Behavioural Patterns of the one horned Indian Rhinoceros

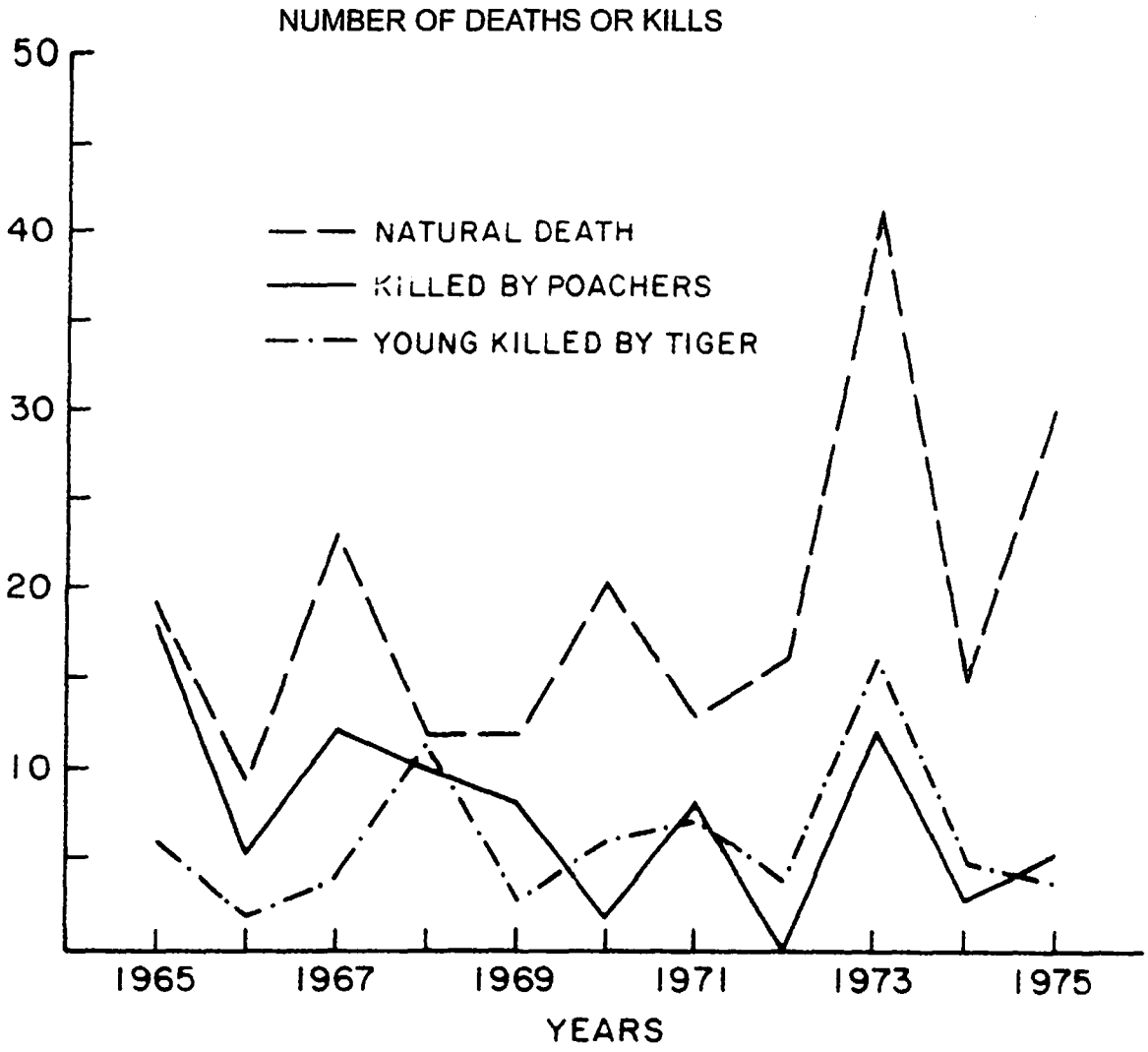

Figure 1

Mortality rates of Rhinoceros *Unicornis* in Kaziranga National Park. Happily, in most recent times, poaching is now a thing of the past with much more vigilant forest guards and scientific prevention techniques.

Behavioural Patterns of the one horned Indian Rhinoceros

Observations in Kaziranga National Park

KAMAL CHANDRA PATAR

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Dedicated to my Mother

Foreword

Amidst the unfathomed deep ocean of forestry, which can be easily divided in more than thirty sub-subjects, wild life occupies an important position. The author of the book Shri Kamal Chandra Patar, IFS (Retd.) deserves congratulations for selecting a topic which is of common interest to professional foresters, wild life lovers, researchers and students as well. Though the topic cannot be called brand new, as much ink has been spilled by other authors on similar topics, yet this scientific study, and the observations and conclusions derived by the author are praiseworthy. In simple language, the author has been successful in doling out precious pearls of valuable knowledge on the Kaziranga one horned rhino. The contents of the book are a good combination of an academic thesis written for obtaining a degree in Michigan State University and the true observations of a practical forester then posted as Divisional Forest Officer (DFO) in the Kaziranga National Park.

The significance of the publication of the book increases manifold at this time, when the centenary of the Kaziranga National Park is knocking at our door. 1905 was the year, when Kaziranga was declared as a Proposed Reserve Forest. During a century long journey, from 1905 to date, Kaziranga has crossed many milestones such as declaration as a Reserve Forest in 1908, as a Game Sanctuary in 1916, as a Wild Life Sanctuary in 1950 and finally as a National Park in 1974.

There is a famous proverb, "A true forester never retires" meaning that the contribution of a professional forester in the field of forestry is never ending. I sincerely wish that the creativity of Shri Kamal Chandra Patar, IFS (Retd.) will continue and others will emulate him.

D. Mathur, IFS
Conservator of Forests.

October, 2004.

Preface

Travelling down the memory lanes of my career as a Forest Officer spanning over more than three decades, the year 1974 sometimes comes alive right before me. Courtesy of the then Secretary to the Government of Assam, Education Department, Shri M. P. Bezbaruah, IAS, I got an opportunity for Post Graduate study leading to the M.S. Degree in the Michigan State University (USA). As a partial requirement of the study, I was supposed to submit a thesis on Food preferences of the One Horned Indian Rhino, which I did.

The contents of this book are partially a compilation of my above referred thesis, updated with some latest figures and facts, but also includes some of my observations, which I gathered after my return from the USA, during my posting as Divisional Forest Officer (DFO) at the Kaziranga National Park.

At this juncture, I also remember the Chairman, Dr. George A. Petrides and Members, Dr. Rollin H. Baker and Dr. Christine S. F. Williams of my guidance committee in the Michigan State University with profound gratefulness.

I take this opportunity to pay my homage with a sense of gratitude to some senior colleagues: Late M. A. Islam, IFS, Late P. Baruah, IFS and Late R. M. Das, IFS. Though they have left for their heavenly abodes, yet the indelible mark of their helpfulness at each and every step of my study is still fresh in my memory.

I am also thankful to Shri D. Mathur, IFS, Conservator of Forests, whose practical suggestions could help me in converting a dream into reality. The valuable help and providing of photographs by Shri R. K. Das, Divisional Forest Officer (who was DFO, Eastern Assam Wild Life Division till September, 2004, and is also working on another Kaziranga book project, with my publishers, Spectrum Publications) and Shri J.P. Das deserves special mention. I further acknowledge my thankfulness to all those officers and employees of the Assam Forest Department, who contributed something or other in my endeavours.

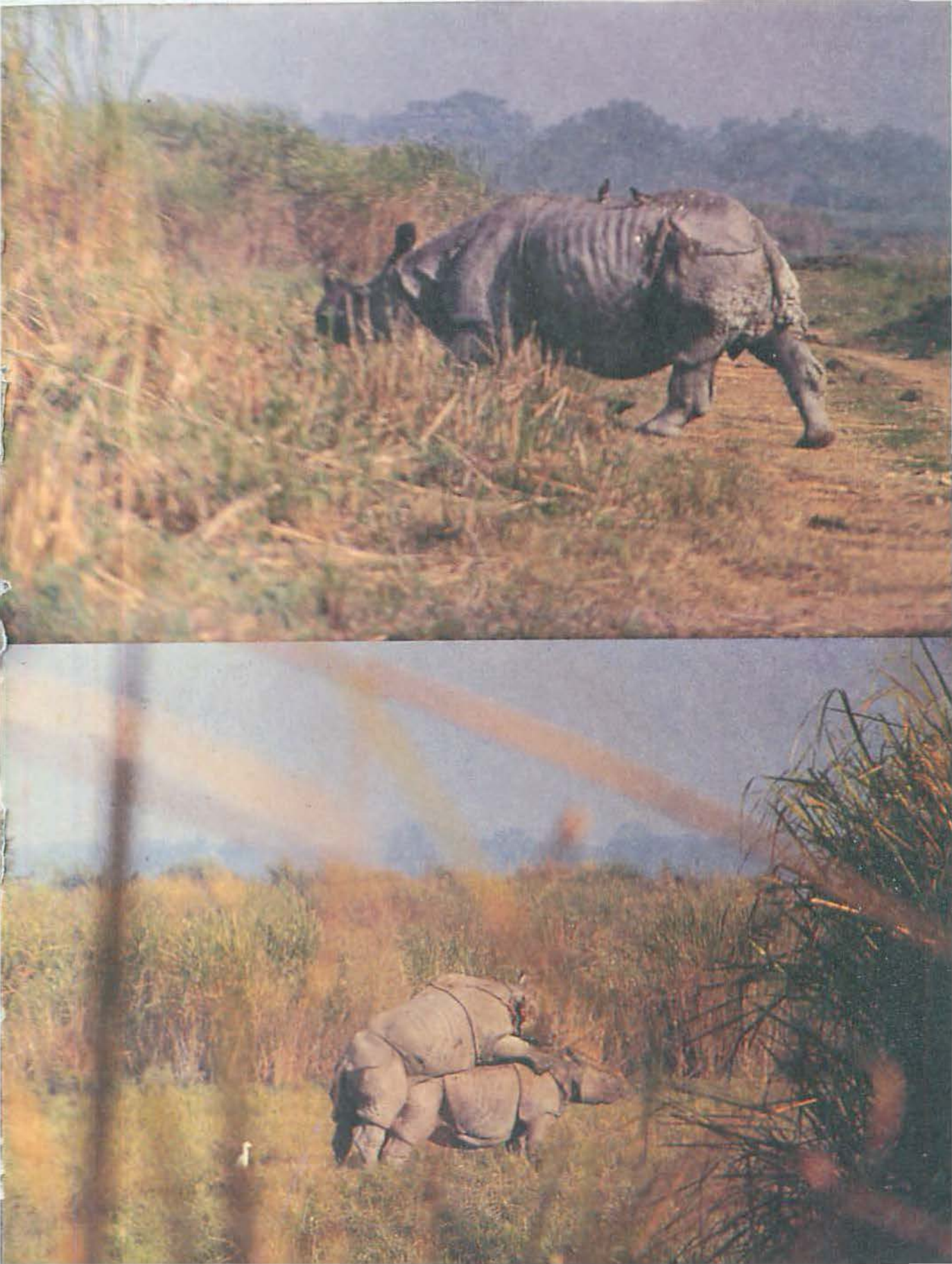
I also extend my sincere thanks to Shri Santanu Das [working in Assam Secretariat (Civil), Dispur], whose hard work in typing the manuscript helped me a lot.

I would like to place on record my heartfelt thanks to Shri K. Kumar of Modern Book Depot, Guwahati, Shillong and now New Delhi, without whose initiative and persuasion, the book would not have seen the light of the day.

Finally, I would like to invite suggestions and feedback from the readers to draw my attentions towards errors and omissions, which might have crept in unknowingly.

I will feel amply rewarded if this book is found of some use by the foresters, wild life lovers, researchers and students etc. of this field.

Guwahati. **Kamal Chandra Patar**



INTRODUCTION

Kaziranga National Park is situated in the Eastern part of Assam on the South bank of the Brahmaputra River in Golaghat and Nagaon Districts, from longitude $90^0$5/W to $90^0$40/E and from latitude $26^0$30/S to $26^0$45/N. The area is nearly flat.

In 1905, an area of 22,892 hectares was declared as the Proposed Reserved Forest which was finally notified in 1908 as the Kaziranga Reserved Forest. This Reserve was declared a Game Sanctuary in 1916 and later was enlarged to become the Kaziranga Wildlife Sanctuary with an area of 430 sq. km. In 1974, this tract was declared the Kaziranga National Park. In addition to the initially notified areas of Kaziranga National Park, there are six additions to the Park covering an area of 429.40 sq. km. Out of the six additions only the first addition with an area of 43.79 sq. km. near Burapahar was finalized in the year 1997 and added to the Park. Due to legal hassles, the rest of the additions are not yet finalized. In the year 1995 Kaziranga was declared as a World Heritage Site and now it has also been proposed as a biosphere reserve.

The mighty Brahmaputra river flows Westward along the Northern boundary of the National Park and is fed by streams that originate from the bordering Karbi Anglong District. Water courses criss-cross through the National Park before joining the Brahmaputra. The Mordaiffolu River follows the Southern boundary and the Diffolu and Bhengra Rivers flow through the National Park from East to West.

In addition to these streams, the National Park is dotted with numerous *beels* (lakes or ponds which contain water throughout the year). *Beels* and marshes are the principal places in which the rhinos wallow. These are evenly scattered throughout the Park and it is near water that rhinos concentrate in the dry season, when only 5.6% of the National Park is wet. Rhinos are most numerous in and around the wet areas of the Southern and Western part of the Park where the water table is highest.

Observations in Kaziranga National Park

The soils of Kaziranga National Park are deep alluvial deposits. In the South Western portion, loams are characteristic, while the North Eastern portion is sandy. The most fertile soils occur in the Southern half of the Park where the rhinos are most numerous during the dry months.

Climatically, the area is tropical. The mean annual temperature is 23.4^{0}C with mean annual maximum and minimum temperatures of 27.8^{0}C and 18.9^{0}C respectively. Temperatures as low as 8.9^{0}C and as high as 34.7^{0}C, have been individually recorded.

A dry season prevails from November to March. During the dry or winter months, the nights are cold, fog is common, and dew-fall is heavy, but frost and snow are absent.

Pre-monsoon showers start in March and April and heavy monsoon rain occurs from May to September. The average annual rainfall is 1827 mm; 76% of which falls from May to September. Monthly precipitation is usually highest in June (320 mm) and lowest in December (11 mm).

At Kaziranga, four major vegetative types are found: forests, tall-grass, short-grass, and aquatic areas. The relative habitat composition of the Park is 27.9% forests, 66.5% tall and short grass and 5.6% water areas. Numerous plant species occur in each habitat.

During the monsoon floods, animals move in search of high land for shelter and food. Some animals move out of the Park and take shelter in the nearby Karbi Anglong forest areas, tea gardens and rubber plantation areas. Many animals die either by drowning or in accidents with speedy vehicles while crossing the National Highway and also some of the animals being helpless fall easy victims to the villagers who kill them.

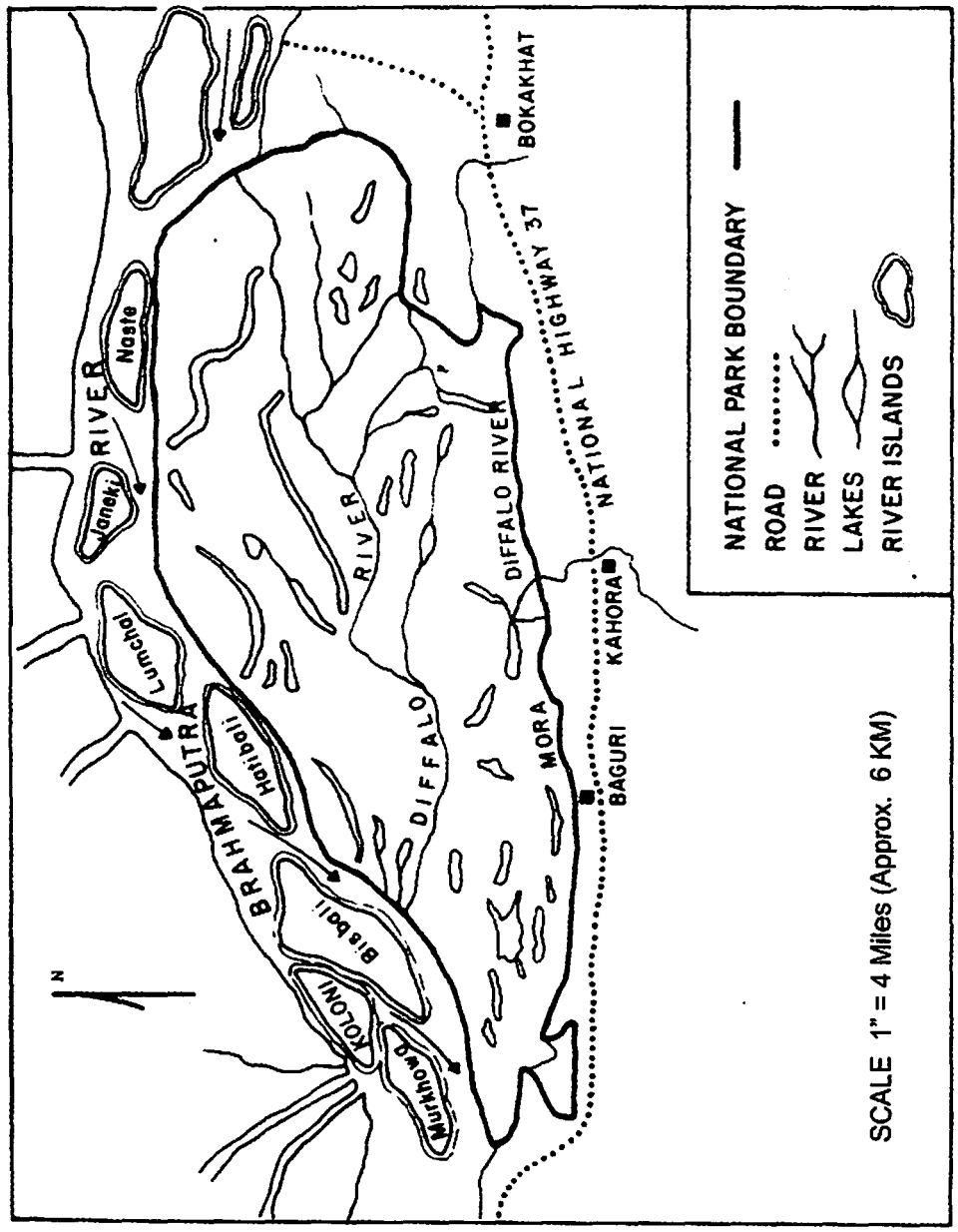


Figure 2

Map of Kaziranga National Park showing the rivers, *beels*, islands etc.

Most of the high grounds are either in occupation of tea gardens or rubber plantations/*jhoom* cultivation or under human settlement. When animals remain in such areas for food and shelter, poachers particularly take advantage and kill the helpless creatures. Non availability of safe high grounds in the periphery of the Park, justifies the building of raised platforms inside the Park. In order to give on the spot shelter, the Forest department has built up around 69 raised platforms measuring 180 metres length, 9 metres width and 3 metres height. Such platforms are really necessary for the calves and old animals. As the animal population is large, the present number of platforms are inadequate to meet the requirement.

Approximately an area of 290 square kilometres in the Park is burnt annually. An effort is made to burn the entire tall-grass area, mainly in February and March to increase the availability of forage and its utilization by wildlife. Vegetative compartments are bordered by patrol paths and roads which tend to act as fire lines. This practice is conducted also to control invading shrubs and various diseases such as brown-spot on grasses and ungulate liver fluke etc.

On the Northern side of the Park erosion takes place every year after the flood water has receded resulting in loss of wildlife habitat. The exact area in such losses has not yet been ascertained but it is quite substantial. Now the time has come to take some positive measures to check the erosion.

In addition to rhinos, several other species of large wild mammals are common in the National Park such as: water buffalo, (*Bubalus bubalis*), swamp deer (*Cervus duvauceli*), hog deer (*Axis porcinus*), *sambhar* (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), boar (*Sus scrofa*), gaur (*bos gaurus*), Indian elephant (*Elephas maximus*), sloth bear (*Melursus ursinus*), tiger (*Panthera tigris*) and leopard (*Panthera pardus*).

Kaziranga is a suitable habitat for the rhino because of the fact that the varieties of grasses, forbs and shrubs eaten by rhino are available in all the habitat types (Appendix-I). The rhinos here have adapted well to this. All necessary ingredients of a good habitat are

available such as good cover close to availability of food and ample open water. As mentioned earlier, in Kaziranga, four different types of habitats are found. These are forests, tall grass, short grass and water areas. It is a suitable habitat because it develops maximum edges i.e. where two habitats meet. It is a specialty of the Park that the variety of grasses, forbs and shrubs occurs in all the habitat types. As mentioned in the previous chapters, maximum grasses and forbs are found in short grass areas. In tall grass habitat eleven spp. of grasses and forbs constitutes rhino diet such as, *Arundo donax, saccharum spps., oxalis spps., polygonum Chinese, pteridium aquilinum* etc. In forest areas, the bottom canopy spps. of grasses and forbs and sometimes shrubs are also eaten, such as *Erianthus elephantinus* (Ravanae), *Cyperus pilosus, Eleocharis fistulosa, cyperus auricomus, cynodon dactylon, Eleusina indica, oxalis corniculata* etc. In the aquatic area, grasses and forbs consist of *Ipomaea aquatica, Leersia hexandra, Andropogon sp., potamogeton crispus, Najas graminea, Fussiaea repens, Eichhornia crassipes, Monochoria has taefolia, Eichhornia speciosa* etc.

In addition to rhinos, several other species of large wild mammals are common in the National Park such as: water buffalo, (*Bubalus bubalis*), swamp deer (*Cervus duvauceli*), hog deer (*Axis porcinus*), sambhar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), boar (*Sus scrofa*), gaur (*bos gaurus*), Indian elephant (*Elephas maximus*), sloth bear (*Melursus ursinus*), tiger (*Panthera tigris*) and leopard (*Panthera pardus*). Some census data is given in Figure 3.

Other animals which are found are Assamese macaque, (*Macaca assamensis)* Rhesus macaque, (*Macaca mulatto*), Hoolock gibbon (*Hylobates hoolock*), Common or Eurasian otter (*Lutra lutra*), Leopard Cat (*Felis viverrinus*), Fishing cat (*Felis bengalensis*), Gangetic dolphin, (*Platanista gangetica*), Wild pig (*Sus scrofa*), Crestless himalayan porcupine (*Hystrix brachyura*), Small-clawed otter (*Lutra lutra*), Malayan box turtle (*Cuora*

amboinensis), Common Bengal monitor (*Varanus bengalensis*). Reptiles such as: Rock python (*Phython molurus*), Bengal cobra (*Naja kaouthia*), and Checkered keelback watersnake (*Xenochrophis piscator*) etc.

Year of census	Elephant	Buffalo	Swamp Deer	Hog Deer	Wild Pig
1966	349	471	213	1311	1551
1972	422	555	516	4551	522
1978	773	610	697	6855	733
1984	523	677	756	9872	1645
1991	515	1090	635	2911	555
1993	1094	1034	427	2048	140
1998	--	--	526	--	--
1999	882	1192	398	5045	431
2001	--	1666	--	--	--
2002	1007	--	--	--	--

Figure 3

Wild animal population during various census years in Kaziranga National Park

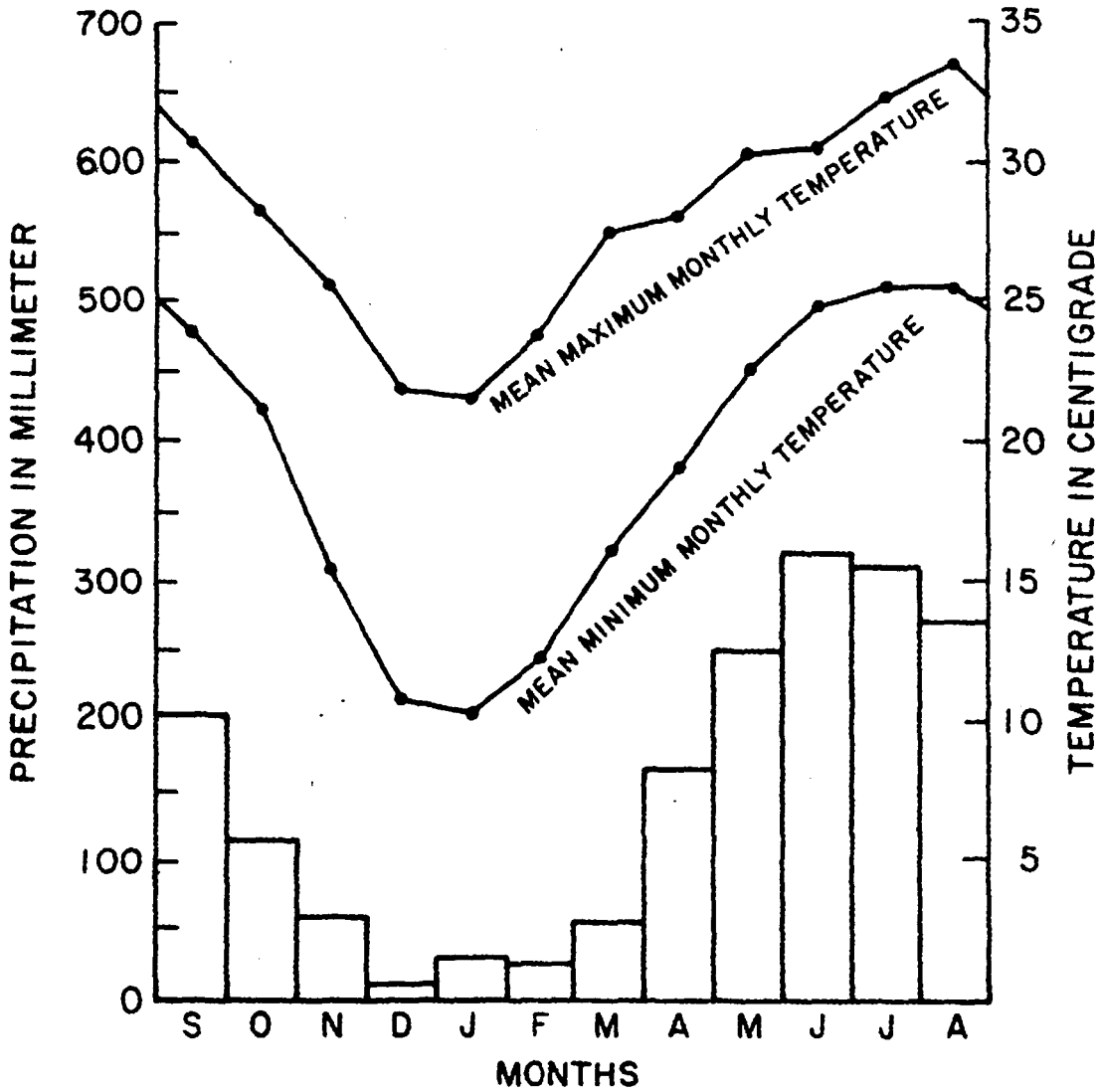


Figure **4**

Mean monthly distribution of precipitation, and maximum and minimum temperatures during 1965-1974 in Kaziranga National Park.

Simultaneously the number of tigers (a dominant carnivore spp.) in the Kaziranga National Park, as acquired from different census reports is also on a constant rise. The following figures are supportive of this:

Year of Census	1966	1972	1978	1984	1991	1993	2000
Number	20	30	40	52	50	72	86

Figure 5

Estimate of tiger population in Kaziranga National Park

A rhino grazing with buffalos and deer in short grass area of Kaziranga National Park.

Behavioural Patterns of the one horned Indian Rhinoceros

THE RHINO

The one horned Indian rhinoceros (*Rhinoceros unicornis*) is one of the world's five living species (Havass, 1970). Of the Asian spp. of rhino, only the Indian and Javan rhino (*Rhinoceros sondaicus*) have one horn, while the Sumatran (*Didermocerus sumatrensis*) has two horns. As surviving members of the late tertiary and Pleistocene ungulate fauna, rhinos are often regarded as living fossils. Formerly extensively distributed, the Indian rhino is today limited to parts of Nepal and to portions of West Bengal and Assam in India (Prater, 1965). In Assam, the rhino occurs in Kaziranga, Manas and Orang National Parks and Pabitora and Lackhowa Wild Life Sanctuaries. It occurs and is also protected on some islands (*chaporis*) in the Brahmaputra river, but must compete with livestock there.

In Assam the rhino's primary mating season is from February to June, but mating also occurs during other months (Kakati and Rajkonwar, 1972, and Mukherjee, 1966). Kakati and Rajkonwar, (1972) further state that a female rhino in the Guwahati Zoo first accepted a mate at five years and eleven months of age. The interval between her calving and the next service was approximately twenty eight months. The gestation period is 18-19 months and the period between births is 3-4 years (Mukherjee, 1966). Single birth is the rule.

In some parts of Asia, powdered rhino horn is believed to have magical powers, and is so highly priced that poaching of Rhinos is a continuous threat at Kaziranga despite the rigid measures undertaken to control it. There are superstitions/myths that almost all parts of the rhino are believed to have super medicinal values. Of all these, the horn is supposed to be the most powerful aphrodisiac. The horn is also thought to be useful to cure many ailments like fever, dysentery, tuberculosis etc. There are also myths regarding use of other parts of the rhino such as bone, meat, hoof, tail, urine and blood etc. to cure various diseases.

Rhinos are also in great demand both from Indian and foreign zoos and, therefore highly priced. The rhino is captured by digging pits, and erecting a temporary wooden stockade (25x50 ft/ 8-16 metres), for keeping the captured rhino for about one month. The

stockade is near a water source and near a road. The pits (10 x 6 ½ x 4 ½ ft/3x2x1.5 metres approx) are dug in areas used by the rhinos inside the Park, and are completely covered with twigs and dry leaves for camouflage. After the rhino is entrapped in the pit, it is tied with strong jute ropes (1 ½-2inches/35-50mm in diameter) and fixed till final caging. An iron cage with two opposing and wooden wheels is used to transfer the rhino from the pit to the stockade. The rhino is transferred to the cage by slowly removing the earth between the rhino and the cage, without disturbing the rhino, so that an earthen ramp is built for pushing and pulling the rhino into the cage. Elephants are used to pull the cage with the rhino from the pit to the ground surface, and tractors pull the cage to the stockade. Rhinos escaping from the pits have sustained serious injuries, sometimes causing their death. 12-16 hours are necessary to process the capture, from detection in the pit to the caging, and rhinos are best captured from January to March in the dry season.

Occasional poaching (which later grew to alarming proportions) of rhinos occured in the Kaziranga National Park by local inhabitants financed by smugglers from inside and outside Assam, interested primarily in the rhino horn. Poachers killed the rhino either by gunshot or by digging and occasionally with pointed bamboo stakes fixed in the pit.

Prior to 1966, rhino poaching in the present Kaziranga National Park area had reduced the population to a low level. Before Kaziranga attained National Park status, losses of rhinos were also probably caused by the transmission of rinderpest and anthrax from the domestic water buffaloes (*Bubalus bubalis*) brought into the area by herdsmen. In addition, tigers (*Panthera tigris*) also killed some rhino cubs. Since the Park has been placed under management controls, poaching has been largely eliminated.

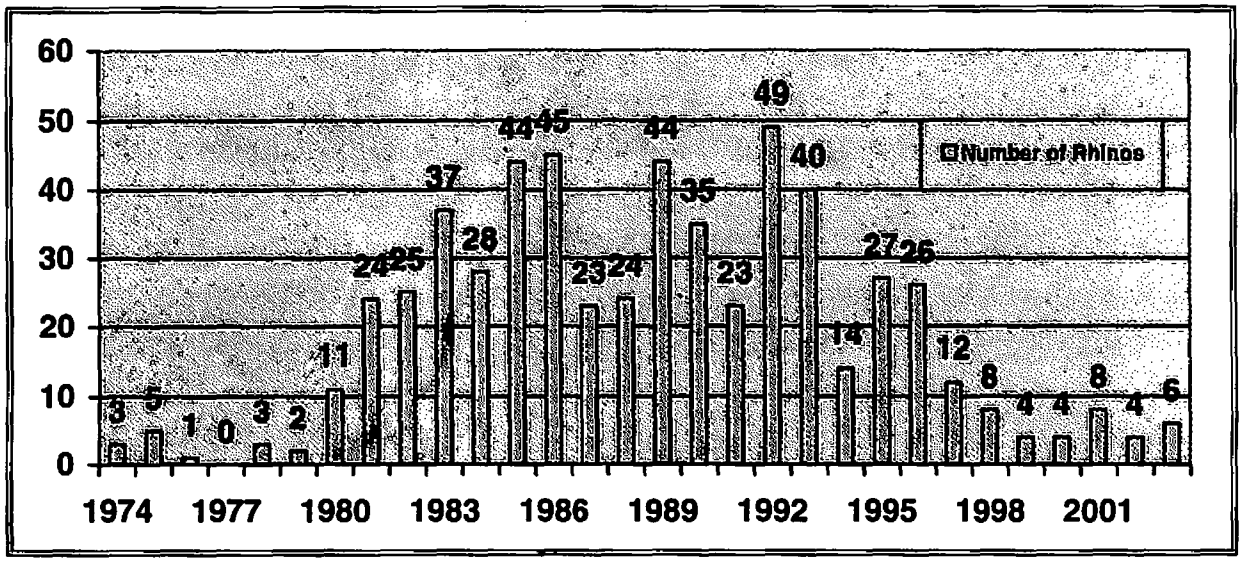


Figure 6 **Poaching of Rhinos in Kaziranga National Park during the last 27 years.**

A sharp variation in the figures of poaching can be easily noted from the above graph. It is quite evident that during the period from 1985 to 1993, a large number of rhinos were killed by the poachers in addition to other causes such as natural deaths, floods and infighting etc. It is very heartening to note that poaching in recent years has further dwindled, so much so that 2003 was a record year in which there was not a single recorded case of poaching.

The 1999 census of Kaziranga National Park revealed that the rhino population had increased to 1552, whereas the corresponding figures in the censuses carried out in 1993, 1991, 1984, 1978, 1972 and 1966 were found to be 1164, 1129, 946, 939, 658 and 366 respectively. Analyzing these figures, an increase from 366 in 1966 to 1552 in 1999 i.e. over a period of thirty three years can be noted. The 1999 population consisted of 507 adult males, 528 adult females, 49 sub adult males, 58 sub adult females, 257 calves plus 57 individuals which were neither sexed nor aged. For the year 2003 the total population was projected to be around 1700.

Observations in Kaziranga National Park

It will be appropriate to mention here a few words regarding the census procedure. Since visibility is best in the grassland during March following the annual burning, the census is normally conducted in the month of March. Direct counts are made from elephant-back with two to three observers from 0500 to 1100 hours and from 1400 to 1730 hours. Usually some trained domesticated elephants are used, and their presence does not appear to disturb the rhinos. The Park is divided into eight blocks and sub-divided into 35 to 45 compartments on the basis of terrain, density of trees and grass cover. This enables one elephant to cover a compartment in a day. Where there were no natural rivers, streams or roads to form compartment boundaries, 10 ft. (approx 3 metres) wide strips were cut to demarcate boundaries.

Sl. No.	Name of Block	Area	No. of Rhinos	Area available for each in sq. km.	No. of Rhinos per sq. km.
1	2	3	4	5	6
1.	Baguri	74.30	684	0.108	9.14
2.	Haldibari	48.00	284	0.169	5.91
3.	Kaziranga	44.77	130	0.343	2.90
4.	Panbari	51.50	105	0.490	2.03
5.	Bhawani	72.90	132	0.552	1.81
6.	Charighoria	55.50	77	0.720	1.38
7.	Tamulipathar	51.40	80	0.642	1.44
8.	Boralimora	31.00	32	0.968	1.03
9.	Addition Areas	--	28	--	--
Total		**429.30**	**1552**	**0.276**	**3.54**

Figure 7 **Block-wise distribution of Rhinos.**

Behavioural Patterns of the one horned Indian Rhinoceros

Concentration of rhino population has been found to be highest in the Baguri block in all the censuses. As many as 684 nos. of rhinos were counted in the 1999 census. In this block, the density of rhino population was found to be 9.14 per sq. km. whereas in Baralimara Block only 32 nos. of rhinos were counted and the density was found to be 1.03 per sq. km. Average density of population, as found in 1999 census in the entire Park was 3.54 per sq. km.

From the census data in the foregoing table it is seen that maximum rhinos were counted in Baguri, Haldibari and Kaziranga blocks. Because of fertile soils, the park supports maximum grasses and forbs which are usually eaten by the rhinos. About 80% of vegetation cover consisting of grassland is found in Baguri, Haldibari and Panbari Blocks, whereas there is about 50% to 80% in Kaziranga Block and less than 50% in other blocks.

Year	Adult			Sub-adult			Calf	Total
	Male	Female	Un-sexed	Male	Female	Un-sexed		
1999	507	528	96	49	58	57	257	1552
1993	387	379	163	18	19	59	139	1164
Incre	(+)120	(+)149	(-)67	(+)31	(+)39	(-)2	(+)118	(+)388

Figure 8 **Comparative statement of population of Rhino of 1999 and 1993 censuses.**

The causes of decline in the number of un-sexed adults and sub-adults may be poaching, predation, death due to floods and other factors and the most important—

identification of sex over a period of six years. This also explains the substantial increase in male and female adults and sub-adults.

In the past, a number of problems developed one after another in Kaziranga National Park. One such problem was *Mimosa rubicaulis* which is an exotic species and which had invaded large grass areas causing imminent danger to the Park. Because of being a leguminous plant with prolific growth, it serves the dual purposes of fixation of nitrogen in the soil on the one hand and replacement of weeds in between tea bushes in the tea gardens on the other hand. For this, some tea planters were said to have brought the seeds from Indonesia about 30-40 years back. The seeds being tiny and light in weight were easily dispersed in the Park from the nearby tea gardens either by water or by wind. This may eventually cause an acute shortage of foods for the animals in the near future, if preventive measures are not taken before its tentacles grasp the entire grass area. In order to remove the Mimosa menace, habitat manipulation practices may be carried out. One of such practices is the raising of quick growing cover crops endemic to the region to keep the Mimosa plants under suppression which may help check it's growth. The Park authorities are right—against using herbicides to remove Mimosa so as to avoid uncontrollable harmful effects on the Park animals in future. Precaution is necessary in selecting eco-friendly spp., endemic to the region, which are usually palatable to herbivores. Before sowing seeds of cover crops, all the jungles of the grass area are to be cut to the ground followed by a bit of soil work with tractors. As suggested by scientists, removing Mimosa manually and mechanically using tractors, may also continue besides pressurizing the tea garden authorities to replace Mimosa with other leguminous plants capable of fixing the nitrogen in the soil.

It is also suggested that in the fringe areas of Karbi Anglong District adjacent to the Park, some grasses, shrubs and forbs eaten by the animals may be raised which will serve as emergency food for the helpless animals moving out of Kaziranga National Park during the high flood season.

Kaziranga is a suitable habitat for the rhino because of the fact that varieties of grasses, forbs and shrubs eaten by the rhinos occur in all the habitat types (Appendix 1). The

rhinos were found to have adapted well because of the good cover, availability of food and ample open water. It is a suitable habitat because it develops maximum edges i.e. where two habitats meet. As mentioned earlier, it has been observed that in short grass habitat, varieties of grasses and forbs are eaten by the rhinos and in a tall grass habitat, around a dozen grasses and forbs constitute the rhino diet such as *Arundo donax, Saccharum Sp. Erianthus elephantinus (Ravanae), Pteridium aquilinum, conodon dactylon, Vetiveria zizanioides, imperata cylindrical, chrysopogon aciculatus, paederia foetida* etc. As soon as the fresh flush of grasses appear, the rhinos move to the burnt area, because they prefer to eat the fresh, tender leaves of the grasses. As a result sometimes 10-12 rhinos are seen grazing together in the burnt area. Coarse grasses are normally avoided. In the forest area, some grasses, forbs and shrubs which occupy the bottom canopy are found being eaten by the rhinos. Some of these are *Cyperus pilosus, Eleocharis fistulosa, Cyperus auricomus, Cynodon dactylon, Eleusina indica, Oxalis corniculata, Mimosa pudica, Hydrocotyle rotundifolia, Centella asiatica* etc.

Different habitat types in Kaziranga National Park

METHODS

All portions of the short grass vegetative type in the Park were visited. Direct observations of rhinos were made and the plant species which occurred there were collected. Unknown plants were identified by personnel of the Botanical Survey of India in Shillong.

Study plots were located in those sections of the short-grass habitat which were not utilized by other large herbivores. These places were mainly near roads, patrol paths and camps where patrol staff mounted on elephants could drive away competitive ungulates such as buffalos, *barasingha* deer and hog deer. Though these species were easily seen from the elevated patrol stations (situated on 10-15 ft./3-5 metre stilts) they were not often present in the study area because of the constant movement of the patrol staff.

In three areas totalling about 120 hectares, other grazers were mainly lacking and 15-20 rhinos were seen to feed regularly. These portions of the short-grass habitat were sampled systematically using a one square-meter frame. Fifty such one sq. metre plots were marked by pegs and spaced at 250 metre intervals along parallel North-South transects 100 metres apart. The distance between plots was measured using a metal tape and lines were kept equidistant using a hand compass. Vegetative plots were sampled between 0900 and 1500 hours, when rhinos usually moved away to their wallows or to wooded and tall-grass areas.

Both Cain (1938) and Braun-Blanquet (1932) have stated that the number of plots needed to sample vegetative compositions is adequate when, after increasing the number of plots, the slope of the species-area curve becomes approximately horizontal. On this basis, it was determined (Figure-7) that on these 120 hectares, only 40 plots were necessary. Fifty plots, nevertheless, were studied.

In each plot the number of individual shrubs, forbs and grasses present, were tallied by species. Each plot was visited two to four times per month from December through March. Forage availability and utilization were measured during each visit, if grazing had occurred during the interval. The several observations at each plot were averaged (Table-1).

Plots completely eaten were not revisited since the lack of moisture prevented further plant growth.

After collecting inventory data on each visit to the 50 plots, 20-50 specimens of uneaten plants near the plots were clipped at the mean minimum grazing height measured on the study plot. Clipped plants were separated by species and placed in paper bags. All plants were dried to a constant weight in an oven at 80^0C. The weights of the plant parts clipped were considered to be equal to the weights of plant parts consumed.

Preference values were determined for each forage species by dividing the percentage weight which that species of that species among foods available (Petrides, 1975). Species with preference values above 1.00 were those which were sought out as preferred foods. Species with a preference rating of 1.00 would be neither preferred nor neglected, but eaten in proportion to their abundance in the field. Ratings below 1.00 represented forage species which tended to be neglected. Species which were totally avoided were given a zero preference rating. This method enables the quantitative determination of relative rhino preference levels for each plant species. In contrast to the calculated dry season preference ratings, wet season food habits were merely recorded from general observations. Direct observations of feeding rhinos were usually made from elephant-back at a distance of 10-15 metres. Binoculars were frequently used. Occasional observations were made at patrol camps or from a jeep. Rhinos were observed during their feeding periods which usually extended from 0600 hours to 0900 hours and 1500 hours to 1800 hours.

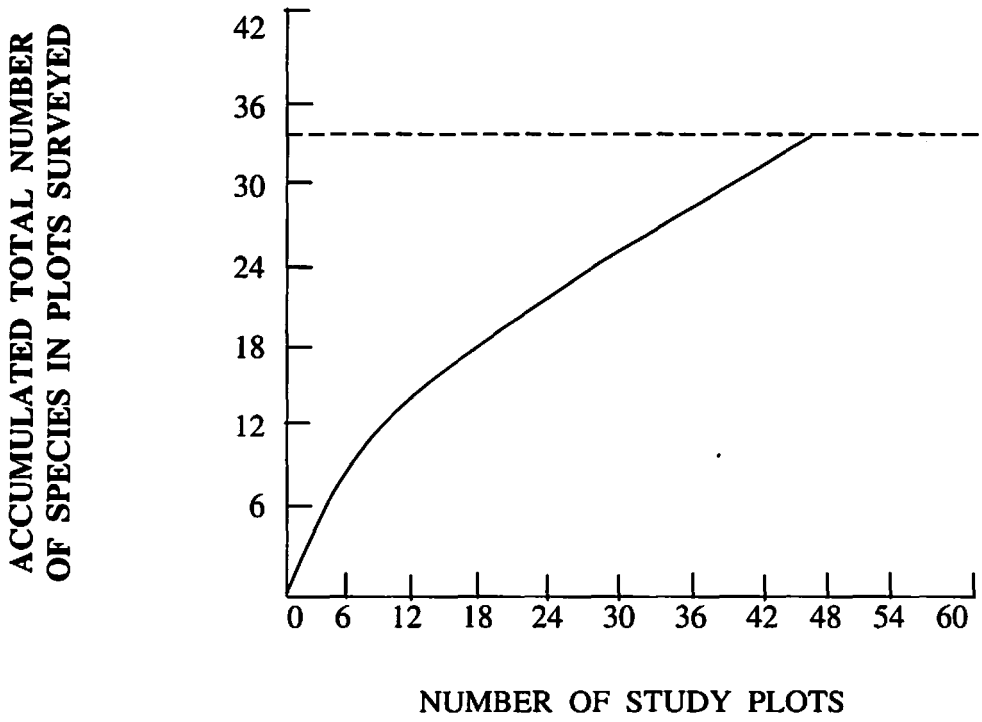


Figure 9 **Species area curve for the vegetation in Kaziranga National Park.**

RESULTS

FOOD PREFERENCES

While 47 plant species were eaten by rhinos in all habitats (Appendix-1), only 18 were consumed in the 120 hectare short-grass study area. Nearly 77% of the rhino's diet consisted of four grass species, i.e. *Arundo donax, Hemarthria compressa, Erianthus elephantinus* and *Cynodon dactylon.* The remaining food plants taken consisted of 14 forbs. Three forbs found in the study area were avoided as foods by rhinos (*see* Figure-10).

During the dry season, rhinos primarily ate non-woody vegetation. In order of preference (Figure-10), *Arundo donax, Hemarthria compressa, Carex rubrobrunnea, Eleochoris fistulosa* and *Lippia geminata* were consumed to a greater degree than their abundance alone would warrant.

Thirteen non-preferred plants were eaten. In order of choice these were: *Nasturtium indica, Polygonum chinense, Centella asiatica, Ficus scandens, Cyperus auricomus, Amaranthus viridis, Polygonum barbatum, Oxalis corniculata, Kyllinga brevifolia, Pteridium aquilinum, Fragaria indica, Cynodon dactylon* and *Erianthus elephantinus.* Forty-nine to 55% of the *N. indica, P. chinense, C. asiatica, F. scandens* and *C. auricomus* was eaten, whereas 10-42% of the remaining eight species was consumed.

Solanum torvum, Xanthium strumarium and *Polygonum hydropiper* were avoided entirely.

During the dry season, rhinos were seen eating the following plants in the forest area: *Amaranthus viridis, Centella asiatica, Fragaria indica* and *Pteridium aquilinum.* Shrubs and trees were not utilized there or elsewhere by rhinos during the dry season study period. Preference ratings were not determined.

Observations in Kaziranga National Park

Forage species	Average Dry Weights		
	Edible Portions per plant (g)	Available/hectare (kg) = A	Consumed/hectare (kg) = C
Arundo donax	1.195	91.78	74.09
Hemarthria compressa	.215	683.57	502.84
Carex rubrobrunnea	.239	190.53	131.55
Eleochoris fistulosa	.127	8.00	5.33
Lippia geminate	1.182	10.40	6.15
Nasturtium indica	.982	3.54	1.96
Polygonum chinense	.505	13.03	6.87
Centella asiatica	.316	5.31	2.78
Ficus scandens	.741	14.82	7.41
Cyperus auricomus	.473	9.93	4.92
Amaranthus viridis	.388	7.14	3.03
Polygonum barbatum	.810	22.68	8.91
Oxalis corniculata	.117	5.03	1.22
Kyllinga brevifolia	.086	.76	.17
Pteridium aquilinum	.425	1.11	.17
Fragaria indica	.120	7.01	.86
Cynodon dactylon	.081	12.49	1.39
Erianthus elephantinus	.475	175.37	17.67
Solanum torvum	3.35	8.71	0.00
Xanthium strumarium	9.97	35.89	0.00
Polygonum hydropiper	6.01	43.27	0.00
TOTAL		**1350.37**	**777.32**

Available forage (%) $a = \frac{A}{\sum A} \times 100$	% consumed $c = \frac{C}{\sum A} \times 100$	Removed (%) $R = \frac{C}{A} \times 100$	Preference ratings $p = \frac{c}{a}$
6.80	9.53	80.73	1.40
50.62	64.69	73.56	1.28
14.11	16.92	69.04	1.20
.59	.69	66.63	1.17
.77	.79	59.13	1.03
.26	.25	55.37	.96
.96	.89	52.72	.93
.39	.36	52.35	.92
1.10	.95	50.00	.86
.74	.63	49.55	.85
.53	.39	42.44	.74
1.68	1.15	39.39	.68
.37	.16	24.25	.43
.06	.02	22.37	.33
.08	.02	15.32	.25
.52	.11	12.27	.21
.92	.18	11.13	.20
12.99	2.27	10.08	.17
.65	0.00	0.00	0.00
2.66	0.00	0.00	0.00
3.20	0.00	0.00	0.00
100.00	100.00	1.	1.74

Figure 10 **Food preferences and available forage.**

IMPORTANT FOODS

The most valuable species, in terms of the bulk contribution to the rhino's diet in the short-grass area (Figure -10) were *H. compressa, C. Rubrobrunnea* and *A. donax*. Together, *Hemarthria, Carex* and *Arundo* seemed to provide an ideal habitat for the rhino. They comprised 71.5% of the available forage and 91.1% of the total food eaten.

A. donax, the most preferred species, is a grass 2-6 metres high, growing from a creeping rhizome. Known regionally as *nal*, it occurs near *beels* in the wet portion on the short-grass habitat. Comprising 6.8% of the available forage, it accounted for 9.5% of the rhino's diet during the dry season. Due to heavy utilization by rhinos, buffaloes and elephants it was being depleted throughout the Park.

H. compressa, the second favorite dry-season food, comprised 50.6% of the available forage and made up 64.7% of the rhino's diet. Known locally as *lokosa*, it appeared to be the most important dry season food of the rhino within the Park. As is true for all species in the short-grass habitat, this plant becomes unavailable during the wet season due to flooding.

E. elephantinus a tall, clumped, reed-like grass, locally called *ekra*, is a 4 metre high perennial. It comprised 13% of the available forage and 10% of the rhino's diet. *E. elephantinus* also occurs in the tall-grass area with *Saccharum sp.* and *Imperata cylindrica*. All of these grasses were eaten there for one to eight weeks after burning. . *E. elephantinus* is increasing in the dry portion of the short-grass area as this non-preferred grass spreads from the tall-grass habitat.

From the middle of June to September, when about 60% of the National Park is under water, rhinos seek the higher ground of the forest area. At this time, plants which are eaten heavily during the dry period, notably *H. compressa* and *C. rubrobrunnea*, are submerged elsewhere and thus unavailable. Forbs and grasses which are little eaten during the dry season become more important in their diet during the monsoon. Some shrubs are eaten under these conditions as Laurie (1974) also observed. A further detailed study on these points is needed.

Behavioural Patterns of the one horned Indian Rhinoceros

As the floods recede, the somewhat-submerged grasses in the aquatic areas, *Leersia hexandra* and *Andropogon sp.*, are heavily grazed upon by the rhinos. Other aquatic plants eaten there are: *Monochoria hastaefolia, Cypersus diffusus, Eleochoris fistulosa, Sagittara sagitifolia, Eichornia speciosa, Potamogeton crispus, Cyperus iria, Jussaea suffruticosa,* and *Najas major* (Appendix-1). These plants occur in both the short-grass and aquatic habitats, but most show no green above-ground parts during the dry season and do not seem to be eaten then.

In the tall-grass areas, the leaves and inflorescences of the grasses *Vetiveria zizanioides, Saccharum sp.* and *E. elephantinus* were seen to be eaten somewhat but no detailed data was available.

RANGE CONDITION AND TRENDS

Very heavy utilization by rhinos of their preferred food grasses was seen on the short-grass habitat around the Sohola *Beel*, in the Eastern portion of the Park. It appears that the preferred dry season food species *A. donax, H. compressa, C. rubrobrunnea* and *E. fistulosa* were being replaced there *by P. hydropier. X. strumarium* and *S. torvum.* The latter three species were avoided as foods by the rhinos (Table-1) *P. hydropiper* was increasing in the wetter portions of the short-grass habitat and *X. strumarium* and *S. torvum* increased in the drier sections.

Over the study area, 15-20 adult rhinos grazed regularly during the dry season study period. Approximately 777 kg. per hectare of vegetation was removed by rhinos from the 120 hectare study area then (Table-1). About fifty percent of the forage available from the nine most preferred species (Table-1) was eaten. Though it seems possible that overgrazing of these species may be occurring, further study of their productivity under rhino grazing pressure is desirable.

RECOMMENDATIONS FOR MANAGEMENT

In considering a program for the management of rhinos in the Park ecosystem, it is suggested that :

1. Assessment of the rhino population and range conditions be conducted annually.

2. Permanent plots be established to help evaluate habitat trends within the Park.

3. Studies on the food preferences of other large herbivores be carried out to determine the availability of the plants occurring in the Park, their utilization and preferred herbivore stocking density.

4. Changes in range composition should be assessed periodically to determine whether overuse is occurring. If the preferred and important forages H. compressa, C. rubrobrunnea and A. donax become depleted or if the neglected and avoided plant species show evidence of increasing over considerable areas or in places preferred by the ungulates, then the animal populations may require further scientific management.

A solitary rhino in the short grass area, Kaziranga National Park

SUMMARY

Food preferences of the Indian rhinoceros (*Rhinoceros unicornis*) were studied in the Kaziranga National Park, Assam, India, from November, 1975 through April, 1976. Studies were made of the forages available and consumed by means of vegetation plots. Of the 47 plant species eaten, only 21 occurred on the 120-hectare short grass study area. In the latter group, 18 were eaten. Feeding rhinos also were directly observed.

Preferred dry season food plants were *Arundo donax, Hemarthria compressa, Carex rubrobrunnea, Eleochoris fistulosa* and *Lippia geminate*. The species eaten but not preferred were : *Nasturtium indica, Polygonum chinense, Centella, asiatica, Ficus scandens, Cyperus auricomus, Amaranthus viridis, Polygonum barbatum, Oxalis corniculata, Kyllinga brevifolia, Pteridium aquilinum, Fragaria indica, Cynodon dactylon and Erianthus elephantinus.* Common, but totally avoided species were *Solanum torvum, Xanthium strumarium*, and *Polygonum hydropiper.*

Plants contributing most to the rhino's diet were : *H. compressa, C. rubrobrunnea, A. donax, E. elephantinus* and *P. barbatum.*

More than 50% of the available *A. donax, H. compressa, C. rubrobrunnea, E. fistulosa, L. geminate, N. indica, P. chinense, C. asiatica* and *F. scandens* forages was consumed.

The three grasses *H. compressa, C. rubrobrunnea* and *A. donax* comprised 71.5% of the available forage and 91.1% of the rhino's diet. These grasses typify the ideal dry-season habitat of the rhino. In some areas, however, these grasses appear to be overgrazed. There is thus some indication that maximum ungulate populations have been achieved or possibly even exceeded.

A. donax was the most preferred dry season food, comprising 9.53% of the diet and 6.8% of the food available. *H. compressa*, the second most preferred food, comprised 64.69%

of the diet and 50.62% of the available food. Fifty-nine to 81% of the available forage of the five most preferred food plants was consumed.

During the dry season in the short grass habitat, *A. donax, H. compressa, C. rubrobrunnea*, and *L. geminata* are reduced. In this important habitat, *P. hydropiper, X. strumarium,* and *S. torvum* tended to increase. It appeared that the biomass of large herbivores may be at or near the carrying capacity of the Park.

Rhinos move to forest habitats when the short grass area is flooded, usually between July and September. Here some shrubs are eaten in addition to the somewhat aquatic grasses and forbs.

It is recommended that the rhino population and condition of the range be evaluated annually; that food preference studies be undertaken on the other large herbivores in the Park; and that permanent plots be established to help assess habitat trends.

Wallowing

OBSERVATIONS ON THE BEHAVIOUR OF THE ONE HORNED RHINOCEROS IN KAZIRANGA NATIONAL PARK

During 1976-1978, ecological studies were made of rhinos in Kaziranga National Park and observations were made from atop elephants, jeeps and tower houses, sometimes also using binoculars.

TERRITORIALITY

An adult rhinoceros actively defends smaller areas of exceptional importance such as the wallowing place, an especially rich feeding spot and even a mating area within the home range. Such areas may be called territory. The common features such as restriction to certain adult males, a dominant assertiveness in interactions and exclusive participation in reproduction etc. are exhibited by an adult male in a given territory. Because of his territorial behaviour, the adult male rhino has the advantage of access to limited resources such as space, food, water and mates. Female adolescents and sub-adult rhinos do not exhibit territoriality which is restricted to the dominant males. Two to thirteen rhinos were commonly observed living in the same *beel* during the hot hours of the day. *Beels,* where one or two adult males wallow, may be shared by females and juveniles. These mixed groups may also be seen in nearby grazing areas. On many occasions, ten to fifteen rhinos were observed grazing together on the burnt areas of the tall grass habitat. This was particularly common when the new flush of grasses appear after burning i.e. between 7-30 days after burning.

The size of the home range varies considerably according to the availability of food and water. Home ranges do overlap. The proportion of the home range which is utilized by the rhino is considerably greater during high floods when rhinos move to the tree habitat. From November through April, rhinos occupy only that part of the home range in the vicinity

of the *beels*. That is why it is not uncommon for a visitor to see 10-15 rhinos sometimes, in and around the *beels*. Rhinoceroses tend to be very regular in their movement patterns within their home range. Most of the adult rhinoceroses remain attached to their home range unless disturbed by floods or other natural calamities.

SOCIAL GROUPS

It has been observed that the rhinoceros population can be classified with 5 (five) social groups on the basis of age, sex, utilization of space etc. They are: calves, adolescents, cows (in case of females), subsidiary bulls (in case of males) and territorial bulls (in case of males). Normally, calves move along with their mother cow till the time another new calf is born. Then the former enters the period of adolescence and is known as adolescent. In case of female adolescents, the period ends as soon as the first calf is born to her and she gets the status of a cow. The period is about 6-7 years. In case of male adolescents, the period is somehow longer, say about 10-12 years. The period of adolescence is the advance stage of growth. After adolescence the animal remains as a subsidiary bull till it becomes capable of challenging a territory and attains full weight and vigour. Then the role of a territorial bull begins— like defending a rich feeding spot or wallowing place, and dominance over other animals within the territory. The territory may be occupied by a territorial bull with mother rhino with a calf, and some adolescents and subsidiary bulls.

WALLOWING

Wallowing probably disposes of excess heat and provides protection from insect bites and acts as mud-therapy against skin ailments. *Beels* with muddy soils are selected for wallowing. Ninety percent of the observations on wallowing rhinos were recorded between 0800 hours to 1600 hours during the wet season and between 0900 hours to 1400 hours during the dry season. Occupancy in wallows depends upon the season of the year, and the availability of water. Dried up wallows are generally abandoned.

RESTING

During the hot hours of the day, they lie down either in the wallow or inside the tall grass habitat or tree habitat. In summer, they prefer to sleep in the wallow and in winter 50% of the animals sleep in the tall grass habitat.

ASSOCIATION

The birds in close association with the rhino are the Cattle egret (*Bubulcus ibis*), Little egret (*Egretta garzetta*), Common myna (*Acridotheres tristis*), Jungle myna (*Acridotheres fuscus*), Bank myna (*Acridotheres ginginianus*), Black drongos (*Dicrurus adsimilis*), Red-Wattled Lepwing (*Vanellus indicus*), Jungle Crow (*Corvus macrorhynchos*) and Bush chat (*Saxicola spp.*). These birds follow the rhinos, as they graze on the open terrain and often on its back, probably removing ticks and insects. Swamp deer, hog deer and buffaloes live in close association with the rhino. Buffaloes may form a second line of defence for the female rhino with calf, especially against tigers. Most of the larger rhino groups which were observed appear to be temporary aggregation at grazing or wallowing places. The adult male rhino is essentially a solitary animal, but with the following exceptions, cow with a calf potentially estrous cow with one or two bulls and an adult male with one or two cows and 2-3 adolescents. The territorial bulls attach themselves to potentially estrous cows which remain with other within the territory for a few weeks.

MOVEMENT

Rhinos move to forest habitats when the short grass area is flooded, usually between July and September. Here some shrubs and aquatic grasses and forbs are eaten. Swamp deer, hog deer and buffaloes appear as the primary competitors of rhinos for their food. However, it is evident that there are food preferences. Rhinos do not eat the roots and bark of certain plants as do swamp deer and sambhar: also they do not feed as close to the ground as do the buffaloes. Rhinos generally graze during the late afternoon, evening, night and morning.

DIRECT INTERACTION PATTERNS

Rhinos which share common parts of their home range and come in frequent contact with one another are not usually aggressive towards each other. Rhinos are often seen grazing side by side with other animals such as buffalo, swamp deer, hog deer and pigs, but mother rhinos with calf will readily attack on seeing someone approaching. If a male discovers another male within it's territory, confrontation may take place. Here, heads are lowered, eyes rolled, ears flattened, tails sometimes raised and snorting is often heard. If the intruder retreats, he will be pursued to a considerable distance. Violent fighting between two males sometimes causes severe and fatal injuries. If a female in heat is reluctant to co-operate with the male, she will be chased, bitten and struck by the male until mating occurs or she escapes often into a deep wallow. Several reports indicate that prolonged chasing by the male has severely injured the female, even sometimes resulting in her death. On 16-01-1970, a female rhino was found dead near Kaziranga Sub-Beat as a result of wounds caused by a male Rhino. On 08-12-1974, a female Rhino escaped a male by running into the Barbheroni *beel.* She got stuck in deep marshy mud and ultimately, though she was dragged out, she died on 12-12-1974. On 10-06-1976, at Baruntika, a female Rhino was also found dead, apparently after a prolonged chase and severe injuries caused by a male Rhino.

INDIRECT COMMUNICATION THROUGH TELL TALE MARKS

Defecation and urination functions as olfactory marking of the territories. These are restricted to the territorial bulls. During the study period, all dung piles in a sample plot near Bimoli Camp found were recorded and mapped. Dung piles are normally observed along paths and roads and near wallows. The same dung pile may be used by several rhinos of both sexes. Rhinos do not defecate on every dung pile they visit, but most defecation occurs at dung piles. Fresh dung piles appear to be a stimulus to defecate. Rhinos may also defecate after an encounter with an elephant or like animals.

Because of their poor eye sight and some behavioural characteristics, the rhinoceroses are particularly dependent of their olfactory senses. This may be the method; the rhino uses to orient itself. On many occasions rhinoceroses have been observed following each other for considerable distances. Rhinos may squirt urine while crossing different types of terrains, or

encounter with other rhinos, elephants, smelling dung piles and another individuals' urine, walking and feeding. Usually defecation is followed by urination and vice-versa. Dung piles reach a maximum of 70 centimetres in height and may cover an area of 5-7 metres diameter. Dung piles are allocated mere or less randomly over territory. There may be as many as thirty three dung piles scattered throughout a territory.

INTERSPECIFIC COMPETITION

Swamp deer, hog deer and buffalo appear to be the primary competiton. They directly compete for foods. These competitors may take the same food, but differ in their food preference and mainly in foraging techniques. Rhinos eat the grasses systematically at one place for some time keeping their heads down for 2-3 minutes and cannot nomally eat upto the roots of the grasses as the buffaloes do. Rhinos appear to be less selective in their feeding habits than the deer and the buffalo. During mid afternoon, evening and occasionally after dark, there is a general movement of the rhino to the short grass habitat from the resting areas. Grazing generally occurs during the late afternoon, evening, night and morning. It is estimated that the rhino usually cover 2-5 kilometres distance on an average day.

Two Young Rhinos in the Short Grass Area

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A rhino standing by the B*eel*

WILD LIFE CONSERVATION PROGRAMMES IN ASSAM

The Forest Department Government of Assam, have given emphasis on *in-situ* conservation of wildlife by declaring "protection areas" (e.g. National Parks, Sanctuaries, Nature Reserves etc.) in addition to upgrading some of the existing Wild Life Sanctuaries to National Parks. At present there are 5 National Parks, 18 Wild Life Sanctuaries, 2 proposed Wild Life Sanctuaries and 5 Elephant Reserves (Appendix III)

The rhino habitat has been shrinking since long due to erosion in the Northern fringe of the park under Agartali Range. Around 50 Sq. Km. area has already been eroded. If such erosion continues there will hardly be any area left for habitat. Now the time has come to take effective measures to check erosion. Further, it has been observed that the rivers, streams and *beels* are getting silted, for which their beds have risen up. The short grass areas where rhinos normally graze remain under water during high floods. As a result, the grasses are covered by mud and so are not suitable for grazing for a month or so, till the grasses overtop the soil. For flood times, some sort of emergency food may be made available to the rhinos and other herbivores by creating a Silvi-pasto ralism zone in the Southern fringe of the park in Karbi Anglong District. In between the rows of trees, grasses and forbs eaten by rhinos and other animals are to be planted. During floods, many rhino calves are washed away. In 1998, as may as 39 rhinos were drowned along with 473 hog deer. As the rhino population is going to reach near to the saturation point, proper management of the rhinos is necessary. Some rhinos may be translocated to other suitable rhino habitats such as human free *char* areas and other grassy lands. Translocation of rhinos was made to the Dudhwa National Park in the 1980s and the rhinos have adapted to that habitat.

In order to control poaching, strict implementation of the existing laws is the urgent need of the hour. It will be desirable to withdraw all the arms of the people living in the vicinity of the protected areas and confiscate all illegal guns. For this, support of persons from all walks of life is to be ensured to make the programme a success. Involvement of local people is a must and this can also be achieved by propaganda through select NGOs.

SOME MEMORABLE EXPERIENCES

It was a pleasant afternoon sometime in February 1976. In Assam, summers and the sultry season can be as long as 8-9 months. Therefore locals eagerly wait for winters which are mostly pleasant and enjoyable, and of course, for the tourists they are the main rhino watching season too. After finishing my forenoon work at Arimora rest house, I was returning to Bokakhat headquarters with my staff. While on the way I decided to visit Bhaisamari *Beel.* Here there is a watch tower near the *Beel*, which is an excellent vantage spot from where one can spot the wild animals. From this watch tower we saw a herd of wild buffaloes grazing near the *Beel*, and a female rhino with her baby calf, having a taste of the 'locosa' grass. The time was around 3 P.M. and the scene was quite enjoyable. All of a sudden, there was a dramatic change. A tiger suddenly tried to attack the rhino calf from the Western side, and the buffaloes chased the tiger away to protect the mother rhino and her baby. The tiger, which is known for its 'poor' hunting capabilities, had to run away.

A half hour later, the tiger had a changed strategy and tried to attack from the Eastern side. This time too, the buffaloes prevented attack and the tiger had to face failure again. This was a noteworthy experience from the animal world and showed the cooperation and mutual help between two different species against another animal- a known predator.

II

Another experience, again on another winter day. On receipt of information about poaching of a rhino, I rushed to the probable area in KNP. In the forest area, information is not very accurate, and many areas look alike, but there are many clues around, for a keen observer. For instance the flying of vultures over a particular area, usually indicates a carcass lying nearby. I could thus locate the area, as there was a pit where the carcass of the rhino was lying, of which the horn had already been removed. After the day's hard work, I had to spend that night at a camp in the Park itself. The camp was named *Gore Mati Khowa,* and by the time I reached there, the sun had set. Being located near the banks of the river Brahmaputra, and the month being January, soon a cold breeze began at the camp. Of course the camp staff received me cordially and provided me a warm and simple dinner. When one's happiness is at its peak, anything and everything is delicious, and the fatigue of the day followed by the totally satisfying dinner, provided for a deep and satisfying sleep.

Some details about the camp. Such camps are usually built on a raised platform locally known as *chang* which is usually around 2-2.5 metres high, to protect the inhabitants from wild animals. This also keeps the quarters "damp free". The floor is generally made of split bamboos, while the walls consist of ekra (*erianthus spp.*) knitted with cane or jute thread, and usually without the mud/clay plaster. The roof structure of such rooms is generally of bamboo frames fitted to the wooden posts, covered by layers of *lilu kher (Imperata cyclindrica).* These camps, fabricated from locally available material are quite comfortable for both the main seasons, i.e. summer and winter. They are undoubtedly eco friendly as well.

Coming back to my main story— around 3A.M. while still in slumber, I felt a cold touch on the skin of one of my hands. Sleepily, I assumed it to be a touch of cool breeze, through the reeds of the walls, but I was mistaken. Very soon, and to my utter surprise, I found that it was the touch of the trunk of an elephant, inserted through the larger gap in the wall. I immediately got up. The peculiarity of the habitat, such as this camp, was that as one got up, his movement and sound would quickly reach the others, making them get up as well. So very soon, the staff sleeping with me in the camp were all up, too. I narrated what had just happened, in an almost horrified voice, but there was nothing new in it for them. They told me that it was common for the wild elephants to come near human habitation in search of items like sugar, salt and other edibles, but that they never caused any harm to human beings. Peeping through the gaps in the wall, I soon saw that it was not a single elephant, but a whole herd! The staff created some noise, and very soon the herd disappeared. It was rather unfortunate, that the single elephant and the herd, that had provided me a memorable occasion, were unable to get anything for themselves, that morning from us.

A couple of hours later, after giving instructions to the staff for disposal of the dead rhino carcass, I returned to my headquarters.

APPENDIX - I

List of principal plant species occurring (x) in the Kaziranga National Park (India) habitats. The average length of plant parts eaten by rhinos is given in centimetres.

Name of the species	Wooded forest habitat			Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
	T C[1]	M C	B C				
Anacardiaceae							
Spondias magnifera	x						
Lanea grandis	x						
Apocynaceae							
Alstonia scholaris	x						
Wrightia tomentosa		x					
Rauwolfia serpentina			x				
Anonaceae							
Polyalthia jenkinsii		x					
Amaranthaceae							
Amaranthus viridis			16		16		SLI
Amaranthus spinosus			x		x		
Alismaceae							
Sagittaria sagittifolia						10	SL
Asteraceae							
Grangea maderspatana			x		x		
Acanthaceae							
Lepidagathis sp.							
Bignoniaceae							
Oroxylum indicum	x						

Behavioural Patterns of the one horned Indian Rhinoceros

Name of the species	Wooded forest habitat T C[1] M C B C	Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
Convolvulaceae					
Ipomaea aquatica				15	SLI
Combretaceae					
Terminalia belerica	x				
Terminalia chebula	x				
Compositae					
Eupatorium odoratum	x				
Mikania scandens	x	x			
Ageratum conyzoides	x	x	x		
Sphaeranthus indicus	x	x	x		
Blumea laciniata	x	x	x		
Gnaphalium indicum	x	x	x		
Eclipta alba	x	x	x		
Xanthium strumarium			x		
Cyperaceae					
Cyperus pilosus	25		25		SL
Carex rubrobrunnea	30		30		SL
Kyllinga brevifolia	15		15		SL
Eleocharis fistulosa	15		10		SL
Cyperus auricomus	15		15		SL
Cyperus iria			x		
Scirpus articulatus			x		
Cruciferae					
Capsella bursapestoris	15		15		SLI
Brassica campestris		15	15		SLI
Nasturtium indicum		15	15		SL
Chenopodiaceae					
Chenopodium album	x		x		

Observations in Kaziranga National Park

Name of the species	Wooded forest habitat			Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
	T C[1]	M C	B C				
Commelinaceae							
Floscopa scandens			15		15		SL
Commelina bengalensis			20		20		SL
Caryphyllaceae							
Drymaria cordata			10		10		SL
Dilleniaceae							
Dillenia indica	x						
Dillenia pentagyna		x					
Datiscaceae							
Tetrameles nudiflora	x						
Dioscoreaceae							
Dioscorea pentaphylla			x				
Euphorbiaceae							
Bridelia retusa	x						
Bischofia javanica	x						
Trewia nudiflora	x						
Gramineae							
Saccharum arundinaceum				30			LIT
Arundo donax				35	35	35	LIT
Erianthus elephantinus (Ravanae)				35	35		LIT
Saccharum spontaneum				30			LIT
Saccharum elephatinus				x			
Imperata cylindrica				20	20		
Vetiveria zizanioides				15	15		T
Hamarthria compressa					16		SLI
Cynodon dactylon			10		10		SLI
Eleusina indica			10		10		SLI
Seteria glauca			10		10		SLI
Chrysopogon aciculatus				8	8		LT

Behavioural Patterns of the one horned Indian Rhinoceros

Name of the species	Wooded forest habitat			Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
	T C[1]	M C	B C				
Eragrostis unioloides				x	x		
Leersia hexandra						35	SLI
Andropogon sp.						35	SLI
Lauraceae							
Litsaea polyantha		x					
Baccaurea sapida	x						
Liliaceae							
Smilax latifolia			x				
Leguminosae							
Albizzia procera	x						
Albizzia lebek	x						
Bauhinia variegate		x					
Cassia fistula		x					
Flemingia chappar			x				
Cassia tora			x				
Mimosa pudica			8				SLI
Desmodium cephalotes			x				
Spatholobus roxburghi			x				
Bauhinia vahlii			x				
Milletia auriculata			x				
Abrus precatorius			x				
Labiatae							
Leucas linifolia			x		x		
Lythraceae							
Lagerstremia parviflora	x						
Lagerstremia flosreginae	x						
Malvaceae							
Bombax malabaricum	x						
Kydia calycina	X						

Name of the species	Wooded forest habitat			Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
	T C[1]	M C	B C				
Meliaceae							
Amoora walichii	x						
Cedrela toona	x						
Myrtaceae							
Eugenia jambolana	x						
Careya arborea		x					
Myrsinaceae							
Ardisia humilis							
Naiadaceae							
Potamogeton crispus						10	SLI
Najas minor						8	SLI
Najas graminea						10	SLI
Onagraceae							
Trapa bispinosa						x	
Fussiaea repens						10	SLI
Fussiaea suffruticosa						8	SLI
Oxalidaceae							
Oxalis corniculata			10		10		SLI
Oxalis acetosella			10		10		SLI
Palmae							
Calamus tenuis			x				
Polygonaceae							
Polygonum hydropiper			x		x		
Polygonum chinense			30		30		SLI
Polygonum barbatum			30		30		SLI
Polypodaceae							
Pteridium aquilinum			17	17	17		LT

Behavioural Patterns of the one horned Indian Rhinoceros

Name of the species	Wooded forest habitat			Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
	T C[1]	M C	B C				
Ponteriaceae							
Eichhornia crassipes						15	SL
Monochoria hastaefolia						12	SLI
Monochoria vaginalis						x	
Eichhornia speciosa						10	SLI
Rhamnaceae							
Zizyphus jujuba		x					
Rubiaceae							
Anthocephalus cadamba	x						
Morinda angustifolia			x	x			
Randia fasciculate				x			
Paederia foetida				15			SL
Rutaceae							
Murraya koenigii				x		x	
Rosaceae							
Rosa moschata			x				
Rosa macraphylla			x		x		
Fragaria indica			10		10		SLI
Solanaceae							
Solanum indicum			x				
Solanum torvum			x		x		
Solanum khasianum			x		x		
Sterculiaceae							
Sterculia alata		x					
Tiliaceae							
Grewia sapida			x				
Umbeliferae							
Eryngium foetidum			x				

Observations in Kaziranga National Park

Name of the species	Wooded forest habitat			Tall-grass habitat	Short-grass habitat	Aquatic habitat	Plant parts eaten
	T C[1]	M C	B C				
Hydrocotyle javanica			x		x		
Hydrocotyle rotundifolia			5		5		SL
Oenanthe stolonifera			x		x		
Centella asiatica			8		8		SL
Urticaceae							
Randia dumetorium		x					
Girardinia zeylanica			x				
Leportia crenulata			x	x	x		
Ficus bengalensis			x	x	x		
Ficus religiosa	x						
Ficus scandens			20		20		SL
Verbenaceae							
Premna latifolia	x						
Vitex peduncularis	x						
Gmelina arborea	x						
Clerodendron infortunatum			x				
Lippia geminata			15		15		SLT
Zingiberaceae							
Alpinia allughas			x				

[1] T C - Top canopy; M C - Middle canopy; B C - Bottom canopy; X - Plant present; S = stems; L = leaves; I = inflorescene; T = tender shoots.

APPENDIX - II

DEFINITIONS

Since a number of different terms are widely used to express similar concepts definitions of in this report these terms are given briefly:

Beel	Swampy area having water throughout the year, ox-bowlake
Browse	The edible portions: twigs, leaves or shoots of woody shrubs, vines and trees that are within the reach of animal.
Browsing	The process of feeding on the available, edible portions of woody plants.
Chang	Raised floor usually made of bamboo splits.
Chapori, Char	Riverine islets
Cover	The degree to which plants, by over hanging, protect the ground surface from rainfall.
Density	Population number per unit area.
Ekra	Reed (*Erianthus spp*) In the village houses, walls are normally made of 'Ekra'.
Endangered species	The species which are in danger of extinction and whose survival is unlikely if the casual factors continue to be operating.
Extinct	Species that are no longer known to extinct in the wild.
Forage	All vegetation, harvested and unharvested that is available and possibly acceptable to animals (except seeds and fruits of woody plants).

Forb	Any herb or flowering plant other than grasses which lacks persistent above ground woody stems.
Forests	Includes all lands classed as forests under any legal enactment dealing with forests or administered as forests, whether State owned or private and whether wooded or maintained as potential forest land.
Frequency	The regularity with which a species is distributed throughout a community.
Grass	Herbaceous vegetation which belongs to the grass family (*poaceade*).
Grazing	The eating of any herbaceous vegetation by domestic livestock or wild animals.
Herb	A flowing plant in which the stem does not become woody or persistent, it includes both forbs and grasses.
Kher	Thatch as roofing materials. Normally 'Ulu' *kher* is the best (*Imperata cylindrical*) for roofing and the most durable.
National Park	An area of natural landscapes and scenery which contains the vegetation and animal life native to the region and which is legally dedicated to the permanent preservation of nature and wilderness for the enjoyment, education and inspiration of the public.
Overgrazing	Excessive cropping of range plants by animals with consequent damage to the soils and with effects on both flora and fauna.
Protected area	According to IUCN (World Conservation Union) a Protected area is defined as "An area of land and/or sea specially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources and managed through legal or other effective means".

Range	Any large tract of land not under cultivation which supports vegetation suitable for grazing by wild animals.
Rare species	Are those species which are at risk because of their low number
Reserves	If an area is demarcated especially for the protection of wildlife, it is called a reserve.
Sanctuary	It is an area where killing or capturing of any species of bird or animal is prohibited except under the order of the competent authority and whose boundaries and character should be sacrosanct as far as possible. A sanctuary is the whole or portion of a reserve or protected forest as declared by the Government.
Shrub	Any plant with persistent woody stems and relatively low (under about 5 meters) from which generally produces several basal shoots instead of a single bole or stem.
Species	All those closely related and freely interbreeding individuals which are reproductively isolated from other organisms and which have a peculiar set of inherited structural, metabolic and behavioral characteristics.
Utilization	The degree to which animals have removed forage from that available.
Vulnerable	The species likely to move into the endangered category in the near future if the casual factors continue to operate.
Wildlife	Mammals, binds and higher reptiles of particular economic and aesthetic significance to man.

APPENDIX – III

NATIONAL PARKS AND WILDLIFE SANCTUARIES IN ASSAM, 2003

Sl. No.	National Parks/Wildlife Sanctuaries	Districts	Area in sq. km.	Remarks
(A)	**NATIONAL PARKS**			
1.	Kaziranga National Park	Golaghat /Nagaon	430.00	Of the 6 additions, 43.78 Sq Km area of the 1st addition stands settled.
2.	Manas National Park	Baksa /Chirang	500.00	
3.	Nameri National Park	Sonitpur	200.00	
4.	Dibru-Saikhowa National Park	Tinsukia / Dibrugarh	340.00	
5.	Orang National Park	Darrang /Sonitpur	78.81	
(B)	**WILDLIFE SANCTUARIES**			
1.	Gibbon Wildlife Sanctuary	Jorhat	20.98	
2.	Garampani Wildlife Sanctuary	Sibsagar	6.05	

3.	Burachapari Wildlife Sanctuary	Sonitpur	44.06
4.	Bornadi Wildlife Sanctuary	Udalguri	26.22
5.	Sonai-Rupa Wildlife Sanctuary	Sonitpur	220.00
6.	Pabitora Wildlife Sanctuary	Morigaon	38.80
7.	Panidihing Bird Sanctuary	Sibsagar	33.93
8.	Bherjan-Borajan-Padumoni WL Sanctuary	Tinsukia	7.22
9.	Nambor Wildlife Sanctuary	Karbi Anglong	37.00
10.	North Karbi-Anglong Wildlife Sanctuary	Karbi Anglong	96.00
11.	East Karbi-Anglong Wildlife Sanctuary	Karbi Anglong	221.81
12.	Laokhowa Wildlife Sanctuary	Nagaon	70.13
13.	Chakrasila Wildlife Sanctuary	Dhubri Dt/ Kokrajhar Dt.	45.57
14.	Marat Longri Wildlife Sanctuary	Karbi Anglong	451.00
15.	Nambor-Doigrung Wildlife Sanctuary	Golaghat	97.15

16.	Dehing Patkai Wildlife Sanctuary	Tinsukia / Dibrugarh	111.19
17.	Borail Wildlife Sanctuary	Cachar /Karimganj	326.25
17.	Amsang Wildlife Sanctuary	Kamrup (Metro)	78.64
(C)	**PROPOSED WILDLIFE SANCTUAR**		
1.	Deepar *Beel* Wildlife Sanctuary	Kamrup	4.14
2	Bordoibuam-Beelmukh Wildlife Sanctuary	Lakhimpur / Dhemaji	11.25
(D)	**ELEPHANT RESERVES**		
1.	Sonitpur Elephant Reserve	Sonitpur	1420
2.	Chirang-Ripu Elephant Reserve	Chirang	2600
3.	Kaziranga-Karbi Anglong Elephant Reserve	Golaghat /Karbi Anglong	3270
4.	Dehing Patkai Elephant Reserve	Tinsukia / Dibrugarh	937
5.	Dhansiri Lungding Elephant Reserve	Karbi Anglong	2740

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MAP OF KAZIRA
(A WORL

A R U N A C H

TOWARDS BOMDILA & TAWANG

TIPI ORCHIDARIUM

BHALUKPUNG

SEIJUSA

NAMERI NP

POTASALI RANGE OFFICE

SONITPUR DISTRICT

JIA BHARALI R

TEZPUR

BISHWANATH GHAT

TO ORANG NP

TO TEZPUR

DIPHALOO MUKH

KUKURAKATA RF

RHINOLAND PARK

BAGSER RF

KANDHANJURI

NAGAON DISTRICT

NH 37

TO GUWAHATI, MANAS NP & PABITORA SANCTUARY

DESCRIPTION	SYMBOL	LOCATION
Director and DFO Office		Bokakhat
Range Office		Agoratoli, Kohora, Bagori, Burhapahar.
Assam Tourism		Kohora
Resort		Kohora, Aranya, Banhabi, Wild grass, CL Resort
Bank		Kohora
Interpretation & Education Centre		Kohora, Mihimukh
Elephant Safari		Bagori, Mihimukh, Burhapahar
[illegible] Safari		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]

DESCRIPTION	SYMBOL	
Pelican Colony		
Tracking		Pa
Bird Watching		Soholi
Rafting		
Angling		
Airport		Ga
Religious Historic Place		
Tea Garden		Ag
[illegible]		
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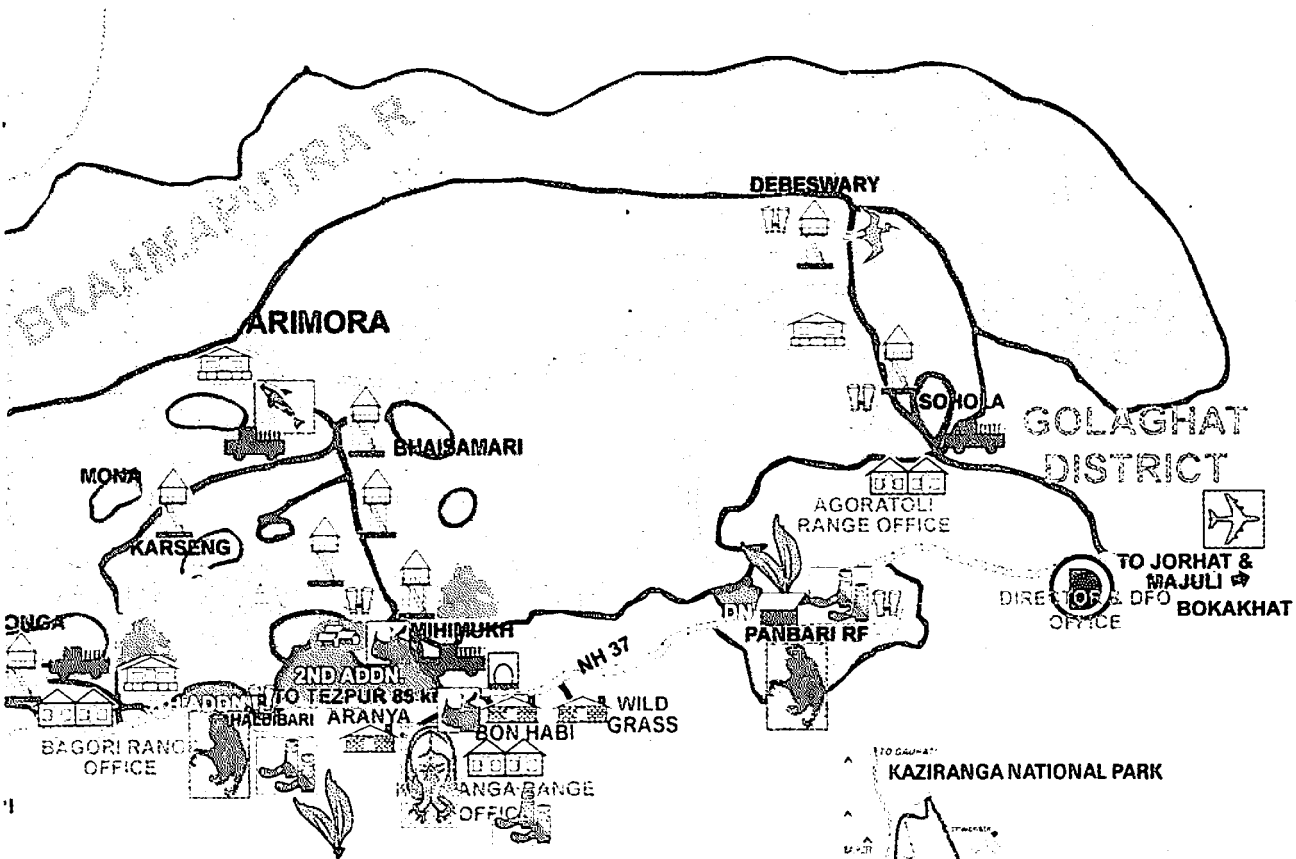
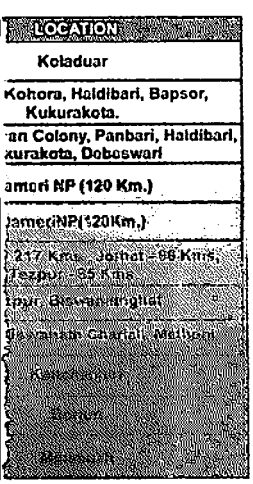
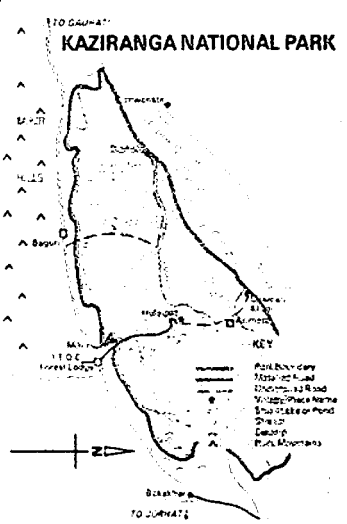
NGA NATIONAL PARK
HERITAGE SITE)

A L P R A D E S H

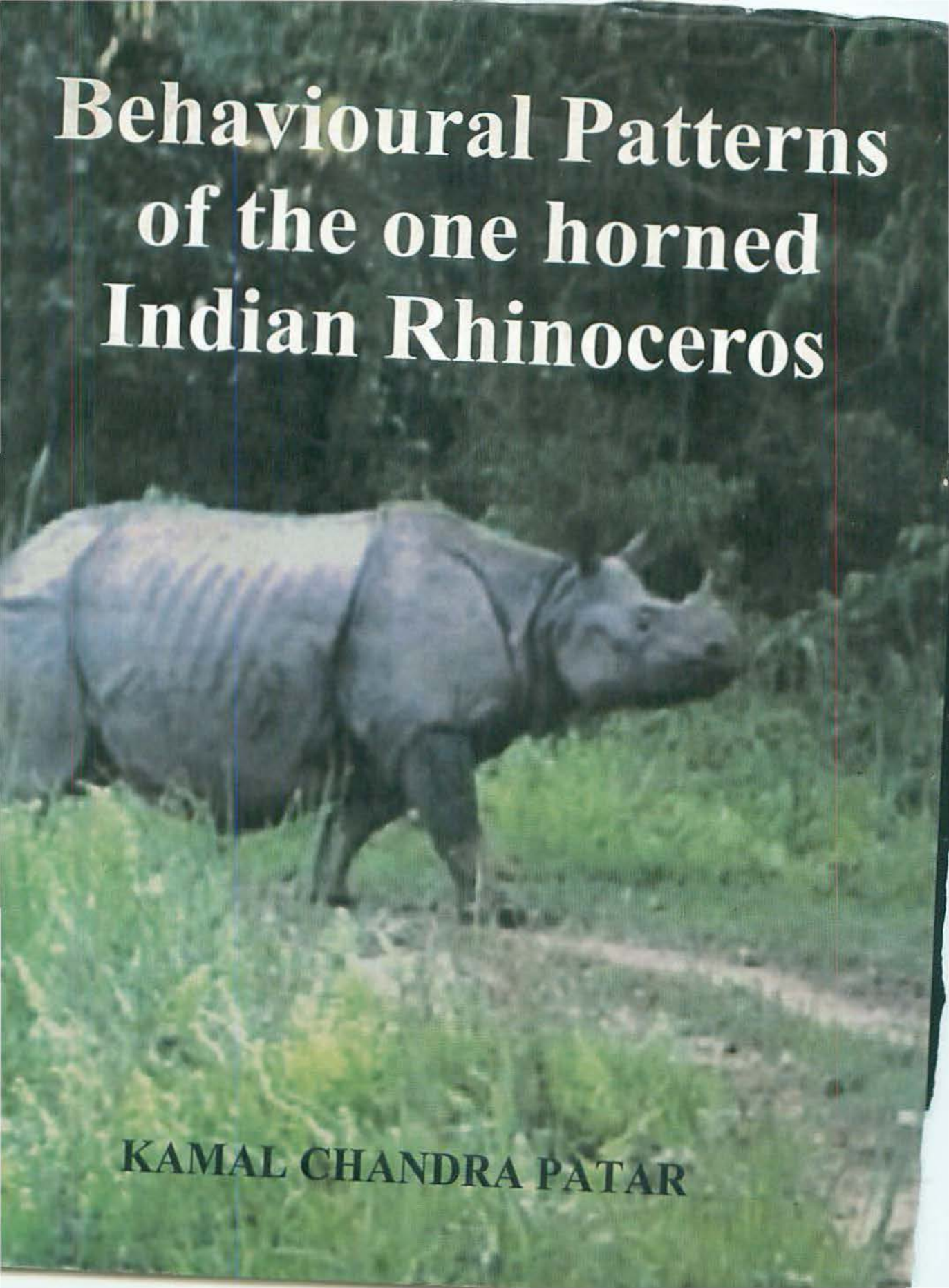






An earlier map of KNP. Presently even the mighty Brahmaputra flowing alongside has been attached to the Park area for all practical purposes.

Behavioural Patterns of the one horned Indian Rhinoceros



KAMAL CHANDRA PATAR

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Mr. Kamal Chandra Patar, IFS (Retd.) was a Conservator of Forests, Assam for a pretty long time. He took his MS Degree in Management of Wild Life under Plan A, from Michigan State University, USA. He also held important posts, such as, Managing Director of Assam Plantation Crops Development Corporation Ltd (APCDC). After retirement, for a brief period, Mr. Patar was OSD (Forests) in the Karbi Anglong District Council, and was also a Member of the Wildlife Advisory Board, Assam.

He attended a Symposium on *Tropical Ecological Society* in Kuala Lumpur in which his paper was published. Local journals and newspapers have carried several of his articles. He was also Guest Lecturer in the State Forest Service College, Byrnihat, where he gave lectures on *Eco Systems and the tribal people.*

The food preferences of the one horned Indian rhinoceros (*Rhinoceros unicornis*) were determined in the Kaziranga National Park. (KNP) during the dry season of 1975-1976.

Square-meter vegetation plots are located over 120 hectares of a short-grass rhino habitat. Grasses make up 77% and forbs 23% of the rhino's diet during the November to April dry season. Highly preferred species were *Arundo donax*, *Hemarthria compressa*, *Carex rubrobrunnea*, *Eleochoris fistulosa* and *Lippia geminate*. Thirteen grass and forb species are eaten by rhinos but not to the extent warranted by their abundance. Three forbs are avoided as foods.

H. compressa, *C. rubrobrunnea*, and *A. donax* together comprise 71.5% of the available forage and 91.1% of the rhino's diet. They seem to typify the ideal dry-season habitat of the rhino. In some areas, however, these species seem to be overgrazed. There was thus some indication that maximum ungulate population had been achieved.

Range conditions and vegetative trends are affected by foraging herbivores. In order to determine these factors, it is essential to know the order in which forage plants are selected by various ungulate species. Rhinos are important grazers in KNP and this study was undertaken to learn their preferences in its short-grass dry-season habitat.

Also included in this book are some of the latest statistics and findings and some brilliant photographs.

ISBN 81-8344-000-2