RELATIVE ABUNDANCE AND DISTRIBUTION OF WILD UNGULATES IN SUKLAPHANTA WILDLIFE RESERVE, NEPAL

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ABSTRACT

We determined distribution, abundance, and habitat preferences of wild ungulates for hot season from early of March to mid of May in SWR 2005. A total of 7,342 pellet groups were recorded from 2500 plots of 25 different samples. Spotted deer, hog deer, swamp deer, barking deer, wild boar, and blue bull were recorded as main ungulate species occupying the western part of SWR. Spotted deer was more abundantly distributed (2.28 ± 2.23) among all ungulate species where as blue bull was least abundant (0.002±0.05). Ungulates were highly abundant (3.37±2.58) in grassland habitat. In four different types of habitat, spotted deer was highly abundant (2.67±2.08) in Sal forest, hog deer in grassland (0.53±0.74), swamp deer in grassland (1.03±1.52), barking deer in Sal forest (0.02±0.14), blue bull in Sal forest (0.002±0.06) and wild boar in grassland (0.13±0.034). The distribution pattern of wild ungulates was clumped type among studied samples. Habitat preference was found high in Sal forest for spotted deer (29.20%), barking deer (44.16%) and blue bull (64.51%), and grassland for hog deer (74.81%), swamp deer (92.18%), and wild boar (55.52%). Present study found relatively high distribution of ungulate species in core area suggests to ungulate monitoring in extension areas.

Key words: Ungulate, Distribution, Abundance, Pellet Groups, Habitat

INTRODUCTION

Wild ungulates represent an important faunal assemblage in Terai contributing to diversity, biomass and conservation values. The evidence of evolutionary history suggests that ungulate communities act as determinant of tiger (*Panthera tigris)* distribution and abundance across the distributional range (Seidensticker *et al.* 1999). So tiger density is positively related to prey abundance particularly wild ungulates (Smith 1984, Karanth and Stith 1999, Sunquist *et al.* 1999) and large wild ungulates with wider spatial distribution (e.g. chital) play a significant role in deciding the occurrence of tiger (WII, 2004). Moreover, a threshold of prey abundance that determines poor or good quality of habitat reflecting the breeding possibility is important for developing necessary conservation action (Smith *et al* 1998). Thus, information on habitat quality as measured by prey abundance is critical for guiding tiger conservation action from local management intervention to regional conservation planning in the focal landscape (WWF, 2002).

The study area Suklaphanta Wildlife Reserve (SWR), located within the Terai Arc Landscape (TAL), supports many wildlife species including many wild ungulate species

namely- swamp deer (*Cervus duvauceli*), spotted deer (*Axis axis*), hog deer (*Axis porcinus*), barking deer (*Muntiacus muntjak*), sambar deer (*Cervus unicolor*), blue bull (*Boselaphus tragocamelus*), wild boar (*Sus scrofa*), rhino (*Rhinoceros unicornis*) and elephant (*Elephas maximus*) and also good number of tiger (18 individuals) (WWF, 2005). Periodic population monitoring data are available only for swamp deer (Schaff 1978, Bhatta 1998, Gyawali 2003) and rhino (Adhikari, 2003) but for other ungulate species inhabiting SWR (spotted deer, hog deer, barking deer, sambar deer, blue bull, and wild boar), the population data and other ecological information are not available. Thus, the information on the population distribution, abundance and conservation threats for these ungulates species are not adequate in SWR for management purpose. So, the finding of this study seems to be highly useful and time worthy for conservation planning of not only ungulate species but also the umbrella species such as tiger, leopard etc. This study was carried out to determine relative abundance, assess the habitat preference and to determine distribution pattern of ungulates in western part of SWR.

MATERIALS AND METHOD

Study Area

The study was carried out in Suklaphata Wildlife Reserve (SWR). In 1976 an area of 155 km^2 was gazetted as SWR to protect Nepal's last remaining herd of swamp deer (DNPWC, 2002). The reserve lies in the extreme southwestern part of the Terai in Kanchanpur district of Mahakali zone. It is located between $28^o45'16"$ N and $28^o57'23"$ N and $80^o06'04"$ E and $80^o21'40"$ E and the elevation of the reserve range from 90m to 270masl (Adhikari, 2003).The study was mainly concentrated in the western part of SWR. The vegetation types in the study area were categorized into Sal forest, grassland, mixed forest and Riverine forest (Pokhrel, 2005).

Methods

Five different sites (Majgoan, Pipariya, Barcaula, Suklaphanta and Singhpur) and other locations (Paliya, near Babatal, Salgaudital, Sundariphanta, Paterintal, Dudhiya camp, Gohital, Hagnea Khola, Ranital) of the western part of the reserve were selected for the monitoring sites of transects. Simple random sampling method was used to select pellet monitoring sites. The monitoring sites were delineated and shape files were generated using Geographical Information System using ARCVIEW 3.2a (ESRI, Inc, NY). This stratum was used in distance software to generate sampling design for ungulate abundance based pellet count survey based on line transects. This systematic random sampling design ensured that the sampling points could be treated as a set of independent data points to avoid bias in data collection.

The distribution, abundance and habitat preference of ungulates were determined by pellet groups counting method. To assess relative abundance of ungulates, we used the method developed by Smith *et al.* (1999). A total of 25 sample sites were monitored. Each sample has 4 transects (sides) forming square shaped geometry for track line so each side of the sample is treated as the continuous lines for the purpose of analysis. The starting and ending points of first transect of each sample were geo referenced.

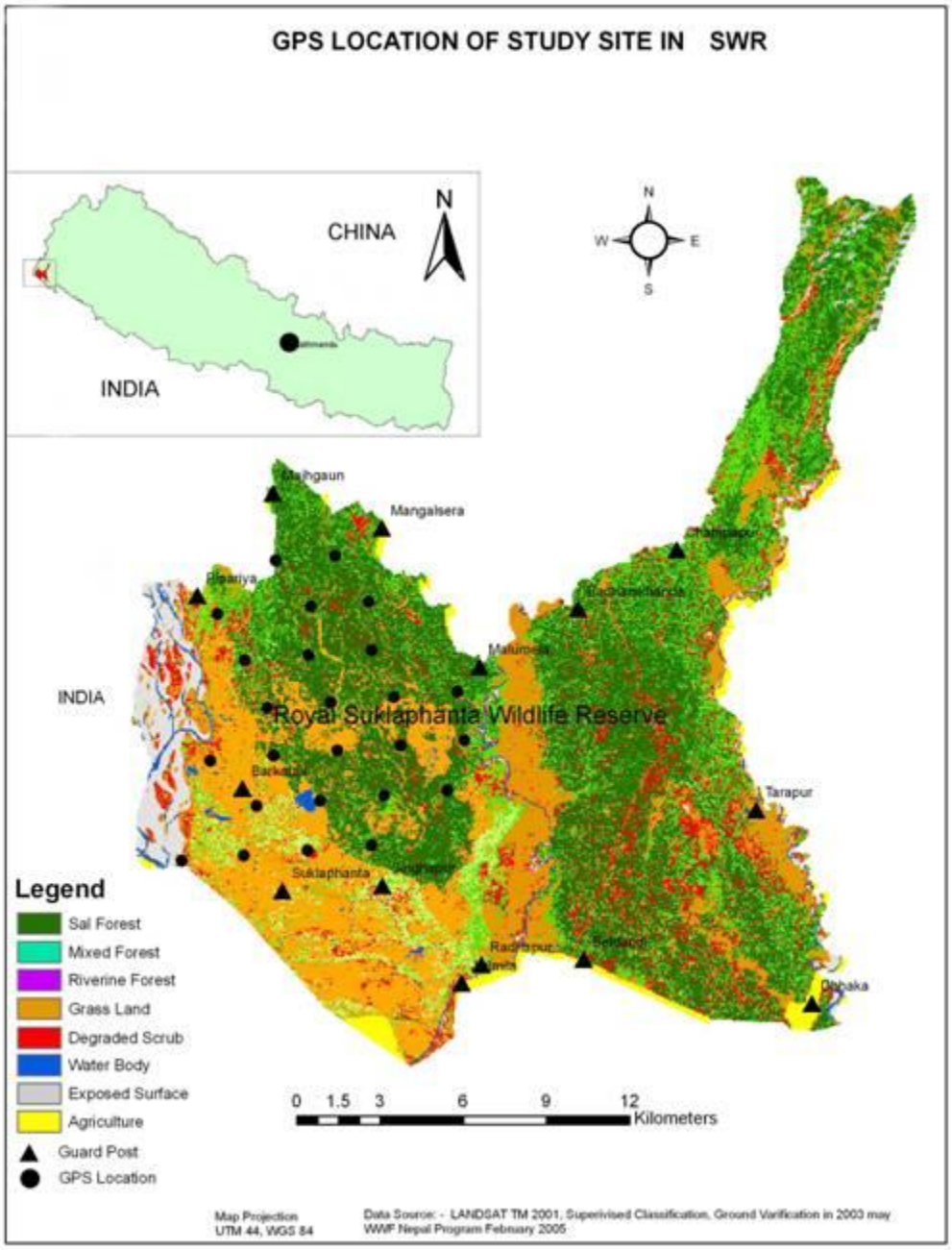

Figure: 1 Map of the intensive study area in the SWR showing GPS locations of the 25 sample sites.

Pellet groups or droppings of ungulate species were counted within 10 m^2 circular plots (r=1.785m) placed at 25 m intervals along 625 m transect. Animals were recorded for

their presence when more than 50% of the pellets in a group lied inside the circular plot. Following method was used to determine abundance of ungulates.

$$\text{Abundance} = \frac{\text{Total number of pellet groups presence in all studied plots}}{\text{Total plots studied}}$$

Distribution pattern of ungulates was analyzed by variance to mean ratio (Odum, 1996). Habitat preference was calculated by using following formula (Pokhrel, 1996)

$$\text{Habitat preference (HP)} = \frac{\text{PPE}}{\text{TPP}} \times 100 \quad \text{Where,}$$

PPE = Pellet present **(%)** in each habitat type

TPP = Total pellet present (%) in all the habitat type.

A chi-square test was used to judge the significance of association between the different habitats utilized by ungulates.

RESULT

Abundance of Ungulate Species

A total of 7342 pellet groups of ungulate species were observed. The spotted deer, swamp deer, hog deer, barking deer, wild boar and blue bull were found as main ungulate species in the SWR. Spotted deer was more abundant (2.28 ± 2.23) among the ungulate species followed by swamp deer, hog deer, barking deer and wild boar (Figure 2). Blue bull was lowest abundant ungulate (0.002±0.05).

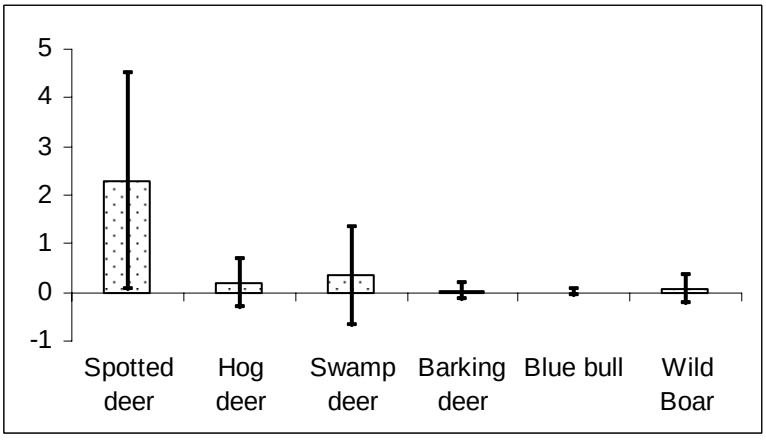

Figure 2. Pellet group abundance (Pellet group/plot±Standard Deviation) of Wild ungulate Species

A total of 1444, 147, 59, 850 plots were laid in the Sal forest, mixed forest, Riverine forest and grassland respectively. Pellet frequency of ungulates showed different pattern of abundance in different habitat types. In general, the abundance of ungulates was found highest in grassland (3.37±2.58) and lowest in Riverine forest (1.68±1.47). The grassland was followed by Sal forest (2.76±2.15) and by mixed forest (2.59±2.37) in ungulates abundance (Figure 3).

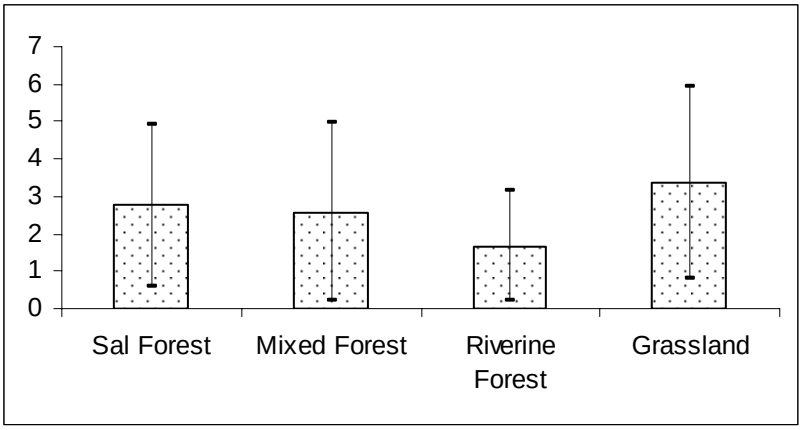

Figure 3. Pellet group abundance (Pellet group/plot ± Standard Deviation) of wild ungulates (Habitat wise)

Spotted deer was more abundant in the Sal forest (2.67±2.08) and mixed forest (2.46±2.27) than in other habitats. Spotted deer was relatively low abundant in grassland (1.67±2.39) and riverine forest (1.56±1.36). Swamp deer, hog deer and wild boar were more abundant in grassland. Barking deer was found more abundant in grassland and Sal forest, whereas pellets of this species were not recorded from Riverine forest. Similarly, Blue bull was more abundant in Sal forest than in grassland but was not recorded from Riverine forest and mixed forest (Table I).

Table I: Pellet group abundance (pellet group/plot ± Standard Deviation) of wild ungulates (Habitat-wise with respect to different species)

	abundance ±standard deviation			
Species	Grass land	Mixed forest	Riverine forest	Sal forest
Spotted deer	1.67±2.39	2.46±2.27	1.56±1.36	2.67±2.08
Hog deer	0.53±0.74	0.06±0.27	0.08±0.33	0.01±0.12
Swamp deer	1.03±1.52	0.02±0.18	0.02±0.13	0.01±0.09
Barking deer	0.02±0.14	0.01±0.08	0	0.02±0.18
Blue bull	0.001±0.03	0	0	0.002±0.06
Wild boar	0.13±0.34	0.04±0.20	0.02±0.13	0.05±0.24

Distribution Pattern

On the basis of pellet groups encountered in 25 different samples studied in different habitat types, maximum number of evidences of ungulates were recorded from different samples studied in grassland (643 pellet groups, 371 pellet groups, 345 pellets groups etc.) as well as from the samples studied in sal forest (437 pellet groups, 417 pellet groups) and in sample studied in combined habitat of sal forest and grassland (431pellet groups).Whereas minimum numbers of ungulates were recorded in a sample studied in sal forest (144 pellet groups). However, considerable numbers of ungulates were recorded also from mixed forest (223 pellet groups) and riverine forest (197 pellet groups). In over all studied samples the distribution pattern of ungulate species in SWR was found to be clumped type ($S^2/\overline{X} = 38.77 > 1$).

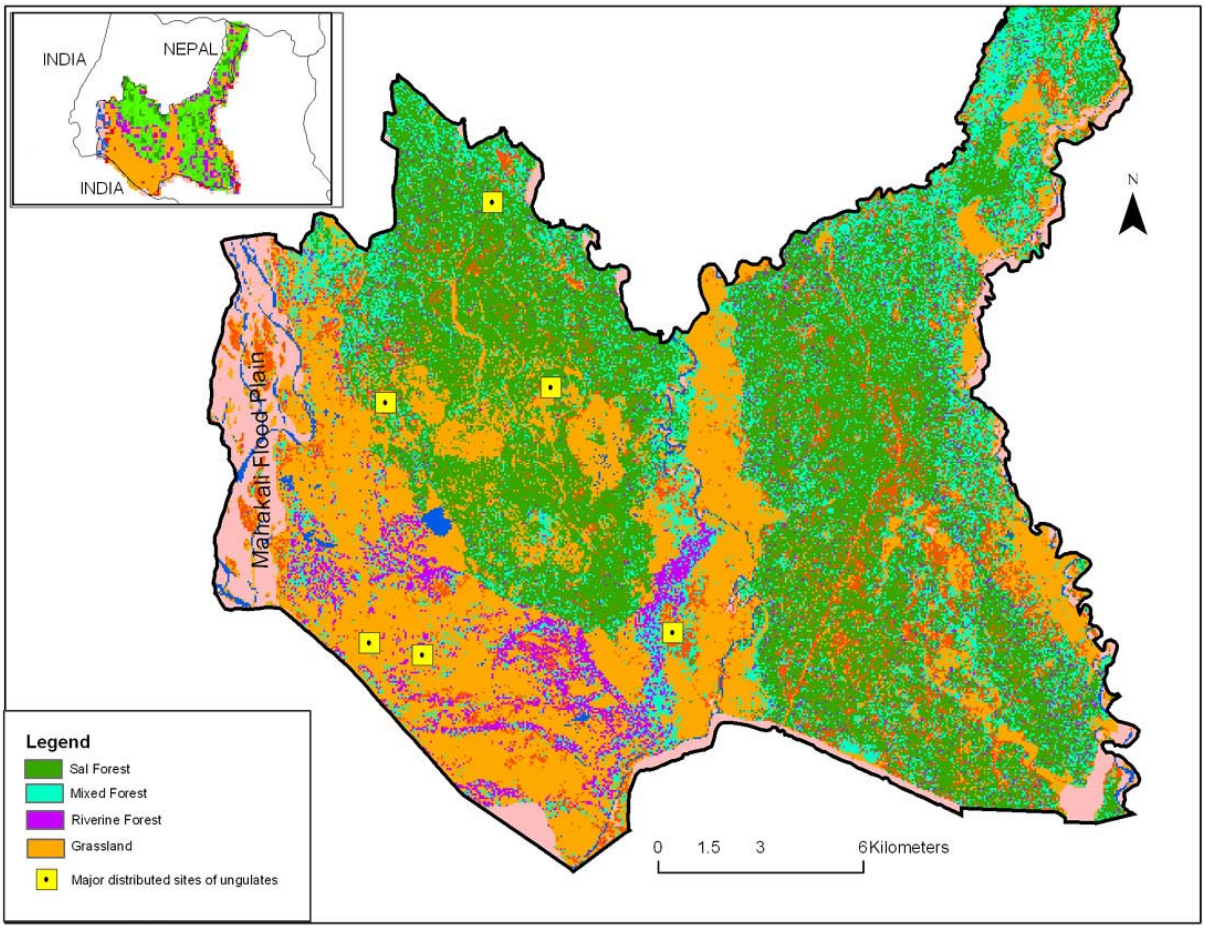

Figure 4. Map of the intensive study area in the SWR showing GPS locations of Hot spots for ungulates distribution

Habitat Preference

Among four habitat types Sal forest (SF) was highly preferred (29.20%) habitat by the spotted deer (Figure 5). Hog deer was found to have the highest habitat preference (74.81%) for grassland (GL) and lowest (2.67%) for Sal forest. Similarly, Swamp deer highly preferred the grassland (92.18%) and avoided the Sal forest (1.67%). Barking deer was found highest at Sal forest (44.16%) and no preference for Riverine (RF) forest during the study period. Blue bull was found highest in Sal forest (64.51%) and had no preference for mixed forest (MF) and Riverine forest. Wild boar had highest habitat preference for grassland (55.52%) and lowest for Riverine forest (7.52%).

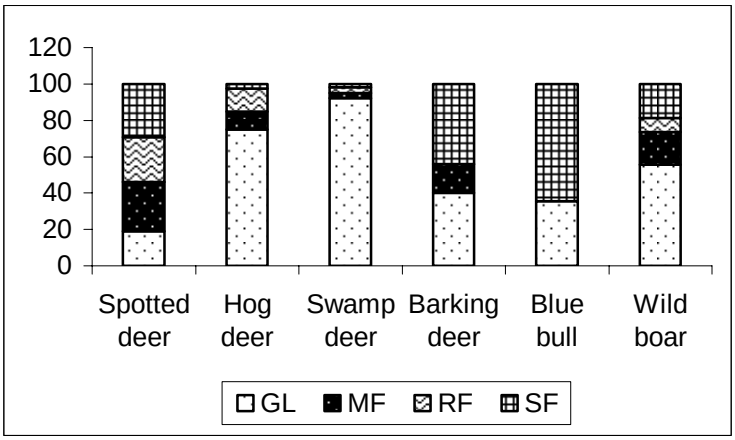

Figure 5. Habitat preferences of different ungulate

A Chi-Square contingency test to spotted deer showed very significant (χ^2= 262.23, p = 0.05, df = 1) difference between two habitats–grassland and Sal forest. While there is no significant (χ2=1.34, p = 0.05, df = 1) difference between mixed forest and riverine forest. Hog deer habitat preference showed no significant (χ2=0.13, p=0.05, df =1) difference between mixed forest and riverine forest while use of grassland and Sal forest has very significant (χ2=611.08, p=0.05, df =1) difference. In case of swamp deer, grassland was significantly (χ2=748.9, p = 0.05, df = 1) used than Sal forest but in case of mixed forest and riverine forest (χ2=0.03, p=0.05, df=1) and mixed forest and sal forest (χ2=0.42, p=0.05, df=1) there were no significant differences in habitat utilization by this species. Similarly, in using the sal forest and mixed forest (χ2=1.18, p=0.05, df=1) and the grassland and sal forest (χ2=0.08, p=0.05, df=1) by barking deer were not found any significance differences. Also, there was not any significant (χ2=0.0.24, p=0.05, df=1) difference of habitat preference by blue bull in between grassland and sal forest. Among two habitat (grassland and Sal forest) there was found significant used (χ2=45.46, p = 0.05, df = 1) by wild boar but there is no significant difference in between mixed forest and Sal forest (χ2=0.09, p=0.05, df=1) and mixed forest and riverine forest (χ2=0.73, p=0.05, df=1).

DISCUSSION

Ungulate in SWR was found to be abundant in the grassland areas. The largest herd of Swamp deer concentrates in the Suklaphanta grassland. Generally grassland is preferred habitat for grazing animals. In fact, high quality habitat of grassland supports high ungulates biomass that in turn supports high density of tiger (Shrestha 2004, Smith et al. 1999).

Spotted deer was more abundant species in SWR among all the ungulates. Shrestha (2004) and Thapa (2003) in their studies in TAL and Barandabhar Corridor Forest (BCF) respectively found similar results. Spotted deer is generalist in habitat use but it has relatively more preference to the Sal forest. Even though, it can be adaptive to habitats with differential forage production rather than homogeneous vegetation structure (Thapa, 2003) due to dual foraging strategy (Schaller 1967, McKay and Eisenberg 1974, Dinerstein 1979, Martin 1987, Mishra and Wemmer 1987, Moe and Wegge 1994).Findings of present study regarding the swamp deer showed its high abundant and habitat preference in open grassland of Suklaphanta which matched with the results of Pokhrel (1996) and Gyawali (2003). Availability of fresh sprouts of preferred grasses of swamp deer such as *Imperata cylindrica, Saccharum spontaneum* and *Saccharum bengalensis* (Schaaf 1978, Pokhrel 1996), large escape area and nearby waterholes could be the cause of high preference of Suklaphanta grassland and its high abundance in it. Hog deer was less abundant than spotted deer and swamp deer in SWR with more preference to use grassland. Similar results were made by Naess and Andersen (1993), Dhungel and O'gara (1991), Haugo and Hoem (1999), Tamang (1982) and Dinerstein (1987). Previous studies have revealed an almost exclusive utilization of grassland by hog deer both as feeding-site and shelter from predators (Dhungel and O'gara 1991, Dinerstein 1987). So, high preference of grassland of hog deer in SWR could be explained by its nature as obligate species of grassland (WII, 2004) and high quality forage. The barking deer was found relatively low abundant than other deer species in SWR with relatively high distribution in the Sal forest and grassland whereas Sal forest was found highly preferred habitat. Thapa (2003) also recorded same result. However, in contrast to Heggdal's (1999) findings, the barking deer was found absent in Riverine forest. The higher probability of finding barking deer latrines closer to its territory border (Brown and MacDonald 1985, Mosand 2001) than other places may bias random sampling for their distribution (Thapa, 2003). Low sampling effort (only a single sample was studied in the riverine forest) during this study could be the cause of present findings in Riverine forest.Wild boar was found abundant in all types of habitats but it was relatively highly preferred to use grassland habitat followed by the Sal forest and mixed forest . Thapa (2003) and Tamang (1982) made similar observations. The wild boar is a typical generalist species in habitat use (Spitz and Janeau 1990, Abaigar et al. 1994, Virgo's 2002) specifically more frequent in the fragmented parts than in continuous forest (Thapa, 2003) and availability of food, water, bedding sites and marshy places in grassland could be the reason of its high preference of grassland in SWR.The blue bull was less frequent in SWR. It preferred to use the Sal forest and grassland in Suklaphanta. Shrestha (2004) recorded very restricted distribution of blue bull in TAL only in dry scrub forest while significantly higher proportion outside the

protected areas (WII 2004, Shrestha 2004). A combination of high poaching, tiger predation and habitat deterioration are the major causes of decline of blue bull (Khatri, 1993) and its less frequent distribution in SWR.

Distribution pattern of ungulates in SWR was clumped type. Shrestha (2004) also reported similar type of ungulate distribution in the TAL. Among the different samples, ungulates are found highly concentrated Singhpur grassland, Majgaon sal forest, Suklaphanta grassland and grassland of Suklaphanta near 24 number pillar of Nepal-India border. Such distribution pattern is generally exhibited by biological populations in natural habitat (Odum, 1996). In addition to specific preference the grassland, availability of water holes at Purano Tal and other newly made Tal in Suklaphanta, nearby Bahuni River in Singhpurphanta, green growth, and large escaping area from the predators could be the factors to support high concentration of ungulates in these areas.

CONCLUSION AND RECOMMENDATION

High distribution and abundance suggested the grassland areas of SWR are good habitat for wild ungulate species that explains presence of good number of tiger in SWR. Ungulates and tiger can be used as baseline data to initiate monitoring program in reserve. Present study observed low abundance of ungulates in Riverine forest in comparison to other habitat types and limited plots were surveyed in this habitat. So, in depths study in Riverine forest in necessary. Wild ungulates monitoring in extension areas of SWR can provide valuable information in conservation as well as in ecosystem management endeavor of the reserve. And many studies have been carried out regarding grassland vegetation of the reserve but very few have been recorded for the forest vegetation. This implies that monitoring of vegetation regarding forest habitat is necessary and this may give information on management practices for habitat improvement of wild ungulates to support high density of endangered species like tigers.

REFERENCES CITED

Abaigar, T., Del Barrio G. and Vericad, J.R. 1994. Habitat preference of wild boar (*Sus scrofa*) in a Mediterranean environment: indirect evaluation by Signs. *Mammalia*, 58:201-210.

Adhikari, P. 2003. Status, Dispersal and Habitat use of greater one horned rhinoceros (*Rhinoceros unicornis*) in RSWR far western lowland Nepal. M.Sc. dissertation submitted to the Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu.

Bhatta, A.D. 1998. Factors affecting the population of swamp deer (*Cervus duvauceli*) in RSWR. M.Sc. dissertation submitted to the Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu.

Brown, R.E. and Mac Donald, D.W. 1985. Social odours in Mammals. Volume 2, Clarendon Press, Oxford, U.K.

Dhungel, S.K. and B.W. O' Gara. 1991. Ecology of the hog deer in Royal Chitwan National Park, Nepal. Wildlife Monograph No. 119. Wildlife Society, Bethesda, MD.

Dinerstein, E. 1979. An ecological survey of the Royal Karnali-Bardia Wildlife Reserve, Nepal, Part II: Habitat/Animal interaction Biological Conservation, 16: 265-300.

Dinerstein, E. 1987. Deer, plant phenology, and succession in the low land forest of Nepal. In: Wemmer, C.N. (Ed) Biology and Management of the Cervidae, Research symposia of the national zoological park Smithsonian institution, Pp. 272-288. Smithsosonian Institution Press, Washington D.C., USA.

DNPWC. 2002. Brochure of RSWR published by DNPWC, Babarmaharl, Ktm.

Gyawali, N. 2003. Population status and habitat use of Barasingha (*Cervus duvauceli duvauceli*) in Royal Suklaphanta Wildlife Reserve. B.Sc. Thesis, Institute of Forestry, T.U., Pokhara (ix + 34p).

Haugo, S.B. and Hoem, A. 1999. Spacing behaviour, habitat use, and activity pattern of hog deer (*Axis porcinus*) in relation to the annual grass-cutting in RBNP, low land Nepal. M.Sc. Thesis, Agriculture University of Norway (v+71p).

Heggdal, P.ϕ. 1999. Spatial Organization, habitat preferences and activity of barking deer (*Muntiacus muntjak*) during the dry season in Royal Bardia National Park, lowland Nepal. M.Sc. Thesis, Agriculture University of Norway (iv+59p).

Karanth, K.U., and B.M. Stith. 1999. Prey depletion as a critical determinant of tiger population viability. Pages 100-113 in J. Seidensticker, S. Christie, and P. Jackson, editors. Riding the tiger: tiger conservation in human-dominated landscapes. Cambridge University Press, Cambridge, United Kingdom.

Khatri, T.B. 1993. Status and Food habit of Nilgai in Royal Bardia National Park. M.Sc. Thesis. Agricultural University of Normay (v+65p).

Martin, C. 1987. Inter specific relationships between Barasingha and Axis deer in Kanha National Park, India and relevance to management. In: Wemmer, C.M. (Ed) Biology and Management of the cervidae, Research symposia of the national zoological park Smithsonian institution, Pp. 299-306. Smithsonian Institution Press, Washington D.C., USA.

Mckey, G.M. and Eisenberg, J.F. 1974. Movement Patterns and habitat utilization of ungulates in Ceylon. In Geist, V. and Walther, F. (Eds), the Behavior of Ungulates and its Relation to Management, Pp. 708-724, IUCN Publication, NewSeries, No. 39.

Mishra, H.R. and Wemmer, C.M. 1987. The comparative breeding ecology of four cervids in Royal Chitwan National Park. In: Wemmer, C.M. (Ed) Biodogy and management of the cervidae: Pp. 259-271, Smithsonian Institution Press, Washington, D.C. USA.

Moe, S.R. and Wegge, P. 1994. Spacing behaviour and seasonal habitat preferences of axis deer (*Axis axis*) in Royal Bardia National Park, Nepal. Canadian Journal of Zoology, 72: 1735-1744.

Mosand, H.M. 2001. Spatial relationships, social structure and territoriality of muntjac (*Muntiacus muntjak*) in lowland Nepal. M.Sc. Thesis, Agriculture University of Norway 52p.

Naess, K.M. and Andersen, H.J. 1993. Assessing census techniques for wild ungulates in Royal Bardia National Park, Nepal. M.Sc. Thesis, Agriculture University of Norway 102p.

Odum, E.P. 1996. Fundamental of Ecology. Third Edition, Nataraj Publishers, Dehradun, India.

Pokhrel, C.P. 1996. Food habit and habitat utilization of swamp deer (*Cervus duvauceli duvauceli*) in the RBNP, Nepal. M.Sc. dissertation submitted to the Central Department of Zoology, Tribhuvan University, Kirtipur, Kathmandu 38p.

Pokhrel, S. 2005. Distribution and abundance of wild ungulates in Royal Suklaphanta Wildlife Reserve,Nepal (vi+52p).

Schaaf, C.D. 1978. Population size and structure and habitat relations of the barasingha (*Cervus duvauceli duvauceli*) in RSWR, Nepal. Ph.D. dissertation Michigan State University 123p.

Schaller, G.B. 1967. The deer and the tiger: a study of wildlife in India. University of Chicago Press (Year of publication, 1967), Chicago, USA (iii+370p).

Seidensticker, J., Christie, S., Jackson P., 1999. Tiger ecology: understanding and encouraging landscape patterns and conditions where tiger can persist. In: Scidensticker, J., Christie, S., Jackson, P.(Eds), Riding the tiger: tiger conservation in human dominated landscapes. The Zoological society of London, Cambridge University Press, Cambridge, Pp. 55-60.

Shrestha, M.K. 2004. Relative Ungulate Abundance in fragmented landscape: Implications for tiger's conservation. A Thesis submitted to the faculty of the graduate school of the University of Minnesota. In partial fulfillment of the requirements for the degree of Doctor of Philosophy (vi+99p).

Smith, J.L.D. 1984. Dispersal communication, and conservation strategies for the tiger (*Panthera tigris*) in Royal Chitwan National Park, Nepal. Ph.D. Thesis, University of Minnesota, St. Poul, Minnesota USA.

Smith J.L.D., McDougal C., Ahearn, S.C., 1998 Landscape analysis of tiger distribution and habitat quality in Nepal. Conservation Biology 12, 1338-1346.

Smith, J.L.D., McDougal, C. Ahearn, S.C., Joshi, A. and Conforti, K. 1999. Metapopulation structure of tigers in Nepal. Pages 176-189 in J. Scidensticker, S. Christie, and P. Jackson editors, riding the tiger: tiger conservation in human-dominated landscapes. Cambridge University Press, Cambridge, United Kingdom.

Spitz, F. and Janeau, G. 1990. Spatial strategies: an attempt to classify daily movements of wild boar. Acta Theriol, 35: 129-149.

Sunquist, M., Karanth, K.U., and Sunquist, F. 1999. Ecology, behaviour and resilience of the tiger and its conservation needs. Pages 4-18 in J. Seidenstiker, S. Christie and P. Jackson, editors. Riding the tiger: tiger conservation in human - Dominated landscapes. Cambridge University Press, Cambridge, United Kingdom.

Tamang, K.M. 1982. The status of the tiger (*Panthera tigris*) and its impact on the principal prey population in the RCNP, Nepal. Ph.D. Thesis, Michigan State University 123p.

Thapa, V. 2003. Habitat heterogeneity and distribution of some ungulate prey species in Barandabhar Forest, Chitwan, Nepal. A thesis submitted in partial fulfillment of

the requirement for the degree of Master of Science. Agriculture University of Norway (NLH) (vii+79p).

Virgo's, E. 2002. Factors affecting wild boar (*Sus scrofa*) occurrence in highly fragmented Mediterranean landscapes. Canadian Journal of Zoology, 80: 430-435.

WII 2004. Conservation status of Tiger and associated species in the Terai Arc landscape, India. Wildlife Institute of India, RR - 04/001.

WWF 2002. Conserving tigers in the wild: A WWF framework and strategy for action 2002-2010. Species programme, World Wildlife Fund International, Gland.

WWF 2005. Annual Wildlife Monitoring report. World Wildlife Fund Nepal Programme.