley

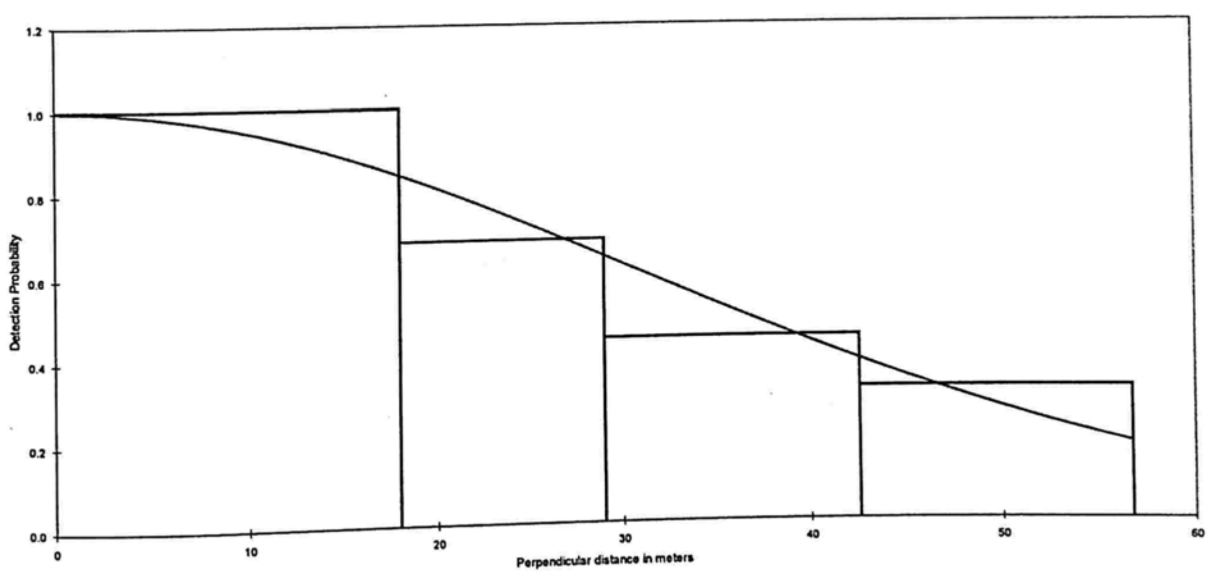

Figure 5.1.4: Detection probability curve (Uniform-Cosine) for Barking deer across all habitat types in Bardia NP

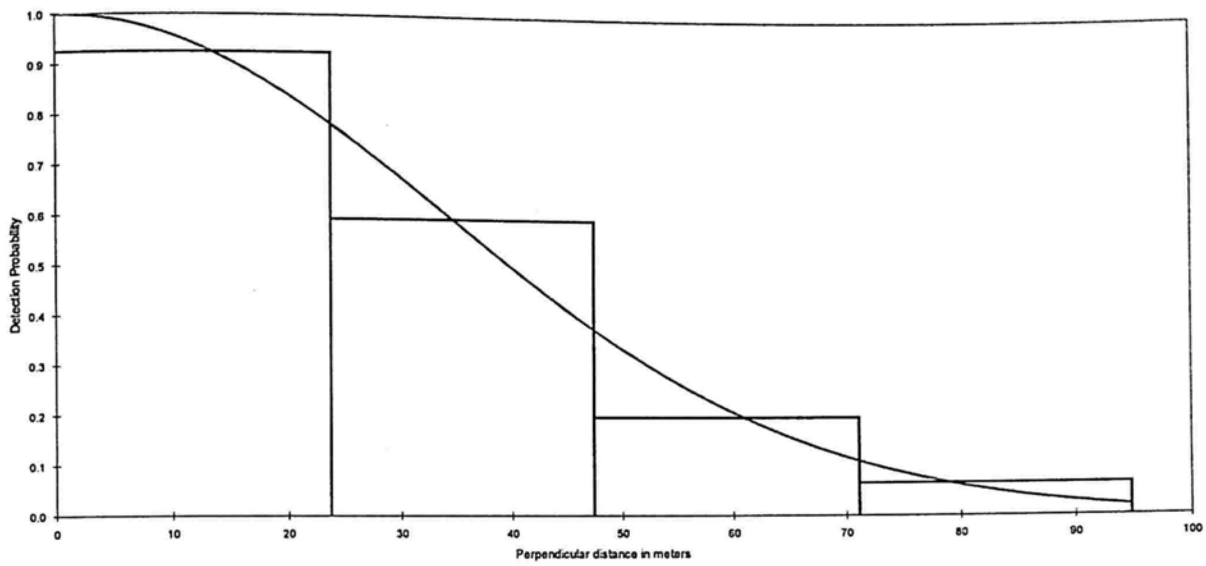

Figure 5.1.5: Detection probability curve (Uniform-Cosine) for Sambar aross all habitat types in Bardia NP

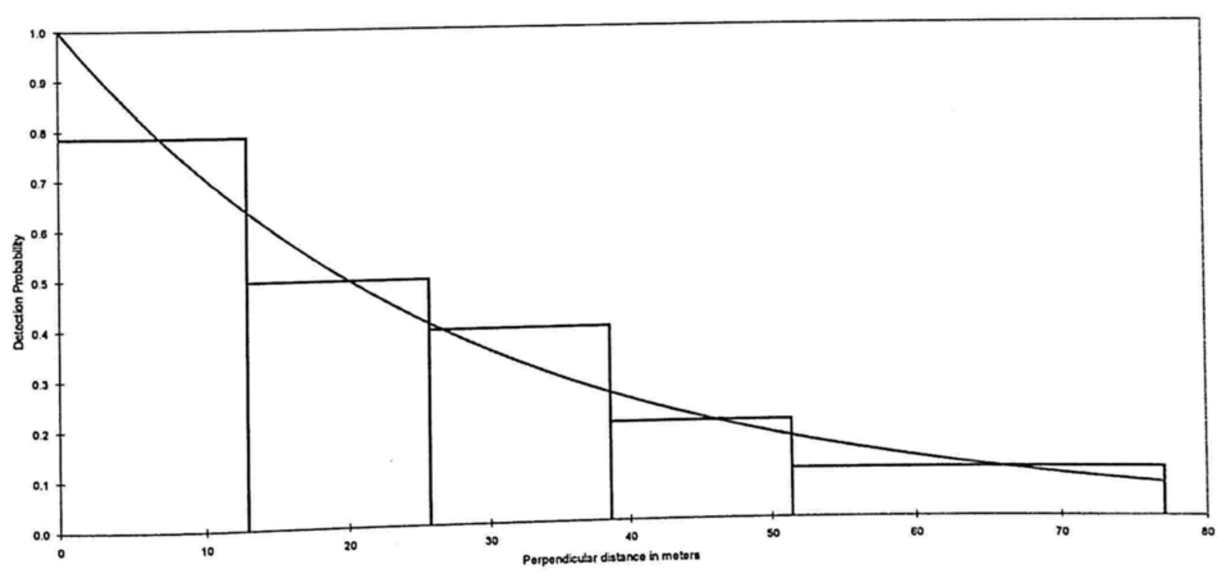

Figure 5.1.6: Detection probability curve (Negative- Exponential) for Langur across all habitat types in Bardia NP

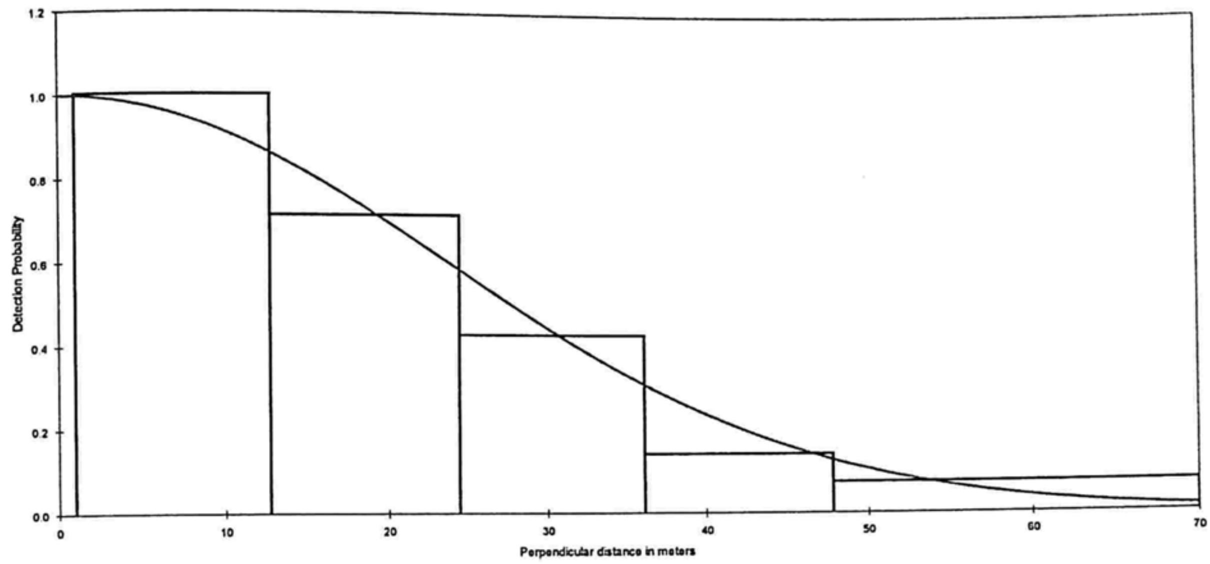

Figure 5.1.7.: Detection probability curve (Half Normal –Cosine) for Hog deer across all habitat types in Bardia NP

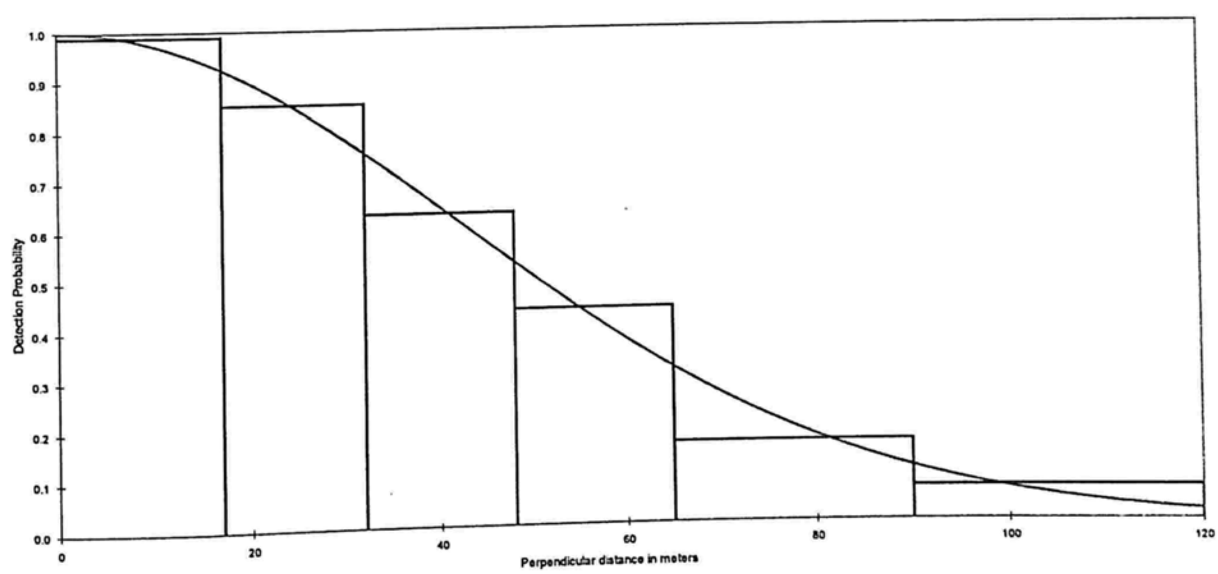

Figure 5.1.8: Detection probability curve (Half Normal –Cosine) for the entire prey-base across all habitat types in Babai valley

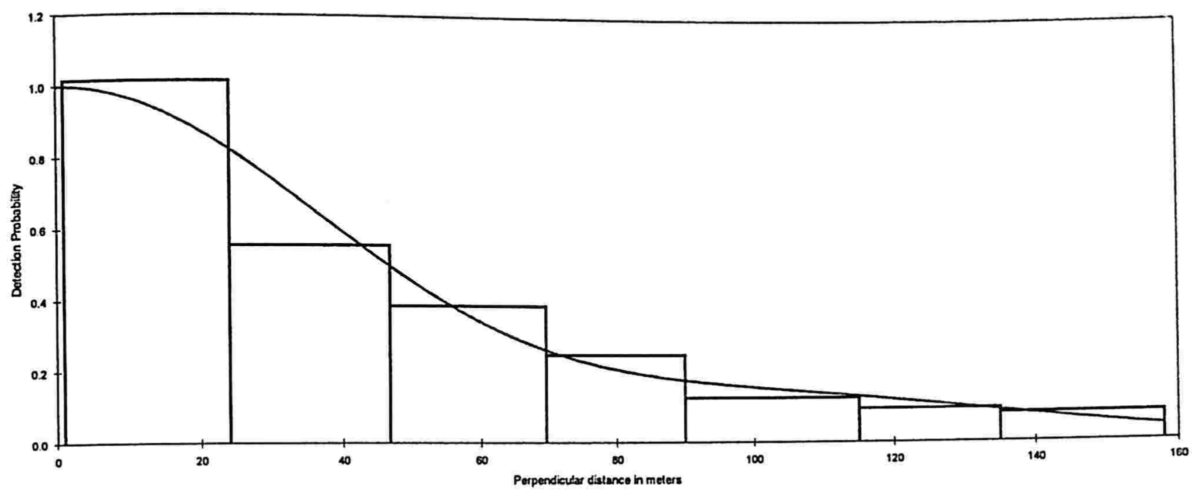

Figure 5.1.9: Detection probability curve (Half Normal –Cosine) for the entire-prey base across all habitat types in Karnali.

5.2 Biomass Estimation

We estimated prey biomass (Table 5.2.1) using estimates of ungulate densities arrived at from line transect sampling (Table 5.2).

Table: 5.2.1 (Density and Biomass of major prey species in the study sites)

Species	Average body weight (kg)	Density (N/km^2)	Biomass (kg/km^2)
Chital (Babai)	53	25.47	1349.91
Sambar(Babai)	134	4.14	544.76
Barking deer (Babai)	17	2.45	41.65
Wildpig(Babai)	38	1.19	45.22
		Total	1981.54
Chital(Karnali)	53	85.32	4521.96
Barking deer(Karnali)	17	3.08	52.36
Hogdeer(Karnali)	27	4.96	133.92
Wildpig(Karnali)	38	3.07	116.66
		Total	4824.9

5.3 Demography and behavior

5.3.1 Group Size

Chital group sizes were significantly smaller in Babai valley (mean group size=3.24±0.27 as compared to Karnali (mean group size=8.06±0.85 ($Z=2.548$, $p<0.001$) (Fig 5.3.1).

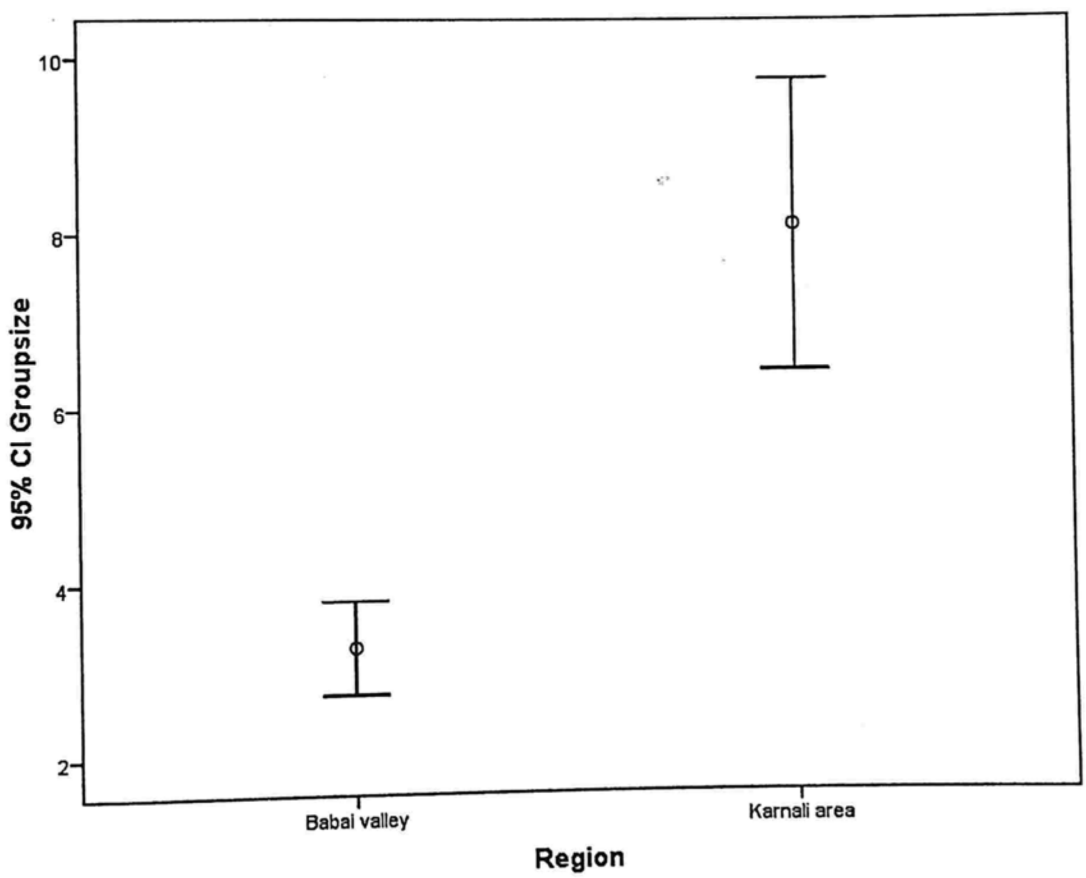

Fig 5.3.1 Difference in group size of Chital in Karnali and Babai valley

Table 5. 3.1: Group Size and group structure of ungulates and primates in Bardia National Park

	Group Size range	N	Mean (S.E)	1	2-3.0	4-6.0	7-10.0	11-16.0	16-30	30+
Langur(both)	1-16.0	18	7.4(0.94)	5.56	11.11	38.89	16.67	27.78	-	-
Barking deer(both)	1	34	1(0)	100.00	-	-	-	-	-	-
Wildpig(both)	1-12.0	23	3(0.54)	43.48	26.09	13.04	17.39	-	-	-
Four horned antelope (Babai valley)	1	2	1(0)	100.00	-	-	-	-	-	-
Swamp deer(Karnali)	2-39.0	15	11.47(2.6)	0.00	13.33	13.33	26.67	40.00	-	6.67
Sambar (Babai valley)	1-5.0	45	1.64(01.6)	55.56	33.33	11.11	-	-	-	-
Hogdeer(Karnali)	1-9.0	52	2.8(0.3)	46.15	28.85	17.31	7.69	-	-	-
Chital (Babai valley)	1-16.0	110	3.24(0.27)	33.64	36.36	20.00	6.36	3.64	-	-
Chital(Karnali)	1-75.0	160	8.06(0.85)	19.38	18.13	21.25	18.13	11.25	8.13	3.75

5.3.2 Group composition

Chital group composition differed significantly in Karnali and Babai valley. (Adult male: $\chi2=828.87$. d.f=10, $p<0.001$; Sub-Adult Male: $\chi2=625.72$ d.f=3, $p<0.001$; Yearling male: $\chi2=912.37$. d.f=4, $p<0.001$; Adult female $\chi2=345.97$. d.f=15, $p<0.001$; Sub- Adult female: $\chi2=1291.71$. d.f=8, $p<0.001$; Yearling female: $\chi2= 478.2$.d.f=10, $p<0.001$; Fawn: $\chi2=1.19$. d.f=7, $p<0.001$).

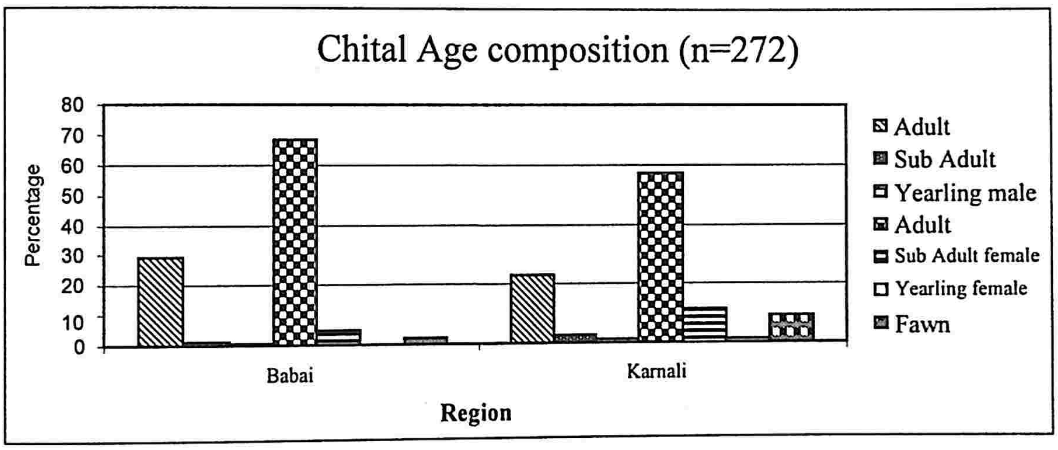

Fig 5.3.2 1: Chital Group Composition in Babai and Karnali

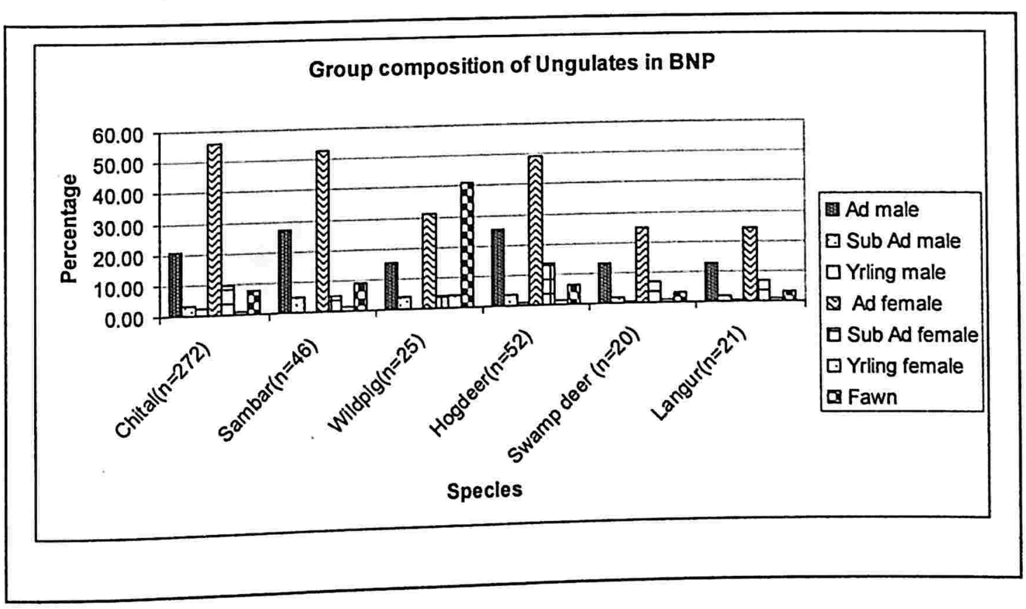

Fig. 5.3.2.2 Group composition of ungulates and Primates in Bardia NP

5.3.3 Sex Ratio

Chital sex-ratio was slightly greater in Babai valley (0.41) than that of Karnali (0.32). The difference in sex-ratio between the two areas was significant at ($\chi 2$= 2.88p<0.001) (Table 5.3.3.1)

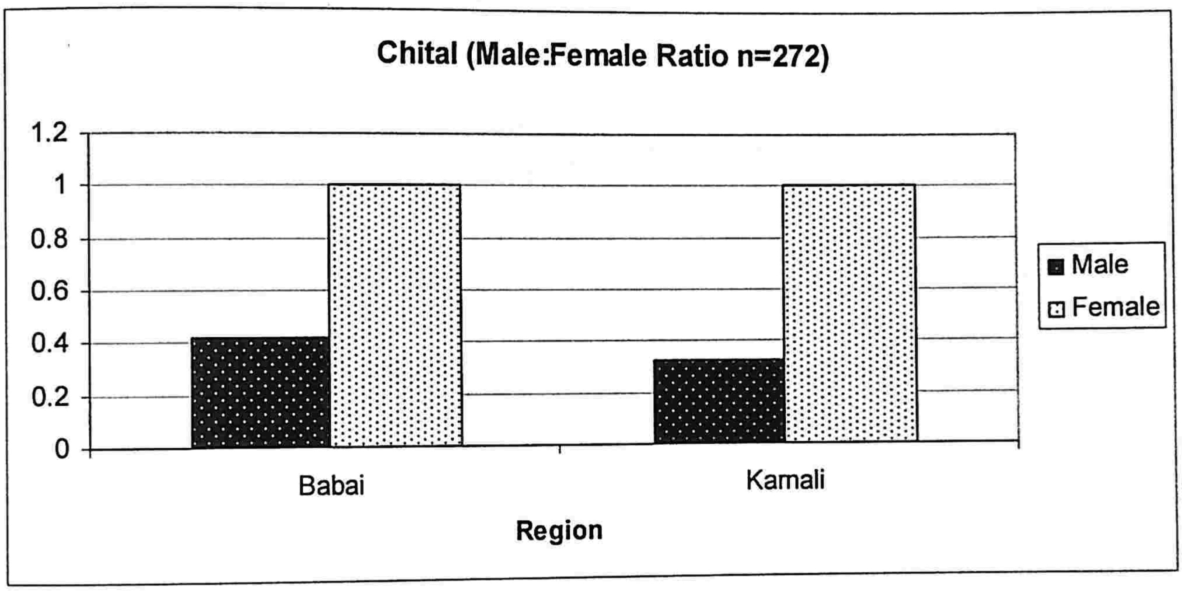

Fig 5.3.3.1 Chital Sex-ratio in Bardia NP

Table 5.3.3.1 Species wise Sex-Ratio in Bardia NP

Species	**Chital (n=272)**	**Sambar (n=45)**	**Hogdeer (n=52)**	**Swamp deer (n=17)**	**Barking deer(n=34)**
	Sex ratio	Sex ratio	Sex ratio	Sex ratio	Sex ratio
Babai	**0.41**	0.52	-	-	0.42
Karnali	**0.32**	0.66	0.46	0.77	0.5
Chi-Square	**2.881**	27.091	64.308	3.176	2.94
df	**24**	18	5	6	1
Asymp. Sig.	**0.0001**	0.0001	0.001	0.786	0.086

5.3.4 Flight Distance

Chital's flight distance did vary significantly between the two areas. However mean FD was greater in Karnali than of Babai valley (Table 5.3.4).

Table 5. 3.4: Species- wise flight distance in Bardia NP

Region	Sample size	Mean FD	Mann-Whitney Test	
			Z	P
Babai (Barking deer)	21	45.95	0.887	0.89
Karnali (Barking deer)	13	46.76		
Babai(Chital)	**110**	**49.51**	**-4.42**	**0.001**
Karnali(Chital)	**161**	**73.14**		
Babai (Sambar)	37	55.94	1.04	0.23
Karnali (Sambar)	8	66.25		
Babai (Wildpig)	7	39.71	-0.34	0.74
Karnali (Wildpig	14	37.5		

5.4 Habitat parameters

ANOSIM Result shows that the vegetation types of Babai and Karnali are highly similar with the corresponding R-value and *P*-values as in Table 5.4.

Table 5.4: Pair-wise Test Babai vs Karnali

	Vegetation types	R	*P*
Trees	Sal forest	0.028	0.001
	Hill Sal forest	0.135	0.009
	Grassland	0.044	0.143
	Riverine forest	0.062	0.004
	Miscellanous forest	0.05	0.047
Shrubs	Sal forest	0.028	0.001
	Hill Sal forest	0.063	0.001
	Grassland	0.044	0.166
	Riverine forest	0.062	0.002
	Miscelleneous forest	0.05	0.038
Herbs	Sal forest	0.04	0.001
	Hill Sal forest	0.198	0.036
	Grassland	0.112	0.001
	Riverine forest	0.063	0.001
	Miscelleneous forest	0.02	0.05

5.5 Impacts of hunting

5.5.1 Hunting Intensity

The villages differed significantly in hunting intensity ($\chi 2=53.06$, d.f=5, $p<0.001$). Among the villages surveyed the severity of the problem was extremely high in the hill villages. The intensity was found to be highest in Taranga with 143.78 hunter days per month (Table 5.5.1) followed by Hariharpur with the hunter days of 91.71/month. The hunting intensity was comparatively much lower in the villages in the plains. Shivapur, Pashupatinagar, Gola and Manau had the perceived hunting intensity of 13.89, 0.77, 0.99 and 1.87hunter days per month respectively (Table 5.5.1).

Table 5.5.1: Hunting activity recorded for Surveyed Villages

Village name	AH	freqAH	LPH	freqLPH	HP	AH/AP (X)	LPH/HP (Y)	X* freq AH	Y* freq LPH	Total frequency/ month
Hariharpur	14.5±1.06	1.64±0.12	61.12±3.9	0.82±0.6	3.35±0.28	5.00	20.37	75.00	16.71	91.71
Taranga	20±3.51	1.65±0.18	38±3.65	0.825±0.9	3.35±0.28	6.67	12.67	133.33	10.45	143.78
Shivapur	5±0.087	0.48±0.7	50.48±0.2358	0.33	3.35±0.28	1.67	16.83	8.33	5.55	13.89
Pashupatinagar	0	0	8.28±0.41	0.28±0.13	3.35±0.28	2.76	2.76	0.00	0.77	0.77
Gola	0	0	9±1.11	0.33		3.00	3.00	0.00	0.99	0.99
Manau	0	0	17.14±0.55	0.33	3.35±0.28	5.67	5.67	0.00	1.87	1.87

Note: AH=No of Active hunters, freqAH=Average hunting frequency of Active hunters, LPH= No of Occasional- Opportunistic hunters, freqLPH= Average frequency of Occasional-Opportunistic hunters, HP=Average hunting party, X= Hunting party of Active hunters, Y=Hunting party of Occasional-opportunistic hunters, X* freqAH= Total frequency of Active hunters, Y* freqLPH =Total frequency of Occasional-opportunistic hunters.

Table 5.5.2: List of the species poached

ORDER	Family	Local name	Common name	Scientific name
PHOLIDOTA	Manidae	*Shalak*	Chinese Pangolin	*Manis pentadactyla*
PRIMATES	Ceropithecidae	*Bandar*	Rhesus macaque	*Macaca mulatta*
	Ceropithecidae	*Gunna*	Hanuman Langur	*Semnopithecus entellus*
CARNIVORA	Canidae	*Shyal*	Golden jackal	*Canis aureus*
	Ursidae	*Bhalu*	Sloth bear	*Ursus ursinus*
ARTIODACTYLA	Suidae	*Bandel*	Wild boar	*Sus scrofa*
	Cervidae	*Chital (Mirga)*	Spotted deer	*Axis axis*
		Laguna	Hog deer	*Axis porcinus*
		Barasinghe	Swamp deer	*Cervus duvauceli*
		Jarayo	Sambar deer	*Cervus unicolor*
		Ratuwa	Barking deer	*Muntiacus muntjak*
		Nilgaddi	Nilgai	*Boselaphus tragocamelus*
		Chauka	Four horned antelope	*Tetracerus quadricornis*
CETARTIODACTYLA	Bovidae	*Thar*	Himalayan serow	*Capricornis tahr*
		Ghoral	Himalayan goral	*Naemorhedus goral*
	Hystricidae	*Dumsi*	Indian crested porcupine	*Hystrix indica*
LAGOMORPHA	Leporidae	*Kharayo*	Indian hare	*Lepus nigricollis*
RODENTIA	Muridae	*Musa (Dhanchari)*	Lesser Bandicoot Rat	*Bandicota bengalensis*
			Large Bandicoot Rat	*Bandicota indica*
			Indian Bush Rat	*Golunda ellioti*

ORDER	Family	Local name	Common name	Scientific name
			Metad	*Millardia meltada*
			Little Indian Field	*Mouse Mus booduga*
			Fawn Colored Mouse	*Mus cervicolor*
			House Rat	*Mus musculus*
			Indian spiny mouse	*Mus platythrix*
			Roof Rat	*Rattus rattus*

5.5.2 Species Poached

From the recorded cases, Chital was found to be the most poached species in Karnali (66%). Other species poached were Hogdeer (12%), Sambar (8%), Wildpig (6%), Nilgai(4%), Barking deer and Porcupine (2%) each (Fig 5.5.2.2). While in Babai valley Chital and Sambar have almost equal representation (45 and 41% each). The other recorded cases were for Wildpig and Barking deer. From field survey 17 species of mammals >3 kg were found to be eaten by the hunters (Table 5.5.2).

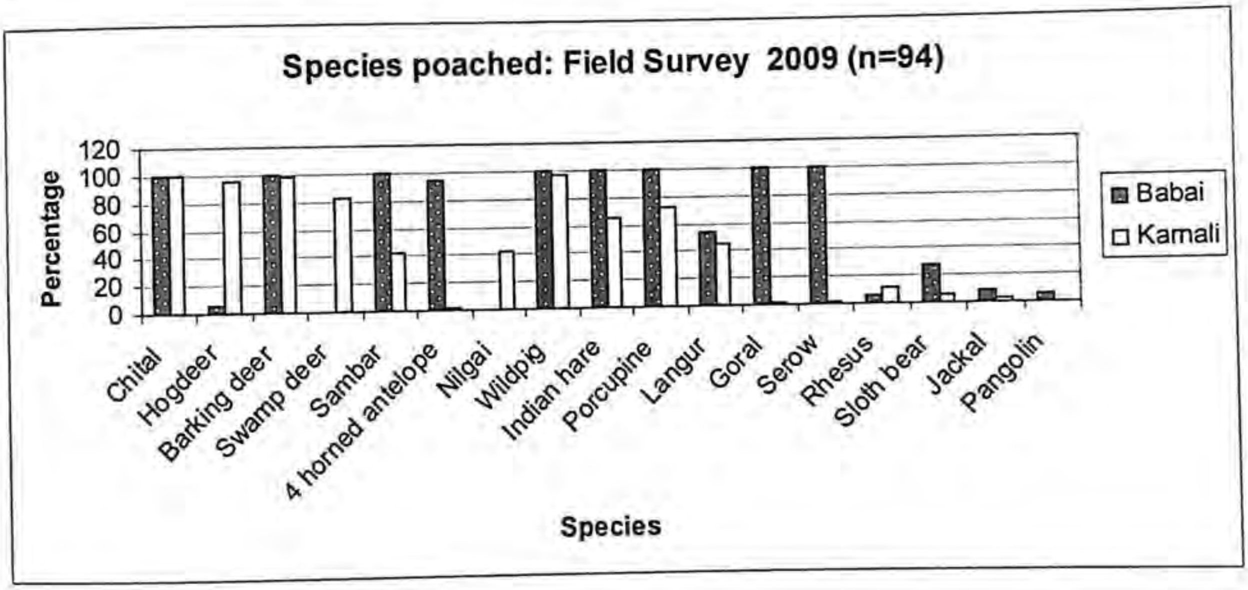

Fig 5.5.2.1: Species poached in Babai and Karnali area of Bardia NP

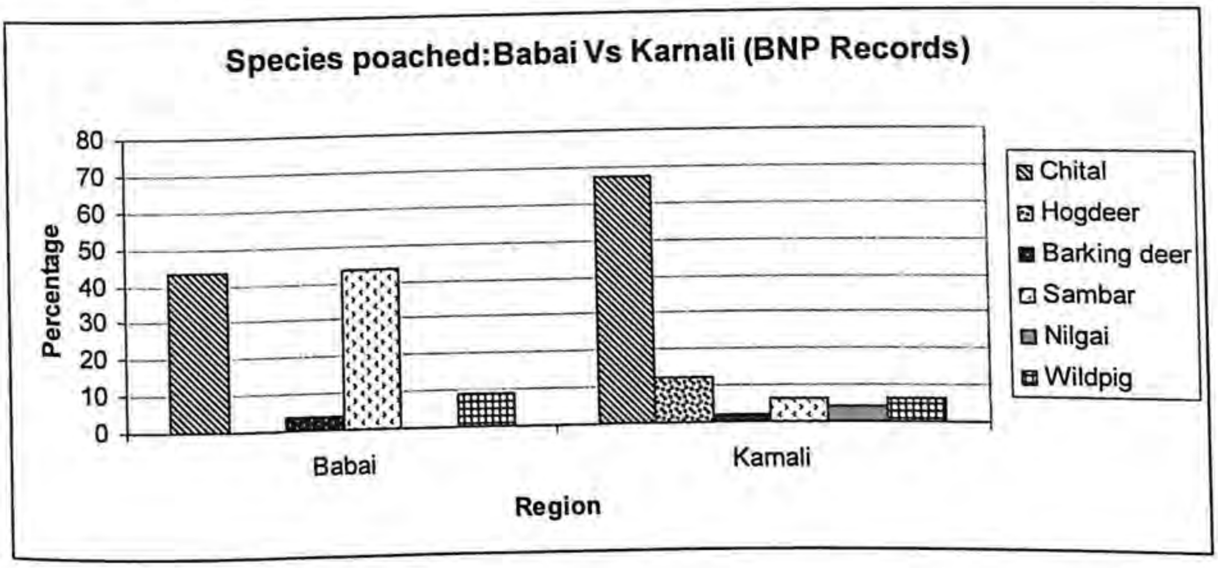

Figure 5.5.2.2: Species Poached in Bardia NP for wild meat (Park Records)

5.5.3 Hunting methods in vogue

5.5.3.1 Khabar net drive method

Locally known as *Amboisa* in Tharu and *Hakuwa khel* in general is a sport hunting method practiced by the natives of this area. Though this practice has been reduced to a great extent over the years people do practice it occasionally during festivals such as Maghi and just after crop cultivation (known as *Hardwaii*) gets over. Khabar nets are often wreathed by Tharu themselves using cotton, linen mixed or nylon threads (Fig 5.5.3.1). The length of the net can vary from 60-100ft and the height is kept 6ft from the ground with the mesh size of 15-20cm. The width is often kept 8-10ft.

Once the area for setting up the khabar net is selected, teams of 10-12 take their position in a circle. They all move together and push the animals towards the khabar net raised with bamboo sticks in an inclined manner, supported by other bamboo sticks. No animals present in that particular patch of forest or grassland are missed. Once the animals are forced into the net the bamboo post falls off and the animals get entangled inside the net. The animals are then killed with spear, axe or sticks and the catch is shared among the teams equally except the team leader (*hakuwa*) who gets the larger share. The method works extremely well in high density area of chital and hogdeer.

5.5.3.2 Snares

Snares are made either with gabion, steel or electric-fence wires (Fig 5.5.3.2) These are placed at the existing animal path both in grassland, wooded grassland and in dense vegetation. On selection of the site, one end of the snare is anchored to a tree or shrub and is well camouflaged with the vegetation. Any animal attempting to pass through is caught by the noose, which tightens around the neck, chest, abdomen or leg of the animal. On ensuing attempt to free itself, the noose tightens resulting in suffocation and subsequent death of an animal.

5.5.3.3Traps

Traps are made of a metal frame covered with metal wire (Fig 5.5.3.3). The door is connected by a wire to the bait (fruit or vegetables/ meat), or to a footboard inside the trap. The size range of the traps varies depending upon the target species. Traps were mostly found to be used for rodents and porcupines in the crop fields.

5.5.3.4 Hand-held catapults

Hand-held catapults are made of Y-shaped twigs in combination with rubber bands. Small metal balls or stones are used with catapults. Though most commonly used for birds, these were also used to kill langurs, squirrels and Rhesus macaques.

5.5.3.5 Muzzle loaders

Local black-smiths were found handy in preparing muzzleloaders on their own (Fig 5.5.3.5). They used a combination of wood, GI pipe and a metal trigger for its preparation. And for loading the muzzle, a projectile and usually the propellant is loaded from the muzzle of the gun. Hunters prepare the propellent charge with the combination of ingredients such as grounded gandak @100gm, pure alcohol (5ml), finely burnt and grounded red chilly along with soda used in jewellery@ 300gm.

5.5.3.6 Poisoning

Hunters didn't confess the use of poison for killing animals but from the park data several instances were found where hunters had used metacid to kill the animals. Hunters spray the metacid mostly at the salt licks and small water pools resulting in mass death of animals.

5.5.3.7 Hunting dogs

Hunting dogs are generally used for killing animals like hares and chitals. Dogs are first made to chase the animals and the hunters in turn kill them with the local weapons such as spear and knives.

5.5.3.8 Electric shock

Of the various methods discussed above, use of electric shock was not very common except in Mohanpur village (Fig 5.5.3.8). This method comes into vogue especially during the time of crop ripening time; people connect the current to the 2 lines of live wires and place them nicely around their crop field. On animal's arrival to the field, it dies of electric shock.

5.5.3.9 Baited Explosives

Baited explosives (Fig 5.5.3.9) are most commonly used for wildpigs. Kerosene is sprinkled by tracking the foot prints and dug holes of the animal as it lures the animal. Then the baited explosives (commonly known as *sutlibomb*) wrapped with maize or wheat flour is kept on its way. Kerosene lures the wildpig and on feeding it the animal's mouth is blasted.

5.5.3.10 Burn and chase method

This method is extremely devastating. Apart from being inhumane, untargeted species are also killed since the hunters lit the fire from one ends of the forest and chase animals from the other end. This not only kills the animals but also ruin their habitats. This method is practiced mostly during the dry period of the years.

5.5.3.11 Smoking and digging out of the burrows

This is the most common method used for killing porcupines (Fig 5.5.3.11). After locating the burrows the hunters lit the fire into it. Animals try to escape suffocation but at this stage hunters injure them with the weapons like spear, axe and khukuri.

5.5.3.12 Drive and chase method (Axe, Spear and Stick)

Apart from the wide use of other methods drive method was very common in flood plains especially carried out for hogdeer. Hunters operating across Karnali river come to the islands in their boat, chase the animals and force them to the water. While animals try to escape, people hit them with axe, spear or stick (Fig 5.5.3.12).

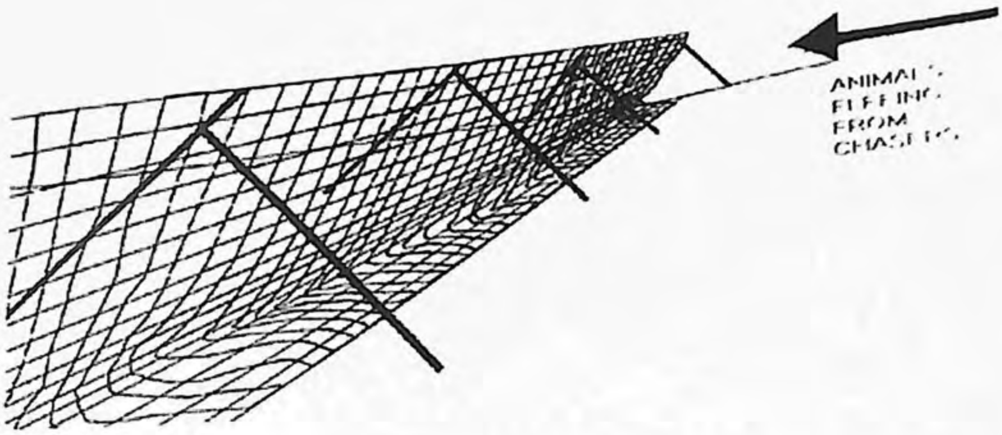

Fig: 5.5.3.1 Khabar net drive method

Fig:5.5.3.2 Snares

5.5.3.3 : Traps

Fig 5.5.3.5:Muzzle loader

5.5.3.8: Electric shock

Fig 5.5.3.9 Baited explosive

Fig 5.5.3.11 Smoking and diging out of the burrow

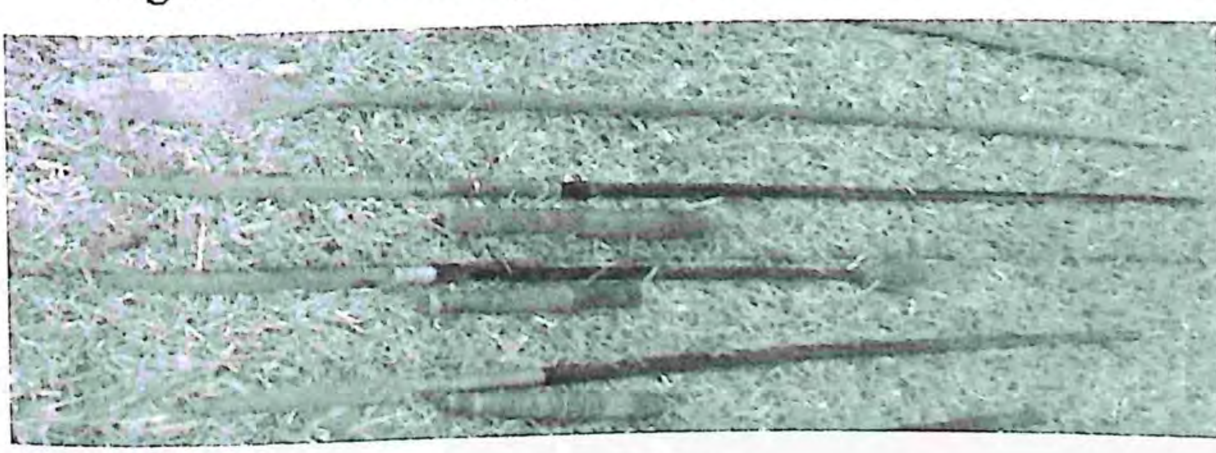

Fig 5.5.3.12 Spears

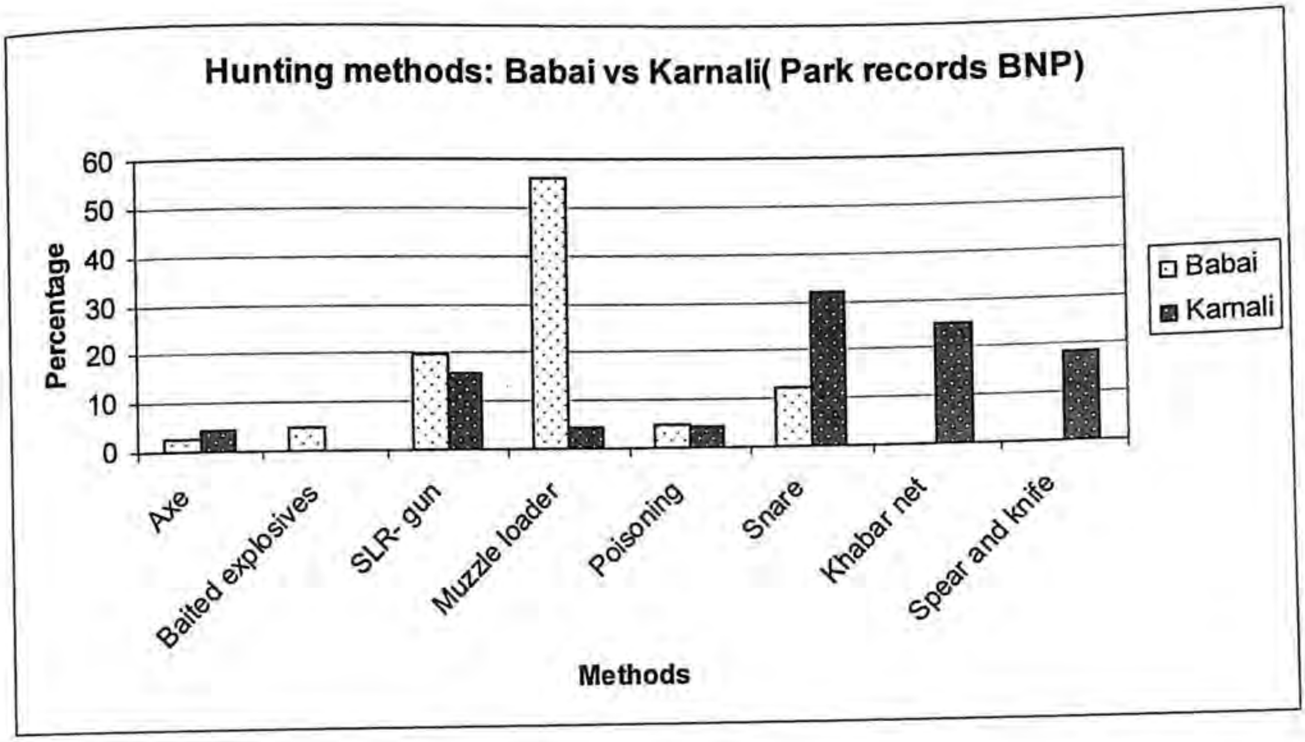

Fig 5.5.3.1: Hunting Methods used in Babai and Karnali area of Bardia National Park (Bardia NP Records)

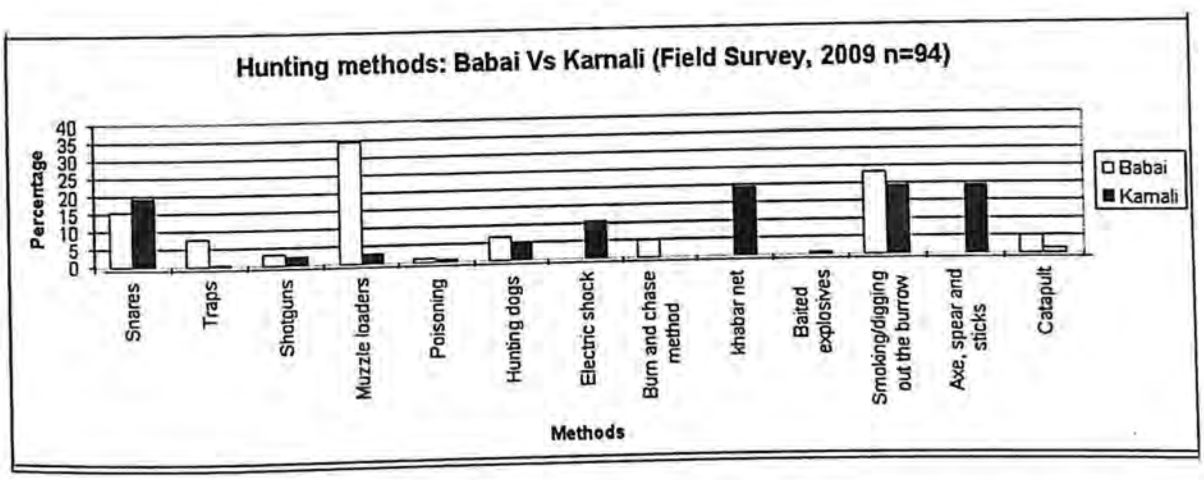

Fig 5.5.3.2: Hunting Methods used in Babai and Karnali area of Bardia National Park (Field Survey,2009)

The use of hunting methods varied between Karnali and Babai valley. Snares ($\chi2$=40.49,d.f=1, $p<0.001$), Muzzle loaders ($\chi2$=65.59,d.f=1, $p<0.001$), Traps ($\chi2$=10.66,d.f=1, $p<0.005$), Electric shock ($\chi2$=28.40,d.f=1, $p<0.001$) Burn and Chase method ($\chi2$=8.41,d.f=1, $p<0.005$), Khabar net ($\chi2$=93,d.f=1, $p<0.001$)

Smoking and Digging out of burrows: ($\chi2$=21.92,d.f=1, p<0.001) Spear and Axe ($\chi2$=93,d.f=1, p<0.001) were significantly different, however the use of shotguns, poisoning of the salt licks, use of hunting dogs, and the use of baited explosives didn't show any difference.

5.5.4 Hunting and Socio-economic variables

Apart from the data on family size, land holding and education we also collected information on the average annual income of the respondents. Incomes were estimated as accruals on the basis of cash value of the wild-meat, agricultural goods, employment opportunities (governmental or non-governmental job) or daily wages. Bulk of the average income to Hariharpur and Telpani villages were derived from wild-meat where as in the rest of the other villages it was through agricultural based products.

ble 5.5.4: Socio-economic profile of the Respondents (village-wise) in Surveyed villages und Bardia NP

illage	Family size (n)		Income (Thousand)		Land holding (Kattha)		Education (class)		Literacy rate	
	Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E	Literate	Illiterate
ola	6.00	0.73	56.67	13.2	1.63	0.87	5.00	1.61	66.67	33.33
ariharpur	6.92	0.55	36.64	2.42	0.30	0.03	1.64	0.63	80.00	20.00
lanau	9.14	1.06	73.57	3.89	0.61	0.33	0.86	0.86	14.29	85.71
ashupatina ar	6.71	0.79	54.21	8.62	0.90	0.26	5.93	0.99	78.57	21.43
hivapur	6.32	0.48	68.42	5.42	1.57	0.24	6.16	0.60	80.65	19.35
aranga	5.82	0.40	36.27	5.61	0.53	0.12	4.82	1.27	63.64	36.36

A difference existed among the surveyed villages in Income ($\chi2$=32.60,d.f=5, p<0.001), Landholding ($\chi2$=34.70, d.f=5, p<0.001), Education ($\chi2$=48.51, d.f=5, p<0.001), Wild meat consumption ($\chi2$=48.51, d.f=5, p<0.001), Wildmeat Sale ($\chi2$=48.49, d.f=5, p<0.001), and Frequency of hunting ($\chi2$=57.34, d.f=5, p<0.001).

5.5. 5 Factors governing hunting in the area

Significant negative correlations was observed between cash income (r=-0.49, p<0.001), land holdings (r=-0.37, p<0.001), education (r=-0.28, p=0.001) and the frequency of hunting.

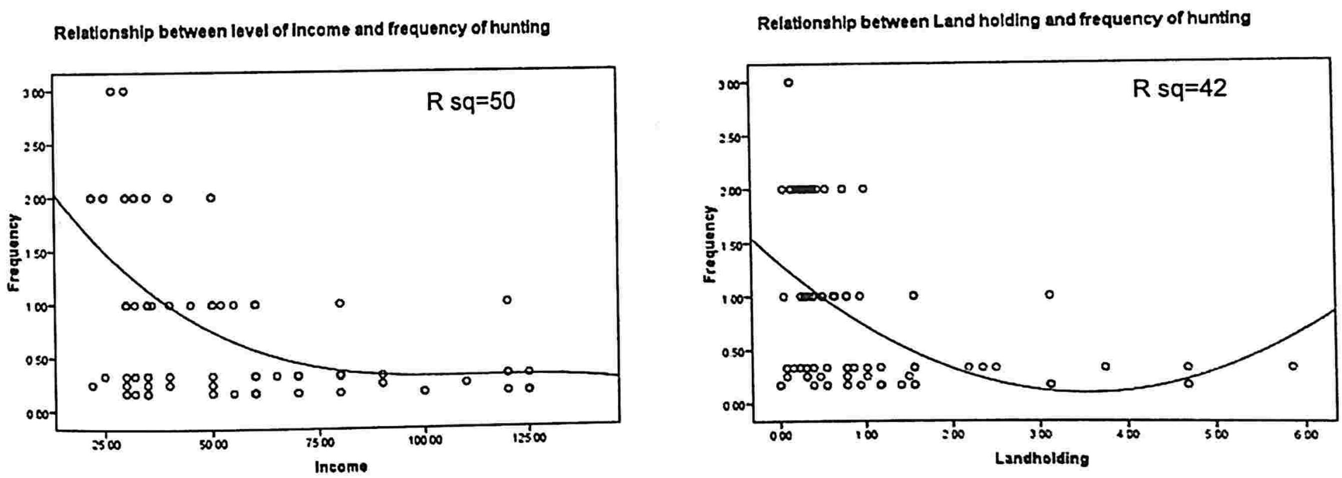

Figure 5.5.5: Relationship between Income, Land holding and Frequency of Hunting

5.5.6 Factors governing wild meat consumption and sale

Socio-economic factor does play an important role in consumption and sale of the wild meat. Significant positive correlations were observed between wild meat consumption and the level of income (r=0.498, p<0.001), land holdings (r=0.409, p<0.001) and education (r=0.309, p=0.001).

Significant negative correlation were observed between wild meat sale and income (r=0.496, p<0.001), land holdings (r=0.407 p<0.001) and education (r=0.309, p=0.001).

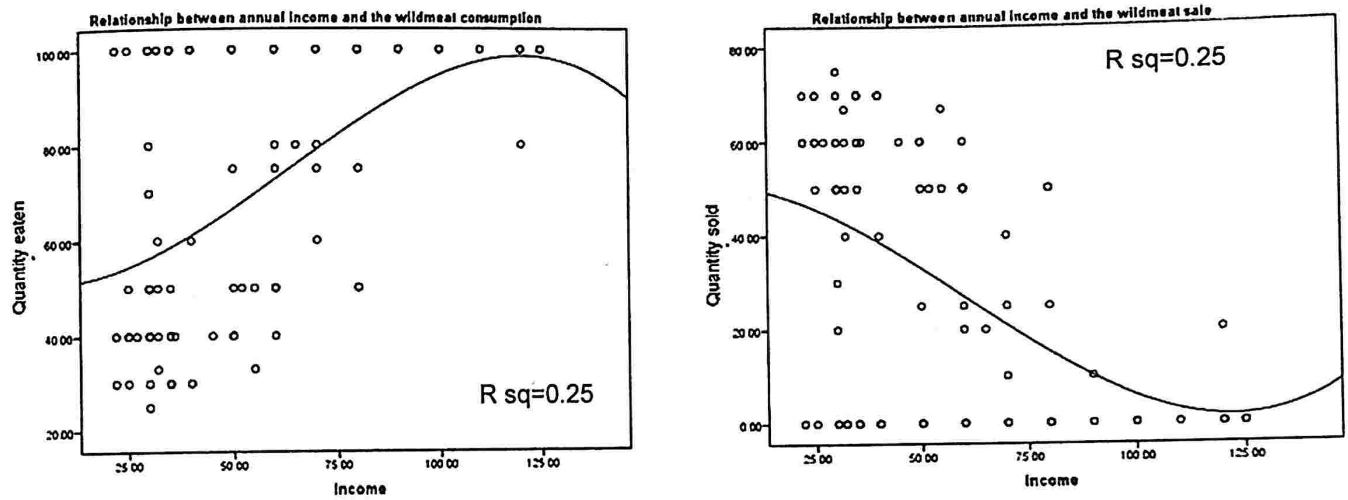

Figure 5.5.6: Relationship between Wild meat consumption, sale and level of income

5.5.7 Price of Wild meat and Domestic meat

The prices of both the wild meat and domestic meat varied across the villages. But we couldn't test between the villages due to the unavailability of some species in one or the other area. The prices varied across the villages but were fixed for each species within the villages. The wildmeat was sold at the highest price in Shivapur (Table 5.5.7) It was much higher as compared to domestic meat. Similarly, in villages such as Gola, Manau and Pashupatinagar, the price was slightly higher than the domestic meat except for lamb.

But the prices were just the reverse in the hill villages i.e. Hariharpur and Taranga where the price was much cheaper than the domestic meat.

Table 5.5.7: Price of the wild and domestic meat

VDC	Lamb	Goat	Chicken	Fish	Pig	Wildboar	SD	Sambar	SD	Chital	SD	Barking deer	Hog deer	Swamp deer	Porcupine	4 horned antelope	SD	Langur***	Nilgai	Dry meat
Gola	200	170	150	150	130	190	13	-	-	175	0	175	175	175	175	-	-	-	-	600
Hariharpur	200	160	160	160	140	160	0	110	0	110	0	110	-	-	130	108	4	300	-	260
Manau	200	150	160	120	110	180	12	-	-	175	0	175	175	175	175	-	-	-	-	600
Pashupatinagar	200	170	150	150	130	175	0	-	-	175	0	175	175	175	175	-	-	-	-	600
Shivapur	220	200	180	160	130	300	0	300	0	200	0	200	200	200	200	-	-	-	200	600
Taranga	200	160	160	160	140	145	21	105	5	105	5	105	-	-	125	104	5	300	-	260

Note: Prices are given in Nepalese currency (Rs/kg). SD is calculated for the villages where the prices had variations. ***Price is for the whole animal.

5.5.8 Dependency on wild meat

Though I was not able to actually quantify the amount of contribution that the wildmeat had in the livelihood of the people. Through the interviews I was able to generate the approximate contribution. Dependency varied across the villages. The people's dependency on wildmeat across villages was significantly (KW test, $\chi2=58.26$; d.f=5 $P<0.001$) different.

Table 5.5.8: Mean contribution of the wildmeat to the local livelihood.

Village	N	Mean dependency(% of the total income)	S.E
Gola	6	10	0
Hariharpur	25	60	3.48
Manau	8	10	0
Pashupatinagar	14	13	3.65
Shivapur	31	26	3.62
Taranga	10	53	4.49
Total	94	33	2.62

6. DISCUSSION

6.1 Estimating prey densities

Transects have been used widely to estimate populations of tiger prey (Biswas and Sankar 2002, Bagchi *et al.,* 2003). Since deriving prey species densities and biomass is essential in studies pertaining to predator ecology (Karanth and Sunquist 1995, Karanth and Nichols 1998), line transect sampling in conjunction to distance sampling methods are used.

In this study I have chosen similar habitat types in Babai and Karnali to control for the habitat related variability. The study area was stratified based on habitat types to arrive at better ecological estimates of prey species densities. From a total of 83 spatial replicates in the study area (Appendix I and II), 35 were distributed in the Karnali region and 48 in Babai valley. Estimates of ungulate prey density derived are 91.52 animals/km^2 in Karnali primarily contributed by chital, hogdeer, wildpig, barking deer and swamp deer and in Babai valley density was estimated to be 28.75 animals /km^2 contributed by chital, sambar, barking deer and wildpig(Table 5.2).

The overall estimates of density derived from this study (Table 5.2) shows that Chital is the most abundant of all ungulate species found in the study area. However my results vary from an earlier study of 1993(Wegge *et al.* 2009) which shows the Chital density of 190.8 animals/km^2 and of (Dinerstein 1980) Thus, my study indicates the sharp decline (more than 50%) in Chital densities over the last 13 years. The political unrest from 1996-2006 may have lead to the opportunistic hunting for wildmeat.

Table 6.1 Comparison of the density estimates with the past study

Species	Dinerstein 1976(1980)	Wegge 1993(2009)	Present study 2009
Chital (Babai)	-	-	25.47±5.3
Chital(Karnali)	31.8±3.7	190.8±16.6	85.32±24.9
Barking deer (Babai)	-	-	2.45±0.8
Barking deer(Karnali)	1.7(-)	2.6±0.4	3.08±1.9
Sambar	-	-	4.14±1.2
Langur/ Rhesus	-	-	16.73±6.6
Hogdeer	3.2±1.2	6.9±0.8	4.96±4
Barasingha	0.5(-)	0.2±0.1	-
Wildpig(Babai)	-	-	1.19±0.7
Wildpig(Karnali	4.2±0.6	1±0.2	3.07±0.7
Nilgai	5±0.3	0.1±0.1	-
Entire prey species (Babai)			28.75±5.5
Entire prey species (Karnali)			91.52±26.5

Since, the density estimation for Babai valley is attempted for the first time; we can only compare the result with the similar habitat types elsewhere or the Karnali region with control for the habitat types. The chital density in Babai valley is only 29% of the Karnali area (Table 5.2). Similarly, comparing with the similar habitat types in India, Dholkhand of the Rajaji National Park with density estimates of 56.21animals/km^2 (Harihar 2005) the Chital densities are again highly depressed in Babai valley. Though one can easily conclude Chital prefer plain to undulating terrain (eg. Sharatchandar and Gadgil, 1975) observations in Hawaii (Graf and Nichols,

1966) support the fact that chital can equally use hilly terrain so terrain alone cannot be the limiting factor for the present density in Babai valley.

Owing to the fact that sambar was detected only on four out of thirty-five spatial replicates; we pooled the estimates together with the sightings of Babai valley. The coefficient of variation on the estimate of Sambar density is primarily contributed by spatial heterogeneity in detection across the habitat types which were pooled for arriving at the density estimates. On comparing the estimates of Sambar density derived from this study with those reported from other protected areas in the country (Karanth and Nichols 1998, 2000) it is evident that Bardia National park has the comparable Sambar densities but almost only 1/6th of Rajaji National Park (Harihar, 2005). Babai valley provides excellent habitat for sambar since it has the interspersion of all habitat types like the valleys, slopes, riparian zones and the mosaic of grasslands. The low sambar density in the area therefore requires special attention. Unlike in many parts of India, where atleast day time hunting using gunshots is considered risky; in Babai valley it is not the case. Gunshots were heard almost every day (47 days in the field) suggesting there were atleast no logistical constraints for hunting sambar.

The present density estimate of the Barking deer in Karnali is slightly greater than the one estimated by Wegge *et al.* 2009. However, the result didn't show difference between the two study sites; a significant overlap exists in confidence interval (Table 5.2). This small-bodied animal is likely to be more resilient to hunting pressure than the larger ungulates even in hunted areas (Datta *et al,* 2008). This could be the prime reason for the similar result in the two areas. It is also known that only effective way of hunting them is daytime shooting and the hunters would have to spend considerable effort to hunt them (Madhusudhan and Karanth 2002). From interviews it was found that hunters were not selective of the species.

Density estimates for hog deer in Karnali is accompanied by the high CV % (Table 4.2) most probably indicating that the elephant transects were not the right method for the species census (Naess & Anderson, 1993). Never the less the density estimates are comparable with that of Wegge's study (Table 8.2). We sighted hogdeer only on two occasions in Babai valley so density estimates were not attempted separately. Babai valley too holds the promising habitat for hogdeer with tall grasslands but such a low encounter rate of the species forces one to think about the other probable reason apart from the habitat parameters.

Wildpig detections were made on 11 transects in total with high coefficient of variation (Table 5.2) on the estimated density. The results for Karnali are thrice the estimates of Wegge's study (2009). Again, the Babai estimates for Wildpig is only one-third of the Karnali area (Table 5.2). The trend in wildpig population also suggests the species might be under the rampant hunting pressure in Babai valley.

Nilgai was never detected on any of the transect lines though I sighted male bull on four occasions in grassland habitat of the Karnali flood plain. The low sighting explains it could be on the verge of extinction in Bardia National Park. Interviews confirmed the fact of Nilgai being poached for wild-meat.

Swamp deer density couldn't be estimated due to sample size constraints. But we did attempt to make the total count of the species covering all the possible sites of swamp deer occurrence based on the past studies (Pokhrel 1996, Ghimire 1996, and Khadka 2007) and the maximum count we recorded on the three different counts was 83 animals which is a 13% increase since the last study on swamp deer.

6.2 Prey Biomass

The studies of Dinerstein (1980), Eisenberg & Seidensticker (1976) and Karanth & Sunquist (1992) have all shown that the greatest ungulate biomass is reached in areas where grassland and forests form a mosaic with the inter-digitations of many different vegetation types. Changing river courses, fire and anthropogenic disturbances all contribute to increase in the edge habitat, which is preferred by many ungulate species (Sunquist *et al.* 1999). In Bardia NP mosaics of habitat are maintained by annual flooding and human induced management interventions such as controlled burning and grass cutting of grasslands thereby supporting incredibly high prey-biomass. Since high prey biomass correlates to higher chances of survival of predator populations (Carbone & Gittleman 2002), areas of high prey biomass will have to be protected so as ensure the survival of the species. The prey biomass estimates (Table 5.3) for Babai valley is 1981.54 kg/km^2 for Babai valley which is remarkably lower than for Karnali with biomass of 4824.9 kg/ km$^{2.}$

6.3 Demograpy and Behavior

6.3.1 Group size

Chital showed significantly lower group sizes in Babai valley (Table 5.1). The low group size of chital indicates their response to hunting intensity.

6.3.2 Group composition

On comparing the group composition, the difference existed in all the age-sex classes between the two areas (Fig 5.3.1). All the categories seemed to be severely depressed as compared to the Karnali area.

6.3.3 Sex- ratio

Chital sex ratio was slightly greater in Babai valley (Table 5.3.2.1). This suggests that unlike trophy hunting in which the males are targeted wild meat hunting doesn't necessarily bring about the change in sex-ratio. The interview revealed that hunters were not selective of the males for the wild meat. Tiger predation is also known to take off more males as compared to the females (Johnsingh, 1983). Karnali area with greater tiger densities might also be contributing to the male biased sex ratio.

6.3.4 Flight distance

Chital flight distance, showed significant difference (5.3.4) but a greater flight distance was observed in Karnali which suggests that only hunting as a disturbance factor may not show the behavioral change of the species since there are other modifiers like tourism. In Sariska it has been observed that ungulates flight distance was higher on tourist days in comparison to non tourist days (Qureshi, pers. Communication). Hence Karnali might be responding well to this disturbance level. Apart from these animals are known to respond better with the use of vehicles (Frid and Dill 2002; Blumstein *et al.* 2005, Caro 1999) but we were solely doing it on foot.

6.4 Comparison of habitats

The selected study sites are comparatively very similar in vegetational composition(Table 5.4)

6.5 Impacts of hunting

I interviewed a total of 94 active and lean period (occasional and opportunistic) hunters along with 7 key informers in 12 villages of the 6 VDC (village development committee) (Table 3.5.1).

6.5.1 Hunting Activity

From interview data I was able to gather information on the total number of active and Occasional- Opportunistic hunters operating in each village and their perceived frequency of hunting. I was able to calculate the average hunting party from the Offence Record available in the park office of Bardia National Park which was cross checked with our interview data. From this hunter days/hunting incidents per month for each village surveyed was calculated. Hill villages namely Taranga and Hariharpur were found to invest more time in hunting as compared to the villages in the plains. The proportion of all categories of hunters was greater in the hill villages. (Table 5.5.1)

Hunting party: Hunting party ranged from a single individual to the number exceeding 10. But on an average hunting party comprised of a hunter, helper (locally called *Pacchuwa*) and the cook , making a team of 3(±1). They go on extended treks inside the park that generally last for 3-5 days but can extend for a week.

6.5.2 Most hunted Species

Respondents admitted hunting at least 17 of the 59 species of mammals reported in the park weighing over 3 kg (Table 5.5.2). Respondents also hunted several species of birds including pheasants, doves, pigeons, hornbills, barbets, parakeets, and owls; reptiles such as the monitor lizard, pythons, snakes, turtles and frogs were also equally hunted.

In Karnali the most hunted species was Chital and hogdeer whereas in Babai valley the most hunted species were equally represented by Sambar and Chital (Fig. 7.3.2). However as far the choice of species is concerned people were more likely to hunt the ones that were easily available and were within the easy reach from their villages. On an average all the respondents had killed at least 6 species of animals in their lifetime.

Interviews captured all species consumed while; Bardia NP records didn't reflect all the species indicating shortcomings in bringing all cases to record.

6.5.3 Hunting methods in vogue

A total of 13 hunting methods were recorded out of which 7 more methods were recorded during the field survey. The most common method of hunting was use of muzzle loaders in Babai valley where as in Karnali Snares and Khabar nets were used extensively. Snaring was most favored in Karnali area due to the lower cost and its inconspicuous nature.

All respondents from the hill villages (n=36) admitted the use of muzzle loaders for hunting. It was interesting to find that only 6% of them didn't posses the gun and they either borrow gun or assist the other hunters during the hunting trip. Forty- four percentages of the respondents admitted the use of snares but it was basically for birds rather than the mammals. The other most commonly used method by the hill dwelling hunters was Smoking and Digging out the burrows (67%) especially for porcupines.

6.5.4 Socio-economic Status and hunting

Of the hill villages that we surveyed Telpani, Lekgaun, Harrekanda, Simplepani and Sungurkhal lie on the northern border of the park (Fig 3.5 and Table 3.5.1). These villages lack infrastructural and development needs and the first impressions that one gets on visiting the area are much deeper level of poverty than in Terai. Levels of education and awareness are very low; hence avenues for employment are limited, or non-existent. The major problems are a lack of access to water, education, health, or a road to markets. The people in these villages live in most deplorable socio-economic conditions and the aggregate income and their land holdings on an average is only sufficient to sustain them for 3-5 months. They practice agriculture, rear chicken and livestock comprising goats and cattle. Domestic animals are kept as a security against immediate needs and hardship rather than to fulfill their protein needs. Many of the men also go to different parts of India and work on daily wages for atleast 2-3 months of the year. Apart from this villagers rely on wild meat both for their own protein needs and as a subsistence livelihood strategy. They have easy access to the wildlife as they live just adjacent and their only route to the market is through the park. In addition there is poor security in this area; the only guard post exists in Guthi area which again does not posses the facilities for patrolling the area.

The major hunting ground for them is Babai valley and all these villages have their own entry points to the park which lie just 500m to 2kms from their villages. They have been hunting in this area for at least a century and they still relate to the place as a hunting reserve though it has almost been 32 years since the place was upgraded to the status of a National Park.

Similarly, we surveyed 7 villages namely Mohanpur, Syaulibazar, Banjaria, Jodhipur, Rajipur, Saijana and Parsenipur in the Karnali flood plain. Mohanpur village is located just on the periphery of the southern border of the park where as rest of the villages lie on the western border across Geruwa- Karnali extension. The majority of the people practice agriculture as their major occupation, though people are also engaged in small scale business, teaching, governmental and non-governmental jobs. People undertake number of farm activities (paddy, maize, wheat, barley and millet, cash crops, pulse, oilseed and potato, vegetable and fruits cultivation) and non farm activities such as wage earning. Besides, livestock rearing is an integral part of the farming system and it is considered as an important economic asset and source of income. People raise livestock such as cattle, goat, and poultry birds such as chicken and duck. Hunting is not a subsistence requirement except for the minority of the people in the flood plain. Most of the people are therefore occasional and the opportunistic hunters. Traditional nets, Khabar nets, Gabbion and metal snares are most commonly used for hunting animals.

6.5.5 Factors governing hunting

Understanding the factors driving demand for wild meat and its substitutes is crucial for predicting the effects of changing socioeconomic conditions on consumption, and managing supplies sustainably (East 2005). The socio-economic data reveal that both the socio-economics and the cultural profiles of the hill and the plains villages are immensely different. More than 90% of the respondents from the hill villages considered wild meat essential for their subsistence (n = 35). They also raised livestock but domestic ones were kept as an insurance against the immediate needs. With increasing level of poverty, the investment in hunting activities have shown increasing trend (Fig 7.6.1 & Fig 7.6.2). Similarly, there is also a negative relationship of income level with that of wild meat sale. The more the income, the less is the sale of wild meat and more is the consumption (Fig 5.5.5 and Fig 5.5.6).

The prevailing price of wild meat is cheaper in the hills as compared to the plains. This again strongly supports the fact that the wild meat apart from being easily available is also economical. The level of poverty and in some extent socio-cultural profile are the two important factors governing the hunting levels, consumption and sale of wild meat in the villages around Bardia National park.

6.5.6 Prevailing markets of wild meat

Though my study couldn't invest time in the market survey of the wild meat our respondents were able to provide information. Many of the hill dwellers sold the meat to the middle-men (from the same villages) who came to collect meat depending upon the availability. Some in fact visit nearby towns like Bhurigaon and sell wild meat to their known contacts. The centre trading point for wild meat sale was Ranighat, a well off village in Hariharpur V.D.C just 10 kms away from the Surkhet valley. There are small eateries in Ranighat where the cooked as well as raw wild meat is available on demand basis on placing the order in advance. In towns like Surkhet, wild meat is considered superior to domestic animal's meat. On personal communication with the known contacts in Surkhet valley, we came to know that many people have now developed a taste for wild meat and were paying Rs 600/kg for wild dry meat. City dwellers were ready to pay more as they believed that they were contributing to the livelihood of the poorest of the poor. This was a false notion since the profit through wild meat sale was made only by the middle men and the hill dwellers were not getting the benefits.

The wide spread sale and open market of wild meat in Surkhet are primarily due to the park's low influence in the area. The park doesn't have any authority to arrest the people in Surkhet district since it is beyond the park border and the wild meat reaches there without having to pass through the park area. Other major urban centers where wild meat is supplied from these hill dwellers and those operating from the Surkhet-Kohalpur highway are Chhinchu, Chepang, Kohalpur and Nepalgunj. The hunters operating across Karnali sell the wild meat in Kothiyaghat, Taratal, Guleria, Lamkhi, Tikapur and Chisapani areas. The prices do vary depending upon the localities.

6.5.7 Differential Protection Measures

The two areas of our comparison, Babai valley and Karnali posses a distinct conservation history. Of these, Karnali received its repute in the world following the extensive work carried out by Dinerstein in 1976, since then it's been known worldwide for its large faunal assemblage. Thereafter it drew the attention of the scientific community and kept Karnali under close scrutiny. Apart from this, the presence of park headquarters in Karnali also meant greater interest and funding for wildlife protection from the government and International non- governmental agencies.

Babai valley though included into the park in the year 1984, is lacking in park security measures. The situation worsened during the armed-conflict in which out of 16 in total 10 Army security posts were deployed from the park. And of these 9 were exclusively of the Babai area. Presently a guard post, named Guthi with 39 Army staff operates in the park for antipoaching, vigilance and enforcement. But in a difficult terrain like Babai with no transport facilities foot patrol on daily basis is almost difficult to cover the large tracts of forest. Nevertheless, the wide spread gunshots heard in 47 days (Fig 6.6.6) duration of field work in Babai valley clearly indicates the enforcement of law is a failure, at least in this area. Besides, the presence of numerous poachers camping sites, the bullets, the accessories, left over of dry meat greatly explains the intensity of the problem.

Whereas in Karnali we heard the gunshots only at two occasions in the Khairbhatti area, and collected 3 snares from Baghtapu area in the floodplain. Though the low encounters of direct evidences in Karnali could also be due to the use of inconspicuous methods of hunting (Fig 5.5.3.2) we stress that the patrolling in Karnali area was much more effective.

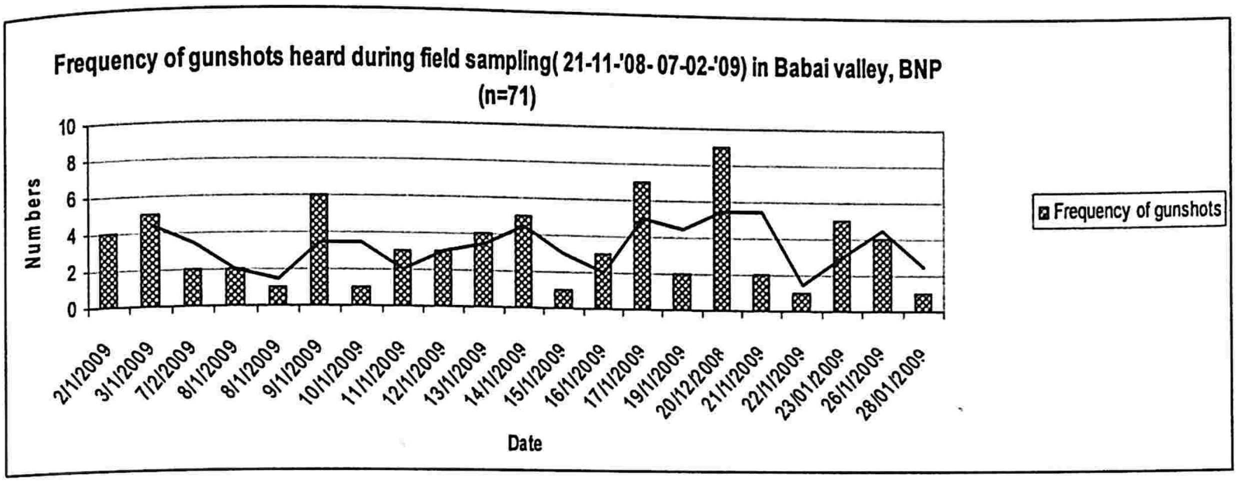

Fig 6.6.6: Frequency of gunshots heard during field sampling in Babai valley

CONCLUSION

Bardia NP is the largest protected area lying in the lowland Terai that represents a unique Shiwalik-Terai ecosystem and has a great potential for tiger conservation. My results show that though the similarity existed in the two study areas, yet the densities of the prey species differed significantly showing depressed densities in Babai valley. In the current scenario the prey density is likely to support low tiger densities hence the hunting pressures should be brought under control. Though our results for the Chitals demography and behavior are not conclusive enough to show the negative effects of hunting. These parameters are likely to manifest in the future and therefore require continuous monitoring. The pressures in the park are indicative of the fact that the wildlife population is under stress. From the market perspective it is likely that with more demand from the urban population, the wild meat extraction intensities by the hunters will also increase. This can be controlled through increased vigilance and severe penalty for offenders. The situation in Bardia National Park reflects a strong disparity between the law and its enforcement, indicating that legal protected status alone cannot serve to conserve wildlife populations even in a Protected Area unless the livelihood issues of the local people are addressed. There is increased awareness and willingness among the villagers in the plains to control and reduce hunting since the launch of the Bardia conservation programme (BCP, National Trust for Nature Conservation) and other economic benefits such as the share of the park revenue and compensation to wildlife damage. Similar benefits should reach the hill villages in order to gain the support and co-operation. The hill villages deprived of all the benefits the villages of bufferzone are getting, should be targeted for developmental and livelihood programmes in order to gain the support and co-operation.

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APPENDIX-1: Line transects in Babai valley

Transect ID	Habitat type	Transect length (km)	Start GPS (Degree decimal) Lat	Start GPS (Degree decimal) Long	End GPS (Degree decimal) Lat	End GPS (Degree decimal) Long
B1	Mixed Sal forest	1.2	28.350306	81.682889	28.365056	81.671000
B2	Hill Sal forest	1.1	28.366444	81.666611	28.365000	81.656722
B3	Hill Sal forest	1	28.368444	81.670306	28.364667	81.680861
B4	Wooded grassland	1.4	28.363250	81.682472	28.361083	81.697750
B5	Tall grassland	2.26	28.357444	81.703611	28.360111	81.679889
B6	Mixed Sal forest	1.2	28.370972	81.666750	28.378222	81.665806
B7	Mixed Sal forest	2	28.444972	81.523167	28.444333	81.545306
B8	Riverine forest	1.2	28.445194	81.517139	28.450472	81.507111
B9	Grassland	2.1	28.432694	81.548667	28.438750	81.529528
B10	Riverine forest	1	28.458167	81.506222	28.462167	81.500389
B11	Riverine forest	1	28.462639	81.492000	28.464306	81.484833
B12	Mixed Sal forest	2	28.436694	81.537806	28.450861	81.552472
B13	Mixed Sal forest	1.8	28.434333	81.552556	28.450806	81.544194
B14	Riverine forest	1.6	28.419778	81.562833	28.425833	81.545917
B15	Mixed Sal forest	2	28.424250	81.570611	28.435167	81.551222
B16	Wooded grassland	1.8	28.425472	81.525639	28.427500	81.543000
B17	Wooded grassland	2.3	28.426889	81.546861	28.427278	81.522472
B18	Tall grassland	3.8	28.426250	81.548639	28.439111	81.516361
B19	Mixed Sal forest	2	28.402472	81.619583	28.410028	81.602556
B20	Hill Sal forest	2	28.411667	81.594750	28.425500	81.583333
B21	Riverine forest	2	28.401667	81.627639	28.389944	81.640889
B22	Mixed Sal forest	1.4	28.392389	81.630778	28.399528	81.623972
B23	Grassland	2	28.401806	81.624306	28.389944	81.642472
B24	Mixed Sal forest	2	28.411667	81.594750	28.400000	81.623111

B25	Grassland	3.64	28.398583	81.614611	28.409611	81.569417
B26	Wooded grassland	2.18	28.400583	81.612083	28.405556	81.595056
B27	Wooded grassland	2.16	28.401222	81.628028	28.386306	81.634806
B28	Hill Sal forest	1.6	28.492250	81.441472	28.503917	81.453056
B29	Hill Sal forest	1.7	28.501444	81.423472	28.514889	81.420000
B30	Hill Sal forest	1	28.498111	81.442278	28.506500	81.445972
B31	Mixed Sal forest	1	28.506306	81.436528	28.499028	81.433417
B32	Misc. forest	1	28.498639	81.432778	28.497917	81.436250
B33	Riverine forest	1.6	28.487944	81.437806	28.470167	81.441083
B34	Hill Sal forest	2	28.430250	81.378500	28.440806	81.367861
B35	Mixed Sal forest	2	28.422611	81.387028	28.408639	81.388333
B36	Misc. forest	1	28.441472	81.430972	28.437250	81.425667
B37	Mixed Sal forest	2	28.419833	81.385611	28.410694	81.394889
B39	Mixed Sal forest	2	28.436222	81.404528	28.425583	81.397333
B40	Misc. forest	2	28.367583	81.428611	28.385667	81.427250
B41	Mixed Sal forest	2	28.390000	81.402472	28.381389	81.392028
B42	Misc. forest	1.3	28.354139	81.436667	28.365944	81.438194
B43	Misc. forest	2	28.363250	81.434556	28.381778	81.427306
B44	Mixed Sal forest	2	28.463528	81.325278	28.450972	81.343250
B45	Mixed Sal forest	2	28.450194	81.360194	28.433750	81.347806
B46	Mixed Sal forest	1.2	28.426472	81.372361	28.432389	81.363444
B47	Mixed Sal forest	2	28.529139	81.361833	28.542500	81.364000
B48	Mixed Sal forest	1.8	28.528806	81.364083	28.523750	81.378500
	Total	83.34				

APPENDIX-II: Line Transects in Karnali

			Start GPS (Degree decimal)		End GPS (Degree decimal)	
Transect ID	Habitat type	Transect length (km)	Lat	Long	Lat	Long
K1	Mixed Sal forest	2	28.466083	81.251361	28.480972	81.260167
K2	Mixed Sal forest	2	28.480611	81.255139	28.492111	81.272222
K3	Mixed Sal forest	2	28.505750	81.266028	28.520361	81.277250
K4	Grassland	2	28.454222	81.240250	28.469556	81.228111
K5	Mixed Sal forest	2	28.501111	81.285556	28.522444	81.287333
K6	Grassland	2	28.503028	81.274028	28.522500	81.286167
K7	Misc. forest	2	28.520333	81.303472	28.527000	81.322139
K8	Mixed Sal forest	2	28.511000	81.332361	28.520722	81.352472
K9	Mixed Sal forest	2.1	28.520750	81.334139	28.542861	81.336972
K10	Mixed Sal forest	1.6	28.557472	81.359972	28.573194	81.375528
K11	Hill sal forest	1.86	28.613583	81.280694	28.629389	81.285861
K12	Hill Sal forest	2	28.612056	81.282667	28.617028	81.304250
K13	Mixed Sal forest	2	28.552861	81.263528	28.531611	81.269806
K14	Misc. forest	1.5	28.454667	81.239583	28.450083	81.224722
K15	Riverine forest	2.2	28.436556	81.227111	28.450611	81.239639
K16	Misc. forest	1.4	28.436389	81.226667	28.445833	81.225000
K17	Wooded grassland	1.6	28.451000	81.233111	28.459639	81.226889
K18	Riverine forest	2	28.523000	81.243833	28.537056	81.258028
K19	Riverine forest	1.5	28.506694	81.247500	28.524528	81.255194
K20	Grassland	1.8	28.514694	81.253167	28.496444	81.250833
K21	Mixed Sal forest	2	28.548722	81.264917	28.526972	81.264917
K22	Riverine forest	2.6	28.553500	81.250417	28.532000	81.240056
K23	Riverine forest	1.3	28.536194	81.251194	28.545056	81.255361
K24	Grassland	2.68	28.516750	81.253917	28.496611	81.252139

K25	Tall grassland	1.02	28.521389	81.241472	28.512444	81.235861
K26	Tall grassland	1	28.506500	81.234833	28.498000	81.235639
K27	Wooded grassland	1.09	28.466722	81.239028	28.475722	81.235472
K28	Tall grassland	1.65	28.482944	81.233222	28.471472	81.223056
K29	Mixed Sal forest	2	28.602639	81.273417	28.620806	81.277417
K30	Mixed Sal forest	2	28.489972	81.330944	28.500556	81.346722
K31	Mixed Sal forest	2	28.507417	81.264417	28.521417	81.273917
K32	Mixed Sal forest	2	28.532361	81.284194	28.543222	81.297694
K33	Grassland	2.06	28.518417	81.286833	28.503222	81.276722
K34	Misc. forest	2	28.514722	81.309972	28.531972	81.318167
K35	Misc. forest	2	28.542056	81.321000	28.559972	81.311889
	Total	64.96				

APPENDIX-III: Semi-structured interview

For villagers (Questionnaire-I)

1. Name of the person:
2. V.D.C……………. Ward no…………….
3. Occupation Agriculture ☐ Pastoralist ☐ Labor ☐

   Agro- pastoralist ☐ others ☐ Other (Specify)….

4. Educational background:

   Illiterate ☐ School level ☐ 10^{th} pass ☐ College ☐

5. Ethnicity………………………………

6. Economic status:

   Poor ☐ Average ☐ Well off ☐

   Indicators:

   Housing

   Ornaments

   Dress up

7. Family Composition:

   Earning members: Source of income

   a.

b.

c.

8. What are the types and number of domestic animals in your home including pets?

9. Livestock rearing system:

Stall feeding ☐ Conc. feeding ☐ Free grazing ☐ Bringing fodder ☐

10. System of cooking:

Gas ☐ Kerosene ☐ Fuelwod ☐ Electricity ☐

11. Are you a vegetarian or non- vegetarian?

12. What all meat do you eat? Can you please elaborate on this part?

Chicken ☐ Muttton ☐ Buff ☐ Pork ☐ Other (Specify)

13. How often do you eat meat?

Twice a week ☐ once a week ☐ fortnightly ☐

14. Are there any shops nearby in the village where you can buy meat?

a) If yes, how many exists and what all meats do you get there?

b) If no, where do you get the meat from?

15. What is the price per/kg meat?

Lamb ☐ Goat ☐ Chicken ☐ Fish ☐

Wild boar ☐ others (Specify)............

16. Which meat do you prefer and why?

17. What do you think about the price tag? Is it expensive or you can afford to buy it?

18. Do you have any idea where does the butcher get the animal from?

19. What all wild animals have you seen?

20. Can you recognize these?

a) Sambar b) chital c) wild pig d) barking deer e) hog deer

21. Have you hunted any of these animals?

a) Yes ☐ b) No ☐

22. What all animals have you hunted in your lifetime?

23. How often do you hunt?

Twice a week ☐ once a week ☐ monthly ☐

24. What methods do you use in hunting animals?

Snares ☐ Traps ☐ Shotguns ☐ Muzzle loaders ☐

Poisoning ☐ Other (Specify)

25. What do you do with the catch?

Self consumption ☐ share with the villagers ☐ Sell in the market ☐

26. If you sell how much earning do you make from the sale of wildmeat?

26. How many families in your village consume wild meat? Is it only occasional or occurs through out the year?

27. Are there any such families, who truly depend upon wild meat, can u please tell me the approximate number?

28. Are there people who bring wild animals only during the lean periods, approximate number?

B) For Key Informers (Questionnaires-2)

1. What governs hunting in this area?

   a) For subsistence (livelihood)

   b) For social and cultural reasons (social elite performing hunting as a symbol of status)

   c) Killing for revenge (human wildlife conflict)

   d) For illegal trade (professional poachers, middle men involved from the village)

2. Can you please tell me in brief about the past history of the villagers (involved in hunting?

3. How many families depend on hunting in this village?

4. How often do they hunt? Is hunting done on a seasonal basis during lean period or is it done through out the year?

5. If it is seasonal, which part of the year it is extensive?

   Summer ☐ Winter ☐ Monsoon ☐

6. Which are the animals that usually get caught?

7. What are the major animals which hunters usually target and why?

8. What are the methods they use in hunting an animal?

   Snares ☐ Traps ☐ Shotguns ☐

9. Which part of the park do they usually go for hunting animals?

10. What is the major location preferred in setting up the snares, traps?

11. Is hunting (catch) effective with increasing distance from the village?

12. Which are the major areas from where the hunters venture into the protected area?

13. Do the people hunt during the day or night? Which one is effective?

14. Do the hunters bring animals' every time they go to hunt or sometimes come without a catch?

15. What do they say about the trend in catch of animals as compared to the past?

Increasing ☐ Decreasing ☐ Stable ☐

16. If they do sell, do they directly sell to the market or are there any middle men operating in the sale of wildmeat?

17. Where does the demand come from?

Near by bhattis (small dhaba) ☐ Larger restaurants ☐

Butchers in Nepalgunj or Surkhet ☐

18. What is the price the hunters get for an animal? (Species wise)?

19. And what is the market price per/kg of wild meat at Neplgunj and Surkhet?

20. How is the demand of wild meat?

Extremely high ☐ High ☐ Low ☐ Very low ☐

21. What is the total number of meat shops?

Nepalgunj ☐ Surkhet ☐

22. What is the total number of meat shops where wild meat is sold? Where are all these shops located?

23. Is wild meat available in daily basis / weekly basis?

24. What is the average (quantity) turn over of the wild meat in the meat shop per week/month?

25. Who are the regular costumers of wild meat?

Low class family ☐ Middle class family ☐ High class family ☐

Other (Specify):