

ECOLOGY AND BEHAVIOR

OF THE

INDIAN RHINOCEROS

PROGRESS REPORT NO. III

15th June, 1974

Andrew Laurie  
c/o Tiger Tops  
P.O. Box 242  
Kathmandu, Nepal

NOT FOR PUBLICATION

3609

CONTENTS

	Page No.
INTRODUCTION .....	1
RESULTS :	
I <u>THE POPULATION</u> .....	2
1. Numbers and Distribution .....	2
2. Population Dynamics .....	2
3. Reproduction .....	3
II <u>THE HABITAT</u> .....	4
1. Food Selection and Preferences .....	4
2. Movements Related to Food Supply .....	5
III <u>BEHAVIOUR</u> .....	7
1. Intraspecific Communication .....	7
a. Direct Visual and Auditory Signals	7
b. Indirect Visual and Olfactory Signals	8
i. Defecation .....	8
ii. Urination .....	8
iii. Discussion .....	9
2. Associations .....	10
a. Adult males .....	10
b. Adult females .....	10
c. Subadult males .....	11
d. Subadult females .....	12
3. Interactions .....	12
4. Movements .....	15
5. Discussion .....	16
IV <u>MANAGEMENT</u> .....	18

## INTRODUCTION

Observations have continued mainly in the Saurah study area though visits have been made to other districts for five short periods\*.

Fifty machan sites have been used during the last six months. During the first quarter of 1974, tall trees in the open burnt grassland areas were used. Now most observations are made from machans erected in trees or on stilts near forest and grassland wallows and along river banks. Transport has been by elephant\*\*, foot and boat.

Simon Mitchell helped with observations in Chitawan from November to February and in Kaziranga during two weeks in March. Plans to immobilise rhinos for radio telemetry and marking of individual subadults were abandoned after refusal of permission from H.M.G., Nepal. In order to facilitate identification of subadults: self-attaching collars have been set out on rhino paths and so far three have been successfully attached. Two have since broken but the method has proved successful and the collars, consisting of crocodile clips, nylon rope and metal rings, are being modified. The Rank image intensifying device continues to be invaluable for nocturnal observations and has been used to photograph at night.

A Pentax motordrive unit and a tape recorder with parabolic reflector are being used to record the aggressive behaviour at the wallows during the coming months. This should enable a detailed analysis to be made of the visual and auditory signals exchanged during such encounters.

The rhino identification file now holds cards for 168 individuals positively identified on more than one occasion and 124 cards for rhinos incompletely identified on a single occasion. Among the latter, there may be duplicates of both the positively and incompletely identified individuals. All have verbal and graphic descriptions and 102 are with photographs illustrating identification features. Subadult sexing and identification has improved considerably. Photographic measurement of shoulder heights of adults, calves and subadults is being done with the help of a measured pole photographed after the rhino in its fore footprint.

\* The research is sponsored by the Centre for Field Biology and Conservation of the New York Zoological Society.

\*\* The elephant is kindly lent to me by the Ministry of Forests, H.M.G., Nepal.

## I. THE POPULATION

### 1. Numbers and Distribution

Estimate of the Nepal rhino population stands at between 200-250. Concentration within the National Park boundary is greatest from January to May when grass regrowth after burning provides high quality grazing. From May onwards the tall grass species are less preferred and rhinos move away to cutlying areas near fields or shallow rivers with aquatic plants.

A trip to the Mahabarat range north of Tikkuli in January revealed that though five or six were present until December, only the old bull remained. Signs of rhino have been found in the Reu Valley but evidence is that they are transient only.

### 2. Population Dynamics

Since December eight births and six deaths have been recorded. Three of the deaths were of calves less than one year old. Also found was the skeleton of a subadult which died about a year ago.

TABLE I

#### Rhino Deaths: January - June 1974

<u>Date</u>	<u>Class</u>	<u>Cause</u>
15th Jan.	Adult female	Unknown
17th Jan.	Male calf	Starvation and faint after capture (Weight: 158 kg., shoulder height: 71cm)
25th Feb.	One month calf	Killed by tiger no teeth through gums
27th Mar.	One month calf	Found without cow. Emaciated. (weight: 50.5 kg., shoulder height: 63 cms.)
29th Mar.	Adult	Unknown. Skeleton found. Horn missing.
3rd May	Subadult male	Killed as a result of injuries sustained in two fights with an adult male.

There have been no proven cases of poaching since November, 1973, though one cow at present in the Saurah area is suffering from a possible bullet wound in the shoulder.

19 deaths have been recorded since December 1972. Eight animals died before achieving adult dentition and five before leaving their mother. Six of these deaths have been due to poaching. During the same period twenty births have been recorded. Disregarding deaths due to poaching, these figures predict an increase in the population of 2.7% per year. A long-lived animal such as the rhino would not be expected to show rapid changes in population, size and composition but if poaching continues to be controlled the population should increase slowly.

### 3. Reproduction

Of 25 cows followed since the start of the study, 12 have produced calves during the last eighteen months. 10 are with the calves they had at the start and two have apparently not had calves, though the tiger-predated rhino calf probably belonged to one of these. 57 adult females have 15 first-year calves between them indicating a calving interval of 3.8 years. Synchronisation of births, by chance or otherwise, may confound this calculation but the calving interval appears to be at least three years.

Calves stay longer with their mothers in the east of the area than in the west. In the east 40% of calves still with their mothers are over two years old as against 32% in the west. The east is more crowded than the west and this may possibly be a mechanism whereby rate of population increase is reduced.

There is no evidence yet for a breeding season. A year-round food supply, favourable conditions, a long pregnancy and maturation period mean that there is little advantage in a regular breeding season.

Birth normally takes place in seclusion and the cow disappears into thick forest for a period of several days before the birth.

## II. THE HABITAT

### 1. Food Selection and Preferences

Further observations of feeding habits have emphasised the great seasonal variations in food sources and the movements of rhinos associated with food availability. Effects of burning and cattle grazing, grass cutting and variation in rainfall are difficult to determine. A few "natural experiments" were observed:

- a. Higher rainfall in March/April this year led to increased growth of short grasses and other aquatic plants along riverbeds and riverbanks and numbers of rhinos seen grazing along riverbanks at night were much higher.
- b. A combination of earlier grass burning and higher rainfall than 1973 led to faster regrowth of the Saccharum, Phragmites stands and an earlier concentration of rhinos in these burnt areas.
- c. Exclusion of cattle this year from an area of low riverbed at Saurah led to extensive differences in vegetation compared with last year. A wide variety of aquatic grasses, sedges and other plants were grazed heavily by rhinos and chital but were not completely consumed. Women were attacked in to cut two to three foot high S. spontaneum for their cattle. In a similar area upstream cattle grazed everything to the ground.
- d. Burning Saccharum and Phragmites leads to the immediate arrival of rhinos to eat the charred stalks. About two weeks later they return to eat the new shoots. Burning of Imperata cylindrica attracts deer and rhino but only after the new regrowth and in the Jamungala area rhinos prefer Saccharum to the Imperata growth.
- e. Burning of an area of S. spp. very late in a great wind on the 1st April led to concentration of rhinos grazing there after the rest of the area had passed its most palatable growth stage.
- f. An area of mixed Saccharum munja, S. spontaneum and Phragmites karka was burnt last year and this year. A nearby pure stand of S. spp. unburnt last year was burnt this year, attracted far more rhinos than last year and reduced the grazing pressure on the first area.

Up until February some rhinos feed on wheat in the fields but they prefer the young Saccharum shoots and pressure is reduced as the wheat plants mature. As the Saccharum reaches 6 ft. high

short grasses under 1 ft. high, browse and waterweed become more important in the diet. At this time a great number of species may be eaten.

There are 29 common species of grasses and rushes around the wallows and along the riverbeds. Of these, all except one have been eaten by rhino and on one occasion 20 species were eaten in a period of 15 minutes. Most favoured in wet areas are Cyperus spp. and in drier areas Cynodon dactylon. There is direct competition for these by domestic stock.

Many plants are pulled out and bitten off a few inches above the roots. This does not seem to affect the viability of plants as they soon grow up again in the warm, wet environment.

A rhino grazing on short grass about 2 ins. high uses its lips to bite off or pull up the shoots. Chewing is continual and about once a second the lips bite off new grass. Some roots and grass drop out of the side of the mouth but most are eaten together with any dead leaves which happen to be on the ground. Longer grasses and sedges are often pulled up and the bottom 4 ins. with the roots are dropped untouched.

Movements into farmland to feed on the first rice and maize start as early as April in Katar and areas east but not until late May in the Saurah area. This is due to earlier planting dates to the east and the better grazing available in the forest areas at Saurah.

As the maize grows, raids get worse and some rhinos visit the fields regularly by early June. Not all individuals do so, and there is plenty of food available in the forestlands. Crop-raiding continues on a large scale until February. One old bull went into the fields every month of the year eating bananas, weeds and ripe wheat during the months of March and April.

Coprophagy has been observed in a calf and subadult female. They ate the calf's mother's dung, the subadult following the calf.

## 2. Movements related to food supply

Jan. to      Influx of new individuals to long grass jungle after April      it burns. Occurrence in some areas for these months only

June to      Movement away from tall grass jungle to forest edge, July      river edges and outlying jungle next to fields.

There are many examples of individuals who have made these movements but not all individuals show the same movement patterns and hence they exist on different diets. Some animals stay on the north of the Rapti away from the long grass areas all year. Some individuals seen in February had not been seen since May last year.

In the Saurah area, of 19 cows with calves seven have been resident south of the Rapti year round, four have resided north of the Rapti and eight have travelled from north to south in December (2), February (1), March (3), April (1) and May (1). Of nine adult males one is resident north the year round, one resident south, three regularly cross the river and four stayed north until March and then crossed to the south.

Movement around the home area is regular and frequent. Many movements are made within a few square miles between grazing grounds and wallows. In this way new sources of food such as recently burnt grassland or new grass shoots along a riverbank are rapidly discovered and the quantity and variety of the diet increased.

### III. BEHAVIOUR

#### 1. Intraspecific Communication

##### a. Direct Visual and Auditory Signals

Detailed analysis of these will be carried out using the motor drive unit and tape recorder. The signals exchanged during an encounter between individuals decide the following course of events.

Greetings are common, especially between calves and approaching strange rhinos and between subadults. A slow approach with nose stretched forward is usual. Noses are touched and there may follow a bout of sparring with one's horn circling the other's snout with horns clashing audibly and nuzzling of the side of one's face with the other's mouth. During nuzzling, the mouth is often open and attempts at biting may occur.

An individual may approach another bobbing its head up and down or grazing and sweeping the head rapidly from side to side. At high intensity this turns into a circular motion of the head and appears as such during sparring when one individual is withdrawing. When the low intensity form occurs in an approach situation no aggressive response is elicited from the individual so approached. This has only been seen between subadults and females, and never involving adult males or cows with calves.

The approached rhino never displays this behaviour pattern but stretches its nose forward and touches noses or nuzzles the newcomer. After such a greeting both rhinos graze peacefully beside each other.

Adult cows and bulls rarely initiate such encounters and tend to avoid other individuals. When they do contact other rhinos they adopt a head up posture and may snort repeatedly. Flight is a common reaction of the other individual. Alternatively, as the first gets nearer a head low, open mouth posture is taken up. The corners of the mouth are pulled back and teeth displayed. A high pitched bleating vocalisation is repeated alternately with the honk and the head on position is maintained at risk of turning the rump which is vulnerable then to slashes from the tusks. On one occasion when an adult male approached a subadult female in a wallow the latter backed off bleating and honking with the open mouth posture for ten minutes as the male slowly and silently advanced. Eventually she turned and ran. He followed and she turned again to face him and continued backing off. Eventually she turned and escaped. On other occasions

the same display has successfully driven off threatening rhinos. It can be used simultaneously by both participants. Thus attack or flight are the main methods of defence.

Sounds of a fight quickly attract rhinos to the scene. Mainly adult males but also adult females have been observed hurrying towards sounds of a fight.

b. Indirect visual and olfactory signals

(i) Defecation

Dungpiles are used by all members of the population. Fresh dung is a stimulus to defecate. Calves invariably defecate after their mothers. Dungpiles naturally develop in areas frequented by rhinos especially along paths and near walls. The number of used dungpiles in an area increase with an influx of rhinos. Failure to use a dungpile one day leads to a reduced chance of it being used the next day. An animal will walk past a large old dungpile but dung at a small freshly used dungpile 20 ft. further on. New dungpiles are quite common and arise from single defecations in well frequented positions. Rhinos approach a dung-pile, sniff at it, swivel round their hindquarters, lift their tails and defecate.

Dungpiles are often areas 20 ft. in diameter. Rarely is dung piled higher than 2 ft. and often defecation is beside or simply in the same area as the stimulating dung.

Very occasionally a hind foot is scraped backwards at or just after the moment of defecation and sand or earth may be thrown up onto the dung.

Defecation may follow an encounter with another rhino, elephant or man, especially with cows.

(ii) Urination

Adult males may squirt urine (on average five squirts). Squirt urination takes place:

- a. during or after encounters with another rhino, elephant or man, especially while walking away
- b. on leaving a wallow or going across any kind of boundary such as the border of a forest, or grassland, a ditch, a wallow edge, a field or road edge

- c. on smelling another individual's urine
- d. while walking/feeding.

Squirt urination may be accompanied by dragging of the hind legs which causes the long furrows described in the last report.

Not all adult males squirt urinate. Some urinate in a continuous stream and do not urinate particularly in the circumstances described above. Some adult males which used to squirt urinate have since stopped and are now weaker in encounters with others and have a lower flight threshold from man or elephant.

Adult males may vigorously horn small cappings and bushes, swinging their head from side to side and then walk away over them squirt urinating and sometimes dragging the hind feet as well.

Adult females and subadults normally urinate in a continuous stream. Squirting urine is normally confined to oestrus periods when in the company of a male. However, urination is a common reaction during or just after encounters with a rhino, elephant or man and most often while walking away.

One male calf about three years old urinates normally when in the presence of its mother but squirt urinates when away from her for periods of a few days.

On detection of the smell of another's urine rhino of any age or sex class is likely to smell the spot carefully, nibble the leaves on which drops of urine are resting and adopt the "Flehmen" posture. On about half the occasions observed urination followed the investigation.

### iii. Discussion

The marking behaviour described above functions as a communication system between individuals. A communication system is the better for being organised. Hence the system of dunging on dungpiles. Scent left at one of a number of discrete locations is more likely to be smelt by another rhino than if left anywhere. During encounters the presence of the other individual is the stimulus to defecate or urinate. Otherwise the presence of the mark serves as the stimulus.

Furrows are probably visual as well as scent marks. The sight of the furrows and the smell of the urine indicate to rhinos that there is a squirt urinating male in the area and the smell may individually identify him. Schenkel (1969) reports black

rhinoceros (*Diceros bicornis*) walking away with a stiff-legged gait after encounters with other rhinos. This appears to be a vestige of the foot dragging of the Indian rhino.

Black rhinoceros scrape their hind legs vigorously in their dung piles and impregnate their feet and hence their tracks with the smell of the dung. This scraping behaviour is present only as a vestige in the Indian rhino.

The wetter habitat of the Indian rhino may explain these two differences. In wetter conditions, scent marking is less effective than in the dry plains of Africa. Thus the behaviour pattern which scent marks the tracks is less developed in the Indian rhino and that which produces visual signs is less developed in the African black rhino. Scent marking is still used in Indian rhinos but supplemented by the visual sign. On dry ground they are capable of following the tracks of another individual at least an hour later. The scent of the urine is extremely strong.

## 2. Associations

Association here means moving together for periods of more than one hour or wallowing in physical contact.

### a. Adult males

Adult males are generally solitary and do not tolerate the proximity of another adult male though several may use the same areas. They occasionally associate with subadult males and with adult females during certain periods as discussed below.

### b. Adult females

The cow/calf unit is the only permanent association. Calves stay with their mothers for three years or more in the Saurah area but evidence suggests they leave earlier in less dense populations to the west.

Physical contact is very important in the cow/calf relationship. Wallowing cows and calves often lie touching each other. Small calves play as described in the last report and spend long periods rubbing their heads and flanks along their mother's body. Suckling from the side or from between the hind legs has been observed in calves up to two years of age. Three-year calves often leave their mothers for periods of several days and then rejoin again. During such absences calves have never been seen in the company of others.

Mating takes place when the calf is about two years old and the calf is usually driven away by the male at the time of courtship. Intermittent association of a male with an oestrus cow for three or four days before mating is normal and during this time the calf may rejoin the female for short periods.

Calves normally remain with their mothers up to less than a month before the birth of the new calf. After the birth, they are driven off by the mother if they try to approach. However, two cows parted from their calves in November and have still not given birth.

Single cows remain solitary, apart from associating occasionally with subadult females and adult males. One female who produced her first calf in early May associated with a breeding male in early February. Both male and female followed each other's tracks if they lost contact and greeted each other by touching noses. The cow rubbed her chin on the bull's rump and smelt his urine whenever he urinated. Another pregnant female due to give birth in late June was followed by two males on two days in late March. Thus on both occasions three months before parturition there is a recurrence of sexual behaviour. Possibly it is of some advantage at that stage of pregnancy to be protected from aggressive interactions by such behaviour patterns.

Associations between two adult cows with or without calves are not seen but subadult females occasionally remain with cow/calf pairs for long periods.

c. Subadult males

Subadult males often form temporary associations amongst themselves. Up to seven subadults including at least five males have been seen grazing together and groups of three or four subadult males are commonly seen north of the Rappi grazing at night or early evening on short grass beside the river. Occasionally single subadult females join these groups. During the day groups are smaller in size and they rest in ones, twos and threes in the forest or in wallows. At these times they may be seen in the company of adult males. On several occasions a subadult male has been seen wallowing in actual physical contact with an adult male but only in the presence of other subadults. The subadult may kick the adult's flanks and face and on one occasion two did so in succession. A lone subadult male has been seen wallowing near an adult male, though not in physical contact.

Subadult males have only twice been seen to accompany cow/calf pairs. On one occasion the subadult was repeatedly chased

off by the cow and on the other occasion followed them at a distance of 20 to 50 yards, sniffing their tracks when they went out of sight.

d. Subadult females

Subadult females are normally solitary but regularly associate with single cows, cow/calf pairs and occasionally with subadult male groups, though never with single subadult males or other subadult females. Cows with calves normally discourage accompanying subadult females and chase them off within a few hours but such associations sometimes last several weeks.

3. Interactions

The approach of an unseen rhino through thick vegetation normally leads to alertness and then to rapid flight or a loud snort. The nature of the initial reaction and the following encounter depends on the individuals involved, their activities, positions and any accompanying individuals.

Many subadults will flee on hearing or seeing the approach of another or at least stand alert and ready to flee. The approach of wildboar or man, the sudden cracking of twigs or a bird landing nearby can also cause panic flight. As they get older the flight threshold increases.

Immediate flight is the most common result of an encounter away from wallows and is the simplest strategy for preventing fights and possible injury, especially in a solitary animal with poorly developed social relationships.

TABLE II

Frequency of Flight as the Immediate Reaction in 254 Encounters  
Compared for Different Age/Sex Classes

	Adult Male	Adult Cow/Calf	Adult Cow	Subadult	TOTAL
<u>FUGITIVES</u>					
lt e	14/29(50%)	13/42(30%)	1/13( 8%)	0/15(0%)	28/109(26%)
lt /calf	12/42(29%)	10/72(14%)	0/7 ( 0%)	0/10(0%)	22/138(16%)
lt	7/13(54%)	2/7 (28%)	0/2 (0%)	2/5(40%)	11/33 (33%)
adult	20/25(80%)	6/17(35%)	4/11(27%)	6/13(46%)	36/89 (40%)

In each fraction the denominator is the number of encounters observed and the numerator is the number of occasions on which the class listed under FUGITIVES fled immediately.

Adult males which display by squirting urine are generally victors in encounters with non squirt urinating males. There are examples of males which stopped squirt urinating after a severe fight.

In aggressive interactions cows with calves are normally victors over all others except other cows with calves in which case the result depends on circumstances, the size of the calf and the relative positions of the combatants. Adult males normally flee from cows with calves, though the situation changes when the cow is in oestrus. Single cows, and single subadults, normally flee from adult males but it depends on the individual male. A male A approached a pool where a single cow K was grazing. She fled to the opposite bank on hearing his approach and turned to look back. When A appeared, she descended again to the pool and A moved off. Ten minutes later male E approached unseen and K behaved in the same way but when E appeared she ran away honking. The next day male A fought with and chased away male C who fled three miles west and stayed there for three days.

Subadults are safer from attack by adult males when in the company of other rhinos. A single male calf who lost his mother was killed as a result of wounds sustained in attacks by the resident strong male of that area. He was attacked twice over a period of four days and died five days later from internal injuries. A subadult female driven off by her mother was attacked by a strong male over a period of two days but now lives in the area unmolested, occasionally associating with cow/calf pairs or single cows.

Calves when encountering other individuals while with their mothers are very inquisitive and are often the first to make a move to investigate rhinos approaching a wallow or rhinos grazing nearby. While grazing the tendency of the cows is to avoid contact but the calves initiate it. They make a slow approach sniffing with nose stretched out and after perhaps two quick retreats to the cow, may make contact with an approaching subadult female or the calf of a nearby cow. Naso naso greeting and nuzzling are often followed by some sparring. The cow will often chase off the intruding subadult or calf. At this point the calf will return to behind the cow. Alternatively, the calf will return to its mother of its own accord. Very young calves initiate such encounters more often than older ones.

Calves may be quicker than the cow in detecting the approach of another rhino. Older calves begin to show aggressive behaviour towards intruders in the same way as the mother. The normal reaction however is to retreat to a position on the other side of the female and in physical contact with her. If the cow turns

to flee the calf turns and flees in the lead. If the opponent flees they both continue grazing or lying in a wallow. Of 142 wallow interactions in which cows and calves were involved, on 32 occasions the approaching cow was chased off by the calf. After a calf has left its mother and become a subadult, it never initiates aggression with an adult.

Subadult males generally win in encounters with subadult females at wallows.

#### 4. Movements

There are rhinos which are resident in the Saurah area year round and others that come in after the burn in the early part of the year. New males which come in are not by any means weaker than the resident males. One newcomer chased off a resident male from an oestrus female.

There are socially related variations in these movements. Subadult males very rarely crossed the river to feed in the burnt grass though subadult females did. A particularly bold and fearless adult male roams regularly north and south of the Rapti at Saurah over about five square miles. He has replaced another male who used to occupy this role but now remains confined largely to south of the Rapti.

Adult males and adult females with large calves are the most common users of the fields.

TABLE III  
Individuals Feeding in Fields

<u>Individual</u>	<u>Number of occasions seen</u>
Adult male	94
Adult female	9
Adult female calf	70
Subadult	24
TOTAL	197

## 5. Discussion

There is no shortage of food and no obvious land tenure system. Many rhinos may use the same area. They do so as solitary animals or in small groups. Various behaviour mechanisms operate to avert serious injury from the common aggressive interactions.

Subadult males congregate into groups possibly because the aggression of an adult male is not aroused by a group of subadults as it is by a lone subadult. There are examples of lone subadults killed by adult males but none of attacks by male adults on subadult groups. Similarly subadult females seek the company of adult cows and calves to avoid aggression from adult males.

Subadult females do not form groups because it is more important for them than it is for subadult males to become familiarised with the areas of optimum habitat for calf production. If they associate with adult cows and calves they are in the optimum areas. Subadult male groups remain north of the Rapti while the subadult females go south and feed on the regrowth after the burn.

There is no breeding season. The most effective breeding strategy for adult males is to move around in the area of highest rhino cow concentration looking for signs of oestrus females - visual or olfactory. Other males met in their wanderings are competitors and if the encounter itself does not result in flight of one individual a fight ensues. There is a social escape route or subterfuge for males which cannot take the beating: they can stop displaying and squirt urinating and then co-exist in the same area as the stronger males using flight as their most effective defence mechanism. Adult males never associate in groups such as the subadults described above.

Adult males will not attack subadults in groups and in fact wallow peacefully in physical contact with them. Such behaviour presents no threat to the adult male and so is tolerated. In the areas of high cow/calf concentration it might not be tolerated.

The curiosity of very young calves and their tendency to initiate contact with other individuals, to greet and nuzzle them, is a mechanism whereby they become familiar with the other individuals in the population. Mothers discourage such contacts by driving off intruders. The result is a balance between allowing the calf to familiarise itself with other members of the population and protecting it from the hostile advances of some members.

It becomes clear that each sex/age class has a role to play in the population. The behaviour patterns change as the animal matures from baby to calf to subadult to breeding adult. All changes have been documented except that of subadult to male to breeding male. Males may be very old by the time they start breeding.

During the last twenty years man has invaded the Rapti Valley in large numbers and cultivated most of the mixed forest/grassland areas which are good rhino habitat. This is well within the lifespan of a rhino and many of the rhinos in Chitawan must have lived 20 years ago in a completely wild environment with few people and little cultivation. This must have some effect on their behaviour now. Their movement round a home area in constant search of food has now been restricted so that they move after dark in the cultivated areas which used to be forest and retreat to the forest areas at night. They are opportunists and surprisingly adaptable, utilising a wide range of food species.

#### IV. MANAGEMENT

Rhinoceros conservation has to be considered in relation to the conservation of other species and habitats. Management for conservation assumes an aim towards which conservation measures work. If the biology of an area is known in detail the results of a number of management programmes can be predicted and choice of programme is by comparison between the predictions and the aims.

A simple model of interactions between plant and animal species, human populations, latitude, biotic and physical factors can be constructed to give some idea of the factors affecting the National Park. Manipulation of some factors is possible and can proceed if the results can be predicted and are compatible with the aims.

In the Chitawan National Park there are a number of habitat types which illustrate a successional series resulting from repeated changes in the course of the rivers. Man has affected the habitats more recently by cultivation, deforestation, and selective wood felling. The following diagram illustrates a simple model. Sal forest, Khair-sissoo forest and mixed forest described in Progress Report II are the starting points. Man's effect on the mixed forest can be seen clearly by comparing the Khoria Mohan forest where there are 17 common species of trees to the Itarni/Janakpur forest where there are only four common species. (See FIG. I)

Sal forest and Khair-sissoo forest have not been so closely studied. Sal is on higher ground usually and not so greatly affected by changes in river course. Old riverbeds in the Sal forest are characterised by low wet areas with Saccharum, Themeda and Arundo growth in the wettest areas. As soon as cattle grazing starts all such areas are converted to short grass, cropped regularly by domestic stock. Khair-sissoo forest gradually occurring higher up the Rapti and Narayani Valleys nearer the hills, is in more gravelly soil. Destruction of it is probably followed by Saccharum regeneration and then regeneration of the trees.

Fire perpetuates the mixed grassland and the Saccharum spontaneum stands and due to the cool nature of the burns does not destroy the forest. It is an important factor in maintaining the small areas of grasslands suitable for rhino.

Cutting of Imperata cylindrica for thatch appears to be a way of perpetuating the species. In areas where I. cylindrica has been burned, Saccharum spp. are becoming more common. The

FIGURE I

Successional Changes in Mixed Forest/Grassland

MIXED FOREST

River changes course

RIVER BED SANDY

River changes course

*S*  
*spp.*  
*spp.*

SHORT GRASS spp.

Saccharum spontaneum Fire

MIXED GRASSLAND/TREES

Saccharum spp.

Phragmites spp.

Bombax

Trewia

Bauhinia

Terminalia

MIXED FOREST

Cut out good wood

Graze domestic stock

Fire

Fire

Cultivate

Imperata cylindrica for  
Evacuate  
FIELDS

cut

thatch

DEPLETED FOREST

containing Bombax  
Trewia and unpalatable  
Pogostemon understory

effects of factors such as fire must be considered for all species. It may well be that the high concentration of hogdeer in the Kachwani/Hanipur area is due to the amount of Imperata cylindrica which they graze extensively in its young stages. A high hogdeer population probably has a beneficial effect on the tiger population. The villagers have leaky hedges this year because they could not cut enough thatch grass. All these factors and many more have to be considered in deciding policy on management procedures.

The following type of diagram (see FIG. II) when complete would help to work out which problems will arise here for rhino only but all species could be included. Only management measures are implemented. The information gathered so far about rhinos has several applications in planning such procedures.

The rhino population is larger than originally thought to be. Poaching has been successfully controlled and a slow increase in population is predicted. Food is plentiful. Most of the rhinos could live within the borders of the National Park year round but prefer to raid crops for 8-9 months of the year. Many rhinos to the east of Saurah have probably never been within the National Park boundaries and have had their tall grassland habitat destroyed by invading agriculturalists with the last 20 years. They are left with Sal and mixed forest areas but make extensive use of crops occurring in their original home areas.

The crop raiding habit has proved successful from an energy budget point of view. The most successful strategy is to live near the fields in remaining tall grassland areas such as the area south of the Rapti at Saurah. This optimum habitat is occupied mainly by cows with calves. Concentration of cows and calves here seems to have reduced the calving interval possibly as an indirect result of the increased frequency of aggression at wallows described in Progress Report No. XI. Subadult male groups occur near the high concentration areas but in sub-optimum habitats and do not use the fields to the extent what adults do. There are no records of subadult male groups larger than two from the west. If any sales to zoos or croppings are contemplated, the results of removals from different areas and different age/sex classes can be predicted.

The main problem connected with rhino conservation at present is that of croppings. As the human population increases, the pressure on the agricultural land will increase and the losses to rhino, deer and wildboar will become less tolerable. Rhinos have been seen to completely destroy a 500 square yard field of 10 in. wheat plants in three hours.

FIGURE II

Factors Affecting Habitats and Their Components

<u>Biotic/Physical/Human Factors</u>	<u>Habitats</u>	<u>Habitat Components</u>
Fire (Dec. to March)	1 Sal forest	A <u>Saccharum/Phragmites</u> regrowth (Feb. to May)
Stock grazing (year round. Greatest Dec. to May)	2 Khair-Sissoo forest	B <u>Saccharum/Phragmites</u> old shoots (June-Jan)
Thatch cutting (Nov. to Jan.) ( <u>Imperata cylindrica</u> )	3 Mixed forest	C <u>Imperata cylindrica</u> regrowth (Feb-April)
Feeder Cutting ( <u>Saccharum</u> spp. Mixed forest trees) (Year round. Greatest Dec. to May)	4 Mixed grass- land/trees	D Riveredge short grasses/sedges Cynodon dactylon (April to Nov)
Cane cutting ( <u>Saccharum</u> spp burnt stalks for wall construction) Feb to May)	5 <u>S. spontaneum</u> grassland	E Mixed forest browse
Collection of fruits rope fibres, veget- ables, flowers, kapok leaves (Year round)	6 Oxbows. <u>Arundonax</u> , <u>Typha</u> spp	F Sal forest browse (Year round)
Wood collection (Year round. Greatest Nov. to Feb.)	7 River edge, short grass and sedges	G <u>Arundonax</u> , <u>Typha</u> spp. (March-July)
Fishing (Year round)	8 Previously cultivated grassland <u>I. cylindrica</u>	H Waterweeds (Dec.-June)
Fencing jungle	9 Depleted mixed forest	I Colonising shrubs <u>Calliandra</u> , <u>Artemesia</u> , <u>Zizyphus</u> (Dec-June)
Climatic variations	10 <u>Calliandra</u> , <u>Artemesia</u> , <u>Zizyphus</u> , <u>Callotropis</u> Grassland Colonising shrubs	J Agricultural crops (June-Feb)
Disease		K <u>Albergia sissoo</u> new leaves, twigs (March-April)
Changes in river course		(i) shade/low cover
Poaching		(ii) wallows
Controlled cropping and removals		
Cultivation		

Fencing is definitely not the answer to the crop raiding problem. Many observations of rhinos breaking down or walking round fences have confirmed this. Fencing, however strong, would be ineffective and expensive. The problem has to be approached on another tack. Changing the culturally inherited movement patterns has possibilities: either by intensive scaring programmes in the fields, aimed at the younger animals, or by discouraging animals from using the depleted forest areas outside the National Park as daytime refuges from nocturnal crop raids.

One approach is the socio-economic one. Looking at Figure II, the outputs and inputs of the National Park can be listed. II, III, IV, V, VI, VII, VIII are all outputs. J is the only input.

This implies that the Park is very important in the lives of the local people. Some kind of negotiation may become possible. V, VI, VII have little effect on habitats or species but disturbance. II, III, IV, VIII have more complicated effects, some of which can be shown to the villagers to be destructive to the jungle which is so important to them. There is no firewood or thatch grass in the villages - no snails or fernshoots either. Complete exclusion of such activities as thatch grass cutting, cane cutting, fruit and wood collection merely makes people less likely to condone raids of rhino, deer, and wildboar on their crops. In some areas relations are very bad. A guard was attacked in May in Belod by men accosted for felling trees. The guard shot one man dead.

Permission to remove certain forest products under proper control, careful explanation of the effects of cattle grazing and fodder cutting and more contact between Park officials and local villagers would improve relations.

Figure II lists factors affecting habitats and animal populations, habitats and habitat components. A maze of inter-connecting arrows can be drawn between the columns and the relationships change with the time of year. For any kind of predictions to be made a fourth column listing animal species is necessary. Seasonal food preferences, social behaviour patterns, movement patterns, reproductive rates, interspecific interactions (predation and competition), have to be considered for each species - also the economics of tourism, the effects of wildlife on the village economy and a myriad of other factors which are in turn affected by the factors listed in column one.

It is towards this type of predictive capacity that research must progress to help in managing and maintaining the animal and plant communities.