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Status of Golden Jackal *Canis aureus* and ungulates in a small enclosed area- Van Vihar National Park, Madhya Pradesh, India

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Abstract: We estimated densities of Golden Jackals and five ungulate species in Van Vihar National Park, Madhya Pradesh, India. It is an enclosed area of about 4.45km², out of which 3.5km² is available for free ranging animals. Twenty-six transects with a combined length of 22.6km and an effort of 50.2km were walked. A total of 1079 animal detections belonging to six different species were made. The density of jackals was (17±3.8SE)/km². Among the ungulates, chital had the highest density (118±18.8SE)/km² followed by Sambar (34.1±6.9 SE)/km², Nilgai (13.1±2.8SE)/km², Blackbuck (6.6±1.5 SE)/km² and Wild Pig (3.7±0.8 SE)/km². The ungulate biomass was found to be (12979.2±2463.26 SE)kg/km². Chital biomass was the highest at (5574.2±886.58 SE)kg/km², followed by Sambar biomass of (4569.4±913.75 SE)kg/km², Nilgai (2358±523.24 SE)kg/km², Blackbuck (211.2±66.18 SE)kg/km² and Wild Pig (118.4±28.37 SE)kg/km². The sex ratio was calculated and most ungulates had female-biased adult sex ratio.

Keywords: Biomass, *Canis aureus*, density, Golden Jackals, line transect, population, ungulates.

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Author Contribution: SP - Study design, Analysis, Field Work, Lab Work, Writing; AE - Study design, Analysis; YD - Logistics, study design.

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INTRODUCTION

Scientific monitoring programs developed for the purpose of management have two objectives: to identify the state of the system and to provide information on the response of the system to the management actions (Yoccuz et al. 2001). Monitoring of carnivores and ungulate populations is needed to evaluate the success or failure of management practices, to establish standard data that can serve as a basis for future management and to develop a body of empirical and theoretical knowledge that can improve our capacity to deal with new situations (Karanth et al. 2002). Van Vihar National Park (VVNP) is a small protected area, which has also been developed and managed as a modern zoological park. The major carnivore in VVNP is the Golden Jackal *Canis aureus*. Ungulates found here are Chital *Axis axis*, Sambar *Rusa unicolor*, Nilgai *Boselaphus tragocamelus*, Blackbuck *Antilope cervicapra* and Wild Pig *Sus scrofa*. The aim of our present study was to obtain the first objective, i.e., to characterize the state of the system by obtaining a baseline estimate of population densities of Golden Jackals and five species of ungulates in the park, so that future management decisions are based on scientifically gathered data.

MATERIALS AND METHODS

Study Area

We estimated the densities of the Golden Jackal and some ungulates using line transect sampling in VVNP (23.2300^{0}N & 77.3664^{0}E), Madhya Pradesh, India, between March and May 2013. VVNP is situated at the foot of the Shyamla Hills, which is one of the several hills constituting the geography of the city of Bhopal, the capital of Madhya Pradesh in central India. It is on the fringe of the Upper Lake, which is a Ramsar Site, and was declared as a national park in 1983. The total area is about 4.45km², out of which only 3.5km² is available for free ranging animals, the rest being enclosures for captive animals. It houses species like Tiger *Panthera tigris*, Leopard *Panthera pardus*, Lion *Panthera leo persica*, Sloth Bear *Melursus ursinus*, Striped Hyena *Hyaena hyaena*, crocodiles and several species of snakes (Van Vihar National Park 2011).

The natural areas are tropical dry deciduous forest, comprising of species such as *Aegle marmelos, Wrightia tinctoria, Cassia fistula, Acacia nilotica, Anona squamosal, Anogeissus latifolia, Adina cordifolia, Butea monosperma, Phoenix* spp., *Holarrhena antidysenterica, Acacia catechu, Diospyros melanoxylon, Lagestromia parviflora, Tamarindus indica* and *Zizyphus mauritiana.*

VVNP has a concrete wall above which there is barbed wire fencing along its northern and eastern boundary. On its west, the VVNP has a five kilometer stretch of lake fenced off with a wire mesh. The areas abutting VVNP are the residential localities of Shyamla Hills and Prempura Village, and the campuses of the Regional Institute of Education and Indira Gandhi Rashtriya Manav Sangrahalaya (National Museum of Mankind), an anthropological museum. However, given the natural topography of the area, it is possible that the jackals from within VVNP can venture into the neighboring townships to exploit garbage resources. There are many visitors to this park, there are dustbins provided for the public use. There is a canteen and some tea shops. The scraps of leftover food from the housed carnivores are often dumped within VVNP and are likely scavenged upon by the jackals.

Method

VVNP has 26 permanent systematically marked transects for annual census of free ranging animals (Fig. 1.), totaling a length of 22.6km. These 26 transects were walked in summer (March and April) in the early morning and evening during times of peak jackal (Patil & Jhala 2008) and ungulate activity (Sankar & Goyal 2004). While walking on these transects, whenever an animal or group of animals was/were detected, a laser rangefinder (Bushnell Sports 850) was used to record the sighting distance to the animal or center of the group and a magnetic compass (Suunto MC-2) was used to record the bearing to the animal or center of the group. Other data such as date, time, cluster size, species, numbers and whenever possible sex and age class (adult, sub adult and fawn/calf) were also recorded. To estimate density of jackals and ungulates of VVNP, analysis was carried out for each species using Program DISTANCE 6.0 release 2 (Thomas et al. 2010). Exploratory analyses of the data were carried out (Buckland et al. 2001) to check for any evidence of evasive movement before detection, 'rounding' and 'heaping' of data and to truncate outlier observations, if necessary, for improving model fit. The fit of possible alternative models to each data set was judged using Akaike information criteria (AIC) values (Buckland et al. 2001) which presented a compromise between the quality of fit and increased number of model parameters and the goodness of fit tests generated by program DISTANCE (Burnham & Anderson 2003). Once an appropriate model was selected, parameters such as encounter rate (n/L), strip width (ESW), average

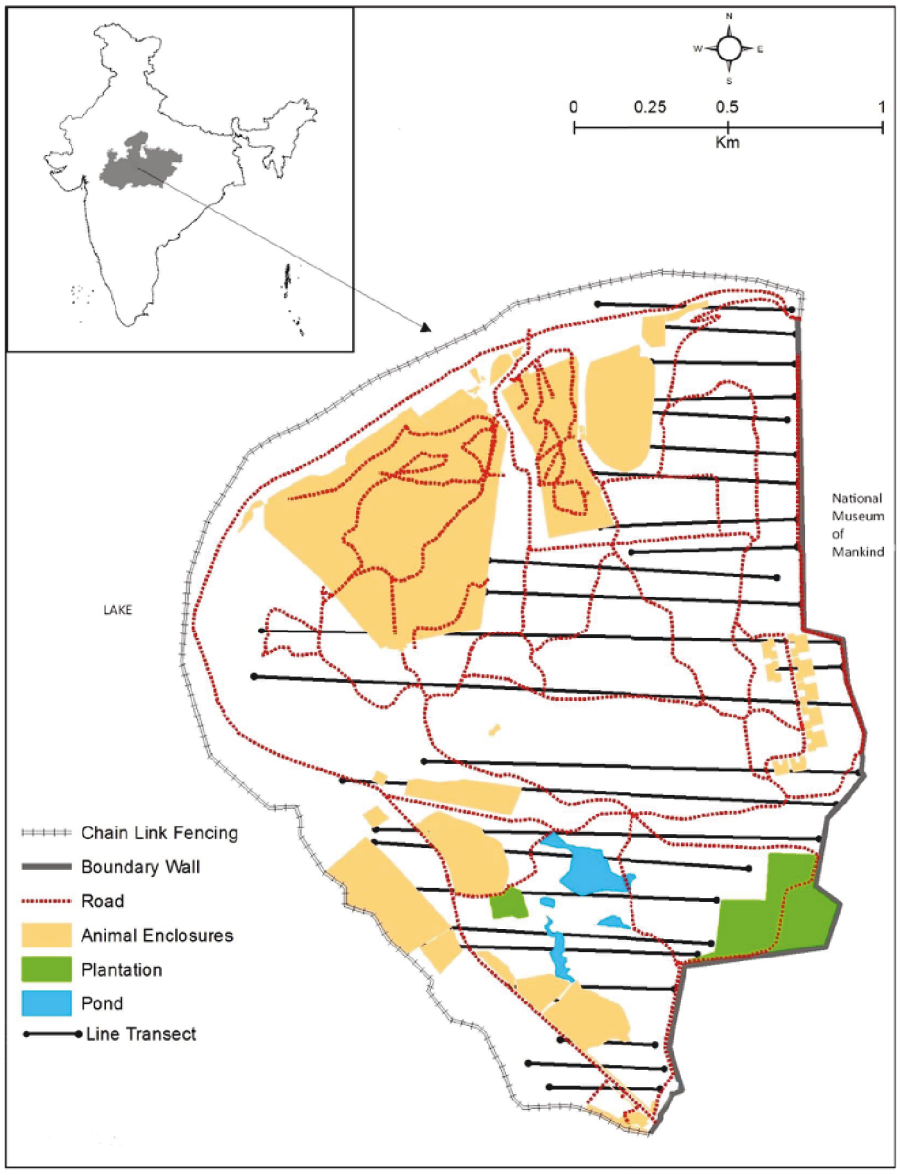

Figure 1. Map of Van Vihar National Park showing the location of transects.

probability of detection (p), cluster density (Ds), cluster size (Y) and animal density (D) were estimated by program itself (Burnham et al. 1980; Buckland et al. 1993). We computed sex ratio using the "sampling with replacement" (Skalski et al. 2005) approach as number of adult females to adult males.

The density estimates were then used to estimate the biomass of ungulates in the study area. The biomass (kg/km^2) of each ungulate was calculated by multiplying the mean individual density (D) by its average estimated unit weight (Wegge et al. 2009). Estimates of body weight for south Asian major ungulate species were obtained from Schaller (1967), Eisenberg & Seidensticker (1976), Johnsingh (1983), Mungall (1991), Karanth & Sunquist (1992), Wegge et al. (2009) and Leslie (2011).

RESULTS

Density Estimation

In total, 50.2km were traversed with a total of 1079 animal observations belonging to six different species (Table 1). While a total six species were sighted, adequate numbers, i.e., ≥40 (Burnham et al. 1980; Buckland et al. 1993) were available for jackals, Chital, Nilgai, Sambar, and Blackbuck but not for Wild Pig. The sex ratio of most ungulates was female biased. Sex ratios of four ungulates are presented in Table 2. The Sambar dataset showed evidence of 'heaping' of data. Based on comparisons of AIC values, the half–normal model with one cosine adjustment best described the jackal, Chital and Nilgai dataset, with polynomial adjustment fitted

Table 1. Number of detections and density estimates of jackals and ungulates in Van Vihar National Park Bhopal, Madhya Pradesh

Species	N	Best fit model	Y(SE)	ESW (SE)	p(SE)	n/L	Chi sq p-value	DS (SE)	D (SE)	%CV (D)	CI (D)
Blackbuck	51	Uniform/Polynomial	2.2 (0.3)	175.0	1.0	1.0	0.8	2.9 (0.5)	6.6 (1.5)	23.21	4.1 10.4
Chital	598	Half-normal / Cosine	2.9 (0.2)	127.6 (7.8)	0.5 (0.03)	11.9	0.7	46.6 (7.2)	118.6 (18.8)	15.90	86.1 163.2
Jackal	108	Hazard/Polynomial	1.25 (0.07)	77.8 (9.6)	0.4 (0.05)	2.2	0.8	13.8 (3.1)	17.0 (3.8)	22.56	10.8 26.5
Nilgai	108	Uniform/Polynomial	2.1 (0.2)	170.8 (10.8)	0.7 (0.05)	2.2	0.5	6.2 (1.2)	13.1 (2.8)	21.46	8.5 20.2
Sambar	160	Half-normal / Cosine	2.7 (0.2)	135.7 (10.1)	0.7 (0.06)	3.2	0.9	11.7 (2.2)	34.1 (6.9)	20.36	22.7 51.2
Wild pig	37	Uniform /Polynomial	1.1 (0.06)	112.8 (9.2)	0.6 (0.05)	0.7	0.9	3.2 (0.7)	3.7 (0.8)	23.60	2.3 5.9

N - Number of detections; SE - Standard error; DS - Group density/km^2; D - Individual density/km^2; CI - 95% Confidence interval; n/L - Encounter rate; ESW - Effective Strip Width; %CV - Percent coefficient of variation; Y - Mean Cluster size; p - Detection Probability.

Table 2. Sex ratio of the ungulates species of VVNP, Bhopal.

Species	Female	Male	Sex ratio (SE)
Chital	732	461	1.59(0.29)
Sambar	151	123	1.23(0.16)
Nilgai	92	54	1.7(0.73)
Blackbuck	52	62	0.84(0.25)

Table 3. Biomass estimates for ungulates in VVNP, Bhopal.

Species	Average weight (in kg)	Density (SE) /km^2	Mean Biomass (SE) kg/km^2
Blackbuck	32	6.6(1.5)	211.2(66.18)
Chital	47	118.6(18.8)	5574.2(886.58)
Nilgai	180	13.1(2.8)	2358(523.24)
Sambar	134	34.1(6.9)	4569.4(913.75)
Wild pig	32	3.7(0.8)	118.4(28.37)
Total			12979.2(2418.12)

Sambar and Wild Pig, while uniform with polynomial adjustment was best fit for Blackbuck. The estimates generated by the DISTANCE analyses are presented in Table 1. The density (+SE) of jackal was 17±3.8 per km^2. Among the ungulates, Chital had the highest density (118±18.8) per km^2 followed by Sambar (34.1±6.9) per km^2, Nilgai (13.1±2.8) per km^2, Blackbuck (6.6±1.5) per km^2 and Wild Pig (3.7±0.8) per km^2.

Biomass Estimates

Chital biomass was the highest with contribution to overall ungulate biomass followed by Sambar, Nilgai, Blackbuck and Wild Pig (Table 3).

DISCUSSION

Over 80,000 Golden Jackals are estimated for the Indian sub-continent, being in higher densities where there is abundant food and cover (Jhala & Moehlman 2008). We found that VVNP has an extremely high density of jackals, far more than the average density estimated (1–2 per km^2) in the Velavadar National Park (Jhala et al., unpubl. cited in Jhala & Moehlman 2008) and more than that in certain parts of the Thar Desert of between 1.4–3 Jackals per km^2 (Sharma 1998). This is probably due to the enclosed nature of the park and the very high potential prey density. The density of Chital is also very high, though lower than Guindy National Park (GNP) having an area of 2.7km^2 (Raman et al. 1995) which showed a higher density of chital 185.4 per km^2 (in 1991) and 239.2 per km^2 (in 1992) and blackbuck of 19.6 per km^2 (in 1991) and 15.3 per km^2 (in 1992). In GNP, Chital and Blackbuck are maintained during summers by artificial feed, i.e., Paragrass *Bracharia mutica* and during other seasons they are sustained by natural forage. Similarly In VVNP, ungulates are fed Berseem *Trifolium alexandrinum* or Jowar Fodder *Sorghum bicolor* during summers. Density of ungulates at VVNP was also found to be more than the previous studies conducted in other protected areas of central India including Kanha Tiger Reserve (Karanth & Nichols 2000), Pench Tiger Reserve (Biswas & Sankar 2002), Satpura Tiger Reserve (Edgaonkar 2008), and Panna Tiger Reserve (Gopal et al. 2010). It must be noted that compared to VVNP, these are bigger areas with presence of tigers, leopards and dholes *Cuon alpinus* that prey on these ungulates, and so have limited utility for comparative purposes. With higher densities of most of the ungulates especially of

chital there is a very high prey biomass in VVNP. The high prey densities are likely to affect the vegetation, and the high mesopredator density may affect other components of the ecosystem like the small mammals and ground birds community. We speculate that the combination of small enclosed area, absence of large carnivores and artificial feeding combine to increase the densities of ungulates to unsustainable levels in the absence of intensive management.

Sex ratio of chital was found to be similar with the other studies having a bias towards females. Breeding can occur at any time of year but there are site specific peak fawning seasons (Sankar & Acharya 2004 and references therein). In Kanha Tiger Reserve of central India, fawning was observed throughout the year with a peak during January to April (Schaller 1967). The present study was conducted during the probable peak fawning season reported for the chital in central India yet only a single sighting of a chital fawn was obtained in our sampling, therefore it was not possible to calculate female to fawn ratio.

Schaller (1967) estimated an annual fawn mortality of 48% in Kanha Tiger Reserve and Raman (1996) estimated a mean monthly mortality of 9.7% in Guindy National Park. Pariwakam (2006) found it to be 66% over a six-week study period in Bandipur using photographic capture-recapture method. The possible reasons for the absence of fawns in VVNP could be very low birthrate, death of fawns due to disease or nutritional stress or due to predation by jackals.

A focused study needs to be done to find out which of these hypotheses is true. VVNP is in urgent need to estimate the carrying capacity of jackals and ungulates and perhaps active management to reduce the population of both. While we have quantified the predation on ungulates by the jackals (Prerna 2013), the energy obtained from fruits of Ber *Ziziphus mauritiana*, Bael *Aegle marmelos* and Tendu *Diospyros melanoxylon* needs to be estimated, to be able to estimate carrying capacity for jackals. It is likely that they are far above carrying capacity, and are subsidized by garbage and meat leftovers from the carnivore enclosures. Finally we recommend that vegetation trends, especially seedling growth, be monitored to make sure that over browsing by ungulates does not cause eventual habitat degradation.

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