Research Article

Distribution of Nilgai antelope (*Boselaphus tragocamelus*) and its interaction with local communities in the Abohar wildlife sanctuary, Northwestern India

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Abstract

The information regarding animal distribution and perceptiveness of local communities play an essential role in designing and planning protected areas, and their management policies as well. To this aim, we mapped the distribution of our focal species, Nilgai antelope (*Boselaphus tragocamelus*) in and around the Abohar wildlife sanctuary from December 2017 to November 2018. Mapping the species density helped in identifying the critical spots regarding animal density. Our data indicated Nilgai density ranging from 0.0654 to 6.946 individuals/km^2. The seasonal group size of males and females was observed to be significantly different throughout ($p<0.01$) the study period. The mean female group size ranged from 3.91 individuals to 6.26 individuals, whereas, in comparison, the average male group size varied less from 4.00 individuals to 4.76 individuals. Concurrently, the attitude of local people towards Nilgai and its related attributes including crop damage, vehicle collisions and conservation was recorded through the semi-structured survey of local individuals (n = 139) working in the farming or allied practices. The results showed that 37% of the respondents considered Nilgai to be responsible for crop depredation, while more than 50% perceived negative Human-Nilgai interaction through vehicle collisions in the sanctuary. Considering the expansive views of the respondents on other related animals and environmental factors, the 3D perceptual maps were prepared to exhibit a holistic sight of their opinion which can help strengthen the management of wild animals in the sanctuary.

Keywords: Antelope, community, conservation, density, perceptual mapping.

Introduction

India has a rich biological heritage and comprising nearly 89,451 species, which includes 390 species of mammals (Kumar and Khanna 2006). Among mammals, ungulates are the vital component as they do not only form the significant prey base for large mammalian predators but also are considered as indicators of habitat quality, protection and management levels (Chopra and Rai 2009). Development in agriculture, the industry as well as increased urbanization has dramatically affected the populations of these ecological dislocates (Chauhan and Sawarkar 1989, Singh 1995, Green *et al*. 2005).

There are certain species which are indigenous and sensitive to particular areas. The commercial practices of such habitats may result in loss of these vulnerable species. Intensification of agriculture and conservation of cropland generally result in loss of wildlife habitats (Gonser *et al*. 2009). Consequently, ungulates are surviving in fragmented habitats, and occasionally become locally overabundant due to the realization of wildlife values and timely conservation efforts adopted by man particularly in protected areas, reserve forests and surrounding habitats (Singh 1995, Hoseti

2002). Hence, suitable and retirement programmes can be chosen, leaving some land for a certain period so that these may serve as suitable habitats for wild animals. These are ecological dislocates and continue to be affected by land-use practices which have disturbed the balanced habitat-species relationship (Aryal *et al.* 2016). Wild animals increasingly migrate into human colonization and cultivated areas for food resources and cause a significant amount of damage to the agricultural crops or harm people due to mere confrontation in India and other parts of the world (Chauhan 1999, Lenth *et al.* 2008, Young *et al.* 2011, Silva-Rodriguez and Sieving 2012, Home *et al.* 2018). Agricultural crop damage by such locally copious wildlife populations has been widely reported from many parts of the globe (Chauhan and Sawarkar 1989, Weladji and Tchamba 2003, Karanth*et al.* 2012, Lashley*et al.* 2014). Although advancement in agricultural practices and technology, and community development at rural subparts (Bartonička *et al.* 2018, Favilli *et al.* 2018) approaches to the eco-development planning and integrated forest management practices are in progress in these areas, such measures alone will not help attain the long term solution to the above conflict situations.

In Abohar wildlife sanctuary (AWS), large herds of the Asian antelope, Nilgai have been invading the cultivation areas and feeding on crops, causing considerable damage (Bajwa and Chauhan 2019). In this research article, we aim to provide the density distribution of Nilgai in the sanctuary area, which is built on the private agrarian lands owned by the Bishnoi community. Also, we tend to reflect the perception of the local community towards the conflict situation leading from the crop damage done by these animals. Due to lack of potential predators in the area, and with the restricted poaching, Nilgai population is multiplying fast and consequently; the growing damage is engendering serious Human-Nilgai conflict affairs in the AWS.

## Materials and Methods
Study area
The Abohar wildlife sanctuary (AWS) is located in the Southeast of Fazilka district of Punjab, India (29°59'57.768"N and 74°4'47.819"E). The sanctuary is situated alongside the intersection of three states, Haryana, Rajasthan and Punjab (Figure 1). The region is one of the largest producers of cotton (*Gossypium arboreum*) in Northern India. Also, varieties of wheat (*Triticum* spp.) and mustard (*Brassica* spp.) are important Rabi (winter) crops available in the vicinity of the protected area. The sanctuary covers an area of 186.5 km2 with scattered 13 villages. The 'Bishnoi' community's religious belief has played a vital role in safeguarding these species from poachers. Micro-regional geography shows marked variation in its semi-arid plains with scattered dunes. The soil in the sanctuary is fertile, sandy and alluvial. The temperature varies from 5°C in winters to 50°C in summers. The former starts during the end of November when both day and night temperature fall rapidly, and the latter starts during the end of April. The sanctuary on an average receives an annual rainfall of approximately 120 mm. The area within the confines of the sanctuary is under private ownership of local 'Bishnoi' community, and the economy is mainly agrarian. Agriculture provides sustenance to more than 82% of the inhabitants, either through cultivation or allied occupations.

Data Collection
Line transects (n=152, average length=1.39km) were laid on the selected roads and agricultural fields already existing within the network. Traversed transects were passing through the wildlife sanctuary, croplands, built-up areas, canals and other landholdings. During Nilgai sightings, the information about the number of individuals, group structure, age and sex was recorded. The data were recorded from early morning 0700 hrs to 1100 hrs and 1500 hrs to 1900 hrs in the evening from December 2017 to November 2018 following Sale and

Berkmuller 1988. The Questionnaire survey perception and attitude of the local community engaged in farming practices (dominatingly 'Bishnoi') towards human-interactions through semi-structured interviews (n=139). The responses were collected from January 2018 to May 2018. The interviews were conducted in the local languages, and both male and female respondents were encouraged to participate. In was conducted in the sanctuary to know the all efforts, respondents were not restricted to Nilgai only and were asked to express their views about any related attribute or other animals. To avoid overrated response, the objective of the survey was explained to make sure that they did not misinterpret it as a part of any subsidy scheme attempt.
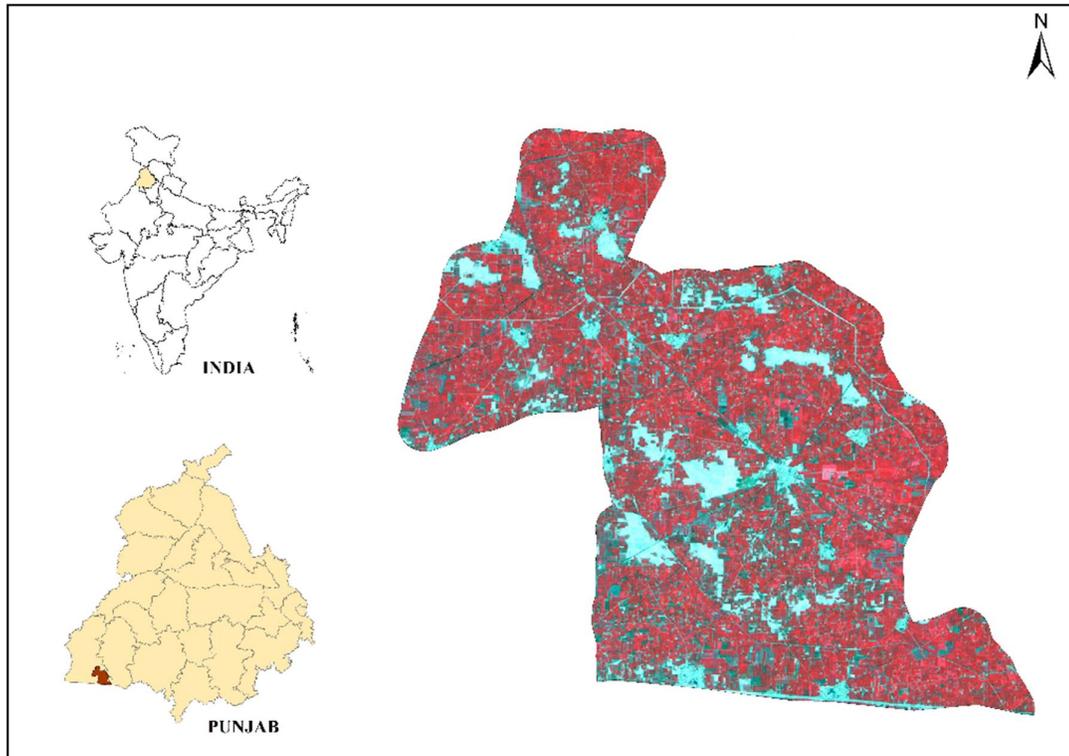
Figure 1. Location map of the Abohar wildlife sanctuary, India

Data analysis

The data recorded were analysed in Spatio-temporal scale to understand the kernel density distribution of Nilgai, seasonal group structure and attitude of local people. The kernel density map of Nilgai distribution was prepared using the ArcGIS (10.2.2) software. The Z test statistics were performed to test seasonal differences in Nilgai male and female group structure (number of individuals). To prospect the local community's attitude towards Nilgai and its related attributes together, perceptual maps were prepared using the positioning model software in DecisionPro, Inc. The attribute lines on the perceptual map indicated the direction in which the attribute increased while moving away from the origin along that line. The longer and closer attribute line to a perceived 'risk' (red sphere) mentioned earlier by the respondents exhibited the greater importance of that particular attribute in apropos of each factor.

Results

The kernel density distribution of Nilgai (Figure 2) in and around the Abohar wildlife sanctuary was mapped. It was observed that the minimum and the maximum range of kernel density of Nilgai population was 0.0654 individuals/km^2 and 6.9460 individuals/km^2, respectively. Thehighlighted areas (red) in the

map reflected the regions with the highest Nilgai densities while the darker regions (green) represent the sites with significantly lower Nilgai densities in the sanctuary. The seasonal group size of Nilgai male and female population (Figure 3) was recorded during the study period. Further scrutinization of the data revealed that the average male and female group size of Nilgai was significantly different (p<0.01) from December 2017 through November 2018 (Table 1). The mean proportion of female groups was also found to be larger than male groups during all the seasons except for April-July.

Table 1. Group size variation of Nilgai male and female in Abohar wildlife sanctuary

Season	Mean group size (Nilgai Male)	Mean group size (Nilgai Female)	Z statistics
December-March	4.00	6.26	-8.588 (p < 0.01)
April-July	4.47	3.91	2.782 (p < 0.01)
August-November	4.76	5.90	-3.624 (p < 0.01)
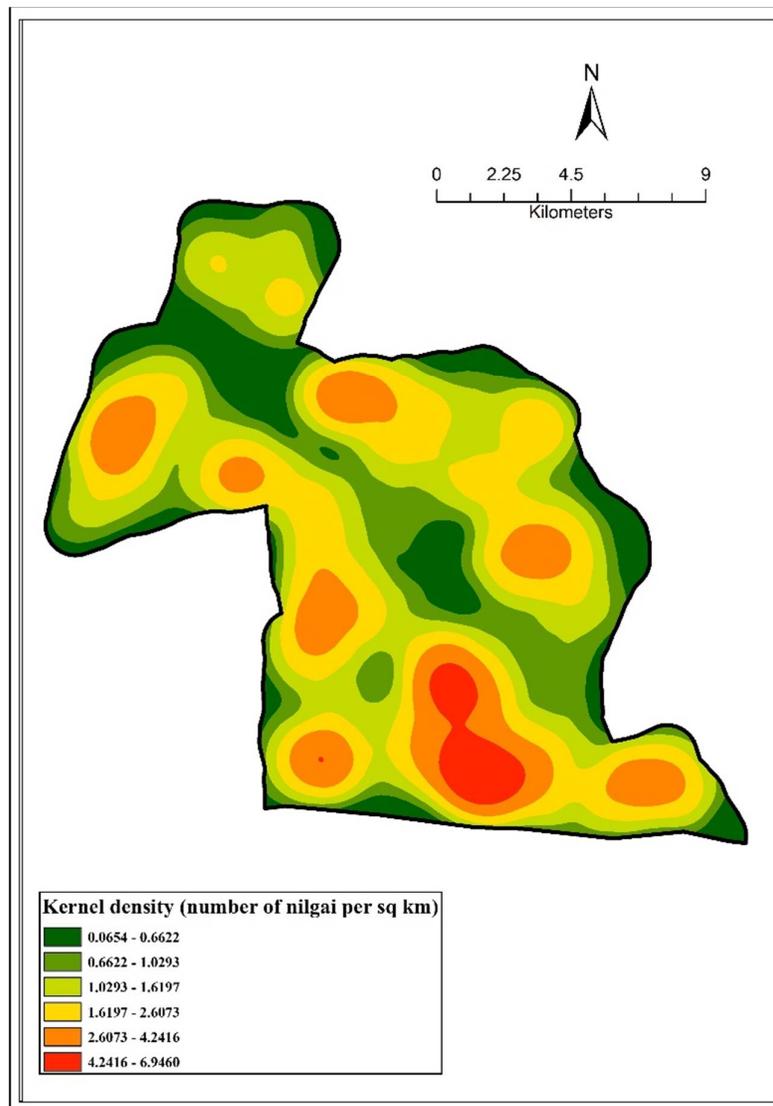
Figure 2. Kernel density distribution of Nilgai antelope in Abohar wildlife sanctuary
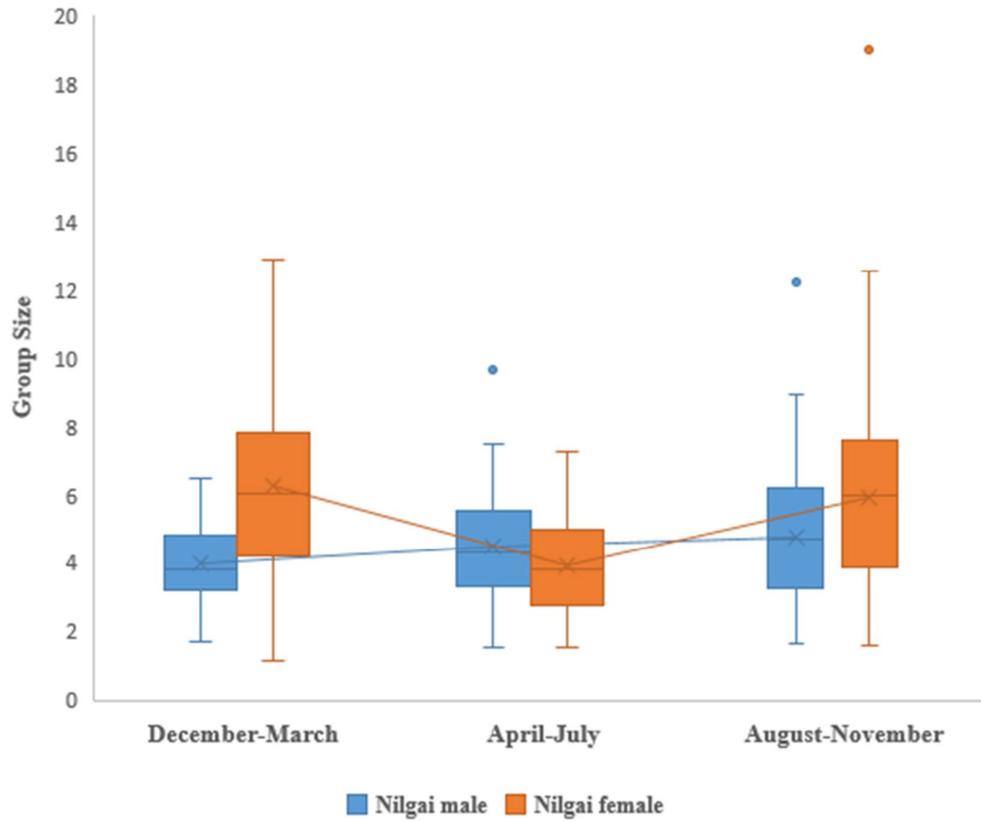
Figure 3. Seasonal group size variation in mean groups of Nilgai male and female from December 2017 to November 2018
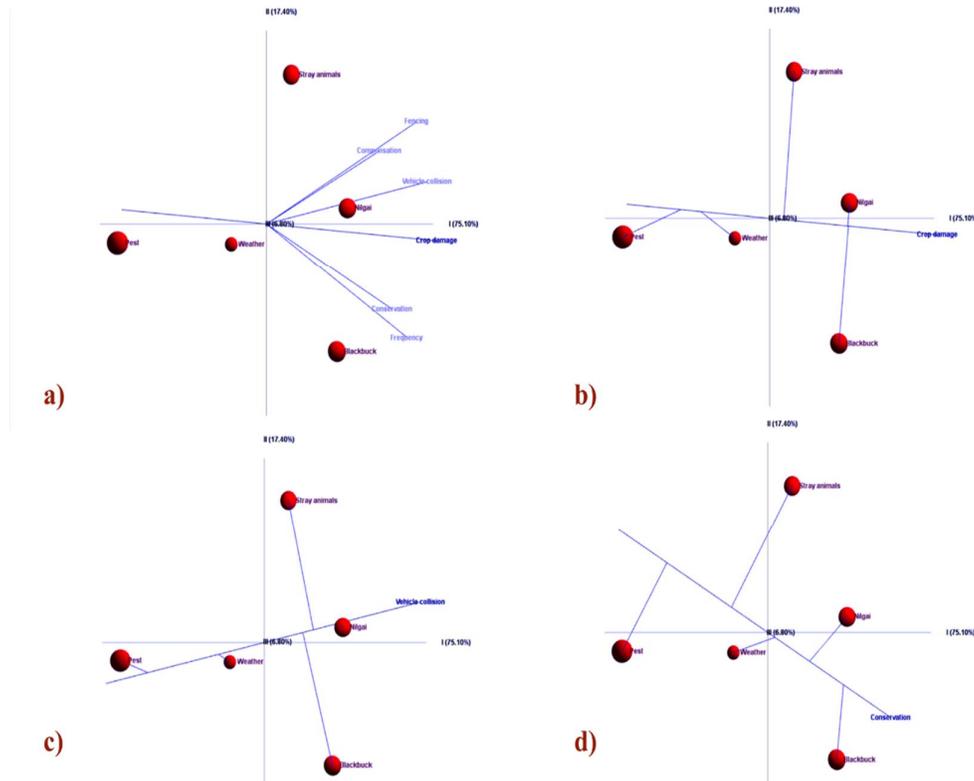
Figure 4. 3D perceptual maps of the Bishnoi community (n=139) on different attributes in Abohar wildlife sanctuary a) Overall b) Crop damage c) Vehicle collision d) Conservation

The minimum and maximum recorded values of Nilgai males in a group during the study period were two and ten, respectively. However, on the other side, the minimum and the maximum number of individuals in female groups were observed to be 2 and 19, respectively. A close examination of figure 3 further revealed that the females exhibited more fluctuations in group size than the males.

A total number of 139 individuals (53% females and 47% males) of the local Bishnoi community participated in the survey and expressed concern about the various attributes related to Nilgai including crop damage, vehicle collisions (VCs) and conservation value. The respondents were extensively allowed to mention other animals or factors linked with the attributes mentioned earlier. It was visible from the perceptual maps that respondents view crop damage and vehicle collisions (VCs) to be closely related. An overall and individual 3D perceptual maps were prepared based on the information received from the interviewees (Figure 4). The three-axis on the perceptual maps explained the variance and hence, the importance of the axis in explaining the percipience of respondents.

The horizontal X-axis (abscissa) explained 75.1% of the variance while the vertical Y (ordinate) and Z-axis (applicate) illustrated only 17.40% and 6.8% of the variation in the perception of respondents, respectively. This further describes that the horizontal X-axis was four times as important in explaining community perception. Thus, the orientation of perceptual maps revealed that local people perceive Nilgai to have 37% greater extent of damaging crops as compared to other factors like blackbuck (*Antilope cervicapra*), weather, stray animals and pest. However, Nilgai (55%) had a higher perceived threat of VCs mentioned by 77 respondents (Table 2) followed by stray animals, blackbuck, weather and pests. Confoundingly, the perceptual maps further described that the entire community was still of the opinion that Nilgai and blackbuck holds a firm conservation value and should be protected (for mutual existence) as a part of their religious customs.

Table 2. Perceived response of the local people towards crop damage, vehicle collisions and conservation of Nilgai antelope in Abohar wildlife sanctuary (n=139)

Attribute	Number of Respondents mentioning a particular attribute	No. of male Respondents	No. of Female Respondents
Crop damage	52	34	18
Vehicle collisions	77	51	26
Conservation	133	60	73

Discussion

It is being debated, both for and against, since long about declaring Nilgai antelope a vermin in various states of India. This antelope, along with blackbuck, is protected by some communities like the Bishnoi (Hundal 2004, Pathak 2009) as a part of their religious customs. However, it is essential to mention here that the peculiar environment conditions for Nilgai in the current study area does not give enough freedom for group structuring and formation. These antelopes are chased by the free ranging feral dogs (Bajwa and Chauhan 2019, Rana 2011, Jagga 2018) and driven away from the agricultural fields, and as a result, the entire population of Nilgai remains disturbed throughout the sanctuary. The calculated kernel density range of Nilgai antelope (0.06 to 6.95 individuals/km^2) during this first study in the agrarian landscapes of Abohar wildlife sanctuary was within the range of the estimated Nilgai density around similar protected areas

within the country (Chauhan and Sawarkar 1989). Notably, a comparable number of individuals 2-6 individuals/km^2 were recorded in a past study conducted in similar landscape (Singh 1995). The results exhibited that the females showed a higher degree of fluctuations in group formation than the males. This could be attributed to the breeding time of the Nilgai antelope. The mean female group size which was more extensive during the breeding season (6.26 individuals) from December to March decreased to 3.91 individuals during the summer season (April to July) and later increased to 5.90 individuals during August to November. On the other side, the average male group size throughout all the seasons ranged from 4 to 4.76 individuals. This information can help in better understanding of the Nilgai distribution in the sanctuary for its management and planning. Variation in the Nilgai female group structure is also related to the calving activity influenced by the extrinsic factors. The Nilgai calves and young ones tend to shelter more than the adults and do not follow their mothers much. Due to the dense cropping pattern existing in the study area throughout the year, they could not be located and thus accounted in the observations. As per the previous reports, farmers considered crop loss due to wild animals to be the most significant factor responsible for human-wildlife conflict (Bayani *et al.* 2016). This substantiates the results of the present study, where more than 37% of the local people had a perception of Nilgai as a threat to their crops. They further mentioned that the magnitude of crop loss done through trampling or fighting is far higher than that of feeding.

Moreover, the community have claimed that limited herbivory helps stimulate regeneration of crops. Vehicle collisions have been recently reported as one of the primary concern in the area (Jagga 2018, Bajwa and Chauhan 2019) as the community owned sanctuary serves one state highway, a major ancillary road and several residential roads through it. The response of a few male respondents also indicated the developing intolerance towards the damage which was found vital for the consideration while mitigating issues of conflict. Almost all the respondents of the community expressed unhappiness on the non-existence of compensation schemes for crop damage due to animals and perceived that the particular issue should be addressed on the order of equal priority from large animals to pests (to safeguard farmer's interest of animal protection without leading to intolerance). Through capitalising the community's theological outlook and preserving their attitude, the national administrative bodies can improve the conservation status of Nilgai in the region.

Conclusion

This study highlights the density distribution map of Nilgai antelope throughout the Abohar wildlife sanctuary. Different density regions identified in the map can help to prioritise the management action plans of the government (taking into account the community's perception) for the species conservation. The present study delineates two essential elements; kernel density distribution of Nilgai throughout the sanctuary area, and views of local people about the antelope, required for the mitigation strategies in an unexplored community conserved area. It is evident from the results that reinforcing the perspective of the local people by the introduction of compensation tool, knowledge seminars (regarding the importance of biodiversity and role of wild animals) and training workshops, can sustain the support of local people for Nilgai conservation. Such initiatives can protect the legacy of mutual existence of the Bishnoi community and Nilgai antelope in the Abohar wildlife sanctuary.

Acknowledgements

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