STATUS AND FOOD HABITS OF NILGAI (Boselaphus tragocamelus) IN ROYAL BARDIA NATIONAL PARK, NEPAL

BY

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THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES AND SUSTAINABLE AGRICULTURE

NORAGRIC

AGRICULTURAL UNIVERSITY OF NORWAY

1993

ABSTRACT

A six months (August 1992 - January 1993) study on the status and food habits of nilgai (Boselaphus tragocamelus) was carried out in Royal Bardia National Park, south western Nepal. Methods used were questionnaire surveys, field observations and microhistological analysis of faecal material. A total of 57-86 animals were estimated to exist in nine different semi-isolated subpopulations inside and outside the park, reflecting a decline of 80-90% since the 1970's. A combination of high poaching, tiger predation and habitat deterioration both inside and outside the park was identified as the major cause of decline.

Nilgai was found to be a mixed feeder. Browse species comprised about 45%, grass 27% and agricultural crops 17%. A total of 26 food plant species were recorded. Callicarpa macrophylla Mallotus philippinensis , Artemesia vulgaris, Eugenia jambolana and Casearia tomentosa were the most important browse species. Short grasses, Cynodon dactylon and Imperata cylindrica were preferred compared to tall grass species. Rice was eaten during all months from August to January but peaked during November and January with 12.9 % and 12.3% of the total diet, respectively. Mustard was particularly high during December (16.6%).

Crop damage by nilgai averaged 8.3 % of the total crop loss caused by wild animals. The present distribution pattern and the food habit study confirmed that the nilgai antelope is adapted to a certain degree of human disturbance, including domestic livestock grazing. However, because of it's large size and affinity for feeding on agricultural crops, it is highly vulnerable to poaching. In order to conserve this species in Nepal, the remaining small subpopulations need to be protected and their habitats included in a buffer zone management plan for the park.

ACKNOWLEDGEMENT

This work would not have been possible without the help and cooperation of several organizations and people to whom I express my sincere thanks. I am much indebted to the Norwegian Agency for International Development Cooperation (NORAD) for providing me with this scholarship and funds for the study, and to NORAGRIC and it's staff who made this study possible.

I would like to extend special thanks to my institution (King Mahendra Trust for Nature Conservation) for selecting and granting me leave. I extend my deepest gratitude to Dr Hemanta Mishra for his kind support and unfailing inspiration in my studies.

I would also like to thank the Department of National Parks and Wildlife Conservation, particularly Dr. Tirtha Man Maskey, Director General, Dr. Bijaya Kattel, Chief Ecologist, and Ram Prit Yadav, Chief Paık Warden (RBNP), for giving me the support which made my field work possible.

Other thanks are due to the following people who assisted me directly in the field; Babu Ram Yadav, Asst. Warden, Rangers Bhod Raj Subedi and Birendra Kandel deserve special mention for their sincere help. I have benefitted a lot from the following park game scouts particularly Chamu Tharu, Damodar Bhandari, Sewak Tharu and Gopal Shahi at Betani post, and Lahanu Tharu, Lapton Tharu, Jantu Tharu and Narendra Tharu at Chisapani Sub H.Q. Senior Game Scout Gagan Singh, all elephant drivers and administrative staff also helped in their respective fields.

My sincere appreciations also go to the Tiger Tops and it's staff, both at the lodge and tented camp, for allowing me to use their facilities for the study. Special thanks to Chandra Thapa, Karan Rana, Joshi, Sakali Gurung and Tul Bahadur.

The KMTNC/Bardia Conservation Project provided necessary logistics. Wildlife technicians Man Bahadur and Man Singh Lama, and other field assistants Gopal Tamang, Basu Bhattarai, Badlu Tharu and Prem Tharu helped both in the jungle and villages to collect valuable information. Cooks Binti Ram Tharu and Laubatse Tharu and driver Shyam Lama, provided good food and careful driving.

Thanks are due to Mr Narayan Dhakal and Sriram Ghimire for their help and cooperation. I am thankful to my colleague Mr Anup Raj Joshi for his special help and valuable comments provided for my study.

I am very much grateful to my friend Mr Shant Raj Jnawali and Mrs Sarita Jnawali for supporting me both academically and socially in Nepal as well as in Norway. Mr Jnawali helped me unfailingly from the very begining of surveying the Nilgai areas in Bardia National Park up to the end of my thesis write-up. I would like to thank many friends both in Nepal and Norway. Mr Shailendra Pokharel offered good companionship and help throughout the study period. Mr Stein Moe provided fruitful ideas and relevant literature. Mr Narendra B. Pradhan and Shiva Raj Bhatta are full of praise for their help rendered while in Nepal. Several others friends; namely Sajani Shrestha, Jan Eric Studsr¢, Dyre Vaa Saetre, Kjersti Mathilde Naess and Heidi Andersen made the study atmosphere more pleasant and enjoyable.

Last but not least, I owe my sincere gratitude to my academic supervisor Prof. Per Wegge for his scientific guidelines and supervision to carry out my field work. He tirelessly spent many hours guiding me and correcting my writings for which I remain highly indebted.

Finally, I am indebted to my wife Puspha who shared the stress and strain of my absence, especially during the delivery of our daughter Bhumika and parenting her singlehandedly.

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1. INTRODUCTION

The nilgai (Boselaphus tragocamelus) is the largest of the Asian antelopes, looking rather like an Indian version of the African eland, with a slim, antelopine face, and a large, sleek body more like a zebu cow than an antelope (Kyle 1987). They are only found in the Indian peninsula from the base of the Himalayas to Mysore (Prater 1971). They are found in a variety of habitats from level ground to hillsides, in thin brush with scattered trees to cultivated plains, but not in thick forests. Nilgai have also been reported in Pakistan, mainly along the border with India (Mirza and Khan 1975, Roberts 1977).

In their native range, nilgai have not fared well. They were common and plentiful in Indian peninsula during the 1800's, as Adams (1858) and Blanford (1888), cited in Sheffield (1983). Like all other mammalian fauna they have declined drastically because of overshooting and habitat destruction (Schaller 1967). Although not yet endangered, nilgai were considered "scarce" in the 1960's (Schaller 1968). Mirza and Khan (1975) stated that nilgai were vanishing and recommended a strict ban on hunting to allow the species to survive in their natural habitat.

The present population of nilgai in the State of Rajasthan, India, is estimated to be around 3,000 animals and 7000 in the neighbouring state of Haryana (Schultz 1987). Elsewhere in the continent the nilgai occur only in small, isolated populations, so that the continentwide population must be well below 15,000 (Kyle 1989). In 1985, a survey of nilgai in Texas showed a figure of 15,400 animals (cited in Kyle 1989). Although it is one of the most successful exotic bovids, the nilgai is perhaps the least known species. Little scientific information has been published in India or other parts of it's natural range on the Indian sub-continent.

In Nepal, nilgai were widely distributed in the Terai, the southern plain. They are regarded as "blue cow" by the Hindus which offers protection as a sacred animal. They occurred in seemingly viable numbers in Kosi Tappu in the east, Parsa in the middle, and Shukla-Phanta and Banke-Bardia in the west (Wegge 1976). Bolton (1976), estimated no less than 200 animals in

Bardia Wildlife Reserve (before National Park status). Dinerstein (1979) mentioned that Bardia had the largest nilgai population in Nepal. Chital combined with nilgai constituted about 88 % of the total wild herbivore biomass in the south-western part of the reserve. He estimated about 80-100 individuals in a study area of 11.8 km^2.

However, recent observations in Bardia (Wegge pers.comm.) indicated that the population of nilgai had been drastically reduced in recent years. Unsubstantiated reports from other parts of the country also indicated that this species was becoming rare within Nepal borders. The Bardia population, estimated at about 200 individuals in 1976, had declined so much so that in 1989, Moe could not find a workable population for his study (Upreti 1992).

2. OBJECTIVES

The primary objective of this study was to map the distribution and assess the current status of this species within Royal Bardia National Park. A secondary objective was to study the food habits in order to identify the main habitat requirements for management. Thirdly, since this animal is known to be a serious pest on agricultural crops and therefore represents a conflict animal for local villagers, such a study seemed appropriate.

3. STUDY AREA

3.1 History and Location

The Royal Bardia National Park (81° 20'E and 28° 35'N) is located in south-west Terai, the southern plain of Nepal. The total area of Bardia is 1,608 sq km. It occupies a major portion of Bardia district and a part of Banke district. Originally the area was established as a Royal Hunting Reserve in 1969. It was gazetted as a Wildlife Reserve in 1976. Later, in 1984, it was extended to include the Babai valley in the north-east. About 1500 households residing in the Babai valley were moved and relocated in Taratal close to the district headquarter, Guleria. The whole area of 968 sq km was then declared as a National Park in 1989. The park borders

Geruwa river in the west and Kohalpur-Surkhet highway in the east. The high Siwalik range in the north forms the northern boundary. The southern boundary adjoins agricultural settlements intermingled with forested buffer zones.

The present park was intensively utilized for domestic livestock and cultivation before it was gazetted as a wildlife reserve. Previously cultivated fields are now revegetated naturally and have formed short open grasslands, locally known as phantas.

The main study was carried out along the southern border of the park and a more intensive field study was done in Khauraha island near the park headquarter. This area, approximately 7.4 km^2, borders the Geruwa river in the west, floodplain and sal forest in the north and government forest and cultivated land in the south and east (Fig. 1).

3.2 Physiography and Climate

The northern border of the park is formed by the crest of the Siwalik (Churia) ridge and reaches an elevation of 1441m at Sukarmala. The southern section is charecterized by low- lying unbroken terrain. The Siwalik is composed of late tertiary material, containing fine grained sandstone with deposits of clay, shale, freshwater limestone and conglomerate. Soils of Churia are highly prone to erosion. The broad alluvial plain that slopes gently away from the base of the Churias to the Indian Border is known as Bhaber. Most of Bardia National Park falls into this category. Bhaber deposits are composed of boulders, cobbles, and coarse sand layers amidst silt and clay (HMG, Soil survey, Bardia 1971). The study area is predominantly underlain by sandy loams. Soils of the flood plain islands in the Geruwa and along it's bank range from sands to gravel to sandy loams.

The Royal Bardia National Park is drained in the west by Geruwa river, the biggest branch of Karnali river. From the middle of the park flows Babai river which also contributes substantially to the drainage. Khauraha, Orai, Ambasa rivers in the west, and Kareli and Man Khola in the east are also important draining sources of the park.

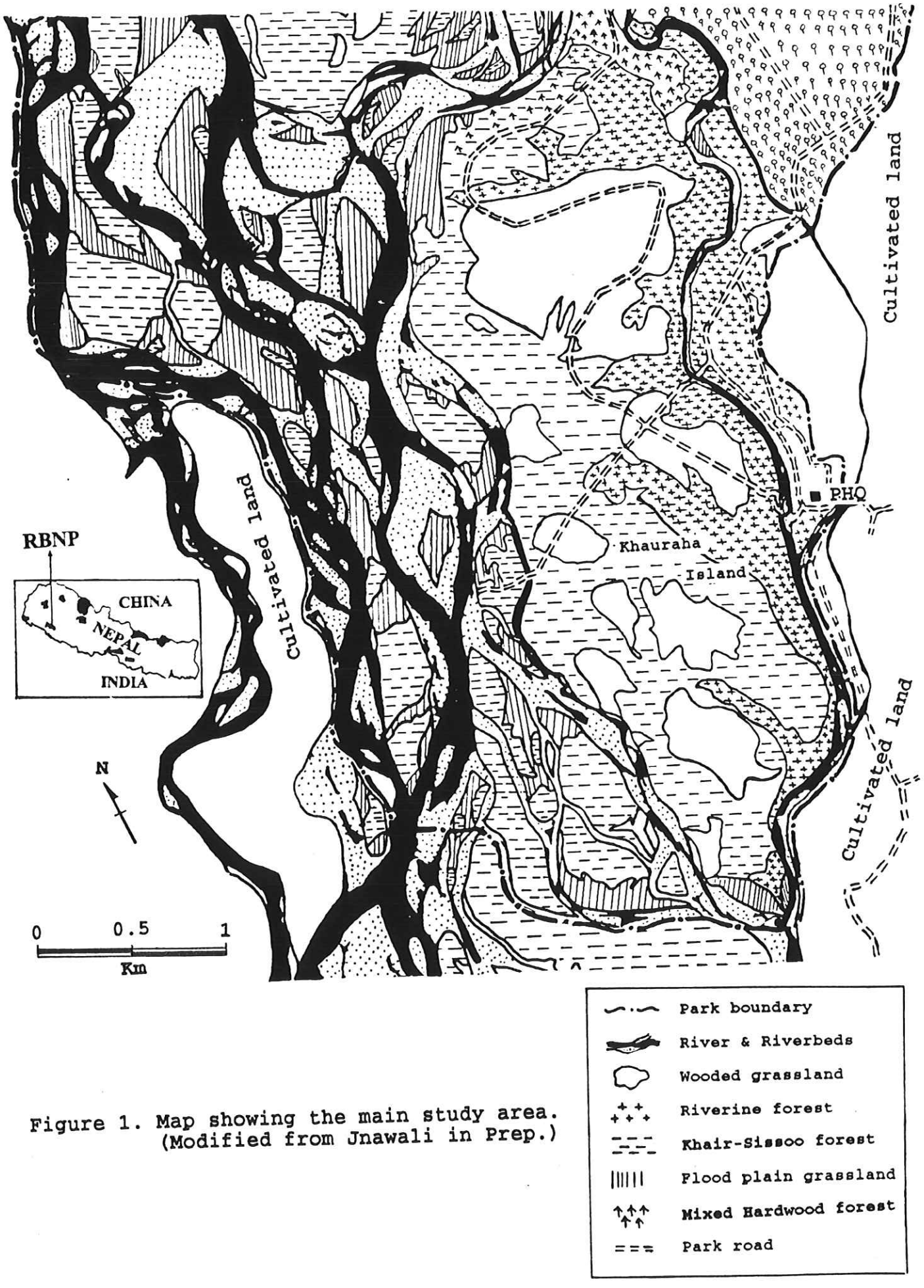

Figure 1. Map showing the main study area. (Modified from Jnawali in Prep.)

The Royal Bardia National Park has a sub-tropical monsoonal climate with a summer monsoon from mid June to late September and a relatively long dry winter. The temperature recorded in 1970 had an average maximum of 30.5° C (May) and average minimum of 17.7° C The maximum temperature recorded in that year was 43.6° C and minimum was 8.6° C. The average rainfall recorded in the same year at Chisapani was 2,099.4 mm and in Guleria (District HQ), it was 1,396.5 mm (Upreti 1992). There are three distinct seasons, hot- dry season from February to mid-June, monsoon season from mid-June to late September and cool dry season from late September to February.

3.3 Flora and Fauna

The vegetation in the study area has been classified into seven major types (Jnawali and Wegge 1991), modified from Dinerstein (1979).

1) Sal forest is dominated by sal Shorea robusta covering an area of about 70% of the total park area. Buchanania latifolia and Terminalia tomentosa are two important associated tree species.

2) Khair-Sissoo forest grows on the alluvial river bed along the Geruwa river. This type of forest is dominated by khair Acacia catechu and sissoo Dalbergia sissoo. Two shrub species, Murraya koenigii and Callicapra macrophylla, form a dense understory cover.

3) Moist Riverine forest is distributed in patches along the water courses and in depressions. Mallotus philippinensis and Ehretia laevis are two dominant tree species in this type. The understory is relatively poor with two main shrub species, M. koenigii and C. macrophylla.

4) Mixed Hardwood forest is an open forest type which grows on well drained flat land. Casearia tomentosa and Schleichera trijuga are two important tree species in this type.

5) Wooded Grasslands are grass covered areas with sparsely distributed trees. These grasslands are found on Khauraha island and locally named as Dabdabe and Simal phantas. Among the grasses Imperata cylindrica, Saccharum spontaneum, Vetiveria zizanoides, Cyperus kyllingia,

Erianthus ravennae and Cymbopogon flaxuous are common. Similarly, Bombax ceiba, Adina cordifolia, Bahunia malabarica and Mallotus philippinensis are common tree species in this vegetation type.

6) Phanta are naturally revegetated open short grasslands in previously cultivated fields. I. cylindrica is the dominant short grass species in Lamkauli and lower Baghaura phanta. Northern Baghaura is dominated by the tall grass species Narenga porphyrocoma and Saccharum spontaneum.

7) Floodplain grasslands are the tall grasslands on the floodplain along the Geruwa river. This grassland is dominated by Saccharum spontaneum, Phragmatis karka, Saccharum bengalensis and Narenga phorphyrocoma.

The Royal Bardia National Park harbours endangered species such as the Royal Bengal tiger Panthera tigris, a re-introduced population of the Greater One-horned rhinoceros Rhinoceros unicornis, elephant Elephas maximus, and sloth bear Melursus ursinus. Six species of deer: swamp deer Cervus duvauceli (an endangered species), spotted deer Axis axis, hog deer Axis porcinus, barking deer Muntiacus muntjak, and sambar deer Cervus unicolor are found in the area. In addition a small population of blackbuck Antilope cervicapra was introduced in the winter season, 1992. Nilgai Boselaphus tragocamelus is the largest antelope found in the park. Two species of crocodile, gharial Gavialis gangeticus and marsh mugger Crocodilus palustrus, and the highly endangered Gangetic dolphin Platanista gangetica are among the important aquatic fauna. About 143 species of avifauna, a variety of small mammals and reptiles are also common in the area (Bolton 1976).

3.4 Ethnic Composition and Land Use

The Majority of the inhabitants in Bardia are Tharus. They are probably the oldest and original inhabitants of the Terai (Bista 1967). But a considerable number of people migrated from the hills have also settled lately in Bardia. Among them Brahmin and Chhetris form the non-

matwalis group and Magars, Gurungs, Tamangs, Damais, Kamis, and Sarkis form the Matwali people. According to a census in 1991, the population of Bardia was 2,89,840, of which 1,47,454 were males and 1,42,386 were females. The Tharus comprised about 75% of the total population according to a census of 1971. The total number of households in Bardia is 4,11,94. Average household size is 7.04 (CBS 1992). Tharus live in an extended joint family. Women have the overall responsibilty of the house and decision is made by the eldest women of the house (mother-in-law). They worship animistic spirit as well as Hindu Gods. Magi is the main festival.

Agriculture is the main profession and source of income. Bardia is considered one of the breadbasket areas of Nepal. About 58,214 hectares of land is under cultivation. Major crops grown in this area are rice, maize, wheat, mustard, and pulses. Fishing is very common among Tharus. Despite being a productive area, only two crops are grown in a year. Irrigation is done by diverting the sub-branches of Geruwa and Karnali river, and Orai river, Ambasa nala, Babai river and Man Khola.

With the completion of the eastwest highway and easy access to the park, tourism is likely to increase in coming years. One new lodge has also come up in addition to the Tiger Tops. Plans are underway to open new lodges around the park headquarter.

Originally, the reserve was highly utilized by the local people. Stock grazing and fuelwood and fodder collection were very common. In addition to the above, fishes, fruits and vegetables were collected by the local people. After the park establishment, the people are now prohibited to utilize the park resources. Only grass cutting is allowed for a period of two weeks. Hence the pressure has increased on the existing Government forests outside the park, although some illegal cattle grazing and fuelwood collection does exist in many parts of the park.

4. MATERIALS AND METHODS

4.1 Population Status

The following two methods were employed to estimate the present status of the nilgai population in RBNP.

4.1.1 Field survey

A preliminary survey of the study area was carried out to find out the likely nilgai areas before the actual field work started. This was superficially done by questioning the park authorities such as the warden, game scouts, elephant drivers and field technicians from an ongoing conservation project as well as naturalists from Tiger Tops lodge and Tented Camp.

Actual field work took place from mid August, 1992 to the first week of February, 1993. Population estimation was done by various means ranging from walking on foot in nilgai areas to using elephants, vehicle, boat and machan (raised plateform for viewing) observations. Only elephants provided the safest means of transportation during the monsoon season to cross rivers and visit inaccessible areas. Machan observations were effective during the dry season because tall grasses and dense bushes hindered the visibility during the monsoon.

4.1.2. Questionnaire survey

Two sets of questionnaires were employed to find out the local views about the status of the existing nilgai population. The first set was distributed among 173 households within a range of 500 m from the park boundary along the southern boundary from west to east. For convenience the villages adjoining the park boundary were divided into three different zones (see figure 2). Prior to interviewing, farmers were informed about the purpose of the study basically to reduce hesitation during the interview session.

A second set of questionnaire were designed for the park authorities, namely park warden, game scouts, and elephant drivers. Army staff of the park protection unit were also taken into account and interviewed. Besides, experienced naturalists and the elephant staff from the Tiger Tops lodge and its Tented Camp were also interviewed. Tourist record files which have been maintained since the lodge was established in 1980 were also used to identify nilgai areas and compare the previous and the present rate of sightings of the animal. The population status in other protected areas in Nepal was obtained through park rangers, wardens, at the Departmrnt of National Parks and Wildlife Conservation and other related persons. Samples of questionnaire are given in appendix (VII).

4.2 Feeding Habits

4.2.1 Machan observation

Machans were used to observe the feeding habits of nilgai within the main study area. Two machans were used in Khauraha phanta where nilgai were seen frequently during the early dry season. Machan observation was effective only during early morning and evening. Binoculars (7 x 50) were used to observe animals from a distance. Grazing pattern and the plant species eaten by the animal were identified and recorded in the field or brought to the research station for proper identification.

4.2.2 Habitat study

The floristic composition of the nilgai habitat in the main study area was described by a crude vegetation analysis. It was carried out in three main vegetation types; khair-sissoo forest, riverine forest, and wooded grassland. A total number of 8 plots in each vegetation type were analyzed. The first plot was laid about 25 m away from the road with a distance of 20 m between plots. Quadrat size of 10x10 m was used for shrub species and 2.5x2.5m for grasses and herbs.

4.2.3 Micro-histological technique

To investigate the food habit of the nilgai the following procedure, adopted from a previous study of rhinoceros (Gyawali 1986), was used.

i) Collection of reference material

Reference slides from 71 known plant species were prepared. Plant samples were oven-dried to about 70° C. The dried samples were grounded to a coarse uniform size. A small portion of the grounded material was transferred into a test tube and boiled in 10% NaOH (sodium-hydroxide) solution in a waterbath. The samples were then washed thoroughly with warm water and transferred into a series of alcohol (30%, 50%, 75% & 100%) for dehydration. Alcohol treated samples were finally treated with a xylene-alcohol mixture for complete dehydration. The dehydrated sample was finally mounted in dpx and kept in room temperature for drying.

ii) Faecal samples

Fresh pellets were collected from three different nilgai areas, Khauraha, Gobrella and east Chisapani, every month. Samples collected within each month and area were mixed together into composite samples. These pellets were lightly washed with warm water to remove dirt attached to them and oven dried. The pellets were then grounded by hand and seived. A small portion of the sample was transferred into a test tube and mixed with a solution of 10% sodium-hydroxide and heated in a hot water bath. After 2-3 treatments with NaOH the sample was washed with hot water thoroughly. Then the sample was passed through a series of alcohol and xylene dehydration. The dehydrated sample was mounted into a slide using dpx and kept in room temperature for drying.

iii) Preparation of diagnostic key

The diagnostic key for faecal analysis was made on the basis of microscopic structures observed

in reference slides. The observed microscopic structures were sketched on a graph paper and kept as diagnostic key.

iv) Method of slide study

Two slides were prepared from each monthly sample for each of the three study sites. The slides were numbered and marked. Each slide was transected with five horizontal lines and observed under a microscope of 40 x magnification to identify the plant fragments. The fragment that intercepted the transect line was identifed and it's length measured to estimate the percent coverage of different plant species. A simple model used to estimate the percentage of different species is given as:

$$\text{Relative species percentage} = \frac{n_1+n_2\ldots}{N} \times 100$$

where,

n = Sum of species fragment size from each slide,
N = Grand total of all fragment sizes

4.2.4 Questionnaire survey

A questionnaire survey was conducted with the local farmers to find out the various crops and vegetables grown in the study area and the extent of damage done by nilgai. The growth stage of the crop species preferred by the animal was also noted (Table 23).

4.3 Conflict Issues

4.3.1 Agricultural field survey

Nilgai affected fields were visited in the morning to find the nilgai tracks entering the field. The track was traced until the damaged area was found. Local farmers and trained wildlife technicians were used to ascertain the foot prints. Local farmers were asked various questions

about the nilgai it's past and present visit to agricultural fields, which season did they come and the extent of damage to their crops. In addition to the above inqueries, the reasons of nilgai decline and how they felt about the animal was also examined (appendix V).

5. Results and Disscussion

5.1 Population Status

5.1.1 Population Status in Nepal

The overall status of nilgai in Nepal appears now to be critical. Unsubstantiated report from other parts of the country and information from the park authorities in various parks and reserves indicate an accelerating decline of this species (Table 1).

Table 1. Present status of nilgai in Nepal, 1992-93.

Nilgai areas	Estimated numbers minimum	maximum
Kosi Tappu Wildlife Reserve	5	10
Parsa Wildlife Reserve	**	**
Taulihawa jungle (Kapilvastu district)	5	10
Banke District	10	15
Bardia District(mainly RBNP)	57	86
Shukla Phanta Wildlife Reserve	20	30
Total	97	151

** = No estimate of numbers.

A total minimum number of 97 nilgai were estimated for Nepal. Nilgai in Kosi Tappu seems to be vulnerable. No real data exists about the situation in this reserve except a few stray cases of sightings (Durga Poudyal. Pers. Comm.). About 5 to 10 individuals might still exist.

Likewise the status of nilgai is unknown in Parsa, where there is no record of sightings during the past few years (Narendra Pradhan. Pers. Comm.).

A small herd of 5 to 10 animals was reported to exist in Taulihawa jungle, close to Lumbini, Kapilvastu district (Pers. comm. Rajendra Suwal.). The animals in this forest are likely to vanish in the near future due to severe hunting pressure, since no protection exists. Banke district also has a few animals in Government forests, but these are also threatened and may disappear very soon. The only viable populations that exist are in Shukla Phanta Wildlife Reserve and in Bardia National Park. Even in Shukla Phanta the animals are now decreasing rapidly (Pers. Comm. Surya B. Pandey, warden). About 150 hectares of buffer area was given as compensation to farmers and nilgai has decreased after fencing of the reserve according to the staff and warden in recent years.

5.1.2 Population Status in RBNP

A minimum number of 57 nilgai were estimated for RBNP and a forest a pocket outside the park (Table 2). The population was divided into nine different subpopulations, including one in Baniyabhar outside the park. Among them Khauraha , Asneri-Amaiya and Ranjha-kareli Khola were estimated to have the highest number of animals. The Baniyabhar subpopulation outside the park numbered 4-7 animals.

All subpopulations residing inside the park lived within a short distance of 100-500 m from the agricultural fields (Fig 2). The distance between these subpopulations was between 8 and 10 km. The Baniyabhar subpopulation occurs about 6 km south from the park boundary.

Table 2. Estimated number of nilgai in RBNP, 1992-93.

Nilgai Hotspots	Estimated numbers	
	Minimum	Maximum
Khauraha	9	11
Gobrella	5	8
West Chisapani flood plain	7	10
Amreni-Karmala	5	8
Dumreni-Sainwar	4	7
Parewaodar	3	5
Asneri-Amaiya	10	15
Ranjha-Kareli Khola	10	15
Baniyabhar	4	7
Total	57	86

5.1.3 Population Quality in the Main Study Area

Table 3 shows the present status of the two nilgai subpopulations in the main study area, Khauraha and Gobrella. Altogether 14 animals were observed during the study period. Among them 3 were adult males, 6 adult females and 5 young.

Table 3. Composition of nilgai subpopulation in the main study area near park headquarter.

Area	Adult male	Adult female	Young*	Total
Khauraha	2	4	3	9
Gobrella	1	2	2	5
Total	3	6	5	14

* = Less than six months.

The recruitment rates for Khauraha and Gobrella " subpopulations" were 0.33 and 0.4, respectively.

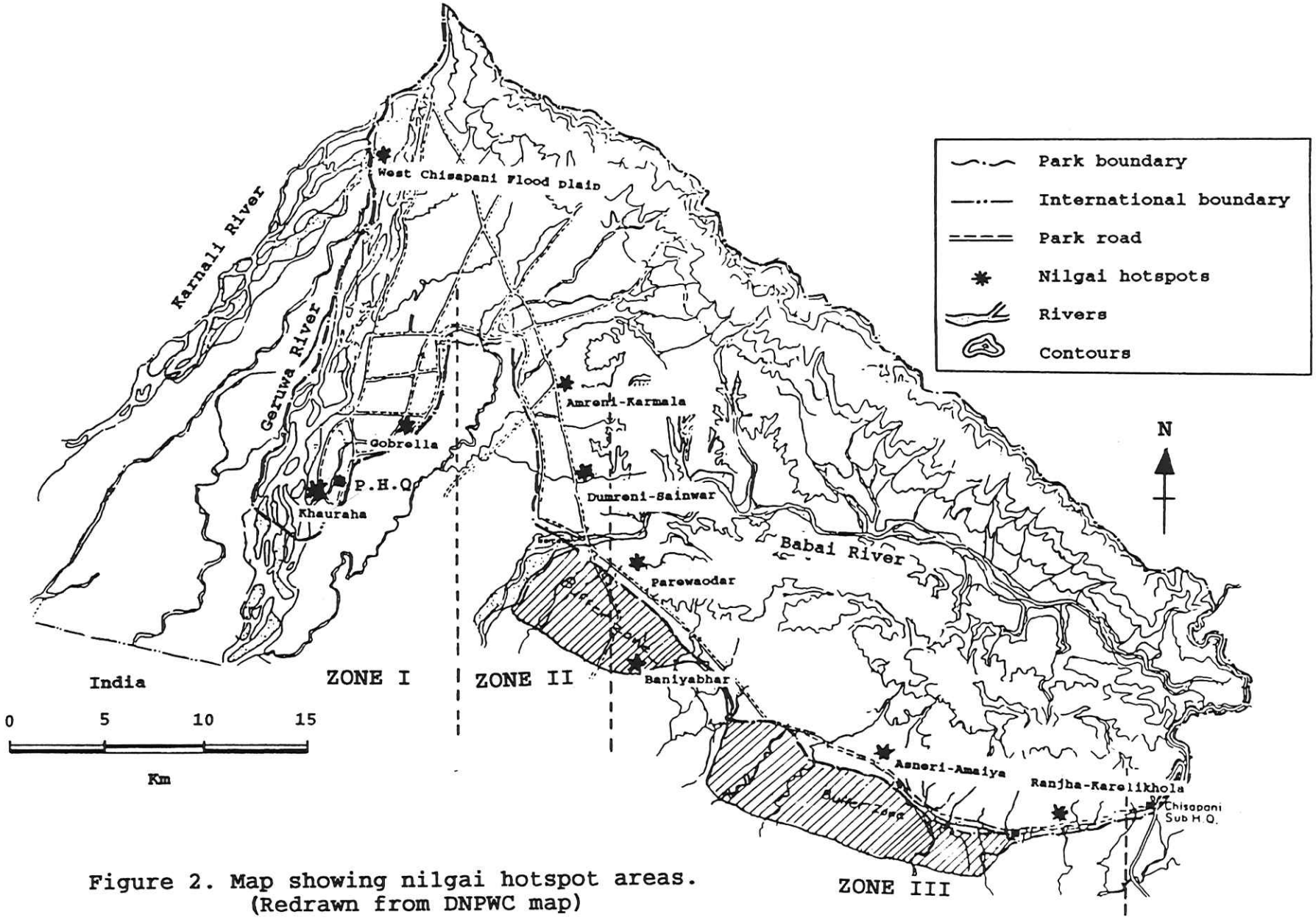

Figure 2. Map showing nilgai hotspot areas.
(Redrawn from DNPWC map)

Table 4 shows the group size classification in Khauraha and Gobrella. The average group size was 2.75. The largest group observed during the study period was a herd of 7 animals in Kharuaha phanta.

Table 4. Group size classification of nilgai in the main study area

Solitary Adult male		Solitary Adult female		Adult females		Males with females		Females with young		Young alone		All mixed	
f	Gs	f	Gs	f	Gs	f	Gs	f	Gs	f	Gs	f	Gs
6	1	9	1	7	2.4	10	2.5	10	3.3	4	2.3	8	6.3

Mean group size = 2.75 for Khauraha & Gobrella.
f = frequency, Gs = mean group size.
(n = 54).

Among these groups, males with females and females with young were most frequently observed. The male to female sex ratio for both subpopulations combined was 1:2. The nilgai sex ratio at Keoladeo Ghana Sanctuary, Rajasthan, India, was 59 males:100 females (Schaller & Spillet 1966). In Vanbihar Sanctuary, India, male to female ratio was found to be 37:100 (Schaller,1966). The largest herd observed during Dinerstein's (1979) study was a breeding herd of 27 animals. The largest herd size seen during the current study was a group of 7 animals, comprising 1 male, 3 females and 3 young.

The relatively high numbers of nilgai in Khauraha could possibly be due to the close proximity of the area to park headquarter which provided better protection. Nevertheless, the population in this area has been decreasing steadily compared to the numbers that Dinerstein (1979) estimated during his study period (1974-76). He estimated about 80-100 animals within the main study area of the present work.

The 85-90% decline over a 16 year period has seemingly affected males more than females:

during Dinerstein's study period males outnumbered females, but at present there were more females than males in the same study area.

5.1.4 Population Trend

5.1.4.1 Local people's opinion

The results from the household survey along the southern east-west park boundary showed a declining trend of nilgai in Bardia (Fig. 3). 86 % of the total respondents (n = 72) in zone 1 reported that the frequency of visiting the agricultural fields by nilgai had been reduced after the park establishment. Similarly, 93% of the informants (n = 33) in the second zone responded that nilgai visits to the agricultural fields had drastically reduced. In zone three only 15% of the total respondents (n = 62) reported that the visit to the field were reduced.

A chi-square contingency test showed that the nilgai visits had been significantly ($p<o.oo1$) reduced in all three zones ($x^2 = 94.79$, $p< 0.001$, 2 df).

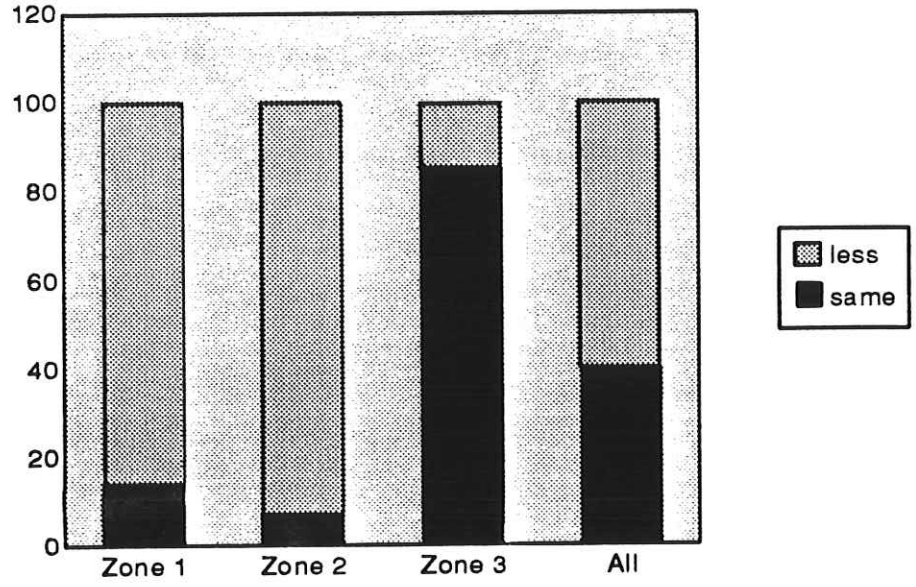

Figure 3. Percent number of respondents (N=173) in different zones of the park reporting that nilgai visits had declined since the establishment of protected area in 1976.

5.1.4.2 Opinion of the Park and Tiger Tops staff

Table 5 shows the opinion of the park (game scouts and elephant drivers) and Tiger Tops staff (naturalists and elephant drivers) regarding the trend of nigai population in RBNP. All these respondents indicated that the nilgai population was declining. Of the total respondants (n = 37), 57 % said that the population had decreasing over the past few years. About 10 % of the respondents said that the population was same as before.

Table 5. Opinion about nilgai population by park staff. Respondents divided into those with more or fewer than 10 years work experience in the park.

	Working experience					
Opinion	Below 10 years no	%	Above 10 years no	%	Total	%
Increasing	2	7.4	1	10	3	8.1
Decreasing	15	55.5	6	60	21	56.7
Same as before	1	3.7	3	30	4	10.8
Not sure	9	33.3	0	0	9	24.3
	27	100	10	100	37	100

According to the Park and Tiger Tops staff Poaching was identified as a major cause of decline of nilgai population in RBNP (Table 6). About 47 % of the respondents (n = 30) attributed poaching as a major cause while 26% attributed to tiger depredation. About 55 % (below 10 years experience) and 60 % (above 10 years experience) of the staff have more or less the same opinion on the nilgai. On the whole about 56% of the staff responded with the decline of the animal. About 10 % reported as same as before.

Table 6. Causes of decline according to the park and Tiger Tops staff (n = 30).

Causes	Below 10 Years	%	Above 10 years	%	Total	%
Habitat loss	3	16.6	2	16.6	5	16.6
Poaching	11	61.1	3	25.0	14	46.6
Predation	4	22.2	4	33.3	8	26.6
Floods	0	0	3	25.0	3	10.0
Disease	0	0	0	0	0	0
Total	18	99.9	12	99.9	30	99.8

The frequency of sightings of animals from the tourist record books in Tiger Tops lodge and Tented Camp also showed a declining trend (Table 7 and Fig 4). The frequency of animals observed during the last four years by the lodge showed a significant ($r = -0.999$, $p<0.001$) decrease.

Table 7. Frequency of nilgai sightings by tourists during jungle safaris at the Tiger Tops lodge and Tented Camp.

Year	Trips	No. times nilgai seen	Frequency in %	Correlation coefficient(r)
Lodge				
1989	54	7	13.0	
1990	81	8	9.8	0.999**
1991	66	5	7.5	
1992	69	4	5.7	
Tented Camp				
1989	48	12	25.0	
1990	65	6	9.2	0.805(ns)
1991	61	2	3.2	
1992	70	5	7.1	

** = significant ($p < 0.001$)
ns = not significant
(Source: Tiger Tops, Bardia)

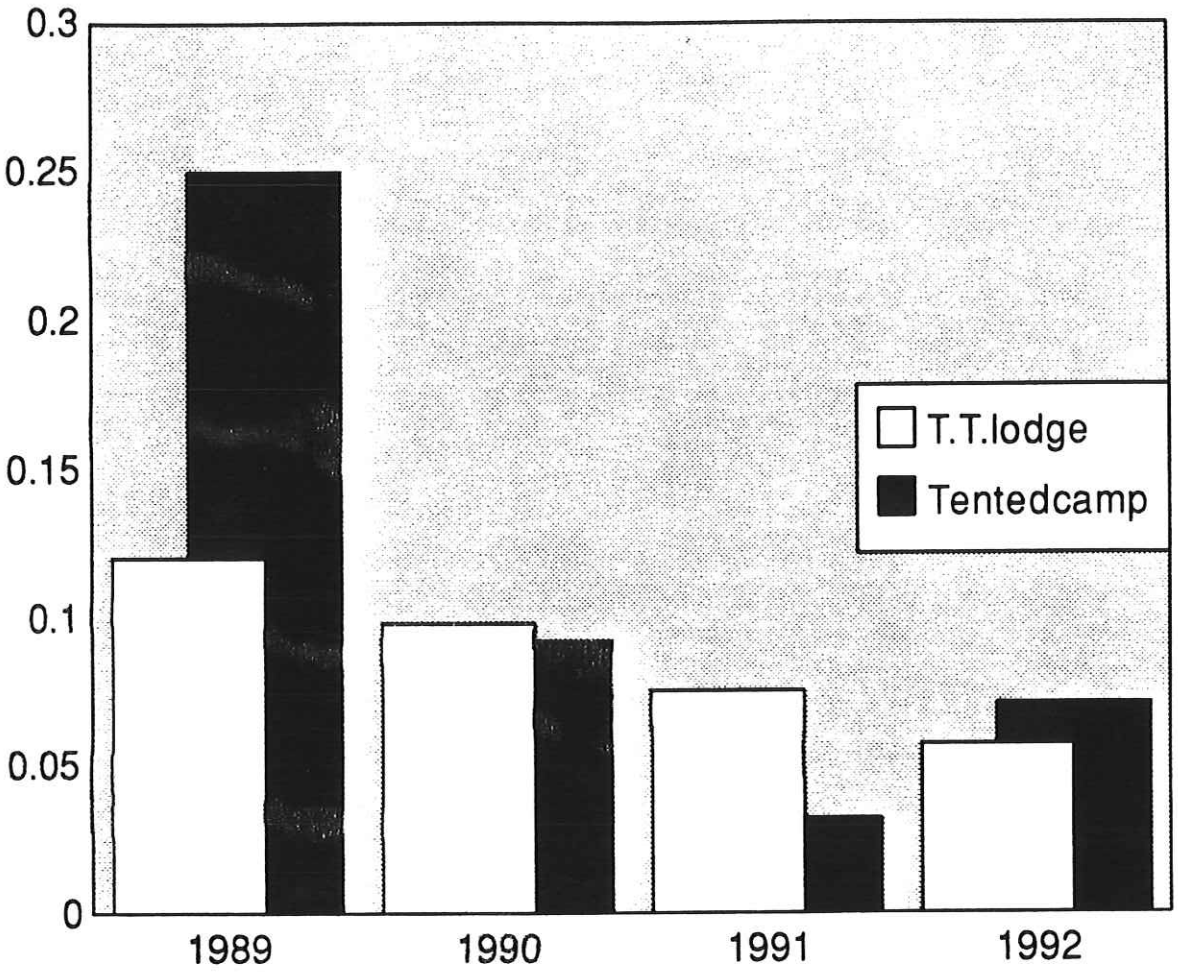

Figure 4. Frequency of nilgai sightings during jungle trips by Tiger Tops lodge and Tented Camp.

The local villagers present a different opinion on the cause of nilgai decline (Table 8). Altogether 46 nilgai deaths were recorded in the questionnaire survey in the three zones. The highest number (23) of incidence were recorded in zone I, followed by zone III (15) and zone II (8).

Table 8. Causes of nilgai death according to local villagers

	Disease	%	Tiger predat.	%	Poached	%	Flood	%	Unsure	%	Total	%
Zone I	1	4.3	17	73.9	0	0	1	4.3	4	17.4	23	100
Zone II	2	25.0	5	62.5	0	0	0	0	1	12.5	8	100
Zone III	2	13.3	9	60.0	0	0	1	6.6	3	20.0	15	100

In all three zones, more than (60%) of the respondents attribute tiger predation as the primary cause. Disease was secondary to tiger predation. The highest death by disease (25%) was recorded in zone 2. Poaching was not recorded in any of the three zones. The reason behind not responding to poaching could probably due to the fear that they would be prosecuted if they said anything about it.

Altogether 23 kills by the tiger were recorded by the staff during the last ten years (Table 8). About(65%) of these were adult males and the rest(35 %) were adult females.

Table 9. Sexes of the nilgai killed by tiger

Adult male	%	Adult female	%	Young	Total	%
15	65.2	8	34.8	0	23	100

Males seem to be more vulnerable to tiger predation than females. All five nilgai kills encountered by Dinerstein (1979) during his study period were males. The reason why more males than females are killed by tigers could be that males often occur solitarily and wander more and that they are optimum prey size for tigers.

The relatively high number of nilgai in Asneri-Amaiya and Ranjha-Kareli khola in the east might be due to the availability of better quality of the buffer-habitat outside the park and fewer tigers compared to the western sector. The Amreni-Karmala and Dumreni-Sainwar areas held very good populations of nilgai in the past (Gagan Singh pers. commn.). Today only a maximum of 15 animals survive in this area. The Baniyabhar subpopulation outside the park is in a very vulnerable state due to the lack of protection.

A combination of various factors have led to the decline of nilgai in RBNP. According to park and Tiger Tops staff the major cause seems to be poaching . The animal's affinity for agricultural crops make them quite vulnerable to poachers. The west Chisapani flood-plain

population has shifted to the west, across the Geruwa river, from its original habitat mainly due to bridge construction activities. This has made this population even more prone to poaching. During field visits gun shots were noticed in this area. Besides, snaring is also a common practice to trap nilgai in the agricultural fields. During the study period two females were found carrying ropes around the neck which supposedly had been used for snaring by the local people. The change of local name from nilgai or nilgaddi to ghodgadaha could possibly be due to a change in attitude towards this animal.

In August 1991, a rotten nilgai was found by the staff of Tiger Tops Tented Camp across the Geruwa river. They suspected that the animal must have been wounded by gunfire. During December 1992, an adult male was found dead by gunfire in the cotton field near Kalbari. Elephant drivers found it when they had gone there to evacuate the illegal settlers in the Government forest.

The local people present a different explanation. According to them tiger depredation is the major cause. Nobody talked about poaching despite their answer that the nilgai were decreasing. Besides poaching, predation by tiger is probably another important factor for the decline. The local farmers reported that the sighting of tigers had become more common after the park establishment. Park and Tiger Tops staff also agreed on an increase of tigers in recent years.

Nilgai usually avoids dense forest. They prefer semi-open forests and freely enter into cultivated lands (Prater 1980). After park establishment and prohibition of livestock grazing inside the park, the park has become denser in terms of habitat structure due to thick understory of shrubs and tall grasses. At the same time, the buffer forests have become degraded and disturbed due to encroachment, so the animal is losing it's original ground and is also easier to poach.

5.2 Food Habits

5.2.1 Machan Observations

Visual observations of the feeding habit of nilgai were done by machan observations, all in the morning, for three consecutive months, November and December, 1992, and January, 1993 (Table 13). A total of 15 plant, 9 tree, 4 shrub and two grass, species were recorded. Among the tree species, M. philippinensis was observed every month. Similarly, nilgai was frequently seen feeding on C. macrophylla, a shrub species. Likewise, the animals were seen grazing on the short grass I. cylindrica, especially during January.

Table 10. Number of instances nilgai was seen feeding on different plant species on Khauraha island in three consecutive months.

Species	November (n=8)	December (n=13)	January (n=24)	Total (n=45)
Trees				
Mallotus philippinensis	1	1	3	5
Terminalia tomentosa	0	2	1	3
Eugenia jambolana	0	1	1	2
Buchanania latifolia	0	0	1	1
Casearia tomentosa	0	0	1	1
Adina cordifolia	0	0	1	1
Ehretia laevis	0	0	1	1
Zizyphus incurba	0	1	0	1
Ficus glomerata	2	0	1	3
Shrubs				
Callicarpa macrophylla	0	4	5	9
Colebrookia oppositifolia	1	0	0	1
Murraya koenigii	0	0	1	1
Flemingia spp.	3	2	1	6
Grasses				
Imperata cylindrica	1	1	7	9
Saccharum spontaneum	0	1	0	1

(n = number of times observed feeding)

Observations from machan were most feasible after the end of monsoon, especially after November. Sightings became more frequent after the cutting of the grassland. Observations

were hindered in the monsoon mainly due to heavy rainfall and dense vegetation which impeded visibility. Besides, high flood in Khauraha river prevented for the frequent trips to the study area. In winter, observations were also hampered due to the shy and cryptic nature of the animal. On many occasions animals were scared by tourist vehicles. Secondly, foggy mornings during winter reduced the visibility of animals. Thirdly, Khauraha is the main route for park elephants for grazing, and elephant drivers regularly collected fodder from this area, the time coinciding with the observation period. Once animals were scared by the above mentioned factors they seldom appeared again the same day.

Despite these hindrances, 15 different plant species were observed to be eaten by nilgai. Among browse species, C. macrophylla and M. philippinensis were frequently recorded. Similarly, nilgai were frequently recorded feeding on the short grass lawns dominated by I. cylindrica. They were never observed feeding on mature grasses. Feeding on Flemingia spp was observed by animals in the Gobrella area during collection of pellet samples. During the early part of the observation period, which coincided with the peak crop raiding season, nilgai were not seen feeding voraciously. Instead they fed intermittently. During that period they were seen eating mostly on the tender fruits and shoots of C. macrophylla.
M. philippinensis was also taken regularly. The animals became more active after the grass cutting was over. In January they seemed to be more concentrated on the phanta than in November and December. They then tended to disregard the presence of a car, but fled away from a man on foot. During the month of November and early December, nilgai seldom came out on the phanta in the evening, whereas after January they were observed until 9.30 hrs and came back around 15 hrs and stayed until 18 hrs unless disturbed.

5.2.2 Faecal Analysis

Faecal analysis has received greater use for evaluating herbivore food habits than any other procedure. It has several advantages and disadvantages which are discussed by Croker (1959), Ward (1970), Anthony and Smith (1974) and Scother (1979). Histological techniques are considered the most accurate method for identifying plant species in faecal material (Dublin 1980).
Plant species identified in faecal samples were classified into three main types, browse (trees,

shrubs and seeds), grasses and agricultural crops (Table 11, & Figure 5). Browse was most important in all three areas followed by grasses and agricultural crops. Agricultural crops seemed to be more important in Gobrella and Chisapani than in Khauraha. Grasses were more prominent for Khauraha compared to Gobrella and Chisapani. On average, the unidentified portion comprised about 12% for all three areas.

Table 11. Proportion of food plants (%) observed in faecal samples from the three study sites during August 1992-January 1993.

Area	Browse	Grasses	Agriculture	Unidentified
Khauraha	44.4	33.3	11.4	10.9
Gobrella	46.5	23.9	19.0	12.6
Chisapani	43.8	23.7	19.9	12.6
Mean	44.9	26.9	16.7	12.0

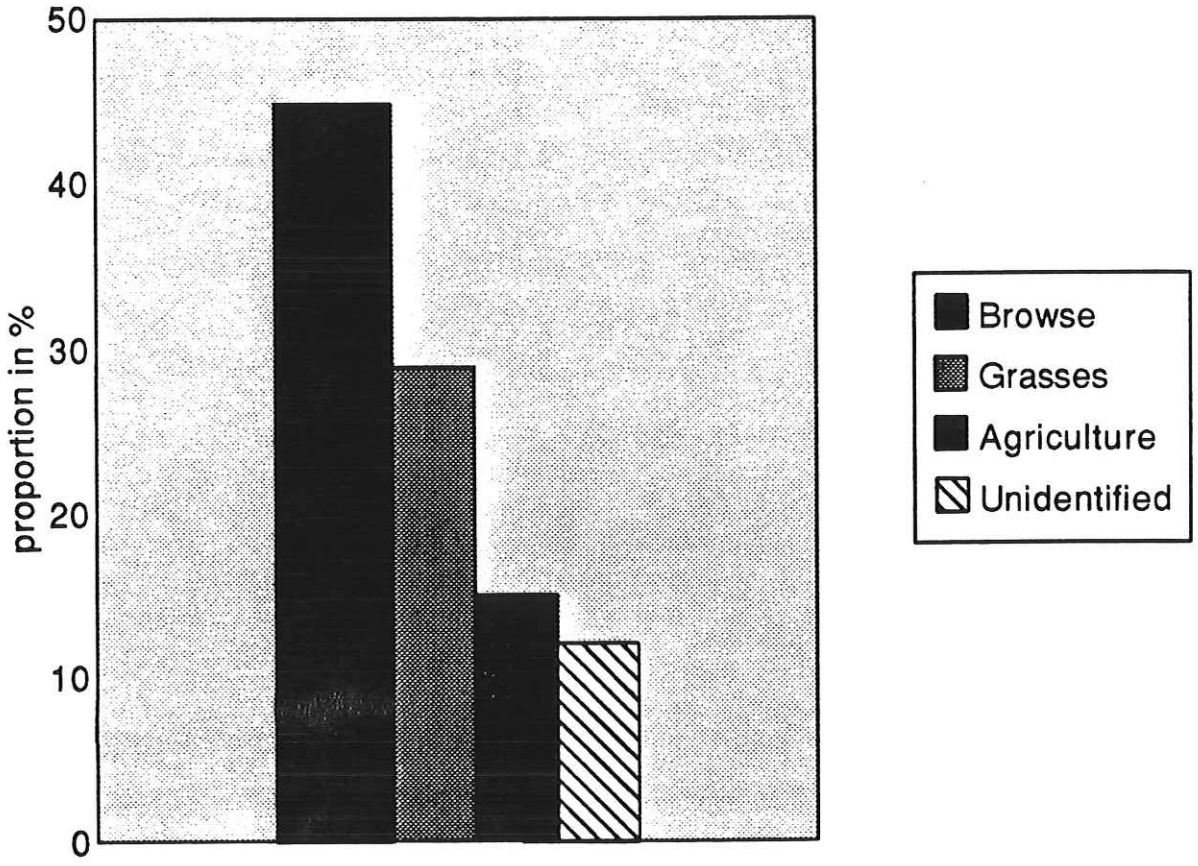

Fig. 5. The proportion of different food plants(%) in the faecal material of nilgai during August 1992 - January 1993.

The current study during late monsoon to mid-winter indicated that nilgai is basically a mixed feeder. The proportion of browse was fairly high (45%), and Dinerstein (1979) also reported that the bulk of its diet was composed of browse plants. Thus the feeding strategy of the nilgai adheres to the Jarman-Bell principle (cited in Dinerstein 1979) which associates ungulate body size with the relative digestibility of forage selected. A large bodied ruminant like nilgai would require a less nutritrious forage (a higher fiber/protein ratio) than smaller bodied ruminants. Nilgai was also reported to be principally a browsers in India both in the Gir forest (Berwick and Jordan 1971) and in the Keoladeo Ghana Sanctuary (Schaller 1967). However in Texas, they were shown to be primarily grazers, their average diet consisting of 60% grasses, 25% forbs, and 15% browse (Sheffield 1983).

A total of 20 plant species were identified in the faecal material from August 1992 to January 1993. Table 12 and Figure 6 show their frequency of occurrence. C. macrophylla and M. philippinensis occurred in highest frequency, followed by C. tora, C. tomentosa, C. tenuis, C. officinalis and C. dactylon.

Table 12. Frequency of occurrence of different plant species in faecal samples from three study sites during August 1992-January 1993.

Species	Au	Se	Oc	No	De	Ja	Frequency
Callicarpa macrophylla	1	1	1	1	1	1	1.00
Mallotus philippinensis	1	1	1	0	1	1	0.83
Cassia tora	0	1	1	1	1	0	0.66
Casearia tomentosa	0	1	1	1	0	1	0.66
Calamus tenuis	0	1	1	1	1	0	0.66
Cirsisum officinalis	1	1	0	0	1	1	0.66
Cynodon dactylon	1	1	1	1	0	0	0.66
Ficus cunia	1	1	0	0	1	0	0.50
Bahunia racemosa	1	0	1	1	0	0	0.50
Terminalia tomentosa	0	1	1	0	0	1	0.50
Eugenia jambolana	0	1	1	1	0	0	0.50
Artemesia vulgaris	1	0	1	1	0	0	0.50
Saccharum spontaneum	1	1	1	0	0	0	0.50
Equisetum spp*	1	1	1	0	0	0	0.50
Colebrookia oppositifolia	0	1	0	0	1	0	0.33
Imperata cylindrica	1	0	1	0	0	0	0.33
Zizyphus jujuba	0	1	0	0	0	0	0.16
Murraya koenigii	0	0	1	0	0	0	0.16
Pogostemon bengalensis	0	0	0	0	1	0	0.16
Solanum khasianum	0	0	1	0	0	0	0.16

Note: * is a pteridophyte.

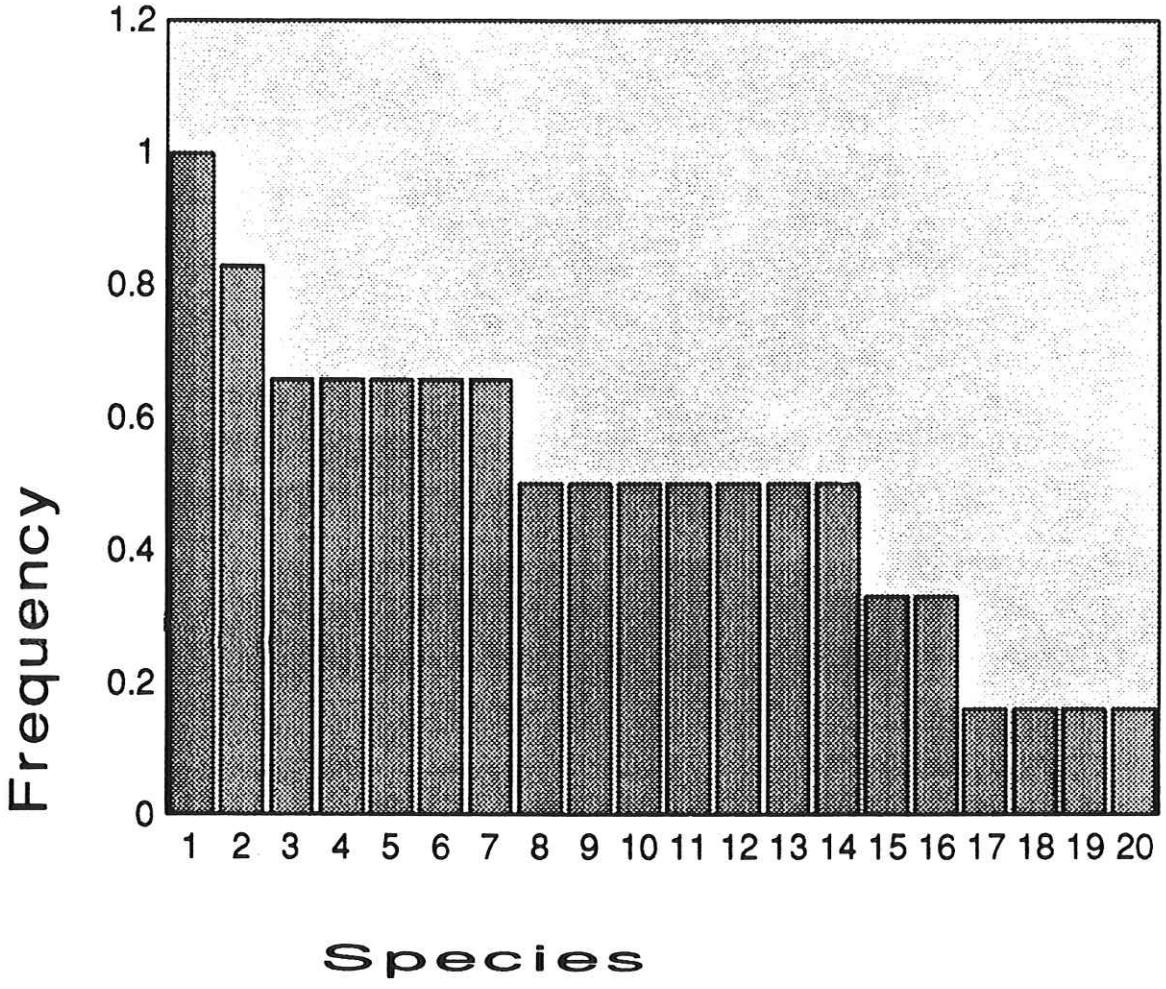

Fig 6. Frequency of occurrence of different plants in nilgai faecal samples collected during August 1992- January 1993.

When machan observations and faecal analysis are combined, a total of 26 wild plant species were recorded in the diet of nilgai in the main study area from late monsoon to mid- winter (Table 13).

Table 13. Different food plant species recorded in feacal analysis (FA) and by machan observations (DO) in Khauraha island during November 1992-January 1993.

Species	November		December		January	
	DO	FA	DO	FA	DO	FA
Trees						
M.phillippinensis	+	_	+	+	+	+
T.tomentosa	-	_	+	_	+	+
E.jambolana	-	+	+	-	+	_
B.latifolia	_	_	_	_	+	_
A.cordifolia	_	_	_	_	+	_
E.laevis	_	_	_	_	+	_
Z.incurba	_	_	+	_	-	_
F.glomerata	+	_	_	_	+	_
F.cunia	_	_	_	+	-	_
B.racemosa	_	+	_	_	-	_
C.tomentosa	_	+	_	_	+	+
Shrubs						
C.macrophylla	_	+	_	+	+	+
C.oppositifolia	+	_	_	+	_	_
M.koenigii	_	_	_	_	+	_
Flemingia spp.	+	_	+	_	+	_
Z.jujuba	_	_	_	_	_	_
C.officinalis	_	_	_	+	_	+
P.bengalensis	_	_	_	+	_	_
A.vulgaris	_	+	_	_	_	_
Cassia tora	_	_	_	+	_	_
S.khasianum	_	_	_	_	_	_
Climber						
Calamus tenuis	_	+	_	+	_	_
Grasses						
S.spontaneum	_	_	+	_	_	_
I.cylindrica	+	_	+	_	+	_
C.dactylon	_	+	_	_	_	_
Equisetum sps*	_	_	_	_	_	_

(+ = present, - = not present)
DO = direct observation, FA = faecal analysis.

Although nilgai, a ruminant, has a high digestive capacity, the faecal analysis was fairly effective in species identification. A total number of twenty different plant species were detected in the faecal samples collected from the study area. Six species, A. cordifolia, B. latifolia, F. glomerata, Z. incurba, E. laevis and Flemingia spp were recorded during direct observations were not found in the faecal samples. However, C. macrophylla and M. philippinensis ranked high both in the faecal material and in the machan observations. Early growth stages of grasses and other browse species were not detected by the faecal analysis, and eight species were recorded by both methods. Dinerstein (1979) listed 41 species of plants utilized by nilgai during the hot-dry season 16 years ago. He used two machans to observe the animals one of which in lower Baghaura about 3 km from the present study site. No animals were seen in the above mentioned site at least during the current study from August until February. When Dinerstein conducted his study, the vegetation structure and floristic composition must have been very different from what it is now, since the reserve was then extensively utilized by livestock. Trees that were heavily browsed during Dinerstein's study included Randia dumetorum, C. tomentosa, B. racemosa and Zizyphus spp. This discrepancy in species number was mainli be due to Dinerstein's longer as well as different observation period and that he exclusively based his study on direct observation. Faecal analysis as mainly used in this study does not incorporate all species, as illustrated by an unidentified portion of 12%.

5.2.2.1 Relative importance value (RIV)

The relative importance value (RIV) of browse and grass species was calculated on the basis of frequency of occurrence and mean percentage of individual plant species in the dung samples (Table 14). The highest RIV for browse species was found for C. macrophylla, C. tomentosa, M. philippinensis, 1.77, 1.61, 1.42, respectively. Among grasses, C. dactylon ranked the highest value (RIV = 0.64).

Table 14. Relative importance of different browse and grass species in nilgai diet during August 1992 - January 1993.

Species	Frequency in dung	Mean % in dung	RIV value
Browse			
Callicarpa macrophylla	1.0	1.77	1.77
Casearia tomentosa	0.66	2.44	1.66
Mallotus philippinensis	0.83	1.72	1.42
Artemesia vulgaris	0.5	1.38	0.69
Bahunia racemosa	0.5	1.03	0.51
Terminalia tomentosa	0.5	0.91	0.45
Calamus tenuis	0.66	0.68	0.44
Cirsium officinalis	0.66	0.62	0.40
Eugenia jambolana	0.5	0.48	0.24
Equisetum*	0.5	0.39	0.19
Colebrookia oppositifolia	0.33	0.51	0.16
Ficus cunia	0.5	0.15	0.075
Zizyphus jujuba	0.16	0.20	0.032
Solanum khasianum	0.16	0.10	0.016
Cassia tora	0.66	0.02	0.013
Pogostemon bengalensis	0.16	0.12	0.02
Murraya koenigii	0.16	0.02	0.003
Grasses			
Cynodon dactylon	0.66	0.98	0.64
Saccharum spontaneum	0.5	0.73	0.36
Imperata cylindrica	0.33	0.74	0.24

* is a pteridophyte.
RIV = frequency x mean % in faecal samples.

5.2.2.2 Monthly diet composition in the main study area

Table 15 and Fig 7 show the diet composition of nilgai during six months in the main study area on Khauraha island. As described above the identified plant species were classified into three main types, browse, grass and agricultural crops.

Table 15. Proportion of monthly diet found in fecal samples of Khauraha animals.

Months	Browse	Grass	Agriculture	Unidentified
August	44.0	44.9	1.5	9.5
September	25.3	56.1	4.6	13.9
october	36.3	51.6	6.5	5.5
November	52.5	19.0	12.9	15.5
December	63.2	2.8	24.5	9.5
January	44.8	25.4	18.3	11.4
Mean	44.4	33.3	11.4	10.9
Sd	13.0	20.9	8.8	3.6

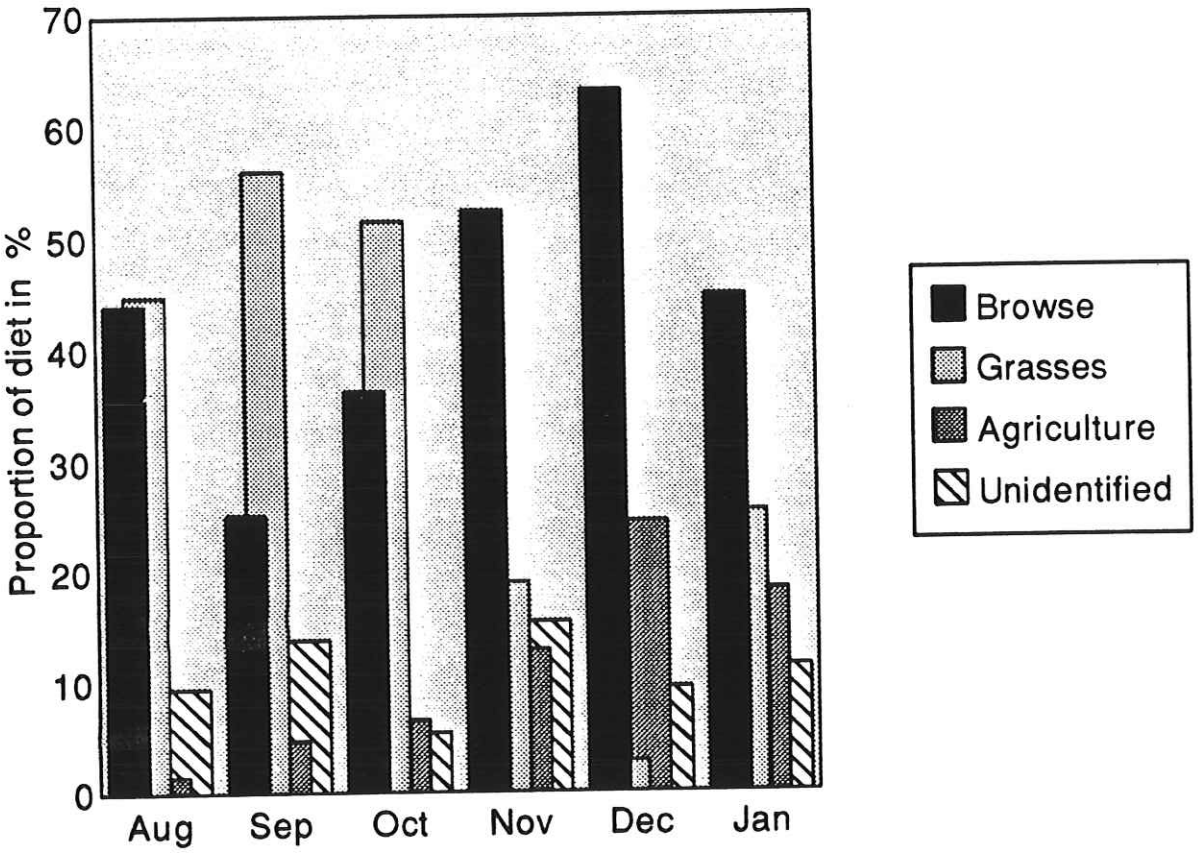

Fig 7 Monthly diet of nilgai in Khauraha area.

Browse to grass ratio for the Khauraha area is shown in Fig. 8. This ratio ascends gradually from October and reaches highest point, 22.6, in the month of December and declines sharply in January. This decline is probably due to the fact that the animals start feeding on new shoots of grasses after cutting and burning of the phanta.

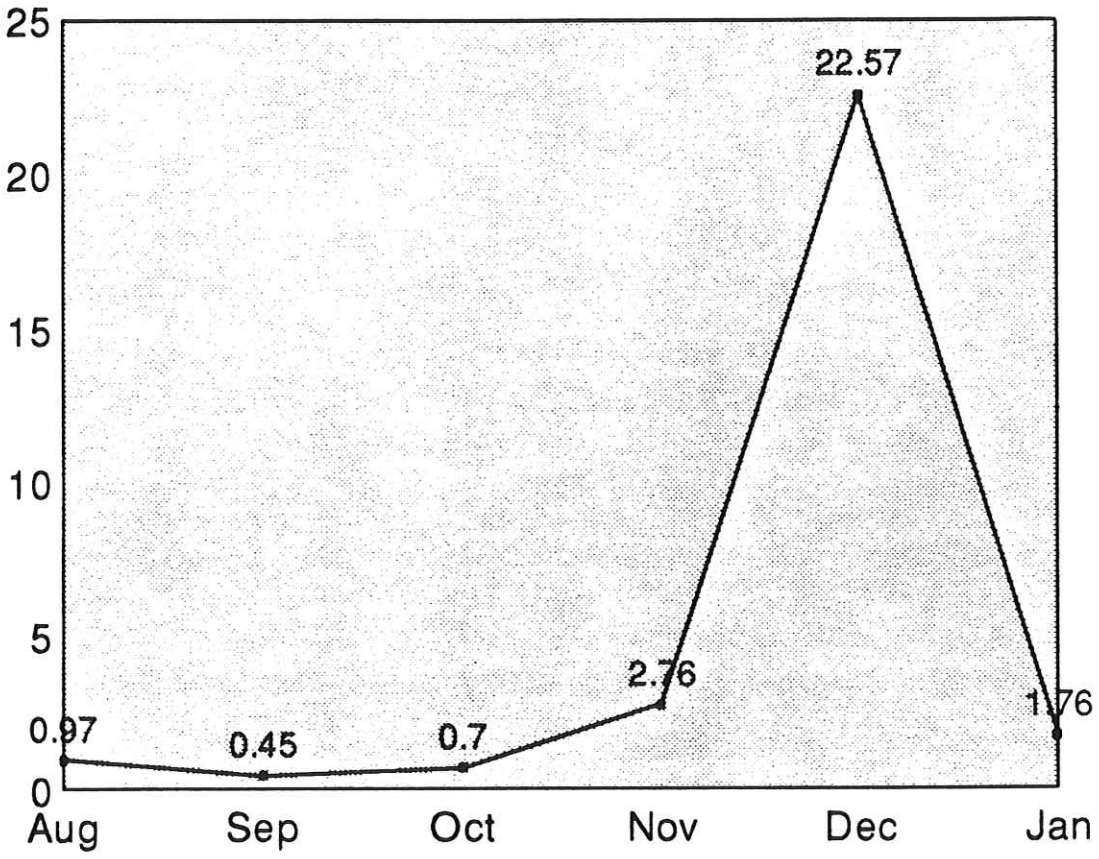

Fig. 8. Browse to grass ratio of faecal samples from Khauraha island during August 1992-January 1993.

The composition of the main wild grasses found in the faecal samples during August-January is given in Table 16 and Fig 9. On the basis of their abundance, the species are divided into four major groups, S. spontaneum, I. cylindrica, other grasses and unidentified grasses.

Table 16. Composition of wild grasses in the faecal samples of nilgai of the main study area.

Months	Saccharum spontaneum	Imperata cylindrica	Other grasses	Unidentified grasses	Total
August	4.5	4.4	6.9	29.2	44.9
September	3.7	0	7.2	45.2	56.1
October	0.7	0	1.9	49.0	51.6
November	0	4.5	0	14.6	19.0
December	0	0	0	2.8	2.8
January	0	0	0	25.4	25.4

During all six months, the grass content was highest in September (56 %) followed by (51.6 %) in October. The percentage of grass content dropped abruptly in December (2.8%) and increased rapidly again in January to about 25% (Fig. 9). The proportion of unidentified grasses was very high in all months except December. This may be because the animals eat a considerable amount of agricultural crops in November and December.

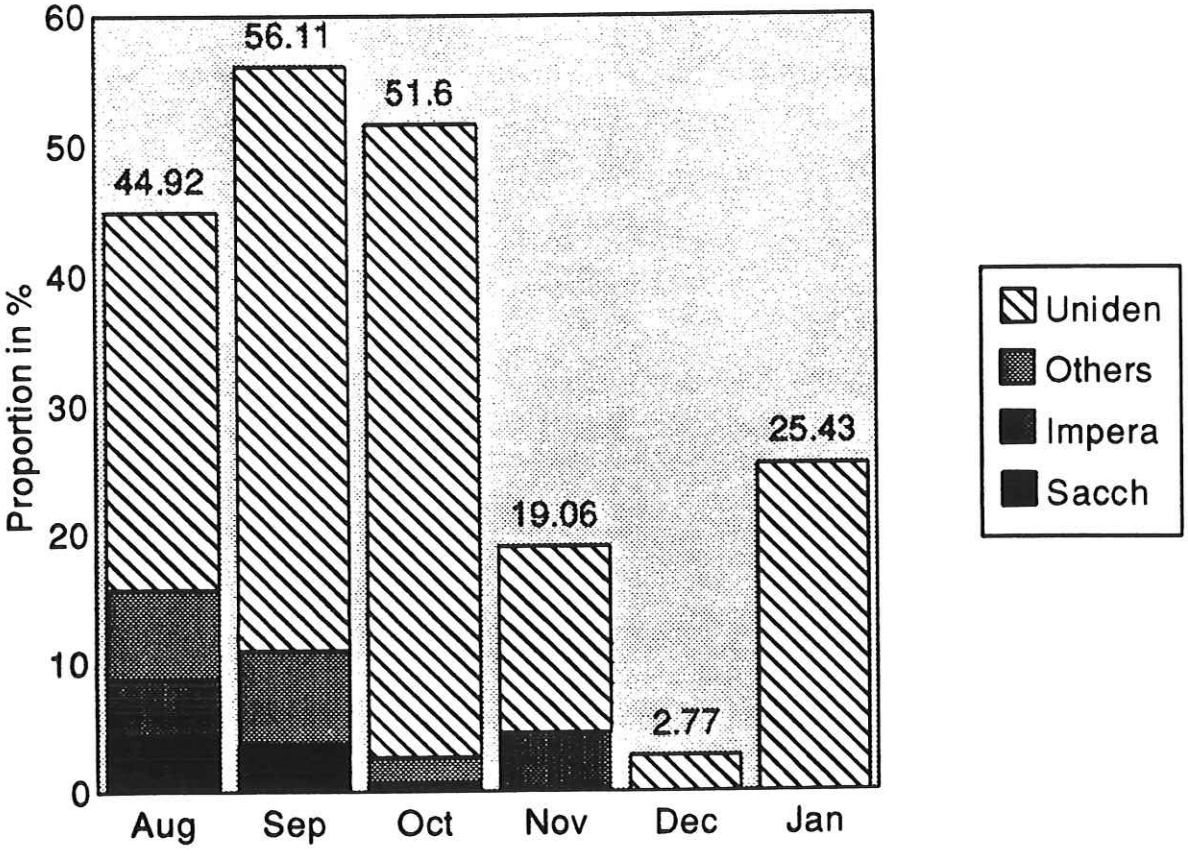

Fig. 9. Proportion of wild grasses in the faecal samples from Khauraha area.

Agricultural crops, particularly rice, was evident in all six months in the faecal samples collected from the main study area (Table 17). November (12.9%) and January (12.3%) had highest amount of rice, whereas mustard was present only in December and January. The proportion of mustard was particularly high in December (16.6 %), the month when rice content was relatively low (Fig. 10.)

Table 17. Percentage of agricultural crops in the faecal samples from Khauraha area.

Months	% rice	% mustard	% of total diet
August	1.5	0	1.5
September	4.6	0	4.6
October	6.5	0	6.5
November	12.9	0	12.9
December	7.8	16.6	24.9
January	12.3	6.0	18.3

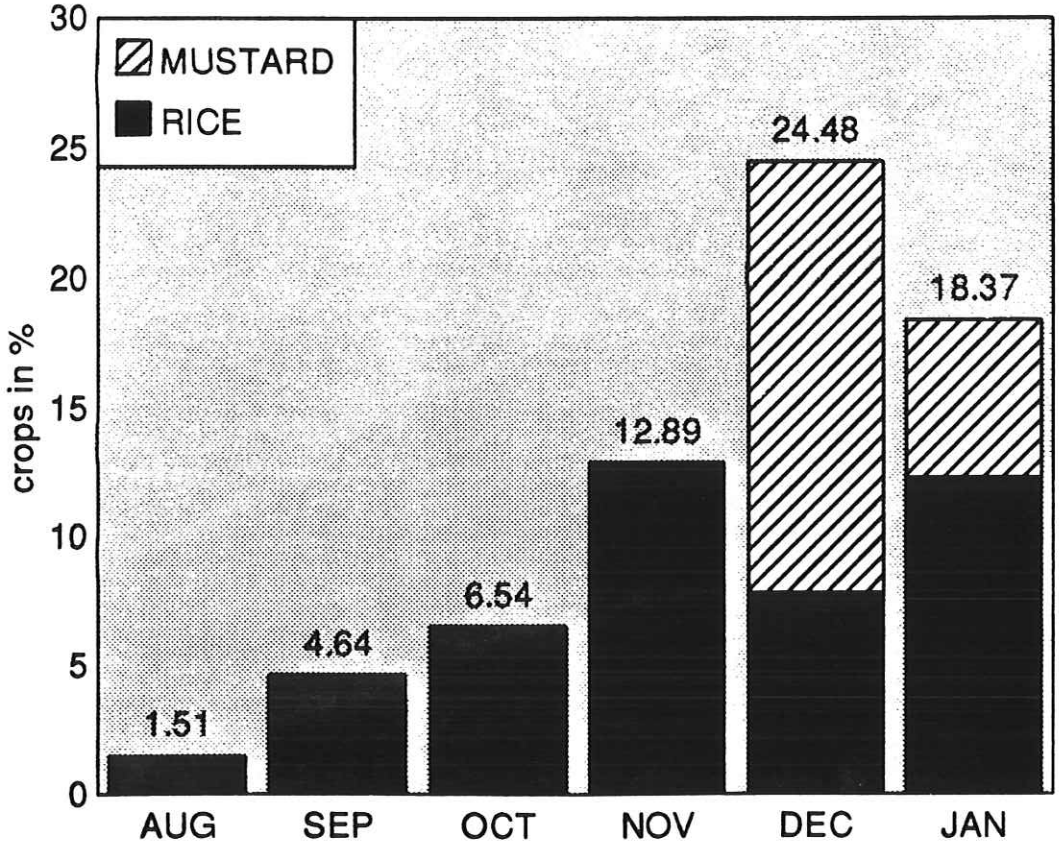

Fig. 10. Proportion of Agricultural crops in dung samples from Khauraha island.

Among the agricultural crops, rice peaked during November when this crop was in its mature stage in the cultivated fields. A high proportion of rice was also evident during January when rice is already harvested. This is mainly because nilgai then feed on the unthreshed rice stacks, Kharai, during night. Despite the records of feeding on early stages of rice, the proportion recorded in August and September was relatively low. But a large proportion of unidentified grasslike fragments during the early monsoon period probably includes rice in partially digested form. Mustard peaked in the month of December. This crop was preferred during its maturing stage.

Browse species which occurred regularly in the faecal analysis in a order of prominence were C. macrophylla, M. philippinensis, A. vulgaris, C. tenuis, B. racemosa, C. officinalis, and C. oppositifolia (Table 18).

Table 18. Proportion of main browse species (%) in faecal samples from Khauraha island in different months.

Month	Callica	Mallotus	Artemesia	Calamus	Bahunia	Cirsium	Cole
Aug	6.3	0	9.3	0	3.0	0	0
Sep	3.3	1.9	0	1.2	0	0.7	0
Oct	3.4	0	2.9	2.9	3.6	0	0.8
Nov	4.7	0	4.4	0.7	5.5	0	0
Dec	3.2	9.7	0	1.3	0	4.5	5.4
Jan	0.2	4.9	0	0	0	1.5	0

C. macrophylla was evident in all months. It was particularly high in August, and remained relatively constant through December. M. philippinensis also occurred prominently especially during December and January. A. vulgaris was found to be high in August but relatively low in October and November. Except C. macrophylla no plant occurred in all months.
Mirza and Khan (1975) listed 29 species of plants eaten a captive nilgai. Preferred species were Morus alba, Zizyphus spp. Ficus religiosa, Acacia arabica, and Melia azedarach . Among grasses C. dactylon was highly preferred.

5.3 Habitat Analysis and Food Plant Selection

A larger study area had originally been classified into seven types (Jnawali and Wegge 1993). On Khauraha island nilgai were confined to three of these : moist riverine forest, khair-sissoo forest, and wooded grassland. Altogether 7 different plant species were recorded in the riverine forest. Among these, Karot, a climber species, had the highest(29.5 %) mean relative cover but was not recorded in the faecal samples (Table 19). Both C. oppositifolia and M. koenigii had the same relative cover (19%) but low selection value. C. macrophylla had a relatively low (8.6%) relative cover, but high importance as food and therefore a very high selection value in this habitat type.

Table 19. Availability, importance and selection values of seven plant species available in the Moist Riverine forest habitat type on Khauraha island.

Species	Availability	Importance value	Selection value
Callicarpa macrophylla	8.6	1.77	20.6
Mallotus philippinensis	12.4	1.42	11.5
Eugenia jambolana	5.7	0.24	4.2
Colebrookia oppositifolia	19.0	0.16	0.8
Murraya koenigii	19.0	0.003	0.015
Karot(local name)	29.5	0	0
Dudhelahara(local name)	5.7	0	0

Availability = mean relative cover value (in percent).
Importance value = mean proportion of plant species in the dung samples x frequency of occurrence (see table 12).
Selection = (importance value/availability) x 100.

In wooded grassland, C. macrophylla comprised the highest relative cover (7.3%) among shrubs and herbs and had second highest (24.2) selection value (Table 20). E.jambolana represented a small (0.47%) coverage, but had the highest selection value (60.0). Among grasses, the highest selection value (53.3) was found for C. dactylon.

Table 20. Availability, importance and selection value of different plant species in Wooded Grassland habitat type on Khauraha island.

Species	Availability	Importance value	Selection value
Shrubs and herbs			
Eugenia jambolana	0.5	0.24	60.0
Callicarpa macrophylla	7.3	1.77	24.2
Murraya koenigii	1.5	0.003	0.2
Cordia myxa	0.4	0	0
Bridilia retusa	0.3	0	0
Karot(local name)	0.2	0	0
Grasses			
Cynodon dactylon	1.2	0.64	53.3
Saccharum spontaneum	1.0	0.36	32.7
Vetiveria zyzanoides	31.2	0	0
Imperata cylindrica	27.7	0.24	0.9
Desmostachia bipinnata	13.5	0	0
Saccharum bengalensis	6.5	0	0
Narenga phorphyrocoma	0.4	0	0

In Khair-Sissoo forest, C. oppositifolia and P. bengalensis had the highest coverage, (17.6%) and (12.6%) respectively, but low selection. A. vulgaris and C.macrophylla had comparatively low coverage but the highest selection values in this habitat. Among grass species, C. dactylon came out with the highest selection value (29.0), followed by S. spontaneum (5.45) (Table 21).

Table 21. Availability, importance and selection values of different plant species in Khair-Sissoo habitat type on Khauraha island.

Species	Availability	Importance value	Selection value
Shrubs/herbs			
Artemesia vulgaris	1.1	0.69	62.7
Callicarpa macrophylla	7.7	1.77	22.1
Eugenia jambolana	2.2	0.24	10.9
Colebrookia oppositifolia	17.6	0.16	0.9
Cassia tora	3.3	0.013	0.4
Pogostemon bengalensis	12.6	0.02	0.15
Murraya koenigii	9.9	0.003	0.03
Ehretia laevis	4.4	0	0
Dalbergia sissoo	1.1	0	0
Grasses			
Cynodon dactylon	2.2	0.64	29.0
Saccharum spontaneum	6.6	0.36	5.4
Imperata cylindrica	9.3	0.24	2.5
Cymbopogon spp.	9.9	0	0
Desmostachia bipinnata	8.8	0	0
Vetiveria zyzanoides	3.3	0	0

When all habitat types were combined in the main study area on Khauraha island, A. vulgaris was the most highly selected species followed by M. philippinensis, C. macrophylla and E. jambolana (Table 22). Among grasses, C.dactylon was the highest selected species.

In his study 16 years ago, Dinerstein (1979) calculated preference values from frequency of use divided by a scale of relative availability in the habitat based on visual observations. During his study fruits of E. officinalis and leaves of a shrub U. lobata had a very high preference during the cool dry season. B. racemosa also had a high preference value. Other species like C. tomentosa, E.jambolana, Zizyphus spp, C. tenuis, C. dactylon, I. cylindrica, and S. spontaneum were moderately preferred, and T.tomentosa had a lower preference.

Table 22. Availability, importance and selection values of different plant species in all three habitat types on Khauraha island.

Shrubs & herbs	Mean relative cover	Importance value	Selection value
Artemesia vulgaris	0.4	0.69	191.6
Mallotus philippinensis	4.1	1.72	41.7
Callicarpa macrophylla	7.8	1.77	22.7
Eugenia jambolana	2.8	0.24	8.6
Colebrookia oppositifolia	12.2	0.16	1.3
Cassia tora	1.1	0.013	1.2
Pogostemon bengalensis	4.2	0.02	0.5
Murraya koenigii	10.1	0.003	0.03
Karot(local name)	9.9	0	0
Dudhelahara (local name)	1.9	0	0
Ehretia laevis	1.5	0	0
Dalbergia sissoo	0.4	0	0
Cordia myxa	0.1	0	0
Bridelia retusa	0.09	0	0
Grasses			
Cynodon dactylon	1.1	0.64	56.1
Saccharum spontaneum	2.5	0.36	14.0
Imperata cylindrica	12.3	0.24	1.9
Vetiveria zyzanoides	11.7	0	0
Desmotachia bipinnata	7.4	0	0
Cymbopogon spp.	3.3	0	0
Saccharum benghalensis	2.2	0	0
Narenga phorphyrocoma	0.1	0	0

In the presence study A. vulgaris, M. philippinensis, C. macrophylla and E. jambolana appeared to be most highly preferred. Among grasses C. dactylon and S. spontaneum were the most preferred species. None of these were highly preferred in Dinerstein's study. The discrepancy is probably related to different methods used, and different vegetation composition of the habitats, and that Dinerstein mainly referred to fruits rather than leaves. In a study by Mirza and Khan (1975), in Pakistan C. dactylon was the most highly preferred grass species, a result consistent with the present findings.

5.4 Local Conflicts

Nilgai are always closely associated with farmlands. All nilgai habitats in RBNP were located in a distance between 100 and 500 meters from human settlements. According to the local farmers most of the agricultural crops grown adjacent to the park boundary are damaged by nilgai. Different crops and stages of growth preferred by the animal are shown in Table 23.

Table 23. Agricultural crops preferred by nilgai in RBNP.

Major crops	Preferred stages of growth		
	Early	Flowering	Mature
Rice	*	**	***
Maize	*	*	***
Wheat	***	*	
Mustard	**	*	***
Lentil	***	***	***
Cow-pea	*	**	***
Cluster beans	*	*	**
Black gram	*	***	***
Pigeon pea	*	*	
Chick pea	***	***	***
Soyabean	**	***	***
Potato	***	***	**
Raddish	***	***	**
Cabbage	*	***	***
Cauliflower	***	***	**
Onions	*	*	
Tomatoes	*	***	***
Chilly	***	***	***
Egg plant	*	*	*
Broadleaved mustard	**	*	*
Broad bean	*	*	
Pumpkin	***	***	
Bottlegourd	*		
Colocassia	*	*	*

* = less preferred, ** = moderately preferred and *** = highly preferred

Nilgai were reported to feed on all the major crops grown in this area. Rice was reported to be eaten at all stages, but the mature stage was most preferred. Maize, mustard and lentils

were also recorded to be eaten at all stages. Wheat was highly preferred at the early stage, where as lentils were highly preferred at all stages. Apart from agricultural crops, vegetables were also considerably damaged by nilgai. Farmers reported that males visited more frequently than females to kitchen gardens and caused damage to vegetables.

During this study, a total of seven main crop raiding animals were recorded: chital, hog deer, monkey, wild boar, nilgai, rhinoceros and elephant. Hog deer, rhino and elephant were primarily confined to zone 1 but occasional raidings by rhinos and elephants were recorded in zone II also. Zone III was free from these three animals. Chital, nilgai and wild boar were the main crop damaging animals in all three zones (Figure 11).

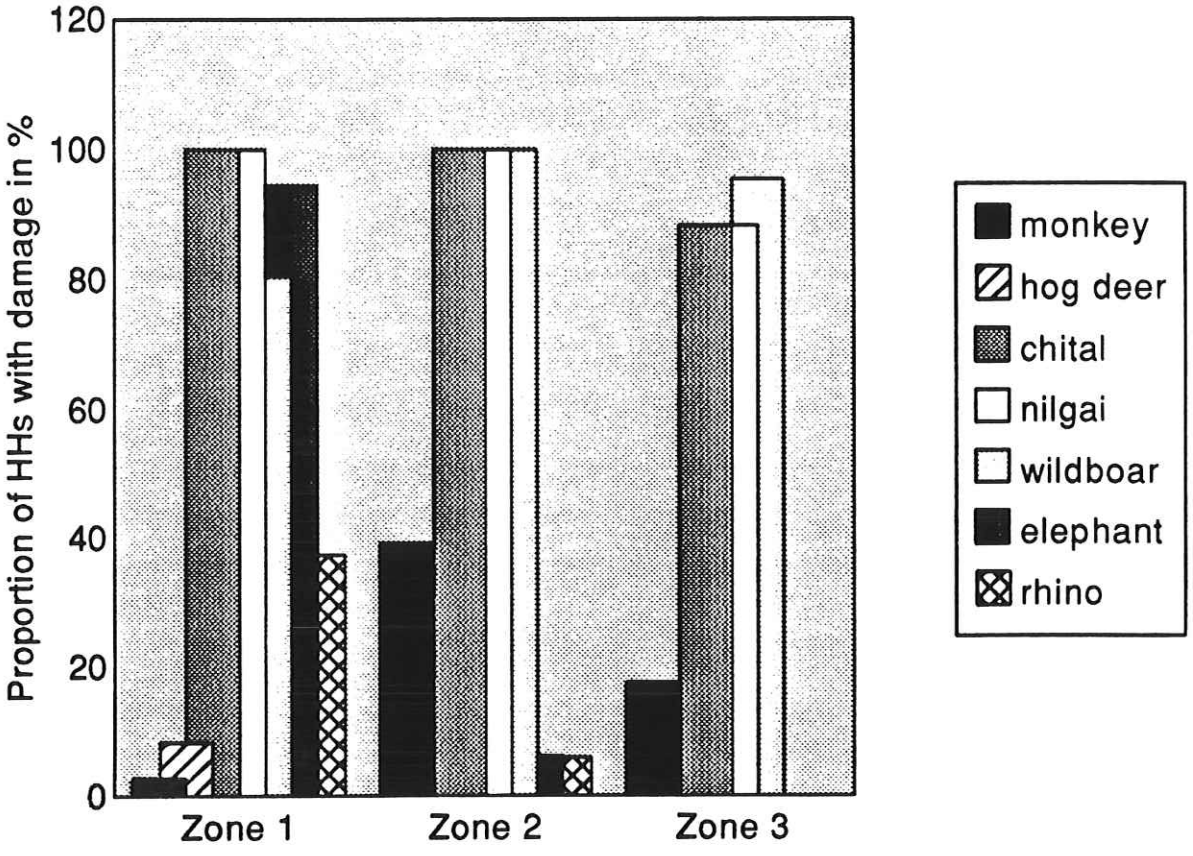

Figure 11. Major crop raiding animals, in RBNP.

Results from the questionnaire survey about whether the local farmers would like to see nilgai increasing or not are shown in Table 24. In zone I about 30 % of the farmers responded that they would like to see the animal increasing. In Zone II and III only 3 % and 7.4 % of the respondents would like to see the animal increasing, respectively.

Table 24. Local farmers opinion about nilgai.

	Proportion wanting the animal to increase			
	Yes		No	
	nos	%	nos	%
Zone I	22	30.5	50	69.4
Zone II	1	3.0	32	97.0
Zone III	5	7.4	63	92.6

This negative opinion about the nilgai in all three zones is probably due to the loss of crops by the animal. They do not care about conserving this species, because they simply do not know how rare it is in Nepal. But the relatively high positive attitude of the local farmers towards the animal in the Zone I could possibly be due to some job opportunities in tourism related business.

Table 25 shows the estimated percentage loss by nilgai as reported by the respondents in the three zones.

Table 25. Estimated percentage loss of agriculcural crops by nilgai in three zones, in RBNP.

	% crop loss by nilgai
Zone I	7.27
Zone II	9.53
Zone III	8.11
Mean loss	8.30

Crop damage by nilgai in all three zones adjacent to the park contributed to about 8.30 % of the total loss by all the park animals. The high loss of crops in Zone II , where the nilgai has declined markedly in recent years may be due to exaggeration by the farmers. Nevertheless, the crop damage intensity was more or less the same in all three zones, and was confined to monsoon and winter seasons only.

Similar studies of crop damage by nilgai have been carried out in Nahar Tehsil, Haryana, India (Chauhan and Sawarkar 1989). In their study damage varied from 10% to 75 % and crops preferred were grams, wheat seedlings and mung.

A study on wildlife damage in Padampur in Chitwan National Park (Milton and Binny 1980) showed a mean loss of 56% of all crops grown. Similarly, crop damage by rhinoceros in Chitwan National Park (Jnawali 1989) reported an economic loss of 68%. Crop destruction by all wild animals ranged from 10 % to as high as 90 % in areas around the Chitwan National Park (Mishra and Jefferies 1991).

In addition to crop loss farmers spend sleepless nights guarding their fields throughout the growing season. Guarding of fields works to some extent but not for elephants. Despite intensive guarding, a large share of the agricultural crops is damaged by the wild animals due to poor fencing, mainly by chital and wildboar.

A study of the effects of forested buffer zones on park-people relationships (Leisure & Mehta 1993) indicated that crop damage was inevitable even in areas with forested buffer zones bordering the park. The degree of crop raiding was similar in areas with and without buffer zones. Because of the high intensity of damage to agricultural crops, reports of alleged poisoning and blasting of these animals were received. Park staff and Army personnel in the eastern sector of the park reported that foodballs stacked with explosives were used by the local people. This needs to be examined more thoroughly. Whatever the case, there is a clear indication that people are becoming very intolerant about the loss of crops by park animals. Dogs are frequently used to chase chital during the night and chasing is sometimes fatal. This has been a common practice to kill animals during the night, although discreetly.

Nilgai was reported to visit the fields even after the harvest. The high proportion of rice during the month of January is a clear indication that these animals are a serious pest on crops as well as on vegetable gardens. Snaring has also been noticed as a possible means to trap nilgai during the night. Two adult female nilgai were seen with ropes around their neck, probably snares that had been broken by the animals when entering or leaving the agricultural fields. Similary, an adult male was found seriously wounded by spearing in Gola area in January 1991 (Ram N. Shah Vet. Asst. RBNP, Pers. Comm.).

Besides crop raiding, livestock depredation by tiger and leopard and harrassment by rhinos and elephants are other problems faced by local people. But the most serious impact on the local people is caused by the prohibition of resource use in the park. Basic needs like fuelwood, fodder, timber, grazing, and collection of vegetables, fruits, fishes are also forbidden which were the traditional practice of the Tharus. People are penalised and harassed by the park management if found violating the rules. This creates a conflict between the National Park and local people.

6. Recommendations and Management Implications

The overall situation of nilgai in Nepal is very critical. At present only two viable populations, in Shukla Phanta and Bardia National Park, remain. The other populations seem to be very fragile unless serious protective measures are employed. The following measures could possibly be helpful in order to conserve the remnant nilgai populations in Nepal.

1) All the nine nilgai hotspots inside and outside the park need special protection to increase viable breeding populations. The Baniyabhar subpopulation outside the park boundary is highly vulnerable mainly due to the lack of protective measures. The park authority should consider to include this area under its jurisdiction and provide necessary protection.

2) All the nilgai habitats within the park lie in close proximity of the park boundary and the animals move frequently in the remaining forest pockets outside the park. Efforts should be made to include these areas in a buffer zone management plan in the park.

3) Nilgai utilize areas that are grazed by livestock. Hence a certain level of livestock grazing in nilgai habitats should be allowed to prevent the habitats from becoming too dense in structure.

4) Nilgai is a serious pest on agricultural crops. The temptation to poaching is very high. Intensive patrolling and surveillance of the remaining nilgai areas is therefore very crucial.

5) To reduce agricultural conflicts a barbed wire fence, about 7 feet tall, should be erected and maintained regularly to minimize crop damage in the most critical areas.

6) Public awareness programmes should be initiated to disseminate conservation education to the local villagers about the importance of the park and its wildlife resources, especially about the newly endangered nilgai species.

7) The remaining forest patches along the park boundary should be managed and strengthened so as to avoid the pressure on the park resources. The local people should be included in the management system of the buffer forests by forming local users' committees. Local people should have their say in the formulation of the management plans and receive some benefits from the park in order to assure their positive cooperation.

8) Surprisingly little is known about the biology and behaviour of nilgai and it's habitat requirements. A more comprehensive study is therefore necessary in order to conserve this antelope in the long term in Nepal.

7. Conclusion

The overall population status of nilgai within Nepal borders look very bleak unless serious efforts are made to conserve them. Nilgai is the only species that has not fared well after the creation of National Parks and Protected Areas.

The nilgai population in Royal Bardia National Park has declined to an unprecedented low

level. Nine hotspots in Bardia hold the remaining remnant populations of probably less than 100 animals. One subpopulation outside the National Park, near the Baniyabhar jungle, is in a highly vulnerable state. The Chisapani flood plain population across Geruwa river is also under threat from poaching. Poaching and tiger predation were identified as the major cause of decline of this species. Declining habitat quality due to denser vegetation structure inside the park and more human disturbance in nilgai areas immediately outside the park border, are probably also contributing to the decline.

Nilgai seems to be primarily a mixed feeder. Among the food plants, browse and grasses comprised 45% and 27%, respectively of their late monsoon midwinter diet. 26 plant species were recorded eaten by nilgai from direct observations and faecal analysis. Heavily utilized browse species were M. philippinensis, C. macrophylla, and C.tomentosa. Other browse species that appeared to be selectively eaten were A. vulgaris and E. jambolana.

The nilgai habitats within the park are not far from human settlements. The animal favours open forest with less dense understory vegetation. It utilizes the peripheral areas of the park as well as the areas utilized by livestock. A relatively high occurrence of disturbed site plants like Cirsium, Artemesia, Cassia and Zizyphus spp in their diet indicates that this animal readily exploits areas with a certain degree of disturbance. The relatively high numbers of nilgai in the eastern sector of the park could possibly be due to the presence of buffer forests and fewer numbers of tigers than in the western sector.

Nilgai feed in cultivated fields and during August-January an estimated 17% of their diet consisted of agricultural crops. The highest proportion of crops (24%) was recorded in December. Rice was evident from August to January. Mustard peaked during December and January. However, due to their few numbers compared to other crop raiding species, nilgai only contributed about 8% to the total crop loss by all wildlife in the villages adjacent to the park.

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9. Appendix

Appendix I. Opinion about Nilgai by Park Staff

Opinion	Working experience Below 10	%	Above 10	%	Total	%
Increasing	2	7.4	1	10	3	8.1
Decreasing	15	55.5	6	60	21	56.7
Same as before	1	3.7	3	30	4	10.8
Not sure	9	33.3	0	0	9	24.3
Total	27	100	10	100	37	100

Rate of decline

Decline	Below 10	%	Above 10	%	Total	%
Gradual	4	26.6	0	0	4	19.0
Increasingly	8	53.3	5	83.3	13	62.0
Rapid	3	20.0	1	16.6	4	19.0
Total	15	100	6	100	21	100

Causes of decline

Causes	Below 10	%	Above 10	%	Total	%
Habitat loss	3	16.6	2	16.6	5	16.7
Poaching	11	61.1	3	25.0	14	46.7
Predation	4	22.2	4	33.3	8	26.7
Floods	0	0	3	25.0	3	10.0
Disease	0	0	0	0	0	0
Total	18	100	12	100	30	100

Suggestions for improvement

Suggestions	Below 10	%	Above 10	%	Total	%
Habitat management	2	5.2	2	18.0	4	8.1
Increased patrolling	20	52.6	6	54.5	26	53.0
Public awareness	10	26.3	1	9.0	11	22.4
Not sure	6	15.7	2	18.8	8	16.3
Total	38	100	11	100	49	100

Appendix II. Frequency of nilgai sightings during jungle trips.

A) Tiger Tops Lodge

Year	Trips	No.Games seen	Frequency	Corr.coef.
1989	54	7	0.12	
1990	81	8	0.098	0.999**
1991	66	5	0.075	
1992	69	4	0.057	

B. Tiger Tops Tented Camp

Year	Trips	No.Games seen	Frequency	Corr.coef.
1989	48	12	0.25	
1990	65	6	0.092	0.788 (n.s.)
1991	61	2	0.032	
1992	70	5	0.071	

**=p<0.001
n.s.=not significant

Appendix III. Monthly food diet of nilgai in Khauraha area.

Khauraha	Browse	Grass	Agriculture	Unidentified
August	44.0	44.9	1.5	9.5
September	25.3	56.1	4.6	13.9
october	36.3	51.6	6.5	5.5
November	52.5	19.0	12.9	5.5
December	63.2	2.8	24.5	9.5
January	44.8	25.4	18.3	11.4
Mean,SD.	44.4	33.3	11.4	10.9
	13.0	20.1	8.8	3.6

Monthly food diet of nilgai in Gobrela area.

Gobrella	Browse	Grass	Agriculture	Unidentified
August	40.9	43.5	1.8	13.7
September	54.9	27.6	1.2	16.3
october	51.2	22.7	13.9	12.1
November	41.1	18.3	20.6	19.1
December	39.0	12.8	46.1	1.1
January	50.9	18.6	30.5	0
Mean,SD.	46.5	23.9	19.0	12.6
	6.6	10.8	17.4	6.5

Chisapani	Browse	Grass	Agriculture	Unidentified
October	43.8	31.6	12.9	11.6
November	45.4	16.4	24.9	13.1
December	42.0	23.0	21.8	13.1
Mean,SD.	43.8	23.7	19.9	12.6
	1.7	7.6	6.2	0.9

Appendix IV. Local farmers opinion about nilgai

	Proportion wanting the animal to increase			
	Yes		No	
	nos	%	nos	%
Zone 1	22	30.5	50	69.4
Zone 11	1	3.0	32	97.0
Zone 111	5	7.4	63	92.6

Appendix V. Plants found in faecal sample and observed eating by nilgai during directobservation.

Local name	Scientific name
Sindure	Mallotus philippinensis
Saj,Asna	Terminalia tomentosa
Jamun	Eugenia jambolana
Piyari	Buchanania latifolia
Karam	Adina cordifolia
Datrung	Ehretia laevis
Thulobayar	Zizyphus incurba
Gullar, dumri	Ficus glomerata
Khanayo	Ficus cunia
Tanki	Bahunia racemosa, purperia
Pipari	Casearia tomentosa
Daikamala	Callicarpa macrophylla
Dhusrel	Colebrookia oppositifolia
Asare	Murraya koenigii
Bansapti	Flemingia spp
Bayar	Zizyphus jujuba
Gaidakara	Cirsium officinalis
Rudilo	Pogostemon bengalensis
Titepati	Artemesia vulgaris
Tapre	Cassia tora
Kantakari	Solanum khasianum
Beth	Calamus tenuis
"Ghodapuchre"	Equisetum spp
Kans	Saccharum spontaneum
Siru	Imperata cylindrica
Dubo	Cynodon dactylon

Appendix VI. Local and Scientific names of Different crops and vegetables eaten by nilgai.

Local name	Common name	Scientific name
Dhan	Rice	Oryza sativa
Makai	Maize	Zea mays
Ganhu	Wheat	Triticum aestivum
Tori	Mustard	Brassica campestris
Masuro	lentil	Lens culinaris
Mash	Black gram	Phaseolus mungo
Bodi	Cowpea	Vigna sinensis
Ratosimi	Cluster beans	Cyamopsis tetragonoloba
Arhar	Pigeon pea	Cajanus cajan
Chana	Chick pea	Cicer arietinum
Lauka	Bottlegourd	Lagenaria siceraria
Pidaloo	Colocassia	Colocassia esculenta
Pumpkin	Vegetable marrow	Cucurbita pepo
Bhatmas	Soyabean	Glycine max
Kerau	Common pea	Pisum sativum
Pyaj	Onion	Allium cepa
Khursani	Red pepper	Capsicum frutescens
Aaloo	Potato	Solanum tuberosum
Bakula simi	Broad bean	Vicia jaba
Bandhagobi	Cabbage	Brassica capitata
Kauli	Cauliflower	Brassica oleracea
Bhanta	Egg plant	Solanum melongena
Golbhenda	Tomato	S. lycopersicum
Mula	Raddish	Raphanus sativus
Rayo ko sag	Broad leaved mustard	Brassica juneca
Sakarkhanda	Sweet potato	Ipomoea batatas

Appendix VII. Plants recorded eaten by nilgai, according to staff and local villagers.

Scientific name	Local name
Antidesma diandrum	Amari
Bridelia retusa	Gayo
Ficus glomerata	Gular,Dumri
Terminalia chebula	Harro
Ficus lacor	Kavhro
Anthocephalus kadamba	Kadam
Myrsine semeserrata	Kalikhat
Ficus cunia	Khanayo
Schleichera trijuga	Kusum
Bassia latifolia	Mauha
Randia dumetorum	Maidal
Casia fistula	Rajbricha
Pogostemon glaber,benghalensis.	Rudilo
Dalbergia latifolia	Sattissal
Bahunia racemosa,purperia	Tanki
Adina cordifolia	Karam,Haledo
Calotropis gigantea	Aank
Terminalia tomentosa	Saj,Asna
Eugenia jambolana	Jamun
Eugenia operculata	Kyamun
Artocarpus lakoocha	Badhar
Ficus benghalensis	Bar
Herium odorum	Baramase
Terminalia bellerica	Barro
Zizyphus spp.	Bayar
Aegle marmelos	Bel
Calamus tenuis	Beth
Semicarpus anacardium	Bhalayo
Bahunia vahlii	Bhorlo
Smilax lanceaefolia	Chatiwan
Bassia butyracea	Chiuri
Caruga pinnata	Dabdabe
Grewia tiliaefolia	Phorso
Solanum khasianum	Kantakari
Senecio densiflorus	Marcha
Centella asiatica	Gotttapre
Thysanolaena maxima	Amriso
Themeda spp	Dhaddi
Cynodon dactylon	Dubo
Vicia sativa	Kutalikosa
Emblica officinalis	Amala

Casearia tomentosa	Pipari
Woodfordia oppositifolia	Dhairo
Lagerostromia parviflora	Botdhairo
Phoenix humilis	Thakal
Melia azedarach	Bakaino
Mallotus philippinensis	Raini,Asare

Appendix VIII. Household questionnaire survey

l) Name of the village----------

2) Household number----------

3) How long have you been living here?------ years.

4) What is the distance of your house from the park boundary?
----------km.

5) How many domestic stock do you have?
a) goats-----
b) cattle------
c) buffaloes----
d) pigs---------

6) How much land do you own?
------- bighas
--------kataas

6) What are the major crops that you grow?
maize-----
wheat-----
rice-----
lentils -----
mustards -----
others if any-----
---

7) Do you practice mixed cropping?
Yes---
No---

8) If yes, which crops do you grow combinely?
1)----------
2)----------
3)----------

9) Do you have any problems from the park animals?
Yes---
No----

10) If yes, what kind of problems do you face?
   1) crop damage---
   2) livestock depredation---
   3) harassment----
   4) others if any----

11) Which are the main crop damaging animals?
   1) Nilgai----------
   2) Deers----------
   3) wild boar---------
   4) others----------

12) When do you experience damage by the following species?

	Monsoon	Winter	summer
1) chital	-------	-------	--------
2) Nilgai	-------	-------	---------
3) wild boar	-------	-------	--------
4) rhino	--------	--------	--------
5) others	---------	---------	--------

13) How often does nilgai come to the field?

	monsoon	winter	summer
1) everyday	--------	-------	-------
2) quite often	-------	-------	-------
3) 2-3 times a week	-------	--------	--------
4) ocassionally	-------	--------	--------

14) How do you recognize the damage done by the nilgai?
1) By seeing---
2) By noise made by the animal---
3) foot prints---
4) grazing pattern---
5) others if any-----

15) Is nilgai selective on certain crops?
   Yes----
   No----

16) What crops do they prefer most?(preference wise)
   1)maize------
   2)wheat------
   3)mustard-----
   4)lentil------
   5)rice--------
   6)vegetables---------- 7)others----------

17) Do they damage equally in all the growing stages?
Yes---
No----

18) If no, when do they damage most?
1) maize a) young stage
b) flowering stage
c) mature stage
2) wheat a) young stage
b) flowering stage
c) mature stage
3) rice a) young stage
b) flowering stage
c) mature stage
4) mustard a) juvenile stage
b) flowering stage
c) maturing stage

5)Lentil a) young stage
b) flowering stage
c) mature stage

19) How much damage did nilgai do to your crop this year?
1) Rice----------
2) maize----------
3) mustard----------
4) Wheat----------
5) Lentils----------
6) Others----------

20) How do you protect your crops during night from the wild animals?
a) Nightm guarding------
b) Keeping fire---
c) keeping dogs---
d) fencing---
e) others if any---

21) Do you grow all kinds of crops which are common in the nearby villages?

a) Yes--- b) no---

22) If no, what are the crops not grown?
a) wheat
b) maize
c) mustard
d) rice
e) lentils
f) others 1)---- 2)---- 3)----

23) If any crop from 22, reason for not growing?
   a) difficult to grow----------
   b) low yield----------
   c) low value----------
   d) problems from nilgai----------
   e) problems from other wild animals----

24) If 23b or e, would you grow if there were no problem from the nilgai?.
   a) Yes----
   b) No-----

25) Is the damage mainly due to nilgai or other animals too?

   a) mainly due to nilgai----------
   b) nilgai and deer----------
   c) wild boar----------
   d) Others----------

26) How much land would you allocate for that crops if nilgai damage was eliminated?

   1) 25 % --------
   2) 50%---------
   3) 75%---------
   4) More than above-------

27) Are the nilgai visiting the field like before?
   Yes--
   No---

28) If no, what has been the rate of decline?

   very high----------
   very low----------
   drastically low----------

29) What may be the cause of decline?
   a) habitat loss----------
   b) poaching----------
   c) other causes---------- specify if any?

   ----

30) Would you tell us about the situation before and after the establishment of park?

a) before 20-30 years ago----------
b) 10 year ago----------

31)If the nilgai were in very high numbers before what were the reasons for it?
a) better habitat----------
b) more live stock grazing in the past----------
c) low predation----------
d) less poaching----------

---

32) Has there been a change in vegetation structure inside the park where you used to graze your livestock?

a) less open grassland now--------
b) denser forest cover now--------
c) others----------

33) What has been the change in livestock numbers after the establishment of the park?
a) more than before----------
b) less than before(2/3 - 1/2 the number)----------
c) much less than before(less than 1/2 the number)------

---

34) where do you graze your animals now?
a) public land---------
b) fringes of the park------
c) sneaking into the park-----
d) stall feeding----------
e) other areas----------

---

35) Did the nilgai get along with the live stock before while grazing?
a) yes------
b) no-------
c) not sure------

36) Has there been a change in land use pattern after the park establishment by the farmers?
a) Yes
b) No

37) If yes, what are the changes?

---

38) Have you ever come across a dead nilgai, while cutting grass inside the park?
a) Yes------
b) no-------

39) If yes, do you think it killed by some animals or due to any disease?
a) not sure------
b) likely by tigers-------
c) due to some disease------

40) what are the sightings of tigers now compared to 10-15 years ago?

a) more than before-------
b) same as before---------
c) less than before-------
d) not sure ----------

41) would you like to see the nilgai increasing?
a) Yes-------
b) No---------

42) If no, why?

---

3) If Yes, why?.

---
44) If yes,how do you think we can improve it?
a) better habitat management----------
b) increased patrolling----------
c) others specify----------

Appendix VIII. Questionnaire survey for Park Staff(Game scouts, Elephant drivers, Army personnel and Tiger tops).

1) Name----------

2) occupation----------

3) Which is your main duty station ?----------

4) How long have you been working here ?----------

5) What is your opinion about nilgai ?

a) The numbers increasing----------?
b) The numbers are decreasing-------?
C) not quite sure--------

6) If 4.b, what hase been the rate of during the last ten years?.

a) gradual----
b) increasingly---
c) rapid-----

7) If any of the above, why do you think so?

	inside park	outside park
a) no suitable habitat	----------	----------
b) intense poaching	----------	----------
c) high predation	----------	----------
d) increased competition from stocks-----		----------
e) increased competition from deer-------		----------

f) others if any----------

8) What kind of habitat do they prefer?

a) open grassland----------
b) mixed scrub----------
c) woody----------
d) riverine forest----------

9) Does the park hold enough area preferred by them?

a) Yes----------
b) N0----------

10) If no, why?
---

11) What is the sighting rate nowadys?

a) rare -------
b) common-------

12) If rare, how often do you see them nowadays compared to a few years back?

a) once in a while----------
b) very rarely----------

13) When you see, where do you find them most often?

a) inside the park----------
b) fringes of the park----------
c) outside in the fields----------

14) What is the general herd size that you have seen mostly?
a) 1 - 3
b) 3 - 5
c) 5 - 10
d) more than 10

15) Have you ever seen a dead nilgai inside the park?
a) Yes------
b) no-------

16) If yes, what could have been the reason?
a) poaching-----
b) not sure-----
c) due to disease-------
d) predated----------

17) Was it an adult or a young one that have been found dead mostly ?
a) mostly adult------
b) mostly youngs------

18) How do you think the situation will improve?
a) habitat management--------
b) patrolling ----------
c) public awareness----------
others_____