ASSESSMENT OF WILD UNGULATES IN THE
KARNALI FLOOD PLAIN OF BARDIA NATIONAL PARK, NEPAL

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Abstract

The population of ungulates depends on the habitat factors and prey-predator interaction. This study aims to explore the habitat preference of ungulates and their relation with associated predators in the Bardia National Park, Nepal. The study was based on the transect survey and indirect observation of ungulates. Spotted deer recorded the highest density and blue bull recorded the lowest. Hog deer preferred mostly flood plains habitat and barking deer preferring mixed hardwood forest and tall grass flood plains. However, barking deer completely avoided the riverine forest and flood plain habitats. Swamp deer preferred Phata (grassland) and blue bull was recorded only in flood plains. The higher concentration of ungulates' pellet groups were found in areas close to water sources. The study concluded that different habitat features influence the distribution and abundance of ungulates. The higher density of spotted deer and hog deer suggests these species as the major prey base to maintain viable populations of tigers in the park.

Keywords: Bardia National Park; distribution; ungulate; habitat preference.

Introduction

Wild ungulates form an important part of ecosystem contributing to diversity, biomass and conservation values in the Terai Arc Landscape (TAL), Nepal [1]. TAL is a project that connects 11 protected areas of Nepal and India including Bardia National Park (BNP) [1, 2]. It is an initiative undertaken by the Government of Nepal and other interested non-government agencies to conserve and manage the ecosystem of low land area of the country. This area supports eight species of ungulates; which include five species of deer {sambar deer *(Cervus unicolor),* hog deer *(Axis porcinus),* barking deer *(Muntiacus muntjak),* spotted deer *(Axis axis)* and swamp deer *(Cervus duvauceli duvauceli)},* wild boar *(Sus scrofa)*, blue bull *(Boselaphus tragocamelus),* and greater one horned rhinoceros *(Rhinoceros unicornis)*. It also supports endangered mammals like the Royal bengal tiger *(Panthera tigris)* [2]. The ungulates play a vital role in maintaining predators such as tigers and other associated cats *(Panthera spp)* [4, 5].

It is important to monitor and analyze the different aspects of the available habitat in relation to prey species and predators to achieve the conservation goal. Good quality of suitable habitat is essential for tiger conservation [6]. The size of prey is also one of the major

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determinants of tiger population and its distribution pattern [7]. Ungulates are categorized as; : small (barking deer), medium (spotted deer and hog deer) and large (swamp deer, blue bull and sambar deer) on the basis of their size. Tiger prefers larger prey [7] and decline in prey is directly responsible for the decline in tiger density and its reproduction rate [8]. Periodical monitoring of tiger habitat is necessary to prioritize areas for conservation action, assessing the effectiveness of management efforts and to develop a conservation strategy [6]. Preparation of a site specific management plan is essential in protecting the endangered species [9]. This study was conducted to investigate the current status of ungulates in the park which will help to categorize habitat suitability for the intended species (tiger and its prey) and to predict the level of disturbance and succession within these habitats.

Materials and Methods

Study Area

This study focused on Karnali flood plain of Bardia National Park, Nepal, which is located in the south-west of the park lying southern of the east-west *Mahendra Highway* (Fig. 1) covering an area of approximately 154 km^2. This lies in low land area of tropical region with maximum elevation 220m and the maximum temperature may be as high as 45°C in summer [10].
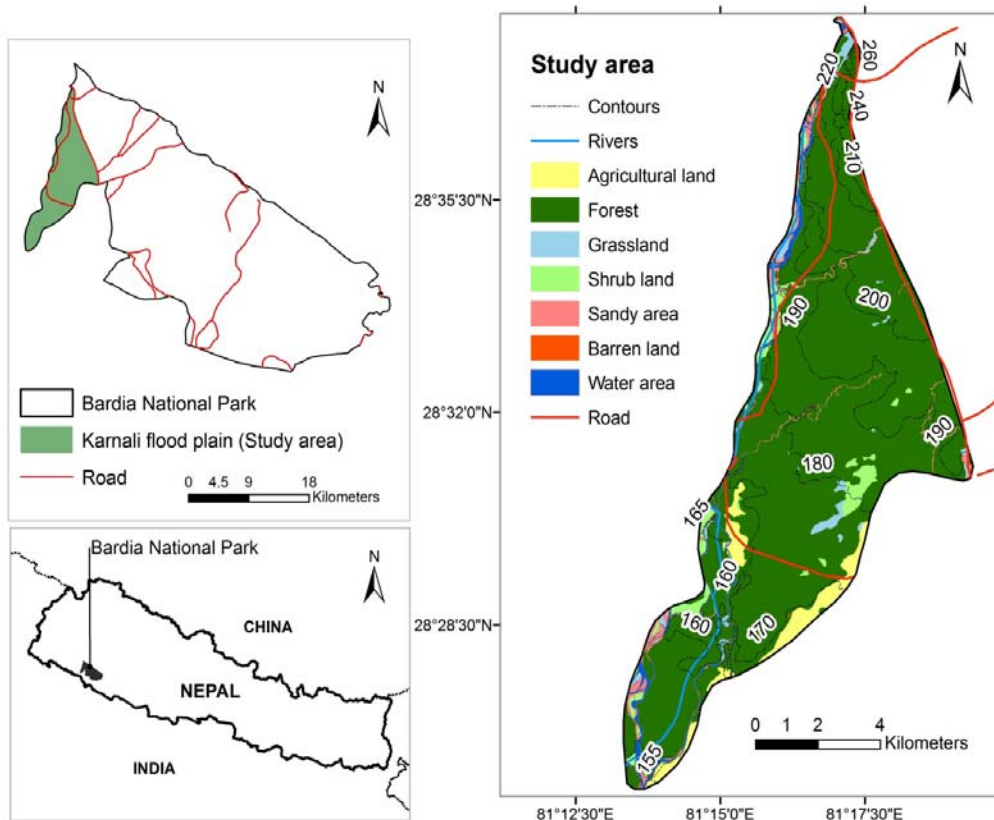
Fig. 1. Location map of the study area; Bardia National Park, Nepal.

A narrow strip of degraded forest stretches along *Geruwa* and *Orai* Rivers and connects the park to Katarniyaghat Wildlife Sanctuary located across the Nepal-India border. *Babai* and

Karnali are the major river systems that flow through the park [11]. These areas support different types of habitat including **sal forest** (**SF**), **riverine forest** (**RF**), **mixed-hardwood forest** (**MH**), wooded **flood plain** grassland (**FP**) and grassland (Phata) [11].

Sampling Design

The study was carried out during the period of April-May 2005. The literature review, social and biophysical information of the study area were collated during January- March 2011 through direct field visits and a selection of published and unpublished studies

Digital topo-layers (1:500000) of the study area provided by the Department of Survey, Government of Nepal was used to design sampling plots and transects. Before moving to the field, the transects were fixed in those layers and field verification was done. ARCVIEW 3.2a (ESRI, Inc, NY) software was used to prepare habitat maps. The sampling locations were selected using *DISTANCE 4.1* software. This provided sampling design for ungulates' abundance based on pellet count. The area was delineated into systematic transects and two ends of each transect were marked by their coordinates. The coordinates were entered into hand held Global Positioning System unit (Garmin TM, Etrex) to find the exact location during field study. All collected data was entered and analyzed using *Ms-Excel*.

Indirect and direct ungulates' signs (pellets, hair, scavenger presence and direct observations) were used to collect information on target study ungulates. The pellet counting method used in this study is the most useful indirect method for determining the habitat utilization by ungulates. This method has been widely used in previous studies [4, 12, 13]. A total of 23 sites, each of the sites with 4 transects (625m long each) forming a square geometry were sampled. Pellet groups inside circular plots (size $10m^2$; r=1.785m) in every 25m of 625m transects were counted. Detecting probability was assumed to be 100% as the plots were small and searched carefully.

The abundance, frequency and habitat preference of the ungulates were calculated by using the following formulae [14]:

Abundance of species = Total number of pellets groups in all sampling plots/Total number of sampling plots in which pellets occurred

Relative abundance (%) = Abundance of individual species/ Total abundance of all species*100

Frequency = Total number of plots in which pellet groups found/ Total number of sampling plots studied

Relative frequency (%) = Frequency of species/Total frequency of all species*100

Habitat preference (%) = Pellet groups (%) in each habitat/ Total pellet groups (%) in all habitat types*100

The distribution pattern is determined by calculating the mean and variance of the pellet groups obtained in different habitats [15].

Results and Discussion

A total of 2,055 sampling plots were laid out in the study area; out of them 1,069 were laid in SF followed by FP (379), MH (170), Phata (176) and RF (266). Spotted deer was recorded in most of the plots with the highest average pellet density (2.5 pellet groups/plot) followed by hog deer, swamp deer, sambar deer, barking deer and blue bull (Table 1). Similar findings; highest density of spotted deer, have been recorded in *Khata Corridor* [1]. The higher number of spotted deer and hog deer and low (declining) number of blue bull is mentioned by P. Wegge et al. [16].

Table 1. Number of Pellet groups per plot in different habitats

| Habitat	Spotted deer	Hog deer	Sambar deer	Barking deer	Blue bull	Swamp deer
Flood Plain (FP)	1.03	2.21	0.01	0.00	0.02	0.15
Mixed hardwood forest (MH)	3.48	0.00	0.15	0.03	0.00	0.00
Grass land (Phata)	3.81	0.85	0.04	0.02	0.00	0.27
Riverine forest (RF)	2.77	1.08	0.00	0.00	0.00	0.05
Sal forest (SF)	2.53	0.00	0.08	0.02	0.00	0.04

Frequency, relative abundance and distribution of ungulates

Spotted deer had the highest relative frequency among the species in MH, Phata, RF and SF with relative frequency of 86.69%, 64.15%, 65.60% and 75.98% respectively. Similarly, hog deer had the highest relative frequency, 56% in FP. Barking deer was completely absent from FP and blue bull was completely absent from MH, Phata, RF and SF (Table 2).

Table 2. Frequency distribution of ungulates in different habitats

Habitat	Flood Plain (FP)	Mixed Hardwood Forest (MH)	Grassland (Phata)	Riverine Forest (RF)	Sal Forest (SF)
Mean number of pellet groups	216.5	104.17	146.33	172.67	476
Variance	115605.90	57914.17	69038.67	88961.07	1188232.00
Chi-square	χ^2=2669.88 (p<0.05)	χ^2=2779.79 (p<0.05)	χ^2=2359.01 (p<0.05)	χ^2=2576.04 (p<0.05)	χ^2=12481.43 (p<0.05)
Distribution pattern	Clumped	Clumped	Clumped	Clumped	Clumped

The study showed that the ungulates' abundance depend on the habitat features. Hog deer was the most abundant species (RA = 32.63 in FP) and barking deer was the least abundant (RA = 0.00). Hog deer was found only in FP, RF and Phata avoiding SF and MH which can be related to its diet availability. K.M. Naess and H. J. Anderson [17] also recorded a higher density of hog deer in FP. Similarly, barking deer was absent in FP and blue bull in MH, RF, SF and Phata. Likewise, spotted deer was the most abundant species in MH (38.76), RF (39.93) and Phata (57.24) (Fig. 2). Clumped type of distribution was found for all ungulates indicating that each of the habitats is not equally utilized by ungulates (Table 3). Similar results were obtained in Suklaphanta Wildlife Reserve of Western Nepal (18).
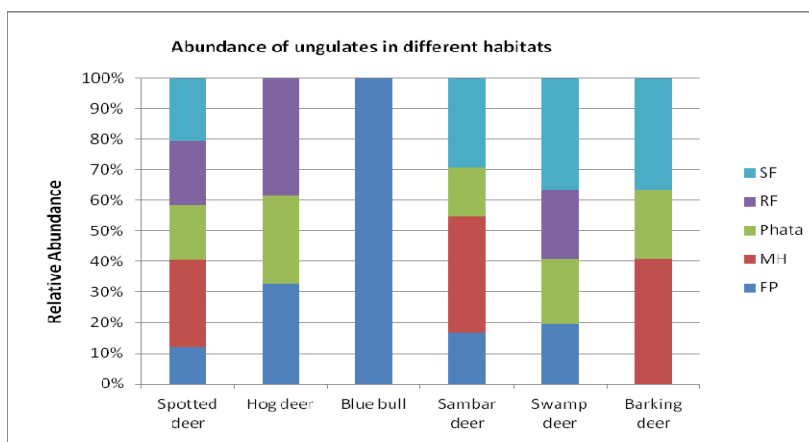
Fig. 2. Habitat wise abundance of ungulates

Table 3. Distribution pattern of Ungulates (%)

Habitat	FP		MH		Phata		RF		SF	
	F*	RF**	F*	RF**	F*	RF**	F*	RF**	F*	RF**
Spotted deer	0.32	32.58	0.82	86.69	0.80	64.15	0.64	65.60	0.74	75.98
Hog deer	0.55	56.00	0.00	0.00	0.24	19.70	0.30	30.69	0.00	0.00
Blue bull	0.01	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sambar deer	0.01	1.08	0.09	9.91	0.03	2.75	0.00	0.00	0.06	6.40
Swamp deer	0.09	9.42	0.00	0.00	0.15	12.37	0.04	3.84	0.02	2.39
Barking deer	0.00	0.00	0.03	3.10	0.02	1.37	0.00	0.00	0.02	1.81

*Frequency **Relative frequency

Habitat preference

Phata found to be the habitat most utilized by the ungulates except blue bull. Barking deer and sambar deer were completely absent in RF (Table 4).

Table 4. Habitat preference (HP%) of ungulates

Habitat	Barking deer	Hog deer	Spotted deer	Sambar deer	Swamp deer	Blue bull
FP	0.00	50.17	9.60	5.24	30.11	99.57
MH	45.81	0.00	24.76	46.73	0.00	0.00
Phata	26.55	22.33	23.92	16.93	50.02	0.00
RF	0.00	27.49	19.33	0.00	12.26	0.00
SF	27.68	0.00	22.39	31.12	7.63	0.00

Barking deer

Barking deer preferred mostly MH (45.81 %), and less to FP and RF (Table 4). SF and Phata had a medium level of preference by the barking deer with value 27.68 % and 26.55% respectively (Table 4). The avoidance of RF and FP habitats could be because of the habitat which is difficult for the deer to escape from the predators due to bushy shrubs, and epiphytes in RF and tall grasses in FP which are difficult to graze. The avoidance of RF habitat by this deer was also recorded in *Barandabhar Corridor Forest* (19). However, the result obtained contradicts with K.M Naess and H.J Anderson (17) and P. R. Kuinkel (20) who concluded SF and RF as preferred habitats for barking deer.

Hog deer

Hog deer was found in all habitats with the highest HP value in FP (50.17%) followed by RF, Phata, SF and MH respectively (Table 4). The result obtained is similar to the result obtained by G. B. Schaller [21] and J. L. D. Smith et al. [6]. The preference of FP may be due to the behavioral and morphological characteristics of hog deer which are closely linked with the tall grass areas (21). S.K. Dhungel and B.W. O'Gara [22] concluded that hog deer are specially adopted for living in tall grass. SF and MH were least preferred by hog deer which may be due to the lack of its suitable diet. The less use of RF than FP by hog deer may be due to the probability of being predated while foraging [23] and lack of water.

Spotted deer

Spotted deer had the highest HP in MH (24.76 %) followed by Phata, SF, RF and FP respectively (Table 4). The least preference to FP may be due to the tall grasses. The burning of pellets by controlled fire in the area might have shown less than actual HP value in SF, MH and Phata. Earlier studies have indicated that tiger predation on spotted deer reduced in the period after grass cutting and burning [21, 24, 25, 26]. More use of areas cleared after cutting and or burning of grassland was also recorded [24, 26]. This might be due to increased forage quality and being relatively easier to escape from predators. The habitat preference varies with season

and RF was the most preferred habitat during the whole dry season [12]. Preference to short grassland and forest or forest edge was mentioned by B.P. Bhattarai [19].

Blue bull

Blue bull was recorded only in FP with HP value 99.57 %. During this study, the pellets were seen at only one place of SF and that was outside the sampling plot laid. The study doesn't coincide with the result obtained by T.K. Lasiwa [27] in Bardia National Park and the result for Suklaphanta Wildlife Reserve [18] who found higher preference of blue bull to SF. Its absence in SF may be due to the controlled fires in the area which might have burned the pellets. The decrease in blue bull in recent years is also noted by P. Wegge et al. [16]. The limitation of blue bull in FP may be related to water availability in dry season and being far from human influence. Its preference to small phata and far from agricultural areas and human activity was noted by T.K. Lasiwa [27].

Sambar deer

The highest HP value of sambar deer was found in MH (46.73%) followed by SF, Phata, FP and RF (Table 4). The absence of this ungulate in RF habitat may be due to the foraging quality provided by the RF habitat and to avoid the predators where it would be at a higher risk of predation.

Swamp deer

Phata was the most preferred habitat for swamp deer with HP 50.02 % (Table 4). This supports similar findings of N. Gayawali, S.R. Jnawali [29] and C.P. Pokhrel [30]. The HP for Phata is related to the availability of preferred food plants such as S. *spontenum, I. cylindrical,* and *V. zizanoides* [30] and their shoots which are available after grass cutting and burning [31]. They also preferred river beds to eat aquatic vegetation to fulfill their demand of Na concentration [26].

MH is the habitat least and SF is the second least preferred habitat by this deer which could be explained by the scarcity of water and preferred food. C.P. Pokhrel [30] also found the lowest HP value in SF of Suklaphanta Wildlife Reserve, Nepal.

Threats

The evidence of threats was also observed. The areas adjoining the buffer zone communities were affected by illegal cutting of grass and livestock grazing. This was more intense near *Bankhet* and *Ambasa* area of the park. More than 20 people that entered illegally were seen inside the park. Most of them were found picking *Neuro*; a local vegetable. The presence of tree stumps inside the park suggests the illegal logging for fuel wood, fodder and timber.

A higher number of pellet groups were recorded near water sources suggesting water as the major limiting factor. Poaching activity was found to be high in southern section of the park near *Laguna Machan*, *Lalmati* and along the braids of Karnali River. Area near *Karnali bridge* appeared to be highly influenced by human activities. Boating, fishing and logging were common in the area, which could be due to the absence of national park staff in the area.

Conclusions

From the above study, the abundance of ungulates species was found habitat dependent. Hog deer and spotted deer were the most abundant ungulates and blue bull the least. This suggests hog deer and spotted deer are major prey base of tiger in that area. The preference to Phata by most of the ungulates may be due to the presence of suitable diet in this habitat. Similarly, the occurrence of high number of pellet groups adjoining the water bodies signifies

the importance of water for the survival of ungulates. It emphasizes the necessity of more water holes and ponds in the park especially during dry season. The distribution pattern of ungulates was found to be clumped type.

The habitat preference value shows that hog deer preferred mostly the FP habitat where as spotted deer used all of the habitats. Similarly, MH was the most preferred habitat whereas RF and FP were completely avoided by barking deer. Likewise, swamp deer mostly preferred Phata and blue bull was recorded only in FP.

Open grasslands and other habitats should be maintained to ensure the ungulates abundance in the area. Specific programs to improve the habitat condition of ungulates thereby protecting the tiger population are of great essence. The reinstatement of the posts which were evacuated due to the security reason would also be very important to prevent the illegal activities inside the park.

Acknowledgement

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