Population Status and Habitat Use of Nilgai (*Boselaphus tragocamelus*) in Suklaphanta Wildlife Reserve

A Thesis Submitted to Central Department of Environmental Science

for the Partial Fulfillment of Master's Degree in Environmental Science

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Symbol No. 6368

T.U. Registration No. 5-1-61-75-2003

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2012

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LETTER OF RECOMMENDATION

It is our pleasure to mention that Ms. Kalpana Bisht has completed the thesis work entitled **"Population Status and Habitat Use of Nilgai (*Boselaphus tragocamelus*) in Suklaphanta Wildlife Reserve"** under our supervision and guidance. This work embodies her own research and brings out useful findings in the concerned field. To the best of our knowledge this thesis has not been submitted for any other degree.

We strongly recommend this thesis work to be accepted as partial fulfillment of the requirements for the Master's Degree in Environmental Science.

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LETTER OF APPROVAL

A thesis entitled **"Population Status and Habitat Use of Nilgai (*Boselaphus tragocamelus*) in Suklaphanta Wildlife Reserve"** submitted by Ms. Kalpana Bisht to Central Department of Environmental Science, Tribhuvan University for the partial fulfillment of the requirement for Master's degree in Environmental Science has been accepted and approved for examination.

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DECLARATION

I, Ms. Kalpana Bisht, hereby declare that the piece of work entitled **"Population Status and Habitat Use of Nilgai (*Boselaphus tragocamelus*) in Suklaphanta Wildlife Reserve"** presented herein is genuine work, done originally by me and has not been published or submitted elsewhere for the requirements of a degree program. Any literature cited within this thesis has been given due acknowledgement and listed in the references section.

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ACKNOWLEDGEMENT

I am sincerely grateful to Shant Raj Jnawali, PhD, my supervisor for his valuable suggestions, excellent guidance and supervision on this work. I am much indebted to Dr. Kedar Rijal, Head of Central Department of Environmental Science, for providing me necessary suggestion and facilitation from the department.

I extend my deepest gratitude to my co-supervisor Mr. Hemant Yadav, NTNC Suklaphanta Conservation Program (SCP) for technical and logistic supports. I am also obliged to my co-supervisor Suman Aryal, faculty of the Central Department of Environmental Science, Tribhuvan University, for his valuable suggestions during my thesis work.

I would like to extend my special thanks to the National Trust for Nature Conservation (NTNC) for providing financial support to undertake this study. My thanks also goes to Department of National Park and Wildlife Conservation (DNPWC) particularly Dr. Maheshwar Dhakal, Ecologist for giving permission and support to work in the Suklaphanta Wildlife Reserve (SWR). I would also like to thank Mr. Kishwor Mehata, Assistant warden of SWR and Santa Magar, Ranger for their support in the field. Also NTNC-SCP staff members specially Suman Malla, Pramod Subedi, Raju Chaudhary and Dev Raj Joshi also deserve special thank for assisting me in the field.

I am very thankful to Bhola Nath Dhakal, DNPWC for helping me in preparing GIS maps and Dr. Nanda Bahadur Singh, Associate Professor at Central Department of Zoology for invaluable suggestion and inspiration. I am very grateful to my friends Uma Kant Mishra, Aman Dangaura, Naresh Prasad Bhatta, Tek Raj Bhatt, Manju Joshi and Utsav Neupane for their valuable suggestions during data analysis and map preparation. Finally, I would like to extend my sincere thanks to all the staff of Central Department of Environmental Science, Tribhuvan University for their co-operation.

Last but not least, my sincere respect goes to my parents and all the family members for their inspiration and generous support.

ABSTRACT

A study on the population status and habitat use of Nilgai (*Boselaphus tragocamelus)* in Suklaphanta Wildlife Reserve (SWR) was carried out during the summer (May–July) 2011. The study aimed at studying the current status, distribution and habitat use of blue bull in SWR. Population status and habitat utilization were studied by direct observation and vegetation composition in the study area was studied by quadrate method. For vegetation study, all the plant species inside the quadrate were counted as well as ocular estimation was made to measure the coverage for shrub and ground vegetation and approximate crown coverage was conducted for tree species. All the stage of tree including tree, pole size, sapling and seedling were also analyzed.

A total of 17 individual animals with average group size of 1.89 were recorded during the study. The population shows the reflecting decline as well as in critical state from the previous recorded data probably due to poaching, high predation and poor habitat quality. Nilgai were found using three main different habitats available in the study area, Sal forest, Riverine forest and Mixed forest. Of these, Sal forest with grass patches was highly preferred mainly due to the availability of preferred browse and grass species and also the semi-open land helps animals to avoid the risk of predation. Riverine forest is also utilized due to the presence of different ground vegetation and the other browse species with their fruits in dry hot season. Apart from this Riverine forests provides shade and cover. Four major types of vegetation were found in the main study area. **Sal forest** was dominated by *Shorea robusta, Cleistocalyxn operculatus.* **Riverine forest** was mainly dominated by *Murraya koenigii, Syzygium cumini, Trewia nudiflora, Mallotus philippensis* and **Mixed forest** was dominated by *Symplocos pyrifolia, Termenalia alata, Lagerstroemia parviflora,* Ber (local name) tree species. Highest tree density was recorded in the Riverine forest (300 ind/ha) than in Mixed forest (225 ind/ha) and Sal forest (103.97 ind/ha).

Key words: *Nilgai, SWR, Habitat utilization, Population, Quadrate method*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

ACRONYMS AND ABBREVIATIONS

BNP = Bardia National Park

C = Cover

cm = centimeter

D/ha = Density per hectare

DNPWC = Department of National Park and Wildlife Conservation

F = Frequency

GPS = Global Positioning System

HMG/Nepal = His Majesty's Government of Nepal

IUCN = International Union for Conservation of Nature

IVI = Importance Value Index

Kg = kilogram

km = Kilometer

KTWR = Kosi Tappu Wildlife Reserve

m = meter

mm = milimeter

NTNC = National Trust for Nature Conservation

^{o}C = degree Celsius

PA = Protected Area

PWR = Parsa Wildlife Reserve

RC = Relative Cover

RD = Relative density

RF = Relative frequency

SWR = Suklaphanta Wildlife Reserve

TAL = Terai Arc Landscape

WWF = World Wildlife Fund

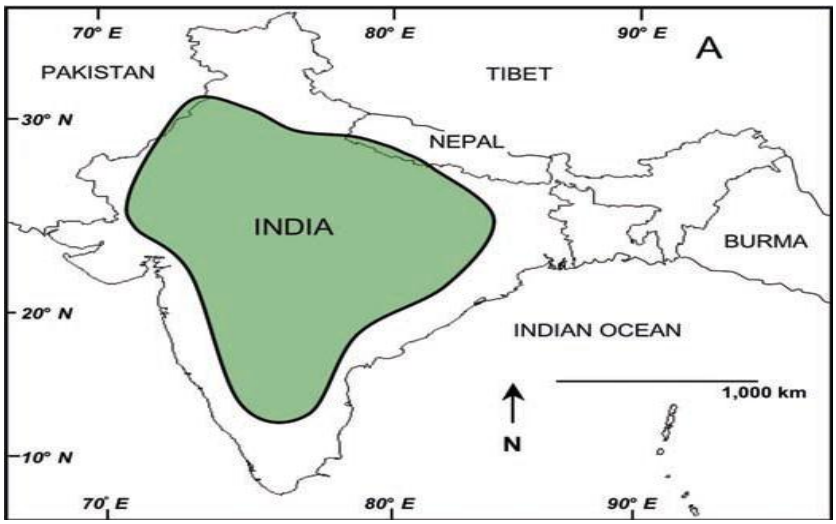
CHAPTER 1

INTRODUCTION

1.1 Background

The Blue bull *Boselaphus tragocamelus* locally called as Nilgai is Asia's largest antelope. A sexually dimorphic ungulate of large stature and unique coloration, it is the only species in the genus *Boselaphus* (Leslie 2008). In most respects, this typical antelope is considered as Asian version of African eland and is one of the fastest and best-horned beasts of Asia (Lasiwa 1999).

Nilgai is endemic to the Peninsular Indian and Indus divisions of the Indian sub-region in the Asian Indomalayan Region (Corbet and Hill 1992) (Figure 1). It's native range in Asia includes the foothills of the Himalayas in Nepal (Dinerstein 1980), northeastern Pakistan (Mirza and Khan 1975), and almost all of India, except eastern Bengal, Assam, east of the Bay of Bengal, and the Malabar coast (Blanford 1888; Ellerman and Morrison-Scott 1966; Prater 1980) and also exists in southern parts of North America where latitude, climate, and habitat characteristics are comparable to those of India (Ables and Ramsey 1972; Sheffield *et al*. 1983). Nilgai were introduced into Texas, USA in 1924 as game animals and have readily reproduced and established free-ranging populations. Today, Blue bulls are the most abundant free-ranging exotic ungulate in Texas and have done well in South Texas (cited in Leslie 2008).



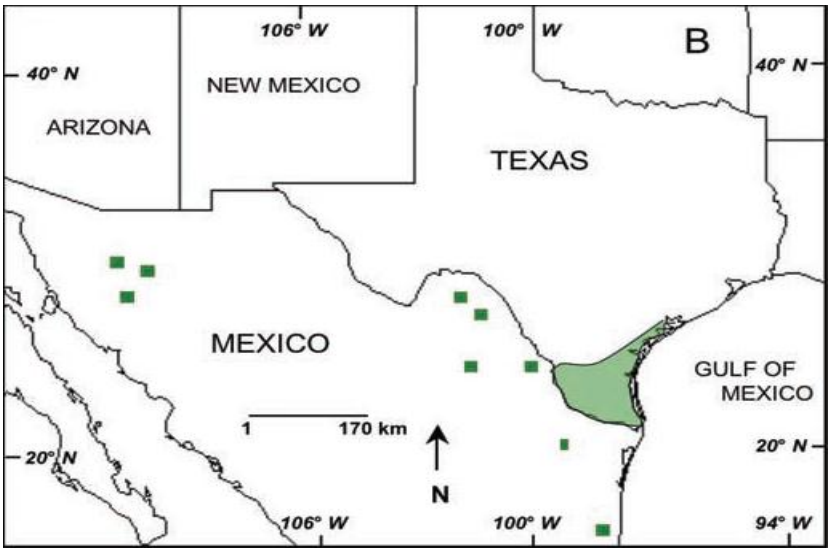


Figure 1: Distribution of *Boselaphus tragocamelus* in (A) Native India, Nepal and Pakistan and (B) Southern North America (green squares = distinct areas of occurrence in Mexico), where exotic free ranging populations occur (source: Leslie 2008).

Nilgai has got distinctive features from both cow and horse especially male. Sexual dimorphism can easily be distinguished through colour and shape of body. This particular bovine antelope has long slender legs, long head, short neck and a slanted back which is higher in the withers. The front part of body is heavier and bulkier than the rear part. The mature males appear ox-like and grey blue, hence are known as blue bulls. The female's heads are long and narrow, as in female red deer. In males, heads are more compact, with straight nose and a slightly rising forehead. The hooves are narrow with pointed tips and pseudo-claws are short, broad and flat. A large male Nilgai may reach up to 150 cm in height and about 250 kg in weight and blue grey in colour while young bulls and cows are tawny in colour. The male Nilgai has about 20 cm long cones like slightly curve horn and has a curious pendent tuft of coarse hair on throat. Females are hornless and noticeably small with about 170 kg weight. Both sexes carry a short dark mane in the ventral side of neck and have white rings above the hoof and pale buttocks. There is a small pit gland below either eye. The tail extends to just below the hack and terminates in a tuft of coarse black hair (Lasiwa 1999).

Maximum life span of this animal is reported to be 12–13 years in the wild (Berwick 1974; Mungall and Sheffield 1994; Mungall 2000) and 20–21 years in captivity (Jones 1982; Grzimek 1990), Survival patterns among male and female are similar to those of

other ungulates (Brown 1976) but vary depending on population density and status of particular populations, either on native or introduced range (Berwick 1974; Sheffield *et al*. 1983). High rates of mortality are common for males in particular, but also females, before age of 3 (Berwick 1974; Brown 1976 cited in Leslie 2008).

Nilgai is non-migratory, although individuals and groups are capable of considerable movement if ambient conditions (e.g., drought) dictate (Dharmakumarsinhji 1959; Berwick 1974; Sheffield *et al*. 1983). It is not as gregarious as other herding ungulates and occurs in relatively small groups throughout the year. Adult males segregate from females and sub-adults during non-breeding seasons (cited in Dinerstein 1980).

Diet-Premaxillary shape of Nilgai suggests a mixed feeder (Solounias and Moelleken 1993). Dietary selection varies seasonally and includes grasses *Cenchrus sps., Cynodon dactylon, Desmostachya bipinnata, Scripus tuberosus*, and *Vetiveria zizanoides*, woody vegetation *Acacia nilotica, A. senegal, A. leucophloea*, *Clerodendrum phlomidis*, *Crotalaria burhia, Indigofera oblogifolia, Morus alba*, and *Zizyphus nummularia*, and herbaceous species *Cocculus hirsutus, Euphorbia hirta*, and *Sida rhombifolia* (Mirza and Khan 1975; Sharma 1981; Sankar and Vijayan 1992; Khan 1994; Prajapati and Singh 1994; Shukla and Khare 1998; Solanki and Naik 1998; cited in Leslie 2008).

In India and Nepal, Nilgai is limited by availability of free water (Berwick 1974; Dinerstein 1979, 1980; Bagchi *et al*. 2004). Wild adult males and calves in India will drink continuously for 2 minute 10 seconds and 1 minute 10 seconds, respectively (Bohra *et al*. 1992 cited in Leslie 2008).

1.2 Status of Nilgai in Nepal

Nilgai is widely distributed in the southern plain Terai region of Nepal. They occurred in seemingly viable numbers in the Kosi Tappu Wildlife Reserve (KTWR) in the east, Parsa Wildlife Reserve (PWR) in the middle, and SWR and Bardia National Park (BNP) in the west (Wegge 1976). Outside the protected areas they are found in Rupandehi, Kapilbastu, Bardia, Kailali, Kanchanpur and Nawalparasi districts (Bagale 2003). Nilgai is listed in IUCN red list of threatened species; as status: least concern ver. 3.1 and population trend: stable (IUCN 2012). Due to hunting and habitat destruction its population is declining from Terai region of Nepal (HMG/Nepal 2002; Aryal 2004),

however not enough studies have been carried out to understand the actual population trend at national level. A major problem in conserving and managing large mammal species like blue bull is the relative lack of reliable quantitative information regarding the distribution, abundance and habitat requirements of these species, using which the effectiveness of management practices can be assessed, and goals set for the future (Jathana *et al*. 2001).

Regular updates in Nilgai population in Nepal are lacking and no comprehensive study has been carried out after 2002. Population estimation made in different location between early 1990s and early 2000 is given in Table 1 below:

Table 1: Population status of Nilgai in Nepal from 1992-2007

S.N	Location	Minimum population			Maximum population				Remarks
		1992-93	1997-98	2000	1992-93	1997-98	2000	2007	
1	Trijuga-Tarahara forest	-	-	7	-	-	12	-	
2	Sharlai-Mahottari	-	-	10	-	-	20	-	
3	Rautahat	-	-	8	-	-	12	-	
4	Bara Reserve Forest	-	-	15	-	-	20	-	
5	Parsa Wildlife Reserve	-	3	29	-	5	35	-	Increase
6	Nawalparasi (Tribeni)	-	-	10	-	-	15	-	
7	Lumbini Development Trust	-	-	11	-	-	15	41	Increase
8	Rupandehi-Kapilbastu forest	5	180	20	10	200	25	-	Increase-Decrease
9	Banke (Samsherjung, Kusum, Dhakeri)	10	4	20	15	5	25	-	Decrease -Increase
10	Bardia National Park and Bufferzone	57	52	36	86	64	54	-	Decrease
11	Bardia district forest area	-	-	18	-	-	28	-	
12	Kailai reserve forest	-	6	15	-	8	20	-	Increase

13	Kanchanpur Laljhandi forest	-	-	7	-	-	10	-	
14	Suklaphanta Wildlife Reserve	20	20	35	30	26	47	-	Increase
15	Koshi Tappu Wildlife Reserve	5	14	-	10	16	-	-	Increase
	Total	**97**	**279**	**241**	**151**	**324**	**338**	**41**	

1992-93: Khatri 1995; 1997-98: Lasiwa 1999; 2000: Subedi 2001; 2007: Aryal 2007

Note: - indicates lack of data

1.3 Objectives

The main objective of this research is to study the population status and habitat use of Nilgai in SWR.

The specific objectives are:

- To determine the population status and its distribution in SWR.
- To determine its group size and sex composition.
- To study the vegetation in Nilgai potential areas.

1.4 Rationale of the study

Wild ungulates represent an important faunal assemblage in Terai contributing to diversity, biomass and conservation values. Biodiversity loss is one of the major crises of the world. In SWR periodic population monitoring data are available only for swamp deer (Schaff 1978; Bhatta 1998; Gyawali 2003) and rhino (Adhikari 2003) but for other ungulate species (Spotted deer, Hog deer, Barking deer, Sambar deer, Nilgai, and Wild boar), the population data and other ecological information are lacking. Only few studies on Nilgai have been undertaken in Nepal by different researchers including Khatri (1993), Lasiwa (1999), Sen (1999), Shakya (1999), Subedi (2001), Bagale (2003) and Aryal (2007).

There is high density and biomass of ungulates in SWR which makes SWR as potential area for long term conservation of tigers. Besides high density and biomass of ungulates, there is low density and biomass of one of the preferred prey of tiger i.e. Nilgai, it could be an obstacle for long term conservation of tiger in SWR (Yadav

2006). Thus the management of tiger depends on the management of their prey especially wild ungulates. On the other hand, a regular population study is imperative to understand the population trend of species with relatively numbers. Population size and trend greatly helps to prepare the long term conservation strategy for species like Nilgai. Therefore the present study is essential and will have a conservation implication in securing not only the Nilgai population but also the umbrella species such as tiger in SWR.

1.5 Limitations of study

Due to inadequate resources and time the data were collected only for the summer season. Besides, animal sighting was very much hindered by the fire and openness caused by the heavy fire. Animal observation becomes extremely difficult throughout and after-burnt period. Due to ground fire on previous dry season only a few species of herbs, shrubs and other ground vegetation were reported.

CHAPTER 2

LITERATURE REVIEW

Khatri (1993) estimated total of 57-86 individual Nilgai in 9 different semi-isolated sub-population in and around Bardia National Park (BNP) during 1992-93, reflecting a decline of 80-90% since 1970's. He concluded that high poaching, tiger predation and habitat deterioration as major cause of decrease in its population in BNP.

Lasiwa (1999) studied the population status and habitat mapping of Nilgai and vegetation analysis on South- western section of BNP and estimated about 52-64 individuals in twelve different semi-isolated sub-populations during his study in 1997-98. He also concluded marked reduction of Nilgai population within two decades in BNP. He reported that Nilgai used four different types of forest habitats and grassland available in the main study area and of them Wooded grassland was the highly preferred habitat of this animal.

Subedi (2001) studied status and distribution of Nilgai in Nepal and estimated a minimum of 241 and maximum of 338 animals in whole country and 30 in SWR during 2000.

Bagale (2003) studied population status of Nilgai and Nilgai-Livestock-People interaction in Lumbini and estimated a total of 37 individuals in Lumbini garden during 2002 .He found mean herd size of 3.7 animals.

Kuikel (2003) studied wild ungulates in BNP – extension area. He recorded six different wild ungulates as Axis deer 357, Wild boar 202, Sambar 33, Hog deer 20 Barking deer 22, and Nilgai 9. Nilgai was mainly found in isolated areas of Riverine and Sal forest.

Pokhrel (2005) studied distribution and abundance of wild ungulates in SWR by pellet count method. He found Spotted deer, Hog deer, Swamp deer, Barking deer, Wild boar and Nilgai as main ungulate species occupying in the core area of reserve. He found Spotted deer was most abundant (2.28±2.23) and Nilgai was least abundant (0.002±0.05) in his results also he found most of ungulates were highly abundant on Grassland habitat while Nilgai was abundant (2.76±2.15) on Sal forest.

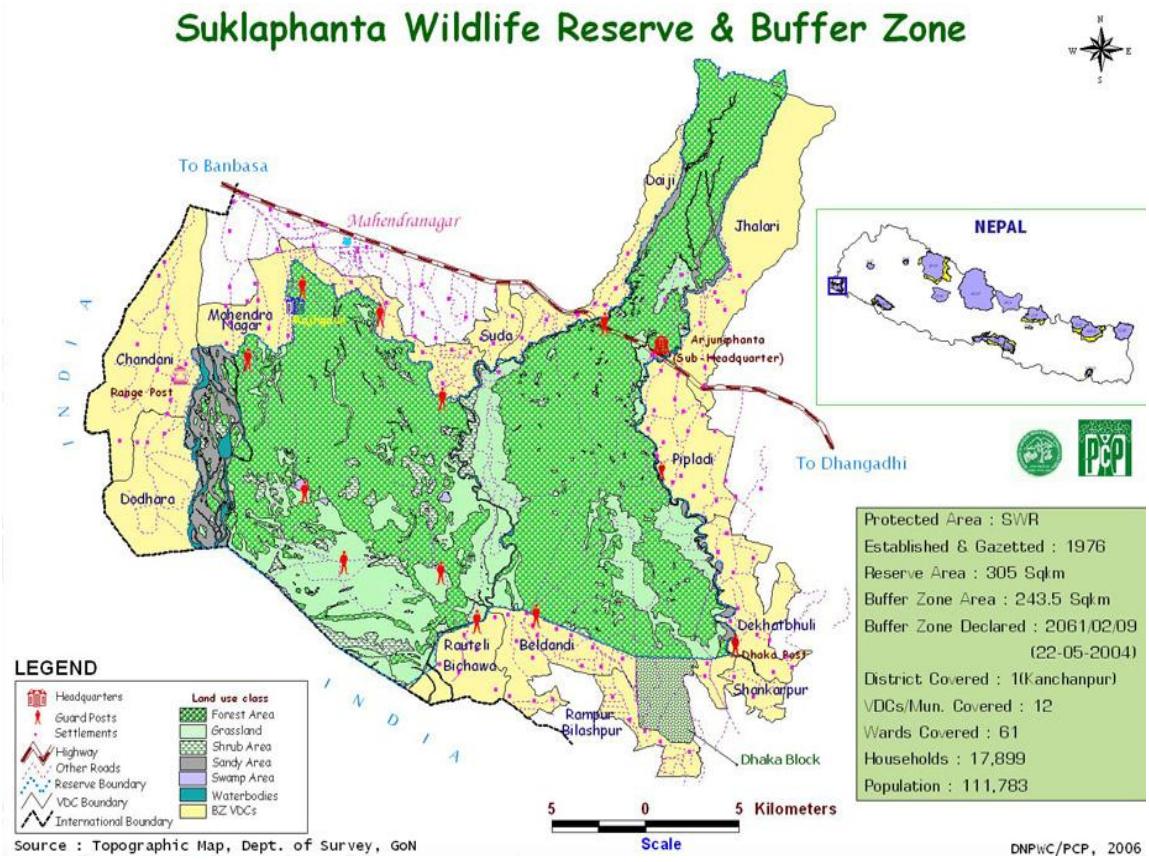
Aryal (2007) reported there were 41 Nilgai's counted in Lumbini development trust with population density of 8 individuals/km^2 and sex ratio of male to female was 2:3, published in his paper Blue Bull (*Boselaphus tragocamelus*) in Lumbini- a world heritage site of Nepal.

CHAPTER 3

STUDY AREA

3.1 Location

Suklaphanta Wildlife Reserve (28° 45'16" N - 28° 57' 23" N and 80° 06'04" E - 80° 21'40" E) is located in the Terai of Far-Western Region, Nepal and covers 305 km^2 of open grassland, forests, riverbeds and wetlands at an altitude of 174 to 1,386 meters. The Mahakali River forms the western boundary of the reserve and Nepal-India Border forms southern boundary. The reserve expands up to Syali River, in the east and to the crest of Churia hills in the north east corner (DNPWC 2000).



Map1: Map showing study area (SWR).

3.2 Climate

The area has a sub-tropical monsoonal climate with four distinct seasons: winter, spring, summer and monsoon. The months of December and January are fairly cold and misty with occasional frost. The mean monthly minimum temperature varies from 10 to 12^{o}C in winter, gradually rising to 17^{o}C in the spring and 26^{o}C in the summer. The maximum temperature varies from 22^{0}C to 36^{0}C reaching as high as 42^{0}C in the pre-monsoon period. The average rainfall ranges from 1300mm to 2300mm, 80% of which falls during monsoon. The relative humidity remains fairly high throughout the year except in the dry months of the pre-monsoon period (Yadav *et al*. 2000).

3.3 Flora

Vegetation of the reserve is subtropical type. The vegetation comprises mainly Sal forest, grassland, mixed forest, riverine forest and Khair-Sisoo forest (DNPWC 2005). The Khair-Sisso forests are present on the Mahakali floodplains and pure stands of Sisso on the banks and gravel bars of the Mahakali River. Mixed deciduous forest occupies about 20 km^2 of the lowland. Some 700 species of flora are estimated in the reserve (BPP 1995 cited in Bhuju *et al*. 2007), with records of 553 vascular plants, 18 pteridophytes, 410 dicots, and 125 monocots. The major tree species in this forest are Guthail (*Trewia nudiflora*), Jamun (*Syzygium cumini*), Simal (*Bombax ceiba*), Sindure (*Mallotus philippensis*). Dominant grass species in Suklaphanta are *Imperata cylindrica, Cynodon dactylon, Saccharum spontaneum, S. bengalensis, Narenga prophyrocoma*. The grassland in Suklaphanta covers 16.10% of the total Reserve area (DNPWC/PCP 2004).

3.4 Fauna

The reserve is reputed for its abundant and diverse wildlife resources consisting of the largest herd of swamp deer. In addition, it is a home to 46 species of mammals, 351 species of birds, 7 species of herpeto-fauna and 28 species of fish (Bhuju *et al*. 2007), including endangered mammal like 7 Rhinos (DNPWC 2011), 10 Royal Bengal tiger (DNPWC 2012), as many as 25-30 wild Elephants. Also Hispid hare, Nilgai, Spotted deer, Barking deer, Hog deer, Wild boar , Leopard, Jackal, Langur and Rhesus monkey, fish including Mahseer, Rohu and Tenger are found in this reserve. The reserve is also house for diverse population of reptiles like the Mugger crocodile, Cobra, Python, Krait,

the Indian pangolin and Golden lizard. Birds of SWR includes mainly Sarus crane, White-rumped vulture, Slender-billed vulture, Long-billed vulture, Swamp francolin, Grass owl, Warblers, Flycatchers, and the endangered *Bengal florican* (DNPWC 2009).

CHAPTER 4

MATERIALS AND METHODS

4.1 Methods of data collection

4.1.1 Primary data collection

4.1.1.1 Reconnaissance survey

A reconnaissance survey of the study area was carried out in last week of April 2011, to find out the likely Nilgai areas. This was done by discussing with park authorities such as warden, rangers, game scouts and elephant staffs, wildlife biologist and wildlife technician of National Trust for Nature Conservation (NTNC) and local people living adjacent to the reserve. The field was surveyed on foot and by motorbike. Based on the interaction with different people, a short-quick visit was also made to the reserve.

4.1.1.2 Detailed field survey

Intensive, field work was carried out from 15thMay to 15th June, 2011 when the reserve was very much open due to burning that occurs every year. The intensive grazing and browsing of Nilgai was observed early in morning and evening. Usually during day, they rested in the phanta as well as inside the wooded grassland, facing opposite direction with each other in somewhat round fashion.

i. Population estimation

Estimation of population status of Nilgai in potential areas was carried out by direct observation and count method. The population count was done in the morning (5-9AM), day (12-2PM) and evening (4-6PM) hours. Animals were searched by walking through the transect lines which were laid at a difference of 1 km through the potential habitat area of Nilgai identified from reconnaissance survey. An animal track following was effective method to find out the Nilgai's presence. Presence and absence of Nilgai's pellet also helped to point out the animal spots. Major waterholes in the study area were also mapped.

Hidings in bush, climbing on trees and observation from wildlife view towers (machans) were applied to avoid disturbance to the animals. In some potential areas,

Nilgai were not seen even in the regular monitoring. In such case following basis were encountered to know the habitat and to estimate the animal population.

- The areas with presence of pellet were keenly observed to analyze the habitat and distribution.
- Game scouts and wildlife technicians familiar to these areas were interviewed and mobilized in the field.

ii. Habitat use

During the present investigation all the habitat components including vegetation types were recorded wherever Nilgai or signs such as footprint, pellet were observed. In addition machan observation was used to observe the habitat use of Nilgai in the study area. Machans were used near Baba tal, Rani tal, Bagmara tal, Pipariya area from where Nilgai could be seen frequently during the hot season. Usually machan observation was effective at morning and evening while animals were active in grazing. Binoculars (7×35 powers) were used to observe animals from a distance. Grazing pattern and the plant species eaten by the animals were identified and unidentified plants were collected and later identified with the help of reserve staffs.

iii. Habitat mapping

Habitat mapping of animal was performed on the basis of presence of animal and signs. The Global Positioning System (GPS) locations of animal sightings, pellets and waterhole locations used by animal during study period and their respective vegetation type were recorded.

iv. Vegetation sampling

The floristic composition of Nilgai habitat in the reserve was described by crude vegetation analysis. Quadrates were laid where animal or pellets were observed in different habitats of the study area for vegetation analysis. Vegetation analysis was carried out in four main vegetation types - Grassland, Sal forest, Riverine forest and Mixed forest where animals or pellets were recorded. Quadrates of size 20m×20m were used for tree species, 10m×10m for shrubs and climbers and 1m×1m for grass.

4.1.2 Secondary data collection

Secondary data were collected from various published reports and unpublished documents, thesis, project documents, internet, journals, etc. to gather additional information.

4.2 Methods of data analysis

Various data obtained from field were analyzed by using different tools and techniques as described below.

4.2.1 Population estimation

4.2.1.1 Population status and distribution

Population status of SWR was studied on the basis of direct count of animal in potential areas of the reserve by various means; walking on foot in potential areas, using elephants and machan observations. The searching of footprints and distribution of fecal materials were also done to identify the grazing spot of the Nilgai.

Distribution of Nilgai was done by mapping geographic locations of observed groups or individuals with the help of GPS. GPS locations were later used to prepare distribution maps by using ArcGIS v9.3.

4.2.1.2 Group size

The group size was calculated by the method described by Martin (1977). Total numbers of Nilgai observed during study period were divided by a total number of groups observed.

4.2.1.3 Age and sex composition

Age and sex of the animal was determined by direct observation using following body characteristics as described by Lasiwa (1999).

Females have a short yellow-brown coat. Male coat gradually darkens to grey-blue and has white spots on the cheeks and white coloring on the edges of the lips. Females are hornless and noticeably smaller than male. Age groups among the young can be

distinguished by their body proportion, height and size. Age estimation of male was made on the basis of size of horn and color intensity of body coat.

1. Calves: Both young male and female are tawny in color. They remained always associated with their mothers.

2. Sub-adult: Individuals of 1 to 2 years are classified as sub-adults. The body size of sub-adults is remarkably longer than young or calves.

a) Sub-adult female: Sub-adult female reach above the central body line of the adult female.

b) Sub-adult male: They are larger than female sub-adults and body color starts to darken, they possess noticeable horns (longer than 4 inches).

3. Adults: Adults of both sexes are estimated to be over 2 years of age and are distinguished from sub-adult by their body size.

a) Adult female: Adult female could be distinguished from the sub-adult female as they have longer snout and back and larger head.

b) Adult male: Adult male could be distinguished easily from the male sub-adult as they have larger head with longer horns. The body size becomes massive and slightly taller than fully mature female. Their body color turns blacker but not as mature blue bulls. Adults male always live in group with mother and after being fully matured, it may become partially solitary or in completely isolation.

4.2.2 Habitat use

Habitat use of animal was determined on the basis of direct observation and Machan observation. Presence of animal or their signs in different vegetation types were calculated for habitat preference. Vegetations of different vegetation types of study area were analyzed by various methods of vegetation analysis as described in 4.2.4 Vegetation analysis.

4.2.3 Habitat mapping

All GPS locations of pellets and waterhole locations used by animal in the study area were used on land use map of SWR. A habitat map and waterhole location map of study area was prepared using ArcGIS v9.3.

4.2.4 Vegetation analysis

The vegetation of the study area was analyzed on the basis of qualitative and quantitative analysis. Data and information collected from vegetation sampling in different communities were computed in the following way:

4.2.4.1 Density and relative density

The density of each species was calculated as formula presented by Zobel *et al*. (1987).

$$\text{Density hectare}^{-1} = \frac{\text{No. of individuals of species} \times 10{,}000}{\text{Size of plot} \times \text{Total no. of plot sampled}}$$

Relative density is the density of one species as a percent of total plant density.

$$\text{Relative density (RD)} = \frac{\text{No. of individuals of species} \times 100}{\text{Total no. of individuals of all species}}$$

4.2.4.2 Frequency and relative frequency

Frequency and relative frequency for each species was calculated by using following formula:

$$\text{Frequency (F)} = \frac{\text{Total no. of plots in which the species occur} \times 100}{\text{Total number plots sampled}}$$

$$\text{Relative frequency (RF)} = \frac{\text{Frequency of an individual species} \times 100}{\text{Sum of all frequencies}}$$

4.2.4.3 Cover and relative cover

Cover is defined as the proportion of the ground occupied by perpendicular projection of the aerial parts of individuals of the species under consideration (Greigsith 1964).

The cover value was obtained by visual estimation and calculated by using the formula described by Daubenmire (1968).

$$\text{Cover \%} = \frac{\text{Approximate area covered by an individual species}}{\text{Total number of plots sampled}}$$

$$\text{Relative cover \%} = \frac{\text{Coverage of individual species} \times 100}{\text{Total cover of all species}}$$

For the estimation of coverage, mid-point value was calculated by the help of range mid -point conversion mentioned below.

Scale no.	Range of Coverage (%)	Mid- point of conversion
1	<5	2.5
2	5-25	15
3	25-50	37.5
4	50-75	62.5
5	75-95	85
6	>95	97.5

Zobel *et al*. (1987)

4.2.4.4 Importance Value Index (IVI)

Importance value index refers to the relative to the sum of the relative density, relative frequency and relative covers. Thus,

IVI= RD+RF+RC

Where,

IVI = Importance value index

RD = Relative density

RF = Relative frequency

RC= Relative density

4.2.4.5 Dominancy

Dominancy is one or more kinds of species in an ecological association that exerts a controlling influence on the environment and thereby largely determines what other kinds of species share in the association. Simpson (1943) has given the following formula to estimate the index of dominancy.

Dominancy (c) = $\sum (n_i/N)^2$

Where n_i = important value for each species (number of individual, biomass, production and so forth)

N= total of importance values.

4.2.4.6 Shannon's index of species diversity

Species diversity is a product of richness and evenness, it is species richness weighted by species evenness, and several indices have been proposed over the course of the last four decades (Peet 1974) to explain this relationship. Species diversity was calculated in different forest communities by the Shannon-Weiner index.

$$H' = -\sum_{i=0}^{S} Pi \log 10\ Pi$$

$H_{max} = \log k$

$J = H'/H_{max}$

Where, H′ is the index number, S is the total number of species, $\sum$ is a summation, P_i is the proportion of all individuals in the sample which belongs to species, i and log10 P_i is the log to the base 10 of that proportion. H_{max} is the maximum possible diversity, k is the number of the species at site, J is the relative diversity.

4.2.4.7 Community similarity index

The index of similarity was utilized to compare to coexisting groups.

$$I_s = \frac{2C \times 100}{S_1 + S_2}$$

Where I_s is coefficient of Sorenson's index of species similarity, C is the common species in both communities, S_1 is the number of species in the first community and S_2 is the number of species in second community.

CHAPTER 5

RESULT

5.1 Population status and distribution

A total of 17 Nilgai were recorded in the reserve during the field survey in summer. The population was observed in nine different locations: Paliya, Pipariya-Palashghari, Bankatti-Pipariya, Malumela, Babatal-Singhpur, Bannikheda, Beldadi, Lalpani and Arjuni. All these animals were recorded from Sal forest. The distance between sighting locations ranged between 5-10 km. All individuals were observed inhabiting along the reserve boundary with a maximum of distance of 100 m to less than 1 km from the agricultural fields. Maximum number (n=5) of animals were sighted in Malumela followed by Arjuni (n=3).

Table 2: Distribution of Nilgai observed in SWR

Location	No. of Nilgai
Paliya	1
Pipariya-Palashghari	1
Bankatti-Pipariya	1
Malumela	5
Babatal-Singhpur	1
Bannikheda	2
Beldadi	2
Lalpani	1
Arjuni	3
Total	**17**

5.2 Population trend in Suklaphanta

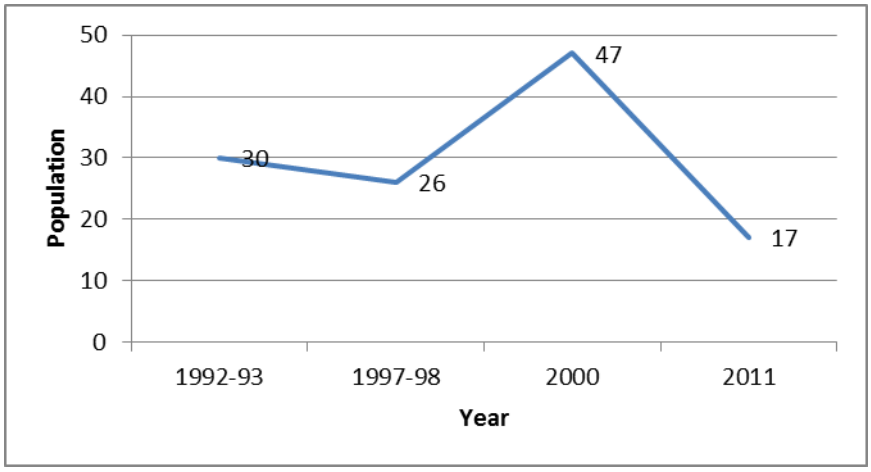
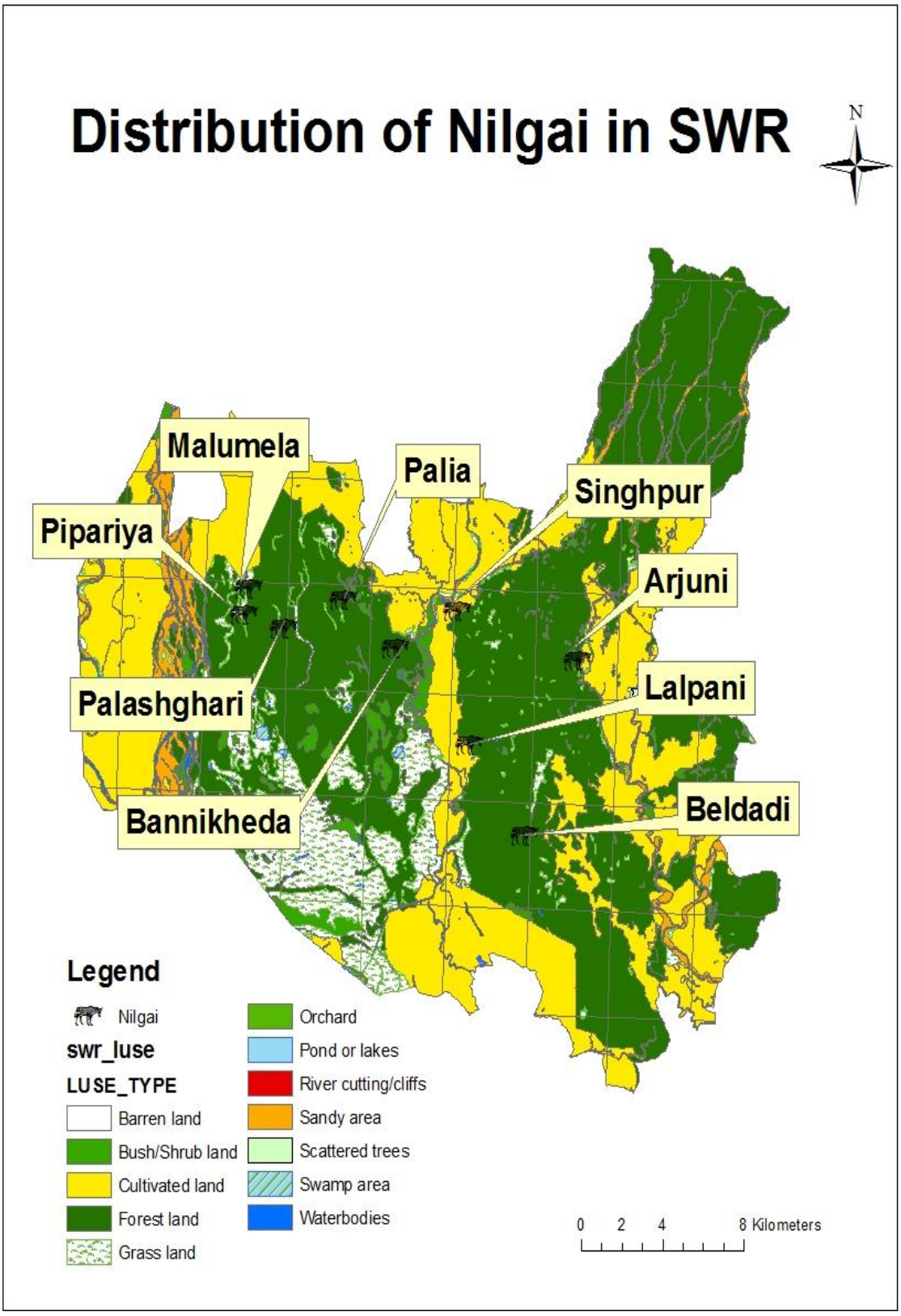


Fig 2: Population trend of Nilgai in SWR (1992-2011)

Figure 2 shows population trend of Nilgai population in SWR. The population trend shows high fluctuation. A total of 30 animals were reported in 1992/93, 26 in 1997/98 47 in 2000 and only 17 during the present study.



Map 2: Map showing distribution of Nilgai in SWR during study period

5.3 Group Size

Most of the adult males were found single while adult females and calves were found in group during the study period. During the study period Nilgai were observed in nine groups, group size ranging from single animal to 5 individuals. The average group size was estimated to be 1.89 animals per group. The largest group observed during the study period was a herd of 5 animals at Malumela.

5.4 Age and sex composition

The population of Nilgai comprises the highest number of adult males (29.41%) followed by adult female (23.53%) and calves (23.53%).The proportion of sub-adult male and female was 17.64% and 5.88%, respectively. The population of male is higher than female, the male and female sex ratio was found 100: 62.

Table 3: Age and sex composition of Nilgai in the study Area

S.N.	Nilgai cited Areas	Habitat	Male		Female		Calves	Total
			Adult	Sub-adult	Adult	Sub-adult		
1	Paliya	Sal forest	1	-	-	-	-	1
2	Pipariya-Palashghari	Sal forest	1	-	-	-	-	1
3	Bankatti-Pipariya	Sal forest	-	1	-	-	-	1
4	Malumela	Sal forest	-	-	2	1	2	5
5	Babatal-Singhpur	Sal forest	-	-	1	-	-	1
6	Bannikheda	Sal forest	2	-	-	-	-	2
7	Beldadi	Sal forest	-	2	-	-	-	2
8	Lalpani	Sal forest	-	-	1	-	-	1
9	Arjuni	Sal forest	1	-	-	-	2	3
Total			**5**	**3**	**4**	**1**	**4**	**17**
Percentage			**29.41%**	**17.64%**	**23.53%**	**5.9%**	**23.53%**	**100%**

5.5 Habitat use

In case of the present study all animals were observed in Sal forest. Also pellets (n=56) were recorded from three different vegetation types; 38 were from Sal forest, 13 from Riverine forest and 5 from Mixed forest indicating high preference for Sal forest (67.9 %) followed by Riverine forest (23.2%) and Mixed forest (8.9%).

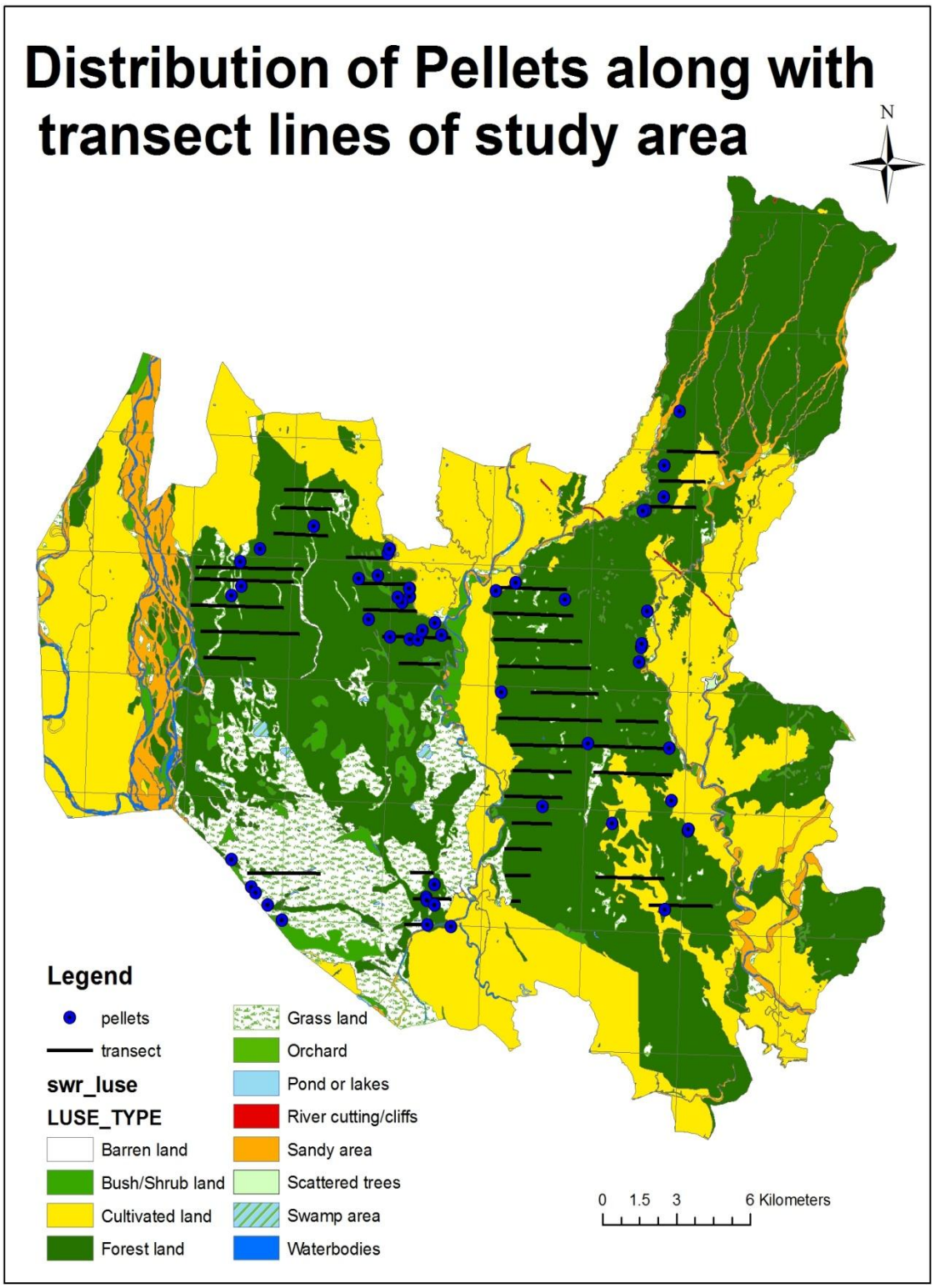
They were recorded feeding on the short grass dominated by *Imperata cylindrica* and *Cynodon dactylon*. The main vegetation of the study area was trees, shrubs, herbs/grass and climbers. Nilgai was seen feeding on following plant species during field study.

Table 4: Observed plant species used by Nilgai during study period.

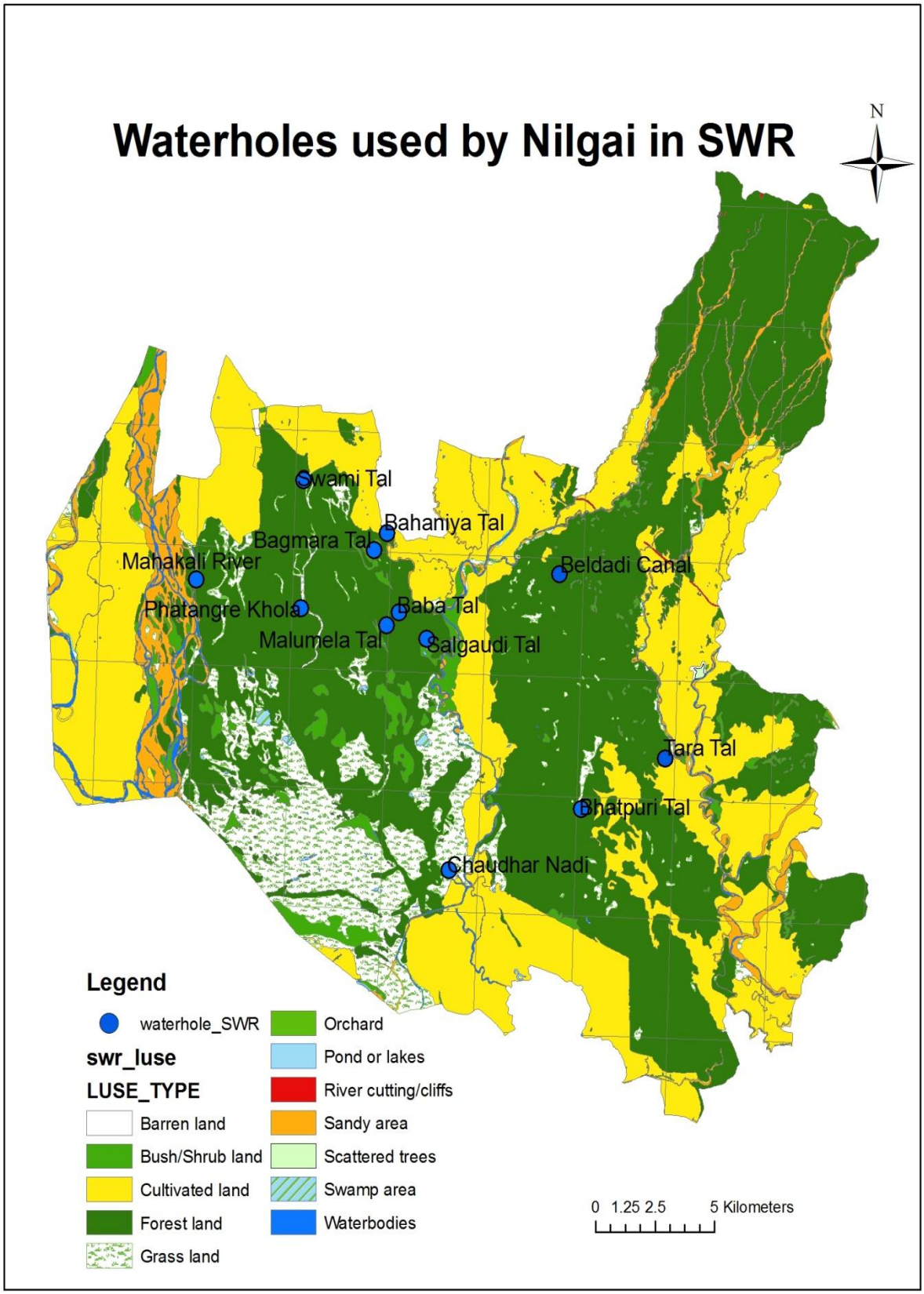
Tree	**Shrub**	**Ground vegetation (Grass/ Herb)**	**Climber**
Mallotus philippensis	*Artemesia vulgaris*	*Cynodon dactylon*	Dudhelahara (Local name)
Eugenia jambolana	*Cassia tora*	*Imperata cylindrica*	
Terminalia tomentosa	*Callicarpa macrophylla*	*Equisetum sps.*	
Buchanania latifolia		*Saccharum spontaneum*	
Terminalia alata		*Narenga porphyrocoma*	
		Hemarthria compressa	

5.6 Habitat mapping

Pellet deposition spots and waterhole locations used by Nilgai were recorded and mapped in the study area.



Map 3: Map showing transects lines and Pellet distribution of Nilgai in the study area.



Map 4: Map showing waterhole locations used by Nilgai in SWR during study period.

5.7 Vegetation analysis

Vegetation of SWR is sub-tropical type. In present study the vegetation of the Reserve was classified into four major types: (i) Sal forest (ii) Mixed forest (iii) Riverine forest (iv) Grassland. The analytical vegetation study was done in the selected potential areas for the Nilgai mainly in Sal forest, Riverine forest and Mixed forest. For this work total 62 plots were laid to study the floristic composition in different habitat types.

5.7.1 Sal forest

The tree layer was dominated by *Shorea robusta* in association with, other tree species such as Ber, Tedo (Local name), *Cleistocalyx operculatus* and *Holorina antidysentica*. Shrub layer was dominated by *Flemingia chappar*, *Grewia sapida* whereas the ground vegetation was dominated by grass species such as *Imperata cylindrica, Cynodon dactylon, Cyperus rotundus.*

Both Density (36.36 ind/ha) and IVI (104.27) was calculated highest for *Shorea robusta.* This was followed by Ber (local name) (11.93 ind/ha and IVI = 22.59). Lowest value of density (0.57 ind/ha) and IVI (2.55) was calculated for Kalikath, Buhari (Local name), *Buchanania latifolia* and *Bauhinia purpurea.* Similarly dominance ranged from 0.0000034 of *Bauhinia purpurea* to 0.0047 of *Shorea robusta* (Annex 2)

Sal forest showed less under growth due to dense and continuous canopy. In the areas where the canopy was open under growth was more common. IVI calculated for seedlings was found highest (192.45) for *Shorea robusta* seedlings followed by *Lagerstroemia parviflora* (IVI = 23.02) and the lowest IVI was calculated for *Symplocos pyrifolia* (IVI = 1.25).

The IVI of sapling of *Holorina antidysentica* was highest (75.79) and *Bauhinia purpurea* and some others had lowest (1.2). The IVI of pole size of *Holorina antidysentica* was highest (89.20) followed by *Terminalia alata* (40.1). IVI of shrub species ranged from 1.25 for *Lantana camara* to 69.06 for *Flemingia chappar*. Some climbers were also recorded in Sal forest in which *Spatholobus parviflorus* was recorded with highest density (46.15ind/ha). The ground vegetation in the Sal forest was dominated by *Imperata cylindrica* (IVI = 90.52) and *Cynodon dactylon* (IVI = 38.08).

5.7.2 Riverine forest

Riverine forest was observed along stream sides, river banks and other damp sites. Riverine forest was dominated by tree species like *Syzigium cumini, Mallotus philippensis, Acacia catechu, Dulbergia sissoo, Trewia nudiflora, Murraya koenigii* etc. Of these species, *Mallotus* is an evergreen plant species and dominates the canopy in the riverine forest. The ground vegetation in *Mallotus* dominated forest is comparatively poor due to thick canopy. However, ground with open canopy was covered with a variety of species including *Dryopteris sps*. The density of tree species ranged from 1.92 ind/ha (*Garuga pinnate, Bridelia restosa*) to 78.84 (*Murraya koenigii*) and IVI ranged from 2.67 (Rukha phosra-local name) to 66.72 (*Syzygium cumini). Murraya koenigii* showed higher dominancy (0.069) among other tree species.

Only seedling of *Syzygium cumini* was found in the studied plot during the field and density was found 36.53 ind/ha and IVI was calculated as 300. Density and IVI of *Syzygium saplings* calculated as 132.69ind/ha and 155.62 respectively followed by *Murraya koenigii* 128.84ind/ha and 133.86 respectively. The lowest (10.5) IVI was calculated for Buhari (local name). Saplings of *Syzygium cumini* showed higher (0.25) dominancy.

The IVI of shrub species in riverine forest ranged from 21.49 for *Colebroo keaoppositifolia* to 84.66 for *Cannabis sativa*. The total density of shrub layer was 1515.38 ind/ha. Two species of climbers *Spotholobus parviflora* (IVI=200) and Malulahara (local name) (IVI=100) were found. Total density of ground vegetation in riverine forest was estimated as 255384.6 ind/ha. Dominancy of *Imperata cylindrica* was found 0.08187873.

5.7.3 Mixed forest

Mixed forest showed a combination of grass and tree species. This type of forest was mainly observed in Malumela, Zonapur and Padau areas.

The tree layer of this forest was found dominated by *Symplocos pyrifolia* and *Termenalia alata*. Tree density ranged from 5 ind/ha (*Schleichera trijuga, Mallotus philippensis*) to 70 ind/ha (*Symplocos pyrifolia*). Highest IVI (48.05) and dominancy (0.096) was found for *Symplocos pyrifolia*.

The seedling density in Mixed forest ranged from 5 ind/ha (*Dillenia pentagyna, Semecarpus anacardium)* to 176 ind/ha (*Shorea robusta*) and IVI ranged from 22.7 (*Syzygium cumini, Dillenia pentagyna*) to 192.14 (*Shorea robusta*). The highest IVI of saplings in Mixed forest ranged from 8.49 (*Dillenia pentagyna, Semecarpus anacardium*) to 41 (*Symplocos pyrifolia*). The IVI of pole size tree species ranged from 24.05 (Tedo-local name) to 141.94 (Dudhikhiro-local name). The shrub layer's IVI ranged from 9 (*Grewia sapida, Calotropis gigantea*) to 128.82 (*Senna tora*). Total density was found 4080ind/ha. Total density of ground vegetation was found 330000 ind/ha, among them highest density and IVI was found 130000 ind/ha and 100.1 respectively for *Cynodon dactylon.*

5.7.4 Species diversity in different forest community

The diversity of different forest components (tree, shrubs, ground vegetation and climbers) varied in different forest types (Table 5). The Diversity Index was found highest in Riverine (0.92) and Mixed forests (0.83) and least in Sal forest (0.37). Diversity of shrubs was found highest in Sal forest (1.07).

Table 5: Species diversity in different forest communities.

S.N	Forest type	Vegetation type	Species Diversity
1.	Sal forest	Tree	0.37
		Seedling	0.22
		Sapling	0.90
		Pole size	0.53
		Shrubs	1.07
		Ground vegetation	0.80
		Climbers	0.55
2.	Riverine forest	Tree	0.91
		Seedling	-1
		Sapling	0.31
		Shrubs	0.69
		Ground vegetation	0.81
		Climbers	0.27
3.		Tree	0.82

	Mixed forest	Seedling	0.37
		Sapling	1.03
		Pole size	0.46
		Shrubs	0.57
		Ground vegetation	0.72

5.7.5 Similarity index

Inter-tree and shrub species composition relationship between Sal forest and Mixed forest was estimated as 58.82 and 40 respectively. Similarly, similarity of ground vegetation species of Sal forest and Riverine forest was highest (51).

Table 6: Similarity index between different forest communities.

S.N	Forest type	Vegetation type	Similarity index
1	Sal-Mixed forest	Tree	58.82
2	Sal-Mixed forest	Pole size	12.5
3	Sal-Mixed forest	Sapling	16.67
4	Sal-Mixed forest	Seedling	12.5
5	Sal-Mixed forest	Shrubs	40
6	Sal-Mixed forest	Ground vegetation	44.44
7	Sal-Riverine forest	Tree	21.62
8	Sal-Riverine forest	Sapling	15.38
9	Sal-Riverine forest	Seedling	7.40
10	Sal-Riverine forest	Shrubs	7.40
11	Sal-Riverine forest	Climbers	66.66
12	Sal-Riverine forest	Ground vegetation	51.61
13	Mixed-Riverine forest	Tree	22.22
14	Mixed-Riverine forest	Sapling	14.28
15	Mixed-Riverine forest	Shrubs	23.52
16	Mixed-Riverine forest	Ground vegetation	45.45

CHAPTER 6

DISCUSSION

6 .1 Population status and distribution

Nilgai, the largest Asian antelope once abundant in almost all Terai forests of Nepal are reported decreasing from many parts of the Terai forests including SWR. This is evident from a number of studies carried out in different period. However, Nilgai population is reported increasing outside of its natural range in Texas, because of well habitat management and low risk of predation, diseases and poaching (Lasiwa 1999). Presently Nilgai in Nepal are found in 14 different areas (Subedi 2001) including SWR. In SWR population was found increased from 20 in 1997 to 47 in 2000 (Table 1), but it was found drastically decreased to 17 individuals during the present study. The low numbers in the present study may probably due to high grazing pressure and changes in habitat quality. Role of predation seems low as the tiger number before 2000 was higher (>25 adults) than today (about 10 individuals). Besides, open vegetation types during the study period might have influenced the observation as animals detect observers much earlier than the observers and scape quickly. Declining trend in Nilgai populations has also been reported in other PAs and forest areas outside PAs by other studies (Naess and Anderson 1993; Kuikel 2003; WWF 2004).

Nilgai population in the present study was dominated by male. The proportion of male, female and calves in the study area was found 47.05%, 29.41% and 23.53% respectively. The proportion of male in SWR was higher than the BNP (Khatri 1993 and Lasiwa 1999). The sex ratio of male and female was 100: 62. Mean group size (herd size) of Nilgai in the study area during the study period was 1.89 animals per herd. The figure was lower than the south western section of BNP where mean group size was found 2.75 individuals per herd (Khatri 1995) and 2.5 individuals per herd (Lasiwa 1999). The largest herd size observed during the study period was of 5 individuals comprising of four female and one calve in Malumela area. A similar herd size 5 individual was found on Khauraha, BNP during 1997-98 (Lasiwa 1999) and it was 7 individual in same area during 1992-93 (Khatri 1993). Recently Nilgai was less frequent in SWR. Nilgai usually use the same habitat unless food and water is abundant and disturbance is limited within tolerance level (Lasiwa 1999). Although some studies reported significantly higher number of Nilgai from outside protected areas (Shrestha

2004, WII 2004), no records of its presence outside SWR was evident in the present study. This may probably due to extremely poor habitat condition and high poaching in the national forests outside PAs.

6.2 Habitat use

As reported by earlier studies, Nilgai in SWR were found mostly in the open Sal forest. Nilgai were not recorded in open grasslands during study period. Nilgai were found using 3 different types of habitat available in the study area. Of these, Sal forest with grass patches was utilized most than the other habitat types. The highest preference may be due to the availability of preferred food plants such as *Adina cardifolia, Terminalia alata, Mallotus philippensis, Bombax ceiba* and grasses like *Imperata cylindrica, Vetiveria zizanoids*. Also the preference to Riverine forest may be due to the availability of browse species like *Acacia catechu, Mallotus philippensis, Syzygium cumini* etc. Likewise Riverine forest provides shelter including shade and cover during the day light. Usually Nilgai were found near park boundary close to agricultural field. The preference of boundary habitat area may be due to availability of food, water and cover. Nilgai has high affinity to the crops species cultivated near the park boundary.

In SWR Nilgai were found grazing mainly in open Sal forest during the study period (May, June). The animals were observed feeding on the *Imperata cylindrica* and *Cynodon dactylon*. Also they were seen eating tender fruits and shoots of *Mallotus philippensis, Buchanania latifolia, Terminalia tomentosa, Artemesia vulgaris.* Similar observation was also made by Khatri (1999).

Nilgai ordinarily preferred wooded grasslands and cultivated land that were mostly used for feeding, loafing, resting, calling and nesting. The high preference in Sal forest may be due to the lower predation pressure and higher availability of food specially grass. The animal uses same place for depositing its pellet called latrine site. Mainly this animal searches for the open and clear place for deposition of pellet. Evidently all the pellets observed during the present study were found along the fire lines located inside the reserve.

6.3 Habitat mapping

Different maps regarding distribution of animal, their pellet and waterhole locations were prepared on the basis of presence of animals, distribution of pellets of animal and waterhole locations used by animals during study period. Nilgai were mostly sighted in Sal forest and their pellets were found in Riverine and Mixed forest. From the observations it was found that, animals were using different vegetation types for feeding and resting.

6.4 Vegetation analysis

SWR is comprised of Terai, Bhabar and Churiya, its vegetation can be broadly classified into forests and grassland. Several variations in species association may lead to formation of many forest types. Different researchers described vegetation of SWR into different types. Schaaf (1978) has described eight different vegetation types. Similarly Thapa (2003) has described the three major forest types: (i) Sal forest (ii) Riverine forest (iii) Khair-Sisso forest. In present study the vegetation was classified into four major types: (i) Sal forest (ii) Riverine forest (iii) Mixed forest and (iv) Grassland.

A total of 102 plant species including 43 species of tree, 30 species of shrubs, 25 species of ground vegetation (herbs, grass) and 4 species of climbers have been recorded from the studied plots in Nilgai habitats during the study period. The species diversity may have been represented low because the vegetation data described here were collected during the May and June, little after the burning of these vegetation types. This might have triggered low representation of ground vegetation. Reserve's forests and grasslands get burnt annually.

Highest tree density was recorded in the Riverine forest than in Mixed forest and Sal forest. Riverine forest was mainly dominated by *Murraya koenigii, Syzygium cumini, Trewia nudiflora, Mallotus philippensis* whereas Mixed forest was dominated by *Symplocos pyrifolia, Termenalia alata, Lagerstroemia parviflora,* Ber (local name) tree species. Similarly, Sal forest was dominated by *Shorea robusta, Cleichera operculatus* etc. Bhatta and Shrestha (1977), Schaaf (1978) Yadav *et al*. (2000) have made similar observations.

The density of shrub species was found highest in Mixed forest than Sal forest and Riverine forest. Among all forests the dominant species of shrubs were *Cannabis sativa, Pogostemon benghalensis, Senna tora, Flemingia chappar*, Banmothe (local name). Density of ground vegetation was found highest in Sal forest than Mixed forest and Riverine forest. The dominant species in these forests were *Imperata cylindrica*, *Cynodon dactylon, Eleusine indica, Desmostachya bipinnata* etc. Of these, *Imperata cylindrica* was most dominant. Only four species of climbers were recorded from the reserve but Bhatta and Shrestha (1977) recorded 12 different species of climbers from the reserve. The low diversity of shrubs, grass, herbs, and climber species in the different forest type could be the result of frequent burning and limited area of sampling.

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Nilgai, one of the largest antelope of Nepal is primarily a mixed feeder. Nilgai were basically observed in the grassland patches inside the Sal forest and in wooded grasslands. They usually come out off forest to graze in buffer zone forests. Habitat areas of Nilgai in SWR were situated close to the human settlement on Buffer zone and Nilgai being a mixed feeder it has high affinity with crop species.

SWR supports many plant and wild ungulate species including spotted deer, hog deer, swamp deer, barking deer, wild boar and Nilgai. But its population inside the park was at risk as no specific activities targeted to Nilgai conservation have been brought into action. The Nilgai population in SWR has been decreasing. Even the hotspot areas for the animal like Beldadi, Arjuni, Lalpani, Bannikheda and others shows very less number of the animals. Only 17 Nilgai were found in the study area during May and June. If the present rate of decline continues and specific programs will not brought into action, Nilgai's long term survival in SWR seems uncertain. Sharp fluctuation (decrease-increase-decrease) in numbers shows that the population of the animal is not stable. Local people have also a negative attitude towards this animal due to its crop raiding nature. Habitat degradation, poaching as well as tiger predation were among the probable causes that affects its population in Suklaphanta. Regular observation of Nilgai latrines in transects has been found most feasible method to study Nilgai, its habitat and long term monitoring because this method does not requires direct observation of animals. Permanent line transects have been strategically been laid down in the reserve and were frequently used for ungulate monitoring by the reserve authority. Herds of Nilgai were found in different habitats of the reserve with very small numbers. Present population may at high risk of local extinction if appropriate measures to protect remaining population and improve its habitat quality will not employed.

7.2 Recommendations

Based on the results and field observations following recommendations can be drawn.

- The overall situation of Nilgai in SWR is very critical and seems to be very fragile therefore serious protective measures should be employed.
- Census in regular intervals is necessary in order to monitor the change in its population.
- Nilgai were found grazing in the open grassy areas of Sal forest near the Buffer zone, such areas of reserve were also utilized by livestock making Nilgai vulnerable to livestock diseases. Appropriate measures should be adopted to reduce such risk.
- Public awareness programs should be initiated to disseminate conservation education among local villagers about the importance of the park and its wildlife resources, especially Nilgai.
- Community based anti-poaching initiatives should be launched to minimize the risk of poaching of wildlife including Nilgai.
- Scientific study need to be initiated at the earliest possible to understand the dynamics of the natural habitats and design appropriate measures to address habitat related issues.
- Since all Nilgai populations across their range have been reported declining, a Nilgai conservation strategy is in need to specifically ensure the long term survival of the largest Asian antelope.

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Annex 1: Enumeration of plant species at different forest types of SWR

Trees		
S.N.	**Common Name of Species**	**Scientific Name of Species**
1	Dabdabe	*Garuga pinnate*
2	Sindure	*Mallotus philippensis (Lam.) Maell. Arg.*
3	Jamun	*Syzygium cumuni (L.) skeels*
4	Amilo chuk	*Citrus aurantifolia christm.*
5	Asare	*Murraya koenigii*
6	Gutel	*Trewia nudiflora*
7	Buhari	
8	Dattarung (Pan ko bokra)	*Piper bettle (L.) (Piperaceae)*
9	Khair	*Acacia catechu (L.F.) wild.*
10	Gayo	*Bridelia restosa*
11	Dudi khirro	*Holorina antidysentica*
12	Ber	
13	Rukha phosra	
14	Simal	*Bombax ceiba L.*
15	Sisso	*Dalbergia sissoo*
16	Rajbriksha	*Cassia fistula*
17	Sal	*Shoria robusta Gaertn*
18	Pariri	*Stereospermum personatum (Hassk.) Chatterjee*
19	Kumbhi	*Carea arborea*
20	Kusum	*Schleichera trijuga*
21	Kalikath	*Symplocos pyrifolia*
22	Mainikada	*Toddalia asiatica (L.) Lam.*

23	Tedo	
24	Asna	*Termenalia tomentosa*
25	Bot Dhairo	*Lagerstroemia parviflora*
26	Kyamun	*Cleistocalyx operculatus*
27	Tanki	*Bauhinia purpurea*
28	Titmauri	
29	Tatari	*Dillenia pentagyna*
30	Piyari	*Buchanania latifolia*
31	Bhalayo	*Semecarpus anacardium*
32	Bar	*Ficus benghalensis*
33	Palas	*Butea monosperma (Lam.) Kuntze*
34	Kutmero	
35	Khoksa	
36	Bel	*Aegle marmelos*
37	Phaledo	*Erythrina strica Roxb.*
38	Bhukur	
39	Asare	*Murraya koenigii*
40	Pidar	
41	Siris	*Albezzia lebbeck*
42	Amba	Psidum gujuva

Shrubs		
S.N.	**Common Name of Species**	**Scientific Name of Species**
1	Ganja	*Cannabis sativa*
2	Dani kamila	*Callicarpa macrophylla*
3	Bhati	*Flemingia chappar*
4	Rudilo	*Pogostemon benghalensis (Burm.F.) Kuntze*
5	Dhursilo	*Colebroo Keaoppositifolia*
6	Bayer	*Ziziphus mauritiana*
7	Besarum	*Ipomea camea*
8	Bhanti	
9	Bansakti	
10	Phasra	*Grewia sapida*
11	Phasraphul	
12	Badampate	
13	Rudilo	Nyctanthes arbortristis
14	Tapre	*Cassia tora*
15	Balupate	
16	Aank	*Calotropis gigantea (Procera)*
17	Dhursilo	
18	Ban moshro	
19	Kurilo	*Asparagus racemosus*
20	Banmothe	
21	Phorsaphul	
22	Dopher	
23	Khajur	

24	Galpuwa	
25	Dadri	*Vernonea cinerea*
26	Simthi	
27	Bhuepharsa	
28	Galeni	
29	Khirro	*Sapium insigne*
30	Banmara	*Lantana camara*

Climbers		
S.N.	**Common Name of Species**	**Scientific Name of Species**
1	Debrelahara	*Spatholobus parviflorus*
2	Malulahara	*Bauhinia vahii*
3	Mayurkhutte	
4	Panilahara	

Ground Vegetation		
S.N.	**Common Name of Species**	**Scientific Name of Species**
1	Chari amilo	*Oxalis corniculata L.*
2	Dubo	*Cynodon dactylon L.Pers*
3	Tulsipate	
4	Mothe	*Cyperus rotundus*
5	Bhiringaraj	*Eclipta prostrata (L.)L.*
6	Gandhe Jhar	*Ageratum conyzoid*
7	Niouro	*Daryopteris cochleata*
8	Kush	*Desmostochya bipinnata(L.) stapf.*
9	Uneu	*Marcicea crennata*

10	Bansilam	*Scrophuslarifolia sp.*
11	Siru	*Imperata cylindrica*
12	Kans	*Saccharum spontanum L.*
13	Kantkari	*Solanum surattense Burm.f.*
14	Boksighans	
15	Ghod tapre	*Centella asiatica*
16	Kodo ghans	*Eleusine indica (L.) Gaertner*
17	Golo Kuro	*Triumfetta sp.*
18	Ghod dubo	
19	Gandhe Kans(Sano kans)	
20	Priya jhar	
21	Kure	
22	Goto chirchiro	
23	Dattiona	*Achyranthus aspera*
24	Balupate	
25	Banpayal	