

STATUS, DISPERSAL AND HABITAT USE OF GREATER ONE-HORNED RHINOCEROS (*Rhinoceros unicornis*) IN ROYAL SUKLAPHATA WILDLIFE RESERVE

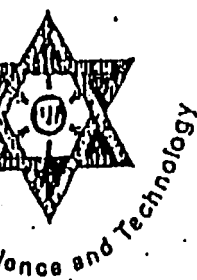
**A Dissertation Submitted to the Institute of Science and Technology,
Tribhuvan University in Partial Fulfillment of the Requirement
for the Master's Degree in Zoology (Ecology)**

**By
Prakash Adhikari**



**Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu
2003**



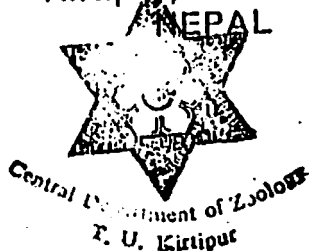


TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu

NEPAL



RECOMMENDATION

This is to certify that Mr. Prakash Adhikari has successfully completed the dissertation work entitled "Status, dispersal and habitat use of greater one-horned Rhinoceros (*Rhinoceros unicornis*) in the Royal Suklaphanta Wildlife Reserve, Nepal", under our supervision. This is candidate's original work and has not been submitted for any other degree to the best of our knowledge. Hence, we recommend this dissertation to be accepted for partial fulfillment of requirement for the degree of Master's of Science in Zoology (Ecology).

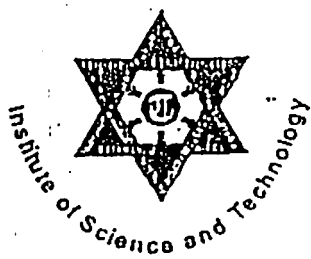
Mr. Tej Bahadur Thapa,
Supervisor,
Lecturer,
Central Department of Zoology
Tribhuvan University, Kirtipur

Dr. Shant Raj Jnawali
Supervisor,
Project Director
KMTNC-BCP
Bardia

Date: Dec. 30, 2003

Date: 23rd Dec 2003





TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu
NEPAL

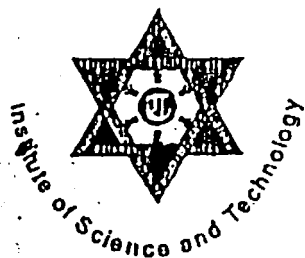


APPROVAL

On the recommendation of supervisors, the dissertation work entitled "Status, dispersal and habitat use of greater one-horned Rhinoceros (*Rhinoceros unicornis*) in the Royal Suklaphanta Wildlife Reserve, Nepal" submitted by Mr. Prakash Adhikari as a partial fulfillment of Master's of Science in Zoology (Ecology) has been approved for examination.

Prof. Dr. Tej Kumar Shrestha
Head,
Central Department of Zoology.
Tribhuvan University,
Kirtipur, Kathmandu

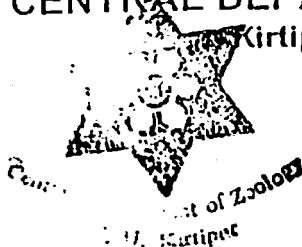
Date. March 11, 2004



TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF ZOOLOGY

Kirtipur, Kathmandu
NEPAL



ACCEPTANCE

The dissertation work entitled "Status, dispersal and habitat use of greater one-horned Rhinoceros (*Rhinoceros unicornis*) in the Royal Suklaphanta Wildlife Reserve, Nepal" has been accepted as the partial fulfillment of the requirement for Master's Degree of Science in Zoology with "Ecology" as a special paper.

EXPERT COMMITTEE

Mr. Tej Bahadur Thapa
Supervisor,
Lecturer,
Central Department of Zoology,
Tribhuvan University, Kirtipur

Prof. Dr. Tej Kumar Shrestha
Head,
Central Department of Zoology,
T.U., Kirtipur, Kathmandu

Dr. Shanta Raj Jnawali
Supervisor
Project Director,
KMTNC-BCP,
Bardia

External Examiner

Date: March 11, 2004

ACKNOWLEDGMENT

I would like to take an opportunity to acknowledge my heartfelt gratitude and sincere thanks to my supervisor Mr. Tej Bahadur Thapa, Lecturer, Central Department of Zoology, Tribhuvan University for his intellectual guidance, kind cooperation and moral support without which this study would not be successful one.

I would like to thank Prof. Dr. Tej Kumar Shrestha, Head, Central Department of Zoology, Tribhuvan University, Kirtipur, for his official support.

I am highly grateful to Dr. Shant Raj Jnawali, Director, KMTNC- BCP for his continuous support, involvement and supervision, since the initial stage of this study. I will always remain indebted to BCP for providing me financial support for this study. My thanks are due to Mrs. Sarita Jnawali, Naresh Subedi, Chiranjivi Prasad Pokhrel and Shriram Ghimire, KMTNC- BCP for their interest and expedient suggestion.

I owe a great debt of gratitude to Department of National Park and Wildlife Conservation for providing permission to pursue this study in the RSWR. I would like to extend my sincere thanks to Mr. Tika Ram Adhikari, Chief Warden, RSWR for kind help and support.

I would like to express my special thanks to Mr. Ram Thapa, a student of IOF Pokhara for providing digitized Landover map and valuable help in this research period. I am thankful to Mr. Karan Bahadur Bom for his help and company throughout the fieldwork. The time I shared with Binti Ram Tharu, member of Hattisar Camp and Nabin Gyawali, which melted my stressful moments during the stay in the field.

My colleagues especially Anand Chaudhari, Krishna Kumar Sharma, Lachuman Bhattarai, Barun Panthi, Deepak Karki, Bikash Karki, Narbir Nembang Arun Shrestha, Surendra Maharjan, and Susan Shrestha deserve my special thanks for their help at various stages of post fieldwork activities.

Last but not the least, I extended my highest recognition and deepest respect to my parents who give me education and being a constant source of inspiration.

Prakash Adhikari

Roll no:1061.

Reg no: 5-3-28-122-2000.

057-58

Abstract

The research work was carried out with the aim to assess the performance and success of translocated rhinoceros population in Royal Suklaphanta Wildlife Reserve.

Population of rhinoceros was determined by the direct count method. The Global Positioning System (GPS) coordinates were marked on the topographic map to assess the dispersal of rhinos in the Reserve. Home range were drawn as convex polygon using the "Modified minimum area method". To know the habitat use by rhinoceros, habitat along with vegetation type of the area wherever the animals and signs such as fresh wallows, footprint, dung and feeding signs were recorded.

A total of six rhinoceros, two adult males (33.3%), three adult females (50%) and one calf (16.7%), were recorded with a population density of 2.8 rhinos per 100 Sq. Km. Study analyzed a total of about 151 locations of four translocated rhinos, they were concentrated around Ranital, Haraiyaphanta, Silalake area and Barkola area. After translocation maximum movements was made by Sukibhar pothi which was about 30 km. and minimum by Chitwan bhale which was 4 km. The approximate average home range size of females and male of the translocated population in Suklaphanta was 33.66 Sq. Km. and 43 Sq. Km. respectively. Following the initial dispersal period, all animals seemed to have settled in more clearly defined ranges, around the release site although extensive movements still occur.

Rhino showed a marked preference towards Tall grassland (Frequency of utilization 42.48%), Riverine forest (Frequency of utilization 20.26%), and Wooded grassland (Frequency of utilization 5.28%) but the Sal forest was significantly avoided. Marsh and Khair-sissoo forest were used according to availability whereas Short grassland were used in less proportion. The present study concluded that the future conservation effort must be directed to improve the quality of habitat which must be large enough to fulfill the requirements of a viable and self sustaining population of rhinoceros in natural condition.

TABLE OF CONTENTS

Recommendation	i
Approval	ii
Acceptance	iii
Acknowledgement	iv
Abstract	v
Contents	vi-vii
List of Tables	viii
List of Figures	ix
 CHAPTER I	 1-7
✓ INTRODUCTION	1
1.1 Background	1
1.2 Distribution	2
1.2.1 Worldwide Distribution ✓	2
1.2.2 Rhinoceros in Nepal ✓	3
1.3 Rhino Translocation ✓	4
1.4 Statement of Problem ✓	6
1.5 Rationale ✓	7
 CHAPTER II	 8-11
STUDY AREA	8
2.1 Locations and Boundary	8
2.2 History	8
2.3 Climate	9
2.4 Geology and Soil	10
2.5 Biological Features	10
2.5.1 Vegetation	10
2.5.2 Fauna	11
 CHAPTER III	 12
OBJECTIVE	12
3.1 Objectives	12
 CHAPTER IV	 13-16
METHODOLOGY	13
4.1 Reconnaissance Survey	13
4.2 Field Survey	13

4.2.1 Population Census	13
4.2.1.1 Age and Sex Composition	14
4.3 Dispersal	14
4.4 Home range	15
4.5 Habitat	15
4.5.1 Habitat Characterization and Classification	15
4.5.2 Habitat Use	15
4.6 Conservation Measures	16
CHAPTER V	17-32
RESULT	17
5.1 Status of Rhinoceros ✓	17
5.2 Dispersal ✓	18
5.3 Home range ✓	20
5.4 Habitat Utilization Pattern ✓	20
5.4.1 Habitat Classification	20
5.4.1.1 Sal Forest	21
5.4.1.2 Riverine Forest	22
5.4.1.3 Khair-Sissoo Forest	23
5.4.1.4 Tall Grassland	23
5.4.1.5 Short Grassland	23
5.4.1.6 Wooded Grassland	24
5.4.1.7 Marsh	24
5.4.2 Use of Habitat Components	24
5.4.2.1 Chitwan Bhale	25
5.4.2.2 Sukibhar Pothi	26
5.4.2.3 Mau Pothi with Calf	28
5.4.2.4 Sukla Pothi	30
5.4.2.5 Sukla Bhale	31
5.5 Habitat Preference ✓	31
5.6 Conservation Measures for Rhino in RSWR ✓	32
CHAPTER VI	33-37
DISCUSSION	33
CHAPTER VII	38-40
CONCLUSION AND RECOMMENDATION	38
REFERENCES	41-44
PLATES	45-46
APPENDICES	47-53

LIST OF TABLE

	Page
Table 1: Translocation of Rhinoceros from Royal Chitwan National Park, Nepal.	6
Table 2: Population size and composition of Rhinoceros in RSWR 2003.	17
Table:3 Land cover classification of the study area.	20
Table:4 Observed frequency of habitat use by Rhino in RSWR, Nepal, 2000-2003.	24
Table: 5 Habitat used by Chitwan Bhale in RSWR 2003.	25
Table:6 Habitat used by Sukibhar pothi in RSWR 2003	27
Table:7 Habitat used by Mau pothi with calf in RSWR 2003.	29
Table:8 Habitat used by Sukla pothi in RSWR, 2003.	30
Table:9 Availability and utilization habitat types in the RSWR, Nepal, 2000-2003.	32

LIST OF FIGURE

Fig: 1:	Map showing the study area.	9
Fig:2:	Age composition of Rhinoceros in RSWR.	17
Fig: 3:	Sex composition of Rhinoceros in RSWR	18
Fig:4:	Land cover map of the study area.	21
Fig:5:	Distribution of locations of Chitwan Bhale in RSWR.	26
Fig:6:	Distribution of locations of Sukibhar pothi in	28
Fig:7:	Distribution of locations of mau pothi with calf.	29
Fig:8:	Distribution of locations of Sukla pothi in RSWR.	31
Fig:9:	Availability (%) and frequency of utilization of habitat in RSWR.	32

CHAPTER ONE

INTRODUCTION

1.1 Background

The greater one horned rhinoceros (*Rhinoceros unicornis* Linnaeus, henceforth called as rhinoceros) is listed as one of the world's most endangered species of mega-herbivores (IUCN, 1990). Rhinoceros (Perissodactyla- odd-toed ungulates, Rhinocerotidae) is a keystone species and has charismatic appeal, making it a flagship species. Rhinoceros has also been included in appendix 1 of the Convention on International Trade in Endangered Species of wild fauna and flora (CITES) and banned all the international trade of rhinos and their products (Chapagai et al., 2002).

The greater one horned rhinoceros requires special habitat conditions including wallows, grasslands/woodlands and forest cover. It is mainly adapted to flood plains and riverine vegetation where water and some green growth remains available all year round (Jnawali, 1995). A mosaic of various forest and tall grassland communities on the alluvial floodplain are the critical habitats for this species (Dinerstein and Price 1991). Other preferred habitat includes marshy lowland Sal forest, wooded grassland, and river and riverbeds. This ecological flexibility may be due to seasonal preferences and to some extent pressure front development, which forces the rhino into sub-optimal habitat (Jnawali, 1995).

Activity takes place mostly at night, early in the morning, and in the late afternoon (Laurie, 1978) but in the middle of the day, animals are commonly seen resting in the shade or mud; and wallowing and bathing in oxbow lakes, rivers and pools. This behavior is especially frequent during hot seasons and seems to be important for thermoregulation and to escape from flies (Laurie, 1978).

The rhinoceros feeds mainly on grasses; and also fruits, leaves, branches of trees and shrubs; and cultivated crops (Jnawali, 1989). When feeding on tall grasses rhinoceros curls its prehensile upper lip around the grass stems, bends the stems over and bites off, and chews the top (Laurie, 1978). Drinking takes place on a daily basis. Drinking normally lasted only a minute or two and mineral licks are visited regularly (Laurie, 1978).

✓ 1.2 Distribution

1.2.1 Worldwide Distribution

Today only five species of rhinoceros are living in wild. Of them white (*Ceratotherium cimum*) and black (*Diceros bicornis*) rhinoceros are confined in African continent mainly in South Africa and West Africa. Other three species namely: Javan (*Rhinoceros sondaicus*), Sumatran (*Diceroshinus sumatrensis*) and greater one-horned rhinoceros (*Rhinoceros unicornis*) are found only in the south and south East Asia. All five species of rhinoceros are true herbivores. The white and black rhinoceros adapted to semi arid climate where water and green grasses are available all year round. Once abundant in Asia and Africa these rhinoceros are now struggling for survival due to rampant poaching and habitat loss (Dhakal, 2002).

Among Asian rhinoceros, the greater One-horned rhinoceros (*Rhinoceros unicornis*) were once common throughout the Indus, Bramahaputra and Gangetic floodplains and nearby foothills of south Asia (Laurie, 1978) between indo-Burmese border in the east and in Sindhu basin, Pakistan in the west. Due to illegal hunting and habitat clearance, rhinoceros are now restricted to small isolated population in protected areas of the Indian sub-continent, mainly in Nepal and India

(Khan and Foose, 1994), and existence of few rhinoceros is also reported from the Manas National Park, Bhutan (IUCN, 2002).

Estimated population of the greater one-horned rhinoceros is around 2100 in India (Dhakal, 2002) and 612 in Nepal (Rhino count, 2000). In India rhinoceros are surviving in protected areas namely Manas, Dudhwa, Kartarniaghat, Kaziranga, Orang, Pabitora, Jaldapara and Garomara (Foose and Strien, 1997). The Kaziranga National Park supports a largest population in India. However, the current annual rate of increase is low and the population seems close to the carrying capacity at about 1200 individuals (Bhattacharya, 1993; Vigne and Martin, 1994). The rhinoceros population in Kaziranga national park, India, is estimated at about 1600 individuals (Dhakal, 2002).

1.2.2 Rhinoceros in Nepal

In Nepal, Chitwan valley, harbored about 1000 rhinoceros until 1950 (Gurung, 1989). Indiscriminate poaching and destruction of prime habitats between mid 1950s and 1960s drastically reduced this population to about 100 animals (Caughley, 1969; Pelinck and Uprety, 1972). However with the establishment of National Park in 1973 and adequate protection measures implemented by the Government the rhino population in Royal Chitwan National Park (RCNP) was increased to about 400 individuals (Dinerstein and Price 1991; Khan and Foose, 1994), 466 in 1994 (Yonzon, 1994) and 544 in 2000 (DNPWC, 2000).

According to a count in 2000, altogether 612 rhinos were surviving in the three protected areas of the country. Among 544 individuals in Chitwan, 332 adults, 87 sub-adults and 117 calves were identified and 8 found unknown. Likewise in Royal Bardia National Park (RBNP), a total of 67 rhinos were counted with 38 adults, 20 sub-adults and 9 calves. It was found that the number of rhinos in Royal Chitwan National Park has

increased by 104 since 1994 with an annual growth rate of 3.88% (DNPWC, 2000). There was one male rhino in Royal Suklaphanta Wildlife Reserve (RSWR) until early 2000 this animal was, believed to have migrated from near by Dhudhwa National Park, India.

1.3 Rhino Translocation

Translocation is ^{the}deliberated and mediated movement of wildlife population from one part of their range to another, executed by man through scientific methods. This is a multidisciplinary approach where the ecologists, biologists, veterinaries and conservationists play different significant roles. Success of translocation depends on several factors and is the outcomes of feasibility study and research, choice of release site, evaluation of reintroduction site, availability of suitable stock and so on.

Although the Royal Chitwan National Park has good habitat condition, which supports a large number of rhinoceros, but additional habitats are necessary to ensure the long-term conservation of another viable population of rhinoceros in Nepal. The rhino population in RCNP was very close to the carrying capacity of the habitat (DNPWC, 1993). In 1989, the Asian Rhino Action Plan recommended (Dhakal, 2002) for translocation of rhino to wildlife sanctuaries wherever possible, to maintain sub-population containing a minimum of 100 individuals.

In mideighties a number of animals were reintroduced from Chitwan to other National Parks in India (Sale, 1986; Sale and Singh, 1987; Sinha and Sawarker, 1993) and Nepal (Anstey, 1987; Bauer, 1988; Wegge et al., 1990; Jnawali and Wegge, 1991), mainly to establish new viable breeding population, to protect this species from extinction due to poaching, natural calamities and disease (Mishra and Dinerstein, 1987).

Another purpose of rhino translocation from Chitwan was to minimize the conflicts with the local villagers residing adjacent to the park border (Jnawali and Wegge, 1993), since in Chitwan they caused heavy damage to agricultural crops and human casualties (Mishra, 1982; Jnawali, 1989; Sharma, 1991; Nepal and Weber, 1993).

In 1984-1985, first experimental translocation of greater One-horned rhinoceros from Kaziranga National Park in Assam, India and from Royal Chitwan National Park, Nepal to Dudhwa National Park, India was carried out (Sanzgiri, 2003). Two males and a female from Kaziranga National Park and four females from Royal Chitwan National Park were successfully introduced to Dudhwa (Sanzgiri, 2003).

In 1986, 13 individuals were translocated from RCNP to RBNP in the western Terai (Mishra and Dinerstein, 1987). In the successive course of translocations 25, 4, 10, 6, 5, 10 and 10 rhinos have been successfully translocated from Chitwan to Bardia in 1991, 1999 and 2000 (1), 2000 (2), 2002 and 2003 respectively with the hope that RBNP, which is dominated by Sal forests with a mixture of grasslands and riverine forest, could be developed as potential home to second viable population of rhinoceros in Nepal (Table 1). The present survival condition of the rhinos in Bardia is satisfactory till today. The rhino translocation from Chitwan to Bardia has been considered successful so far as the rhino count 2000 conducted in Bardia estimated the population to be 67 as translocated rhinos were around 50 and rest of others were added from reproduction in the new habitat Bardia. This suggests that translocated rhinos have well adapted to the new home and have been successfully reproducing. Four rhinos have also been translocated from Chitwan to Royal Suklaphanta Wildlife Reserve in 2000 and one of the translocated female has already given birth to a baby, a positive sign of success in that area (Table 1).

Table 1. Translocation of Rhinoceros from Royal Chitwan National Park, Nepal

S.N.	Year	Sex		Origin Location	Release Site	Destination	Total
		Male	Female				
1.	1984		4	RCNP	Dudhwa	DNPI	4
2.	1986	8	5	IT, KT, KU, BG	Thakurdwara	RBNP	13
3.	1991	8	17	IT, KH, BG	BABAI	RBNP	25
4.	1999	4	-	SL, KA	BABAI	RBNP	4
5.	1999	5	5	IT, KT, KU	BABAI	RBNP	10
6.	2000	3	3	SB	BABAI	RBNP	6
7.	2000	1	3	SB	SHUKLA	RSWR	4
8.	2001	2	3	SB	BABAI	RBNP	5
9.	2002	5	5	IT, SB, KA	BABAI	RBNP	10
10.	2003	4	6	-	BABAI	RBNP	10
					Total		91

Source: DNPWC (2000)

BG= Baghmar

IT = Icharni Island

KA= Kasara

KH = Khagendramali

KT = Kathar

KU = Kumroj

SB = Sukhibhar

SL = Sarlahi

RBNP = Royal Bardia National Park

RSWR = Royal Suklaphanta Wildlife Reserve

DNPI = Dhuduwa National Park, India

1.4 Statement of the Problem


The population of rhinoceros in Nepal faces problem in two major fronts: poaching and habitat loss. Poaching takes place due to high value of its horn and other body parts (hoaf) in the world markets (Sharma, 1991) and always remained as serious problems in rhino conservation in Nepal and else where. The poaching was increased after 1980 because of increasing demand of rhino products in traditional Chinese Medicine (Martin, 1985). More than 100 known poaching cases were reported in Nepal from 1973 to 2000 (Dhakal, 2002). Another threat to rhinoceros conservation is habitat loss due to the expansion of agricultural land and continued over grazing by domestic livestock (Caughley, 1969; Pelinck and Upreti, 1972). Most of the former range has been cleared and rhinoceros are now restricted to protected areas.

At present, the rhino habitats have greatly regenerated as a result of meticulous management and the conservation of wildlife program operating over the last 30 years. Current rhino conservation efforts of the Government mainly focused on the protection and improvement of habitat, poaching control and translocation.

To establish new viable breeding population and to safeguard this species against natural calamities, disease and poaching; and also to minimize the conflicts with the local people many rhinos were translocated from Chitwan to RBNP and RSWR. In this process four rhinos have been translocated from Chitwan to RSWR in 2000.

1.5 Rationale

Although there have been many studies on rhinoceros in Nepal, detailed information on the status and ecology of rhino population in RSWR is not yet well understood. The present work was carried out to assess the status, distribution, dispersal pattern and habitat use. It is hoped that the result of this study will be useful to prepare guidelines for management of rhinoceros in RSWR.



CHAPTER TWO

STUDY AREA

2.1 Locations and Boundary

Present study was conducted in the Royal Suklaphanta Wildlife Reserve (RSWR). The reserve lies in the extreme southwestern part of the Terai in Kanchanpur district of Mahakali zone located between $28^{\circ} 45' 16''$ and $28^{\circ} 57' 23''$ N latitude and $80^{\circ} 06' 04''$ and $80^{\circ} 21' 40''$ E longitude. It occupies an area of 305 km^2 and the elevation of the reserve ranges from 90 m, to 270 m asl. The study area lies mainly on the southwestern part of the reserve (Figure 1).

2.2 History

The Royal Suklaphanta Wildlife Reserve was declared as Royal Hunting Reserve in 1969. Since, then the whole area remained as a famous hunting ground for many years. Following eradication and control program of malaria large numbers 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 forest degradation and habitat destruction, the Royal Hunting Reserve was gazetted as Royal Suklaphanta Wildlife Reserve in 1976. Protection of this reserve was initiated through establishing army posts in strategic locations and in early 1981 one battalion of army has been deployed to protect area strictly. Recently the government has deployed another battalion to strengthen the protection of the reserve. The newly deployed battalion is stationed near Arjune Phanta.

Initial area of 155 km^2 , was extended to 305 km^2 in 1994 to include more forest and arable land in northeastern side. Many illegal settlements:

Singhpur, Jhala, Haraiyaphanta, Barkola, Mangalsera and Jhilmila were inside the reserve evacuated and resettled outside during early 1993.

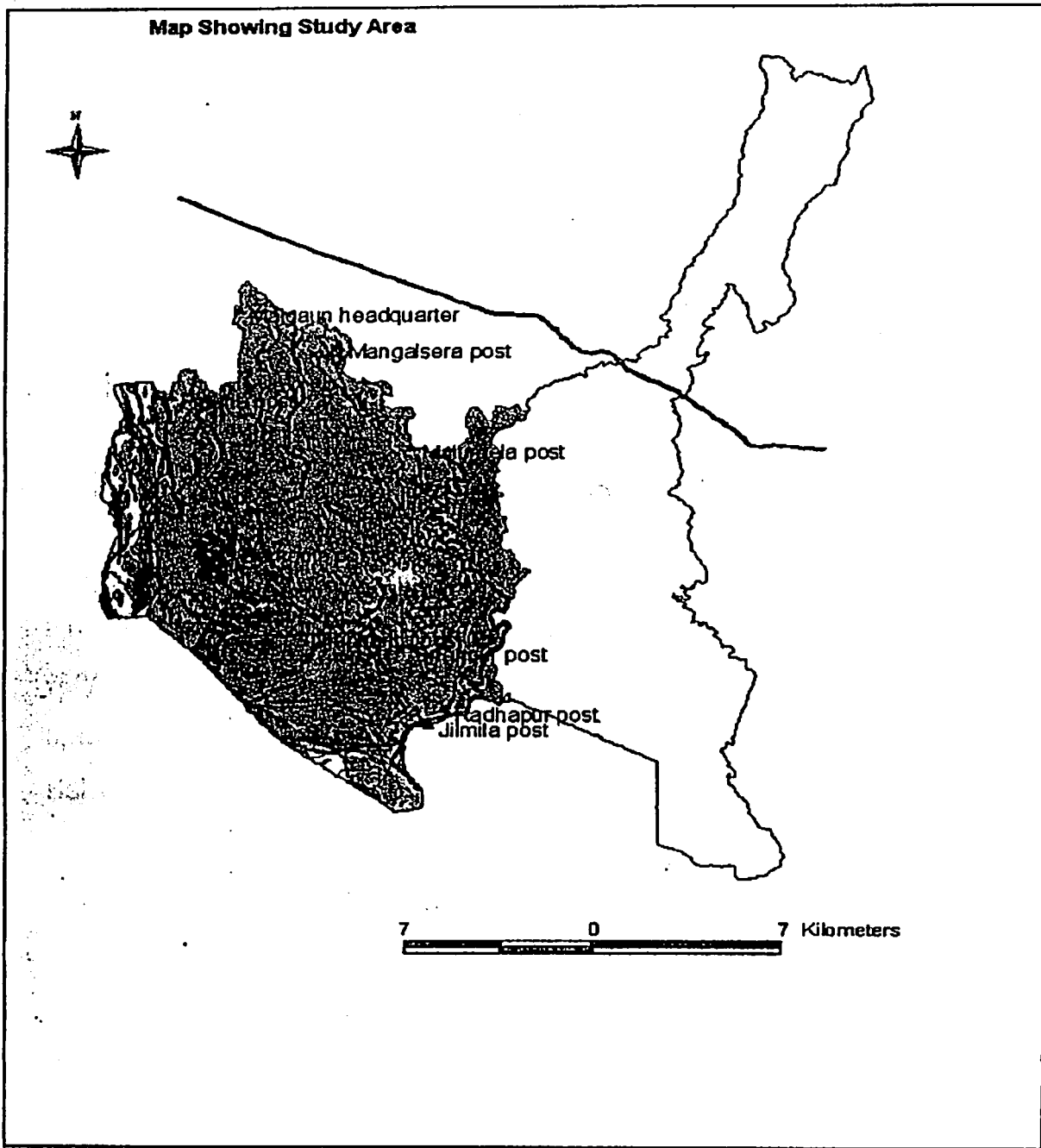


Fig. 1. Map showing the study area (Source: Thapa, 2003)

2.3 Climate

The climate is predominantly sub tropical monsoon, with more than 90% of the annual precipitation (1000 to 2000 mm) occurring between June and September (Bhatt, 1999). Winter months; December and January

are generally cold and misty with occasional frost. The daily temperature varies from 10°C to 20° C gradually rising up to 20°C to 25°C in February and March, respectively. The month of April, May and June are pre-monsoon period with temperature ranges between 30°C to 32°C occasional risings as high 40°C. During hot season at mid-day time the westerly winds blow hot air (locally called as "loo") and dust across the area (Bhatta, 1999).

2.4 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 and clay loam; and in the forest around grassland areas it is slightly alkaline sandy loam with PH value of about 8.0 (Bhatta and Shrestha 1977). In predominant Sal forest area soils vary from loam to sandy loam with slightly acidic and in the grassland areas it is slightly alkaline clay-loam with PH of 7.81 (Bhatta, 1998; Balson, 1976).

2.5 Bio-diversity

2.5.1 Vegetation

The main vegetation types in the reserve area are Sal forests, grasslands, wetlands, marshes, and riverine forest (Bhatta, 1999). Schaff (1978) described eight type of vegetation in the RSWR as (i) Sal forest; (ii) Sal savanna; (iii) Mixed deciduous; (iv) Khair- sisso forest; (v) Dry grassland; (vi) Seasonally wet grassland; (vii) Lowland savanna and (viii) Marsh.

Shorea robusta is the most predominant tree species (Balson, 1976; Bhatta and Shrestha, 1977). In the RSWR mixed deciduous forests are

irregularly distributed among the more extensive grassland. The major tree associate of Sal is *Asna* (*Terminalia fomentosa*), which makes up to 8 to 10% of the species composition (Bhatta, 1999). Other associates of sal are: *Terminalia balerica*, *Adina cardifolia*, *Bombox ceiba*, *Anogeissus latifolia*, *Eugenia jumbolana*, *Dalbergia sisso*, *Accacia catechu*, *Aegle marmeols*, *Lagerstroemia parriflora*, *Schleichera triguga*, *Mitragyna parviflora* and *Ficus* etc.

The main grass species include *Eulaliopsis binata*, *Sacchrum spontaneum*, *Vetiveria zizanoides*, *Cymbopogon species*, *Phragmitis karka*, *Imperata arundinacea*, *Arundo donax*, *Themede species*, etc.

2.5.2 Fauna

The fauna of the reserve includes 46 species of mammals (Appendix I), 350 species of birds (Baral, 2000); many herpeto fauna and 27 species of fishes (Bhatta and Shrestha, 1977). The reserve host array of globally important species of fauna like tiger (*Panthera tigris tigris*), Blue bull (*Boselaphus tragocamelus*), Rhino (*Rhinoceros unicornis*), Elephant (*Elephas maximus*), Leopard cat (*Felis bengalensis*), Pangolin (*Manis crassicaudata*), Leopard (*Panthera pardus*), Chital (*Axis axis*), Hog deer (*Axis percinus*), Samber deer (*Cervus unicolor*), Barking deer (*Montiacus muntjack*), Swamp deer (*Cervus duvauceli duvauceli*) are found.

CHAPTER THREE

OBJECTIVE

3.1 Objectives

The main objective of this study was to assess the performance and success of translocated rhinoceros population in the Royal Suklaphanta Wildlife Reserve. The specific objectives were:

1. To determine current status and dispersal pattern.
2. To analyze habitat use by rhinoceros; and
3. To evaluate the conservation measures for rhinoceros in the RSWR.

CHAPTER FOUR

METHODOLOGY

4.1 Reconnaissance Survey

A preliminary field survey was made in the Royal Suklaphanta Wildlife Reserve in February 2002 to identify the locations of rhinoceros, before the actual fieldwork was initiated. Survey process included discussion with the park authorities (chief warden, ranger and game scouts), staff of the King Mahendra Trust for Nature Conservation (KMTNC), Suklaphanta and the local people residing in adjacent proposed buffer zone area.

4.2 Field Survey

The field study was conducted from February to May 2003. During field survey information on population size, animal locations, habitat types, habitat use and conservation measures adopted by reserve authority were collected.

4.2.1 Population Census

Population of the rhinoceros was determined by using direct-count method. Counting was done either on foot or on the elephant back from 06.30 hours in the morning to 17.00 hours in evening. The counting was done daily on different block of the study area. Two elephants from RSWR were mobilized throughout the study period.

The purpose of direct count was to determine the total number of animals; and to identify their sex and age. Once a rhino was encountered, two elephants were gathered to determine the age and sex of the animal. Age and sex of each observed animal, time of observation, habitat type, vegetation and identifying characters of

animal, etc. were immediately recorded and the animal was allowed to pass.

4.2.1.1 Age and Sex Composition

Criteria for individual identification and classification of age and sex of the observed animals were based on the methodology developed by Laurie (1978). Main distinguishing characters used during the study included shape and size of the horns, body scars, arrangement of skin folds, size and arrangement of tubercles on the rump, ear cuts etc. Rhinos were broadly classified into three age class namely calf, sub-adult and adult. Adults were identified mainly by the observation of their neck folds, bib, horns, length and their height at the shoulder.

Sex of adults was determined by observing the genital organ, urination posture and association with calf. Identification of males was easy, as the genital organ in males is visible from the side, and from behind, especially when the rhino is walking. But female genitalia need closer examination and area only visible from the rear. Besides, males were distinct from females in body size, shape of the head, and neck folds. The body size among males is larger and bulky, the head is large and stout, and the horns are usually wider at the base and are mostly damaged due to fight or rubbing in tree trunks. The neck is deeply folded with noticeably larger bib. Each rhino has given a name.

4.3 Dispersal

During the field study observed locations (geographic coordinates) of all the rhinoceros living in the RSWR were recorded using Global Positioning System (12 SL personal Navigator, Garmin). The Global Positioning System (GPS) coordinates were marked on the Topographic map sheets to assess the dispersal of rhinos in the Reserve. In addition to the field data collected during 2003, available rhino monitoring data

collected by KMTNC, Suklaphanta from 2000 to 2002 were also used. The animal location data were digitized on the land cover map prepared in Institute of Forest (IOF) to assess the dispersal and habitat use of all individual rhinos.

4.4 Home range

A total of 103 location from 4 rhinoceros were obtained between Nov. 2000 to May 2003. Locations were plotted on topographic Maps and measured.

The home ranges were drawn as convex polygons using the "Modified minimum area method" (Harvey and Barbour 1965) as modified by wegge and Larsen (1987). The distance between the two widest locations was divided in half. A line was then drawn clockwise between all successive outer most points that were spaced shorter than half maximum distance. Locations further away than the maximum distance were defined as excursions and were excluded in the estimate of home range size.

4.5 Habitat

4.5.1 Habitat Characterization and Classification

Habitat characterization and classification was based on the land cover map prepared in IOF using Topographic maps produced by HMG/N, and field level study of vegetation physiognomy and species composition.

4.5.2 Habitat Use

All the habitat components were recorded whenever a rhinoceros was observed. During the present investigation habitat along with vegetation types of the area wherever the animals, and signs such as fresh wallow use, footprints, dung and feeding signs were recorded. These

information were plotted on the topographic maps to analyze the habitat utilization of rhinoceros. Habitat preferences were evaluated by comparing frequency distribution of animal locations on different habitat types with size of particular habitat types within the study area (Jnawali, 1995).

4.6 Conservation Measures

Various conservation measures taken by the authority were analyzed by field surveys, interviews with Reserve staffs and local people and by analyzing government's policy, documents and program outlines.

CHAPTER FIVE

RESULT

5.1 Status of Rhinoceros

A total of six rhinoceros were observed in the Reserve (Table 2) of southern section. Out of six animals, 2 were adult males, 3 adult females and one calf of unknown sex. The Suklaphanta Rhino population is composed of four rhinoceros translocated from Chitwan during November 2000, 1 male rhino might have been arrived from Dudhwa National Park, India and a calf, which was born in RSWR after translocation.

Table 2: Population Size and Composition of Rhinoceros in Royal Suklaphanta Wildlife Reserve, 2003.

	Adult			Sub-adult			Calf			Total
	M	F	Un	M	F	Un	M	F	Un	
Number.	2	3	-	-	-	-	-	-	1	6
Percent (%)	33.3	50	-	-	-	-	-	-	16.7	100

Note: M = Male, F = Female and Un = Unknown

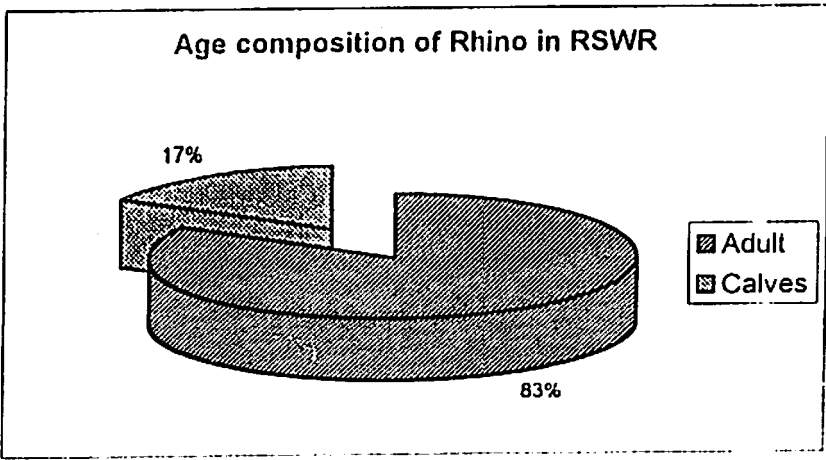


Fig No. 2: Age composition of Rhinoceros in RSWR

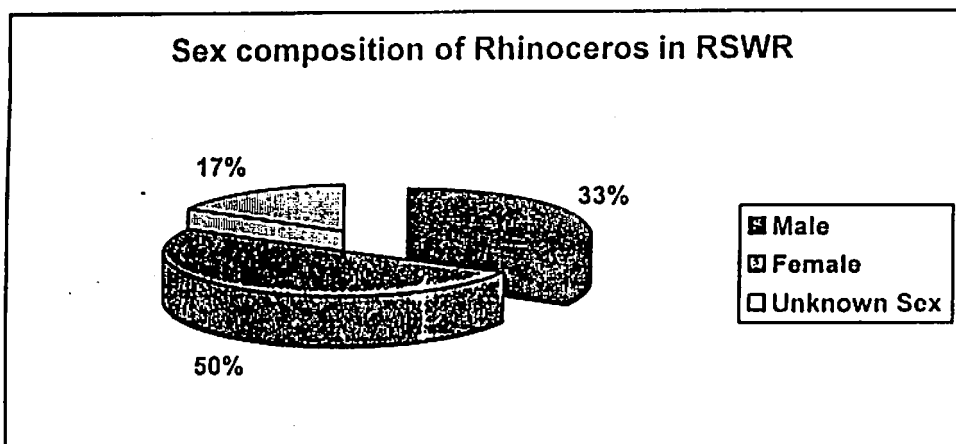


Fig No. 3: Sex Composition of Rhinoceros in RSWR

Of the total animals recorded in RSWR 33.3% were males, 50% females and remaining 16.7% was of unknown sex. The sex ratio (number of males per 100 females) was 66.66 or 2 males and 3 females (Figure 2).

5.2 Dispersal

Rhinoceros were mainly distributed in the southern section of the Reserve mainly in Ranital, Haraiyaphanta, Silalake area, Suklaphanta and Borkala areas (Patero Tal). The animals were not observed in Piparia, Lagga-Baga, Rudhapur and Jhilmila area from where rhinos were reported after they were released in 2000 (Person concerned with Reserve authority)

Present study revealed, a total of 151 locations of 4 rhinos collected between November 2000 and May 2003. The data indicated that all the four animals made some movements after their release and now seem settled.

The Chitwan Bhale, an adult male moved around the release site such as Salgaudi Tal, located about 8 km North, Baba Tal area and Malumela

area about 12 km North from the release site, where it appeared after three months. In September 2001 it appeared in the central part of Haraiyaphanta about 4 km NE from release site and moved to Salgaudi Tal area, where it settled for a few months, and again moved around Suklaphanta area, Haraiyaphanta, and Barkola phanta, which is located about 12 km west from the release site and settle there (Table 5, Figure 4 and Appendix IV).

Out of three adult females, the Sukibhar pothi moved 8.5 km SE within five of release days and then 20km SW towards Dhaknaghat in the next five days of release. Soon after she moved south close to Indian boarder and again traveled about 30 km west from the release site towards Piperia and settled there until March 2001. Then she moved again towards Indian Border, the eafter back to Barkola about 12 km west from the release site and settled (Table 6, Figure 5 and Appendix V). The Maupothi was found with a calf in Salgaudi Tal area about 12 km North from the release site after one year and settled there until 2002. Then she moved around Hara /aphanta area and Barkola Phanta, located about 12 km west from the release site (Table 7, Figure 6 and Appendix VI). Another adult female Sukla pothi made an extensive movement. After two months of released she appeared at Lagabagga area at the Indian border about 18 km SW from the release site, then moved towards Dodhara about 3 km West. Then after she moved towards Salgaudi Tal about 12 km North from the release site. Soon thereafter she moved towards Barkola about 12 km west from the release site and settle there (Table 8, Figure 7 and Appendix VII).

Following the initial dispersal period, all animals now seems to have settled in more clearly defined ranges, around the release site, although extensive movements still occur.

5.3.Home Range:

The average approximate home range size of females and male of the translocated population in Suklaphanta was 33.66 sq. km and 43 sq. km respectively.

5.4 Habitat Utilization Pattern

5.4.1 Habitat Classification

Based on the land cover map, and field level investigation of vegetation physiognomy and species composition seven types of habitat have been identified in the study area, western section of RSWR (Table 3 and Fig.3).

Table 3: Land Cover Classification of the study area.

Habitat types	Area km ²	Percentage
Sal Forest	75.73	35.36
Riverine Forest	36.19	16.90
Khair-Sissoo Forest	5.53	2.58
Tall Grassland	22.43	10.49
Short Grassland	48.49	22.65
Wooded Grassland	7.12	3.32
Marsh	18.62	8.70
Total	214.11	100

Source; Thapa, 2003

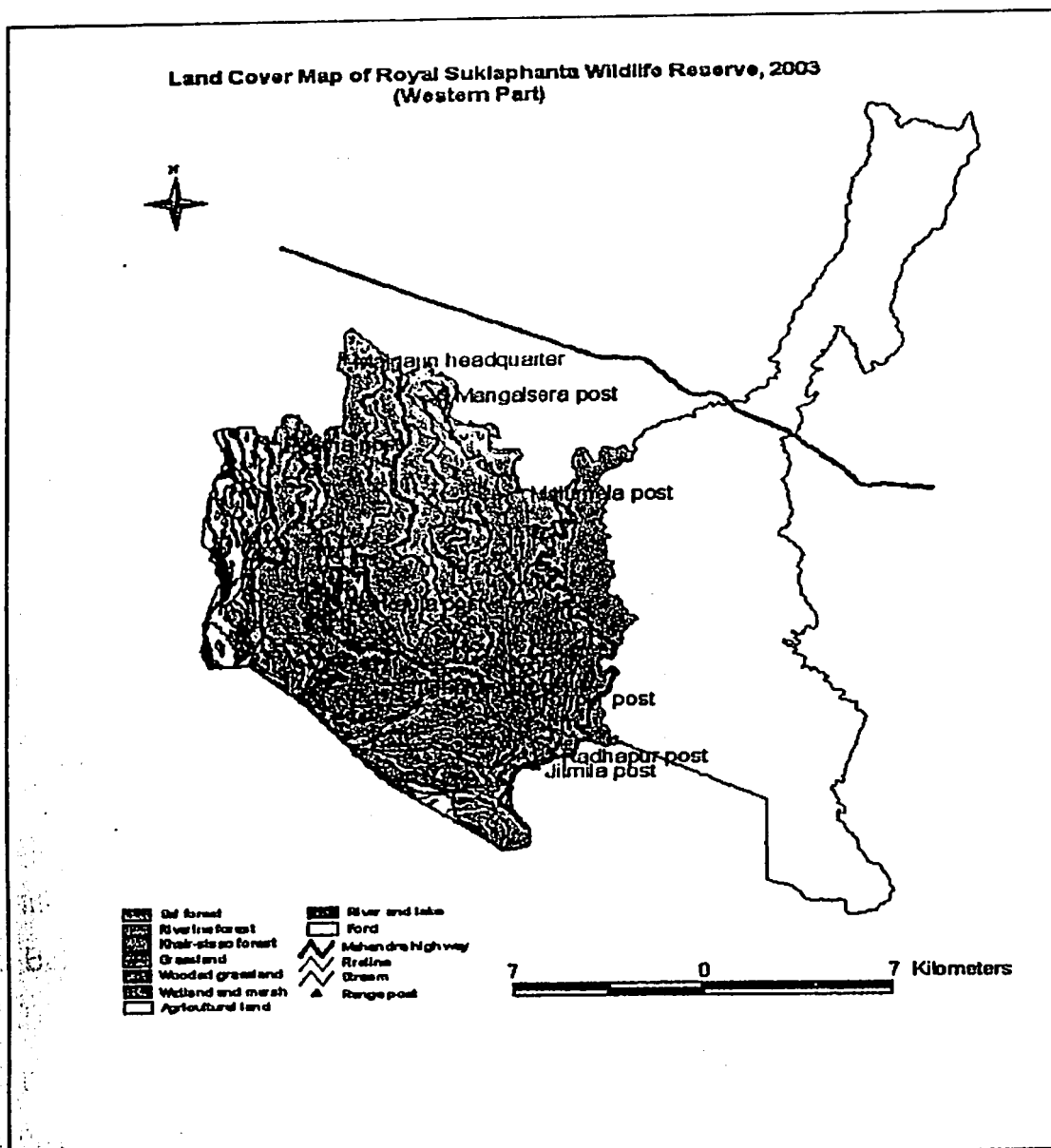


Fig. 4. Land cover map of the study area (Map source: 2003)

5.4.1.1 Sal Forest

Sal forest covers largest portion (35%) of the study area and is located in Majhgoan area, Malumela area, East of Singpur post, west of Rani tal, Dudhiya camp chock and North east of Barkola phanta.

Sal forest is characterized by the dominance of *Shorea robusta*, which is a highly gregasious and forms almost pure stand in many places. Other common associates of Sal forest include *Terminalia tomentora*, *Adina*

cardifolia, *Cleistocalyx operculata*, *Dillenia pentagyna*, *Neduca indica*, *Terminalia chebula*, *Terminalia belerica*, *Lageremia porviflora*, *Phyllanthus emblica*, *Bauhinia vahlii*, *Cassia fistula*, *Nyrrine*, *Semiserrate*, *Garaga pinnata*, *Butea monosperma*, *Mallotus phillippensis* and *Cerosoidum*. The undergrowth shrub species are *Clerodendrum viscosum*, *Grewia tilifolio*, *Asperagus racemosus* and the grasses recorded are mainly *Imperata cylindrica*, *Desmostachya bipinnata*, *Eulalopsis binnata*, *Saccharum spontaneum*, *Saccharum bengalensis*, *Narenga porphyrocoma* and *Vetiveria zizanoides*.

5.4.1.2 Riverine Forest

The Riverine forest occupies about 17% (36.19 sq. km) of the study area. It is mainly concentrated around the damp places near the rivers, streams and lakes such as Eastern bank of Mahakali River, South of Malumela, East of Salgaudi Tal, North west of Sila lake, Jhilmila area, Radhapur area, north west of Suklaphanta, Piparia post area and edge of Bahauni River.

The riverine forest is denser than the Sal forest with dense multi under storey vegetation. The dominant tree species include *Mallotus phillippensis*, *Trewia nudiflora*, *Ficus glomerata*, *Syzygium cumini*, *Garuga pinnata*, *Ehertia laevis*, *Ficus spp.*, *Butea monosperma*, *Alstonia scholasis*, *Litsea polyantha*, *Cleistocalyx operculata*, *Holorrhena antidysenterica*, *Toona ciliata*, *Bauhinia parpurea*, *Sterculia villosa*, *Albezia procera* and *Bambox ceiba*. Shrub species in the middle strata are *Murraya koenigii*, *Colebrookea oppositifolia*, *Clerodendrum viscosum*, *Calamus tenuis*, and *Melia azedavache*. The dominant groundcover consists of some grasses like *Imperata cylindrica*, *Equistem spp.*, *Dryopteris cochleata*, *Pteris spp.*, *Ageratum congzoides* and *Cirrium wallichii*.

5.4.1.3 Khair-Sissoo Forest

The Khair- Sissoo forest covers very small portion(5.53 square kilometers) of the study area and is located in the riverbed of the Mahakali River and other small streams. Khair (*Acacia catechu*) and Sissoo (*Dalbergia sissoo*) are pioneer species to thrive on unstable riverine site. Sissoo forms almost pure stands on the banks and gravel base of Mahakali River. Under storey grasses included *Narenga porphyrocoma*, *Apluda mutica* and *Phragmites karka*.

5.4.1.4 Tall Grassland

The tall grasslands occupy about 10% (22.43 sq. km) of the study area. This type of vegetation is mainly confined to the phantas, close to lake areas and in the areas emendated by monsoon flood. It is found in East of Ranital, haraiya phanta, Barkola phanta, Birsingh planta, Patero tal area, Salgaudi tal, Sundari phanta, and North west of Suklaphanta and along the Mahakali river etc.

The dominant species of tall grassland includes *Narenga porphyrocoma*, *Saccharum spontaneum*, *Saccharum bengalensis*, *Phragmites karka*, *Imperata cylindrica* *Erianthus ravennae* and *Cynodon dactylon*. *Cissium wallichii* are also dispersed in the tall grassland. Encroachment of *Butea monosperma*, *Dalbergia sissoo* and *Bombax ceiba* is also common in the phantas.

5.4.1.5 Short Grassland

Short grasslands covers about 23% (48.49 square kilometers) of the study area. This type of vegetation is mainly confined to Suklaphanta area. As the name suggest these grasses are short in their height. Grasses like *Imperata cylindrica*, *Desmostachya bipinnata*, *Cymbopogon jwarancusa*, *Cyperus spp.*, *Vetiveria zizanoides* and *Cynodon dactylon*, mainly dominate short grassland.

5.4.1.6 Wooded Grassland

Wooded grassland covers about 3% (7.12 sq. km.) of the study area and is found mainly in South-west of Barkola phanta area. The wooded grasslands are invaded with hardwood tree species like *Butea monosperma*, *Dalbergia sissoo*, *Acacia catechu*, *Bombax ceiba*, *Sjgyzium cumini*, *Ficus religiosa*, *Trewia nudiflora* and *Toona ciliata*. The grass species recorded in this vegetation type include *Imperata cylindrica*, *Saccharum spontaneum*, *Saccharum bengalensis*, *Narenga porphyrocoma*, *Cymbopogon jwarancusa* and *Desmostachya bipinnata*.

5.4.1.7 Marsh

Wetland and Marshes covers about 9% (18.62 sq. km.) of the study area and are located in Barkola (paterotal), Ranital, Salgaudi Tal, Baba tal and Sikari tal. Marsh was characterized by the presence of surface water all year round or by soil which is water logged or muddy. Dense *Phragmites karka*, *Saccharum spontanueum*, *Typha elephantina* and *Sclerostachya fusca* comprise the dominant vegetation.

5.4.2 Use of Habitat

Habitat use pattern of different animals are different in RSWR. In general all individual rhino intensively used tall grassland followed by riverine forest and wooded grasslands, but the Sal forest and short grasslands used in low frequency (Table 4 and Table 9)

Table 4. Observed Frequency of Habitat Use by Rhino in RSWR, Nepal, 2000- 2003

Name of animal	Habitat types							Total
	Tall Grassland	Riverrine forest	Wooded grassland	Marsh	Sal forest	Khair-Sissoo Forest	Short grassland	
Chitwan Bhale	11	4	1	4	6	0	1	27
Sukitar Pothi	9	18	6	1	2	2	4	42
Mau Pothi	12	1	0	4	1	0	0	18
Sukla Pothi	6	3	0	0	2	0	3	14
Sukla Bhale	2	0	0	0	0	0	0	2
Unidentified*	25	5	1	7	2	0	10	50
Total	65 (42.48)	31 (20.26)	8 (5.28)	16 (10.45)	13 (8.48)	2 (1.30)	18 (11.75)	153 (100)

*Footprints, wallows and feeding signs of rhinoceros recorded.
Figures in parenthesis represent percentage.

5.4.2.1 Chitwan Bhale

A total of 27 locations of Chitwan bhale were observed in the study area. Most of the locations were in the tall grassland followed by the Sal forest, riverine forest and marsh, no single observation made in Khaire-sissoo forest (Table 4, Table 5 and Figure 5).

Table 5. Habitat Used by Chitwan Bhale in RSWR, 2003

Areas occupied	Habitat type	GPS coordinates
Rani tal area	Sal forest	N 28°50'699" E 80°13'399"
Salgaudi tal	Tall grassland	N 28°52'808" E 80°13'443"
East of Baba tal	Tall grassland	N 28°53'080" E 80°12'360"
Dudhiya camp chowk	Sal forest	N 28°51'764" E 80°13'221"
Haraiya phanta	Tall grassland	N 28°51'001" E 80°13'787"
North west of Suklaphanta	Tall grassland	N 28°49'354" E 80°10'397"
South of Singpur post	Mixed grassland	N 28°49'458" E 80°12'199"
North of Haraiya phanta	Tall grassland	N 28°50'911" E 80°14'493"
South of Malumela	Riverine forest	N 28°53'208" E 80°14'028"
East of Salgaudi tal	Riverine forest	N 28°52'300" E 80°13'820"
(Silalake chowk)	Tall grassland	N 28°50'178" E 80°08'076"
North west of Silalake	Riverine forest	N 28°50'178" E 80°08'290"
Patero tal	Wooded grassland	N 28°52'192" E 80°09'575"
Barkola area	Tall grassland	N 28°52'207" E 80°09'442"

Distribution of Locations of Chitwan Bhole in RSWR, 2003

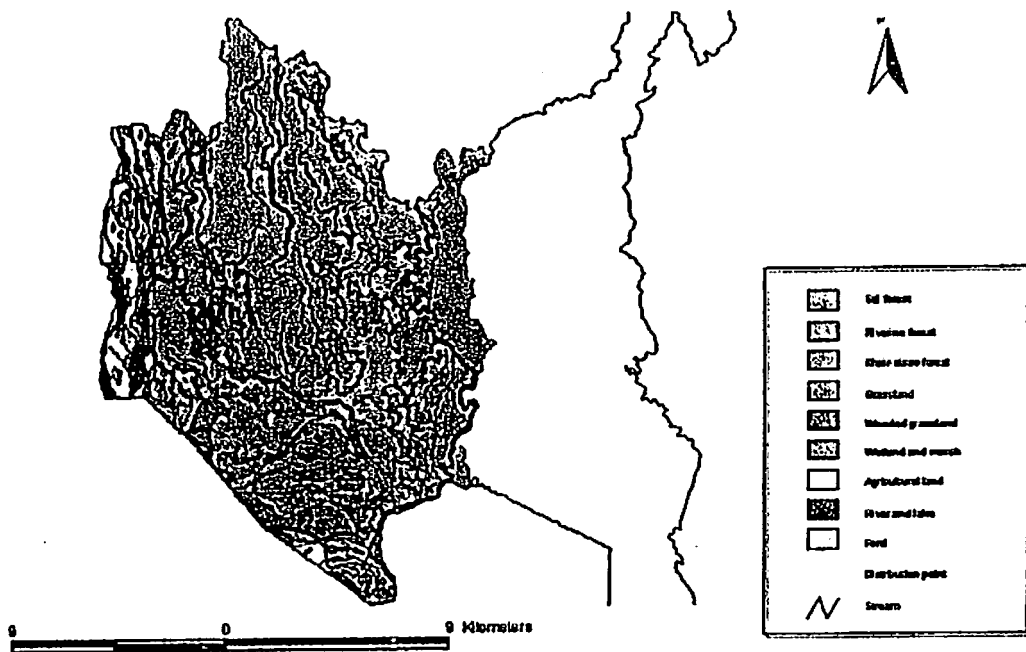


Figure 5: Distribution of Locations of Chitwan Bhole in RSWR

5.4.2.2 Sukibhar Pothi

Of the 42 locations of the Sukibhar Pothi, 18 were distributed in the riverine forest followed by tall grassland, wooded grassland and short grassland. (Table 4, Table 6 and Figure 6).

Table 6. Habitat Used by Sukibhar Pothi in RSWR, 2003

Areas occupied	Habitat type	GPS location
Rani tal area	Sal forest	N 28°50'699" E 80°13'399"
Jhilmila area	Riverine forest	N 28°47'031" E 80°13'109"
Dhaknaghat	Wooded grassland	N 28°51'373" E 80°08'307"
Dodhara	Cultivated field	
22 No. Pillar	Short grassland	N 28°48'731" E 80°08'307"
Gazarghat area	Riverine forest	
Piparia post	Riverine forest	N 28°55'191" E 80°07'313"
Back of Piparia post	Sissoo-forest	N 28°54'834" E 80°06'913"
Bir singh phanta	Mixed grassland	N 28°835888 E 80°108060
Barkola area	Tall grassland	N 28°52'207" E 80°09'442"
Haraiya phanta	Tall grassland	N 28°51'280" E 80°14'123"
North of Haraiya phanta	Tall grassland	N 28°51'012" E 80°14'281"
Haraiya phanta	Tall grassland	N 28°51'001" E 80°13'787"
North east of Haraiya phanta	Tall grassland	N 28°51'444" E 80°14'022"
North west of Suklaphanta	Riverine forest	N 28°50'178" E 80°08'290"
Sudari phanta	Tall grassland	N 28°52'063" E 80°09'444"
Patero tal (Barkola)	Wooded grassland	N 28°52'192" E 80°09'575"

Distribution of Locations of Sukibar Pothi in RSWR, 2003

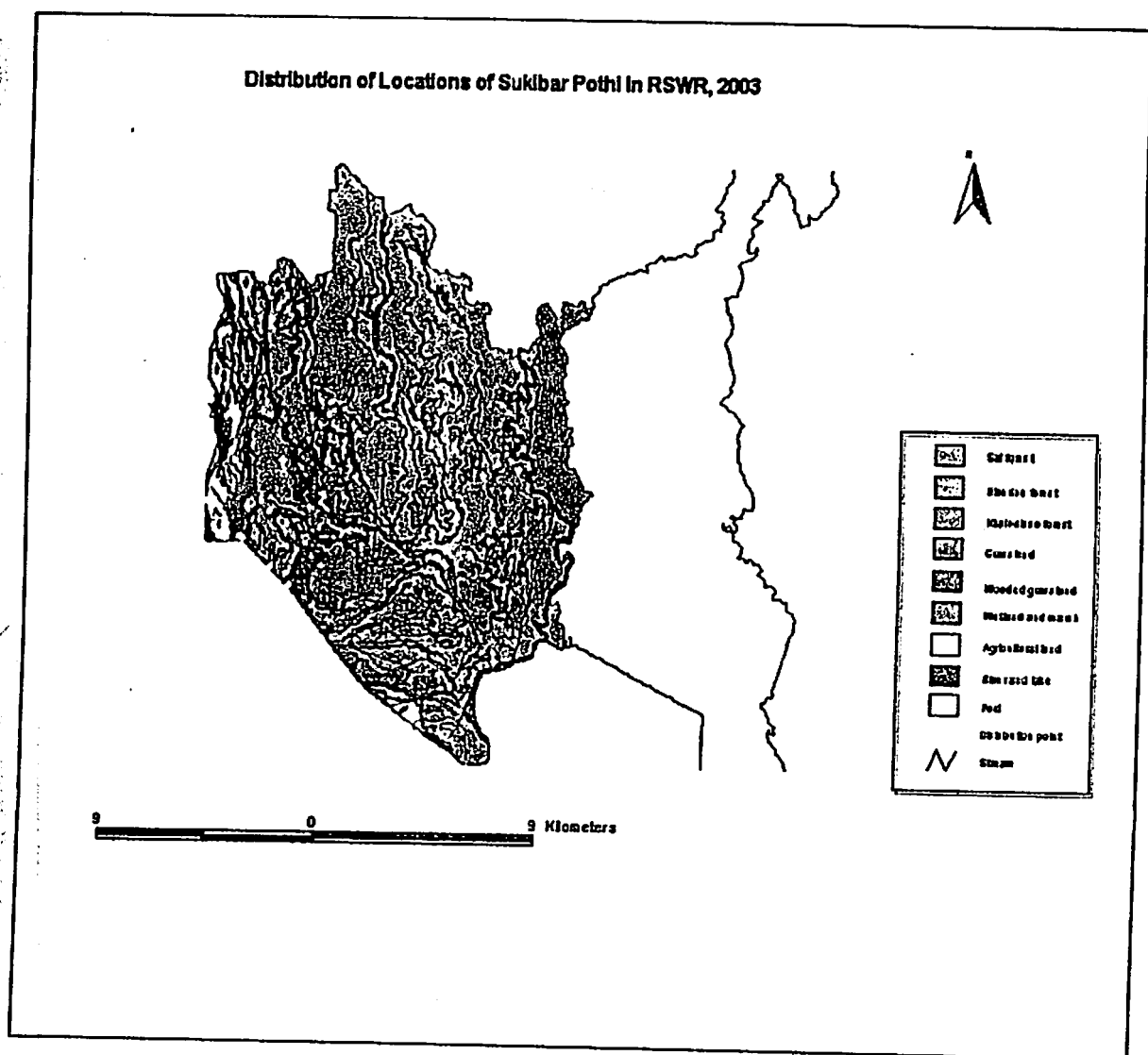


Figure 6. Distribution of Locations of Sukibar pothi (Female)

5.4.2.3 Mau Pothi with Calf

Of the 18 recorded locations of the Mau Pothi, most of these distributed in the tall grassland followed by riverine forest and marsh area, and not a single location distributed in the Khair- Sissoo forest and wooded grassland (Table 4, Table 7 and Figure 7).

Table 7. Habitat Used by Mau Pothi with Calf in RSWR, 2003

Areas occupied	Habitat type	GPS coordinates
Rani tal area	Sal forest	N 28°50'699" E 80°13'399"
West of Salgaudi tal	Riverine forest	N 28°51'808" E 80°13'443"
Salgaudi tal	Tall grassland	N 28°52'808" E 80°13'443"
North of Haraiya phanta	Tall grassland	N 28°50'911" E 80°12'493"
East of Rani tal	Tall grassland	N 28°50'786" E 80°14'629"
North of Haraiya phanta	Tall grassland	N 28°51'320" E 80°14'002"
Haraiya phanta	Tall grassland	N 28°51'444" E 80°14'022"
North east of Patero tal	Sal forest	N 28°51'915" E 80°09'151"
West of Barkola post	Tall grassland	N 28°51'063" E 80°08'572"
Patero tal (Barkola)	Tall grassland	N 28°52'207" E 80°09'442"

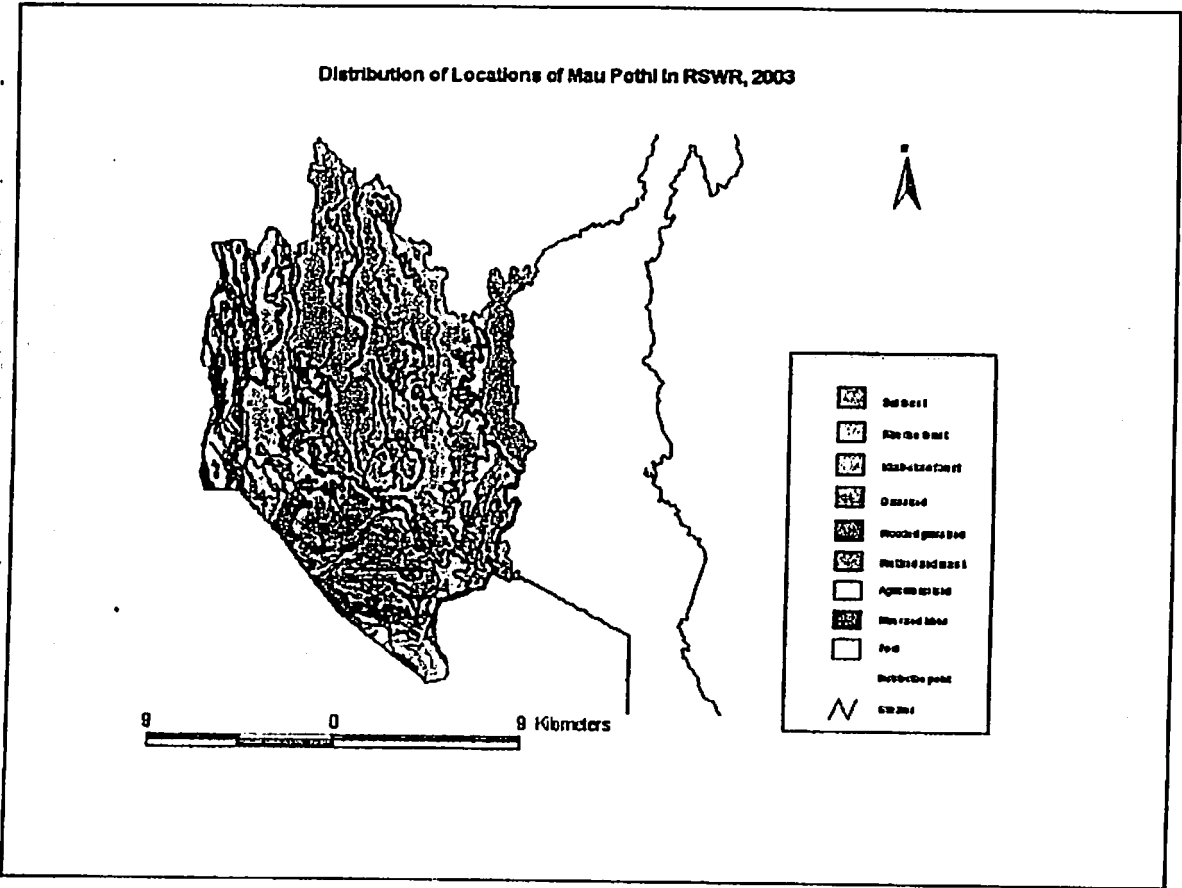


Figure 7: Distribution of Locations of Mau Pothi with calf

5.4.2.4 Sukla Pothi

A total of 14 locations of the Sukla Pothi was observed in RSWR, of these 6, 3 and 3 locations were in the tall grassland, riverine forest, and short grassland respectively and no locations were recorded from wooded grassland, khair –Sissoo forest and marsh (Table 4, Table 8 and Figure 8)

Table 8. Habitat Used by Sukla Pothi in RSWR, 2003

Areas occupied	Habitat type	GPS coordinates
Rani tal area	Sal forest	N 28°50'699" E 80°13'399"
Lagga-bagga	Short grassland	N 28°48'734" E 80°07'462"
Dodhara area	Cultivated field	
Bir singh phanta	Mixed grassland	N 28°835888 E 80°108060
Barkola area	Tall grassland	N 28°52'192" E 80°09'575"
Dhaknaghat	Wooded grassland	N 28°51'373" E 80°08'307"
North west of Silalake	Riverine forest	N 28°50'512" E 80°08'092"
West of Haraiya phanta	Tall grassland	N 28°50'332" E 80°13'630"
Haraiya phanta	Tall grassland	N 28°51'001" E 80°13'787"
Patero tal (Barkola)	Wooded grassland	N 28°52'192" E 80°09'575"

Distribution of Locations of Sukla Pothi in RSWR, 2003

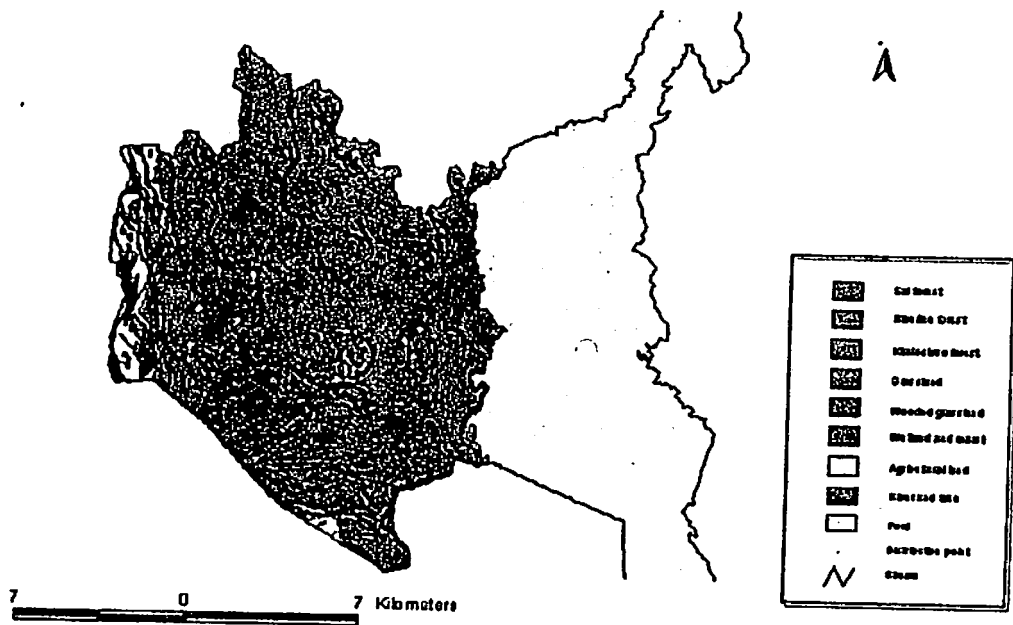


Figure 8: Distribution of Locations of Sukla Pothi in RSWR

5.4.2.5 Sukla Bhale

During this study the Sukla Bhale was observed twice in Ranital area once at the tall grassland and second time in the Riverine forest. Due to inadequate data location distribution map has not been prepared.

5.5 Habitat Preference

In the RSWR, rhino showed a marked preference towards tall grasslands riverine forest and wooded grasslands but the Sal forest was significantly avoided (Table 9). Marsh and Khair- Sissoo forest were used according to availability, but short grassland was used in less proportion.

Table 9. Availability and utilization habitat types in the RSWR, Nepal, 2000-2003

Habitat type	Available habitat		Frequency of utilization (%)
	Km ²	Percentage	
Sal Forest	75.73	35	8.48
Rivernine Forest	36.19	17	20.26
Khair- Sissoo Forest	5.53	2.5	1.30
Tall Grassland	22.43	10	42.48
Short Grassland	48.49	23	11.75
Wooded Grassland	7.12	3	5.28
Marsh	18.62	9	10.45

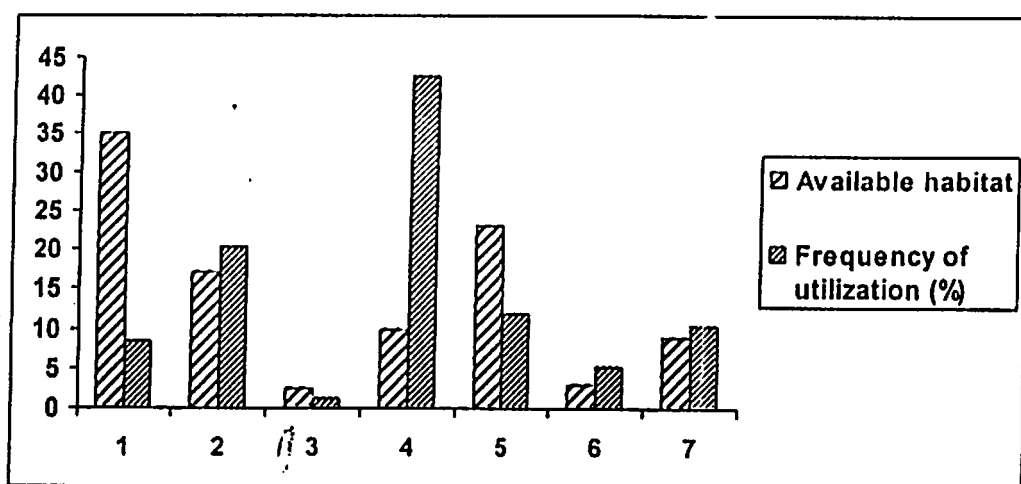


Fig: 9 Availability (%) and frequency of utilization of habitat by Rhinoceros in RSWR.

5.6 Conservation Measures for Rhino in RSWR

Present study shows that the authority in RSWR took different measures to manage rhino.

1. Population monitoring of Rhino.
2. Anti-poaching measurers: patrol group and game scouts.
3. Plantation of palatable grasses.
4. Establishment of waterholes.
5. Public awareness among villagers and school children.

CHAPTER SIX

DISCUSSION

The population of the rhinoceros in Royal Suklaphanta Wildlife Reserve was very small consisting of only six individuals. This population is considered extremely critical one, because, the rhino population under 10 individuals is considered at high risk of local extinction (Yonzon; Adhikari and Subedi 2003). Out of six, 4 adult animals (1 male and 3 females) translocated from Chitwan, a 1.5-year calf born in Suklaphanta and one adult male believed to be arrived from Dhuduwa National Park India. New birth of calf indicates the success of rhino in new environment of Suklaphanta.

The population was small but the sex ratio (number of males per 100 females) was 66.6 or 2 males and 3 females, while in Chitwan and Bardia the ratios were 72.19 and 59.09 respectively (DNPWC, 2000). Thus, the sex ratio of Sukla rhino population is satisfactory, because two males are sufficient to breed three females. In RSWR the adult to calf ratio (5:1) was lower than that of natural population in RCNP (2.84:1) and reintroduced population in RBNP (4.3:1).

Present study indicated that the rhinoceros in RSWR were distributed in Ranital, Haraiya phanta area, Suklaphanta area, Silalake area and Barkola area. This distribution pattern can be partly attributed to the availability of water, food and suitable shelter through out the year in these areas and partly to minimum or no competition for resources. No indication of rhinoceros being found in Piparia, Lagga-Bagga, Radhapur and Jhilmila area from where the rhinos were reported after they were released in 2000. In the beginning animals might have traveled these areas in search of suitable habitat and later received disturbances from

human enter illegally grazing by domestic livestock, collecting grasses and fuel wood, thus, they avoid these areas.

Analyses of the recorded locations indicated that dispersal patterns of all animals in RSWR were irregular following release. The Chitwan Bhale, an adult male did not traveled very far from the release site, his activities were concentrated around about 12 km apart from the release site.

Among the females the Sukibhar pothi made an extensive movements. She moved to 8.5 km SE within 5 days and then 20 km SW in next five days. Then she moved back towards release site about 12 km west and settle there. The activities of the Mau pothi were concentrated around 12 km apart from the release site. Another adult female, the Sukla pothi made moved about 18 km SW from the release site. Then she also moved back towards release site within 12 km and settle. Present study indicates the released site is one of the most suitable habitats for rhinos, because, currently, all day and night activities of all the animals were concentrated not far from the site. The southwestern part of the study area

Baure (1998), Jnawali and Wegge (1991, 1993) and Jnawali (1995) described erratic movements of most of the released animals in Bardia following release. Sukla rhinos did not made such an extensive movement like Bardia probably due to small but better quality of habitat in Sukla to support small population.

The approximate home range of females and male of the translocated population in Suklaphanta were 33.66 sq. km. and 43 sq. km. respectively whereas in Bardia the average annual home range sizes of females and males of the translocated population were estimated at $25.1 \pm 9.3 \text{ sq. km}$ and $41.8 \pm 4.4 \text{ sq. km}$. respectively (Jnawali 1995) whereas

in Chitwan they were only 2.9 sq. km (females) and 3.3 sq. km. (males). (Jhawali 1995)

In RSWR animal shows large and overlapping home range size, i.e. the different animals used almost same habitat. Rhinos commonly maintain home ranges between 2.6 km² to 130-km² depending on food availability (Dhakal, 2002). Large and overlapping home range is probably as a result of the spatial distribution of habitat and less competition for resources, rather than lack of habitat quality.

The rhino population in RSWR intensively used tall grasslands. Jnawali (1995) also reported high preference of tall grassland in the Karnali floodplains; because tall grasslands composed of preferred vegetation such as *saccharum spontaneum*, *S. bengalensis* and *Erianthus revennae*, these species make up about 70% of the diet and attracts animals during the hot season when new flush becomes available after the first rains late in the hot season.

Riverine forest was also preferred to use by rhinos because it provides food and shelter as well as the presence of water allows the animals for wallowing during daytime. *Mallotus phillippinensis*, a dominant tree species and ground vegetation *Imperata cylindrica*, and *Cissium wallichii*, also found in the riverine forest constitute the diet of rhinos (Jnawali, 1989).

Rhinoceros in Suklaphanta also preferred wooded grassland and wetland and marsh. The wooded grassland consists important tall grass species such as *Saccharum spontaneum*, *S. bengalensis* and *Cirsum wallichii* are all preferred diet for rhinos (Jnawali, 1989). The rhinoceros in Suklaphanta also uses Marsh as it contains dense *Phragmites karka*,

Saccharum spontaneum that is an important diet (Jnawali, 1989). Marsh also provides wallows for wallowing during daytime, which allows the animals to escape from heat during hot season.

Khair-sissoo forest in Suklaphanta seems to be less useful in terms of rhino habitat. It can be attributed to very small size (2.5 %) in the study area and mainly located as a narrow strip along the Mahakali River in the border of the reserve, which likely to be disturbed by human activities. But the Khair-sissoo forest is most preferred habitat in Bardia because of its dense and abundant under story vegetation, consisting mainly of *Murraya koenigii*, *Pogostemon bengalensis* and *Callicarpa macrophylla*, provides suitable shelter when the tall grassland become more open after grass cutting and burning in early winter (Jnawali and Wegge, 1993).

In RSWR the Sal forest and short grassland received very little use. Jnawali and Wegge (1993) also made similar observation in Bardia, grass species like *Imperata cylindrica* and *Desmostachya bipinnata* receive some use only during the early sprouting stages in the Sal forest. Similarly short grassland cannot provide shelter during daytime.

In Bardia animals preferred Khair-Sissoo forest, riverine forest and tall grassland and avoided Sal forest, wooded grassland and river and riverbeds (Jnawali 1995) mixed hardwood forest was used according to availability. In Chitwan tall grassland was highly preferred but the seasonal changes in diet in the tall grassland was in the relative proportion of young and mature *Saccharum* grasses, short grassland was proffered during monsoon and winters and riverine forest was preferred in spring and short grasses and fruit during monsoon (Laurie, 1978). Although, present study did not analyzed seasonal preferences of habitat and availability of food, but performance of animals, birth of a calf

Immigration and settlement of an adult male suggest the habitat quality of RSWR is good enough to support small viable population.

Considering the small population, which is susceptible to stochastic effect, various conservation measures have been applied in RSWR. Important measures included population monitoring of released rhinos, anti-poaching measures by mobilization of patrol groups and game scouts, plantation of palatable grasses, near Barkola, establishment of waterholes in western section of Suklaphanta and public awareness campaign among villagers and school children etc.

CHAPTER SEVEN

CONCLUSION AND RECOMMENDATION

The rhinoceros in Royal Suklaphanta Wildlife Reserve is most susceptible to stochastic effect and human disturbance. After two years of irregular movement now they seen more or less settled, mainly on the southwestern section of the Reserve, in Ranital, Haraiyaphanta along the Chaudhar River, Silalake area, Salgoudi Tal area, Suklaphanta and Barkola (Patero tal) area, where water and suitable habitat are available. Because of extremely low density, non-settled behavior and spatial distribution of habitat components, rhinos in RSWR still make extensive movement.

The average approximate home range size of females and male of the translocated population in Suklaphanta was 33.66 sq. km and 43 sq. km respectively.

In the RSWR, rhino showed a marked preference towards tall grasslands, riverine forest and wooded grasslands, and marsh and Khair- Sissoo forest were used according to availability. The Sal forest was significantly avoided. Habitat in RSWR is good enough to support small population of rhino.

Although, some conservation measures have already been initiated to improve habitat quality, but considering the small and newly translocated population special attention should be paid. Future conservation efforts must be directed to improve the quality of habitat, which must be large enough to fulfill the requirements of a viable and self-sustaining population of rhinoceros in natural condition.

The following are some recommendations, which could possibly be helpful in order to increase and maintain a viable breeding population at Royal Suklaphanta Wildlife Reserve:

- 1) The population size of rhinoceros in the Royal Suklaphanta Wildlife Reserve is in very critical condition, as rhino population under 10 individuals is considered at high risk of local extinction. So additional rhinos should be released to maintain a viable population.
- 2) Monitoring of released animals is must warranted at least for a period of one year, thus all the animals should be monitored regularly using GPS and radio transmitters to assess the success, habitat use and ranging patterns in new habitat. The information, thus, collected will guide the future translocation and management program.
- 3) However grazing may help in new sprouting of palatable grass species, but uncontrolled grazing of domestic livestock in the reserve may compete with the rhino and reduce the quality of grassland, hence such practice should be stopped.
- 4) Although there was no record of rhino poaching in RSWR, but considering poaching scenario in RCNP, trained and well equipped anti-poaching squads and strike force should be employed and established in strategic places to prevent animals from poaching.
- 5) The existing water sources are inadequate for all year round, so water holes should be established in various location to make water available for "water loving" animals including rhinoceros all year round.
- 6) Education regarding the importance of wildlife in nature is an important device to create awareness among the people. So, audiovisuals on the importance of protecting wildlife including

rhinoceros should be designed in local language and demonstrated to school children and villager living around the reserve.

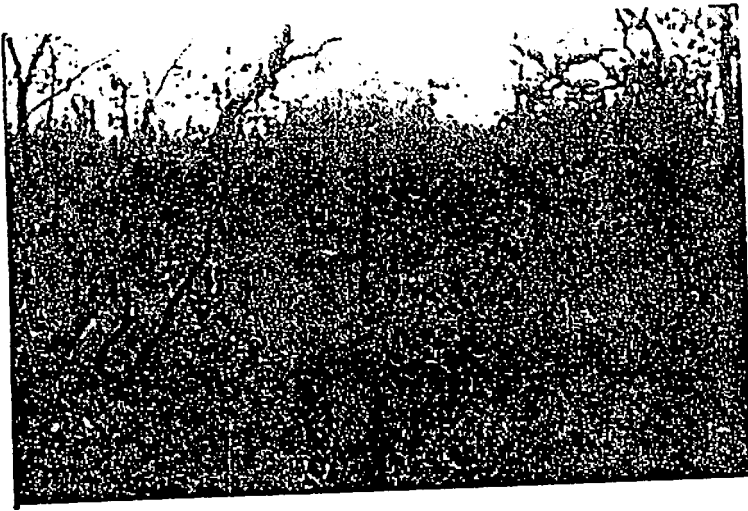
- 7) Long term research intended to collect information on rhinoceros biology should be encouraged.
- 8) Assessment of the habitat including availability of food, seasonal habitat preference, and home range, and also the carrying capacity of the reserve is imperative to manage rhino and other wildlife in RSWR.

REFERENCES

- Anstey, D. 1987. *Report on Stage Two of the Reintroduction of the Greater One-horned Rhinoceros to the Royal Bardia Wildlife Reserve, Nepal*. Report Submitted to DNPWC/KMTNC. 12 pp.
- Balson, E.E. 1976. *Survey of the Royal Suklaphanta Wildlife Reserve*. Project Report no. NEP 72/002, Kathmandu, DNPWC/FAO.
- Baral, H.S. 2000. *Impact of Grassland Management on Avian Fauna*. In: Proceeding of an International Workshop on "Grassland Ecology and Management in Protected Areas of Nepal", Vol. II, pp. 98-113, ICIMOD, Kathmandu, Nepal.
- Bauer, J.J. 1988. *A Preliminary Assessment of the Reintroduction Success of the Asian One-horned Rhinoceros (Rhinoceros unicornis) in Bardia Wildlife Reserve, Nepal*. Tiger Paper, October-December: 26-32.
- Bhatta, A.D. 1998. *Factors Affecting the Population of Swamp Deer (Cervus duvauceli) at RSWR*. Unpublished Dissertation, Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu, Nepal.
- Bhatta, D.D. and Shrestha, T.K. 1977. *The Environment of Shuklaphanta*. Tribhuvan University, Kirtipur, Kathmandu, Nepal.
- Bhatta, N. 1999. *Impact of Burning and Grazing on Vegetation Composition, and above Ground Biomass Production in Mangalsera Grassland of RSWR Nepal*. Unpublished Dissertation, Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, Nepal.
- Bhattacharya, A. 1993. *The Status of the Kaziranga Rhino Population*. Tiger Paper 20:1-6.
- Caughley, G. 1969. *Wildlife and Recreation in the Trisuli Watershed and Other Areas in Nepal*. HMG/FAO/UNDP Trisuli Watershed and Development Project Report No. 6, Kathmandu, 56 pp.
- Chapagain, D. and Dhakal, J., 2002. *CITES Implementation in Nepal*. DNPWC, Kathmandu, Nepal, 36 pp.

- Dhakal, J. 2002. *Status and Conservation of One-horned Rhinoceros in Nepal*. Publication of Wildlife and Environment. pp. 21-26, Issue 7.
- Dinerstein, E. and Price, L. 1991. Demography and Habitat Use by a Greater One-horned Rhinoceros in Nepal. *J. Wildlife Management* 55:401-411.
- DNPWC. 1993. *Strategies of Rhino Conservation in Nepal*. Unpublished Report. DNPWC, Kathmandu. 15 pp.
- DNPWC. 2000. Count Rhino 2000. *Initial Unpublished Report*, Department of National Park and Wildlife Conservation, Kathmandu.
- Foose, T.J. and Van Strien, N. 1997. *Asian Rhinos: Status Survey and Conservation Action Plan*, New Edition, IUCN/SSC Asian Rhinoceros Specialist Group. IUCN, Gland.
- Gurung, K.K. 1989. *The Indian Rhinoceros*. pp. 87-89. In: Indian Wildlife (Israel and Sinclair, eds.). APA Publications, Singapore, 380pp.
- Gyawali, S.R. 1986. *Diet Analysis of Greater One-horned Rhinoceros by Fecal Analysis*, M.Sc. Thesis, T.U., Kathmandu, Nepal, 34pp.
- Harvey, M.J. and Barbour, R. W. 1965. Home Range of *Microtus Ochrogaster* as Determined by a Modified Minimum Area Method. *J. Mammology* 46:398-402.
- IUCN, 1990. 1990. *IUCN Red List of Threatened Animals*. IUCN, Gland Switzerland and Cambridge, UK.
- Jnawali S.R. 1989. *Park People Interaction: Assessment of Crop Damage and Human Harassment by Rhinoceros (Rhinoceros unicornis) in Sauraha Area Adjacent to the Royal Chitwan National Park Nepal*. M.Sc. Thesis. Agriculture University of Norway.
- Jnawali, S.R. 1995. *Population Ecology of Greater One-horned Rhinoceros (Rhinoceros unicornis) with Particular Emphasis on Habitat Preference, Food Ecology and Ranging Behaviours of a Reintroduced Population in Royal Bardia National Park in Lowland Nepal*. Doctor Scientiarum Thesis, Department of Biology and Nature Conservation, Agricultural University of Norway, Aas, Norway.

- Sanzgiri, M.N. 2003. *Dudhuwa National Park Success Story of Conservation of Great Indian One-horned Rhinoceros*. Tigerpaper 30(1):15.
- Schaff, C.D. 1978. *Population Size and Structure and Habitat Relations of the Barasingha (Cervus duvauceli) in RSWR, Nepal*. Ph.D. Dissertation Michigan State University.
- Sharma, U.R. 1991. *Park People Interactions in Royal Chitwan National Park, Nepal*. Ph. D. Dissertation. University of Arizona. 274pp.
- Shrestha, T.K. 1997. *Mammals of Nepal*, Published by Mrs. Bimala Shrestha, G.P.O. Box. 6133, Kathmandu.
- Sinha, S.P. and Sawarkar, V.R. 1993. *Management of the Reintroduction Greater One-horned Rhinoceros (Rhinoceros unicornis) in Dudhuwa National Park*. Uttar Pradesh, India. pp. 218-227. In *Rhinoceros Biology and Conservation* (O.A. Ryder, eds.): Proceeding of An International Conference, Zool. Society. San Diego. USA.
- Thapa, R. 2003. *Study on Habitat Structure of Royal Suklaphanta Wildlife Reserve, Far Western Lowland, Nepal*. B.Sc. Thesis, T.U. Institute of Forestry, Pokhara.
- Vigne, L. and Martin, E.B. 1994. *The Greater One-horned Rhino of Assam; Threatened by Poachers*. Pachyderm, 18:28-43.
- Wegge, P., Jnawali, S.R. and Mac, S.R. 1990. *Bardia Conservation Research Program: Progress Report 1990*. Department of Biology and Nature Conservation, Agricultural University of Norway, King Mahendra Trust for Nature Conservation Nepal and DNPWC. Nepal. 37pp.
- Wegge, P., Larsen, B.B. 1987. *Spacing of Adult and Subadult Male Common Capercaillie during the Breeding Season*. The Auk 104:481-490.
- Yonzon, P. 1994. *Count Rhino 1994*. WWF Nepal Program, Report Series. No. 10. Kathmandu.
- Yonzon, P., Adhikari, T.R. and Subedi, N. 2003. *Systematic Approaches in Rhino Translocation*. A Survey Report Prepared for the World Wildlife Fund Nepal Programme.



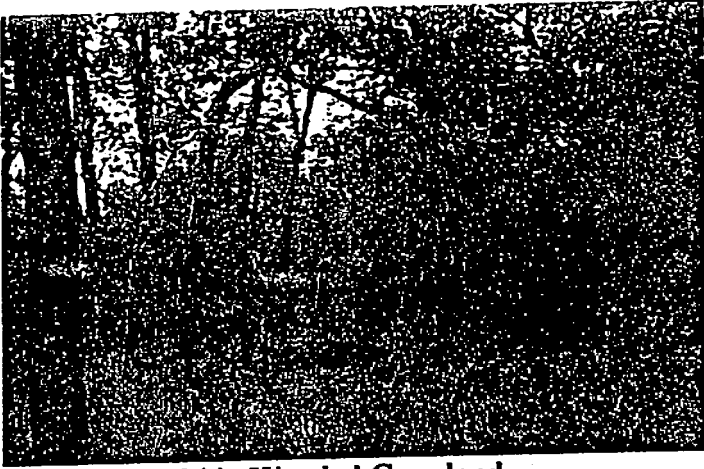
Chitwan Bhale and Sukla pothi near Barkola.



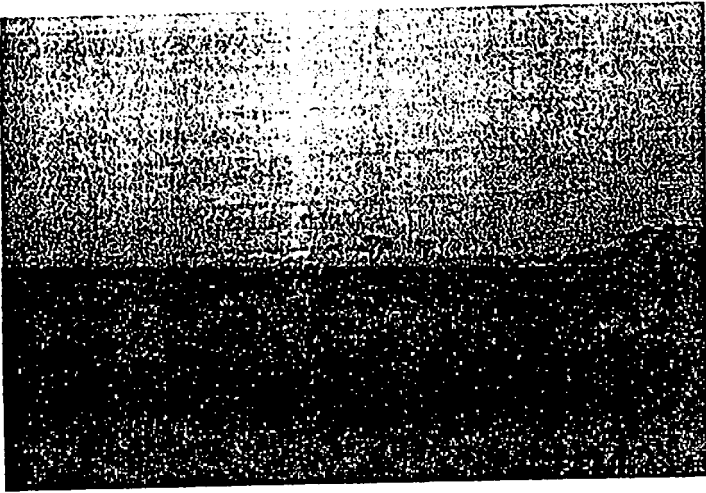
Chitwan Bhale in Wallow near Sila lake.



SukibharPothi near Sundhari Phanta.



Sukibhar Pothi in Wooded Grassland



Sukla Pothi in Harayaphanta.



Sukla Pothi in Barkola(Patero Tal).

Appendix-I: Mammals of RSWR

S.N.	Scientific Name	Common Name
1.	<i>Elephus maximus</i>	Wild elephant
2.	<i>Rhinoceros unicornis</i>	One horned rhino
3.	<i>Panthera tigris</i>	Bengal tiger
4.	<i>Panthera pardus</i>	Common leopard
5.	<i>Felis bengalensis</i>	Leopard cat
6.	<i>Felis chaus</i>	Wild cat
7.	<i>Felis viverrina</i>	Fishing cat
8.	<i>Canis aureus</i>	Jackal
9.	<i>Vulpus bengalensis</i>	Indian fox
10.	<i>Cuon alpinus</i>	Wild dog
11.	<i>Hyaena hyaena</i> ¹	Stripped hyaena
12.	<i>Petaurista petaurista</i>	Flying squirrel
13.	<i>Funambulus palmarum</i>	Three striped palm squirrel
14.	<i>Funambulus pennati</i>	Five striped palm squirrel
15.	<i>Macaca mulata</i>	Rhesus monkey
16.	<i>Presbytis entellus</i>	Common lonyur
17.	<i>Manis crassicaudata</i>	Indian pangolin
18.	<i>Paradoxurus hermaphoditus</i>	Common palm civet
19.	<i>Viverricula indica</i>	Small Indian civet
20.	<i>Lutra lutra</i>	Common otter
21.	<i>Lutra perspicillata</i>	Smooth Indian otter
22.	<i>Melursus ursinus</i>	Sloth bear
23.	<i>Hystrix indica</i>	Indian porcupine
24.	<i>Myotis species</i>	Bat
25.	<i>Sus scrofa</i>	Wild boar
26.	<i>Cervus duvauceli</i>	Swamp deer
27.	<i>Axis axis</i>	Spotted deer
28.	<i>Axis percinus</i>	Hog deer
29.	<i>Cervus unicolor</i>	Sambar deer
30.	<i>Muntiacus muntjak</i>	Barking deer
31.	<i>Boselaphus tragocamelus</i>	Blue bull
32.	<i>Caprolagus hispidus</i> ¹	Hispid hare
33.	<i>Lepus negricolis</i>	Black happed hare
34.	<i>Herpestes auropunctatus</i>	Small Indian mongoose
35.	<i>Hapestes edwardsi</i>	Common mongoose
36.	<i>Herpestes urva</i>	Crab eating mongoose
37.	<i>Rattus rattus</i>	Common house rat
38.	<i>Bandicoota bengalensis</i>	Mole rat
39.	<i>Mus musculus</i>	House mouse

Appendix-II: Fishes of RSWR

S.N.	Scientific Name	Common Name
1.	<i>Tor tor</i>	Sahar or Mahaseer
2.	<i>Labeo rohita</i>	Rohu
3.	<i>Labeo angara</i>	Rohu
4.	<i>Esomus danricus</i>	
5.	<i>Glossogobius giuris</i>	
6.	<i>Lipidocephalichthys guntea</i>	Ghara
7.	<i>Mystus tengra</i>	Tengra
8.	<i>Mystus vitatus</i>	Tenger
9.	<i>Channa gachuwa</i>	Hile
10.	<i>Channa striatus</i>	Saur
11.	<i>Amphipnous cuchia</i>	Bam
12.	<i>Crossocheilus latius</i>	Petfora
13.	<i>Macrognathus aculatus</i>	
14.	<i>Chanda nama</i>	
15.	<i>Gundusia chapra</i>	Sidhri
16.	<i>Puntius sophore</i>	Sidhri
17.	<i>Puntius sarana</i>	Sidhri
18.	<i>Wallago attu</i>	Bahamor buhari
19.	<i>Heterophneustis focsitis</i>	Singi
20.	<i>Catla catla</i>	Catla
21.	<i>Trichogaster lalius</i>	
22.	<i>Channa marulius</i>	Saura
23.	<i>Gara gotyla</i>	Buduna
24.	<i>Cirrhhina reba</i>	
25.	<i>Xenatodon cancila</i>	Chuche bam
26.	<i>Bagarius bagarius</i>	Gouch
27.	<i>Schizothrax richardsoni</i>	Asla

Appendix III: Herpetofauna of RSWR

S.N.	Scientific Name	Common Name
1.	<i>Eumeces faisatus</i>	Five lined skink
2.	<i>Typhlopus braminus</i>	Blind snake
3.	<i>Python molurus</i> ^{1, 2}	Python
4.	<i>Crocodilus palustris</i> ²	Marsh crocodile
5.	<i>Varanus bengalensis</i>	Monitor lizard
6.	<i>Naja naja</i> ²	Cobra

Appendix Iv. Distribution of locations of Chitwan bhale in RSWR, 2000-2003

Date of observation	Areas occupied	Habitat type	GPS location
21, 23, 25 Nov. 2000	Rani tal area	Sal forest	
19 Jan. 2001	Salgaudi tal	Tall grassland	
11 April 2001	Baba tal area	Tall grassland	
12 May 2001	Malumela area	Riverine forest	
21 June 2001	Dughiya camp chowk	Sal forest	
12 Sep. 2001	Dudhiya camp chowk	Sal forest	
13 Sep. 2001	Haraiya phanta	Tall grassland	
16 Nov. 2001	Salgaudi tal	Tall grassland	
14 Jan. 2002	Salgaudi tal	Tall grassland	
25 Dec. 2002	West-north of Suklaphanta post	Mixed grassland	N 28°49'345" E 80°10'397"
26 Dec. 2002	South of Singhpur post	Tall grassland	N 28°49'458" E 80°12'199"
2 Jan. 2003	North of Haraiyaphanta	Sal forest	N 28°50'911" E 80°14'493"
1 May 2003	North west of Suklaphanta (Silalake chowk)	Tall grassland	N 28°50'178" E 80°08' 076"
27 Feb. 2003	Dudhiya camp chowk	Sal forest	N 28°50'764" E 80°13'221"
17 March 2003	Barkola	Tall grassland	N 28°52'063" E 80°09'444"
19 March 2003	Solgaudi tal	Tall grassland	N 28°52'808" E 80°13'443"
24 March 2003	South of Malumela	Sal forest	N 28°52'208" E 80°14'028"
25 March 2003	East of Solgaudi tal	Tall grassland	N 28°52'300" E 80°13'820"
3 May 2003	North west of Silalake	Riverine forest	N 28°50'178" E 80°08' 290"
7 May 2003	Palero tal (Barkola)	Wooded grassland	N 28°52'192" E 80°09' 575"

Appendix v. Distribution of locations of Sukibhar Pothi in RSWR, 2000-2003

Date of observation	Areas occupied	Habitat type	GPS location
21, 23, 25 Nov. 2000	Rani tal area	Sal forest	
30 Nov. 2000	Jhilmila area	Riverine forest	
5 Dec. 2000	Jhilmila area	Riverine forest	
11 Dec. 2000	Dhaknaghat area	Wooded grassland	
12-15 Dec. 2000	Dhaknaghat area	Wooded grassland	
16 Dec. 2000	Dodhara	Cultivated field	
17 Dec. 2000	22 No. Pillar area	Short grassland	
18 Dec. 2000	North east of 23 No. Pillar	Short grassland	
19 Dec. 2000	Dhaknaghat area	Wooded grassland	
21 Dec. 2000	Gazerghat	Riverine forest	
22 Dec. 2000	Gazerghat	Riverine forest	
23 Dec. 2000	Gazerghat	Riverine forest	
24 Dec. 2000	Piparia post area	Riverine forest	
26 Dec. 2000	Gazerghat	Riverine forest	
27 Dec. 2000	Piparia post area	Crop field	
30 Dec. 2000	Piparia post area	Riverine forest	
1 Jan. 2001	Back of piparia post	Sissoo forest	
2 Jan. 2001	Dhaknaghat area	Wooded grassland	
10-13 Jan. 2001	Piparia post area	Sissoo forest	
15 Jan. 2001	Piparia post area	Riverine forest	
18 Jan. 2001	Piparia post area	Riverine forest	
20-23 Jan. 2001	Piparia area	Riverine forest	
29 Jan. 2001	Piparia post area	Riverine forest	
3-8 Feb. 2001	Piparia area	Riverine forest	
16-19 Feb. 2001	Piparia area	Riverine forest	
20 Feb. 2001	Lagga-bagga		
22 Feb. 2001	Piparia area	Riverine forest	
13 March 2001	Piparia area	Riverine forest	
16-19 March 2001	Piparia area	Riverine forest	
26 March 2001	Dhaknaghat	Wooded grassland	
3 April 2001	23 & 24 No. pillar area	Short grassland	
9 Sep. 2001	24 No. Pillar	Short grassland	
20 Sep. 2001	Dudhiya camp chowk	Sal forest	
16 Oct. 2001	Bir singh phanta	Tall grassland	
20 Dec. 2001	Barkola area	Tall grassland	
25 June 2002	Barkola area	Tall grassland	
18 March 2003	Haraiyaphanta	Tall grassland	N 28°51'280" E 80°14'123"
22 March 2003	North of Haraiyaphanta	Tall grassland	N 28°51'012" E 80°14'281"
29 March 2003	Haraiyaphanta	Tall grassland	N 28°51'001" E 80°13'787"
1 May 2003	Silalake chowk	Tall grassland	N 28°50'178" E 80°08' 076"
4 May 2003	Barkola patero tal	Riverine forest	N 28°52'663" E 80°09' 444"
7 May 2003	Patero tal (Barkola)	Wooded grassland	N 28°52'192" E 80°09' 575"

Appendix vi. Distribution of locations of Mau pothi with calf in RSWR, 2000-2003

Date of observation	Areas occupied	Habitat type	GPS location
21, 23, 25 Nov. 2000	Rani tal area	Sal forest	
9 Nov. 2001	Salgaudi tal	Tall grassland	
12 Nov. 2001	Salgaudi tal	Tall grassland	
22 Nov. 2001	Salgaudi tal	Tall grassland	
25 Nov. 2001	Salgaudi tal	Tall grassland	
6 Jan. 2002	Salgaudi tal area	Riverine forest	
6 May 2002	Salgaudi tal	Tall grassland	
2 Jan. 2003	North of Haraiyaphanta	Tall grassland	N 28°50'911" E 80°14'493"
8 Jan. 2003	East of Rani tal	Tall grassland	N 28°51'786" E 80°14'629"
16 March 2003	North of Haraiyaphanta	Tall grassland	N 28°51'320" E 80°14'002"
27 March 2003	Haraiyaphanta	Tall grassland	N 28°51'444" E 80°14'022"
17 April 2003	North east of patero tal	Tall grassland	N 28°52'207" E 80°09' 442"
18 April 2003	West of Barkola post	Tall grassland	N 28°51'063" E 80°08' 572"
6 May 2003	Patero tal area (Tall grassland	N 28°52'207" E 80°09' 447"

Appendix vii. Distribution of locations of Sukla pothi in RSWR, 2000-2003

Date of observation	Areas occupied	Habitat type	GPS location
21, 23, 25 Nov. 2000	Rani tal area	Sal forest	
28 Jan. 2001	Lagga-bagga area	Short grassland	
1 Feb. 2001	Dodhara	Cultivated field	
2 Feb. 2001	Bir singh phanta	Mixed grassland	
20 Sep. 2001	Dudhiya camp chowk	Sal forest	
18 Dec. 2001	Salgaudi tal	Riverine forest	
20 Dec. 2001	Barkola area	Tall grassland	
2 Jan. 2002	Barkola area	Tall grassland	
29 March 2003	Dhaknaghat	Riverine forest	N 28°51'373" E 80°14'307"
1 April 2003	North west of Silalekh	Riverine forest	N 28°50'512" E 80°08'092"
23 April 2003	West of Haraiyaphanta	Tall grassland	N 28°50'332" E 80°13' 630"
27 April 2003	Haraiyaphanta	Tall grassland	N 28°51'001" E 80°13' 787"
7 May 2003	Barkola area	Tall grassland	-

Appendix viii. Distribution of locations of Sukla bhale in RSWR, 2000-2003

Date of observation	Areas occupied	Habitat type	GPS location
23 Nov. 2000	Rani tal area	Tall grassland	
21 April 2003	East of Ranital	Tall grassland	N 28°50'078" E 80°13' 645"

Appendix Ix. Distribution of locations of Rhinoceros footprints, dung, fresh wallows and feeding signs

Date of observation	Areas occupied	Habitat type	GPS location
9 Feb. 2001	Bir singh phanta	Tall grassland	
10 Feb. 2001	Naugalli village	Cultivated field	
11 Feb. 2001	Lagga-bagga	Short grassland	
13 Feb. 2001	Bir singh phanta	Tall grassland	
14 March 2001	Lagga-bagga	Short grassland	
24 March 2001	Barkola area	Tall grassland	
28 March 2001	Dhaknaghat	Wooded grassland	
1 April 2001	Salgaudi tal	Tall grassland & Marsh	
7 April 2001	Salgaudi tal	Tall grassland & Marsh	
15 April 2001	Salgaudi tal	Tall grassland & Marsh	
26 April 2001	Barkola area	Tall grassland	
26 April 2001	Babai river	Riverine forest	
27 May 2001	Singpur post area	Riverine forest	
28 May 2001	Suklaphanta	Short grassland	
20 June 2001	Baba tal	Tall grassland & Marsh	
26 Aug. 2001	23 No. Pillar	Short grassland	
10 Sep. 2001	Barkola area	Tall grassland	
11 Sep. 2001	Lagga-bagga	Short grassland	
15 Sep. 2001	Singpur post area	Riverine forest	
21 Sep. 2001	Haraiya phanta	Tall grassland	
30 Sep. 2001	Barkola area	Tall grassland	
10 Oct. 2001	Barkola area	Tall grassland	
13 Oct. 2001	Baba tal	Tall grassland & Marsh	
30 Oct. 2001	Barkola area	Tall grassland	
10 Nov. 2001	Sila lake area	Tall grassland	
27 Nov. 2001	Barkola area	Tall grassland	
11 Dec. 2001	Suklaphanta	Mixed grassland	
12 Dec. 2001	Barkola area	Tall grassland	
18 Dec. 2001	Suklaphanta	Short grassland	
27 Dec. 2001	Lagga-bagga	Short grassland	
28 Dec. 2001	Barkola area	Tall grassland	
29 Dec. 2001	Dudhiya camp chowk	Sal forest	
30 Dec. 2001	Dodhara area	Cultivated field	
17 Jan. 2002	Baba tal area	Tall grassland & Marsh	
7 Feb. 2002	Barkola area	Tall grassland	
8 Feb. 2002	Piparia area	Riverine forest	
10 Feb. 2002	Barkola area	Tall grassland	
15 Feb. 2002	Barkola area	Tall grassland	
7 March 2002	Salgaudi tal	Tall grassland & Marsh	
11 March 2002	Suklaphanta	Short grassland	
14 March 2002	Barkola area	Tall grassland	
19 May 2002	Baba tal	Tall grassland & Marsh	
23 June 2002	Salgaudi tal	Tall grassland	
18 Aug. 2002	Barkola area	Tall grassland	
5 Sep. 2002	Suklaphanta	Short grassland	
1 Oct. 2002	Barkola area	Wooded grassland	
19 April 2003	Ranital area	Tall grassland	N 28°52'808" E 80°13' 443"
25 April 2003	Salgodi tal	Tall grassland	N 28°53'080" E 80°12' 360"
28 April 2003	Baba tal	Tall grassland	N 28°51'915" E 80°09' 151"
30 April 2003	North of Borkola	Sal forest	N 28°50'178" E 80°08' 076"
2 May 2003	(Sila lake chowk)	Tall grassland	