

**ECOLOGY AND BEHAVIOUR OF REHABILITATED
RHINO, *Rhinoceros unicornis* IN KAKRAHA BLOCK OF
DUDHWA TIGER RESERVE**

Summary of the Thesis
submitted to C.S.J.M. University, Kanpur
for the Degree of
Doctor of Philosophy
in Zoology

By
Arun Kumar Tripathi
Department of Zoology
Y.D.P.G. College, Lakhimpur-Kheri (U.P.)

Supervisor
Dr. Vijay Prakash Singh
Reader
Department of Zoology
Y.D.P.G. College, Lakhimpur-Kheri (U.P.)

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Dedication

*This work is an outcome of concurrent inspiration
to me from my Parents Sri Shyam Narayan Tripathi
and Smt. Parana Tripathi for the cause of conserving
the vanishing wildlife.*



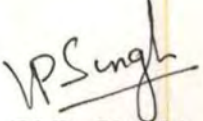
Dr V.P. Singh
Reader
Department of Zoology
Y.D.P.G. College,
Lakhimpur-Kheri (U.P.)

Dated: 24 Dec., 2002

Certificate

This is to certify that this thesis entitled “**Ecology and Behaviour of Rehabilitated Rhino, *Rhinoceros unicornis* in Kakraha Block of Dudhwa Tiger Reserve**”, being submitted by Mr Arun Kumar Tripathi is a bonafied research work by the candidate himself.

This thesis fulfils the requirement of **Chatrapati Shahu Ji Maharaj University, Kanpur**. The thesis has been found satisfactory from the point of view of literary presentation. He has completed 200 days attendance.

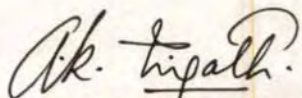

(V.P. Singh)
Supervisor

Declaration

I hereby declare that with the exception of guidance and suggestions received from my guide **Dr V.P. Singh**, Reader, Deptt. of Zoology, Y.D.P.G. College, Lakhimpur-Kheri (U.P.), this doctoral dissertation entitled, "**Ecology and Behaviour of Rehabilitated Rhino, *Rhinoceros unicornis* in Kakraha Block of Dudhwa Tiger Reserve**" is my own unaided work.

It is based upon the research work, which has been carried out in Dudhwa Tiger Reserve and Department of Zoology, Y.D.P.G. College, Lakhimpur-Kheri (U.P.).

Dated: 24 Dec., 2002


(**Arun Kumar Tripathi**)
Department of Zoology
Y.D.P.G. College,
Lakhimpur-Kheri (U.P.)



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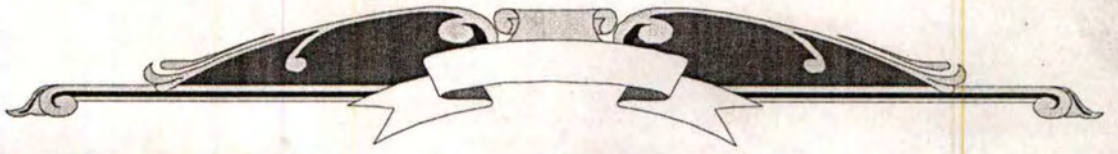
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Introduction



INTRODUCTION

Mammals evolved in great variety and numbers in the Eocene epoch of the Coenozoic era. The Fossils history and other palaeozoological remnant reveal that the ancestors of the Family Rhinocerotidae first appeared during this period. Such fossil forms have been discovered from many locations in North America, Europe, Asia and Africa. Rhinoceroses probably evolved from early tapiroids, as revealed by fossils, but took a different evolutionary route. These tapirs and rhinoceroses were once included in the unnatural assembly of 'Pachydermata' and widely separated from the horses with which they share an early Eocene ancestry. Now they are placed under sub-order Ceratomorpha of order Perissodactyla. Ceratomorphs form two super-families of unequal extent, viz. Tapiroidea and Rhinoceroidea. The super-family Rhinoceroidea, soon after its beginning in the Lower Eocene divided into four main lines of evolution:

1. **Hyrachyidae** (the most primitive forms, e.g. Hyrachyns),
2. **Hyrachodontidae** (light cursorial animal, e.g. Hyrachodont),
3. **Amyndodontidae** (semi-aquatic forms, e.g. Amyndodont).

The above-mentioned lines (Families) became extinct during the Eocene, Oligocene and Miocene period respectively. The remaining 4th line (Family) **Rhinocerotidae** (the true rhinoceros) began in Eocene epoch and

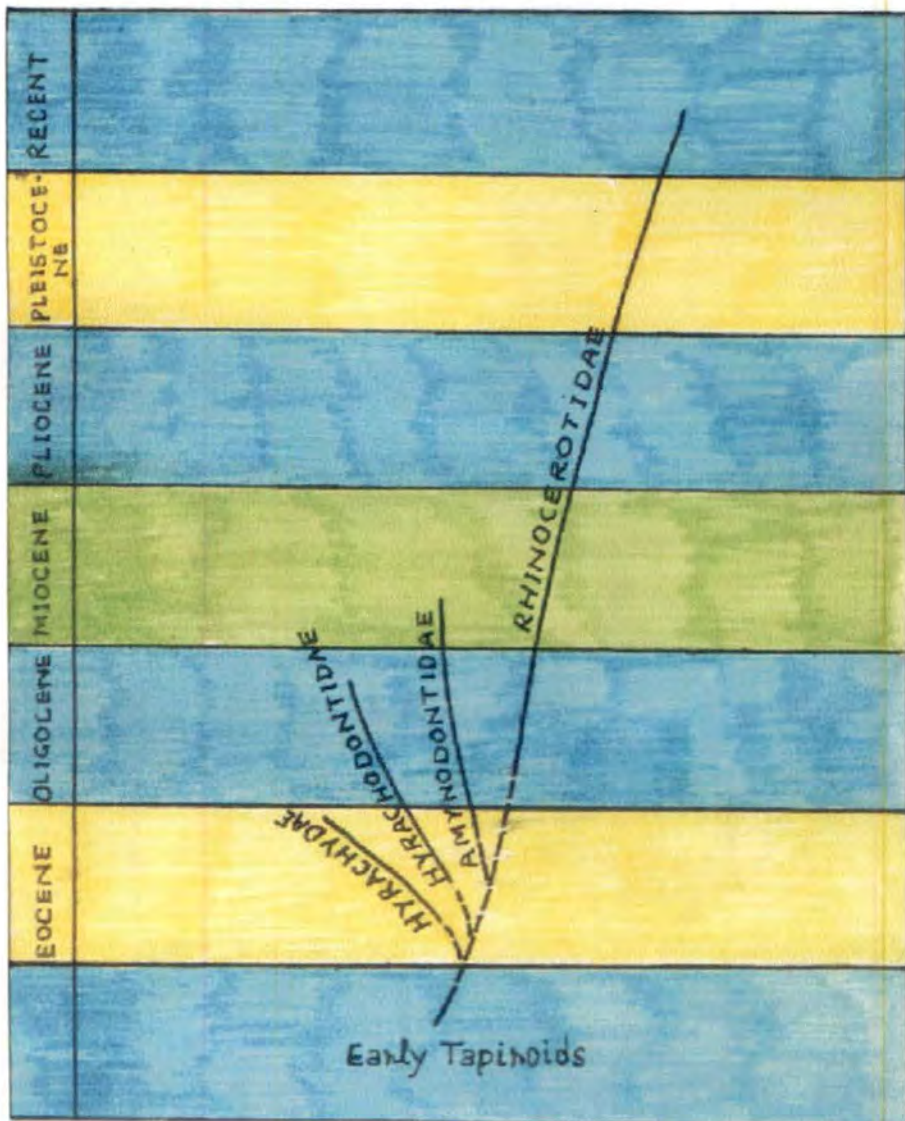


Fig. 1.1 Evolution of families of Rhinocerotoida at various geological horizons
(After Young, J.Z., 1961)

spread out into many lines during the Oligocene and subsequent period until the Pleistocene. Then the group became much reduced (fig. 1.1).

The true rhinoceroses are probably the descendants of the Hyrachodonts of Oligocene epoch, which had long, slender legs with three toes on each foot and typically rhinocerotoid cheek teeth.

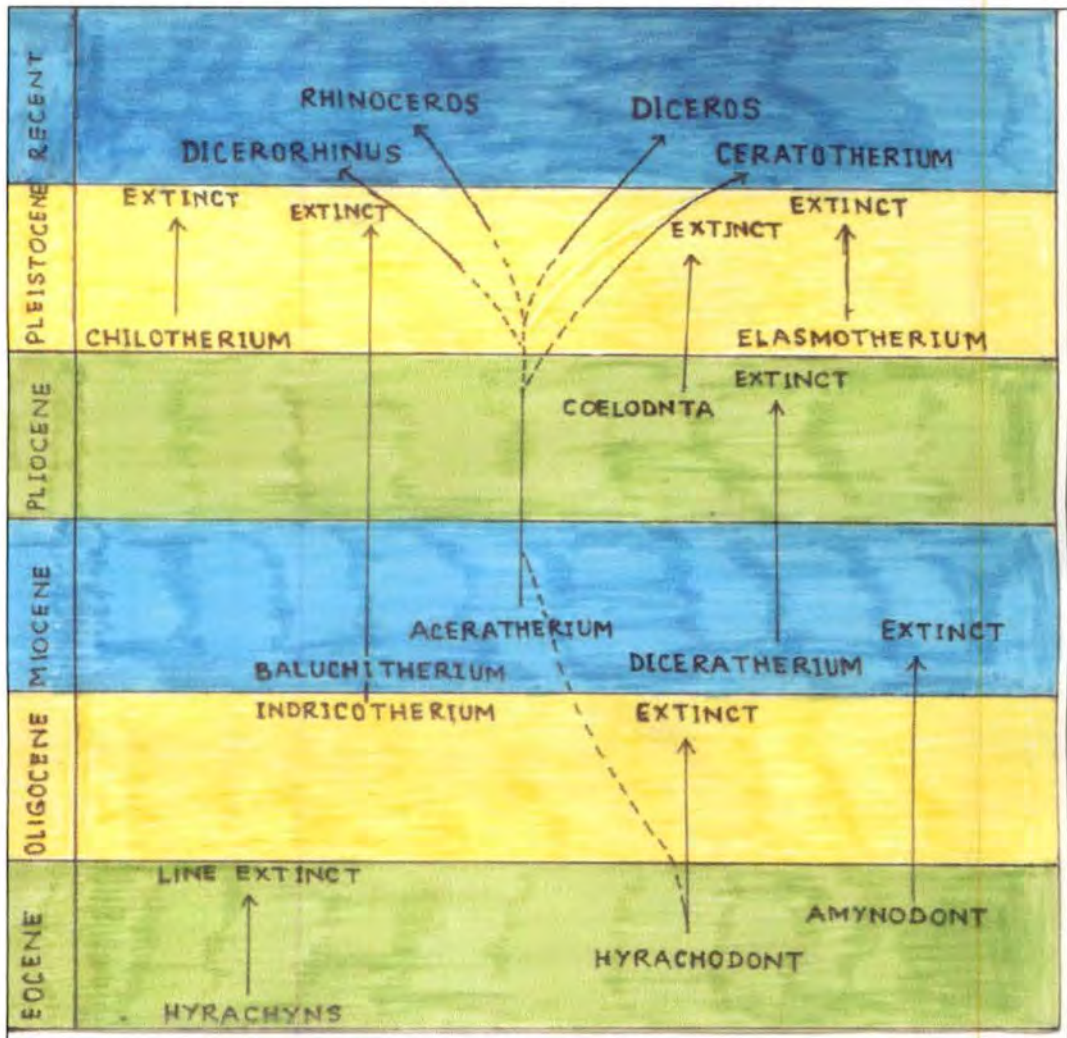


Fig. 1.2 Suggested Phylogeny of Rhinoceros.

The progress of Coenozoic era witnessed several dozen genera that can be said to belong to the Rhinocerotidae family (fig. 1.2). The largest among these in the past were the *Baluchitherium* and *Indricotherium* in the Oligocene and Miocene epoch respectively. They were the denizens

of Asia, and were perhaps the largest terrestrial mammals ever known. Having long neck and forelegs, they stood about 5.5 meters and probable weighed about 25 tonnes.

Rhinoceros became numerous in the Miocene and Pliocene epochs. During Miocene a hornless species, *Aceratherium*, existed in Europe and Asia. Similar species inhabited North America including one known as *Diceratherium*. In the Pleistocene there was the *Coelodonta*, or **woolly rhinoceros**, so-called because of its thick coat of hairs. Bones of this species have been found in almost intact form in caves and river beds from the British Isles across Eurasia to China. The stone-age artists in cave paintings have immortalized the *Coelodonta*. During the same epoch there was another species, *Elasmotherium*, which had a six feet horn between the eyes, and which inhabited Siberia, Russia and Germany. Although considerably larger, this animal resembled the Indian one-horned rhinoceros in appearance and was grazer. In Pleistocene it was a genus *Chilotherium* with an unusually broad mandibular symphysis. In India too the rhinoceros, like North America, Africa, Europe and other parts of Asia, made its first appearance in the Eocene epoch. Fossilized remains found in the upper layer of the Siwalik ranges and in other parts of India reveal an unimaginable mammalian richness in the same period.

Late tertiary mountain building caused great elevation of the continents, withdrawal of the sea and climate change. In this changing environment most of the several dozen genera of the family-Rhinocerotidae have become

extinct. At present there are only five species distributed in four genera living in the world, two in Southern and Eastern Africa and three in tropical Asia. All five extant species today are also threatened with extinction due to interference by man. The extant rhinoceros species are-

1. *Ceratotherium simum* - African white or square-lipped rhinoceros,
2. *Diceros bicornis* - African black rhinoceros,
3. *Dicerorhinus sumatrensis* - Asiatic two-horned or Sumatran rhinoceros,
4. *Rhinoceros sondaicus* - Lesser one-horned or javan rhinoceros,
5. *Rhinoceros unicornis* - Indian one-horned rhinoceros.

All the existing species of rhinoceroses are old world forms; probably separated from each other and become distinct species million of years ago. All three species of Asiatic rhinos (Indian, Javan and Sumatran) were to be found in India in the prehistoric past. The genealogy of Indian and Javan rhinos is somewhat obscure, though both are true and typical rhinoceroses. No fossilized remains of these two

species have been found except in South East Asia. Moreover, in India, the more ancient Siwalik beds do not show remnants of these rhinoceroses. But the ancient species of Indian rhinoceros such as Siwalik Rhinoceros, (*Rhinoceros sivalensis*) and *Rhinoceros paloeindicus* appeared in the upper most and more recent beds. Fossil remnants in the Siwalik Hills show that the Sumatran rhino existed in India



Fig. 1.3 Past distribution range of Great Indian One-horned Rhinoceros (1500 AD)

during the Pliocene. All the three Asiatic species were to be found in Bengal and northeast India well into the 20th century, while the Sumatran

species existed in the Mizo-hills till about 1935, after which it too disappeared.

The great Indian one-horned rhinoceros previously occupied an extensive range across the whole of the northern India and Nepal from what is now Pakistan in the west as far as Peshawar and the north western passes to Assam in the east (fig. 1.3). It is, however, not known whether its range extended further eastward through Myanmar and Southeast Asia, as that of the other two Asiatic species. But given the total absence of any fossil evidence or historical references, this is highly unlikely. The Indian rhino was extensively found in the alluvial flood plains of Mega Rivers like the Indus, Ganges and Brahmaputra, as well as the Tarai regions of the Nepal and Sikkim. Archaeologists have discovered a seal bearing the figure of a one-horned rhino at Mohen-jo-daro excavations. The Mohen-jo-daro civilization existed around 5,000 years ago and the fact that this animal was used as a seal indicates the significance it held in the popular imagination of that era (fig. 1.4).



Fig- 1.4: Seal from Mohen-jo-daro civilization depicting a Rhinoceros.

There is a record that the Great Moghul Emperor Babur hunted it even near Peshawar in 1526. Its southern limit seems somewhat uncertain but presumably, it did not extend into drier parts (**Sale, 1981**) hunting and poaching for sport, horn, or hide as well large scale conversion of the tarai grassland to agriculture and tea plantations during last two hundred years or so has led to the persecution of this species from its past distribution range. This has converted the past continuous range of Indian one-horned rhinoceros from Peshawar (Pakistan) to Arunachal Pradesh (Assam) into isolated pockets of Indian and Nepalese Tarai regions.

Current Status of Indian One-horned Rhinoceros

The original wide range of the Indian One-horned rhinoceros, *Rhinoceros unicornis* in the Indian subcontinent has contracted eastwards. Presently, this species is reported mainly from Assam (Kaziranga National Park and five other locations), West Bengal (Jaldapara Wildlife Sanctuary and Garumara National Park), Dudhwa Tiger Reserve, U.P. (rehabilitated) in India, Royal Chitwan National Park and Royal Bardia Wildlife Reserve (rehabilitated) in Nepal (fig. 1.5), with a population totaling 1,893. Kaziranga alone holds about 63% of the world's one-horned rhino population today (**Kushwaha, Roy, Azeem, Boruah and Lahan, 2000**). They have also reported this species in Lal Suhanra, Pakistan. In the survey carried out in 1959 by a great biologist **Gee E. P.**, the rhino population was estimated to be about 260 individuals, which has risen to about 1,200 ,i.e. a five-fold increase between 1959 and 1985.

Since late 70's Assam Rhino Specialist Group and Indian Board for Wildlife considered reintroducing the Great Indian one-horned rhinoceros

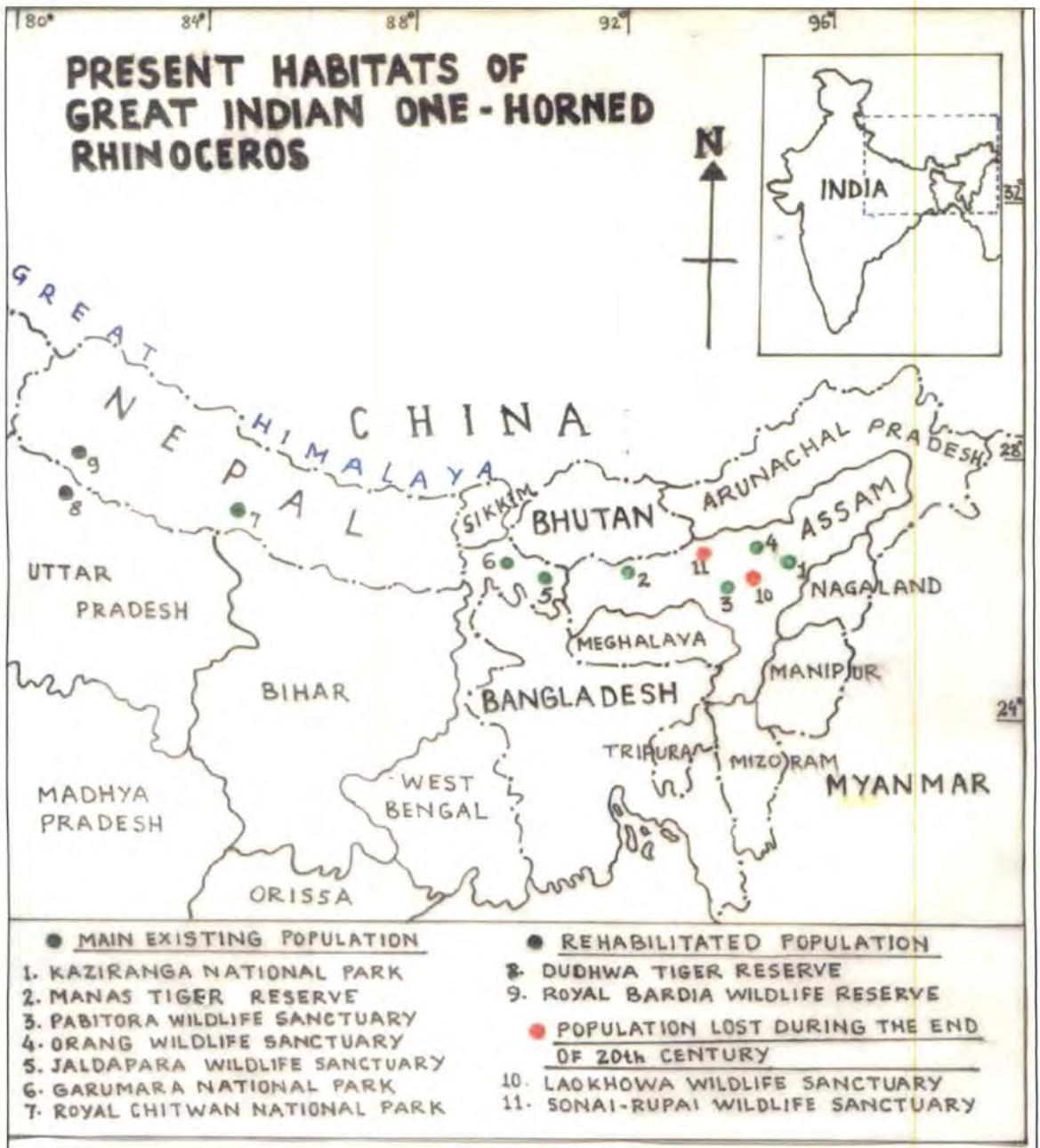


Fig. 1.5 Present habitats of Great Indian One-horned Rhinoceros.

from safe stocks, such as in Kaziranga National Park (Assam) and Chitwan National Park (Nepal) into suitable areas within its former distribution range where it had disappeared or was disappearing. This programme started with translocation of five rhino from Kaziranga

National Park in Dudhwa Tiger Reserve in 1984. In order to establish a vigorous breeding nucleus, this reintroduction was aided by the translocation of four rhinos from Chitwan N.P. into Dudhwa Tiger Reserve in 1985. Within Nepal, rhinos were translocated from Chitwan N.P. to Bardia Wildlife Reserve in 1987(**Bauer, 1988**).

HABITAT of INDIAN ONE-HORNED RHINOCEROS

INDIA

Assam

1. Kaziranga National Park
2. Manas Tiger Reserve
3. Pabitora Wildlife Sanctuary
4. Orang Wildlife Sanctuary
5. Laokhowa Wildlife Sanctuary #
6. Sonai-Rupai. #

West Bengal

1. Jaldapara Wildlife Sanctuary
2. Garumara National Park

Uttar Pradesh

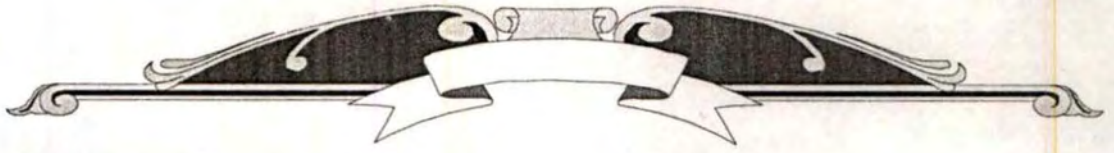
1. Dudhwa Tiger Reserve*

NEPAL

1. Royal Chitwan National Park
2. Royal Bardia Wildlife Reserve*

Population has been lost recently.

*Rehabilitated population



Historical Review



HISTORICAL REVIEW

At the beginning of 20th century, in India **Stebbing (1908)** pioneered the information regarding distribution, morphology, habitat, feeding behaviour of different sub-species of rhinoceros. After a considerable long gap of many years, a great biologist, **Gee (1964)** gave a detailed and vivid description of different species of rhinoceros. In the middle of 20th century a number of biologists such as **Chaudhary (1964)**, **Chaturvedi (1968)** and **Pathak (1978)** carried out study on rhinoceros in different aspect. The reproductive behaviour of Indian one-horned rhinoceros studied by **Chaturvedi (1968)**, who was observed that the desire of courtship and copulation in the male and female do not synchronize all time and so they are termed as “reluctant breeder”. **Chaudhary (1964)** and **Pathak (1978)** have observed different aspects on grazing animals and described that the grazing animals are a potential threat to the wild animal population as they not only compete for the fodder but also spread diseases like ‘anthrax’ among the wild animals, including rhinoceros. **Prater (1971)** has given a detailed description on Indian one-horned rhinoceros in his book “The Book of Indian Animals”.

A field study regarding ecology and social behaviour of black rhinoceros, *Diceros bicornis* was carried out by **Shenkel and Shenkel (1969)** at Tsavo National Park, Africa. The density, distribution, population structure and social organization of the black rhinoceros at Masai Mara Game Reserve, Africa was described by **Mukinya (1973)**.

Smith (1971) has observed territorial behavior in the white rhinoceros, *Ceratotherium simum*. According to **Smith (1971)** each species requires a particular habitat, food, shelter and other survival needs to the extent that species are said to be a product of their habitat. **Laurie (1978) and Patar (1977)** studied on ecology and behaviour of Indian rhinoceros and provided some basic ecological data on the Chitwan population and winter-feeding habits in Kaziranga respectively. Similar study was carried out on the Sumatran rhinoceros, *Dicerorhinus sumatrensis* by **Borner (1979)**.

Sterndale (1982) gave a detailed description regarding the distribution, morphology, and habitat of different species of rhinoceros. A comprehensive study on the different aspects of the defecation behaviour of the great Indian one-horned rhinoceros was carried out at two small eastern sub-Himalayan wildlife sanctuaries (Garumara and Jaldapara,

West Bengal) by **Chaturvedi and Pal (1982)**. It was a part of broader field study of ecology and behaviour of the animal.

Kaziranga (Assam) has been explored from time to time by many field workers. **Mary , Solanki , Limboo , and Upadhyaya (1998)** studied the feeding and territorial behaviour of Indian one-horned rhinoceros in Kaziranga N. P., Assam. They have reported that Indian rhino, *Rhinoceros unicornis* mark the territory by defecating at particular places. There are also some common paths and places, which are shared for grazing or wallowing activity. These places are not defended.

Bhattacharya and Acharya studied identification of Great Indian one-horned rhinoceros by foot impression in 1992. **Bhattacharya (1992)** also carried out a study on interspecific aggression between Great Indian one-horned rhinoceros, *Rhinoceros unicornis* and Indian elephant, *Elephas maximus* at Garumara WLS, West Bengal. The great Indian rhinoceros has a peculiar defecating behaviour by making large dung piles in some selected spots and using the same defecation places over and over again. Some new aspects of pre- and post-defecating behaviour associated with scent marking relationship in great Indian one-horned rhinoceros were reported by **Bhattacharya (1994)**. A number of other workers such as **Kushwaha, Roy, Azeem A., Boruah and Lahan (2000)**

carried out a study on rhino habitat suitability in Kaziranga N. P., Assam and found that in Kaziranga only 5% of the area was to be highly suitable for Indian rhino while 27% area was unsuitable.

Historical fact is that about 160 years ago Indian rhino, *Rhinoceros unicornis* used to roam freely in the nature in Tarai belt of U. P. including Dudhwa forests. The last rhino in U. P. was shot in Pilibhit district not far from Dudhwa in 1878. Hunting and habitat destruction in the last couple of centuries, however, finished off the rhino in much of this range. In 1979, the **Asian Rhino Specialist Group** of the **IUCN Survival Service Commission** (now known as the **Species Survival Commission**) emphasized the need for continuous effort in protection and monitoring of the species, adding that “steps must be envisaged to establish additional population units in suitable areas, preferably in the rhino’s former distribution range”. Of the various areas considered by this sub-committee, Dudhwa Tiger Reserve, U.P. was found to be the most suitable alternate habitat. The suitability of Dudhwa Tiger Reserve was confirmed by **Prof. Schenkel**, chairman of the SSC Asian Rhino specialist Group, after visit to Dudhwa Tiger Reserve in 1980/81 (**Schenkel, 1983**). **Sale (1981)** presented the report regarding the recommendations of translocation of the great Indian one-horned

rhinoceros in Dudhwa Tiger Reserve. **Hajra and Shukla (1982)** made a detailed study on the vegetation of the proposed (recommended) area for rehabilitation of Indian rhinos and found that the availability of the food plants are more or less the same as found in the natural habitat of the Indian rhinoceros such as Kaziranga National Park, Assam. **Singh and Rao (1984)** carried out a study on Indian rhino reintroduction programme. **Sale and Singh (1987)** also presented their views on reintroduction of the great Indian rhinos in Dudhwa Tiger Reserve area and gave a description of the future plan of the same rehabilitated area.

Number of other workers carried out investigations on different aspects of the reintroduced rhinos at Dudhwa Tiger Reserve such as **Sinha and Sawarkar (1991)**, who made a study on “Management of the reintroduced Great Indian one-horned Rhinoceros in Dudhwa Tiger Reserve”. **Quresi (1991)** also made a study on rehabilitated rhinos in newly designed habitat in Dudhwa Tiger Reserve.

In Nepal also rhinos were translocated from Royal Chitwan National Park to Bardia Wildlife Reserve in February and December 1987, following the experiences and methods as taken for release of rhinos at Dudhwa Tiger Reserve. **Laurie (1978)** suggested translocation sites in Nepal. **Bauer (1988)** conducted a survey in Bardia Wildlife

Reserve to assess the distribution and habitat utilization of rehabilitated rhinoceros.

History of Dudhwa Rhino-reintroduction Programme

The Great India one-horned Rhino, *Rhinoceros unicornis* is in the endangered list of the **IUCN** and for its long term survival, the **Asian Rhino Specialist Group** of **IUCN** and the **Rhino Sub-Committee** of **Indian Board of Wildlife (IBWL)** recommended that new areas, preferably the rhino's former range of distribution be identified where additional population of Indian rhinos could be bred by translocation. Following upon these recommendations of the Asian Rhino Specialist Group, the Wildlife status Evaluation Committee of the **IBWL** appointed in 1979 a Sub-Committee to consider alternative areas for rhino rehabilitation.

Of the various areas considered by this sub-committee, Dudhwa Tiger Reserve., U.P. was found to be the most suitable alternate habitat because of the similarities of habitat to that of Kaziranga N.P., Assam; the fact that rhinos had been recorded in this area till the last century and also because of the adequacy of protection available. Professor Schenkel, Chairman of the SSC Asian Rhino Specialist Group, confirmed the

suitability of Dudhwa Tiger Reserve after visit to the Dudhwa Tiger Reserve in 1980/81 (Schenkel, 1983).

In order to ascertain that the Dudhwa Tiger Reserve would provide adequate food for a rhino population, the committee commissioned a survey of rhino food plants in the proposed reintroduction area by the **Botanical Survey of India (Hajra and Shukla, 1982)**. As many as 14 food plants including grasses used by rhinos in Kaziranga, Assam were found in Dudhwa Tiger Reserve. Besides, the area offered the desired diversity of habitat including flooded grasslands, ample shade, water for wallowing and drinking and protection from human disturbance.



Fig. 2.1 A rehabilitated rhino finding its new habitat at D.T.R.

(Courtesy: R.L. Singh)



Fig. 2.2 An old male Rhino (Raju) taking rest in Kakraha tal of R.R.A. (Courtesy: R.L. Singh)

In March 1984 six rhinos were captured from Pabitora Wildlife Sanctuary, Assam. Of these one large male escaped from stockade during night and the rest, two males and three females were translocated to Dudhwa. At Dudhwa, these rhinos were initially kept in stockades for intensive care. Of the five animals, one female died of stressful abortion before she could be released. Another female died on July 31, 1984 after a bid to tranquilize her to treat a wound. With only one female and two males left, an urgent need was felt to translocate some more rhinos.

The collaboration of the Government of Nepal was obtained in the exchange of four young adult female rhinos for sixteen domestic

elephants. It was thought that by selecting only females, the reproductive potential in Dudhwa would be more than double and the eventual mating of these animals with the totally unrelated Assam males would ensure genetic vigour (**Sale and Singh, 1986**). These rhinos captured from Chitwan National Park in Nepal, arrived in Dudhwa in April 1985. Thus these seven rhinos, two males and five females made up the seed population of rhinos in Dudhwa.

The first successful calving occurred in early 1989. Three more calves followed this in the same year. Of the two bulls, the large one named Raju had asserted his dominance amongst the reintroduced animals. The other male named Bankey, however, became more and more assertive with frequent fighting between the two. A fence was created to separate them but in Oct. 1988 Raju was found dead.

It is worthwhile to mention here that in an effort to introduce fresh bloodstock to overcome the problem of inbreeding, a male rhino named Lohit was translocated from Kanpur Zoo in 1992. However, it did not fare very well in the wilderness condition and had to be returned to the Lucknow Zoo only seven months after release in the wild. One female rhino had reached from Nepal in Dudhwa but it died soon thereafter. The rhino rehabilitation programme has now entered in its eighteenth year and

their number has grown to 18. They are in good condition and are breeding well, which marks the success of this unique programme. The following table depicts the rehabilitated rhinos in Dudhwa Tiger Reserve, U.P.

Table 2.1: Released population of Rhinoceros in Dudhwa Tiger Reserve

S. No.	Origin	Name	Sex	Age on arrival	Date of arrival	Death
1	Assam	Raju	M	25 yr.	31.03.84	11.12.88
2	Assam	Bankey	M	7.8 yr.	31.03.84	-----
3	Assam	Saheli	F	30 yr.	31.03.84	12.04.84
4	Assam	Asha	F	16-17 yr.	31.03.84	31.07.84
5	Assam	Pabitri	F	3-4 yr.	31.03.84	-----
6	Nepal	Swayambara	F	4-5 yr.	01.04.85	-----
7	Nepal	Narayani	F	5 yr.	31.03.85	-----
8	Nepal	Himrani	F	4 yr.	01.04.85	-----
9	Nepal	Rapti	F	5-6 yr.	01.04.85	25.09.91
10	Kanpur Zoo	Lohit	M	8 yr.	28.04.92	Returned to Zoo
Total			10			04

(Source: Field Director, Dudhwa Tiger Reserve)

Bardia Rhino-reintroduction Programme

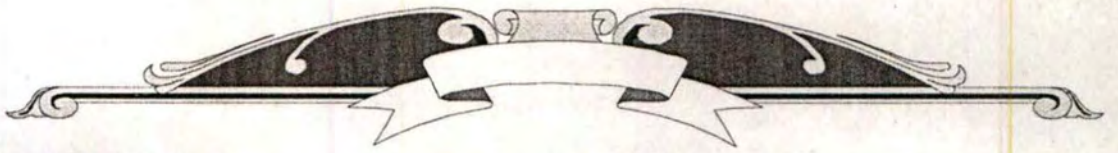
Within Nepal, the Indian rhinos were translocated from Royal Chitwan National Park to Royal Bardia Wildlife Reserve in 1986 (Mishra and Dinersteiner, 1987). The rehabilitation of rhinos into Bardia Wildlife Reserve took place in two phases—one in February 1986 and the other in December 1986.

Bardia Wildlife Reserve, located in the southwest of Nepal (see fig.3) encompasses an area of 968 sq. km. About 70% of the reserve is covered with Sal, *Shorea robusta* forest, and Grassland, Savannah, Riverine forests and gravel/silt cover the remaining 30%. The age and sex structure of the founder population is given in the following table:

Table 2.2: Released Population of Rhinoceros in Bardia Wildlife Reserve

Translocation Year	Adult Female	Adult Male	Sub adult Female	Sub-adult Male	Total
Feb.1986	3	0	0	1	4
Dec.1986	3	1	2	3	9
Total	6	1	2	4	13

Reintroduction of animal species is becoming an increasingly important management tool for the re-establishment of species, which have disappeared from their former ranges. The success of these operations depends very much on the ability of a wildlife biologist to assess and evaluate the suitability of release site and the ability of the animals to colonise this area and establish viable breeding population.



Methodology

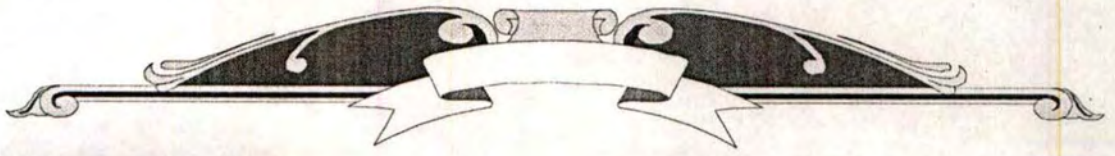


The observations were restricted only in the sunlight. No observation was possible during dark cover of the night. Efforts were made during the moonlight for observation on elephant back but the results were not fruitful. Following methods were employed during the study:

1. Ground-based methods were used to evaluate the **habitat types** in the rhino rehabilitated area. Various habitat types were defined on the basis of presence of major factors, including terrain, open water, swamps and vegetation type characterized by frequency of dominant plant species and physiognomy. Habitat types were also mapped with rhino density at different seasons by use of map overlays and contingency tables.
2. Regular **observations** were made on the **elephant and watchtowers** at suitable locations to know about feeding, resting and wallowing habits. Not necessarily all the rhinos could be located every day. During the dry season a jeep or a motorcycle was used for rapid survey in addition to the elephant being used.

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3. **Feeding habit** was studied both by direct quantified observation of feeding rhinos and analysis of faecal matter in the laboratory.
 4. The indirect observations were based on the basis of footmark, faecal analysis, wallowing areas etc. **Satkopan** method was also adopted for the identification of the food material mainly grasses at regular intervals throughout the year.
 5. **Inter- and intraspecific relationships** were studied to know real adaptations of the species in rehabilitated area. Data was also collected regarding the **natality and mortality** from the date of rehabilitation till July, 2002 to know the vital index.
 6. Rhinos have prominent individual features (**horn shape, cuts in the ear or skin, wounds and scars, folds of skin etc.**) or are recognizable as member of a stable group (**mother and calf**). This proved to be fairly satisfactory for ground observations. Individual identifications were mostly based on the size and peculiarities of their hind footprints. The size and shape of the hind footprints close to the freshly deposited dung were recorded and rubbed off afterwards to avoid repetitions.

-
-
7. It was also tried to compare the data from where they have been rehabilitated to know the success of the programme. Data was also collected from the Zoos (Lucknow and Kanpur) to know the captive breeding, gestation period, calf growth etc.
 8. The help of Field Director, Dudhwa Tiger Reserve as well as of local forest people was also taken time to time in order to facilitate the study. Every observation was regularly discussed with “**Mahouts**” who were monitoring the movements of rhinos everyday in the rhino rehabilitated area.
 9. Range officers, Forest guards, Mahouts and Fence watchers were interviewed time to time for collecting the information on distribution of rhinos, births, mortality, identification of potential habitats for enlarging the rhino habitat in future, land use pattern, ground verification of the vegetation and major threats.
 10. Villages near the rhino rehabilitated area in the south were visited and rapid survey was conducted to assess the extent of straying out problem of the rhinos.
 11. Photographs were also taken during the observation by Camera filled with telelens.



Study Area



STUDY AREA

Dudhwa Tiger Reserve falls within the former distribution range of Great Indian One-horned Rhinoceros, which had become extinct in this part by middle of 19th century. It is the only Tiger Reserve representative of the Tarai-bhabar Biogeographic subdivision of upper Gangetic Plains. The tarai with its characteristic complex Sal forests, tall grasslands and swamps is the most threatened ecosystem in India. Dudhwa Tiger Reserve comprises three separate parts viz., **Dudhwa National Park, Kishanpur Wildlife Sanctuary and Katarniahghat Wildlife Sanctuary**. These areas totaling 128383.25 ha represent one of the few remaining examples of the highly diverse and productive tarai ecosystems, supporting a large number of the endangered species, obligate species of tall wet grasslands and species of restricted distribution. District-wise distribution of the area of three separate parts of the Reserve and their establishment year are given in table no. 4.1.

Table 4.1 Dudhwa Tiger Reserve: Parts and Area (in ha.)

S.No.	Name	District	Tehsil	Estab. year	Area (ha.)
1	Dudhwa NP	lakhimpur-Kheri	Nighasan	Feb. 1, 1977	68032.90
2	Kishanpur WLS	lakhimpur-Kheri & Shahjahanpur	Gola & Powayan	Jan. 1, 1973	20341.00
3	Katarniahghat	Bahraich	Nanpara	1976	40009.35
				Total	128383.25

These three protected area, though separated physically are by themselves compact and continuous forest tracts (Fig. 4.1).

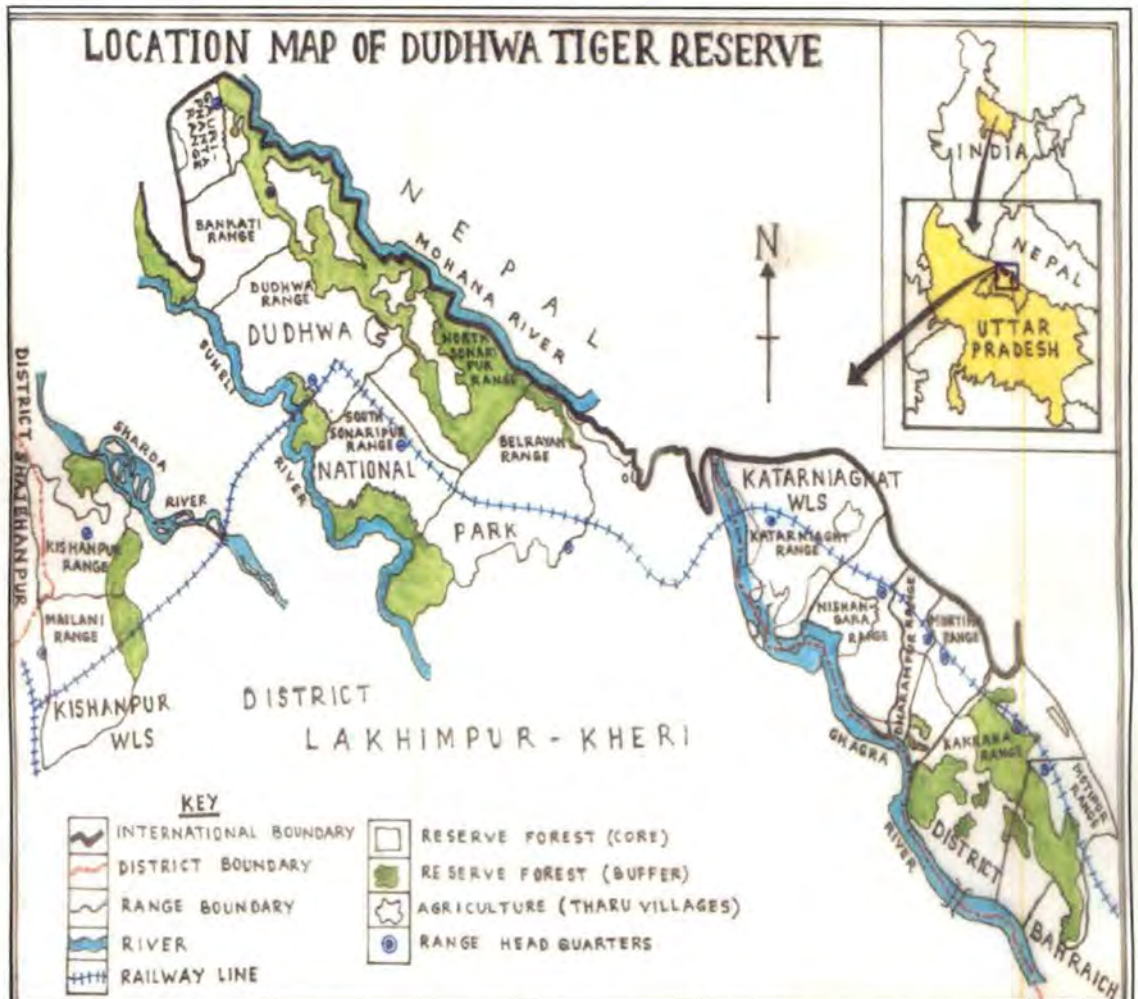


Fig. 4.1 Map showing Dudhwa Tiger Reserve (including Dudhwa National Park, Kishanpur and Katarniaghat W.L.S.

Location

Dudhwa National Park has gained fame due to the successful rehabilitation of Indian one-horned rhinoceros, *Rhinoceros unicornis*. Being a major part of the Tiger Reserve, Dudhwa National Park holds suitable areas for rehabilitated rhinos including the main study

area by the author. Dudhwa National Park lies on the Indo-Nepal border in the Palia Tehsil of District Lakhimpur-Kheri, UP and is situated between the latitudes $28^{\circ} 18'$ to $28^{\circ} 42'$ north, and longitudes $80^{\circ} 28'$ to $80^{\circ} 57'$ in the east.

Kishanpur Wildlife Sanctuary straddles between Gola Tehsil of district Lakhimpur-Kheri and Powayan Tehsil of Shahjahanpur district of UP, and is situated within the latitudes $28^{\circ} 14'$ to $28^{\circ} 30'$ north and longitudes $80^{\circ} 18'$ to $80^{\circ} 30'$ east. It has been the part of the reserve since 1986.

The third and recently included part of Tiger Reserve is Katarniah Ghat Wildlife Sanctuary. It also lies on the Indo-Nepal border in Nanpara tehsil. of district Bahraich, UP, and is situated between the latitudes $28^{\circ} 06'$ to $28^{\circ} 24'$ north and longitudes $81^{\circ} 02'$ to $81^{\circ} 19'$ east. The rhinos often use to migrate from Nepal into Kateeniaghat Wildlife Sanctuary, having suitable habitat.

History of the Study Area

History of forests in Dudhwa dates back to the second half of the 19th century when these private forests were taken over by the Government and reserved under Act passed in 1879. These forests were subsequently declared as 'Reserve Forests' under the Indian Forest Act in

January, 1937. Mr. Brown prepared the first working plan in the year 1886, which led to some protection to the wildlife habitat. It was ultimately in 1958 that a sanctuary for swamp deer was constituted in the area. It was called the **Sonaripur Sanctuary** extending over an area of only 15,766 acres. The area of sanctuary was extended in 1968 to cover 212 sq km and it was declared as **Dudhwa Sanctuary**.

The protection measures undertaken in the sanctuary proved positive result to swamp deer as well as to the other wildlife species. Taking into consideration the ecological importance of this area, the Government of India decided to declare it as a **National Park** by a notification in the official gazette in Oct. 1975. Upon completion of settlement proceedings, the Sanctuary was extended to cover an area of 614 sq km (490 sq km core zone and balance 124 sq km buffer zone) and finally notified through the Govt. of U.P. forest Deptt. Notification no. 6991/14-3-1/74, dated 21.01.77 and established on Feb.1, 1977.

Dudhwa National Park along with Kishanpur **Wildlife Sanctuary** (area 204 sq km approx.) located nearby was declared the **16th Tiger Reserve** under Project Tiger Scheme of Government of India in 1986. Recently, Katarniahghat Wildlife Sanctuary has also been included in Dudhwa Tiger Reserve, U.P. The Dudhwa National Park consists of

some of the best Sal, *Shorea robusta* forests in the country interspersed with grass meadows, lakes and other perennial sources of the waters.

Geology and soil

The area of the park is a vast alluvial plain, the doaba (area between two rivers) of the Mohana and Suheli. The alluvial formation of Park shows a succession of beds of sand, loam and clay. These vary in thickness and depth according to the configuration of the ground. The sub-soil has, at depths of 12m to 21m, a layer of hard clay with narrow shingle beds. The mean elevation above the sea level ranges from 182m in the extreme north to 150m in the southeast.

The surface soil is sandy in more elevated portions and along the high banks of the rivers, loamy in the level uplands and clayey in depressions. However, these are prone to variations. Wherever the ground slopes appreciably, as along the damars, the soil is poor; wherever clay has been deposited on the surface, as in the case of depressions formed by former waterways, the ground is swampy. The rapidity with which the wells in the area silt up, indicates that below spring level sand is more or less universal. Besides, the following types of soil are also met with:

-
1. A moist sandy loam mixed with fair proportion of decayed vegetable matter met within depression and watercourses covered with grasses.
 2. A stiff sandy loam with a fair proportion of clay and very slight admixture of humus.
 3. A miraculous sand with little or no clay and marked by an almost complete absence of humus.
 4. Stiff clay with a large amount of decayed and partly decayed vegetable matter. This soil is found in low-lying area.

Climate, Rainfall and Humidity

The climate is of monsoon type. The year may be broadly divided into **winter, summer and rainy seasons**. The **winter season** extends from the mid-October to mid-March. The days are bright, cool and the nights are cold and foggy. There is heavy deposition of dew during the winter season when the vegetation remains damp until about the middle of the day. The month of January is the coolest part of the year with mean max. temp. of 22.13° c and mean min. temp. of 8.32°c. In winter frost is common in grasslands (phantas). In month of Dec. to middle of Feb. it is usually quite severe.

The **summer season** begins from the mid-March and lasts up to mid-June. In summer season May and June months are the hottest with mean max. temp. of 40.37°C and mean min. temp. of 23.52°C . The high temperature during the daytime is associated with hot westerly winds. The nights are moderately cool until the beginning of May.

The **rainy season** generally starts in the beginning of June and lasts up to September. The ruling day and night temperatures during the months of July/August are 30.43°C and 24.35°C respectively. The average total annual rainfall is about 150 cm, 90% of which is occupied from mid-June to September. Temperature and rainfall recorded at Dudhwa National Park are given in Figure 4.2 and 4.3 respectively.

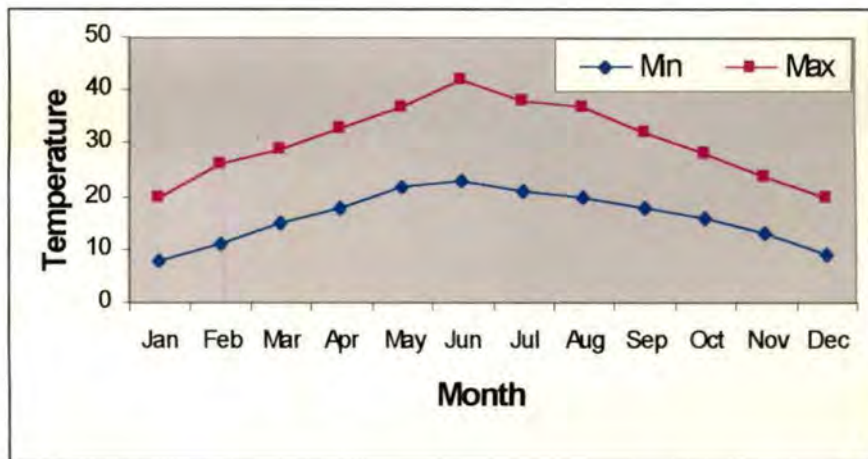


Fig. 4.2 Temperature recorded at Dudhwa National Park (1999-2002)

The prevalent winds are westerly, gathering in strength with the onset of summer. Hot winds blow very strongly from the middle of April

up to the end of May and then replaced by easterly winds which are prevalent during the rainy season. Northern winds also occur during the month of June. Storms were also recorded during the study.

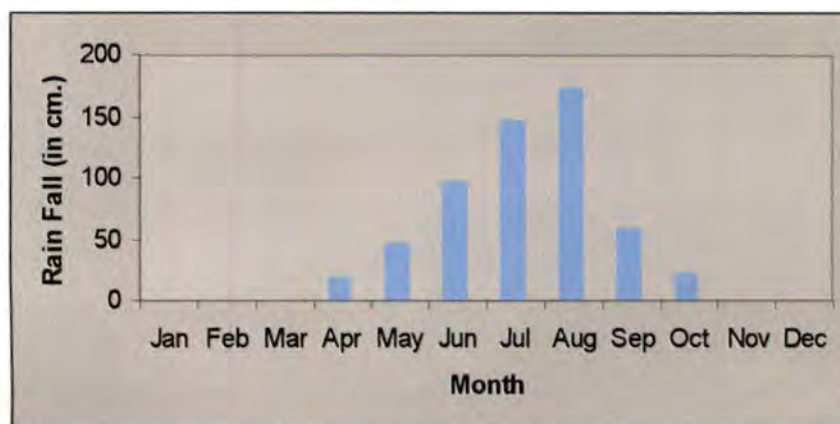


Fig. 4.3 Rain fall in Dudhwa National Park (1999-2002)

Control Burning of Grasslands

Dudhwa grasslands like other tarai grasslands were probably burnt since time immemorial (Fig. 4.4). In humid grasslands the ungulate preference for grassland decline when grasslands permitted to advance beyond the fire climax stage (Taitan and Mentis, 1989).

Fire is a powerful tool for grassland management. Its application should consider the consequences for species other than the target species. It would be impossible to account for all relationships. The endangered species must, however, receive priority attention along with any known fire sensitive species. The **Hispid hare**, *Caprolagus hispidus* and **Bengal florican**, *Houbaropsis bengalensis* are the species of

concern. The areas used by Hispid hare are supposed to be protected from fire, while on the areas used by Bengal Florican, grass is cut first prior to burning in patches in mosaic manner to provide a mosaic of tall and short grasslands. They have only been reported from tarai grasslands and Brahmaputra flood plains. The **Francolins** and many **Warblers** breed during this time when the grasslands were burnt. The **chital**, *Axis axis* and **Hog deer**, *Axis porcinus* drop their fawns during this grass burning period.



Fig. 4.4 Control burning of grassland in D.N.P. (Courtesy: V.P. Singh)

Water sources

The Park area is a vast alluvial plain, traversed by a number of small rivers, nalas (streams) and tals (lakes), the important among these being **Mohana river** which more or less forms international boundary

between Park and Nepal, and **Suheli river** which forms southern boundary of the Park. **Joraha, Neora, Nagrol,** and **Nakua** are the major streams of the Park. There are also a large number of perennial tals or lakes such as **Bankey, Kakraha, Chhedia, Bhadi, Bhandara, Puraina, Chapra, Amha, Mutna, Churaila, Ludaria, Khajua, Chaitua, Dhanghari, Bhadraula, Teria, Nagra** etc. located variously in the Park and ensure permanent water supply to the wildlife of the Park.

A number of artificial water holes have been created to supplement water supply to wild animals during the lean (summer) season. Tube wells are used for filling the artificial water holes. There is large number of wells in the different locations in the Park.

Forest Types and Floral diversity

The Flora of Dudhwa National Park is of tropical moist deciduous type. It may be categorically stated that it is one of the best natural Sal forests, apparently a climatic climax in Uttar Pradesh (Fig. 4.5). According to revised classification of forest types of India (**Champion and Seth, 1968**) the forest types of Dudhwa National Park can be classified as under:

<u>Forest group</u>	<u>Forest type</u>
1. Northern tropical semi-evergreen forests —	Cane Brakes
2. Northern Indian moist-deciduous forests —	a) Damar Sal Forests
	b) Alluvial Plains Sal Forests
	c) Western Light Alluvial Sal Forests
	d) Moist Sal Savannah Forests
	e) Low Alluvial Savannah Woodlands
3. Tropical seasonal swamp forests —	Syzygium cumini Swamp Forests
4. Northern tropical dry deciduous forests —	Khair-Sissoo Forests



Fig. 4.5 The best natural Sal, *Shorea robusta* forest in D.N.P.

The vegetal diversity in the Park is immense. Current documentation indicates presence of 75 species of trees, 21 species of shrubs, 17 species of climbers, 77 species of grasses and grass-like plants and 179 species of aquatic plants. The main tree species are Sal, *Shorea*

robusta, Asna, *Terminalia tomentosa*, Shisham, *Dalbergia sissoo*, Bahera, *Terminalia belerica*, Arjun, *Terminalia arjuna*, Khair, *Acacia catechu*, Jamun, *Syzygium cumini*, Pula (Pataeh), *Kydia calycina*, Phaldu (Kaim), *Mitragyna parvifolia*, Aonla, *Emblica officinalis*, Bel, *Aegle marmelos*, Kusum, *Schleichera oleosa*, Semul, *Bombax ceiba*, Sehore, *Streblus asper*, Lisora, *Cordia dichotoma*, Mahua, *Madhuca indica* etc. including plated species like Sagon (Teak), *Tectona grandis*, and Eucalyptus, *Eucalyptus citriodora*.

Duhdwa National Park is provided with number of large grasslands (Fig. 4.6) The main grass species occurring in the area are Ulla, *Themeda arundinacia*, Sandhaur or Sindur, *Bothriochloa intermedia*, Mayari, *Imperata cylindrical*, Kaans, *Saccharum spontaneum*, Munj, *Saccharum munja*, Retwa, *Sclerostachya fusca*, Jarakush, *Cymbopogon martin*, Dabh, *Desmostachya bipinnata*, Gandar or Khus, *Vetiveria zizanioides* Narengaor Kanwar, *Narenga porphyrocoma* etc. Reed grasses such as Nari, *Arundo donax* and Narkul, *Phragmites karka* are distributed around the water bodies and swamps.



Fig. 4.6 A grassland dominated by Ulla, *Themeda arundinacea* in D. N. P.

Stragglers and climbers such as Ratalu, *Dioscoria bulbifera*, Tarur, *D. belophylla*, Maljhan, *Bauhinia vahlii*, Dudhi bel, *Cryptolepis buchanani*, Dudhi, *Ichnocarpus frutescens*, Ratti or Gumchi, *Arbus precatorius*, Rangoi, *Tiliacora acuminata* etc. are found.

The shrubs and herbs found in the Park are Arusa, *Adhatoda vasica*, Jharberi, *Zizyphus mauratiana*, Chakwad, *Cassia tora*, Dhatura, *Datura metel*, Kathgular, *Ficus hispida*, Latjeera, *Achyranthes aspera*, Ratti or Gumchi, *Arbus precatorius* etc.

Faunal heritage

The faunal heritage of the Park is vast and varied due to the wide and varied vegetation cover and available food. Current documentation

indicates presence of about 51 species of mammals, 400 species of birds, 25 species of reptiles, 15 species of amphibians and 90 species of fishes.

Besides tiger, *Panthera tigris* (Fig. 4.7), the most notable feature of the Park is the simultaneous existence of the five species of deer viz., Hog deer, *Axis porcinus*, Sambhar, *Cervus unicolor*, Barking deer, *Muntjacus muntjac*, Spotted Deer, *Axis axis* and Swamp deer, *Cervus duvauceli duvauceli* (Fig. 4.8 a and b), Leopard, *Panthera pardus* though rare, is found in the Park. The Park is a home to several other carnivores such as Jungle cat, *Felis chaus*, Fishing cat, *Felis viverrina*, Leopard cat, *Felis bengalensis*, Ratel, *Mellivora capensis*, Indian Civet, *Verrucula indica*, Jackal, *Canis aureus*, Indian Fox, *Vulpes bengalensis*, Sloth Bear, *Melursus ursinus*, Smooth-coated Otter, *Lutra perspicillata* etc. Herbivores like blue bull (antelope), *Boselaphus tragocamelus*, Wild boar, *Sus scrofa*, Rhesus Macaque, *Macaca mulatta*, Langur, *Presbytis entellus*, Indian hare, *Lepus nigricollis*, Indian Porcupine, *Hystrix indica*, Giant Flying Squirrel, *Petaurista petaurista* etc., are found in the Park. A migratory population of Indian elephant, *Elephas maximus* is also seen (Fig. 4.9a). It is also home to the extremely rare Hispid Hare, *Caprolagus hispidus* (4.9b).



Fig. 4.7 Tiger, *Panthera tigris* , the top carnivore in D.N.P.

(Courtesy: Suresh Chaudhary)



Fig. 4.8 (a) A herd of Spotted Deer, *Axis axis* in D.N.P.

(Courtesy: Suresh Chaudhary)



Fig. 4.8 (b) A herd of Swamp deer, *Cervus duvauceli duvauceli* in D. N. P.

(Courtesy: Suresh Choudhary)



Fig. 4.9 (a) Wild male Elephant, *Elephas maximus* (mega herbivore) in D. N. P.

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Fig- 4.9(b) Hispid Hare, *Caprolagus hispidus*, a rare species found only in tarai grasslands

Dudhwa National Park is very rich in Avi-fauna. Record indicates the presence of more than 400 species of the birds including some migratory ones. The large water bodies, grasslands, swamps and varied forest types are home to this vast number of birds. Migratory birds include Black-necked Stork, *Ephippiorhynchus asiaticus*, White-necked Stork, *Ciconia episcopus*, Grey-lag Goose, *Anser anser*, Bar-headed Goose, *Anser indicus*, Pintail, *Anas acuta*, Mallard, *Anas platyrhynchos*, Wigeon, *Anas Penelope*, Shoveller, *Anas clypeata*, Spot-billed Duck, *Anas poecilorhyncha*, Spoonbill, *Platalea leucorodia* etc. Birds such as Great-horned Owl (Eagle Owl), *Bubo bubo*, Ladakh Grey-backed Shrike,

Lanius vittatus, Gold-fronted finch, *Serinus pusillus*, Grey-Wagtail, *Motacilla cinerea* come from the Himalayas. Other species of birds found in the Park include Painted Stork, *Mycteria leucocephala*, Comb Duck, *Sarkidiornis melanotus*, Black Partridge, *Francolinus francolinus*, Grey Partridge, *Francolinus pondicerianus*, Whistling Teal, Peafowl, Red Jungle Fowl, Shama, Goshawk, Shikra, Sparrow, Hawk, Hobby falcon, Baza, Sarus Crane, Ibis etc. It is also home to the extremely rare Bengal Florican, *Houbaropsis bengalensis* and Swamp Partridge, *Francolinus gularis*.

Reptiles include lizards, testudenes, snakes, gavialis and crocodiles. Some prominent examples are Monitor Lizard, *Varanus monitor* (Fig. 4.10), Chamaeleon, *Chamaeleon calcaratus*, Gecko, *Hemidactylus brookii*, Gharial, *Gavialis gangeticus*, Crocodile or Magar, *Crocodilus palustris*, Python, *Python molurus*, Cobra, *Naja naja*, Russel's or Pit-less Viper, *Vipera russeli*, Common Krait, *Bungarus caeruleus*, Banded Krait, *Bungarus fasciatus* etc. Among the Amphibians, four species of genus *Hyla* (tree toad), Common Toad, Flying Frog, Leaping Frog are very common, and a new species belonging to the genus *Chirixalis*, is also found in the Park. Fish species

like Rohu, *Labeo rohita*, Bhakur, *Catla catla*, Catfish, *Wallago attu*, Magur, *Clarias batrachus*, Saur, *Channa striatus*, etc. are found here.



Fig. 4.10 Monitor lizard, *Varanus monitor* in D.N.P.

INTENSIVE STUDY AREA

Location and Area

The intensive study area, the so-called Rhino Rehabilitated Area (RRA), is situated in the South Sonaripur Range of Dudhwa National Park. The RRA extends over 28.11 sq Km and comprises more or less entire Kakraha Block and a part of Chhota Palia Block (fig. 4.11). The Suheli River that is not far from the RRA forms the natural southern boundary of the Kakraha Block.

Electric fence

In the beginning the RRA was enclosed by a 1.5 m high, 3-strands power fence. A 9 km Critical section near the Park boundary was additionally protected against the accidental escape by the construction of a rhino-proof trench outside the electric fence. **Holding stockades** for the new arrivals were built within the fenced zone, near Kakraha tal.

The original 1.5 m high 3-strands electric fence was raised in 1988 to the height of 2.8 m with 7-strands alternately energized by two energizers. This was done to prevent the entry of tigers within the RRA to preclude the threat to rhino-calf predation. Presently the power (electric) fence is of 5-strands of which the lower two strands are energized. An

internal partitioning of the 3-strands fence (mini fence) was created in 1993-94 bisecting the area to check the conflict between the male rhinos.

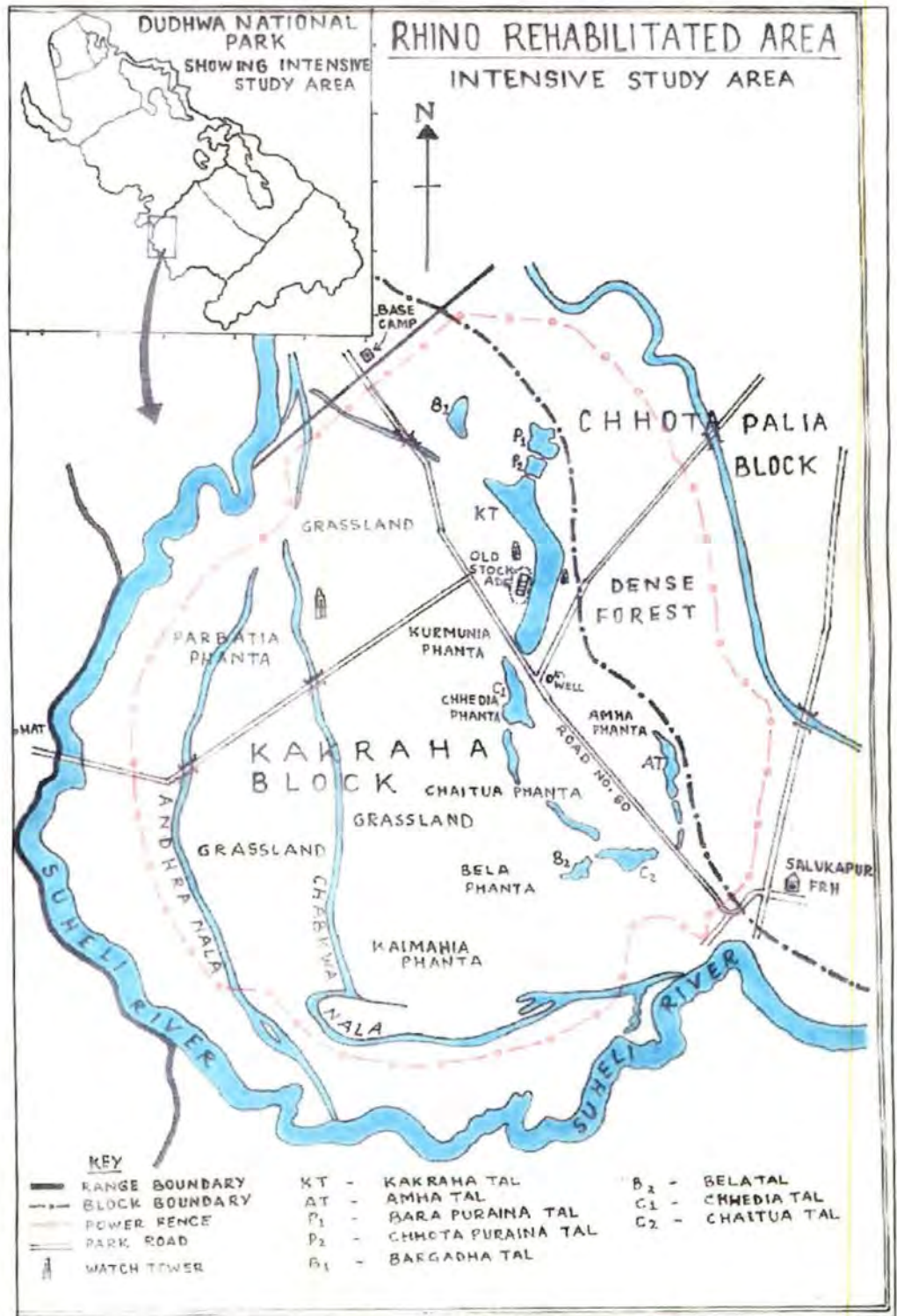


Fig. 4.11 Map showing Intensive Study Area (R.R.A.)

Roads and watchtowers

The RRA has a network of roads and can be approached from three side viz., **Base Camp, Chhota Palia, and Salukapur** where gates have been provided in the electric fence (fig. 4.12). There is a main road (Road No. 60) inside the RRA, which travels, somewhat straight from the Base Camp to Salukapur (Fig. 4.13). Two other roads (one from Chhota Palia and the other from Parbatia Ghat) join to Road No. 60. Still other one road runs along the southern perimeter fence joining the main road at



Fig. 4.12 R.R.A. Fence Gate at Base Camp

either end. As these roads remain unserviceable for long period during and after monsoon, an additional road from Salukapur to Kakraha was made in 1997-98. A feeder road links the main road used for monitoring

the rhinos during monsoon period. At the Base Camp log huts have been built on top of high piles for housing the Park staff. This is a special requirement as the area remains under water for prolonged periods during the monsoon.

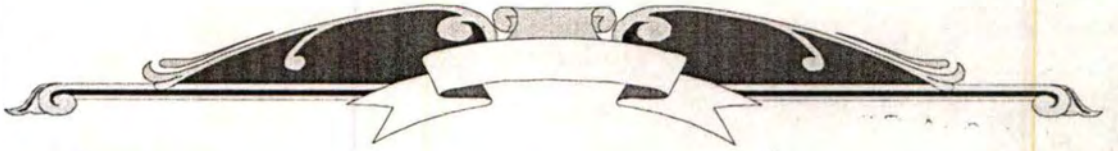
There are four wooden watchtowers inside the RRA, one of them is very big (height 20-22 m.) called “Kakraha Machan” and located west to Kakraha tal. Two of the remaining three are located around the Kakraha Tal in the east, and one is at Kaimahia called “Kaimahia machan”.



Fig. 4.13 The main road (road no. 60) inside R.R.A. running from base camp to Salukapur

The RRA provides a good habitat for a range of animals like Tiger, Swamp deer, Sambhar, Spotted deer, Hog deer, Barking deer, Hispid

Hare, Bengal Florican, and Swamp Partridge. During the field visits Hispid Hare and Tiger were observed. Bengal Florican was also sighted several times during observation.



Observation



5.1 BIOLOGY OF INDIAN RHINOCEROS

Great Indian one-horned rhinoceros, *Rhinoceros unicornis* is massive, thick-skinned herbivorous mammal having three hoofed toes on all feet. The so called one-horned rhinoceros, they have one fibrous horn compressed of the matted hair on the upper surface of the snout having a prehensile lip (Fig. 5.1). They are placed in a single family-Rhinocerotidae under the order-Perissodactyla. The skin of this massive creature is divided into great shields by heavy folds before and behind the shoulders and in front of the thighs. The fold in front of the shoulders is not continued right across the back, a distinctive character of this species. Thick-skin serves as an armour in intraspecific fighting against tiger and when moving through thorny vegetation.

The horn of rhinoceros is not a true horn because it does not have a core of bone. Instead it is a compact mass of keratin fibers, not fixed to the skull in any way, but resting epidermally on a bony cushion. When a hard blow is delivered the horn can be discharged and although there will be some bleeding, a new one will begin to grow in its place.

The prehensile upper lip of the rhinoceros performs the same functions as the flexible proboscis of elephant and tapirs. The pointed

upper lip acts a kind of finger to pluck leaves and twigs. Rhinoceros have three upper and lower molar teeth. In the skull of young Indian rhinoceros, grinding surface is made up of four milk premolars and an adult molar on each jaw (Fig. 5.2). The vision is extremely poor, limited to a hundred meters or so. But its sense of hearing and smell are acute.

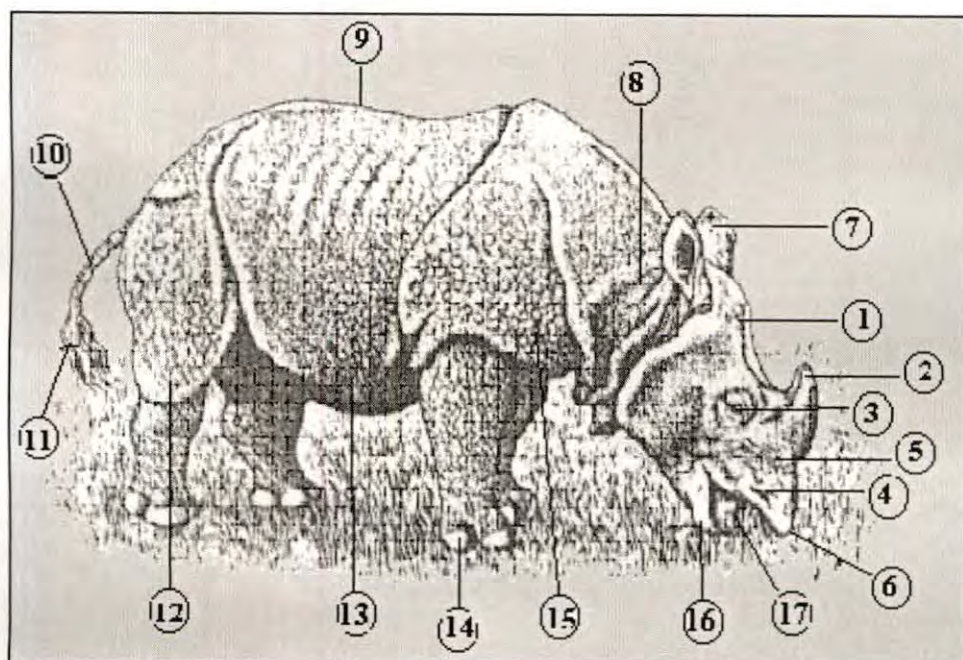


Fig. 5.1 Great Indian One-horned Rhino, *Rhinoceros unicornis*

1. Head, 2. Fibrous horn, 3. Eye, 4. Nostril, 5. Snout, 6. Prehensile upper-lip, 7. Ear, 8. Neck, 9. Trunk, 10. Tail, 11. Caudal tuft of hair, 12. Folded skin on thigh, 13. Abdomen, 14. Toe on four foot, 15. Folded skin on shoulder, 16. Lower jaw, 17. Tongue

The brain of the rhinoceros is small compared to its body size; except for the horn, the large face and head are pig like. The eyes too are small and set against the elongated, boat-shaped head, seen tinier than they really are.

In the case of Indian Rhino, identifying a male and female in the wilderness from external appearances, is very difficult, for the genitalia is not visible, and the horns in both sexes grow to the same length. Their thumb rule is that the male is stockier, its shoulder and neck portion thicker and bulkier. In females the skull is slightly thinner, the base of the horn is narrower and the horn is slimmer. However, for sub-adult rhino and calf such discrimination is impossible without physical examination.

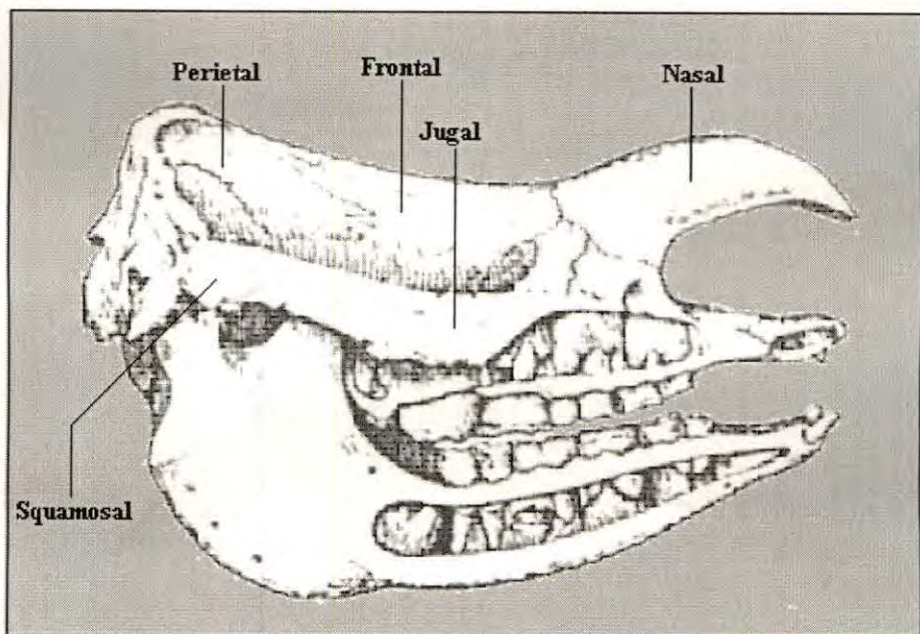


Fig. 5.2 Skull and teeth of a young Indian Rhinoceros.

The grinding is made up of four milk premolars and one adult molar on each teeth have not erupted. (After Reynolds, 1897).

Elephants, Hippopotamuses and rhinoceros all show the same type of skeleton. The vertebral column has long neural spines. Above the forelegs there are many ribs, reaching back nearly to the pelvis. The

whole column thus makes a girder balance on the fore-legs, and the head, being very heavy, counter balances the body weight. The hind legs provide the main locomotor's thrust. It is characteristic of this 'single-girder' type of backbone that the ilia are wide and vertically placed (Fig. 5.3).

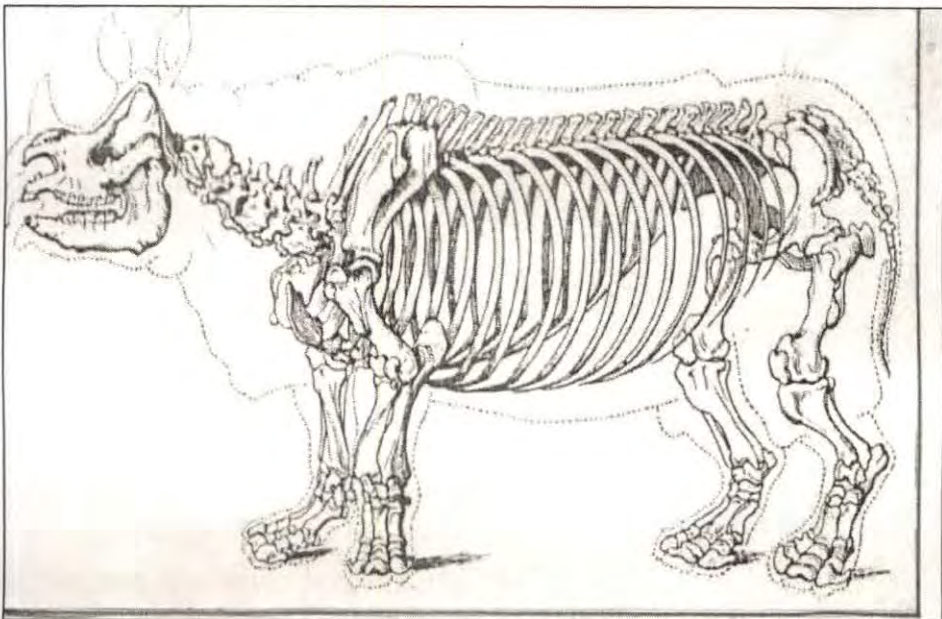


Fig. 5.3 Skeleton of the Indian Rhinoceros (Owen, 1866)

Indian rhino cannot exist without surface water. In regions where good feeding areas are far from water, they visit watering places at intervals of four to six days. They often bath in pools and wallows in mud, which helps to protect their skin against biting flies and to regulate their body temperature. Indian rhinoceros are adapted to a wet habitat (swampy), and feed on swampy grasses like *Saccharum* sps., *Arundo*

donax, *Hygrorhiza aristata*, *Vetevaria zizanioides*, *Imperata cylindrica*, *Phragmites karka*, etc., swamp herbs such as *Polygonum plebedum*, *Ageratum conyzoides*, *Murraya koenigii* etc., and water hyacinth, *Eichhornea*. Some times they also visit to crop fields and feed on sugar cane and paddy. They lie in water and mud, wallows for hours and they can disappear completely in the high elephant grasses (up to 16 ft. or 5m. high), where their paths form a network of tunnels.

Indian rhinoceros are not very social animal. Ten or more numbers of Indian rhinoceros are occasionally found near each other in a large pool, or when feeding. The only strong social bond is the mother-calf bond. It may last for up to two years. The calf is rejected by the mother before she gives birth to the next offspring. The old calf may later rejoin the mother when the new calf is several months old. In this way matriarchal communities may be formed which are, however, not very stable.

The rhino with their acute sense of smell have developed a complex system of olfactory communication by ritualized defecation and urination. Indian rhinos, when coming upon dung of their own species, are stimulated to defecate in a characteristic manner. In the Indian rhino, dung seems less important for marking the track; it is rather used to

maintain special 'scent-posts' in the form of large dung piles. When lying in a wallow, these rhino urinate and then the whole body is covered with a sheet of mud mixed with urine. When walking along the tunnel like tracks in dense vegetation, the smell of urine on the foot-prints and the walls of tunnel are striking. The smell of dung on their foot-prints can be easily detected by man.

The bulls of Indian rhinos produce localized scent marks by frequently squirting urine in a backward shower onto the vegetation. The cows squirt urine often and small quantities when on heat. All the different traces produced by the rhinos serve two main functions: they convey information between individuals in the same area; especially revealing if a cow is in mating condition, the scent traces give special qualities to the living space of a population and thus contribute to guide the individual in its daily life.

The cow on heat has a specific call. In initiating it, one can alert and even attract bulls. In premating contact, which often involves some aggressiveness, vocalization is rich in variation. Sound communications also exist between mother and calf.

In the Indian rhino the bull normally chases the cow at a trot or gallop. From time to time the rhino face each other to fight with horn and

teeth. In Indian rhinos, as in many other vertebrates the pre-mating behaviour has a complex function; a social and a sexual relation are established between the partners. In addition both partners are synchronized in the readiness for mating. In the last part of the pre-mating, mating intention movements occur. The cow stands in front of the bull, with her hind quarters turned in his direction and even steps backwards toward him. The bull may put his head on her rump and mount her. Mating itself lasts from 20 to 80 minutes.

The gestation period is not yet known, but observations made in zoos are only conclusive for the Indian rhino with approx 480 days. The new born rhino which in the Indian species weigh 60 to 70 kg is able to rise within an hour of birth. It then searches for the nipples in the angle between legs and body of its mother and drink.

5.2 HABITAT (Rhino Rehabilitated Area)

All the ecological requirements such as water sources, vegetation cover, habitat types, food plants and wallows were studied in the Rhino Rehabilitated Area.

Water sources

The RRA has as many as eleven Lakes viz., Kakraha, Bada Puraina, Chhota Puraina, Chhedia, Chaitua, Bargadha, Bhandara, Amha, Bela, Kurmunia and Kaimahia. First seven of them are permanent water sources for Rhinos and other wild animals, whereas the last four tals get dried during the summer and water is augmented by tube wells. The chain of these water bodies lies along the damar Sal forest and Grassland ecotone (Fig. 5.4).

The lakes and streams (Andhra, Chabkawa and Khaptahua nala) are old courses of the river Suheli. During monsoon, major parts of the grassland inside the RRA get flooded and water currents can be seen in three streams and chain of lakes while other areas have up to 4 feet of standing water. List of streams and lakes of RRA are given in table no.5.1 & 5.2.

Table- 5.1: Streams in Rhino Rehabilitated Area

Stream	Compartment no.	Remark
1 Andhra Nala	2,3,4	5.6km
2 Chabkawa Nala	2,3,4	5.0km
3 Khaptahua Nala	1,2	1 km. (seasonal)



Fig. 5.4 Kakraha Tal (largest lake inside R.R.A.) lies along the Sal Forest and grassland ecotone

To supplement the water supply especially during summer, seven tube wells are available in RRA. These are one each at Amaha, Chaitua, Bela, Purania and Kurmunia Tals and two at Kakraha Tal. All are running in good condition except the tube well at Bela Tal. There are three artificial water holes. These are one each in comptt.-5, Comptt.-2 and comptt.-3. Tube well borings are available for first two water holes. Third one is filled with rain water during monsoon.

Vegetation cover

The Rhino Rehabilitated Area of 28.11 sq km comprises of higher level woodland and typical low lying wet tall and less moist short grasslands. On the basis of vegetation, habitat may be classified into six major types, viz., Woodland, Tall grassland, Short grassland, Marshy grassland, Aquatic area and Fringes and Riparian. Higher level woodland is about 584.0 ha and covered by trees like *Shorea robusta*, *Terminalia tomentosa*, *T. arjuna*, *Ficus glomerata*, *Schleichera oleosa*, *Cordia dichotoma*, *Mallotus* sps., and numerous creepers like *Tiliacora acuminata*. Grasslands are also interspersed with trees like *Accacia catechu*, *Salmalia malabarica*, *Dalbargia sissoo*, *Ficus religiosa*, *Syzygium cumini*, *Butea monosperma* etc (Fig. 5.6). Patches of tree forest are mainly close to the water bodies in low lying area, which are resting

places for the rhinos during hot period of the day especially in summer season.



Fig. 5.6 Grasslands inside the R.R.A. interspersed with trees

Tall grassland (wet low lying area) occupy an area of about 343.0 ha and are dominated by tall grasses such as *Schlerostachya fusca*, *Saccharum munja*, *Apluda mutica*, *Themeda arundinacea* etc. Short grassland (less moist low lying area) cover an area about 807.0 ha and consists of most common species of short grasses like *Imperata cylindrical*, *Saccharum spontaneum*, *Vetiveria zizanoides* etc. Marshy grassland area (563.0 ha approx.) is covered mainly by the grasses such

as *Typha augustata*, *Phragmites karka*, *Cynodon dactylon* and *Bothriochloa* sps.

All the water bodies (aquatic habitat) contain different hydrophytes, which are as follows:

- a) Free floating hydrophytes- *Lemna perpusilla*, *Trapa natus*, *Hygrorhiza aristata*, *Spirodela polyrhiza* etc.
- b) Suspended submersed hydrophytes- *Apomogeton crispum*, *Potamogeton pectinatis*, *Hydrilla verticellata* etc.
- c) Anchored submersed hydrophytes- *Otellia alismoides*.
- d) Anchored hydrophytes with floating leaves- *Nelumbo nucifera*, *Nymphaea nouchali*, *Nymphoidae cristata* etc.
- e) Anchored hydrophytes with floating shoots- *Monocharia vaginalis*, *Sagittaria guayanensis* etc.
- f) Amphibious hydrophytes- *Echinochloa colonum*, *E. stagnina*, *Panicum paludosum* etc.
- g) Wetland hydrophytes- *Cyanotis cristata*, *Salvia plebia*, *Xanthium strumarium*, *Cyperusiria* etc.

Following table depicts the vegetation types in Rhino Rehabilitated Area.

Table-5.3: Vegetation Types in Rhino Rehabilitated Area

S.No.	Vegetation Type	Area (in ha.)
1	Woodland	584.0
2	Tall Grassland	343.0
3	Short Grassland	807.0
4	Marshy Grassland	563.0
5	Water (Aquatic) Bodies	107.0
6	Fringes & Riparian	107.0

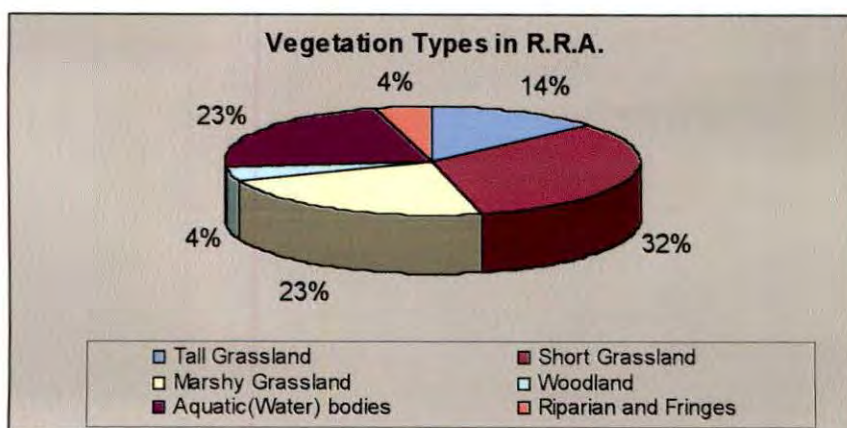


Fig. 5.7 Diagram Showing Vegetation types in R.R.A.

The floral diversity in the RRA is immense. Current documentation indicates presence of 75 species of trees, 21 species of shrubs, 17 species of climbers, 77 species of grasses and 179 species of aquatic plants.



Fig. 5.8 Short grassland to South R.R.A. dominated by *I. cylindrica* and *V. zizanioides*

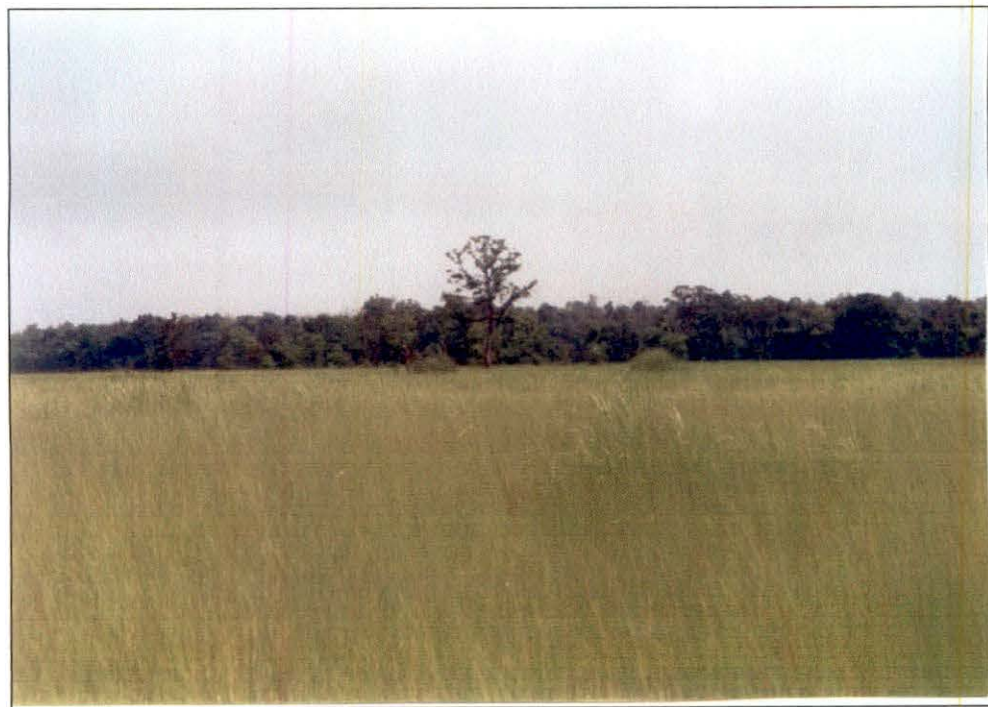


Fig. 5.9 *Vetiveria* dominated Short grassland in the central part of Kakraha Block

Vegetation used as food

The Grassland of Rhino Rehabilitation Area has been studied in details by several workers prior and subsequent to the reintroduction of Indian one-homed Rhinoceros. It has been recorded that Indian Rhino use 55 species of plants as food belonging to different families. These include 23 species of grass and herbs, 8 species of aquatic plants, 12 tree species, 5 species of woody climbers and shrubs each and 1 species of fern. In winter Rhino's diet constitutes 45% grass, 18% aquatic plants and rest 37% includes woody plants, climbers, shrubs, and trees.

During March most of the grass species attain full maturity and start drying. The water level in the water bodies also starts receding. During the burning of grasslands (between February to March) Rhinos feed on bark of *Acacia catechu*, leaves of *Teliacora acuminata* and leaves and twigs of a median sized tree, *Mallotus philippinensis*.

Around water bodies they feed mainly on *Cynodon dactylon*, *Hygrorhryza cristata*, *Trappa* and *Vallisnaria* sps. Within 2-3 days following the grass burn Rhinos start feeding on burned swards of tall grasses and also lick the ash on the ground.

Indian Rhinoceros is essentially a grazer and prefer a variety of grasses and herbs. The food plants on which Indian Rhinos feed were

collected in the Rhino Rehabilitated Area during the observation. They are listed in the table no. 5.4 according to their frequency of occurrence and feeding by rhinos.

Table- 5.4: Common food plants of Indian Rhinoceros in two Habitats

Plant Species	Dudhwa	Kaziranga
<u>Grasses</u>		
1. <i>Imperata cylindrica</i>	+	+
2. <i>Narenga porphyrocoma</i>	+	+
3. <i>Saccharum spontaneum</i>	+	+
4. <i>Vetiveria zizanioides</i>	+	+
5. <i>Setaria spp.</i>	+	+
6. <i>Themeda triandra</i>	+	+
7. <i>Phragmites karka</i>	+	+
8. <i>Arundo donax</i>	+	+
9. <i>Arundinella bengalensis</i>	+	+
10. <i>Saccharum munja</i>	+	+
11. <i>Hygrorhyza aristata</i>	+	+
12. <i>Chrysopogon aciculata</i>	+	+
13. <i>Cynodon dactylon</i>	+	+
14. <i>Eragrostis spp.</i>	+	+
15. <i>Imperata indica</i>	-	+
16. <i>Aciculatus spp.</i>	-	+
17. <i>Andropogon spp.</i>	-	+
18. <i>Saccharum elephantum</i>	-	+
19. <i>Pennisetum</i>	-	+
20. <i>Typha elephanatina</i>	-	+
21. <i>Pollinia ciliata</i>	-	+
22. <i>Tamarix spp.</i>	-	+
23. <i>Themeda arundinacea</i>	-	+
24. <i>Paspalidum flavidum</i>	-	+
25. <i>Bothriochloa sps.</i>	-	+

Plant Species	Dudhwa	Kaziranga
Herbs and shrubs		
1. <i>Cyperus spp.</i>	+	+
2. <i>Solanum spp.</i>	+	+
3. <i>Murraya koenigii</i>	+	?
4. <i>Ehretia acuminata</i>	+	?
5. <i>Ageratum conyzoides</i>	-	+
6. <i>Poligonum plebedum</i>	+	?
7. <i>Ageratum conizoides</i>	+	?
<u>Aquatic Plants</u>		
1. <i>Hydrilla verticillata</i>	+	+
2. <i>Vallisneria spiralis</i>	+	+
3. <i>Hygrorhiza aristata</i>	+	?
4. <i>Potamogeton crispus</i>	+	?
6. <i>Trapa natus</i>	+	+
7. <i>T. bispinnosa</i>	+	?
8. <i>Eichornea crassipes</i>	+	+
9. <i>Ipomoca reptans</i>	-	+
10. <i>Nelumbo speciosum</i>	-	+
11. <i>Nymphaea lotus</i>	-	+
12. <i>N. nouchali</i>	+	?

Symbols (+), (-) and (?) used for present, absent and availability not known respectively.

Wallows

Indian Rhinos are invariably fond of wet muddy wallows that protect them from external parasites and flies which lay eggs between the folds of their armour-plated skin. Many Muddy pools and ditches in the Rhino Rehabilitated area give abundant scope for this activity. Wallowing not only cools their huge bodies but protect them from the infection of ectoparasites.

Indian Rhinos sometimes rest and sleeps in water, as do the African Rhinos. After wallowing whole body is covered with a layer of wet mud which on drying becomes white. In summer they expend their more time in wallows and water. Wallows are to be found on the bank of 'tals' or 'nalas'. Calve with mother were also observed in wallows. It was also observed several times that there was fight among adult rhinos for the same wallow. During the monsoon these wallowing areas were filled with rainwater.