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To estimate the population density of Chital, Nilgai and Sambar by using Distance sampling method in Darrah Wildlife Sanctuary Kota, Rajasthan.

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The study was carried out in Darrah Wildlife Sanctuary from July 2012 to July 2013.Darrah Wildlife Sanctuary (DWLS) lies in the Hadoti region of Kota district in Rajasthan and lies between 24º37' to 25º2' N Latitude and 75º39' to 76º12' E Longitude. Darrah Wildlife Sanctuary comprises of 250 sq km, the area is divided into two ranges, Kolipura range and Darrah range. The climate of the sanctuary is subtropical, characterized by long and intense hot summer, with low rainfall and short but acute winter. The total population of ungulates in direct encounter is 2145 in total of 10 efforts and species wise the population of Nilgai is 1145, Sambar 390, Chital 612. The densities of ungulates are, 12.07/sq.km of Chital, 15.98/sq.km of Nilgai, and 4.36/sq.km of Sambar As compared to the density of ungulates with other protected area (Tiger Reserve), the density of ungulate in study area is very low except for Nilgai. The area of Darrah Wildlife sanctuary forms a major part of the recently declared Mukundara Hills Tiger Reserve in 2012. For future Tiger relocation, in the study area, mitigative measures should be taken up to improve the preferable prey and habitat of ungulates throughout the sanctuary. The main anthropogenic factors for low density of these ungulates are fragmentation, land encroachment, stone mining and livestock grazing.

Keyword: ungulate, population, prey, density.

INTRODUCTION

Ungulates account for the vast majority of large herbivore currently on earth. Their influence stretches across nearly every biome, and their indigenous range include all zoogeographic region except Antarctica. With human help ungulates have expanded into nearly every corner of the globe. India has 39 species of ungulates (Sankar 2008). The International Union for Conservation of Nature and Natural Resources (IUCN) has listed two Indian wild ungulate species as Critically Endangered, 5 species as Endangered, 14 species as Vulnerable and 12 species as

lower risk, and Rajasthan has seven ungulate species. Out of seven, five specie are commonly found in Darrah Sanctuary.

We put our flank on the present status of ungulates in wild and saw abrupt change in population as compare to early 80`s. This emphasizes the need for systematic monitoring of biodiversity components at various scales. Several long-term field studies have stressed the need to maintain healthy herbivore populations, both in terms of overall biomass as well as community structure, if they are to support viable population of large carnivores (Karanth & Sunquist, 1995; Sunquist, Karanth & Sunquist, 1999; Karanth & Stith, 1999). The studies and monitoring of the herbivore population not only gives the accurate data of herbivore but it also provides the ecological processes of landscape and ecosystem level (Jathanna *et al; 2003*).

Study Area: Darrah Wildlife Sanctuary (DWLS)

Darrah Wildlife Sanctuary (DWLS) lies in the Hadoti region of Kota district in Rajasthan. The sanctuary lies between 24º37' to 25º2' N Latitude and 75º39' to 76º12' E Longitude. Darrah Wildlife Sanctuary comprises of 250 sq km, the area is divided into two ranges, Kolipura range and Darrah range. For intensive study the area is further divided into three zones; zone I (Kolipura range), zone II (Darrah range up to Railway crossing and NH-12) and zone III (Mashalpura area). The climate of the sanctuary is subtropical, characterized by long and intense hot summer, with low rafall and short but acute winter.

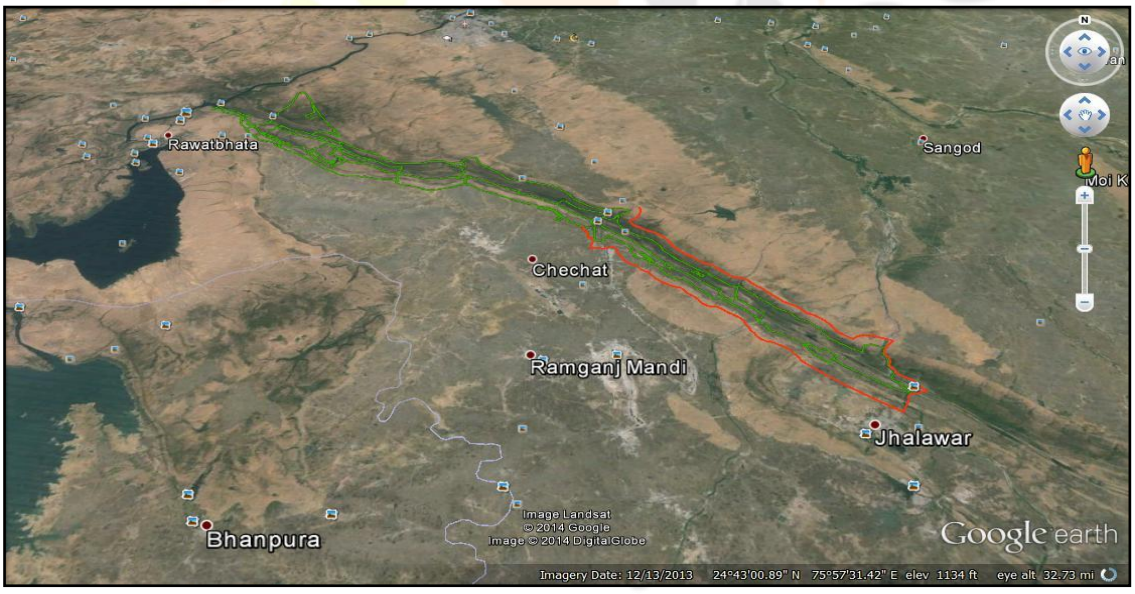

Fig 1: Map of Darrah Wildlife Sanctuary

Methodology

Distance sampling by line transects (Burnham, Anderson & Lake, 1980; Buckland *et al.*, 1993) was used to estimate densities of chital, sambar, nilgai, chinkara, wild pig and common langur in the ISA. This method is efficient (Anderson *et al.*, 2001) and has been widely applied in tropical forests Karanth & Sunquist,1992; Varman & Sukumar, 1995; Khan *et al.*, 1996;Biswas & Sankar, 2002) as it provides relatively unbiased results if certain assumptions are met (Buckland*et al.*, 1993) The.10 line transects (ranging from 2.2 to 3.6 km) were laid in a stratified random manner according to broad topographic classes like slopes, scrub land and plateau, total 288 km.. Each transect was walked 10 times during morning and evening hours when animals were most active, resulting in 288 km of walk. On every animal sighting, the following data were recorded:(1) *Species and group size*: one or more animals of the same species within 30 m of each other and showing signs of coordinated movements were considered as a group; (2) *Sighting angle*: sighting angle to the centre of the group recorded using a liquid –filled compass (Sunto). (3) *Sighting distance*: the distance to the centre of group from the point of observation was measured using a range finder (Yardage Pro 400, Bushnell, Overland Park, Kansas, USA).The program Distance (version 6.0))was used to estimate animal densities. Selection criterion was Akaike Information Criterion (AIC) and the distance scaled by width of line transect. By used of DISTANCE system the following modulate as ESW (Effective strip width).D density of animals, DS density of clusters, N number of animal and E(S) cluster size. The final density estimator model was Uniform key and Cosine adjustment of 1, 2 orders in minimum AIC.

Result and Discussion

The total population of direct encounter is 2,147 in total of 10 efforts and it can be seen species wise population of Nilgai is 1145 with highest number in the whole Sanctuary area likewise Chital 612 and Sambar 390 (Table 1) with lowest number in the Sanctuary and the upper side of Kolipura range, Darrah range (Laxmipura) and Roantha is favourable habitat for these species, Chital and Sambar population is less but as compared to other Sanctuaries and Parks on the basis of area and habitat the population of these species would play a vital role in the prey abundance and biomass for Tiger in Mukundara Hills National Park and Mukundra Tiger Reserve.

Table 1: Number of animal seen on various transects during study period in DWLS

Species	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Total
Nilgai	151	136	51	81	110	162	145	139	77	93	**1145**
Sambar	73	65	36	21	29	21	57	39	27	22	**390**
Chital	95	85	53	63	68	45	94	70	18	21	**612**
Total	**319**	**286**	**140**	**165**	**207**	**228**	**296**	**248**	**122**	**136**	**2147**

Among all the ungulate species Nilgai is common and widely distributed throughout DWLS and contributes 53.33 % of the total wild ungulate density. Chital 28.50% was the second most abundant species in DWLS followed by Sambar 18.16% respectively. Karanth and Stith (1999) show that prey distribution and density determine first order and second order habitat selection by tiger respectively. The estimates of prey density arrived at in this study show that Kolipura range and Darrah range of DWLS harbours a high density of prey species primarily contributed by Nilgai and Chital 81.83% whereas Sambar contributed 18.16% of total density (Table 1).

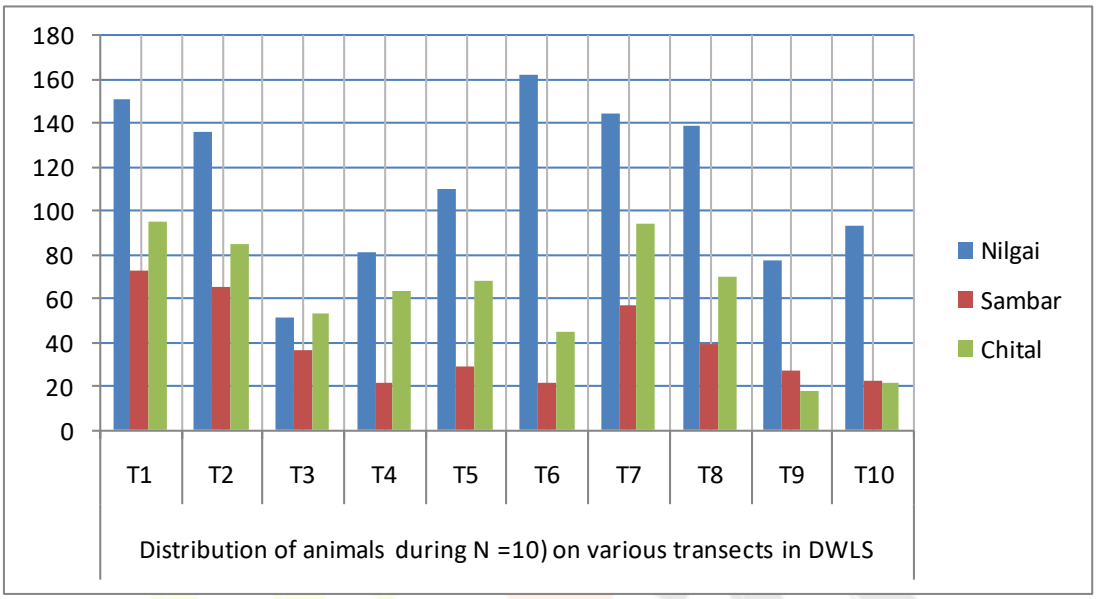

Figure 2 : Distribution of animal on various transects during study period in DWLS

Table2: Result of Encounter rate of Chital, Nilgai and Sambar in DWLS

Species	Sample	effort	Encounter rate/km
Chital	10	288	0.61
Nilgai	10	288	1.06
Sambar	10	288	0.68

Table 3: Population density of Ungulates Chital, Nilgai and Sambar in DWLS

Species	Effort	EWS/ m	Density of cluster/km²	Density of animal/km²	Estimated Population	Model	Function
Chital	288	97.935	1.1966	**12.07± 1.72**	612	Uniform	Cosine
Nilgai	288	132.68	2.7082	**15.98 ± 1.84**	1145	Uniform	Cosine
Sambar	288	95.245	1.3541	**4.36 ± 0.33**	390	Uniform	Cosine

Nilgai was found to be the most abundant ungulate species in the study area with maximum encounter rate 1.06 individuals/ km^2 as compared to other species (Table 2), it was found to be moderate and maximum in whole Darrah Wildlife Sanctuary. Chital, Sambar and Nilgai were found to be bestowed with the highest number in Darrah range and Kolipura range of DWLS. The next abundant ungulate species observed was Sambar with encounter rate 0.68 individuals/km^2 followed by Chital with 0.61 individuals /km^2 it was found to be almost evenly distributed.

Table.4 Herbivore densities comparison with earlier studies of different protected areas of India

Location	Habitat	Chital	Sambar	Nilgai	Wildboar	Chinkara	Muntjac	Langur	Gaur
Ranthambore NP1	Semi-arid dry deciduous	38.4	10.7	NA	NA	NA	SA	NA	SA
Ranthambore NP 2	Semi-arid dry deciduous	13.4	8.61	6.98	2.27	NA	SA	NA	SA
Sariska NP 3	Semi-arid dry deciduous	10.33	13.34	23.56	4.11	NA	SA	NA	SA
Sariska NP 4	Semi-arid dry deciduous	27.62	8.44	5.19	17.53	NA	SA	NA	SA
Gir NP	Semi-arid dry deciduous	57.3	3.5	.58	NA	NA	SA	NA	SA
Pench NP 5	Dry deciduous	51.3	9.6	NA	NA	SA	NA	NA	0.7
Pench NP 6	Dry deciduous	80.75	6.09	0.43	2.59	SA	NA	NA	NA
Bandipur NP	Dry	20.4	5.6	SA	NA	NA	0.7	NA	7

7	deciduous								
Bandipur NP 8	Dry deciduous	43	8	SA	2.5	NA	NA	NA	NA
Kanha NP	Moist deciduous	49.7	1.5	NA	2.5	SA	0.6	NA	NA
Nagarahole NP 9	Moist deciduous	50.6	5.5	SA	NA	SA	4.2	NA	23.8
Nagarahole NP 8	Moist deciduous	38.1	4.2	SA	3.3	SA	NA	NA	NA
Darrah Sanctuary	Semi-arid dry deciduous	5.77	6.53	13.06	7.44	3.57	SA	NA	SA

Density of species (km-²)
NP-National park
NA- estimates not available,
SA- Species absent / very low density,
Gir- Khan *et al*; (1996); **Kanha**- Karanth & Nicholes (2000);
1- N. S. Kumar (2000); 2- WII, (2005);
3- Avinandan (2003); 4- WII, (2005);
5- Karanth & Nichols (2000); 6- Biswas & Sankar (2002);
7- Karanth & Nichols (2000); 7- Johnsingh (1983);
8- Karanth & Sunquist (1992) 9- Karanth & Nichols (1998)

Conservation Issues and Recommendations

Compared to the animal densities in other protected areas (tiger reserves) with similar habitat conditions the animal density is much less, except for Nilgai. If DWLS has to flourish as tiger reserve there is a great need to increase the population of key herbivores. This can be done through strict improvement of protection, habitat manipulation, providing water during pinch period etc. None of the single National park and Sanctuary of India is problem free. Besides all these problems Darrah Wildlife Sanctuary has its own problem-

i) Transportation system-

Recently this area was proposed for the Critical Tiger Reserve but nobody has still forgotten that incident happened on 15-07-2003 when the famous Ranthambore tiger "Broken tail" was killed by train while crossing the Delhi-Mumbai railway track near the Darrah Goan (Eastern part). State highway NH33 Kota to Rawatbhata (western part) and NH 12 (eastern part) is also causing main disturbance to animals in this area. Wild animals are facing accidents while crossing the road and railway track.

ii) Villages inside the Park-

There are 19 villages inside the DWLS and some of them are highly populated such as Laximpura, Damodarpura, Gridarhpura and Kolipura and these villages have more than 40,000 live stock animals including cattle, sheep, goat,

camel which are generally put for grazing inside the sanctuary throughout the year, which makes competition between wild herbivore for fodder and transmitting the wild diseases. Domestic cattle also transmit diseases such as Rinderpest to wildlife. Bhadra Wildlife Sanctuary, which was once known for very high gaur densities, lost several of these animals in a Rinderpest epidemic in 1989 and the gaur population is yet to recover. (Jathanna 2000). Besides these problems the weed invasion *Lantana camera* is invading this sanctuary gradually, especially towards the Eastern part. *Lantana camera* needs phased eradication and replacement with the local suitable species. The local tribes are highly depended on the forest resources, although they have rights of extraction of fallen dry wood on their head for their domestic use but sometimes illegal cutting of trees is also done by tribal and local villagers to sells the fuel wood in the markets of nearby town. Encroachment on forest land poses serious threats to the sanctuary.

The state government and other NGO's were giving their 100 percent for protecting the wild animals from poaching, land encroachment, road kills., Announcements for Fence barriers has also been done by State Government with the help of Indian Railway on both side of the railway track. Relocation of villages will play a great role in increasing the ungulates in the DWLS. The waterholes should be strictly watched during the summer time. Patrolling system is very much drastic in this Sanctuary therefore needs to be further intensified by using mobile squad.

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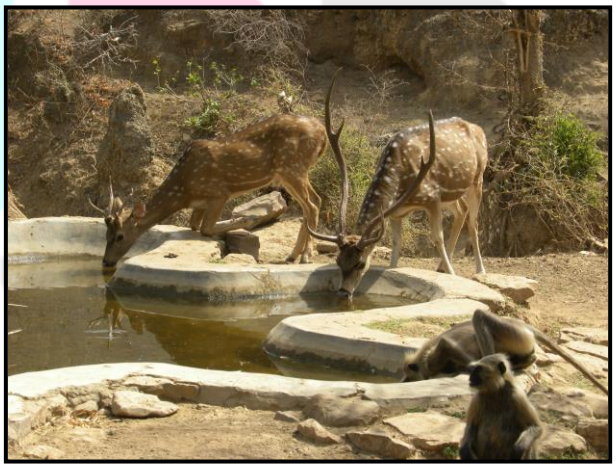

Nilgai and Chital at Laxmipura Water Point in DWLS

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