Journal of Applied and Natural Science
11(2): 468- 477 (2019)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

Opinion survey on the ecology of Sambar, *Rusa unicolor* (Artiodactyla, Cervidae) and its status with respect to crop damage in districts Jhunjhunu and Churu, Rajasthan (India)

Deepak Rai*
Animal Behaviour and Wildlife Conservation Laboratory, Department of Zoology, Kurukshetra University, Kurukshetra-136119 (Haryana), India
Kalpana
Animal Behaviour and Wildlife Conservation Laboratory, Department of Zoology, Kurukshetra University, Kurukshetra-136119 (Haryana), India

*Corresponding author. E-mail:drbkuk@gmail.com

Article Info
DOI:10.31018/jans.v11i2.2092
Received: April 28, 2019
Revised: May 30, 2019
Accepted: June 6, 2019

How to Cite
Rai, D. and Kalpana (2019). Opinion survey on the ecology of Sambar, *Rusa unicolor* (Artiodactyla, Cervidae) and its status with respect to crop damage in districts Jhunjhunu and Churu, Rajasthan (India). *Journal of Applied and Natural Science*, 11(2): 468- 477

Abstract
To obtain the preliminary information regarding various ecological and behavioural aspects of Sambar, an opinion survey through questionnaires was carried out along with periodic fortnightly visits in and around the areas covering Bir Jhunjhunu Conservation Reserve and Bairasar Johad in district Jhunjhunu and Churu of Rajasthan (India) from July, 2018 to December, 2018. During the survey, 173 inhabitants of village Samaspur and 153 inhabitants of village Bairasar were contacted and it was observed that the population of Sambar has declined as compared to its earlier strength as reported by 58.38% inhabitants of village Samaspur and 62.1% inhabitants of village Bairasar. As far as the distribution of Sambar was concerned, 51.4% interviewees of village Samaspur and 54.2% interviewees of village Bairasar reported that Sambar population is randomly distributed in both the study areas. In relation to group size, 62.80% inhabitants of village Bairasar and 64.2% inhabitants of village Samaspur reported that group size of Sambar vary from 5-12 individuals. Further information regarding the crop damage pattern and financial loss was also collected and 61.8% interviewees of village Samaspur and 66% interviewees of village Bairasar were agree on the fact that Sambar causes damage to their crop which results in low to high financial loss. The importance of opinion survey and field survey based monitoring is emphasized for the ecological significance of the species among people of that region.

Keywords: Conservation reserve, Group size, Opinion survey, Population, Ungulates

INTRODUCTION

Ungulates form the major prey base for the large mammalian predators and also considered as indicators of habitat quality, maintain ecosystem stability and biodiversity (Pringle *et al*., 2010). But now the population of ungulates are globally vulnerable because of their biological traits, such as their wide ranging movements, tendency to forage on cropland, body size that attracts hunters, habitat destruction and rapid human population growth (Singh *et al*., 2017). Deer are even-toad ungulate which belongs to order Artiodactyla and family Cervidae. Out of 54 species of deer found worldwide, only nine species are found in India which belong to two families, Cervidae (including seven deer species i.e. Barasingha, *Cervus duvauceli*; Sambar deer, *Cervus unicolor*; Chital, *Axis axis*; Hog deer, *Axis porcinus*; Barking deer, *Muntiacus muntjak*; Kashmir stag, *Cervus elaphus hangul* and Thamin, *Cervus eldi*) and Moschidae (which includes two deer species i.e. Himalayan musk deer, *Moschus leucogaster* and Black musk deer, *Moschus focus*) (Sankar and Goyal, 2004). Among these species, Sambar is the largest South-Asian deer species having wide geographical range and is native to many countries like Sri Lanka, India, Nepal, Bhutan, Southern China, Burma, Taiwan, Thailand, Laos, Cambodia, Indonesia, Malaysia, Celebes and the Philippines (Varman and Sukumar, 1993; Timmins *et al.,* 2015) and also introduced and become established in USA, New Zealand and Australia. Firstly Kerr (1792) gave the generic name of Sambar as *Cervus*. Hamilton-Smith (1827) describes *Rusa* as subgenus of *C*ervus. Later Hodgson (1841) was the first to use *Rusa* as a genus of Sambar (Leslie, 2011). Groves and Grubb (2011) divided Sambar into two species on the basis of morphological differences as well as genetic differences due to differences in diploid number of chromosome, namely, Southeast Asian Sambar, *Cervus equines* (2n=60) of South East Asia (including

North East India) and Southern China, and residual Indian Sambar *Cervus unicolor* (2n=62) of South Asia. They further categorized *Cervus unicolor* into seven sub-species including *Rusa unicolor brookei, Rusa unicolor cambojensis, Rusa unicolor dejeani, Rusa unicolor equine, Rusa unicolor hainana, Rusa unicolor swinhoii* and *Rusa unicolor unicolor*. Despite the widespread distribution of *Rusa unicolor* in Southern Asia and its differential habitat use, it is no longer abundant throughout in most of its native range except in some protected areas. Due to drastic decrease in the population of Sambar, Timmins *et al.* (2015) listed this species in Vulnerable category because of >50% population decrease over the past three generation and it was placed under Schedule III of Wildlife Protection Act (1972) of India.

Being the vulnerable species, it has received little scientific attention regarding the study of ecological and behavioral aspects and mentioned briefly in multi-species studies. Sambar had been recorded from several protected areas of India and intensively studied in Kanha National Park (Schaller, 1967), Bandipur National Park (Johnsingh, 1983), Mundanthurai (Johnsingh and Sankar, 1991), Nagarhole National Park (Karanth and Sunquist, 1992), Corbett National Park (Pant *et al*., 1999), Periyar Tiger Reserve (Harikumar *et al*., 1999), Pench Tiger Reserve (Biswas and Sankar, 2002), Ranthambore Tiger Reserve (Bagchi *et al*., 2003) and Sariska National Park (Chatterjee *et al*., 2014) in India (Jain *et al*., 2018). The major threats to Sambar population in the study area are degradation and fragmentation of habitats, water scarcity and human activities like hunting. Keeping the above points in mind, opinion surveys (through questionnaires) were carried out to acquire preliminary information regarding Sambar population, their distribution, habitat and various other aspects to know the current status of Sambar from the farmers/inhabitants in the study area.

MATERIALS AND METHODS

Study areas

Bir Jhunjhunu Conservation Reserve, Jhunjhunu (Rajasthan): The Bir Jhunjhunu is a reserve forest situated at about 2 km. east of Jhunjhunu city along with the Jhunjhunu-Chirawa state highway and located at 28°09ˈ N latitude and 75°25ˈ E longitude having a total area of 1047 hectares. The region covers 58.8% mammalian diversity of Thar (Dev and Singh, 2016). The Bir area is home to 440 species of plant most of which are representative of arid and semi arid vegetation of western India (Choudhary and Shringi, 2017). Dominant vegetation in the area are *Ziziphus mauritiana* (Ber), *Prosopis cineraria* (Khejri), *Prosopis juliflora* (Vilayati babul), *Azadirachta indica* (Neem), *Capparis deciduas* (Ker), *Acacia nilotica* (Kikar), *Salvadora oleoides* (jar), *Opuntia* species (paddle cactus), *Cenehrus ciliaris* (Buffel grass) and different type of herbs and shrubs. Main wild fauna found in the Bir includes various avian (around 95 species) and mammalian species. The latter includes Nilgai (*Boselophus tragocamelus*), Chinkara (*Gazella bennettii*), Sambar (*Rusa unicolor*), Desert fox (*Vulpes vulpes*) and Desert cat (*Falis silvestris*). The predominant domestic livestock found inside the reserve are goats (*Capra hircus*) and buffaloes (*Bubalus bubalis*).

Bairasar Johad, **Village Bairasar Bara, Churu (Rajasthan):** The Bairasar Johad is situated in village Bairasar bara which is part of tehsil Rajgarh of district Churu (Rajasthan) along with Rajgarh-Jhunjhunu state highway at an latitude of 28º52` N and longitude of 75º38` E. It covers an area of about 36.80 acres. Dominant vegetations in the area are *Ziziphus mauritiana* (Ber), *Prosopis cineraria* (Khejri), *Prosopis juliflora* (Vilayati babul), *Azadirachta indica* (Neem), *Capparis deciduas* (Ker), *Acacia nilotica* (Kikar), *Salvadora oleoides* (jar), *Cenehrus ciliaris* (Buffel grass) and different type of herbs and shrubs. Main wild fauna found in the study area includes Nilgai (*Boselophus tragocamelus*), Chinkara (*Gazella bennettii*), Sambar (*Rusa unicolor*) and various avian species (Dev and Singh, 2016). Climatic conditions of these areas are subtropical arid type with scanty rainfall. The average annual rainfall in the study areas is around 56 cm and the mean annual temperature is 29 °C with a minimum of 2 ° C in January and maximum of 51 °C in June (Shekhawat and Bhatnagar, 2014).

Opinion survey: To obtain the preliminary information about the current status of Sambar with respect to ecological aspects such as population status, group size, activity pattern, calving and breeding period, social organization and habitat used etc., an opinion surveys (through questionnaire) were carried out as per Chopra and Rai (2009) and Rai and Jyoti (2018) in and around Bir Jhunjhunu Conservation Reserve, Jhunjhunu and Bairasar Johad, Churu, Rajasthan (India). During the opinion survey, 173 interviewees of village Samaspur and 153 interviewees of village Bairasar were contacted from July, 2018 to December, 2018.

RESULTS AND DISCUSSION

In present scenario, Sambar are facing some ongoing problem such as loss of forested habitats including habitat fragmentation and agricultural expansion, urban expansion, roads and associated human traffic, illegal hunting, making it vulnerable throughout the India (Bagchi *et al.,* 2008; Chopra and Rai, 2009; Leslie, 2011; Gopalaswamy *et al*., 2012; Jain *et al*., 2018; Rai and Jyoti, 2018). In the present study, an opinion survey was carried

Table 1. Positivity of the response of the interviewees regarding current population and Sambar problem in Rajasthan in village Samaspur (including Bir Jhunjhunu Conservation Reserve) and village Bairasar (including Bairasar Johad), Rajasthan from July, 2018 to December, 2018.

Parameters of opinion survey	Opinion of Interviewees Number (%)							
	Yes		**No**		**Can't say**			
Sambar problem in Rajasthan	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur		Village Bairasar	
	48 (27.7)	60 (39.2)	53 (30.6)	45 (29.4)	72 (41.6)		48 (31.4)	
	Less		**Average**		**Abundant**		**Can't say**	
Present Sambar population in field area	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
	62 (35.8)	44 (28.8)	44 (25.4)	42 (27.5)	29 (16.8)	33 (21.6)	38 (22)	34 (22.2)
	Increased		**Decreased**		**No change**		**Can't say**	
Current Pop. trend w.r.t. 5-10 years earlier	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
	17 (9.8)	19 (12.4)	101 (58.3)	95 (62.1)	35 (20.2)	23 (15)	20 (11.6)	16 (10.5)

out from July, 2018 to December, 2018 along with fortnightly periodic field visits in and around Bir Jhunjhunu Conservation Reserve, Jhunjhunu and Bairasar Johad, Churu (Rajasthan). The survey results revealed that 35.8% and 28.8% interviewees of village Samaspur and village Bairasar respectively gave positive response regarding the presence of less population of Sambar in the study area presently while 58.3% interviewees of village Samaspur and 62.1% interviewees of village Bairasar gave their response about the decreasing population of Sambar as compared to 5-10 years earlier population. As far as the Sambar problem as unconventional agricultural pest is concerned, 27.7% inhabitants of village Samaspur and 39.2% inhabitants of village Bairasar respond that Sambar is posing agricultural threat to their crops (Table 1).

Random distributions of Sambar in both the study areas are reported by 51.4% interviewees and 54.2% interviewees of village Samaspur and village Bairasar respectively. Most of the interviewees revealed their positive response about sighting of the animal. Sambar are mostly seen in groups as per 60.1% interviewees of village Samaspur and 59.5% interviewees of village Bairasar but the solitary sighting of Sambar was also observed by the 26.6% interviewees and 28.1% interviewees of village Samaspur and Bairasar respectively. As per the opinion survey results, group size of Sambar vary from 5-12 individuals as reported by 62.80% inhabitants of village Bairasar and 64.2% inhabitants of village Samaspur (Table 2). As far as group size of Sambar is concerned, the field survey also revealed minimum of one to a maximum of eleven animals in reported group in the study areas (Plate 1). Earlier, Lagory (1986) studied that 75% groups were observed with group size ranging from 1 to 5 individual and adult males mostly recorded solitary, while composition of group varied with season and habitat openness. Bagchi *et al.,* (2008) also reported that Sambar was mostly seen in groups of 4-6 individuals. In relation to daily activity pattern, Sambar are mostly active during morning hours (as per 52.0% inhabitants of village Samaspur and 50.3% inhabitants of village Bairasar) and comparatively less active during evening hours (as per 27.7% inhabitants of village Samaspur and 30.7% inhabitants of village Bairasar) periods and rest during the early afternoon hours. Opinion survey results reflected that despite its great variation on dietary selection depending on food availability, Sambar mostly prefer scrubby forest (59.5% and 58.8% in village Samaspur and Bairasar respectively) followed by agricultural area (33.5% and 36.6% in village Samaspur and Bairasar respectively) which in turn followed by fallow land area (6.9% and 4.6% in village Samaspur and Bairasar respectively) (Table 2). This was in accordance with

Table 2. Positivity of the response of the interviewees regarding some ecological aspects of Sambar in village Samaspur, Jhunjhunu (including Bir Jhunjhunu Conservation Reserve) and village Bairasar, Churu (including Bairasar Johad), Rajasthan from July, 2018 to December, 2018.

Parameters of opinion survey	**Opinion of interviewees Number (%)**									
	Random		**Non-random**		**Can't say**					
Distribution pattern	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar				
	89 (51.4)	83 (54.2)	58 (33.5)	50 (32.7)	26 (15)	20 (13.1)				
	Group		**Solitary**		**Can't say**					
Sighting of Sambar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar				
	104 (60.1)	91 (59.5)	46 (26.6)	43 (28.1)	23 (13.3)	19 (12.4)				
	<5		**5-8**		**9-12**		**>12**		**Can't say**	
Group size	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
	40 (23.1)	34 (22.2)	60 (34.7)	57 (37.3)	51 (29.5)	39 (25.5)	14 (8.1)	14 (9.2)	8 (4.6)	9 (5.9)
	Dawn to 11a.m.		**11a.m. to 3p.m.**		**3p.m. to dusk**		**Can't say**			
Daily activity pattern	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar		
	90 (52.0)	77 (50.3)	28 (16.2)	25 (16.3)	48 (27.7)	47 (30.7)	7 (4)	4 (2.6)		
	Agricultural land		**Fallow land**		**Scrubby forest**					
Habitat preference	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar				
	58 (33.5)	56 (36.6)	12 (6.9)	7 (4.6)	103 (59.5)	90 (58.8)				

Table 3. Positivity of the response of the interviewees regarding crop damage and method of management action of Sambar in village Samaspur, Jhunjhunu (including Bir Jhunjhunu Conservation Reserve) and village Bairasar, Churu (including Bairasar Johad), Rajasthan from July, 2018 to December, 2018.

S. N.	Management Methods used by people	Crop Damage (%)					
		Yes		No		Can't say	
		Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
1.	Use of watch dog	9 (5.2)	11 (7.2)	4 (2.3)	7 (4.6)	2 (1.2)	1 (0.7)
2.	Day and night watchman	8 (4.6)	9 (5.9)	9 (5.2)	3 (2.0)	1 (0.6)	2 (1.3)
3.	Fencing with wires	13 (7.5)	13 (8.5)	4 (2.3)	2 (1.3)	1 (0.6)	2 (1.3)
4.	Dummy model	13 (7.5)	12 (7.8)	1 (0.6)	6 (3.9)	5 (2.9)	2 (1.3)
5.	Simply chasing	8 (4.6)	12 (7.8)	4 (2.3)	2 (1.3)	0 (0)	0 (0)
6.	No action	7 (4)	6 (3.9)	4 (2.3)	4 (2.6)	0 (0)	0 (0)
7.	Use of watch dog and day and night watchman	10 (5.8)	3 (2.0)	1 (0.6)	2 (1.3)	2 (1.2)	1 (0.7)
8.	Use of watch dog and fencing with wires	5 (2.9)	5 (3.3)	1 (0.6)	2 (1.3)	1 (0.6)	3 (2.0)
9.	Use of watch dog and dummy model	3 (1.7)	6 (3.9)	2 (1.2)	2 (1.3)	6 (3.5)	1 (0.7)
10.	Use of watch dog and simply chasing	6 (3.5)	3 (2.0)	6 (3.5)	1 (0.7)	1 (0.6)	0 (0)
11.	Day and night watchman and dummy model	5 (2.9)	7 (4.6)	1 (0.6)	1 (0.7)	1 (0.6)	1 (0.7)
12.	Fencing with wire and dummy model	6 (3.5)	6 (3.9)	1 (0.6)	5 (3.3)	1 (0.6)	1 (0.7)
13.	Dummy model and simply chasing	4 (2.3)	5 (3.3)	1 (0.6)	0 (0)	3 (1.7)	1 (0.7)
14.	Day and night watchman and fencing with wires	3 (1.7)	3 (2.0)	1 (0.6)	0 (0)	1 (0.6)	0 (0)
Total		**107 (61.8)**	**101 (66.0)**	**43 (24.9)**	**37 (24.2)**	**25 (13.3)**	**15 (9.8)**

Table 4. Positivity of the response of the interviewees regarding degree of financial loss and method of management action of Sambar in village Samaspur, Jhunjhunu (including Bir Jhunjhunu Conservation Reserve) and village Bairasar, Churu (including Bairasar Johad), Rajasthan from July, 2018 to December, 2018.

S. N.	Management methods used by people	Degree of Financial loss (%)							
		High		Medium		Low		Can't say	
		Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
1.	Use of watch dog	3 (1.7)	3 (2.0)	3 (1.7)	7 (4.6)	7 (4.0)	6 (3.9)	2 (1.2)	3 (2.0)
2.	Day and night watchman	2 (1.2)	3 (2.0)	3 (1.7)	3 (2.0)	12 (6.9)	6 (3.9)	1 (0.6)	2 (1.3)
3.	Fencing with wires	3 (1.7)	4 (2.6)	10 (5.8)	7 (4.6)	3 (1.7)	5 (3.3)	2 (1.2)	1 (0.7)
4.	Dummy model	5 (2.9)	3 (2.0)	6 (3.5)	6 (3.9)	4 (2.3)	7 (4.6)	4 (2.3)	4 (2.6)
5.	Simply chasing	3 (1.7)	3 (2.0)	3 (1.7)	6 (3.9)	4 (2.3)	4 (2.6)	2 (1.2)	1 (0.7)
6.	No action	2 (1.2)	1 (0.7)	4 (2.3)	6 (3.9)	5 (2.9)	3 (2.0)	0 (0)	0 (0)
7.	Use of watch dog and day and night watchman	2 (1.2)	1 (0.7)	6 (3.5)	1 (0.7)	3 (1.7)	3 (2.0)	2 (1.2)	1 (0.7)
8.	Use of watch dog and fencing with wires	3 (1.7)	2 (1.3)	1 (0.6)	2 (1.3)	2 (1.2)	4 (2.6)	1 (0.6)	2 (1.3)
9.	Use of watch dog and dummy model	1 (0.6)	2 (1.3)	2 (1.2)	3 (2.0)	3 (1.7)	4 (2.6)	2 (1.2)	0 (0)
10.	Use of watch dog and simply chasing	1 (0.6)	0 (0)	4 (2.3)	3 (2.0)	5 (2.9)	1 (0.7)	3 (1.7)	0 (0)
11.	Day and night watchman and dummy model	1 (0.6)	0 (0)	2 (1.2)	4 (2.6)	3 (1.7)	3 (2.0)	1 (0.6)	2 (1.3)
12.	Day and night watchman and simply chasing	1 (0.6)	0 (0)	3 (1.7)	0 (0)	1 (0.6)	0 (0)	1 (0.6)	0 (0)
13.	Fencing with wire and dummy model	1 (0.6)	2 (1.3)	3 (1.7)	3 (2.0)	1 (0.6)	5 (3.3)	3 (1.7)	2 (1.3)
14.	Fencing with wire and simply chasing	2 (1.2)	0 (0)	2 (1.2)	0 (0)	1 (0.6)	0 (0)	0 (0)	0 (0)
15.	Dummy model and simply chasing	1 (0.6)	4 (2.6)	2 (1.2)	0 (0)	3 (1.7)	1 (0.7)	2 (1.2)	1 (0.7)
16.	Day and night watchman and fencing with wires	2 (1.2)	1 (0.7)	1 (0.6)	1 (0.7)	2 (1.2)	1 (0.7)	0 (0)	0 (0)
Total		**33 (19.1)**	**29 (19.0)**	**55 (31.8)**	**52 (34.0)**	**59 (34.1)**	**53 (34.6)**	**26 (15.0)**	**19 (12.4)**

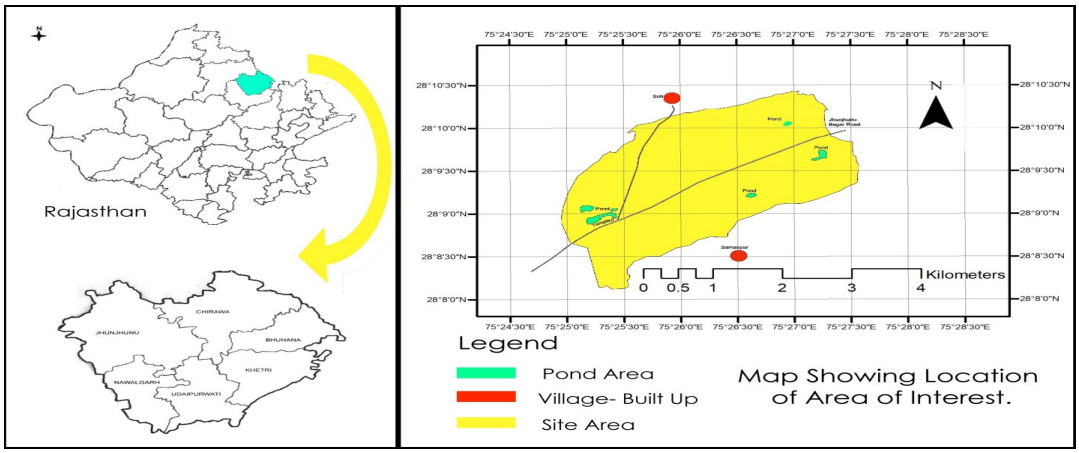

Fig.1. *Location and area of Bir Jhunjhunu Conservation Reserve in Jhunjhunu, Rajasthan (India)*

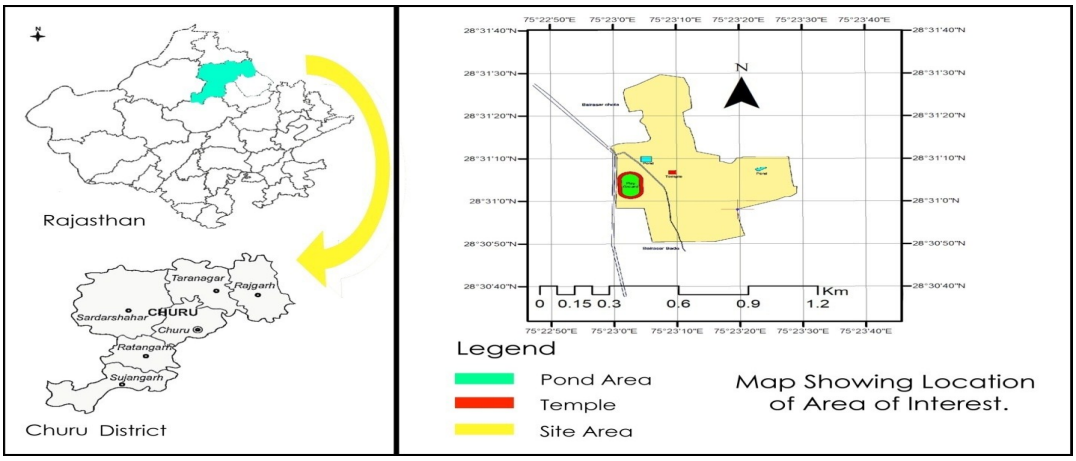

Fig.2. *Location and area of Bairasar Johad in district Churu, Rajasthan (India.)*

Plate 1. *Photograph showing (a) Unimale-Unifemale, (b) Adult male, (c) Mixed herd and (d) Herm herd of Sambar in Bir Jhunjhunu Conservation Reserve (a and d) and Bairasar Johad (b and c).*

Table 5. Positivity of the response of the interviewees regarding reproductive behaviour of Sambar in village Samaspur, Jhunjhunu (including Bir Jhunjhunu Conservation Reserve) and village Bairasar, Churu (including Bairasar Johad), Rajasthan from July, 2018 to December, 2018.

Parameters of opinion survey	Opinion of interviewees Number (%)							
	Throughout year		**March to May**		**October to December**		**Can't say**	
Breeding period	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
	59 (34.1)	49 (32)	20 (11.6)	13 (8.5)	2 (1.2)	2 (1.3)	92 (53.2)	89 (58.2)
	Throughout year		**March to May**		**October to December**		**Can't say**	
Calving period	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
	60 (34.7)	50 (37.7)	2 (1.2)	2 (1.3)	20 (11.6)	13 (8.5)	91 (52.6)	88 (57.5)
	Strongly agree		**Agree**		**Disagree**		**Can't say**	
Sambar should be protected	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar	Village Samaspur	Village Bairasar
	2 (1.2)	1 (0.7)	50 (28.9)	38 (24.8)	43 (24.9)	36 (23.5)	48 (45.1)	78 (51)

Karanth and Sunquist (1992) who recorded highest density of Sambar in dense forest area in Sariska National Park, Rajasthan.

According to the opinion survey results 61.8% and 66% interviewees of village Samaspur and Bairasar respectively complained about the crop damage due to crop raiding by Sambar population and they suffered from low to high financial loss as reported by 85% and 87.6% interviewees of village Samaspur and village Bairasar respectively (Table 3 and Table 4). To protect the crops from Sambar, farmers used various management methods such as use of watch dog, day night watchman, fencing with wires, dummy model, simply chasing and various combinations of these methods to prevent as much damage as they can. In village Samaspur almost all the possible management method were used by farmers while in village Bairasar, not even a single interviewees told about the use of 'day night watchman with simple chasing' and 'fencing with wires along with simple chasing' as a management method (Table 4).

Information regarding the breeding and calving period of Sambar was also collected through these opinion surveys and it was observed that 53.2% interviewees of village Samaspur and 58.2% interviewees of village Bairasar didn't give any response due to lack of knowledge, while 34.1% interviewees of the village Samaspur and 32% interviewees of the village Bairasar told that Sambar breed throughout of the year, so calves were also observed throughout the year by interviewees (Table 5). Sankar (1994) observed in Sariska National Park that the peak rutting season was in winter (November to December) when all male Sambar were carrying hard antler while fawn were observed in April to July whereas Schaller (1967) reported that rutting period of Sambar occurs throughout the year. Due to lack of awareness regarding the ecological significance, current status and frequency of crop raiding by Sambar, people of both the study areas gave different responses in respect to the protection of Sambar. So for the better behaviour understanding of the species, effective legal and social actions as well as better sustainable use of natural resources and conservation program are the needs of the hour to assure adequate conservation of this threatened species.

Conclusion

The results of opinion survey conducted through interviewees of district Jhunjhunu and Churu of Rajasthan revealed that the population of Sambar has decreased from the past few years in the selected sites possibly due to habitat destruction, fragmentation and loss. The interviewees also responded about the various degrees of crop damage in their agricultural fields in the study areas. It is also recommended that there is immediate

need to upgrade the status of existing natural habitats of Sambar in that region at village level and use of various indigenous methods to avoid crop raiding and human wildlife conflicts by local people.

ACKNOWLEDGEMENTS

The authors are highly grateful to the Kurukshetra University Kurukshetra and Department of Zoology, Kurukshetra University, Kurukshetra for providing research facilities to carry out this research work. We are thankful to UGC for providing JRF fellowship for research.

REFERENCES

1. Bagchi, S., Goyal, S.P., and Sankar, K. (2003). Habitat separation among ungulates in dry tropical forests of Ranthambhore National Park, Rajasthan. *Tropical Ecology,* 44 (2): 175-182.
2. Bagchi, S., Goyal, S.P., and Sankar, K. (2008). Social organisation and population structure of ungulates in a dry tropical forest in western India (Mammalia, Artiodactyla). *Mammalia,* 72: 44-49.
3. Biswas, S. and Sankar, K. (2002). Prey abundance and food habit of tigers (*Panthera tigris tigris*) in Pench National Park, Madhya Pradesh, India. *Journal of Zoology,* 256: 411-420. DOI:10.1017/S0952836902000456
4. Chatterjee, D., Sankar, K., Qureshi, Q., Malik, P.K., and Nigam, P. (2014). Ranging pattern and habitat use of sambar (*Rusa unicolor*) in Sariska Tiger Reserve, Rajasthan, Western India. *DSG Newsletter,* 26: 60-71.
5. Chopra, G. and Rai, D. (2009). A study on the ecology of Nilgai (*Boselaphus tragocamelus* Pallas) and its status as an unconventional pest of agriculture in and around Beer-Sonty reserve forest, Haryana, India. *Journal of Applied and Natural Science,* 1 (2): 245-249.
6. Choudhary, M. and Shringi, S.K. (2017). Floristic composition of Beer Jhunjhunu Conservation Reserve of Rajasrhan, India. *The biobrio,* 1: 244-258.
7. Dev, K. and Singh, P. (2016). Mammalian diversity of Shekhawati region in arid zone of Thar Desert, India. *International Journal of Biological Studies,* 3: 16-22.
8. Gopalaswamy, A.M., Karanth, K.U., Kumar, N.S., and Macdonald, D.W. (2012). Estimating tropical forest ungulate densities from sign surveys using abundance models of occupancy. *Animal Conservation,* 15 (6)**:** 669-679.
9. Groves, C. and Grubb, P. (2011). *Ungulate Taxonomy*. The Johns Hopkins University Press, Baltimore, Maryland.
10. Hamilton-Smith, C. (1827). The class Mammalia. Supplement to the order Ruminantia. The animal kingdom, arranged in conformity with its organization, by the Baron Cuvier, with additional descriptions of all the species hitherto named, and of many not before noticed (E. Griffith, C. Hamilton-Smith, and E. Pidgeon, eds.), Volume IV. G.B.Whittaker, London, United Kingdom. pp.105-165.
11. Harikumar, G., Thomas, B., Joseph, K.J. and Zacharias, V.J. (1999). Population dynamics of Sambar *Cervus unicolor*, in Periyar Tiger Reserve. *Indian Forester,* 125 (10): 995-1003.
12. Hodgson, B.H. (1841). Classified catalogue of the mammals of Nepal. *Journal of Asiatic Society of Bengal*, 10: 907-916.
13. Jain, P., Bhasin, A., Talukdar, G., and Habib, B. (2018). Distribution and population status of Sambar *Rusa unicolor* (Mammalia: Cetartiodactyla: Cervidae) from Aravalli landscape with a note on its first record from Aravalli Hills of Haryana, India. *Journal of Threatened Taxa,* 10 (10): 12357-12362.
14. Johnsingh, A.J.T. (1983). Large mammalian prey–predators in Bandipur. *Journal of the Bombay Natural History Society,* 80: 1–57.
15. Johnsingh, A.J.T. and Sankar, K. (1991). Food plants of chital, sambar and cattle on Mundanthurai Plateau, Tamil Nadu, South India. *Mammalia,* 55 (1): 57-66.
16. Karanth, K.U. and M.E. Sunquist. (1992). Population structure, density and biomass of large herbivores in the tropical forests of Nagarahole, India. *Journal of Tropical Ecology,* 8: 21-35.
17. Kerr, R. (1792). The animal kingdom, or zoological system of the celebrated Sir Charles Linnaeus; Class I. Mammalia; containing a complete systematic description, arrangement, and nomenclature, of all the known species and varieties of the Mammalia, or animals which give suck to their young; being a translation of that part of the Systema Naturae, as lately published, with great improvements, by Professor Gmelin of Goettingen. J. Murray and R. faulder, London, UK.
18. Lagory, K.E. (1986). Habitat, group size, and the behaviour of white-tailed deer. *Behaviour*, 98: 168-179.
19. Leslie, Jr.D.M. (2011). *Rusa unicolor* (Artiodactyla: Cervidae). *Mammalian Species,* 43 (871): 1-30. DOI: 10.1644/871.1
20. Pant, A., Chavan, S.G., Roy, P.S. and Das, K.K. (1999). Habitat analysis for sambar in Corbett National Park using remote sensing and GIS. *Journal of the Indian Society of Remote Sensing,* 27 (3): 133-139.
21. Pringle, R.M., Palmer, T.M., Goheen, J.R., Mccauley, D.J. and Keesing, F. (2010). Ecological importance of large herbivores in the Ewaso ecosystem. *Smithsonian contributions to zoology*, 632:43-53
22. Rai, D. and Jyoti (2018). Status and ecological aspects of Blackbuck, *Antilope cervicapra* (Linnaeus, 1758) through opinion surveys in and around Hisar, Haryana (India). *Journal of Experimental Zoology India,* 21: 1195-1201.
23. Sankar, K. (1994). The ecology of three large sympatric herbivores (Chital, sambar and nilgai) with special reference for reserve management in Sariska Tiger Reserve, Rajasthan. Ph.D. Thesis. University of Rajasthan, Jaipur.
24. Sankar, K. and Goyal, S. P. (2004). Ungulates of India. ENVIS Bulletin: Wildlife and protected areas, 7 (1): 163-170.
25. Schaller, G.B. (1967). *'The deer and the tiger: a study of wildlife in India.'* The University of Chicago Press, Chicago.
26. Shekhawat, D.S. and Bhatnagar, C. (2014). Guild, status, and diversity of avian fauna in the Jhunjhunu district, Rajasthan, India. *Journal of Asia-Pacific Biodiversity,* 7 (3): 262-267.
27. Singh, A., Mukherjee, A., Dookia, S. and Kumara, H.N. (2017). An updated account of mammal species and population status of ungulates in Keoladeo National Park, Bharatpur, Rajasthan. *Current Sci-*

ence, 113 (1): 103. DOI: 10.18520/cs/v113/i01/103-111.

28. Timmins, R.J., Steinmetz, R., Sagar Baral, H., Samba, K.N., Duckworth, J.W., Anwarul, I.M., and Chan, B.P.L. (2015). *Rusa unicolor*. The IUCN Red List of Threatened Species.

29. Varman, K.S. and Sukumar, R. (1993). Ecology of sambar in Mudumalai Sanctuary, southern India. In 'Deer of China: biology and management: proceedings of the International Symposium on Deer of China' Elsevier: New York. pp. 273-284.