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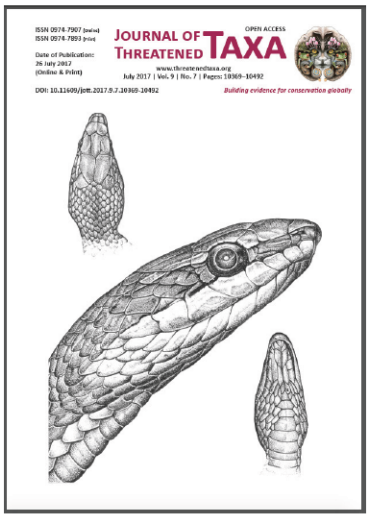

Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

MEASURING INDIAN BLACKBUCK *ANTILOPE CERVICAPRA* (MAMMALIA: CETARTIODACTYLA: BOVIDAE) ABUNDANCE AT BASUR AMRUTH MAHAL KAVAL CONSERVATION RESERVE, CHIKKAMAGALURU, SOUTHERN INDIA

H.S. Sathya Chandra Sagar & P.U. Antoney

26 July 2017 | Vol. 9| No. 7 | Pp. 10468–10472
10.11609/jott.2971.9.7.10468–10472

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Journal of Threatened Taxa | www.threatenedtaxa.org | 26 July 2017 | 9(7): 10468–10472

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

Measuring Indian Blackbuck *Antilope cervicapra* (Mammalia: Cetartiodactyla: Bovidae) abundance at Basur Amruth Mahal Kaval Conservation Reserve, Chikkamagaluru, southern India

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Abstract: Grasslands are among the most critically endangered ecosystems in the tropics, but they are often treated as wastelands and conservation efforts are seldom directed towards these landscapes. The Blackbuck *Antilope cervicapra* is a large wild herbivore found in most grassland ecosystems across India. Despite their critical role in their trophic web, there are no reliable estimates of Blackbuck populations from their geographic range that takes detection probability into consideration. In this study, we conducted field surveys to estimate Blackbuck density in Basur Amruth Mahal Kaval Conservation (BAMKCR) with an area of 7.36km^2 in southern India. We surveyed Blackbucks for a week in July 2014 along straight line transects between 09:00–12:00 hr and used the distance sampling approach to address the imperfect detection. A total of three transect lines of lengths 3.01km, 2.4km and 1.2km were sampled for seven temporal replicates. With an effort of 46.27km, 56 sightings of Blackbucks were recorded that was analyzed using the program DISTANCE. With a detection probability of 0.58 (0.053 SD) the estimated density of Blackbuck was 26.23 (6 SD) individuals/km^2. The derived abundance estimate was 193 (c. 148–238) individuals in the study area. Our results show implications of a statistically robust design that accounts for imperfect detection. It provides an insight into a resident population of Blackbucks in a dynamic and fragile habitat. Blackbuck density estimate from this study sets the background for periodic monitoring of their populations, examination of the impacts of habitat modifications and gauge long-term viability of the grassland habitat in BAMKCR.

Keywords: Density estimation, distance sampling, habitat modification, imperfect detection, long-term viability, monitoring.

Grasslands cover one-third of the planet's terrestrial surface. Intensive land conversion and animal husbandry have turned grasslands into one of the most critically endangered ecosystems on the planet. As recently as 200 years ago, most grasslands supported large populations of wildlife (Verchot et al. 2002). As in most parts of the world, a majority of grasslands in India have been converted into agricultural fields, leading to fragmentation and the remaining areas face heavy grazing by domestic livestock (Dabadghao & Shankarnarayan 1973; Singh & Joshi 1979a, 1979b; Singh et al. 2006).

Savannah grasslands in India are spread across parts of the southern states of Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu and central state of Madhya Pradesh. They harbor Critically Endangered species such as the Great Indian Bustard *Ardeotis nigriceps*, and Endangered species like the Lesser Florican *Sypheotides indicus* and other species such as Indian Wolf *Canis lupus pallipes*, Indian Fox *Vulpes bengalensis* and Blackbuck *Antilope cervicapra*. A majority of these

DOI: http://doi.org/10.11609/jott.2971.9.7.10468-10472

Editor: Mewa Singh, University of Mysore, Mysuru, India. **Date of publication:** 26 July 2017 (online & print)

Manuscript details: Ms # 2971 | Received 08 August 2016 | Final received 11 July 2017 | Finally accepted 13 July 2017

Citation: Sagar, H.S.S. & P.U. Antoney (2017). Measuring Indian Blackbuck *Antilope cervicapra* (Mammalia: Cetartiodactyla: Bovidae) abundance at Basur Amruth Mahal Kaval Conservation Reserve, Chikkamagaluru, southern India. *Journal of Threatened Taxa* 9(7): 10468–10472; http://doi.org/10.11609/jott.2971.9.7.10468-10472

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Funding: Bhadra Wildlife Conservation Trust & Wildlife Conservation Action Team - Chikmagalur (WildCAT-C).

Competing interests: The authors declare no competing interests.

Acknowledgments: We would like to thank Fr. Jobi Xavier, Head of the Department of Life Sciences, Christ University, Bengaluru for giving us an opportunity to carry out this study; Dr. Ravi Shankar Parameshwaran, Arjun Srivatsa, Shweta Shivakumar, Parvathi K Prasad, Mahi Puri, Umesh Srinivasan, for helpful discussions regarding the analyses and valuable comments on the manuscript. We are grateful to Mr. D.V. Girish, Managing Trustee - Bhadra Wildlife Conservation Trust; members of Wildlife Conservation Action Team - Chikkamagaluru for their valuable insight regarding the study site, and providing us with the necessary equipment for the study. A special thanks to our friend Pradeep V. Hegde for volunteering for the project to collect data in the field.

grasslands however do not have legal protection under any government departments. Thus, they remain unprotected as 'common' lands of the community, unless notified as protected areas, under the Wildlife (Protection) Act, 1972 or Indian Forest Act, 1927, threatening the wildlife that is dependent on them (Singh et al. 2006).

The Indian Blackbuck *Antilope cervicapra* is a Near Threatened (Mallon 2008) medium-sized (23–45 kg) (Mungall & Station 1978; Ranjitsinh 1989) species of antelope, once found across India (Jerdon 1874; Ranjitsinh 1989; Rahmani 1991). Distributed across a wide range of habitats, from grasslands to open woodlands, populations may range from two to several hundred individuals (Ranjitsinh 1989). The social units typically observed are: (1) solitary and bachelor herds of males, (2) herds of females (containing adult females and offspring), and (3) mixed-sex herds (containing males with multiple females and young in harem).

The Blackbuck play an important role in the ecosystem by serving as an important prey-base for carnivores such as wolves and Jackals *Canis aureus*. Like most large mammals, (particularly ones larger than 15kg), Blackbucks are threatened from overhunting, habitat destruction and feral dogs (Madhusudan & Mishra 2003; Schipper et al. 2008; Davidson et al. 2009). Despite their critical role in the trophic web and dwindling populations, there are no reliable estimates of Blackbuck population from any part of their geographic range that adjust for detection probability (Jhala 1993; Isvaran 2007).

In the present survey, field studies were conducted to estimate the density of Blackbuck in Basur Amruth Mahal Community Reserve (BAMKCR). We estimated the population density of Blackbucks using the distance sampling approach.

Methods

Study Area

This study was carried out in BAMKCR situated between 13.64153 N – 76.07661 E & 13.66747 N – 76.07647 E (Fig. 1) Located on the southern plateau of the Deccan peninsula, this reserve harbours the typical vegetation structure of peninsular Indian open grassland ecosystems, with floral species such as *Acacia planifrons*, *Acacia nilotica*, *Cassia auriculata*, *Phoenix sylvestris*, *Dodonaea viscosa* and *Opuntia* spp. In this 7.36km^2 reserve area, the spread of the exotic *Prosopis juliflora* has changed the landscape towards the south. Despite its small size, the reserve harbours a rich grassland fauna including mammalian top predators such as the Indian Wolf, Leopard *Panthera paradus fusca* and meso-predators such as Golden Jackal and the Indian Fox.

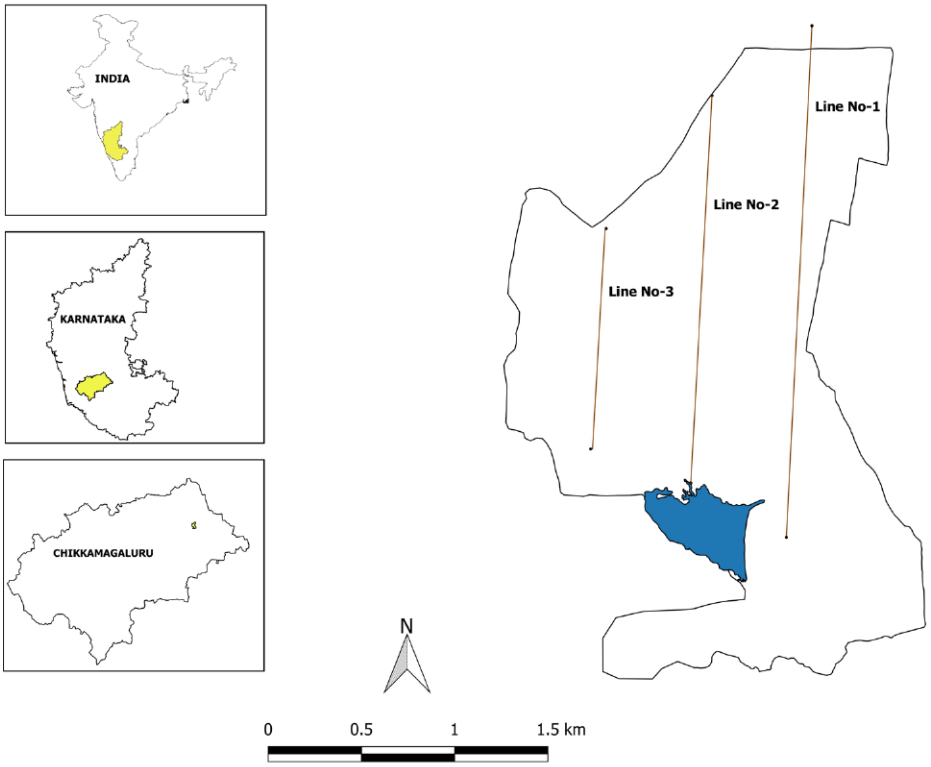

Figure 1. Map of BAMKCR along with the transect lines

Sampling

Line transect sampling was used to estimate the population density and abundance of Blackbuck. Three lines with lengths 3.01km, 2.4km and 1.2km were laid systematically with a random start. Transects were placed 600m apart from each other to avoid individuals from being detected on two neighbouring transects.

Due to the possible presence of a density gradient and linear heterogeneity in landscape composition, biased results were expected towards such areas. Therefore, to avoid unrepresentative samples, lines parallel to the presumed density gradient and perpendicular to the linear feature of habitat with an angle of 4^0 to north were chosen. This minimizes biases in detection probability, which can vary with topography, habitat type, and the density of objects of interest. During the course of the survey, care was taken not to violate the key assumptions of line transect method (Buckland et al. 2001), these assumptions being: (i) all animals present on the line are detected, (ii) animals are detected and measured at their initial locations prior to any behavioural response, and (iii) measurements were made correctly without errors.

Sampling was conducted for one week in July 2014 by walking along the marked transect lines between 09:00–12:00 hr. In order to obtain sufficient sample sizes, each transect line was sampled seven times. Transect lines were marked using GPS unit, Garmin ETrex Venture HC. Distance to the center of Blackbuck clusters was determined using a Bushnell laser range finder and angles to the centres of clusters were measured using a Suunto prismatic compass.

Data Analysis

To address the issue of imperfect detection, detection probability, (p) was estimated using the program DISTANCE 6.2. We improved the estimation of detection function by examining initial outliers and truncating them using right truncation. We chose the best-fit detection function model based upon the Chi-square test. We improved the model fit by pooling the sighting data categories and also assessed size bias of clusters. The estimate of detection probability was utilized to estimate the population density using the Canonical Estimator (Buckland et al. 2001). The variance of density was approximated using the delta method (Seber 1982; Buckland et al. 2001).

Results

We recorded 296 individuals with mean cluster size = 5.30 (Table 1). Sighting distances varied from 0.84–271.00 m. A detection probability of 0.58 (0.05 SD) was selected for the estimation (Fig. 2). The estimated density of Blackbuck was 26.23 (6 SD) individuals/km^2. The derived abundance estimate was 193 (c. 148–238) individuals in the study area of 7.36km^2.

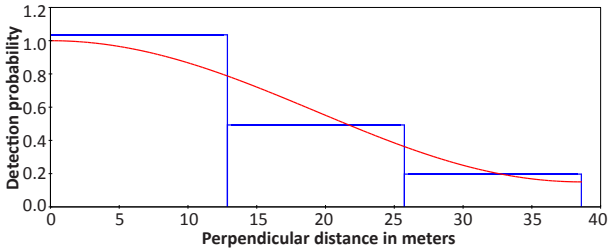

Figure 2. Detection probability curve

Table 1. Line wise sightings of Blackbucks at BAMKCR

Transect No	Line length	Effort (km)	No of Sightings	No of Individuals
1	3.01	21.07	25	115
2	2.4	16.8	30	167
3	1.2	8.4	1	14

Discussion

Our estimate of 193 (c. 148–238) individuals, with a density of 26.23 (6 SD) individuals/km^2 over an area of 7.36km^2 of high quality range gives an insight to population of the Blackbuck at BAMKCR. This is the first time that population estimates have been made for Indian Blackbucks accounting for imperfect detection.

Previous published attempts have estimated the density, distribution and conservation challenges (Karanth & Singh 1990; Raman et al. 1993; Isvaran 2005, 2007; Gehlot & Jakher 2007, 2015). But, there has been no attempt to count this species by explicitly taking detection probability into consideration. The total count method was not applicable in the study area, due to the habitat heterogeneity with northern and southern half. The analysis showed us that we could detect only about 60% of the entire population (p hat is 0.58) and we are missing 40% of Blackbucks during the detection process. The presence of invasive *Prosopis juliflora* to the southern half of the study site may have changed the landscape, thus providing sufficient cover for the Blackbuck.

Population size is a fundamental demographic attribute and a cornerstone of ecology. It is integral to the concepts of density dependence (Ray & Hastings 1996), functional and numerical responses of predators to prey (Morgan et al. 1997) and population regulation (Clutton-

Brock et al. 1985). Estimating population size provides fundamental information about species demography. This helps to design and formulate required conservation and management (Townsend et al. 2003).

Threats and Conservation Implications

The BAMKCR reserve is under great pressure due to wildlife poaching, collection of non-timber forest products and livestock grazing. Feral dogs from surrounding villages also pose a threat to native fauna as they prey on Blackbucks and act as potential carriers of disease, threatening wild canid species (Butler et al. 2004). The major threats to Blackbucks at BAMKCR are almost the same as those across its entire geographic range, like the fawns being preyed upon by feral dogs. Anthropogenic activities such as habitat encroachment, increase in road network and occasional poaching pose a serious danger to the population. As a large population of humans subsists on livestock rearing, excessive grazing inside BAMKCR can harm the ecosystem, posing a further threat to the Blackbuck population.

Our estimate of antelopes indicates that the population is still relatively large in this small pocket of natural grassland ecosystem. Despite being a tiny proportion, this population in BAMKCR, is ecologically very important (Krishna et al. 2016) because Blackbucks are prey for wolves, jackals and other scavengers. Ungulates also play a major role in the ecosystem through indirect interactions by influencing nutrient cycling (N) with their feces and urine, net primary production and disturbance regimes - especially fires in grasslands (Hobbs 1996). Thus, a severe decline in the antelope population may result in an increasing conflict between wolves and shepherds, threatening their survival and even alter the structure and functioning of the ecosystem (Singh & Kumara 2006).

Currently, there is no regular monitoring programme of the Blackbuck population with an established protocol anywhere in its geographic range. Our scientific estimate of its population in BAMKCR shows that detection probability must be accounted for while counting Blackbucks to get a reliable estimate. These estimates allow us to assess the success or failure of management practices, and to deal with new problems by developing empirical and theoretical knowledge (Karanth & Nichols 2002). Effective conservation measures need to be strictly implemented along with population monitoring (Milner-Gulland et al. 2003) to halt the decline of Blackbuck population into oblivion.

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ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

July 2017 | Vol. 9 | No. 7 | Pages: 10369–10492
Date of Publication: 26 July 2017 (Online & Print)
DOI: 10.11609/jott.2017.9.7.10369-10492
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