



Anthropogenic Impact on the Populations of *Antilope cervicapra* and Their Conservation Strategies in Rajasthan.

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ABSTRACT:

The blackbuck (*Antilope cervicapra*, Linn.), being one of the most numerous wild ungulates in India in the past and living in close proximity of human settlements, features most prominently in the country's history, religion and art. This animal is an object of special veneration for the Bishnoi community of western Rajasthan and is protected due to sacred associations and religious taboo of the community who still continue to protect blackbuck herds in their areas of habitation despite the damage that the blackbuck causes to their agricultural crops and have been the primary reason why the blackbuck has continued to survive and even to thrive in isolated areas and has been saved from the holocaust which overwhelmed the species elsewhere in the subcontinent. The blackbucks were observed in some localities of Jodhpur, Barmer, Nagaur, Churu and Bikaner districts. However, three main sites in Nagaur district were selected for more intensive studies. There is hardly a wild animal more representative of India than the blackbuck. No other wild ungulate than blackbuck in the subcontinent has suffered so drastic a decline through hunting pressure. Its preference for the open land and its desire for crop raiding brought it in direct contact and conflict with man. Today it is one of the most isolated and threatened animals in this subcontinent. During present study period factors like limited resources, human interference/anthropogenic impacts and predator pressure showed impact on home range in all the areas and affected the home range of different herds. The predator pressure of village feral dogs was major reason of larger home range of these herds in study areas.

Keywords: Anthropogenic, blackbuck, Antilope, ungulate, religious, species.

INTRODUCTION:

Antilope cervicapra is a medium-sized antelope and found in semi-desert plains and open forests throughout India. One of the few antelopes which exhibit pronounced sexual dimorphism, the genders in the blackbuck are readily distinguishable by their color differences between sexes. In mature males the coloration in upper part of the body is black with the belly and the eye rings in white colour, while subadults are dark brown above and white below and a prominent white circular patch around the eye. The horns are borne only by males and range from 50-61 cm, they are corkscrew-shaped heavily ringed at the base and twisted spirally up to approximately 4 turns. The females are fawn-colored above and white below which is usually hornless.

Blackbucks are active in the very early morning and late afternoon, resting in the shade at other times. They are very fast runners and leap to demonstrate their stamina to predators, as do other ungulates. Their sense of smell and hearing are not highly developed so they rely on eyesight in detecting danger. When in danger, a single animal bounds in the air and is soon followed by the rest of the herd. They are usually silent, but sometimes females give a hissing noise that warns the herd of danger. They are vocal animals that use several kinds of sounds to communicate with each other. Adult males are highly territorial and defend areas ranging from 1.2 to 12 ha in size against trespass by other males. Female group may graze through male territories, and breeding activity may take place at such times, but other males are excluded. Young males, and bucks without territories, form their own all male groups. At physical maturity (2-2.5 years of age) young bucks may split from the all male group to establish or win their own territory. Outside the breeding season, blackbucks are found in mixed groups comprising an old male and several females and fawns. But as the breeding season approaches, the younger males stay away avoiding competition with the old ones and form bachelor's groups or manage to defend a territory individually. Ecologically, *Antilope cervicapra*, a grazer, prefer open area and shows remarkable kind of social organization and behaviour. They like to stay near areas where grassland is available. Due to shrinkage and fragmentation of habitat, the pressure on existing habitats is quite high. Blackbucks usually roam in the plains, graze in herds of 10 to 100 individuals and, unlike most antelopes, graze mostly by day, even in intense heat with one dominant male. Blackbucks are also very territorial and sensitive to environmental pressures. The blackbuck fawns are quite weak during the first few weeks and can be easily predated by dogs. Therefore, it is very essential to have undisturbed open areas with small bush/tall grass cover for the healthy survival of young blackbuck. The fawn will join the mother and other group members when it is about two weeks old. It is on record that in the 1920s, blackbucks were so abundant in the Jodhpur region that if a gun was fired, one could watch a continuous stream of fleeing blackbucks across the road (Prakash, 1977). Jerdon (1874) cited a contemporary Dr. Scott who had informed him that herds calculated at between 8000 and 10,000 heads of blackbuck roamed the forest cover. These animals have adapted to life in wastelands around cultivated areas (Saharia, 1982). The blackbuck prefers level plains and undulating terrain and commonly enter fields (Prater, 1971). It avoids hilly and forest region but stays near cultivated fields having a waterhole nearby. They are now almost typically associated with semi-desert or open grassland country, although some do occur in sub-tropical dry evergreen forests and in tropical rain forests. This indicates the diversity of the blackbuck's ecological environments. Schaller (1967) had noted that the principal distribution of the blackbuck in India is limited to western Rajasthan. In the eastern, non-arid part of Rajasthan, and in some other parts of the country, the blackbuck is mostly found now inside wildlife sanctuaries only or as stated earlier, in and around villages inhabited by people of the Bishnoi community. In western parts of Rajasthan the range of these animals extend from Sri Ganganagar district in the north to Barmer and Jalore districts in the south- western part of the vicinity of one or more water holes.

MATERIALS AND METHODS:

Data collected includes territory, location, group composition, habitat type, time of day and behavioral status. For each blackbuck observed, species, age, sex, date, group size and composition, habitat and location were recorded with the help of binoculars (8 x 40), camera (Canon DSLR 500D) and GPS. The number of

individuals and age-sex composition of groups of blackbuck were recorded during regular block sampling as well as during walks along paths and animal trails in the habitat. Age–Sex classification of blackbuck observed (Mungall,1978) was used to estimate the monthly percentage of males in herd and the monthly proportion of fawns to females. Animal density was estimated using total count of the blocks of cultivated land, scrubland and grassland. The eco-behavioural diversity of Indian blackbuck (*Antelope cervicapra*) was carried out in the selected study sites of arid part of Thar Desert of Rajasthan. To find the present distribution and abundance of blackbuck in the Thar Desert, 12 districts were visited twice during study period. Prismatic field binocular was used throughout the study for direct observations of the animals in the field. Using the binoculars, Scan and focal sampling methods were followed for recording various activities of the focal animals. A line transect method, as suggested by Anderson *et al.* (1979) have been followed for evaluation of population density of both the study animals inside and out side the study areas. Density was estimated by following Sale and Berkmullar (1988) and Rodger (1991).

$$D = \frac{n}{2LR}$$

Where :

D = Population density

n = Total number of animals sighted

2 = For both side of the transect

L = Length of transect

R = Mean perpendicular distance

Population, Abundance and Distribution Pattern

Direct observations were made to collect data on population status and distribution of the blackbuck. In order to collect data on the current status and distribution of blackbuck, field surveys were carried out in protected area to locate blackbuck populations. Five sex and age classes were distinguished as (a) adult males, (b) adult females (c) sub–adult males (d) sub-adult females and (e) fawn according to Mungall (1978). Home ranges were determined by establishing a grid of 50 x 50 m over the map of the scale 1 : 50,000 (Topo Sheet, Survey of India). We studied territorial behaviour as described by Gehlot (2006). Scan sampling was done on all the animals of a herd, irrespective of age and sex, their behaviour was recorded. In order to record daily activity cycle of a focal individual animal of a selected group, the detailed behavioural observations were made from dawn to dusk in all the seasons as per Altman (1974). Observations on status, daily activity and interaction with other individuals were recorded. Individual behaviour *i.e.*, resting, foraging, watering, moving, standing, regurgitation, fighting, running, reproductive behaviour, mating, sucking, urination, defecation, chasing, territory marking, anthropogenic impact etc. were evenly distributed over the daytime and months so as to achieve statistical compatibility of data. Behavioural sampling involved two methods. Focal animal sampling and scan animal sampling (Altman, 1974). Individual activities of all age-sex categories of blackbuck were analysed in hourly, monthly and seasonal basis and calculated as:

$$\% \text{Activity} = \frac{\text{Total time spent/Number of time in particular activity in that hour/month /season}}{\text{Total time spent/Total number of records in all activities in that hour/month /season}} \times 100$$

Society Conservation

A semi-structured questionnaire survey was conducted in randomly interacted local people and landowners. Generally local people had a detailed knowledge of the fauna in their region, and their answers are considered very reliable. Local people were interviewed singly or in groups. Sample questions are divided into 4 categories to collect information and baseline data about the protected area, which are (1) Factor for conservation of blackbuck by local community (2) knowledge about wildlife (3) Crop damage by blackbuck (4) Attitudes towards blackbuck. Data on the above was analyzed by calculating the mean, frequency and percentage of total response in each category. For multiple response questions, relative frequency based upon the total number of responses rather than upon the total number of people surveyed in order relative frequency sum to 100 was reported (Newark *et al.*, 1993).

Data Analysis

The data processing was carried out using SPSS Statistical software (SPSS inc.). The behaviour scan and focal data were analyzed by T-test, Chi-square test, Correlation and Regression of all variables and interactions.

RESULTS AND DISCUSSIONS:

Blackbuck are native to the Indian sub-continent. They are found in a wide range of habitats, from semi-arid grasslands and scrub to open forest (Schaller 1967, Mungall *et al.* 1981, Prasad 1981, Ranjitsinh 1989, Isvaran 2005). They reach their highest densities in semi-arid, open, and short-grass plains. Blackbuck historically ranged from near Peshawar (in Pakistan) in the northwest, through the Indo-Gangetic plains, up to the plains of western Assam in the east, centrally in the Deccan, in open plains areas along the western coast of the peninsula, and along the eastern coastal plains to southern Tamil Nadu (Blanford 1888–91, Lydekker 1907). Within their range, they were one of the most abundant ungulates of the plains. Herds containing many hundred animals were reported until as recently as the early part of the 20th century (Lydekker 1907, Stockley 1928). The current distribution of blackbuck is much reduced. Within India, they are found throughout a large part of their former range. However, their populations, previously large and contiguous, are now small, scattered, and relatively isolated. The most recent survey of blackbuck populations in the country, based on observations made between 1981 and 1988, arrived at an estimate of 29,000–38,000 individuals (Rahmani 1991). This estimate includes populations both within and outside protected areas. Rajasthan, Punjab, Gujarat, and Maharashtra had the largest state-wise population estimates (Rahmani 1991). Velavadar in Gujarat, Tal Chappar in Rajasthan, Nannaj in Maharashtra, Rollapadu in Andhra Pradesh, Ranebennur in Karnataka, and Point Calimere in Tamil Nadu currently hold some of the largest concentrations of blackbuck within protected areas (Ranjitsinh 1989, Rahmani 1991, Jhala 1993a, Isvaran 2003).

There is hardly a wild animal more representative of India than the blackbuck. No other wild ungulate than blackbuck in the subcontinent has suffered so drastic a decline through hunting pressure. Its preference for the open land and its desire for crop raiding brought it in direct contact and conflict with man. Today it is one of the most isolated and threatened animals in this subcontinent. However, this animal is an object of special veneration for the Bishnoi community in Rajasthan and the Wala Kathi clan and Vala Rajputs of Saurashtra, Jain community and Sidh community. Despite the damage that the blackbuck causes to agriculture crops, these communities still continue to protect blackbuck herds in their habitation, due to the belief that the presence of blackbuck in the human habitation and agriculture field brings prosperity for villagers. It is on account of this primary reason, blackbuck thrived in isolated pockets in western Rajasthan even outside the closed areas and sanctuaries. The blackbucks were observed in some localities of Jodhpur, Barmer, Nagaur, Churu and Bikaner districts. However, three main sites in Nagaur district were selected for more intensive studies. The abundance and distribution of individuals of same species in a unit area is obviously known as population. However, it is not easy to estimate population density of fast moving animals because the area occupied by them does not remain same as the individual changes its position frequently for one or other reason. The distribution of blackbuck is limited to some areas, specially restricted to closed areas of sanctuaries but they are also found outside protected areas where Bishnoi community is present. The population density of blackbuck was found the highest (3.34 indiv/sq.km) in some closed areas and outside pockets of Jodhpur district and followed by Nagaur district (2.36 indiv/sq.km). In Jodhpur district good numbers were observed in closed areas where mean population density was comparatively very high. Out of six notified closed areas of Jodhpur, only three namely Guda Bishnoi, Sathin and Dhawa Doli are reported to have blackbuck. The population density of blackbuck was also estimated separately for these three closed areas. The highest density (4.47 indiv/sq. km) was noted from Guda Bishnoi closed area and followed (3.45 indiv/sq. km) by Sathin closed area. The present distribution of the blackbuck in arid region of Rajasthan indicates their occurrence in only few isolated pockets with one sanctuary Tal chhaper and some of closed areas of Jodhpur, Nagaur. There are isolated population of blackbuck in Bhopalgarh, Luni, Bilara and Osian tehsil of Jodhpur and few village of Pali, Jalore and Barmer district. In addition, there is other blackbuck population in Ridmalsar of Shri Ganganagar district. Out of 23 notified closed areas of western Rajasthan only five namely Gudha Bishnoian, Sathin and Dhawa in Jodhpur, Rotu and Jaroda in Nagaur and Tal chhaper sanctuary in Churu district has good numbers of Blackbuck. During present study, the highest population density is, however, noted from closed areas of Churu district followed by Nagaur district. The highest population density 38.5 indivi/sq.km was found in Tal chhaper sanctuary, 12.99 and 9.42 indivi/sq.km were recorded at Jaroda and Rotu closed area of Nagaur district respectively which may be due to availability of good habitat and protection from local people while 9.6 indivi/sq.km at Guda and 7.75 indivi/sq.km was noted at Dhawa closed area of Jodhpur district (Table 1). Data obtained of different closed areas of western Rajasthan from forest (Wildlife) Department showed that during 2007-08 about 811 bucks are in Guda, 401 in Dhawa and 2809 individuals were in Jaroda whereas in 2010-11 blackbuck number reduced in the above three closed area and only 680 in Guda, 386 in Dhawa and 1625 in Jaroda were recorded as per census data. But blackbuck population has been increasing at Tal Chhaper Sanctuary of Churu district, during 2007-08 sanctuary has 1780 blackbuck whereas during 2010-11 blackbucks increased up to 2025 individuals (Table 2). In addition, there are other blackbuck population outside

closed area, notably at Lamba, Ramdawas, Rawal, Ramnagar, Hingoli, Surpura, Sevki Bucheti, Kosana, Mehrana, Rudiya, Mindoli, Birani, Bhawad, Kharda and Jud of Jodhpur district, Kuchera, Butati, Punas, Bichhpadi and Chhakdhani of Nagaur, Doli and Jhakharda of Barmer, Vayad of Pali, Ridmalsar and Rabla of Shri Ganganagar, Nimbli, Kalali, Bhakariwala, Dhureliya, Jethpur, Dudhali, Dungarpur, Nehda, Chingari, Pipaliya ki dhani of Pali district in western Rajasthan.

Table 1:- Density of Indian antelope (Blackbuck) in some areas of western Rajasthan

District	Area/Village	Total number of transect	Density per sq km (Individual per sq km)
Jodhpur	Guda closed area	7	9.3
	Sathin closed area	2	4.33
	Dhawa closed area	6	7.75
Nagaur	Rotu closed area	2	9.42
	Chhakdhani	2	3.58
	Jaroda closed area	2	12.99
Churu	Tal Chhaper WLS	4	38.5

Table 2 :- Census data of Blackbuck population in closed or protected areas of western Rajasthan (Forest Deptt. of Rajasthan).

Year	Jodhpur			Nagaur			Churu	
	Guda	Dhawa	Sathin	Jaroda	Chhakdhani	Rotu	Tal Chhapar	
2002-03	4237	3714	976	842	805	615	1638	
2003-04	1475	386	446	989	712	582	1281	
2004-05	1885	953	844	876	881	645	1698	
2005-06	1051	725	410	802	615	587	1680	
2006-07	-	-	-	-	-	-	1763	
2007-08	811	407	87	2809	728	440	1780	
2008-09	835	477	42	2291	516	659	1827	
2009-10	838	188	100	2505	537	757	1910	
2010-11	680	386	131	1625	631	519	2025	

2011-12	770	405	152	1703	549	779	1955
2012-13	831	487	176	1805	711	709	1891
2013-14	775	430	141	2213	832	727	1852
2014-15	630	401	127	2088	714	844	1905

To find out the present distribution and abundance of blackbuck in western part of the Thar Desert, 12 districts and selected study sites were visited several times during present study for estimation of abundance and group size of blackbuck. The population density of blackbuck was estimated by line transect method in different seasons in study sites. Population density of Indian Antelope was found 9.42 in Rotu 3.58 in Chhakdhani and 12.99 indivi/sq.km in Jaroda area, which is indicating that Jaroda is densely populated (Table 4).

Table 3 :- Blackbuck density in selected area

S.N.	Selected area	No. of transect	Total no. of animal seen	Distance covered (km)	Mean population density (per sq km)
01	Rotu	14	870	24.95	9.42
02	Chhakdhani	14	550	41.50	3.58
03	Jaroda	14	650	15.68	12.99

Table 4 :- District wise population density (in sighted areas) of blackbuck in Thar Desert.

S.N.	District	No. of transect	Total no. of animal seen	Distance covered (km)	Mean population density (per sq km)
1	Jodhpur	08	1301	1050	3.34
2	Nagaur	7	788	900	2.36
3	Bikaner	4	298	360	2.23
4	Barmer	3	126	290	1.17
5	Pali	02	50	160	0.84
6	Churu	02	140	250	1.84
7	Jaisalmer	04	-	190	-
8	Jalore	03	35	220	0.42
9	Hanumangargh	01	-	154	-

10	Sriganganagar	03	56	180	0.84
11	Sikar	02	-	142	-
12	Jhunjhunu	03	-	115	-
Total		42	2794	4011	

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During present study period factors like limited resources, human interference/anthropogenic impacts and predator pressure showed impact on home range in all the areas and affected the home range of different herds. The predator pressure of village feral dogs was major reason of larger home range of these herds in study areas. The blackbucks were seen to move for about 2-8 km a day in their home range to perform various activities. The sizes of different home ranges varied with the size of the occupant herd, availability of food/water hole, topography of terrain and intra and inter specific competition for food resources. The largest home range was noted for herd (Chhakdhani 1st All Male Group) CD-1AM. The direction of movement and the part of the home range used differed from season to season and home range to home range (Table 5). The single home range was shared for the resources available in the particular area by two different herds in different period of time. Such overlapping of home range was observed in Rotu study site. During present study period about 31 incidents of inter-herd contact were recorded in overlapping of home ranges by different herds. Most of these contacts were observed during grazing and mating periods.

Table 5 :- Home range and territorial areas of selected blackbuck herds at different study sites

A. Rotu Conservation Reserve study site

Herd name	Time	Area Home range (in sq. km.)	Area Territory (in sq. km)
RT-1AM (Rotu - 1 st all male group)	Summer	3.10	0.18
	Monsoon	2.40	0.14
	Winter	2.50	0.16
RT-2MH (Rotu – 2 nd all mixed group)	Summer	4.5	0.21
	Monsoon	2.5	0.13
	Winter	2.1	0.20

B. Chhakdhani study site

Herd name	Time	Area home range (in sq. km.)	Area Territory (in sq. km)
CD-1AM (Chhakdhani - 1 st all male group)	Summer	5.3	0.55
	Monsoon	3.5	0.41
	Winter	4.2	0.32
CD-2MH (Chhakdhani – 2 nd all mixed group)	Summer	2.5	0.31
	Monsoon	1.85	0.27
	Winter	1.32	0.22

C. Jaroda conservation reserve study site

Herd name	Time	Area home range (in sq. km.)	Area Territory (in sq. km)
JD-1AM (Jaroda- 1 st all male group)	Summer	3.2	0.46
	Monsoon	1.31	0.24
	Winter	1.86	0.31
JD-2MH (Jaroda- 2 nd all mixed group)	Summer	2.66	0.42
	Monsoon	1.65	0.23
	Winter	2.61	0.30

Home range of different herds has been presented in table 5, according to seasonal variations. The overlap use of home range by neighbouring herd members was usually peaceful. The leader of the herd was mostly sitting and watching the interacting members of two herds quietly. However, on the 6-7 occasions the resident male of Chhakdhani herd 1MH and JD- 2MH was observed to be involved in chasing and horn threat and sparring. The

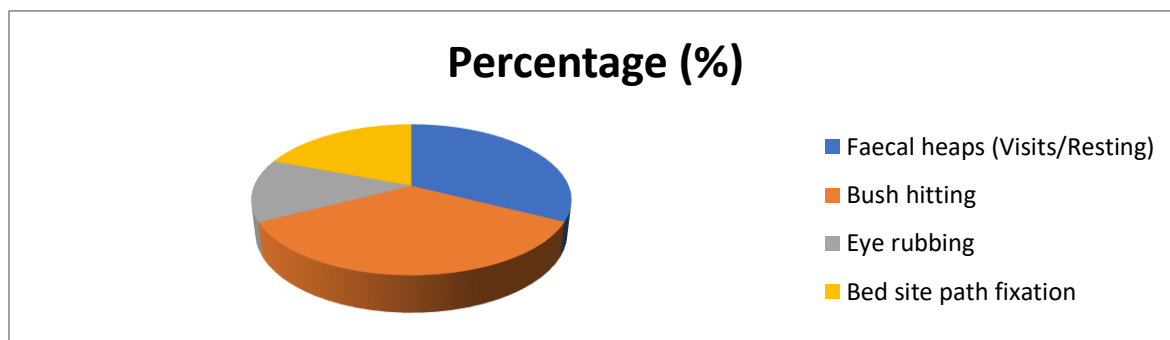


Fig. 01 Territory marking by territorial male

territorial status of the owner as well as the existence of the territorial boundaries is indicated by that individual only. The adult male blackbuck and some other ungulates are observed to define and mark their territory in various ways. The territorial male does not allow to trespass any other adult male at least in his presence. The size of such territory was found different for different territorial males. Mostly it maintained the same throughout the year in normal circumstances. In some cases a superior male of all male herds and a solitary male also showed territorial display. Such events were generally found in the field mainly when an estrous female approached or passed near to the periphery of all male herds. There are several ways, a buck can mark its territory. During present study four types of scent marking strategies were observed (Fig. 01). Territorial behaviour of other male ungulates is frequently used to attract and secure mates (Owen-Smith, 1977), but in the population of blackbuck, males attract mates solely through resources defence (Isvaran, 2006) rather than through differences in behaviour. The habitats in which male blackbuck establish territories act as the main resource to attract females (Isvaran, 2003). Although some still doubt on whether female choice is based solely on a male's defended resources, the lack of behavioural differences between mating and non-mating males. In a geographical area many types of habitats are found and an animal species utilizes different habitats in different degrees. In the case of blackbuck, they are highly influenced by the forage availability (Prasad, 1981). The results of this study showed that both food availability and vegetation cover were very important for blackbuck habitat selection. The results are similar to those of Jhala (1998) from his study of blackbuck at Velvadara. The data collected on various habitat parameters showed that blackbuck in selected site prefer open land like grassland, cropland in different degree according to seasons, grass condition, presence of minimum predator and less disturbances by anthropogenic activities. In conclusion, the habitat use by blackbuck varied accordingly in different seasons due to forage availability, predator pressure, competition with livestock and interaction with human being.

Daily activity budget according to season were managed in time budget by blackbuck. Data revealed that blackbuck out of total 2851 observed hours in study area, spent 1044 hrs for grazing, 753 hours for lying and 356 hours for walking, 154 hours for scanning activity patterns and 544 hours for activities like play, territorial, fighting and other activities etc. (Table 6).

Table 6 :- Time utilization (in hours) on various daily activities by different members of different herds of blackbuck

Activities	A♂	A♀	SA♂	SA♀	FAWN	Total
Grazing	205	244	197	209	189	1044
Lying	180	149	156	134	134	753
Walking	91	79	64	68	54	356
Scanning	31	52	26	34	11	154
Playing	18	28	44	29	52	171
Territorial	43	-	25	-	-	68
Fighting	29	-	16	-	-	45
Others	69	52	54	43	42	260
Total	666	604	582	517	482	2851

During present study it has been observed that the population of blackbuck has drastically declined every where due to destruction of scrub and wasteland areas and hunting even after legal protection. In some small areas in Rajasthan and Saurashtra, religious sentiments may help to prolong their existence. The Mahajan of Botad are effectively protecting the blackbuck herds with armed guards in Dhankaniya Vidi and Bishnoi villages even outside the closed areas or sanctuaries in Rajasthan.

CONSERVATION STRATEGIES:

Blackbuck is one of the most endangered mammals of Indian subcontinent. Compared with the situation even a few decades ago, the present distribution of blackbuck in India is drastically reduced and surviving population is fragmented and usually very small. In Rajasthan, blackbuck population density in the past was very high in comparison to present. This animal has been restricted to only sanctuaries and closed area with very low population density. Population of blackbuck declined in Jodhpur, Nagaur, Bikaner and Churu. The blackbucks are now restricted to Bishnoi dominant villages. The blackbucks are already exterminated by poachers from most of their former habitats. Most of their habitats are being converted into agriculture fields, forcing them to feed on crops. This give rise to man animal conflict and in the bargain hundreds of animals are killed every year. With the increase of human population and livestock, the competition for resources also increased.

In rural areas, where these ungulates are found in their respective habitats, with the increase of human settlement, the population of feral / stray dogs has also increased. The feral dogs are important predators of the ungulates in these areas. The feral dogs live in groups, encircle blackbuck strategically to prey upon it. The killings

by feral dogs are very high especially of fawn in the present study area. However, the populations of blackbuck are also under threat due to habitat destruction, road and railway traffic in habitats, and killing of these animals by human beings. But, still people like Bishnois are protecting these animals even at the cost of their life. In this current scenario, it is utmost important to establishment a long term management plan to fulfill the need of both human and the blackbuck in natural areas for their continued existence in the protected areas that have high population density of human, livestock and blackbuck. Therefore, more micro-level or site-specific management plans should be recommended. Secondly, only when local communities' positive attitudes are put into practice the conservation policies will succeed. But the local communities are partners too, to work together with government to help to meet these goals and to share in the benefits, which may arise from conservation, hence the term co-management (Sidhartha *et al.*, 2006; Robert and Martin, 2003). Present study suggests following recommendation for continued existence and survival of blackbuck harmoniously in protected areas with local community –

- The favoured grassland habitats of the blackbuck be conserved or protected by State Government agencies with the cooperation of the local people.
- The provisions of Wildlife (Protection) Act be strictly imposed against illegal hunting of these animals. The trial against wildlife poachers can be fastened by creating fast track courts separately for these cases only.
- Presently, these ungulates have hardly any natural predators of significance but feral/pariah dogs probably account for more deaths of blackbuck and chinkara than any other creature after man. So, there should be a proper action plan to control the increasing numbers of feral dogs near habitats of the ungulates.
- Grazing of livestock and other activities be strictly stopped by law in natural habitats of blackbuck specially in protected areas and sanctuaries.
- To prevent outbreak of cattle disease contagious to the ungulates, regular prophylactic inoculation of livestock that live or graze in adjacent areas must be carried out.
- The rapid increase of the exotic *Prosopis juliflora* would convert the habitat to one with tree shrub cover and less suitable to the blackbuck as they reduce the total productivity of grass. So, spreading of this exotic plant be controlled because high density of this plant help feral dogs and other predators.
- Establishment of other protected areas.
- Education on local culture, belief, ethics and values of wildlife should be given to the new generation at school level for improving the relationship between blackbuck and people. Sustainance of belief and cultural mechanisms that could be used to increase local people's tolerance of crop damage by blackbuck.
- Making scientific policies and programmes that how one can be encouraged with the belief, ethics and cultural system to be spread from one community to another?
- Farming methods should be improved so as to prevent wild animal's invasion and enhance crop harvest.

- To improve awareness among local communities on National policies and laws regarding community development and sustainable utilization of natural resources.
- Exchange of ideas between communities from different location should be enhanced so as to build trust and joint ventures for more efficient implementation of activities.
- Co-management of blackbuck conservation involving all landowners, forest department personnel and NGOs.
- Essential pre-requisite to conserve the blackbuck in protected area, that how the other beliefs and cultural mechanisms applied elsewhere could be used to increase local people's tolerance of crop damage by blackbuck and how can these belief systems be encouraged to spread from one community to another?
- Maintain their habitat area as open grassland with some plantation for food and shelter.
- Avoid the use of pesticides and herbicides which are harmful to the health of blackbuck.
- Avoid construction and putting concret, especially in the blackbuck habitat area. This reduces the food availability of these animals.
- Protect local biodiversity by protecting the native wild fauna and flora.
- Driving should be careful and slow in the protected area. There have been some cases where blackbuck were killed by vehicles. Sign boards with pictures regarding speed limits should be displayed at key points, such as turning, crossing etc.
- For the conservation of biodiversity, minimum of 5% geographical area of the state should be set apart and declared as protected/conservation areas.
- Inventory of biodiversity of each areas should be prepared meticulously with particular emphasis on critically endangered, endangered, threatened and rare species as per IUCN (International Union on Conservation of Nature) criteria. Such flora *and* fauna should be recommended for inclusion in the relevant Schedule of Wildlife (Protection) Act 1972.
- Both *ex-situ* and *in-situ conservation should be* planned. As an in-situ conservation measure, Under provision of the Wildlife (Protection) Act, a chain of National Parks and Wildlife Sanctuaries wherever possible need to be interconnected by suitable corridors for transmission of genes.
- Rehabilitation of degraded forests should be taken up with people's participation to give sustained income to members of village community by planting diversified species viz. Gwarpath, (*Aloe vera*), Ratanjot (*Jatropha curcus*), Guggal (*Commiphora wighii*) and other plants of medicinal values on ridges of contour trenches of V-ditches. Bamboo (*Dendrocalamus strictus*), Aonla (*Emblica officinalis*) Lasoda (*Cordia mixa*), Sitaphal (*Annona squamosa*) etc. can be planted so as to ensure economic return from plantations in short time.

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