Cibtech Journal of Zoology ISSN: 2319–3883 (Online)
An Online International Journal Available at http://www.cibtech.org/cjz.htm
2013 Vol. 2 (1) January-April, pp.30-39/Kumar and Subudhi
Research Article

ASSESSMENT OF GRASS SPECIES DIVERSITY AND WILD ANIMALS' OCCURRENCE IN *VAN GUJJARS* RELOCATED SITE OF THE RAJAJI NATIONAL PARK IN UTTARAKHAND, NORTHERN INDIA

***Harish Kumar[1] and S. P. Subudhi[2]**
[1]WWF-India, Dehradun Program Office, 32-1/72 Pine Hall School Lane, Rajpur Road, Dehradun, Uttarakhand-248001
[2]Conservator of Forest (Director Rajaji NP), Uttarakhand, Northern India-248001
**Author for Correspondence*

ABSTRACT
Tall wet grasslands in the northern alluvial flood plains of the river Ganges and Brahmaputra are popularly known as *Terai* grasslands. Rajaji National Park (RNP) with an area of 820.42 sq km is along the river Ganges in the state of Uttarakhand in northern India and forms part of *Terai* Arc Landscape, a prime tiger habitat. A study was carried out to estimate the occurrence of the wild animal species after relocation of *Van gujjars* in Chila and Motichur Ranges of Rajaji National Park. Five Van gujjars relocated sites were selected for the present study i.e. Mundal, Amgadi, Mitawali, Kara (in Chila range) and Koelpura (Motichur Range). Diversity of grass species were recorded during the study period. In addition, we assessed the presence of prey species using 1-0 sampling and in addition to that camera trapping was done in this study site to enumerate the capture rate of carnivore species using mark-recapture framework. The different grassland communities indentified are *Saccharum spontaneum – Imperata cylindrica* which is mainly found on the floodplains of the river beds, *Veteveria zizanioides* on upland areas, *Phragmites karka* and *Themeda arundinacea* on marshy areas. The total diversity of grass was found highest in Mundal (21) and lowest in Khara (11). All the five gujjars relocated sites are being recovery state. The camera traps and sign surveys results revealed that the large carnivores like Tiger, Leopard, Hyena, and Jackal, occupied sympatrically in these areas. Chital and Sambar are the most abundant species in these grasslands. The results revealed that the wild animals are frequently using these grasslands for feeding. Removal of anthropogenic pressure from such places, are effective management tool for the sustainable habitat management and wildlife conservation.

Key Words: *Grasslands, Habitat, Relocation, Sympatric*

INTRODUCTION
The subtropical, tall wet grasslands in the foothills of the Himalayas have been variously referred to as riverine, lowland, floodplain or *Terai* grassland (Kumar, 2012 and Kumar *et al.,* 2002; Kumar, 2002; Mathur, 2000; Lehmkuhl 2000, Peet *et al.,* 2000 and Wegge *et al.,* 2000). These grasslands occur in the east-west stretch of the northern alluvial lowland of Nepal; it includes floodplains of Ganga, Brahmaputra Rivers, and is best known as the *Terai* region. These grasslands are often dominated by pure dense stands of 6-8 m tall perennial grasses belonging to family Poaceae, which form a dynamic complex with interspersed woodland and swamps. High water table, annual flooding, and the synergistic influence of annual grassland fires characterize this complex (Lehmkuhl, 1989; 1994; Peet, 1997 and Peet *et al.*, 1997; 1999a, b). Uttarakhand is the state which holds several endangered faunal and floral species like Bengal tiger, Asian Elephant, Rhinos and Bengal Florican, but several species seismic because of high anthropogenic pressure. The high annual rate of deforestation (ca. 1.7%) in the last 16 years has been attributed mainly to human population growth leading to greater demand for farming land, fuel wood, fodder, over grazing, etc. As a result there has been encroachment into the forests, and to supplement their needs people are grazing, lopping and clearing the forests with such a rate that forest degradation has become a serious issue. Particularly in the Siwalik range in Uttarakhand where forest degradation rate was

2.3% per year, more grass species are being endangered due to heavily collection of Bhhabar grass. The lowland grasslands of the Siwalik region are dominated by *Saccharum spontaneum and Veteveria zizanioides*. Other important associated species in the region are: *Imperata cylindrica, Desmostachya bipinnata, Phragmites karka, Leucas cephalotes, Colebookea oppositifolia, Cyperus kyllingia, Ziziphus mauritiana, Cassia tora, Flemingia macrophylla, Bombax ceiba, Acacia catechu, Parthenium hirsuta* and *Argemone maxicana*. Studies on grassland analysis are highly limited in the Siwalik region. The present study was undertaken to determine status of grassland species diversity and wild animal occurrence in sites from where *Van Gujjars* have been relocated out of the Rajaji National Park of Siwalik region of Uttarakhand.

Study Area

The study site, Rajaji National Park, lying along the western limit of the Terai-Arc Landscape, is bisected into eastern (250 km^2) and western (570.42 km^2) sectors owing to development activities along the river Ganges. Rajaji National Park is located between $77^0$57'7'' and $78^0$23'36'' East and $29^0$51'7'' and $30^0$15'50'' North in Uttarakhand state in the districts of Dehradun, Haridwar and Pauri Garhwal (Figure. 1).

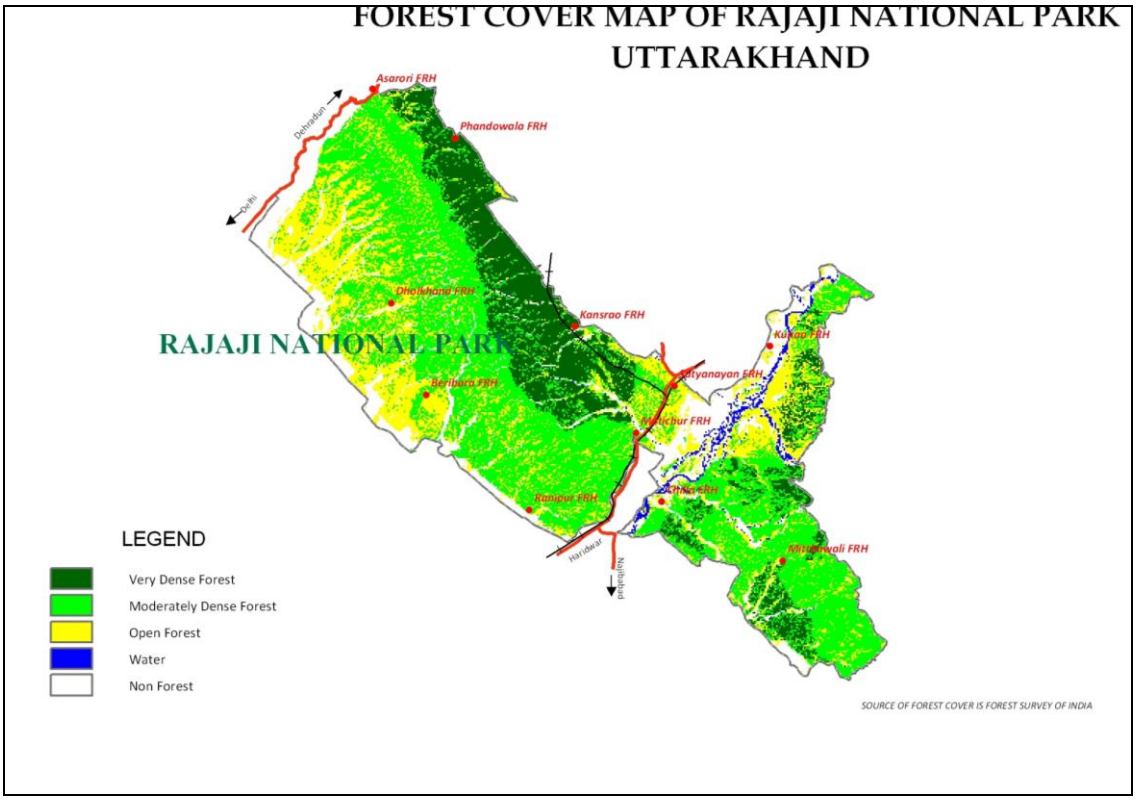

Figure: 1. Map of the Rajaji National Park

It is bounded in the west by Delhi-Dehradun highway and is contiguous with Lansdowne forest division and Rawson River in the East. To the South it extends up to the areas of intensive cultivation that opens up in the Gangetic Plain while to the North bank of the park is about 20 km. The Park spans over an area of 820.42 sq. km and was formed by joining three wildlife sanctuaries for the common interest to conserve biodiversity of Siwalik ecosystem was named after the first governor general of India, Mr. C Rajagopala Chari, who was popularly known as Rajaji. Total annual rainfall was 2357 mm and the monsoon rainfall was 1899 mm. Average relative humidity was 75%. The vegetation of RNP is mainly

composed of heterogeneous deciduous species of tropical subtropical origin with typical characteristics of central Sub Himalayan tract with average annual rainfall of about 1200mm. It represents vegetation of several distinct zones and forest types, like Riverine Forests, Broad leaves mixed forests, Scrub land and Grassy pasture land. There are five types of forests in the park: Moist Siwalik Sal, Dry Siwalik Sal. Northern dry mixed deciduous, *Khair-Sissoo* and lower Siwalik *Chir* pine (Champion and Seth, 1968). There is a wide range of species in each vegetation type which in turn, is influenced by aspect, altitude, soil and water. The moist Siwalik Sal forests are found on poor soils with some moisture. Dry Siwalik Sal forests are found on middle hills on sand rock, usually on ground traversed by nallah or gullies. Northern dry mixed deciduous forests grow on flat or gently sloping terrain on poor, sandy soils in the south. These forests are leafless in the dry months. *Khair-Sissoo* forests are found along the banks of rau (s) on sandy soil. *Chir* pine forests grow only along the higher elevations of the Siwalik ridges.

MATERIALS AND METHODS

A study was carried out to estimate the occurrence of the wild animal species after relocation of *Van gujjars* in Chila and motichur Ranges of Rajaji National Park. A comparison of palatable species of plants between areas inhabited and evacuated by *gujjars* showed significant regeneration which the tiger prey species utilized. Miscellaneous vegetation type was utilized intensively by the *gujjars*. In Chilla Range, a total of 240 plant species were recorded from the grasslands. The richness of plant groups were: herbs (141), grass (43), tree (25), shrub (15), climbers (10) and ferns (6). Majority species belong to *Poaceae* (43) followed by *Fabaceae* (26), *Asteraceae* (21) and *Lamiaceae* (12).

Five Van gujjars relocated sites were selected for the present study: Site I, Mundal; Site II, Amgadi; Site III, Mitawali; Site IV, Kara (in Chila range) and Site V, Koelpura (Motichur Range). Diversity of grass species were recorded during the study period. In addition, we assessed the presence of prey species using 1-0 sampling and in addition to that camera trapping was done in this study site to enumerate the capture rate of carnivore species using mark-recapture framework (Ramesh *et al.,* 2012 and Harihar *et al.,* 2009a, b). Vegetation analysis was done using circular plots based on IFRI (International Forestry Resources and Institutions Research Program, Indiana University) methodology (1994) and the sampling plot size was determined following Walker's (1976) method of having at least 15 to 20 grasses of the dominant species inside a plot. Two plots were systematically placed at 100, 300, 500 and 700 m distances along both side of each transect from each study site. This gave a total of twenty five plots for each site, in which we recorded grass species diversity, density, frequency, dominance and herbs according to method described by Mueller-Dombois and Ellenberg (1974) and Zobel *et al.,* (1987).

RESULTS

A total of 28 different species belonging to 11 different families were recorded from the study sites. Mundal (Site, I) had the highest number (21) of species while Site IV, degraded site, had the lowest number (10) of species. Sites I, II and IV each had five shrub species. Site IV, degraded forest, had the highest value for species loss (78.2% species), followed by Site I regenerating forest which lost 71.7% species (Table 1). Shrestha *et al.* (1998) have reported 68% loss of plant species in degraded forest as compared to natural forest in study site (Figure. 2). The different grassland communities deciphered by cluster analysis are *Saccharum spontaneum –Imperata cylindrica* which is mainly found on the floodplains of the river beds, *Veteveria zizanioides* on upland areas, *Phragmites karka* and *Themeda arundinacea* on marshy areas (Figure 3).

Habitat Use by Wild Animals

The cluster analysis broadly deciphered two categories i.e. Chital, Sambar and other mammal species as shown in the Figure 4. Spotted deer was separated and found in majority of the plots. Common Hare was found abundant in Mudal grasslands. Field studies in the study area revealed that the habitat was used by several species based on an assessment of presence/absence of their signs (dung, pellet and scats). Values

of percentage frequency of occurrence of assessed species in grasslands revealed that about 80% of the total 50 plots sampled showed some formal use by selected species. Distinctly, greater grass species was recorded at Sites I and IV than at other sites except Site III where *Saccharum spontaneum* showed maximum percentage (60%) while the other species exhibited smaller percentage. All grass at Site II showed lower proportion range which indicates the regenerating state of the site (7 years old). The total diversity of grass was found highest in Site II (21) and lowest in Site IV (11). All the five gujjars relocated sites are being recovery state.

Table 1: Grass species diversity in the Van Gujjars relocated site of the Rajaji NP

Species Code	Species Name
1	*Saccharum spontaneum*
2	*Imperata cylindrica*
3	*Veteveria zizanioides*
4	*Phragmites karka*
5	*Lucas cephalotess*
6	*Colebrookea oppositifolia*
7	*Ziziphus mauritiana*
8	*Lantana camara*
9	*Cyperus kyllingia*
10	*Argemone mexicana*
11	*Bothriochloa bladhii*
12	*Cassia tora*
13	*Clerodendrum indicum*
14	*Tamarix dioca*
15	*Olax nana*
16	*Themeda arundinacea*
17	*Parthenium hirsuta*
18	*Grewia sapida*
19	*Flemingia macrophylla*
20	*Desmostachya bipinnata*
21	*Saccharum bengalense*
22	*Apluda mutica*
23	*Lygodium flexuosum*
24	*Cynodon dactylon*
25	*Pogomeston benglensis*
26	*Sida rhombifolia*
27	*Solanum surattense*
28	*Seteria verticillata*

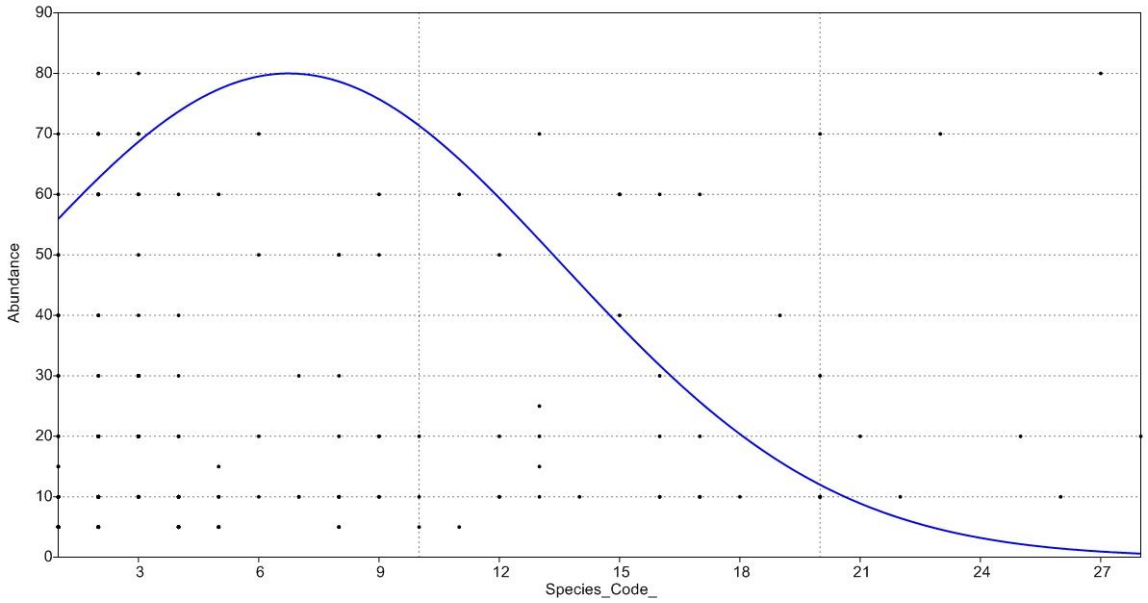

Figure 2: shows the plant species abundance in the Van gujjars relocated sites in the Rajaji NP

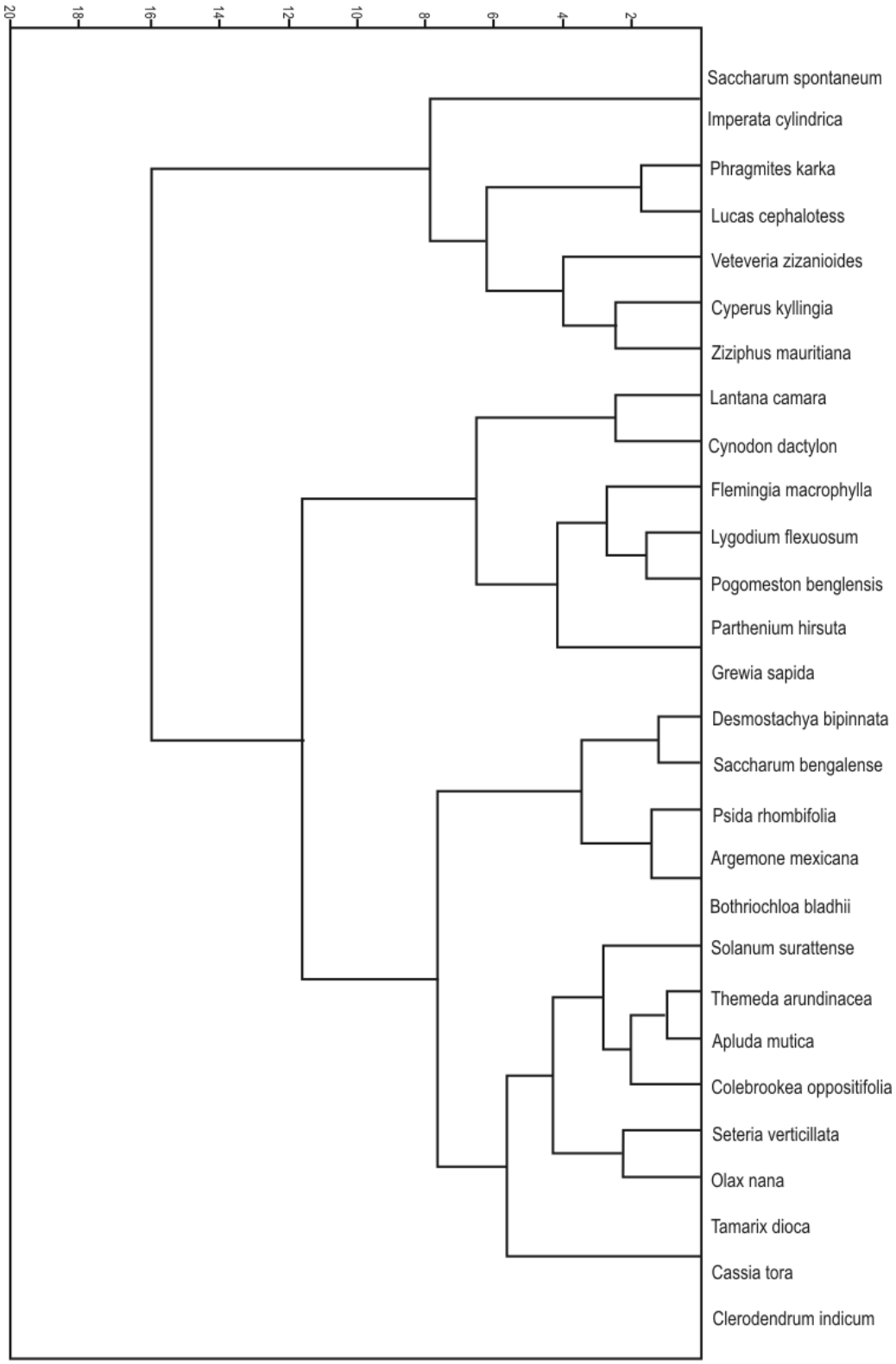

Figure 3: Heterogeneity cluster analysis shows the grass species composition and assemblage in the Van gujjars relocated site in the Rajaji National Park

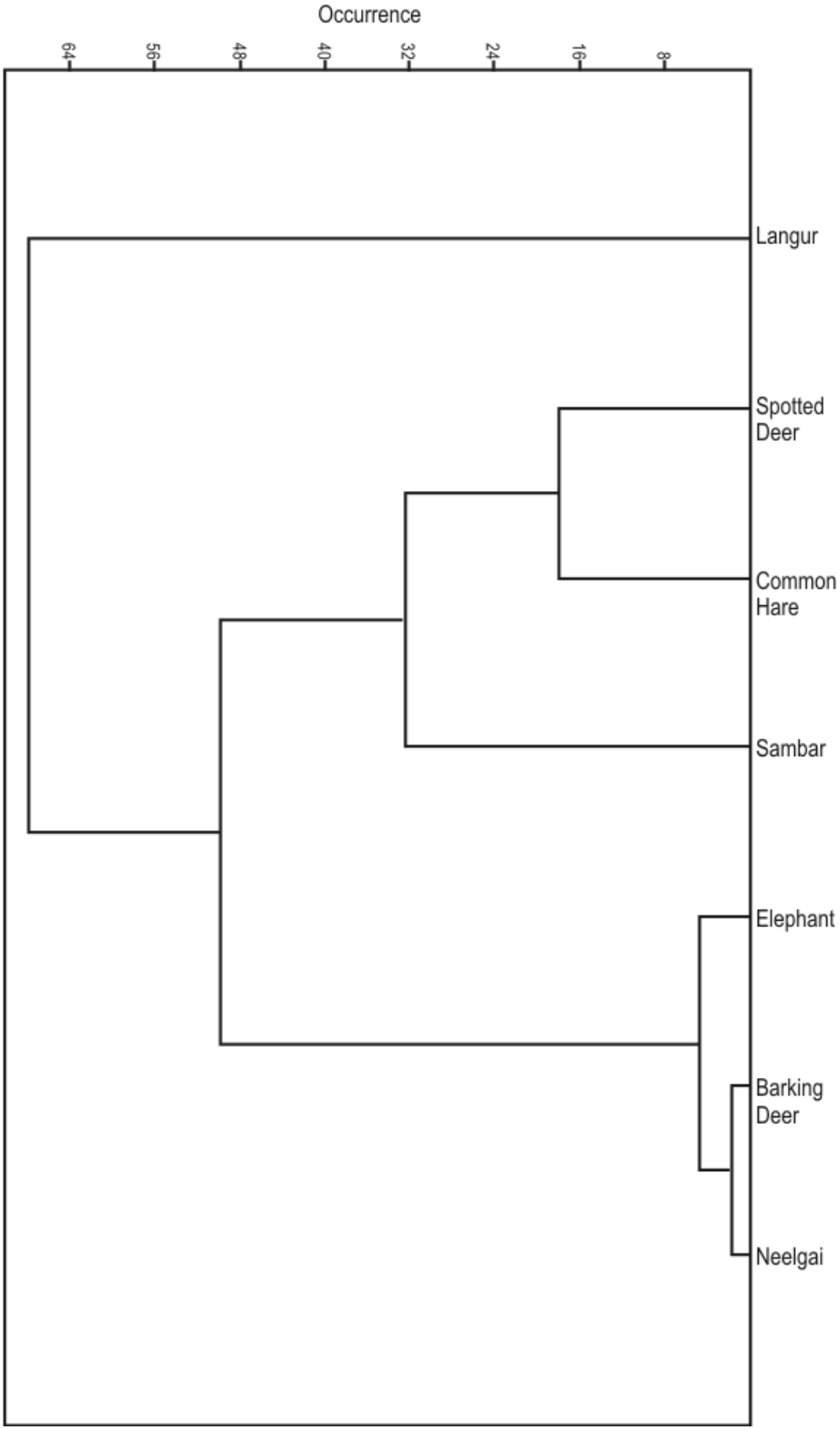

Figure 4: Cluster analysis shows the Prey species occurrence in the Van gujjars relocated site in the Rajaji National Park

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Wild Animal's Occurrence (Capture Rate) in the Study Grasslands

This study has been conducted in Rajaji National Park from June to August of 2012. The study was carried out with the objective to see the occupancy pattern of sympatric carnivores in five major grasslands (four in Chilla Range and one in Motichur range) of Rajaji national park as well as after the voluntary resettlement of the Gujjar communities. We deployed 18 pairs of automatic triggered cameras (*Cuddle Back Attack*) in five study grasslands of Rajaji National Park for sixteen days as well as we also did sign surveys though the trails and routes in these grasslands to obtain information about the wild animal's occurrence.

The Rajaji National Park in the Indian Part of Terai Arc Landscape forms the North western limit of many endangered and flagship species in the country. These include large mammalian herbivores like Elephants as well as the flagship species like Royal Bengal Tiger. The camera traps and sign surveys results revealed that the large carnivores like Tiger, Leopard, Hyena, and Jackal, occupied sympatrically in these areas. Tiger was detected in 5 camera trap location (n=18) of the study area with a highest mean (±SE) capture rate of 0.19±0.03 recorded in Koelpura grassland in the Motichur range. The Leopard was captured at Koelpura, 0.13±0.02 and Mithawali, 0.06±0.01 grassland. Hyena detected in Amgadi, 0.25±0.04 and Mithawali, 0.06±0.01. The avg. capture rate of tiger is found to be highest (0.09/day), among all the sympatric carnivores followed by leopard (0.04/day), hyena (0.06/day) and Jackal (0.01/day) in the studied grasslands. The tiger and leopard were detected in Koelpura and Mithawali with highest capture rate and leopard has high capture rate in Koelpura and Hyena was found only in Mithawali and Amgadi (Table 2 and 3).

Table 2: Mean (±SE) capture rate of cryptic and non-cryptic wild animal species photographed in the RNP

Name of the Grassland	Tiger	Leopard	Hyena	Jackal	Elephant	Chital	Sambar	Wild boar
Koelpura	0.19±0.03	0.13±0.0	-	0.06±0.1	1.13±0.18	8.19±1.31	2.06±0.33	0.88±0.14
Khara	0.13±0.02	-	-	-	3.38±0.54	-	0.88±0.12	-
Mundal	0.12±0.02	-	-	-	1.06±0.17	25.19±4.0	2.69±0.43	1.44±0.23
Amgadi	-	-	0.25±0.04	-	0.50±0.08	0.50±0.08	2.81±0.37	0.25±0.04
Mithawali	-	0.06±0.0	0.06±0.01	-	0.31±0.05	0.56±0.09	0.69±0.11	0.19±0.03
Average	0.09±0.01	0.04±0.0	0.06±0.01	0.012±0.2	1.28±0.20	6.89±1.10	1.8±0.27	0.55±0.09

Table 3: Mean (±SE) capture rate of other smaller wild prey species photographed in the RNP

Name of the Grassland	Peacock	Porcupine	Rhesus Monkey	Common Hare	Common Langur	Vulture	Civet
Koelpura	0.31±0.05	1.25±0.02	0.56±0.09	-	-	-	-
Khara	0.44±0.07	1.25±0.02	-	-	0.13±0.02	0.06±0.01	-
Mundal	0.69±0.11	1.62±0.26	-	0.31±0.05	-	-	0.06±0.01
Mithawali	0.56±0.09	-	-	-	-	-	-

Among other smaller wild prey species porcupine, hare, monkey, common langur, civets were found in the study area (Table-3). In Mundal grassland hare and civet were found with capture of 0.31±0.05 and 0.06±0.01 respectively. Porcupines were detected in three sites Koelpura, Khara and Mundal, the capture rate was maximum 1.62±0.26, in Mundal. Among birds peacock and vultures were detected. Encounter rate (/km) of the sympatric carnivore species were based on the sign survey. Signs of tiger, leopard, sloth bear, and jackal were found in the grasslands and results are given in the Table-4. The mean encounter rate of leopard (0.39 ± 0.09) was higher than the other carnivore species. The elephants were detected all the grassland of the study area, and the highest capture rate was found to be 3.38±0.54 in the Khara grassland. Among the ungulate species Chital was detected in four sites, with a highest capture rate of

25.19±4.03 in Mundal. Sambar was found in all these grasslands, and detected highest in the Amgadi. Wild boar was detected maximum in Mundal grassland.

Table 4: Encounter rate (/km) of the carnivore species recorded from the study area

Species	**Tiger**	**Leopard**			**Sloth bear**
Sign type	Pugmark	Pugmark	Scat	Scrape	Scrape
Encounter Rate	0.05 ± 0.0	0.39 ± 0.09	0.16 ± 0.01	0.04 ± 0.0	0.02 ± 0.00

These sympatric carnivores fairly prefer those grassland because the high density of prey species like Chital had the highest capture rate was (6.89/day) followed by Sambar (1.8/day), Elephant (1.28/day) and Wild boar (0.55/day) attracted by rich fodder and enough water source available moreover avoiding the predation (Fig. 3). Chital and Sambar are the most abundant species in these grasslands. However other species like Porcupine, Small Indian civet, Sloth Bear, Common Hare are also recorded during the camera trap. So the results revealed that the wild animals are frequently using these grasslands for feeding. Removal of anthropogenic pressure from such places, are effective management tool for the sustainable habitat management and wildlife conservation.

Conclusion

Occupancy of wild animals in a natural habitat provides a reasonable estimate of their population status and trends, and it also provides an unbiased, cost-effective alternative method for large-scale, multispecies monitoring programs. In this study, we used camera-trapping and sign survey (e.g., scat, scrape, pugmark and scent mark) data to determine carnivore occupancy and associated environmental factors. The study can be use as a precursor of further long-term multispecies monitoring programs.

The Park has a crucial role in conserving wildlife. In recent times this area came into lime light because of the various problems like rehabilitation issues of Van Gujjar, over grazing of cattle, fringe villages and poaching (Johnsingh *et al*., 2004). RNP is representative of the Siwalik Landscape, which is known for its richness of biological diversity as well as acute eco-fragility. It forms the North-Western limit of distribution of many endangered species like Asian Elephant, Tiger, Great Pied Hornbill and King Cobra. Species found at the extreme end of their distribution limit are generally very susceptible to local extinction and conservation poses tremendous challenges to field managers. However, since 2005 settlements from most parts of western RNP (400 km2) have been voluntarily relocated and the subsequent strengthening of protection in these parts has resulted in the cessation of *bhabar* grass collection. In addition, high prey densities (110 ungulates/ km2) within western RNP indicate that protection, at least within the park, is effective. Since these areas are adequately staffed, equipped and financed, long term effective management could serve as a tool to provide managers with the information they need to make strategic decisions as direct killing of wildlife are the most immediate concerns in securing animal populations range wide.

ACKNOWLEDGEMENT

We greatly thank to the Mr. SS Sharma Chief Wildlife Warden, Uttarakhand Forest Department for permission and kind support for the fieldwork. The work would not have been possible but for the daily hard work taken by the field team K. Narsimmarajan and field assistants Rajendar Bist and Ramesh, we remain forever indebted to their work. Sincere thanks goes to Mr. Abishek Harihar and Jatinder Kaur their constant support and technical inputs.

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