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Assessment of threats to blackbuck *Antilope cervicapra* (Linn) in sorsan grassland, Rajasthan, India

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Abstract
The decreasing natural resources lead to conflicts and threats to the wild population. The cause of threat to the population of blackbuck (*Antilope cervicapra***)** at Sorsan is due to developmental work and human encroachment of grassland area. Human population pressure and change in the land use pattern has further restricted the habitat of blackbuck. There is competition between blackbuck and cattle stock for grazing and territory. Blackbuck cause heavy damage to the crops and thus come in direct conflict with the inhabitants. Sorsan is very close to the National Highway, many animals meet accident while crossing the road. Illegal hunting and poaching is another threat to the blackbuck population of Sorsan.

Keywords: anthropocentricity, habitat loss, human-wildlife conflict, land use, wildlife collision

1. Introduction
The Blackbuck (*Antilope cervicapra)* is native to India and Nepal and earlier occurred across almost the whole of the Indian subcontinent grasslands. Their distribution decreased during the 20th century and they are now nonexistent in Pakistan and Bangladesh [1]. The blackbuck has been introduced to grasslands of the United States of America (Texas) and Argentina [2].
Although blackbuck have disappeared from numerous areas due to habitat destruction for anthropocentric development, they are increasing in many protected areas and areas specially dominated by Vishnoi communities in Rajasthan, Gujarat and Haryana [3]. Blackbuck is listed in Red Data Book of IUCN (International Union for Conservation of Nature and Natural Resources) as least concern and in CITES (Convention of International Trade for Endangered Species of Wild Flora and Fauna) is categorized in Appendix III. In India, hunting and poaching of blackbuck is prohibited under Schedule I of the Wildlife Protection Act of 1972.
The blackbucks prefer open grassland, dry thorn scrubland and agricultural margins as their habitat. The daily water requirement restricts its distribution, to the areas where water is available throughout a year [4, 5]. Blackbucks are principally grazers, but browse when lack of grasses in summer season forces a greater dependency on dry leaf litter, flowers and fruits. Blackbuck is a prominent animal of Sorsan grasslands of Baran district, Rajasthan [6]. The villages adjacent to this grassland are Amalsara, Manpura, Sorsan, Niyana and Kuradia. The main occupations of the inhabitants are agriculture and cattle rearing. Being in the command area of Right Main Canal (RMC) of Chambal the region is fertile and well irrigated. The present study has been accomplished to evaluate the effect of various threats which have potential to limit the survival of blackbuck in Sorsan grassland of Baran district of Rajasthan, India.

2. Study Area
Sorsan is known for conservation of blackbuck and other wild life. It is located in Anta tehsil of Baran district of Rajasthan. The protected area spreads between Amalsara and Sorsan village. It stretches over 35 square kilometers between right main canal of the Chambal and the Parvan River. State government in 1984 has banned poaching or hunting of animals in Sorsan region under wild life act 1972. It is 50 km east of Kota (25.00 -25.8^0 N, 76.12- 76.18^0 E) having scrubby vegetation and numerous small water bodies, which harbor amazing varieties of birds as well as animals.

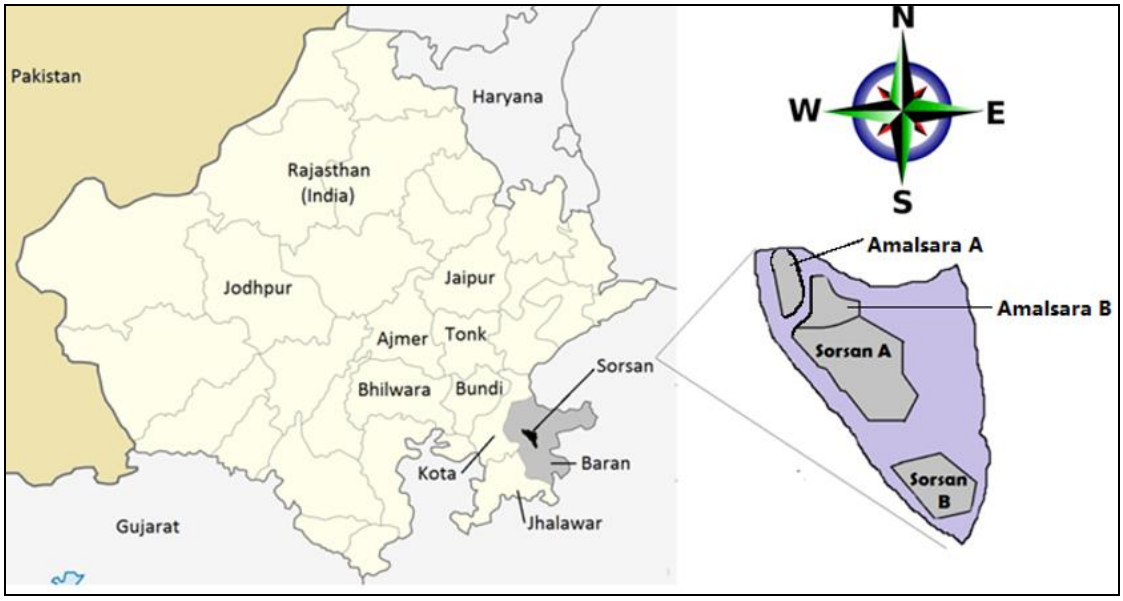

Fig 1: Map of Sorsan grassland showing selected study sites

The total area under forest/grassland cover in study area is shown in Table 1. The Selected habitat has a dry climate except in the monsoon seasons. The winter season spreads from end of November to mid of February and summer season spans from mid of March to end of June. The period from end of June to mid of September is the monsoon season followed by the months October to mid of November constitutes the post monsoon or the retreating monsoon. The average rainfall in and around study area is 824.31 mm. January is the coldest month with the average daily maximum temperature of 24^0 C and the average daily minimum temperature of 10^0 C.

Table 1: Total forest/grassland cover in study area

Study area	Area in Hectare
Amalsara A	226.12
Amalsara B	221.17
Sorsan A	1026.65
Sorsan B	427.22

3. Material and Methods

During the present investigation, visual observations and road transects around selected sites were followed to collect preliminary information on the trends of the blackbuck population and threats which can shrink their population. Observations were made on the crop damage and feeding activity of the Blackbuck. For direct observations suitable route were determined in study area and approached with the least disturbance to the animals. The road kill cases and hunting/poaching related information was collected from local farmers and villagers. Ecologically similar sites were selected to assess blackbuck group sizes and effect on group size due to live-stock. The collected data were analyzed to compare blackbuck demographic parameters between livestock-free and sympatric areas of the Sorsan region. A field binoculars and mobile based GPS were used throughout the study for observation of the study animal in the field. Photographs of blackbucks were taken using high resolution camera.

4. Results

1. Habitat loss

Habitat loss has been the highest threat to biodiversity [7, 8]. It is self-evident that inhabitants and species will suffer when their habitat becomes degraded or is lost completely. Due to habitat destruction the animal became restricted to limited areas, gene pool gets reduced and there are increased chances of inbreeding [9].

Sorsan habitat - the open grasslands - is being encroached upon and slowly converted into agricultural land. Sorsan grassland area is surrounded by several villages. Most of the low-income group families of the nearby village depend on scrubland /grassland to collect fuel wood, fodder for their livestock. Exploitation of important resources is a threat to the quality of the habitat used by blackbucks. There has been a tremendous increase in agricultural activities in earlier uncultivated land of this region and human habitations have spread far and wide (Figure 2a and b). Large groups once roamed freely in study areas as per information collected from farmers and villagers, but they are now observed in small groups.

Table 2: Mean group size of blackbucks in study area

Study Site	Group size		
	Mean	± SD	± SE
Amalsara A (*n = 40*)	6.83	2.06	0.33
Amalsara B (*n = 45*)	6.98	1.84	0.27
Sorsan A (*n = 160*)	7.61	1.84	0.15
Sorsan B (*n = 55*)	7.04	1.95	0.26

In study area, group size of blackbucks ranges from 4 to 15. Maximum group were observed in Soran A region (*n = 160*), while minimum was observed in Amalsara A region (*n = 40*) (Table 2). The maximum mean group size 7.61 ± 0.15 S.E of blackbuck was found in Sorsan A region. The smallest group size (6.83 ± 0.33 SE) was observed in Amalsara A region (Table 2, Figure 3). Herds are mainly composed of adult female and male in ratio of 3:1.

Fig 2: (a & b) Human encroachment of Sorsan grassland for agricultural field (c) Fear provoking sounds of crackers used by farmers to keep blackbucks away from field (d, e & f) Competition with live stocks for grazing.

As their habitat is shrinking due to agricultural activities, blackbuck population in Sorsan grassland is being restricted to small patches. Blackbucks living in fragmented sites are threatened by multiple environmental factors, but their viability can also become compromised by inbreeding, random loss of beneficial mutations, and random fixation of deleterious mutations (increasing genetic load) [10, 11].

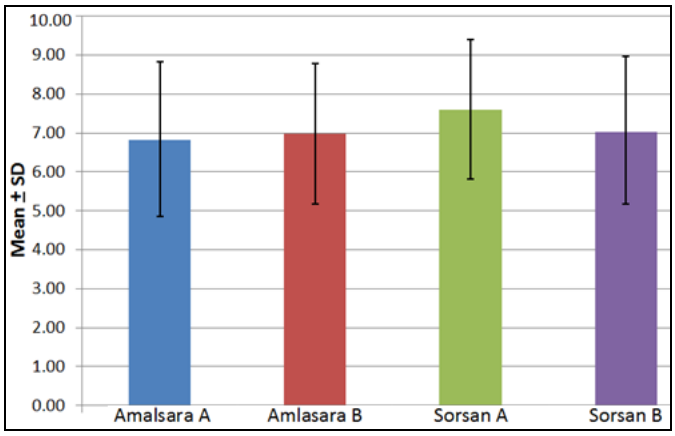

Fig 3: Group size of blackbuck in study area ± Standard deviation

2. Human-Blackbuck Conflict

Conflict amid local people and wildlife is one of the main threats to the continued survival of many species in different regions of the world, including threat to local blackbuck population in study area. Crop-raiding by locally overabundant populations of blackbuck has been widely reported in many parts of the country.

Blackbuck cause considerable damage to the agricultural crops adjacent to their habitat [12, 13, 14]. The gradual encroachment of wild life habitat by human for agriculture, farming and/or as grazing ground for their livestock is shrinking the habitat of blackbuck in Sorsan area. In search of food they stray into fields and damage the crops, so the local farmers realize blackbucks as a menace to their agricultural products.

Blackbuck caused extensive damage to most agricultural crops. Major crops cultivated in field around the blackbuck habitats are wheat (*Triticum aestivum*), rice (*Oryza sativa*), maize (*Zea mays*), gram (*Cicer arietinum*), jawar (*Sorghum vulgare*), mung (*Phaseolus mungo*), soyabean (*Glycine max*) and mustard (*Brassica campestris*). All these crops are damaged by blackbucks not only by foraging but also due to crushing of the crop during movements of the animals. The extent of crop damage varied considerable, depending upon the animal numbers and crop protection strategy followed in the area. Maximum damage was observed to *Sorghum vulgare* (45%) followed by *Triticum aestivum* and *Zea mays.* Least damage was observed *Brassica campestris* in investigated area (Figure 4).

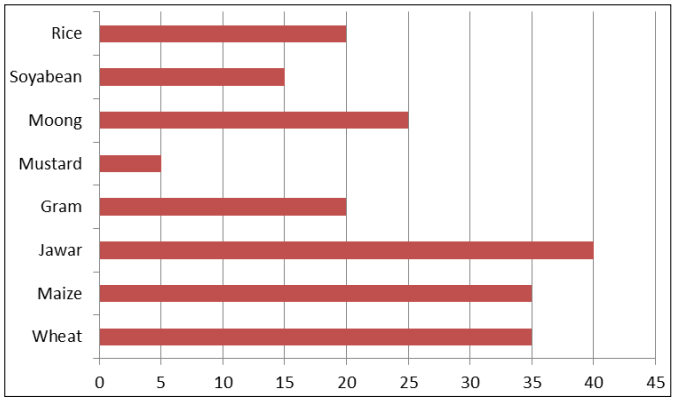

Fig 4: Percentage damage to different crops due to blackbucks

Local farmers relaying on agriculture cannot afford the loss to their crops raided by blackbuck. The most common protection strategy for the farmers is guarding their fields by remaining vigilant during the crop season. Realizing the seriousness of the problem, poor farmers in Sorsan region are now becoming gradually intolerant to damage to their crops. Some have developed outright aggressive attitudes toward the blackbuck [15].

In a larger conservation interest of blackbuck, it is important that administrators and wildlife managers take the initiative to actively control the crop damage mediated by blackbuck by developing suitable strategies. Possible mitigation strategies may include use of fear provoking stimuli (Figure 2c), chemical repellents and fencing agricultural areas or blackbuck habitats [16].

3. Competition with Livestock

Livestock and blackbuck share the same niche in most forest areas of India [17] where they possibly compete for important resources. Studies suggested that such interactions with livestock could be detrimental [18], while other suggests that interaction is facilitative [19]. Competition between livestock and blackbuck has long been the focus of scientific investigation, yet information in this subject is scarce [20, 21].

Sorsan region has a very high number of livestock populations including sheep, goat, cow and buffalo which are fully deepened on grasslands and scrub forest where blackbuck forage. Livestock maintained by farmers and local inhabitants are giving tough completion for grazing to blackbucks in Sorsan region (Figure 2d, e and f). Sympatry and interaction of blackbuck with domesticated livestock also increases exposer to bovine diseases.

The overall mean group size of blackbuck was found to be 7.11 ± 0.25 S.E. across the different selected habitat of Sorsan region. Mean group sizes were similar between livestock-free (7.11 ± 0.25 SE) and sympatric areas (7.05 ± 0.28). Thus, out study suggest that there is no significant negative effect of sympatric livestock or neither it provide any hint of grazing facilitation. Similar reports have been suggested during investigation of effect of livestock on chital population in Gir Forest of India [22]. The research has to be continued further to assess a long-term response to competition in study area.

4. Predation Pressure

The main predator of fawn and adult black buck in Indian peninsular is wolf (*Canis lupus pallipes*) and golden jackal (*Canis aureus*) [23]. In investigated area the wolf, fox and jackal are traditional predators to blackbuck. The predation by feral dogs is very high in Niyana and Amalsara region. In rainy season, the ground become soft and slippery, which makes difficult for blackbuck to run and this creates opportunity for feral dogs to kill infants as well as adult blackbuck.

The maximum attack on fawns of blackbuck by feral dogs as has also been suggested earlier in Thar Desert of Rajasthan. Feral dogs mainly attack blackbucks at peak of fawning periods [24]. Multiple reports suggest that wolf predation is a major limiting factor in grasslands [25] but in Sorsan region predation by wolf and fox does not currently seem to be a major threat to the long-term survival of the Blackbuck in the region. Similar finding were reported in Velvadhar National Park, Gujarat [26]. If predation by feral dogs and wolf, both operate in combination, then it can be a major threat to blackbucks in its habitat.

5. Road Kill

Roads are increasingly common in today's world as human development expands and people increasingly rely on bus, car and trucks for transportation on a daily basis. Worldwide there is increased research and conservation interest in roadkill and road ecology [27], but very few studies have been conducted in India, even though road accidents and kill of wild fauna has the potential to significantly affect biodiversity [28]. Road expansion programs in blackbuck habitat are inviting Blackbuck killing in road accidents.

The National Highway No. 27 passes by the eastern side of the protected area. The traffic along the Highway and the anthropogenic activities near it are main causes of threat to the blackbuck population. When blackbuck crosses roads, they are exposed to vehicles and mortality is often the result. In fact, road mortality is the leading source of mortality to many wildlife populations. In addition to causing direct mortality, roads latter or sooner will lead to habitat fragmentation which will further shrink the population of blackbucks.

In 2016 there have been two incidents of road kill and in 2017 three mortality of blackbuck have been reported in Sorsan region. As the wildlife is coming under increasing pressure from human development, the demand for a quick, reliable, and statistically robust method of recognizing the latent threat of roads is increasingly urgent [29]. In light of expanding road networks and before it is too late for our wildlife populations, strategies must be developed to urgently address this threat [30].

6. Hunting and Poaching

The blackbuck population has decreased throughout the country due to extensive poaching during early twentieth century. Blackbuck is mainly hunted for its meat and horns — the latter being used in ayurveda and to cure skin problems [3, 5].

After India's independence this animal was included in the Schedule-I of Wildlife Protection Act, 1972 and IUCN Red list has designated it as Near Threatened species Red List. Due to strict laws, the hunting of threatened blackbuck has totally banned [15].

In the investigated area one case of hunting of two blackbucks for meat was confirmed in 2016. Although occasional incidents of poaching were reported by nearby villagers but such report cannot not be confirmed as there was no such evidence. It could be concluded that in given area hunting and poaching is not a serious threat for survival of blackbucks.

5. Conclusion

Ecological studies are very important for conservation of vulnerable animal as well as create positive impression among local people towards its conservation. Blackbucks have vanished from many zones due to habitat destruction and other reasons. The study area is being encroached upon and slowly converted into agricultural land. Due to the encroachment of wildlife habitat by human there is always a conflict between the humans and wild animals. In Sorsan the blackbuck has come into direct conflict with human by destroying the agriculture and they also compete with domestic cattle for grazing. Additionally, combined predation by feral dogs, jackals and wolves, especially on calves, likely regulates blackbuck populations. The traffic along the highway and the anthropogenic activities near it are causes of threat to the blackbuck population.

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