

## Chapter-I

# INTRODUCTION

### 1.1 Nepal's Wildlife

Due to extreme contrast in climate and topography and its position at the intersection of oriental and palaeartic zoo-geographical region, Nepal has been endowed with a great diversity of life zones providing a home for large variety of plants, birds and mammals. Of Nepal's wildlife 181 species of mammals, 870 species of birds and 184 species of fishes are recorded (Shrestha, 2003). The Biodiversity Project Profile (BPP) 1996 has recorded 100 species of reptiles and 43 species of amphibians as well.

Nepal is remarkable for abundance and variety of wildlife, especially mammals. Nepal's treasure of wild mammals recaptures a wide spectrum of total fauna of the whole Himalayan range. However, with one of the richest legacies of mammalian fauna, Nepal is guilty of abusing these gifts through centuries. Habitat destruction, hunting and over exploiting, pollution, poisoning and displacement by exotics over the last few decades, a heady cocktail factor, have led to the decline of Nepal's wildlife. The consequences- the life of many valuable game mammals such as tiger, leopard, rhino, wild buffaloes, black bucks, swamp deer etc. are in peril.

Prior to sixties, Nepal is known for undisturbed and luxuriant subtropical forest in its southern lowland area. After the eradication of Malaria during mid 1950s, the human population exploded in lowland areas leading to indiscriminate clearing of forests for agriculture expansion. Further, over grazing of livestock in the forest not only shrunk the area available to wildlife but also modified the habitats. The destruction of potential wildlife habitats and uncontrolled killing drove large mammals such as tiger, rhino, black bucks, wild buffalo and four horned antelopes

close to extinction and swamp deer virtually got extinct from mid and eastern lowland areas.

The present study addresses one of such mammals, the northern subspecies of swamp deer (*Cervus duvauceli duvauceli*), locally known as Barasingha in Western lowland in Suklaphanta wildlife Reserve (SWR) where largest population of vulnerable swamp deer (hereafter barasingha) resides. Once common in the entire lowland of Nepal, the distribution of this species has now been restricted to Suklaphanta wildlife Reserve (SWR) and Bardia National Park (BNP). Chitwan National Park (CNP) population got extinct in early 1970s probably due to habitat loss and uncontrolled poaching.

## **1.2 The Swamp Deer**

The swamp deer (*Cervus duvauceli*) is one of the most handsome and graceful antler bearing deer whose twelve tined twisting and turning antlers borne on the summit of head make it a valuable trophy animal. It represents the family 'Cervidae' and belongs to order 'Artiodactyla' and is endemic to Indian subcontinent.

Swamp deer locally known as Barasingha which literally means 'Twelve horned' and refers to a dozen tines found on the antler of an adult mature stag. However, the numbers of tines varies among individuals ranging from 10 to 14 (schaaf, 1978). Barasingha inhabit the swampy grassland and usually avoid thick forested area. They are primarily grazers (Pokharel 1996) and occasionally fed on aquatic plants (Moe, 1994a, Pokharel 1996).

A fully grown healthy stag stands 135cm at the shoulder and weighs about 170 to 180 kg (prater, 1980). Barasingha shows a marked seasonal change in coat color which varies from rich chestnut brown during summer season to dull greyish brown during summer season to dull greyish brown during dry season (Schaller 1967).

### 1.3 History of Distribution

The barasingha was formerly located in suitable localities throughout the basin of Indus, Ganges and Brahmaputra River as well as central India as far South as the Godawari Rivers, generally in the areas covered by moist deciduous forests (Schaaf, 1978; Shrestha, 2003 and Karki, 1993). According to Bland-ford (1886-1891), past distribution ranged from the foothills of the Himalayas from upper Assam to a few places in Indo-gangetic plains, from the Sunderbans to upper Sind and locally through the area between the Ganges and the Godawari.

In recent decades, the population has declined drastically mainly due to heavy poaching and destruction of preferred habitat for intensive cultivation by human population (Ghimire, 1996). Today swamp deer had become extinct in Bangladesh and Pakistan and its distribution has now been restricted to small isolated pockets in protected areas of Nepal and India (Shrestha, 2003).

### 1.4 The Sub- Species of Swamp Deer

Swamp deer is endemic to the Indian sub- continent. Eller man and Morrison- Scott (1951) recognized into sub- species- *Cervus duvauceli duvauceli* (Northern subspecies) and *C.d. branderi* (Southern sub- species). The northern sub- species is truly a swamp dweller and have splayed spongy hooves for an adaptation to swampy habitats of north India and southern lowland of Nepal (Schaaf 1978). The southern sub- species resides in the grassy habitats in the proximity of the forests and is confined in the Kanha National Park, India (Schaaf, 1978; Prater, 1980). The hard and well knit hooves are accustomed to gallop on the hard ground (Martin, 1977; Schaller, 1967). The Northern sub- species are paler and larger than the Southern sub-species but later sub- species carries large antlers (Groves, 1982). Ranjit Singh recognized a third eastern sub- species *C. d. ranjitsinghi* which is confined in Kaziranga National Park, India. It has

more slender muzzle and smaller, less rounded and distinct pointed ears than the other two sub- species (Groves, 1982).

The sub- species occurring in Nepal is the Northern sub- species, *Cervus duvaceli duvauceli*. At present large population of barasingha are found in Suklanphanta wildlife Reserve (SWR) in Nepal and Dudhwa National Park in India. There are about 5000 individuals surviving in the wild (Wemmer, 1998). The SWR has long been considered the largest stronghold of the swamp deer consisting about 1600 individuals (Gyawali and Jnawali, 2005). A small population of swamp deer also resides in Bardia National park approximately 140 km east of SWR.

### **1.5 Swamp deer in Nepal**

Swamp deer in Nepal inhabit the Terai which is an extension of the north Indo-genetic plain and fringes much of the southern edge of this otherwise mountainous country. During the 1950s, swamp deer were found in the districts of Banke, Bardia, Kailai and Kanchanpur district (Schaaf, 1978). Swamp deer were also reported in Rapti valley of Chitwan division of south central Nepal till the early 1970s what is now CNP (Mishra, 1982, Gurung, 1993). According to Schaller (1967), a few animals were seen in Chitwan as late as 1963. Schaaf (1978) also reported a population of unknown size and status in the 37km<sup>2</sup> Dhakka Hunting Reserve in Kanchanpur districts. None occur there now. The population of Banke and Kailali also had disappeared long time back due to human encroachment and agriculture use.

Malaria–eradication programme launched by Nepalese Government in collaboration with the United States agency for International Development (USAID) in 1950s was so successful that the whole Terai was declared Malaria free in 1960s. Fortunately, a substantial portion of potentially arable flat land was opened to generate financial resources through agriculture to impoverished hill farmers. As a result, thousands of

people migrated from hills and began to settle in the Terai. Heavy human pressure has accelerated encroachment of forest and much of the prime jungle habitat was cleared for settlement and cultivation. Massive poaching of barasingha for meat and destruction of their habitat for intensive cultivation ultimately had to the disappearance of the species from central lowland of Nepal (Fig.-1).

At present, only two barasingha populations are known to survive in Nepal and are isolated from each other by a distance of 140km. In Nepal barasingha are now found only in SWR and BNP. SWR holds the largest remaining population of this species in the world (Henshaw, 1994). Small populations, numbering about 91, also exist in the Southern section of BNP (Fig.-2).

## **1.6 Statement of Problem and Justification of the Study**

### **1.6.1 Problem Statement**

Most species of large mammals that have come to the extreme of endangerment due to consequences of inappropriate action by man. In many instances, the forces that brought them close to extinction are still operating. Thus, the management of threatened deer in the interest of its survival is largely an exercise in man management.

Though the conservation Practices in the reserve aim at maintaining the overall ecosystem diversity at landscape level, there are some high priority species that require special treatments owing to their highly threatened status and specialized habitats.

The Terai has been the ultimate home of the northern variety of barasingha and its decline in status has been proportionate to the advancement of human colonization accelerated after the eradication of Malaria in lowlands. As the human population increased, land hunger grew and migrated people from hills exerted additional pressure on marginal

land. Soon the barasingha got displaced from their prime habitats. Slowly, but inexorably, their number dwindled, hostages to destruction of their age-old habitats and uncontrolled hunting and poaching.

Once distributed in most swampy grasslands of southern Terai of Nepal, barasingha are now restricted to an isolated populations in SWR and BNP mainly due to illegal hunting and habitat clearance (Schaaf, 1978). Massive poaching of barasingha for meat and destruction of their habitats for cultivation cause local extinction of this species from central lowland Nepal.

Owing to the various stochastic and catastrophic events along with human interferences leading to habitat fragmentation, reduced habitat size and isolation of populations resulting inbreeding depressions and vulnerability to different events; the conservation and effective management of swamp deer in SWR, where stronghold population of swamp deer resides deserve almost importance.

The Proper conservation and management of barasingha in SWR will certainly helps to level up the population of barasingha in the reserve and will be a tremendous contribution to the wildlife heritage of the world.

### **1.6.2 Justification of Study**

Recently, the conservation of threatened mammals has been greatly discussed among scientists. Unfortunately, long- term demographic data that can be taken as baseline for many conservation oriented policy formulation and management of certain species; has been lacking.

Barasingha herd of Suklaphanta is the largest in the world which is pride of Sukla. The largest herds of Barasingha in Suklaphanta are seen in Suklaphanta itself. Suklaphanta covers an area of 54m<sup>2</sup> which is covered by grassland.

Very little information is available about the population size, composition and habitat use of Barasingha in Suklaphanta Wildlife Reserve for management purpose. Though establishment of SWR has provided some protection to the Barasingha population, it is very difficult to say anything strongly about their long run survival. Against this backdrop, the study aims to generate some data, especially about the population status, habitat utilization and distribution. The findings of the study are expected to help for designing a viable population for conservation of this endangered species.

## Chapter-II

### 2.1 Objectives

The specific objectives were

- To determine the current population status.
- To determine the habitat utilization of Barasingha.
- To map out the distribution of Barasingha in the SWR.



## Chapter-III

### STUDY AREA

#### 3.1 History of the Reserve

Kanchanpur along with other three district of western Terai is called as Naya Muluk as British emperor returned these areas to Nepal in 1860 as a gift. Earlier this Naya Muluk was mostly covered by forest therefore Rana rulers were using it as a hunting place. They used to organize occasional big hunting on grassy swamp and Jheel (swampy areas) by which wild animal population declined by the occasional Shikar takes long time to recover (Balson, 1976). Mahendranagar, the head quarter of the district, is called after the name of king Mahendra who visited at Suklaphata in 1963 for hunting expedition. Earlier, it was called as Gasudi Bazaar and is 3-4 Km North of reserve area.

Although conservation of wildlife was started from the Jung Bahadur Rana regime, the era of 1960 onwards was milestone for conservation history. After enforcing the wildlife protection Act in 1963, the hunting of wildlife was strictly prohibited for public. In the year 1969, Suklaphata was declared as Royal Hunting Reserve with an area of 131 Km<sup>2</sup>. Since then, the whole area remained as a famous hunting ground for many years. Following the eradication and control program of Malaria, large number of hill immigrants began to settle there. The consequence of the massive human influx in a short time has been widespread, land clearing for settlement and agriculture, intensive grazing and an increase in wildlife killing. To check further degradation of forest and habitat destruction, the Royal hunting Reserve was gazetted as Suklaphata wildlife Reserve in July 1976 (14 Shrawan 2033). Protection of this reserve was initiated through establishing army posts in strategic location and in early 1981; one battalion of army has been deployed to protect area strictly. There is one another

battalion of army to strengthen the protection of the reserve near the Arjuni phanta which is deployed in 2059 B.S.

### **3.2 Location and Physiographic Feature:**

Suklaphata is lowland Reserve situated in far western development region at Kanchnapur district of Nepal. The geographical location of this reserve lies between longitude  $80^{\circ} 06' 04''$  and  $80^{\circ} 21' 40''$  E and  $28^{\circ} 45' 16''$  and  $28^{\circ} 57' 23''$  N latitude in the extreme southwest corner in lowland terai ranging altitude from 90 to 270 m from a.s.l. and encompasses an area of  $305 \text{ Km}^2$ . Earlier in 1976, an area of  $155 \text{ Km}^2$  was gazetted as the reserve and in 1984,  $150 \text{ Km}^2$  areas was added to the reserve making its total  $305 \text{ Km}^2$ . The extended area lies to the east of previously gazetted area.

The North West boundary of the reserve adjoins agricultural and settlement area of Mahendranagar Municipality. The eastward along the canal through Beldandi VDC. The reserve extends up to the Syali River in the east and to the Siwalik in northeast corners. The southern boundary runs along the Nepal- India border for 15Km. The Western is separated by the Mahakali River (DNPWC and PPP, 2000) (figure-3).

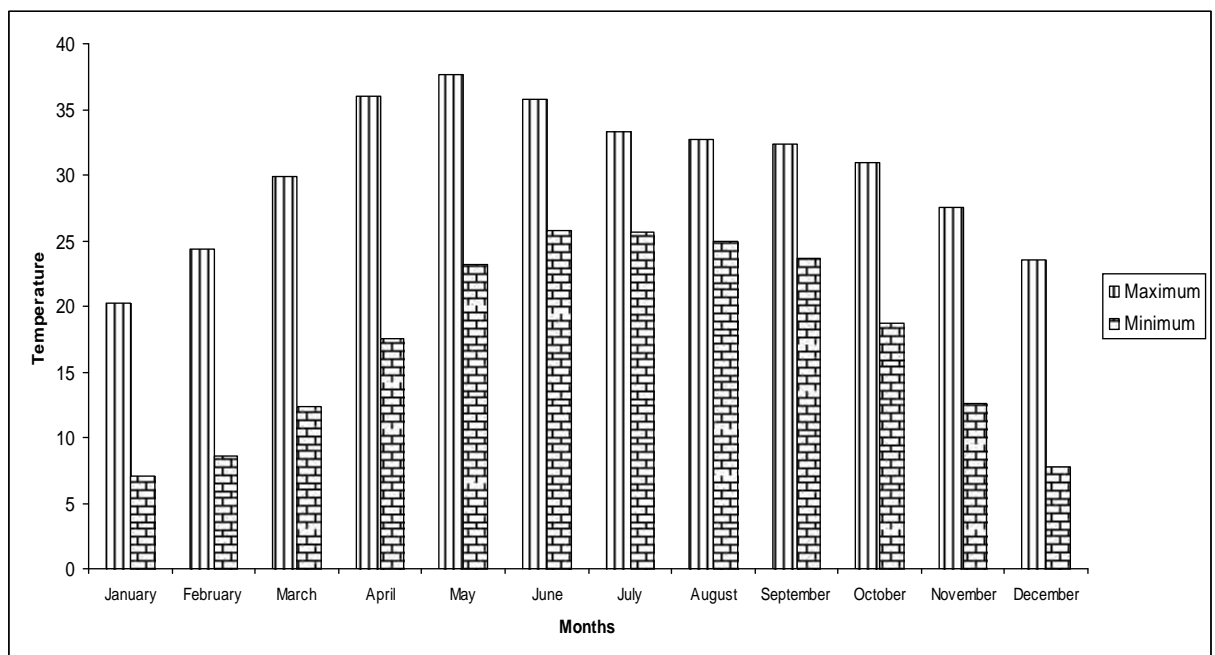
The area extends from the flat lands in the south to the Churia hills range in North and contains many different ecosystem and habitat types (Velde, 1997). The reserve and its vicinity area are comprised of a floodplains of various perennial river system notably Mahakali, Bahuni, Radha, Syali and Chaudhar with alluvial and hill wash deposit's. These river systems play a substantial role in maintaining the ecosystem of the area. The Siwalik ridge and Churia hill links hills with the Terai forests by maintaining a natural corridor for the seasonal movements of the wild animals (figure-4).

### 3.3 Climate

The area has a tropical monsoon climate with four different four seasons: winter, spring, summer and monsoon (Yadav et.al, 2000).The temperature recorded from 1992-2005 shows average of mean monthly minimum temperature of 7.07°C in the month of January and average mean monthly maximum temperature of 37.6°C in the month of may, occasionally rising up to 43°C, (figure-5).December and January are fairly cold and misty with occasional frost. During hot season at mid- day time the westerly wind below hot air, locally called as 100, and dust across the area (Bhatt, 1998).

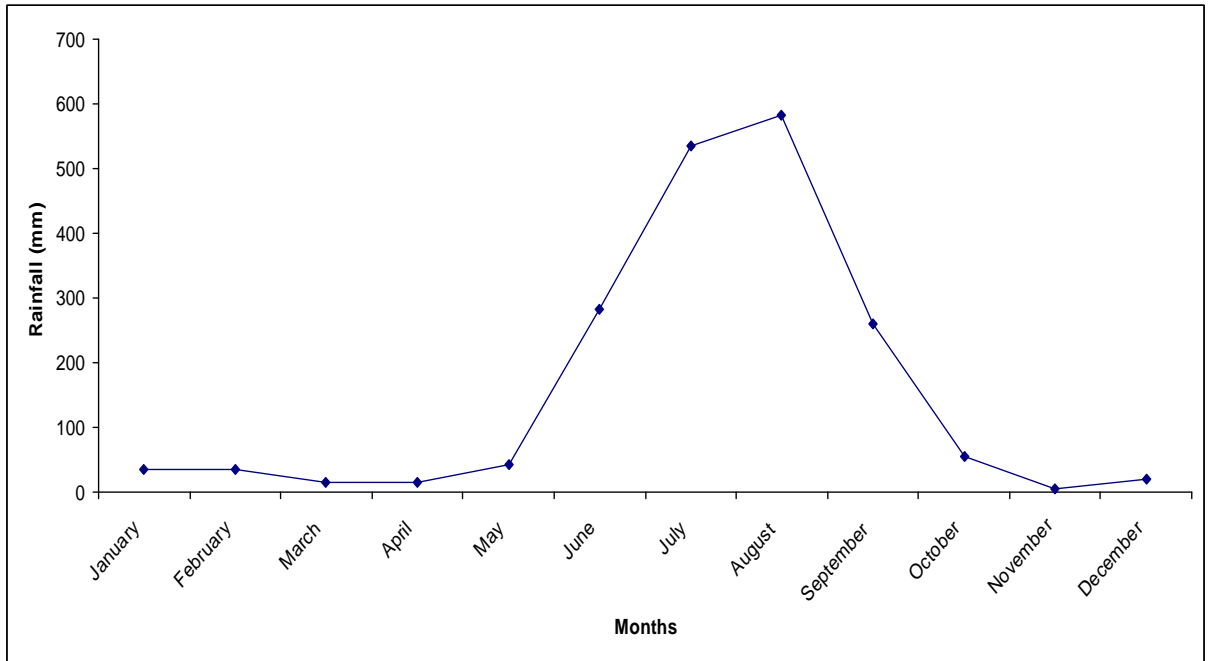
The average annual precipitation was estimated to 1880.4mm for the period 1990-2005 at Mahendranagar, 90%of which falls between June and September. The maximum of 582.8mm precipitation was recorded in the month of august and minimum of 4.7mm was recorded in November (figure-6). Relative humidity of the area remains high year around. The average relative humidity of the area is 83 percent (DDC, 2060).

*Fig 5: Temperature of Study Area (1992-2005)*



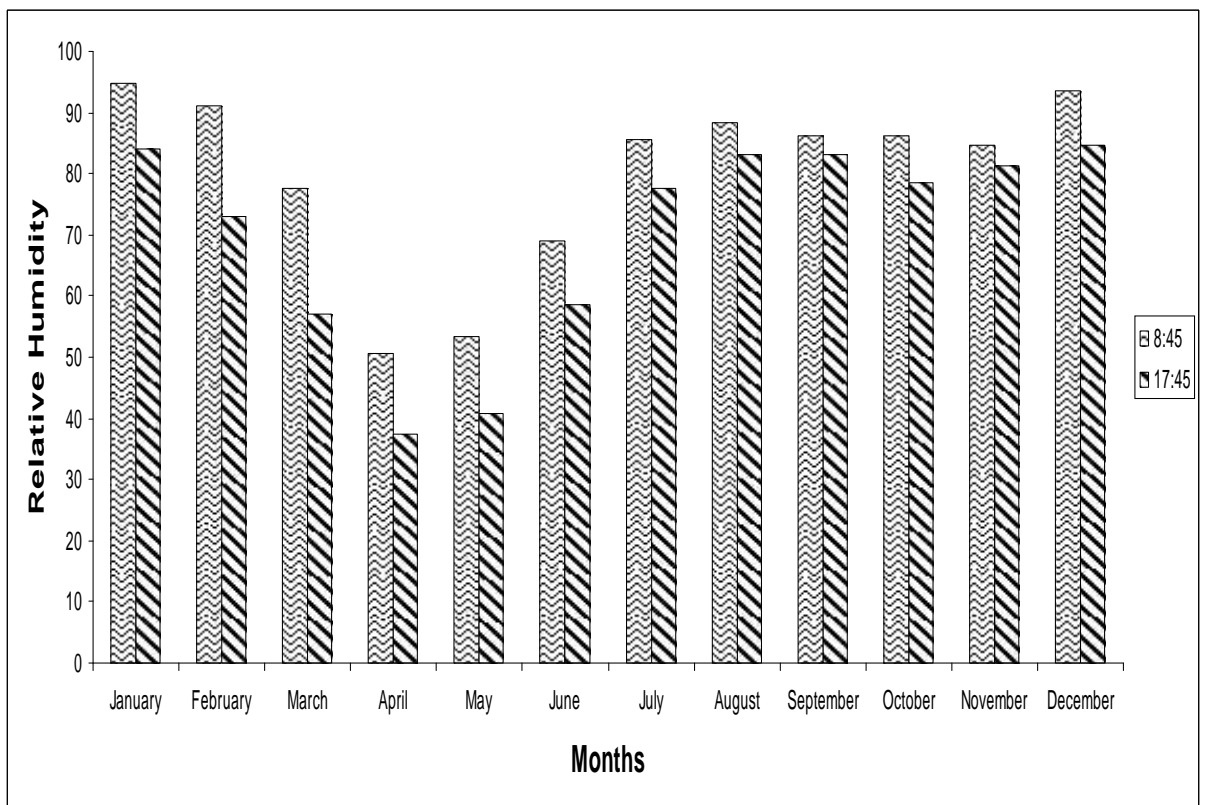
Source: Department of Hydrology and Metrology, Babarmahal, 2006

**Fig.6: Rainfall of Study Area (1990-2005)**



Source: Department of Hydrology and Metrology, Babarmahal, 2006

**Fig 7: Relative Humidity of Study Area (1990-2005)**



Source: Department of Hydrology and Metrology, Babarmahal, 2006

### 3.4 Geology and Soil

The reserve area is generally flat with old deposits of Gangetic alluvium. In some parts, the alluvium is quite deep which makes the soil admirably suited for crop production. The common soil types found in the reserve are loamy sand, sandy loam, silt loam, and clay loam. Khair- Sisoo forest associated soil is sandy loam mixture with small gravel and stone with PH 7.4 whereas the miscellaneous forest around grassland area is sandy loam but is slightly alkaline (PH = 8). In predominant Sal forested area soils vary from loam to sandy loam with slight acidity (Balson, 1976).

In the grass area, which has infolded and taken over river side soil is a clay loam slightly alkaline with a PH of 7.8 (Bhatta, 1998).

### 3.5 Flora and Fauna

#### 3.5.1 Flora

The vegetation in the reserve is of sub- tropical type and consists of three forest types: 1) Sal forest (*Shorea robusta*); 2) Riverine forest; 3) Khair- sisso forest (*Acacia catechu- Dalbergia sisso*) (Thapa, 2003). One third of SWR is grassland and remains are covered by forest (PPP/ SWR, 1997). *Shorea robusta* is the most predominant tree species. Sal forest and Sal savannah are part of the continuum between climax forests and grasslands that are maintained by fire and flood (PPP/ SWR, 1997). Mixed deciduous forests are randomly distributed among the more extensive grasslands. The major tree species include- *Terminalia tomentosa* (Asna), *Terminalia balerica*, *Adina cardifolia*, *Bombax ceiba*, *Anogeisus latifolia*, *Eugenia jambolana*. and *Dalbergia sisso*, *Acacia catechu* and *Aegle marmeols* are found as riverine trees (HMG/ MFSC, 1990).

The SWR is famous for large tracts of grassland, among which Suklaphanta is the largest; covering an area of 54 Km<sup>2</sup>, southwest of Bauhini River and south of forest. The grasslands in the riverbeds are

dominated by tall grass species such as *Saccharum spontaneum* and *Saccharum bengalensis*. The phantas are dominated by *Impetera cylindrica*, *Pharagmites karka*. The important scattered tree species in grasslands includes *Dalbergia sissoo*, *Trewia nudiflora* and *Acacia catechu* (Yadav et.al 2000). This extensive grassland, locally called 'phantas', provide ideal habitat for different animals. schAAF (1978) reported 54 species of grasses and sedge but did not include dicot in his lists. According to recent study, about 125 species of grasses are found in the reserve (Yadav et. al 2000).

### **3.5.2 Fauna**

#### **3.5.2.1 Mammals**

The Reserve is very famous for the Prime habitat of barasingha (*Cervus duvauceli*). Barasingha is a threatened mammal, vulnerable status, which is found in herds of thousands, probably the largest herd of the world. An estimated population of 1600 is found in the reserve (Gyawali, 2003). Other wild species in the reserve are Tiger (*Panthera tigris*), wild elephant (*Elphas maximus*), hispid hare (*Caprologus hispidus*), Blue bull (*Boselaphus tragocamelus*), Leopard (*Pathera pardus*), chital (*Axis axis*), Hog deer (*Axis porcinus*), wild boar (*Sus scrofa*) and Rhinoceros (*Rhinoceros unicornis*).

#### **3.5.2.2 Birds**

The Reserve supports the largest population of the Bengal florican (*Houbaropasis bengalensis*) in Nepal. A total of 372 species of birds has been recorded in this reserve (Tamang, 2003). Grassland birds commonly found are swamp francolin (*Francolinus gularis*), grass owl (*Tyto capensis*) large grass warbler (*Graminicola bengalensis*) and striated marsh warbler (*Megalurus palustris*). The other noticeable bird species in the reserve are pallas's fish eagle (*Haliaeetus leucorophus*), changeable hawk eagle (*Spizaetus cirrhatus*) Brown fish owl (*K tupa zeylonesis*), oriental pied hornbill (*Anthracocerus coronatus*), great slaty wood pecker (*Mulleripicus pulverulentus*), sarus crane (*Grus antigone*), Tickell's blue fly catcher

(*Cyornis tickelliae*), Lesser Florican (*Sypheotides indica*), white rumped vulture and Red headed Vulture.

### **3.5.2.3 Reptiles**

Different varieties of endangered reptiles are also frequently found in the reserve. The reptiles of the reserve are Asiatic Rock Python (*Python molurus*), common Krait (*Bungarus caerule*), cobra (*Naja naja*) Rat snake (*Pytus mucosus*), Marsh mugger crocodile (*Crocodylus palustris*), Monitor lizard (*Varanus bengalensis*) etc.

### **3.5.2.4 Fish**

A large Variety of fishes are found in the water body of the reserve i.e. Rani Tal, Salgaudi Tal, Bahuni Khola. Bhatt and Shrestha (1977) recorded 21 species from the area; some of them are Mahaseer (*Tor tor*), Rohu (*Labeo rohita*, *L. angara*), *Tenger* (*Mystus tengra*, *M. Vitatus*), Hile (*Channa gachua*), *Bam* (*Amphiprourus cuchia*).

## Chapter- IV

# MATERIALS AND METHODS

### 4.1 Preliminary Field Survey

A preliminary field survey was made to find out the Barasingha areas in the SWR before the intensive study was made. This was done by regular discussion with park authorities, elephant staff and nature guide. The field was surveyed on foot, by bicycle and by motorcycle between Septembers and October 2006. A four week intensive field work was initiated from November to December second week 2006.

### 4.2 Direct Observation

Actively grazing Baraingha was observed from machans with the help of binoculars (8 x 42 and 3 x 56). Besides, observations were also done from domestic elephant back, vehicle, and bicycle and on foot. Above 90% of the observation were made during actively feeding period from 7:00 to 10:00 AM and 16:00- 17:00 hr in the evening. Among various means used during direct observation, Machan was found most effective and practicable to observe.

### 4.3 Indirect Method

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



#### 4.4 Distribution

Distribution of Barasingha was determined by the fecal pellets observation. Geographical locations of observed groups or individuals were taken using GPS, later these points were transferred into maps using GIS.

#### 4.5 Habitat Utilization

Habitat utilization was examined by the fecal pellets observation through the line plot transect method. A total of 15 transect lines spaced 500m apart were laid out in North south direction to pass through different vegetation types. Ten meter square ( $r = 1.78m$ ) circular plots were spaced out at 25 m, 35 normal walking steps were regarded as 25m, intervals along the transect lines. Observations of the plots were made with regard to whether pellets were presents or not. Aerial maps (1: 25,000), GPS and compass were used to lie the transect in different habitat types and were also frequently used during the transect survey.

Altogether 576 plots were sampled, covering all habitats. Of the total plots, 43.40% (250 plots) fell in phanta, 18.9% (109 plots) fell in the Sal forest, 15% (86 plots) fell in mixed hard wood forest, 10.41% (60 plots) fell in wooded grassland, 8.9% (51 plots) in Riverine forest and 3.39% (20 plots) fell in Marsh

Habitat Preference was calculated by using the formula (Pokharel, 1996).

$$HP = \frac{PPE}{TPP} \times 100$$

Where,

HP = Habitat Preference

PPE = Pellet Present (%) in each habitat

TPP = Total Pellets present (%) of all habitat types

## 4.6 Population Status

Population status of Barasingha was determined by using direct ground count method. Barasingha congregated annually to the large number on the newly burned grassland of Suklaphanta between November to April. This made total population count reliable.

During the total count, well trained 10-15 persons were mobilized. Six elephants were used to search throughout all potential Barasingha habitats. 2 elephants were in each North and South direction while one elephant in each east and west direction. The assistant persons were mobilized in each direction of the Suklaphanta to make a living fence. All were provided with chart and pencil to record the animal. All the persons and elephants were moved at a same time toward central part of the Phanta making loud which drove the animals from their habitat to central parts. After observing the animals, movement towards the central phanta was stopped but continued making loud for some time. Then, counting of the animal proceeds by using binoculars and directly. Total counts were made in the morning before 10.00 hrs and evening after 16:00 hrs. During this period almost all Barasingha were actively grazing and slowly moved due to large aggregation. Evening count was found more reliable than morning. In evening, more herds of morning were mixed and made large herd as well as slowly moved in straight line.

Total no. of count of the day was considered as total population of the Suklaphanta as no other places was sighted with Barasingha. The result obtained through the method was compared with the formula given by Choudhary (1987).

$$No = 2 n_k - n_{k-1}$$

Where,

No = Population estimate

$n_k$  = highest count

$n_{k-1}$  = next highest count

## Chapter-V

# RESULT AND DISCUSSION

### 5.1 Population Status

Schaaf (1978) mentioned that during the 1950's, Barasingha were found in the districts of Banke, Bardia, Kailali and Kanchanpur. Until early 1960s barasingha were also reported from Chitwan valley of south - central Nepal which is now Chitwan National Park (CNP) (Mishra, 1982 Gyawali, 2003)

Once widely distributed Barasingha is now restricted in isolated pockets of PAs mainly due to illegal hunting, habitat clearance. After the eradication of Malaria from Terai region, massive destruction of prime habitats of the animal occurred between mid 1950 and 1970 for human settlement. This in turn seriously affected the population of large mammals such as Rhinoceros (Jnawali, 1993), Tiger (Tamang, 1982) and Barasingha (Gurung, 1983), which ultimately led to disappearance of barasingha from central lowland Nepal.

SWR harbors the world's largest remaining population of this endangered animal (Henshaw, 1994). A small population of about 91 individuals also exists in the south western section of Bardia national park (Parajuli, 2001).

Current study estimates a minimum of 1951 individual for SWR. Comparing the result with the formula given by Choudhary (1987), the population of the animal was found to be.

$$n_K = 1375$$

$$n_{K-1} = 790$$

$$N_o = 1960$$

The population trend in the area is shown in the Table. 1

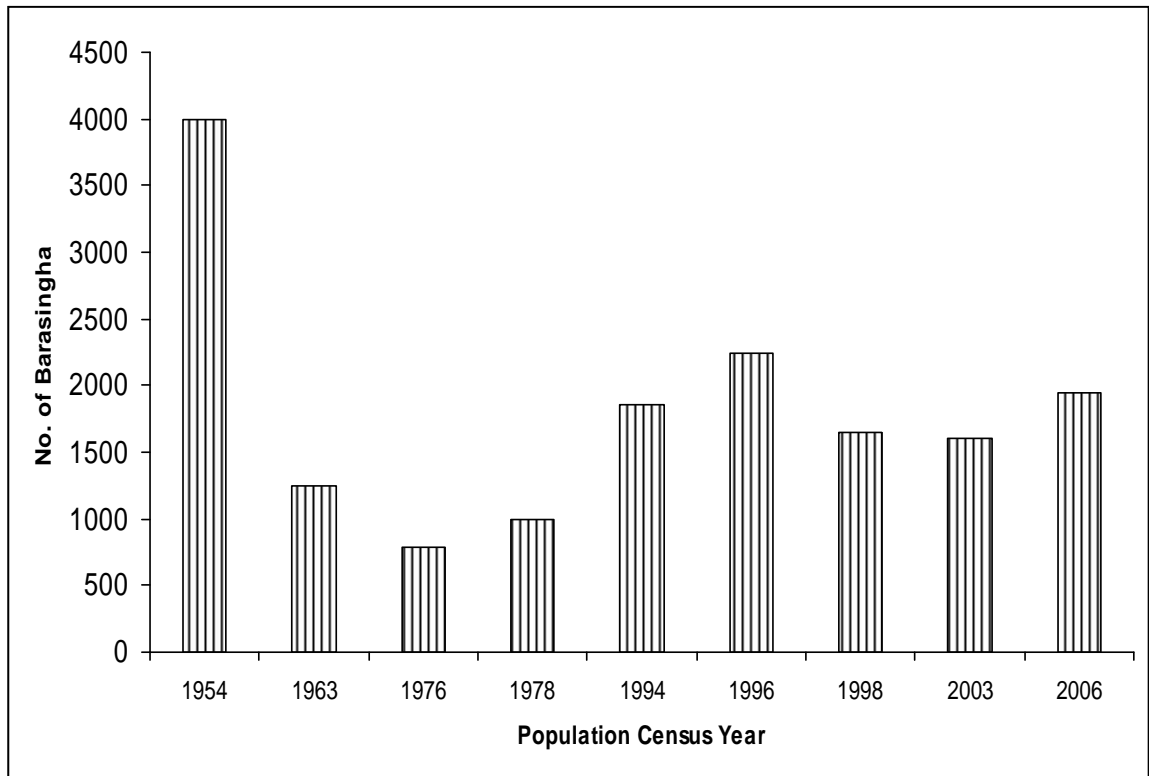
**Table- 1 Population Trend of Barasingha in SWR Before 2006**

<b>Year</b>	<b>No. of Barasingha</b>	<b>Researcher</b>
1954	4000	Gee
1963	1250	Byrne
1976	780	Balson
1978	1000	Schaaf
1994	1850	Henshaw
1996	2250	DNPWC
1998	1654	Bhatt
2003	1607	Gyawali
2006	1951	Present study

Population study of barasingha in SWR was found to be started from 1954 carried out by Gee who counted 4000 individuals. Byrne (1963) Cited in Bhatt and Shrestha (1977) estimated a total of 1250 individuals. Schaaf (1976) estimated 1000 individual in 1976. This reduction in population of Barasingha might be probably due to poaching and habitat clearance in between 1968 and 1976. After establishment of wildlife reserve in 1976 the population of Barasingha increased to 1850 in mid 1990s (Henshaw 1994).DNPWC (1996) counted the population between 2000-2500 giving mean of 2250 in the year while the research scholar found their population about 1654 in 1998. Gyawali in 2003 counted 1607 individuals of Barasingha which showed there was reduction in Barasingha population. The decrease in Barasingha population could probably due to poaching during the state of emergency in 2001/ 2002. Besides, high predation rate might have also affected the population growth. Predation has been identified as the key factor in limiting the population of wild ungulates. Since SWR harbors a handsome tiger population of 19 individuals (Regmi, 2000), one of the highest - density of tiger population in Nepal.

Total number of 1951 Barasingha population was recorded in the present study that shows there is increase in population from the last census made by Gyawali in 2003.

*Figure 8: Population trend of Barasingha in past 50 years*



The increase in population in present study could probably be due to better security, ceasefire, regular monitoring and reduction in poaching pressure.

The total count was made during the second week of December. This was the best time for census because the Barasingha were congregated at a place and group size becomes maximum and number of herds tends to be minimum, and there is a maximum chance of including the entire individual during census. During this time the grassland was burnt which made the habitat favorable by producing sprouts and was mostly grazed by Barasingha. The Barasingha in SWR was located in Shuklaphanta, so the population counted in the phanta is the population of the whole reserve.

## 5.2 Sex Composition of the Population

Table 2 shows the sex composition of Barasingha. Out of 1951, individuals observation, 28.8% were adult male and remaining 71.2% were female and calves.

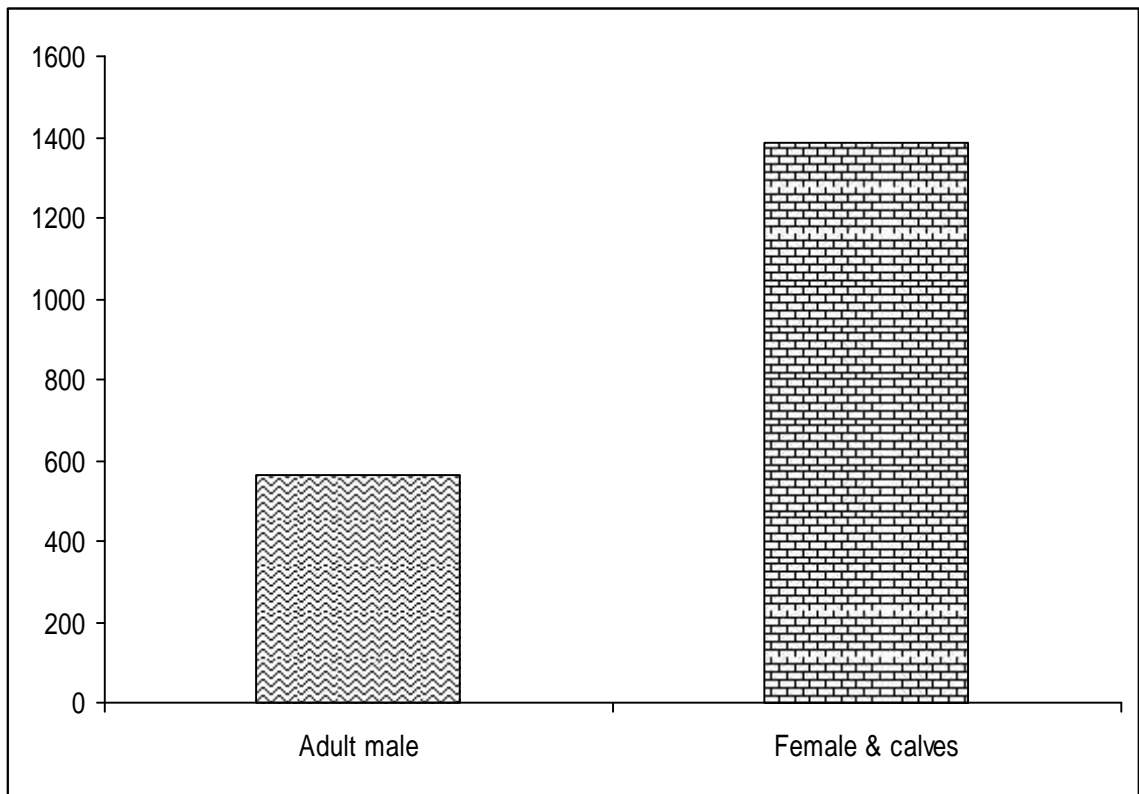
**Table - 2 Composition of Barasingha Population**

<b>Sex</b>	<b>Number</b>	<b>Percentage</b>
Adult male	563	28.8
Female and calves	1388	71.2

*Source: Field Study, 2006*

Gyawali (2003) recorded adult makes up to 30.6% of total count in 2003 while Schaaf (1978) recorded adult makes up to 32.7% of total count in 1976 in SWR. Based on sex ratio and past trend of higher proportion of females and calves indicates the increasing the population in SWR. However, the population increase would also depend upon a biotic factor like temperature, drought, flood, competition, other than sex ratio.

**Figure 9: Sex composition of Barasingha**



### 5.3 Group size

Barasingha usually observed in herds but frequently change their composition. They congregated in herds of varying sizes but never remain constant. The large herd splits occasionally and smaller herds mixed with others. Barasingha were congregated in Suklaphata during the study period (November- December) forming herds of varying sizes. The mean group size observed during the winter season is given below.

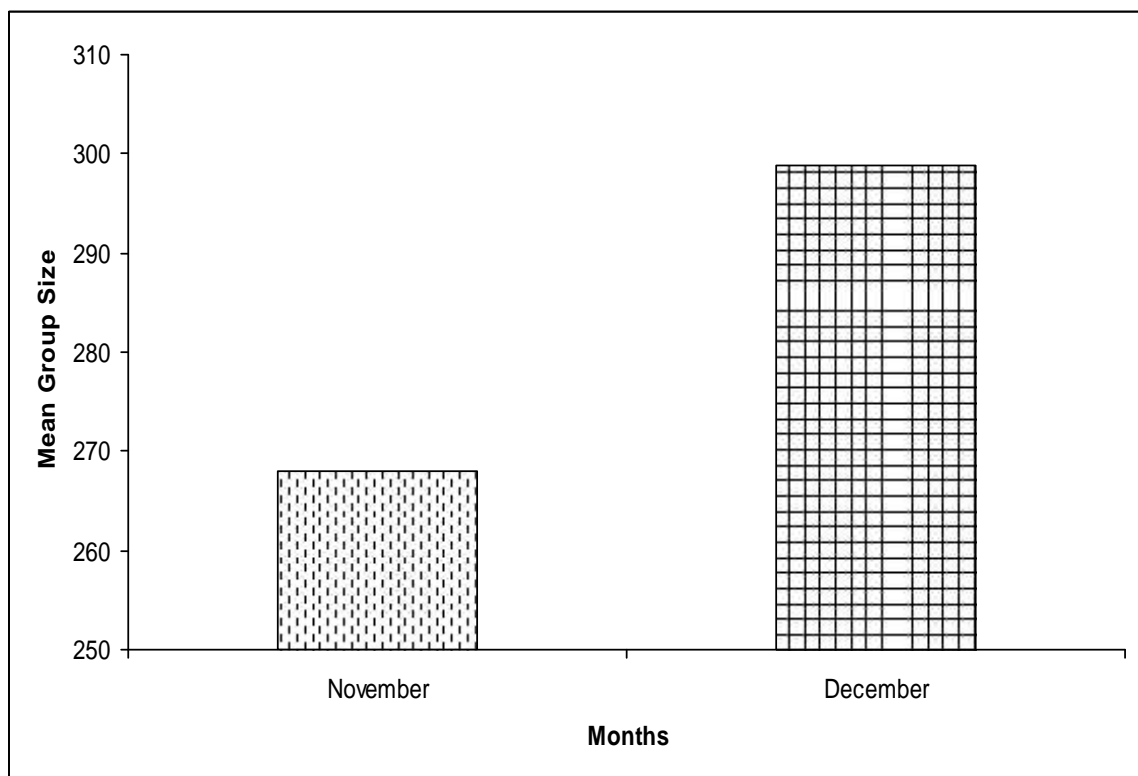
**Table- 3 Groups Size of Barasingha Observed**

Month	Total number of group observation	Total no. of Barasingha	Mean group size	Range
November	16	4289	268.0	5-1133
December	15	4483	298.8	14-1375
Total	31	8772	283.4	

*Source: Field Study, 2006*

Thus, during the study period, a total of 31 groups and 8772 individuals were observed that estimated the mean group size, ranging from 5-1375, to be 283.4 individuals per group. During last week of November and second week of December, the mean group size was recorded to be slightly higher than that of mean group size in early three weeks of November. Mean group size of November 261.8 increased to 298.8 during second week of November (figure-10). The highest group size was recorded during second week of December. This explains the better grazing areas available to the animals after cutting and controlled burning in late November and early December. Relatively large group size was recorded during December supports the statement that cutting and burning are important tools to improve the habitat of Barasingha. Cutting and burning of grasslands caused *Saccharum spontaneum*, *S. bengalense*, *Imparata cylindrica* to produce tender shoot which is highly preferred by Barasingha. Thus, during the time group size become large and group number reduced.

**Figure 10: Group size of Barasingha in SWR in 2006**





It is observed that there was loose social structure as the herd size never remained constant (see Appendix 1 and 2). The stable relationship was only between mother and calves. This behavior was also observed by Ghimire (1996) in Barasingha in BNP.

#### 5.4 Habit Types and Utilization

The line plot method revealed that presence of fecal pellets of Barashigha in 6 different habitat types. Total no. of plots laid in each habitat types and plots with and without fecal pellets and habitat preference values are presented in the table 4 below.

**Table- 4 Number of plots in each habitat type, plots with pellets and habit preference (HP) value**

Habit types	Total No. of plot	Plots with pellets	HP
Phanta	250	163	29.6
Sal forest	109	13	5.8
Mixed hard wood forest	86	24	12.6
Wooded forest grassland	60	32	24.2
Riverine forest	51	8	7.1
Marsh	20	9	20.4
Total	576	250	

*Source: Field Study, 2006*

From above table it was found that among 6 different habitat types, Phanta was most preferred (HP value 29.6%) followed by wooded grassland (HP = 24.2%) and marsh (20.4%). Pokhrel(1996) also found similar result in Bardia where phanta was most preferred and moist Riverine forest was least preferred.

The highest proportions of plots with fecal pellets were recorded in the Phanta (65.2%) where as lowest proportion was recorded in Sal forest.

The highest preference of Phanta might be due to available of most preferred food plants such as *I. Cylindrica*, *S. spontaneum*, *S. bengalensis* (schaaf, 1978; Pokharel 1996, Janawali et. al 2005) and waterholes.

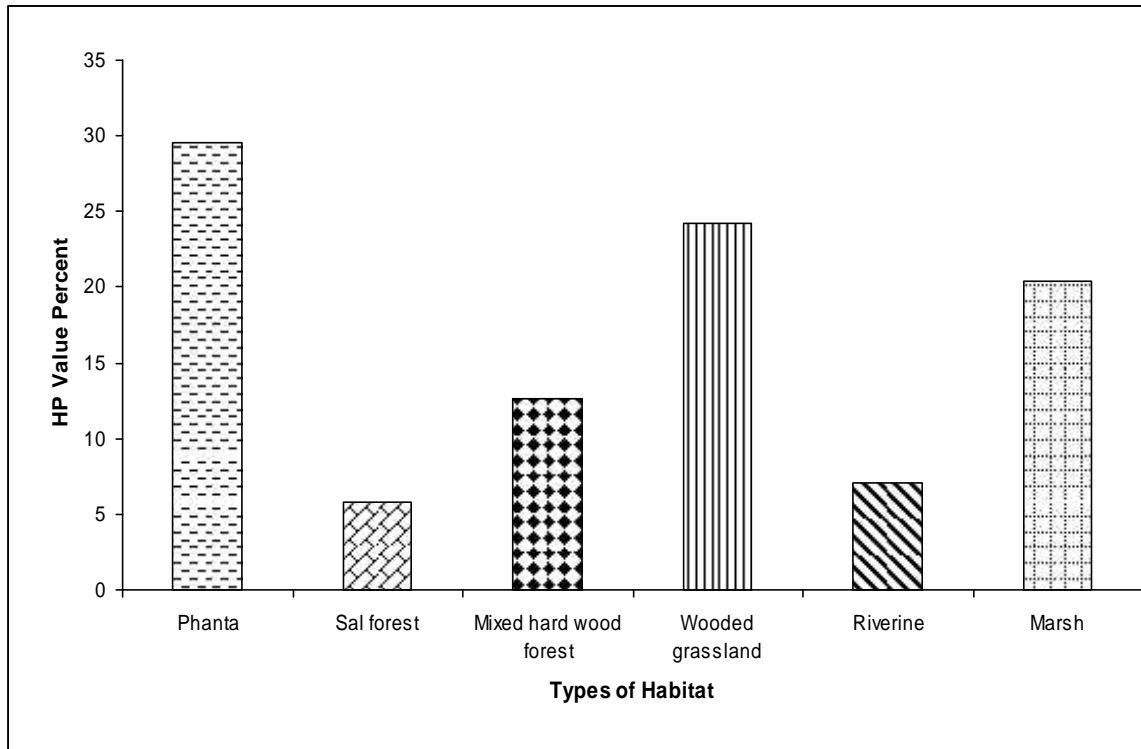
Barasingha also showed high preference for wooded grassland. They heavily used this habitat for resting during day time; another reason for higher use of wooded grassland could be due to its location near the phantas. The wooded grassland forest is toward western side and North-eastern side of Suklaphanta.

Animal also use the mixed forest during day time for resting which is stretched straight north and south. The higher use of mixed hardwood forest and wooded grassland than Sal forest might be due to available of preferred food and easy to detect predators.

The higher preference of marsh is explained by the available of water, aquatic food plants such as *Chara*, *Potamogeton*, *V. zizanoides* species. Animal feed aquatic species to fulfill the minerals (Ca, Na, Mg, and P) requirement (Moe, 1994). Besides, *S. spontaneum* which keeps sprouting all year round due to availability of ample moisture content in abundant supply on the marshy area. This also attracts animal in marshy places. Pokharel (1996) also found same result in Bardia.

Extremely low use of Sal forest by Barasigha is explained by the scarcity of water, preferred food plants. This forest remains dry all year round and includes very few preferred food. In Sal forest *I. cylindrica*, *Narenga porphyrocoma*, *Vetivera zizanoides* grow in lower proportion and due to lack of cover to escape from predation, Barasingha try to avoid the Sal forest to use.

**Figure 11: HP Values for Different Habitat Types**



### **5.5 Habitat Preference between Burned and Unburned Grassland of Phanta**

Grassland is the most preferred habitat of Barasingha but the present study also tried to find out whether Barasingha prefer burned grassland or unburned grassland. There is a common practice practiced by park authority to burn grassland for manipulation of habitat during mid November to march every year. The total no. of plots studied, total no. of plots with fecal pellets and their HP value are presented in table 5 below.

**Table- 5: Total plot studied, plots with fecal pellets and HP values for different habitat**

<b>Habitat type</b>	<b>Total no. of</b>	<b>Plots with fecal pellets</b>	<b>HP</b>
Unburned grassland	97	29	29.8%
Burned grassland	153	107	70.0%
Total	250		

*Source: Field Study, 2006*

From above table, it was found that burned grassland (HP value 70.0%) was more preferred over unburned grassland. It might be due to presence of more palatable food. Burning of grassland helps to sprout new tender shoot. Cut areas attract Barasingha when no burned areas were available. When burning areas were available, areas only cut were no longer preferred although these areas also had newly emerging sprouts (Moe, 1994). Burned over areas had a higher density of sprouts compared with areas unburned. Net above ground primary production of *I. cylindrica* was also increased after burning in Suklaphanta (Sharma,2000). Burned areas had also higher forage quality with higher concentration of Na, K, and P compared with unburned areas (Moe, 1994). The high protein content of young grass shoots may be important for lactating females which require higher level of protein in the forages. The re-sprouting after cutting and burning coincide with the peak of fawning period.

Mishra (1982) found that axis deer in Chitwan used burned areas in January to March while in the same period Barasingha also congregated on burned grassland of Suklaphanta (Schaaf, 1978, Per.Obs.). Improvement of forage quality (Moe, 1994) and quantity (Lehmkuhl, 1989) by burning suggests that foraging aspects attracts the deer to burned site.

Avoidance of unburned areas may also be an antipredator strategy. Another cause of avoidance would be occurrence of coarse and mature grasses whose leaves are tough to chew. It is easy to prey for predators in unburned areas having sufficient cover to hide itself. But, it is not only reason for avoiding unburned areas when burned areas are available.

In this study, few animals were counted on burned sites before grasses sprouted out. Re-sprouting began 7-15 days after burning. The animals were observed eating ash on fresh burn. It might be for balancing minerals in the body (Moe, 1994a).

*Fig 12- HP values for different habitat types*



## **5.6 Distribution and Movement**

### **5.6.1 Distribution**

Distribution of animals depend upon the availability of food, suitable habitat etc. The Barasingha of Suklaphata is primarily located in the Shuklaphant grassland. During the period of study (winter season) the groups were exclusively observed in open grassland in southern and western sides of old machan of Suklaphata. Most of time herds were confined around the Suklaphata post and Purano tal (figure-13).

During the third week of October, Barasingha were not observed in sukla, it may be due to hindrance caused by tall grass. After burning of the grassland in second week of November, the Barasingha were seen in Sukla. In earlier days of burning, the barasingha were seen in small herds which are because of grasses had just sprouting out. The congregation of Barasingha in Sukla was mainly due to availability of new grasses. Schaaf

(1978), Moe, (1993) also recorded Barasingha concentration in open grassland when new sprouts of grass species were available. It is common practice to burn the Suklaphata every year in the month of November and December. (Shah, 2000). After burning, mature and coarse grasses are replaced by the flush of green grass shoot of higher quality. The congregation could be for rutting too.

In the month of December, the Barasingha dominantly concentrated in the south western section of Sukla which was covered by new sprouts of grasses. The phanta is dominated by *Imparata cylindrica*, *Saccharum spontaneum* and followed by *Saccharum bengalensis*.

The distribution of Barasingha during the period was found, around 500m south of the singhpur- Barkaula fire lime. In the North- east of old Machan a small group of 12 individuals was found which was newly burnt. This may also be due to disturbances caused by visitors. A group of 5 male was observed in eastern side of old Machan.

After June the grasses become mature and coarse, which is not preferred by Barasingha, and due to rainfall, it was expected that they were moved toward north of the phanta. The fecal pellets of Barasingha, during the period of field study were found in large number in Mangalsera phanta and sal forest of Baghmara phanta which is adjoined with Baghmara tal, manmade one. In the Sal forest near Baba tal, which is also man made, there was also found the fecal pellets. In the southern side of lake, there is a phanta which was probably used by Barasingha during the monsoon season.

During the unfavorable season the animals used to use the Sal forest was covered by Kansch (*Saccharum spontaneum*) and Siru (*Imparata cylindrica*). Actually Barasingha avoid the Sal forest normally but during the rainy season, the ground surface of Sal forest was covered by their preferred grasses (Siru and Kash), they used it as their habitat and they were widely dispersed with small group size in the all available phantas

which are laid near the prime habitat, Suklaphata, of the animal. The animal was also found near the Majhgaun which is 19 KM north of suklyphanta. They also used the Sal forest during rainy season (joshi, pre.comm.).

### **5.6.2 Distribution and Waterholes**

The distribution of animals not only defined by availability of food but also determined by water. The habitat with sufficient water is the best favored by the animal. The barasingha in SWR are mainly congregated in short grassland of Suklaphata where plenty of food and water is available (figure-14).

Present study found the distribution of Barasingha in Sukla was also affected by presence of waterholes. The Barasingha were seen largely congregated around the Suklaphata post and purano tal. In North east of Sukla post, there is a Tal named as Gathauli tal. Due to having ample food and water, the animals were likely to stay around the Suklapost. Same condition was there around the Purano tal.

Same result was found by Gyawali (2003) in the reserve. Buhuni Khola flows in eastern side of the Machan. It is steep and narrow even though it was used by the Barasingha. There were few individuals of Barasingha observed. Through the intensive filed study it was found that Barasingha were likely to stay around the waterholes.

The presence of fecal pellets of Barasingha in Manglasera phanta, Barghaura phanta, Sal forest in southern part of Baghmara phanta, Sal forest near, the Baba tal showed importance of waterholes in distribution of Barasingha (figure-15).

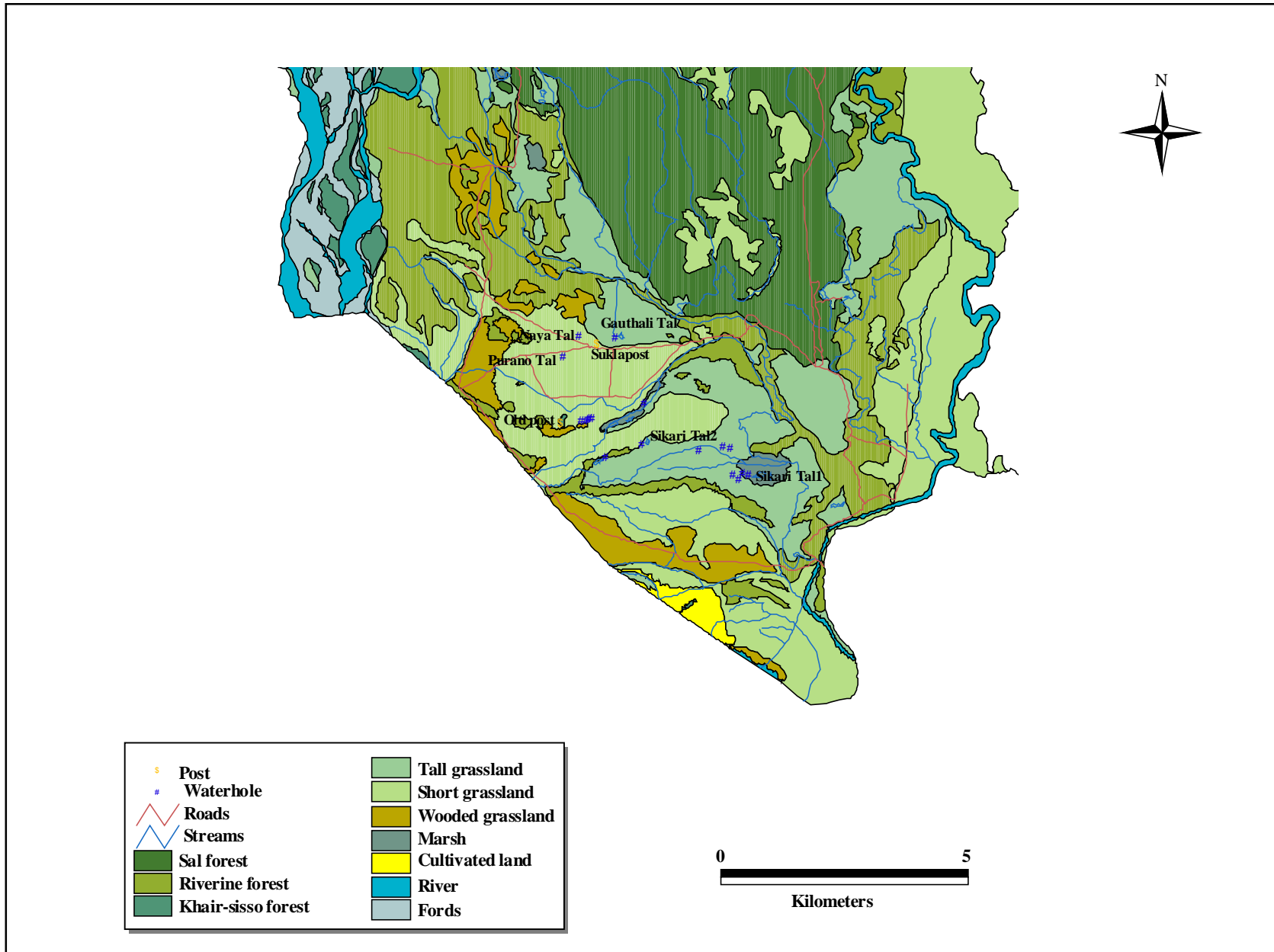
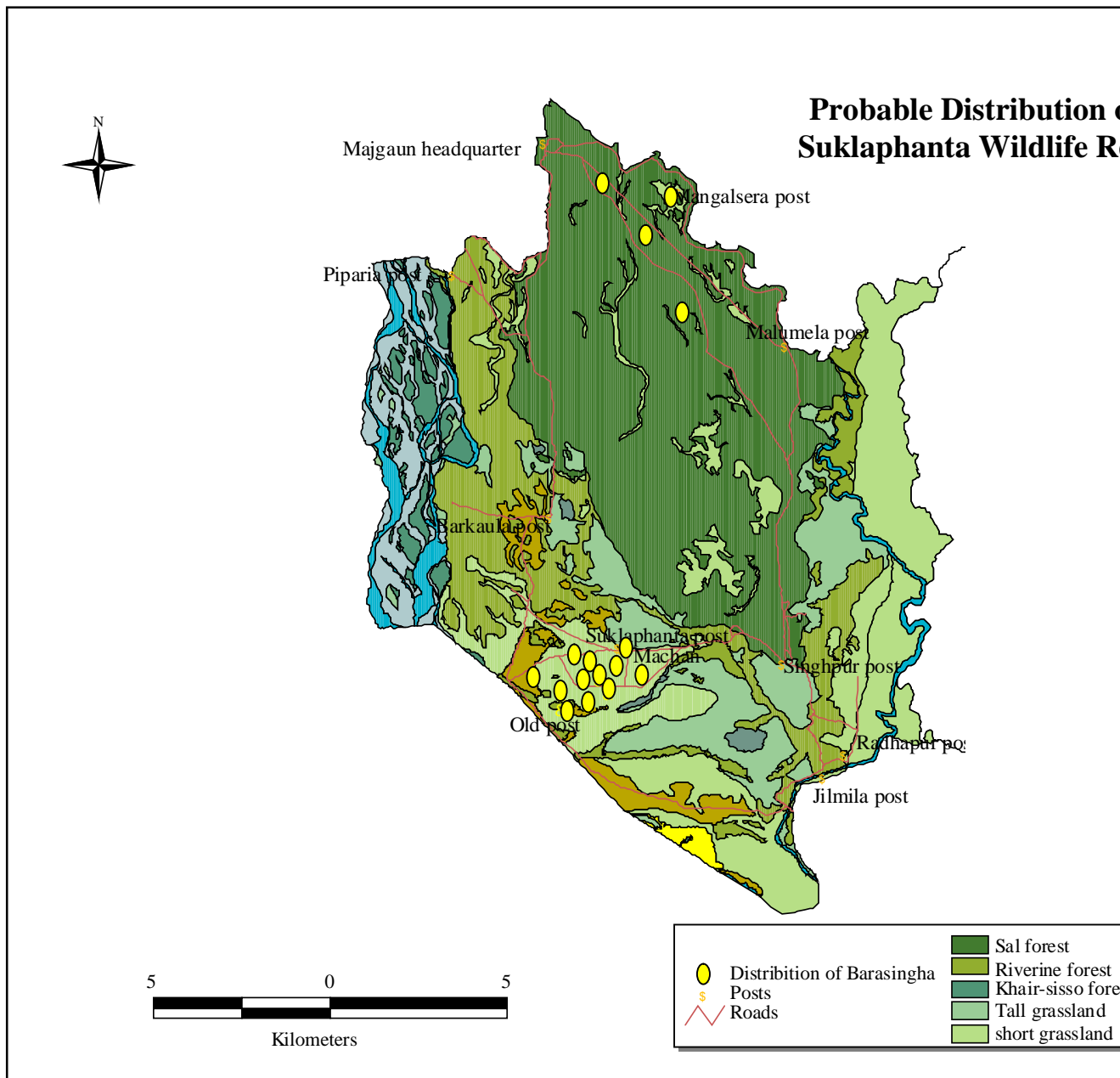


Fig 14: Map showing the distribution of waterholes in and around Suklaphanta.





**Figure 15: Map showing the probable distribution of Barasingha in Suklaphanta Wildlife Reserve**

## Chapter-VI

# BARASINGHA AND ITS HABITAT MANAGEMENT ISSUES

Swamp deer in SWR were facing several conservation problems which may have limited their optimum population proliferations in their natural habitat. On the basis of present study, the problems that barasingha are facing in the SWR discussed below.

### 6.1 Encroachment of Phanta by Trees

Barasingha preferred to graze in open and short grassland locally known as phants. Despite the grazing by Barasigha and other wild animals and regular burning; some areas of Phanta, such as north and west part of Suklaphata, have been heavily invaded by trees like *Beutra monosperma*, *Bombax ceiba* and *Dalbergia sissoo*. If management interventions are not carried out periodically, these trees will colonize the area and the grassland will be lost.

### 6.2 Uncontrolled Burning and Grass cutting

Both cutting and burning can reduce litter inputs and lead a increase in florists diversity that appears to benefit a number of animal inhabiting grassland. In SWR, grasses are burned every year during dry season (Shah, 2000). Each winter, during "Khad- Khadai", the park permits the local people residing around the park to enter the park for a period of a week to collect grasses for thatching roofs and tall grass reeds for making walls of traditional houses. Thousand of people enter the park to collect grasses which virtually affect the grasslands and severely hinder and disturb the daily activities of barasingha. Uncontrolled burning of grasses is thought to be the one of the factor contributing to the deterioration of grass quality.

### **6.3 Scarcity of water**

During hot season, waterholes in the northern Suklaphata dry up. Barasingha and other wild animals move south in search of water to Indian border where high risk of poaching is.

### **6.4 Livestock grazing**

Grazing by cattle and domestic buffalo was prevalent throughout the reserve with the exception of south central grassland of Suklaphata (Malla, 2003). Mostly the livestock from Dodhara and India people grazed in the phantas. Many herds of livestock were seen along the western and southern borders of the phanta.

### **6.5 Grazing Competition with Axis Deer**

The Phanta provided important foraging habitat for ungulates after cutting and burning. Axis deer is classified as the intermediate feeding on mixture of browse and grass and utilize grasslands opportunistically when high quality forage is available there (Mishra, 1982). The number of Axis deer is very large in SWR and comprised entire range of swamp deer.

The barasingha congregated in the Suklaphata after newly sprouted high quality grass species were readily available. At the same time large number of axis deer also congregated there and grazed heavily, this may lead to shortage of fresh food for barasingha.

### **6.6 Predation**

Under certain circumstances, predators can indeed induce serious decline in number of deers. Natural enemies of barasingha include tiger, Leopard, wild dog, Jackal, etc.

SWR harbors handsome population of tiger, leopard. Highest density of tiger in small areas is in Suklaphata. The possible predation on

barasingha was well justified by regular occurrence of tiger pugmarks around the area where barasingha congregated much.

### **6.7 Risk of Poaching**

In past, poaching of the wild animals was a significant problem associated with their conservation. It has been described that poaching was one of the major factors that led to the disappearance of barasingha from central lowland of Nepal. Poaching has the one of the main threats to the conservation of Barasingha population in SWR. Although no incident related to Barasingha poaching was observed during the course of this study. There is no doubt that it was prevalent there, mostly from Indian side.

### **6.8 In accessibility in the Monsoon Areas**

Due to bad condition of roads in many areas during monsoon, patrolling and other management activities are difficult to carryout during the period.

## Chapter-VII

### CONCLUSION

In accordance to the spot counting method operated during the month of December, total population of barasingha in SWR was found to be 1951, showing a steady increase in population than last census during 2003.

The population of 4000 individuals in 1954 (Gee) had reached to 780 individuals in 1976 (Balson, 1976). With establishment of Suklaphata wildlife Reserve in 1976 and with effective management system carried out by park staff, population of Barasingha has been increasing steadily.

Out of the total population counted 1951, 563 were male and 1388 were female and calves showing a sex ratio of 40 adult stag to 100 adult hinds. This shows there was good chance to increase in population of the animal. Barasingha were commonly observed in phanta basically in open short grassland, that congregated to form a large size but the composition of herd never remain constant explaining weak social relationship among the animals. The average group size of Barasingha during study period ranged from 268.0-298.8 individuals per group giving an overall group size of 283.4 individuals per group.

Among 6 different habitat types Barasingha showed highest preference to the phanta basically open short grassland. A forested area were mostly avoided by it but has found to be used during rainy season. Wooded grasslands were also preferred habitat.

The vegetation of Sukla is dominated by *Imperata cylindrica*, *Saccharum spontaneum*, *S. bengalensis* and *Vetevera zezanoides*. Encroachment of phanta by tree species is one of the major issues in the habitat management of the Barasingha. Annual burning of grassland from

November to March is a good technique for habitat manipulation of Barasingha practiced by park authority.

Several waterholes are located on Suklaphata and in the immediate vicinity. Waterholes are found as important factor in determination of barasingha distribution. Having plenty number of waterholes in and around the suklaphanta, the distribution of it is confined in the phanta.

Poaching, predations by tiger and habitat alteration have been found to the major threats for management of Barasingha.

## Chapter-VIII

# RECOMMENDATION AND MANAGEMENT IMPLICATIONS

Although the long term objectives of the conservation of threatened deer may have the eventual return of the species to the wild in numbers that will permit it to be used for recreational purposes. The immediate goal of every wildlife manager is to assure its survival.

Based on present study, for better management of Barasingha in their wild habitat, following recommendations are made for maintaining population in the reserve.

### 8.1 Eradication of Encroaching Species

The encroaching species of trees and shrubs in the Phantas should be controlled. The encroaching tree species like *Bombax ceiba*, *Beutra monosperma* etc. should be uprooted periodically.

### 8.2 Development of Water Sources

The water holding capacity of manmade and naturally created waterholes in Suklaphata should be increased through proper management. More waterholes should be created around the southern section of the phanta.

### 8.3 Controlled Burning

Although controlled burning can have some negative effects in grasslands in the long run, the controlled burning of phantas and floodplain grassland should be practiced regularly to stimulate grass growth. Patch burning should be done to provide fresh sprouts of grasses for a longer period of time. North section of phanta from main fire line should be burnt

during February-March and southern section should be burnt during November-December.

#### **8.4 Protection from Risk of Poaching**

With regard to suspect risk of poaching of barasingha and minimization of such risk; rules and regulations should be strictly implemented. Further, a cooperative effort between India and Nepal is needed to reduce the risk of poaching.

#### **8.5 Protection from Predators**

To reduce the predation pressure, it is essential that the animals of concern should be dispersed to large areas. The Barasingha of SWR is located only in the Suklaphata. So, to reduce the predation pressure, competition and mass casualties, it is recommended that the animal should be translocated in other phanta by providing all the basic requirements needed for Barasingha.

#### **8.6 Introduction and Reintroduction**

One of the effective wildlife management tool is introduction and reintroduction to make viable population of the wild animals in wild. It is found that concentration of the animals at a place may cause mass extinction by various factors such as flood, disease, competition for food, predation. Barasingha congregated only on Suklaphata, there may be a chance of collapsing. Therefore, it is necessary to introduce the animals in other suitable habitat (Bhatpuri and Padaw phanta may be) of extended area or other part of the country like Bardia and Chitwan.

In this context, it may be possible to reestablish the Barasingha population in CNP; however the evaluation of habitat suitability would be a prerequisite for reintroduction.



## **8.7 Research Imperatives**

Management and research should be mutually supportive. Research would give the data which will help to implement management action for population counting. Census should be carried out every year during December to February.

After June, the phanta is covered by tall grassland which is avoided by Barasingha. So, it is essential to explore, the habitat of Barasingha during monsoon period. It helps to manage the habitat of Barasingha for entire year.

## **8.8 Disease Survey**

The epizootics are responsible for the heavy casualties among the wildlife species. Bhatta and Shrestha (1977) reported that rinderpest reduced large number of Barasingha in the reserve. Hence it will be good to study the disease in barasingha at frequent interval and take proper remedial action to conserve the animals in case of outbreak of disease.

## BIBLIOGRAPHY

- Adhikari, H.P. 1998. *An Assessment of Park and People Project in Royal Suklaphanta Wildlife Reserve*, Nepal, M.Sc. Thesis.
- Balson, W. 1976. *Survey of Royal Suklaphanta wildlife Reserve*. A Report Submitted to Department of National Park and Wildlife Conservation, Kathmandu.
- Bhatta D.D. and Shrestha T.K. 1977. *The Environment of Suklaphanta*, Curriculum Development center, T.U. Nepal.
- Bhandari, Kularaj 1994. *An Assessment of Food Habit and Habitat Utilization of Black Buck (Antelope cervicopra) in Bardia*, M.Sc. Thesis, T.U. Kathmandu.
- Bhatt, A.D. 1998. *Factor Affecting Population of Swamp Deer (Cervus duvauceli duvauceli) in R.S.W.R.*, M.Sc. Thesis, T.U., Kathmandu.
- Bhatt, C.R. 2004. *Ecological Studies of Swamp deer (Cervus duvauceli duvauceli) in Royal Suklaphanta wildlife Reserve*, M.Sc. Thesis, Tribuvan University, Kathmandu.
- Bista, H.B. 2002. *Royal Suklaphanta Wildlife Reserve* Danphe 11(1):27.
- Chhetri, Madhu 1999. *Food Habit, Habitat Utilization and Conservation of Gaur (Bos gaurus gaurus) in Parsa Wildlife Reserve Nepal*, M.Sc. Thesis, T.U., Kathmandu.
- Choudhary, R. 1987. *Methodology for Population Estimates of Herbivores, A Statistical Approach in Indian Condition*, Tiger Paper Vol XIV No. 3 pp 11-17.
- DDC (2060). *District Profile Kanchanpur, District Development Committee*, Kanchanpur.
- DNPWC and PPP 2000. *Royal Suklaphanta Wildlife Management strategy Frame Work*. Department of National Park and Park People Programme, Kathmandu, Nepal.
- Ellerman J.B. and Morrison- Scott T.C.S. 1951. *Checklist of Palearctic and Indian Mammals*. British Museum London.
- Ghimire, J.N. 1996. *Status and Distribution of Barasingha (Cervus duvauceli duvauceli) in Royal Bardia National Park*, M.Sc. Thesis, Tribhuvan University, Kathmandu.

- Groves, C.P. 1982. *Geographical Variation in the Barasingha (Cervus duvauleli)* J. Bombay. Nat. His Society 79;620-629.
- Gurung K.K. 1983. *Heart of the Jungle*, The Wildlife of Chitwan, Nepal. Andre Deutch, U.K. and Tiger Tops, Nepal.
- Gurung, J.B. 1995. *Population, Habitat Selection and Conservation of Himalayan thar in Annapurn Sanctuary*, Nepal M.Sc. Thesis, Agriculture University of Norway.
- Gyanwali, N. and Jnawali, S.R. 2005. *Population and Habitat preference of Barasingha (Cervus duvauceli duvauceli) in Royal Suklaphanta Wildlife Reserve*, in Tiger Paper Vol XXXIII No.1 Jan- March 2005.
- Gyawali, N. 2003. *Population and Habitat Preference of Barasingha (Cervus duvauceli duvauceli) in Royal Suklaphanta Wildlife Reserve in Western Lowland Nepal*, B.Sc. Thesis, Institute of Forestry, T.U. Pokhara.
- Henshaw, J. 1994. *The Barasingha in Suklaphanta Wildlife Reserve*, Nepal, Biological Conservation Vol. 76, Issue 2, 1996, pp.213.
- Jnawali, S.R. 1995. *Population Ecology of greater one horned Rhinoceros (Rhinoceros Unicornis) with Particular Emphasis on Habitat Preference, Food Ecology and Ranging Behaviour of a Reintroduced Population on Royal Bardia National Park in Lowland Nepal*, Ph.D. Dissertation, Agriculture university of Norway, Norway.
- Karki, T.B. 1993. *Swamp deer (cervus duvauceli) in Majupuria*, T.C. (ed.) Wild is Beautiful, Introduction to the magnificent rich and varied fauna of Nepal.
- Khajuria. H and Sinha N.K. 1986. *Limiting Factors in Population Dynamics of Vanishing Swamp deer*. In Wildlife Wealth of India (Majupuria, T.C. eds).
- Khatri, T.B. 1993. *Status and Food Habits of Nilgai (Bocelaphus tragocamelus) in Royal Bardia Nalcord Park*, M.Sc. Thesis, Agriculture University of Norway.
- Lehmkuhl, J. F. 1989. *The Ecology of south Asian tall grass community*, Ph. D. Dissertation, University of Washington, Washington.

- Malla, R. 2003. *Park People Conflict in Royal Suklaphanta Wildlife Reserve: A Case Study From Beldandi VDC* Draft B.Sc. Thesis, Institute of forestry, T.U. Pokhara.
- Martin, C. 1977. *Status and Ecology of the Barasingha (Cervus duvauceli barandari) in Kanha National Park* India, J. Bombay Nat. His. Soc. 72 (1) 60-132.
- Mehata, J.N. 1987- *The Population trend of Swamp deer in Royal Suklaphanta Wildlife Reserve* J. Nat. His. Museum 11(1-4): 15-20.
- Mishra H.R. (1982). *Ecology and Behaviour of Chital (Axis axis) in the Royal Chitwan National Park* Ph.D. Dissertation, Edinburgh University Edinburgh.
- Moe, S.R. 1994. *Distribution and Movement Pattern of Deer in Response to Food Quality and Manipulation of Grassy habitat: A Case Study with emphasis on axis deer (Axis axis) in Lowland Nepal*, Ph.D. Dissertation, Agriculture University of Norway.
- Moe,S.R. (1994a). *The Importance of Aquatic Vegetation for the Management of Barasingha in Nepal*, Biological Conservation.
- Moe. S.R. (1994). *Using fire to improve grassland quality for wildlife in lowland Nepal*, Department of Biology and Nature conservation, Agriculture University of Norway, Norway.
- Naess, K.M. and Andersen, H.B. 1993. *Assessing Techniques for Wild Ungulates in Royal Bardia National Park*, Nepal, M.Sc. Thesis, Agriculture University of Norway.
- Newang, Narbir 2003. *Small Mammals of Royal Sukhaphanta Wildlife Reserve*, M.Sc. Thesis, T.U.
- Parajuli, K. 2001. *Ecological Assessment of Swamp deer with particular Emphasis on Conservation Problems of the Same in Western Lowland of Royal Bardia National Park*, Project Report, B.Sc. Kathmandu University, Nepal.
- Pokharel, C.P. 1996. *Food Habit and Habitat Utilization of Swamp deer (Cervus duvauceli duvauceli) in Royal Bardia National Park*, M.Sc. Thesis, T.U. Nepal.
- Prater, S.H 1980. *The Books of Indian Animals*. Bombay Nat. His. Soc; Bombay India.

- Regmi, U.R. 2000. *Status of Tiger (Panthera tigris) and Livestock Depredation in Royal Suklaphanta Wildlife Reserve*, Nepal, M.Sc. Thesis, Agriculture University of Norway.
- Sankaran R. 1997. *Habitat Use by the Lesser Florican in a Mosaic of Grassland and Cropland : The Influence of Grazing and Rain Fall*, J. Bombay. Nat. His. Soc. Vol. 94 (1) April 1997.
- Sankaran, R. 1989. *Status of Swamp deer (Cervus duvauceli duvauceli) in Dudhwa National Park*, J. Bombay Nat. His.Soc, Technical Report no 14
- Sapkota, J. 1999. *Study of Status, Habitat Utilization and Management of chital (Axis axis) in Parsa Wildlife Reserve*, Nepal, M.Sc. Thesis, T.U., Kathmandu.
- Schaaf, C.D. 1978. *Population size, Structure and Habitat Relation of the Barasingha (Cervus duvauceli duvauceli) in Suklaphanta Wildlife Reserve*, Nepal, Ph. D. Thesis, Michigan state University, USA.
- \* Schaller, G.B. 1967. *The Deer and the Tiger*, University of Chicago Press, Chicago, USA.
- \* Seal U.S., Walker, S. and Molur S. (eds) 1995. *Population and Habitat Viability Assesment Workshop (PHVA) for Barasingha (Cervus duvauceli)* A Report, ZOOS Out Reach Organization CBSG India.
- Shakya, Durga Man 1993. *Activity Pattern, Habitat Utilization, Movement and Home range of Sloth Bear in Royal Chitwan National Park*, M.Sc. Thesis, T.U., Kathmandu.
- Sharma, Bindu K. 2000. *Above Ground Biomass and Primary Productivity in the Grassland of Royal Suklaphanta Wildlife Reserve*, Nepal, M.Sc. Thesis, T.U., Kathmandu.
- Shrestha T.K. 1995. *Mammals of Nepal*, Printed on R.K. Printers Teku. Kathmandu.
- Shrestha, T.K. 2003. *Wildlife of Nepal*, curriculum Development Center, T.U., Kathmandu.
- Tamang, B. 2003. *Bird Conservation: An Educational Kit, Bird Conservation* Nepal, Kathmandu.

- Tamang, K.M. 1982. *The Status of Tiger (Panthera tigris) and its impacts on Principal Prey Population in Royal Chitwan National Park*, Nepal, University of Michigan, Michigan.
- Thapa, R. 2003. *Study on Habitat Structure of Royal Suklaphanta Wildlife Reserve, western Lowland*, Nepal, Draft B.Sc. Thesis, Institutes of Forestry, T.U. Pokhara.
- Timilsina, L. P. 2002. *Wildlife Assessment, status, Distribution and Habitat Utilization of Blue Sheep in Kanchajungha Conservation Area Nepal*, M.Sc. Thesis, T.U. Nepal.
- Velde, P.F. 1997. *A Status Report of Nepal's Wild Elephant Population*. WWF. Report, Kathmandu, Nepal.
- \* Wemmer, C. (ed.) 1998. *Deer Status Survey and Conservation Action Plan*. IUCN / SSC Deer Specialist Group, IUCN, Gland Switzerland and Cambridge, U.K. 106.pp
- Yadav, R.D, Thaguna, S.S. and Sah, J.P. 2000. *Grassland in Royal Suklaphanta Wildlife Reserve, Status, Importance and Management*; In Grassland Ecology and Management in PAs of Nepal Vol- 2 Technical and Status Paper on Grassland of Terai Protected areas. ICIMOD, Nepal.
- ) Original Report not consulted.

## APPENDIX-I

### Herd Size Observed during November 2006

Date	Habitat Type	Herd Size	Male
14/11/06	Short grassland	635	190
14/11/06	Short grassland	150	35
14/11/06	Short grassland	227	67
14/11/06	Short grassland	113	12
15/11/06	Mixed hard wood	28	3
15/11/06	Sal forest	15	2
15/11/06	Short grassland	538	147
15/11/06	Short grassland	753	221
15/11/06	Short grassland	10	2
16/11/06	Riverine Forest	5	5
16/11/06	Wooded grassland	44	8
16/11/06	Wooded grassland	210	53
28/11/06	Marsh	53	12
28/11/06	Marsh	7	2
28/11/06	Short grassland	1123	275
28/11/06	Short grassland	378	72

## APPENDIX-II

### Herd Size Observed during December 2006

Date	Habitat Type	Herd Size	Male
1/12/06	Short grassland	235	83
1/12/06	Short grassland	162	45
1/12/06	Short grassland	352	138
4/12/06	Short grassland	663	206
4/12/06	Wooded grassland	105	17
4/12/06	Marsh	32	6
9/12/06	Short grassland	790	205
9/12/06	Short grassland	178	72
9/12/06	Sal forest	15	3
15/12/06	Short grassland	26	6
15/12/06	Short grassland	73	25
15/12/06	Short grassland	285	92
15/12/06	Short grassland	1375	405
15/12/06	Short grassland	178	33
15/12/06	Riverine	14	2



### APPENDIX-III

S.N	Nepali Name	Common Name	English Name	Scientific Name
1	Badar	Banar	Monkey	<i>Macca mulatta</i>
2	Bagh	Bagh	Tiger	<i>Panthera tigris tigris</i>
3	Banbiralo	Binbillo	Jungle cat	<i>Felis chus</i>
4	Bandel	Sungur	Wild Boar	<i>Sus scrofa</i>
5	Bankukur	Bankukur	Wild dog	<i>Cuon alpinus</i>
6	Barasingha	Barasingha	Swamp deer	<i>Cervus duvauceli duvaueli</i>
7	Bwauaso	Bwauaso	Wolf	<i>Canis lupus</i>
8	Chamero		Fruit bat	<i>Cynopetruiis spnix</i>
9	Chhuchundro	Chhuchundro	Musk shrew	<i>Suncus murinus</i>
10	Chital	Chital	Spotted deer	<i>Axis axis</i>
11	Chituwa	Chitwa	Leopard	<i>Panthera pardus</i>
12	Dumsi	Saudo	Porcupine	<i>Hystrix indica</i>
13	Gainda	Gainda	Rhinoceros	<i>Rhinoceros unicornis</i>
14	Hatti	Hatti	Elephant	<i>Elephas maximus</i>
15	Kharayo	Kharayo	Indian rare	<i>Leptus nigricolis</i>
16	Khet muso	Khet muso	Mole Rat	<i>Bandicota bengalensis</i>
17	Laguna	Sugar mirga	Hog deer	<i>Axis porcinus</i>
18	Langur	Guno	Common langur	<i>Presbytis entellus</i>
19	Lokharke	Kath Biralo	Lam squirrel	<i>Funambulus palmoum</i>
20	Muso	Muso	House Rat	<i>Ratts rattus</i>
21	Nilgai	Nilgai	Blue bull	<i>Boslaphus tragocamelus</i>
22	Nyauri	Nyari Muso	Mongoose	<i>Herpestes edwardsi</i>
23	Phyauro	Phyauro	Fox	<i>Vulpes bengalensis</i>
24	Ratuwa	-	Barking Deer	<i>Munacus muntjak</i>
25	Shyal	Shyal	Jackal	<i>Canis aureus</i>
26	Thulo Kharayo	Thulokharayo	Hispid hare	<i>Carpolagus hispidus</i>
27	Unde lokharke	-	Flying squirrel	<i>Petannista nobilis</i>
28	Udni	-	Otter	<i>Lutra lutra</i>

## APPENDIX-IV

### Water Holes in Suklaphanta wildlife Reserve

Water holes	Location	Approx area	Type
Baghmara	N28 <sup>0</sup> 54' 40.6" E 080 <sup>0</sup> 11' 57.4"	1000m <sup>2</sup>	MM
Rani Tal	N28 <sup>0</sup> 50' 00" E 080 <sup>0</sup> 13' 02.4"	1.5 Km <sup>2</sup>	N
Baba Tal	N 28 <sup>0</sup> 53' 05.3" E 080 <sup>0</sup> 12' 19.3"	900m <sup>2</sup>	MM
Sikari Tal <sup>1</sup>	N 28' 48' 05.7" E 080' 12' 30.0"	3000 m <sup>2</sup>	N
Sikari Tal <sup>2</sup>	N 28 <sup>0</sup> 48' 30" E 080 <sup>0</sup> 10' 57.4"	2000 m <sup>2</sup>	N
Purano Tal	N 28 <sup>0</sup> 49' 43.08" C 080 <sup>0</sup> 40' 25.1"	750 m <sup>2</sup>	N
Naya Tal	N 28 <sup>0</sup> 49' 42.7" E 080 <sup>0</sup> 10' 25.2"	1250 m <sup>2</sup>	MM
Gauthali Tal	N 28 <sup>0</sup> 49' 44.3" E 080 <sup>0</sup> 10' 27.9"	1000 m <sup>2</sup>	MM
Bahuni Khola	N 28 <sup>0</sup> 49' 19.3" E 080 <sup>0</sup> 12' 23.9"		N

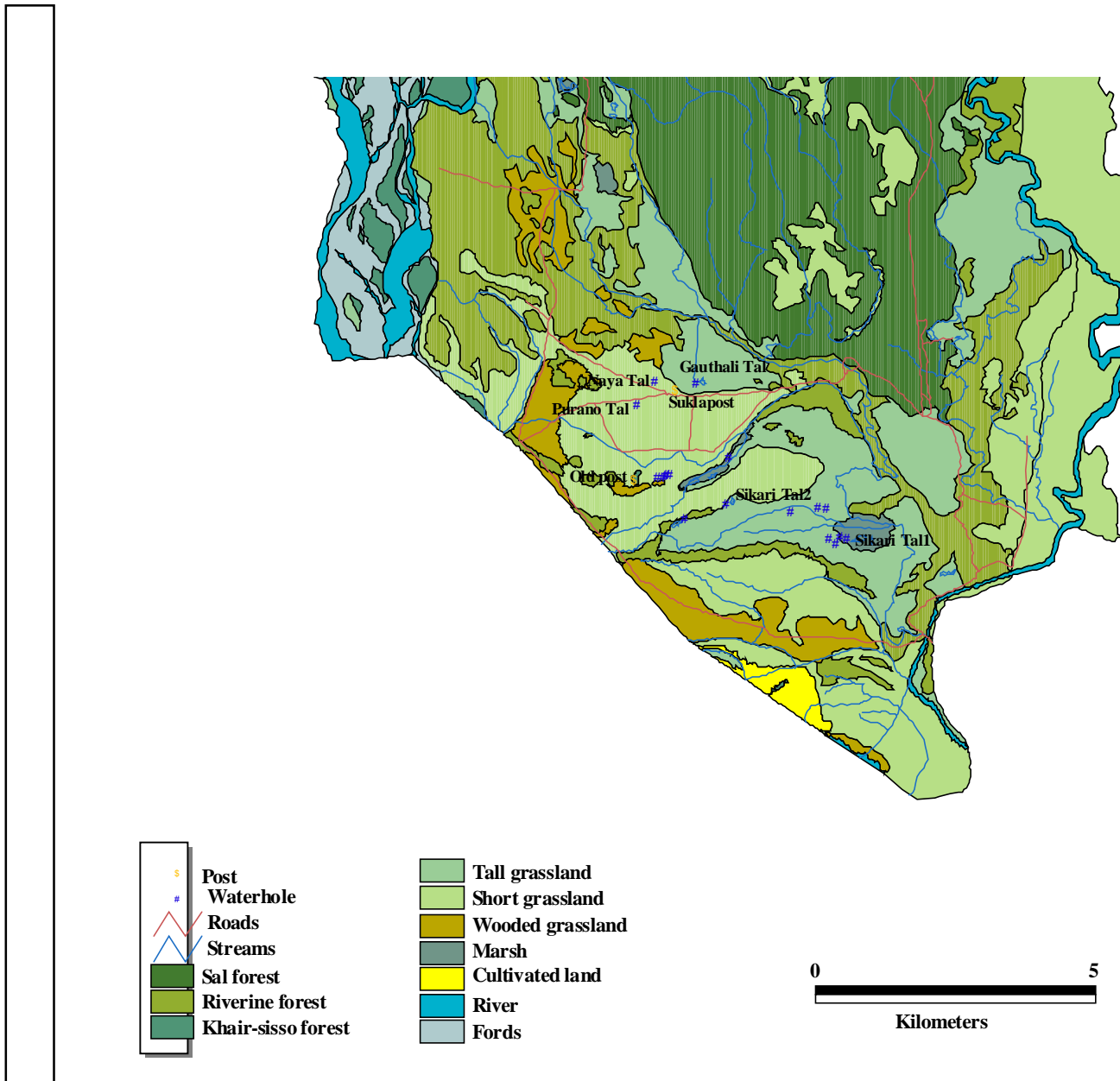
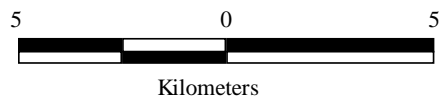
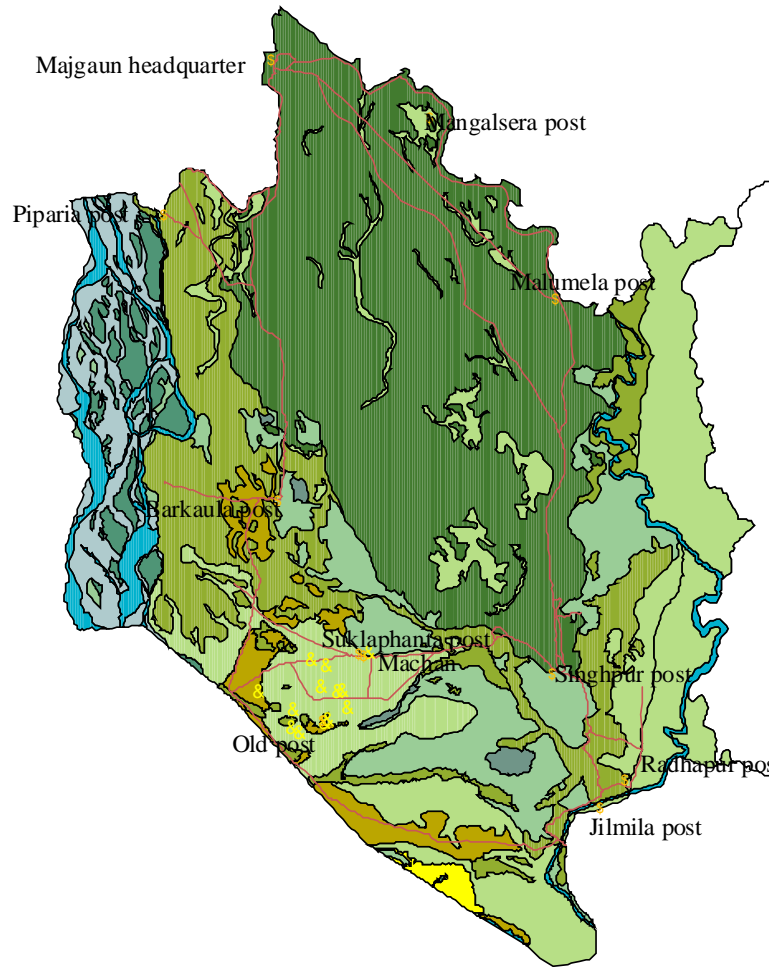
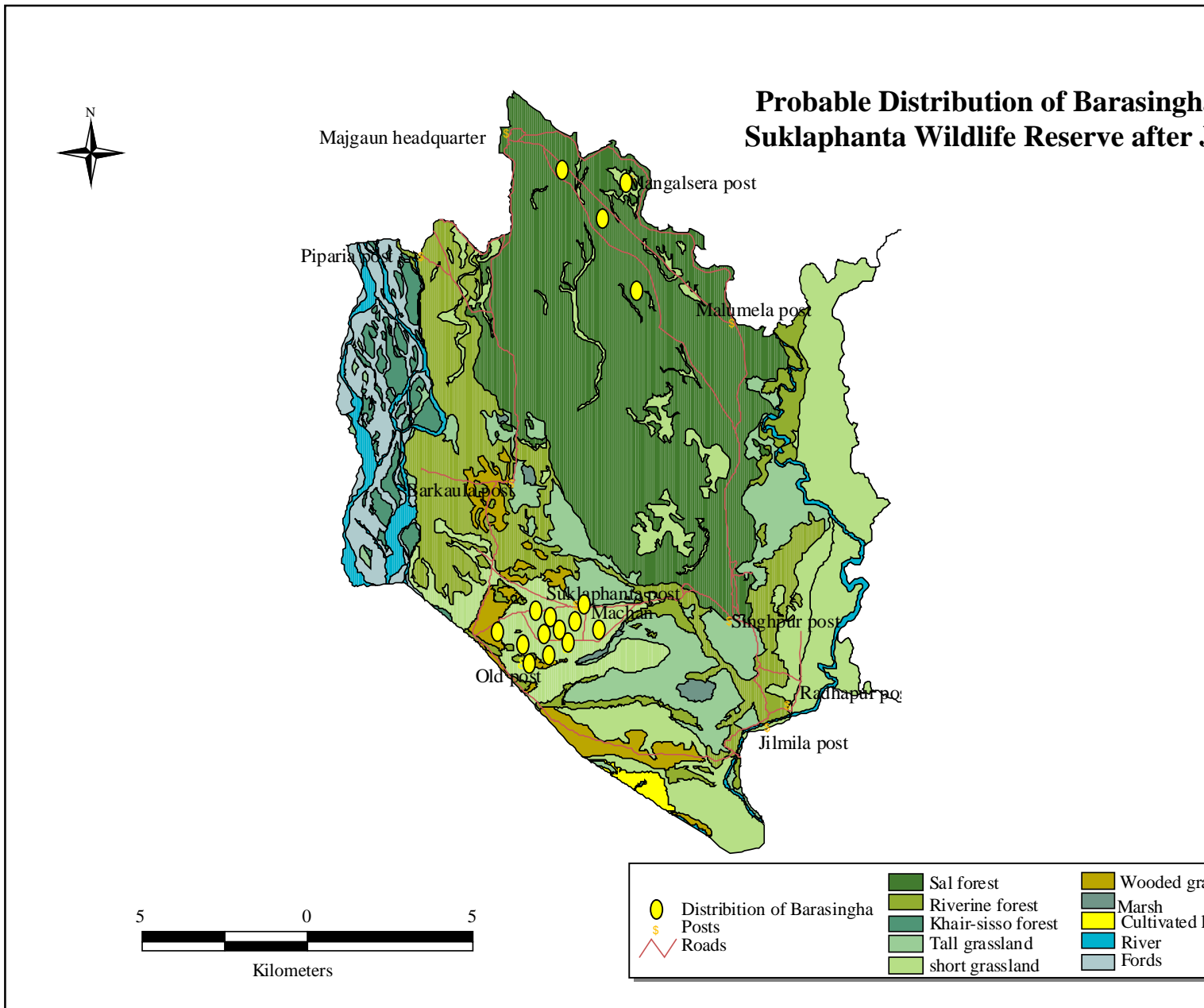


Fig 14: Map showing the distribution of waterholes in and around Suklaphanta.



- & Distribution of Barasingha
- Posts
- ⚡ Roads
- Sal forest
- Riverine forest
- Khair-sisso forest
- Tall grassland
- short grassland



**Figure 15: Map showing the probable distribution of Barasingha in Suklaphanta Wildlife Reserve after**