Distribution of Blue Bull (*Boselaphus tragocamelus*) and its Conservation Threats in Bardia National Park, Nepal

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Abstract

Blue bull is Asia's largest antelope, a species of least concern in IUCN Red data list of 2020. In Nepal, it is vulnerable and is often considered as a problem animal for its crop raiding habit. Although, its population is restricted in India and Nepal, there are insufficient studies conducted on the distribution and threats of the species at local level. This study aimed to assess the distribution of blue bull and its conservation threats in Bardia National Park and its buffer zone. Field survey was carried out to identify the potential area with the information provided by park staff and buffer zone people and by the transect method in the selected habitat to determine the distribution of blue bull population. Additionally, six focus group discussions (1 in each of the five sites and 1 with park staff) and a half-day workshop (involving 25 participants representing each site and park office) were organized to assess the existing threats to the species. Data were analyzed descriptively using MS Excel, while the distribution map was prepared using Arc GIS. Also, 8 major identified threats were ranked using relative threat ranking procedure and classified into four severity classes. We found that the population of blue bull was dispersed from core area of Bardia National Park towards the buffer zone area. Open grazing, invasive species, predation by tiger and flash flood were the major threats to the blue bull as perceived by the local people. Habitat management activities including control of grazing, removal of invasive plant species, plantation of palatable grass species, increase in other prey species of tiger and control of flood in blue bull's habitats are recommended to protect the species and thus sustain their threatened population.

Key words: Dispersed, invasive species, palatable, transect, vulnerable

Introduction

Blue bull (*Boselaphus tragocamelus*) or Nilgai in Nepali, a representative of Bovidae family, is globally in the least concern category in IUCN Red data list and vulnerable category in Nepal (Mallon, 2008; Jnawali *et al.*, 2011). It is the only species of the genus Boselaphus, which is sexually dimorphic ungulate of large stature and unique coloration (Leslie, 2008). This typical antelope is considered as Asian strain of African eland and is one of the fastest and best-horned beasts of Asia (Lasiwa, 1999). Blue bull defecates at a particular spot, perhaps to keep the individuals of a herd together. Although the blue bull congregates in a large herd, group stability is loose (Sheffield *et al.*, 1983; Shukla and Khare, 1998).

Blue bull is endemic to peninsular India, some parts of Pakistan, and Nepal

and has been extinct from Bangladesh (Aryal *et al.,* 2016). The species has been introduced in the United States (Texas), Mexico, South Africa, and Italy (Leslie, 2008). In Nepal, it is widely distributed in protected areas of Terai region, the southern plain of Nepal. It occurs in seemingly viable numbers in Koshi Tappu Wildlife Reserve in the east, Parsa National Park in the middle, and Shuklaphanta National Park and Bardia National Parks in the west (Khanal *et al.,* 2018). It is located in diverse land types including plains, hill sides, arid areas, grassy steppe forests, scrub areas, flood plains, dry deciduous forests, riverine forests and agricultural areas where they strive for resources with human population (Aryal, 2007). It is regarded as a problem animal by the farmer and has been included in the list of 60 mammal species creating conflict in Nepal (DNPWC, 2014). It is believed that Bardia National Park (BNP) has the largest population of blue bull in Nepal. However, this species is distributed outside the protected area of Nepal resulting in possibilities of interaction with people (Khanal *et al.*, 2018).

Although blue bull is regarded as one of the important prey species of tiger due to its optimum size (Leslie, 2008), but studies have documented that both population and habitats of blue bull are threatened and the number is in decreasing trend in Nepal (Subedi, 2001; Aryal, 2007; Aryal *et al.*, 2016). The major global threats are poaching, retaliatory killing in response to crop raiding, predation by tiger and habitat destruction (Jnawali *et al.*, 2011),

which are also the major threats documented in the protected areas of Nepal (Aryal, 2007; Aryal *et al.*, 2016; Khanal *et al.*, 2018). Besides, BNP and its surrounding areas are the potential habitats of blue bull with a large coverage of riverine forest, *Shorea robusta* forest and grassland. However, there is limited information about the blue bull distribution and conservation threats in BNP. Hence, this study aimed to assess its distributional pattern and conservation threats in the study area. Additionally, the findings will assist the conservation managers and concerned stakeholders to prepare the suitable conservation and habitat management plans for the species.

Materials and Methods

Study area

The study was conducted in BNP, geographically located at $28^0 23$'N and $81^0 30$'E in the lowland of western Nepal (Figure 1). It was established in 1988 covering about 968 km^2 with additional buffer zone of about 507 km^2. It is the largest and less disturbed national park of Terai region of Nepal, adjoining the eastern bank of the Karnali River and bisected by the Babai River in the Bardia district. The crest of the Siwalik Hills demarcates its northern limits while the Nepalgunj-Surkhet highway partly forms the southern boundary. Similarly, natural boundaries to human settlements are formed in the west by Geruwa, a tributary of Karnali River, and in the southeast by Babai River. The climate is subtropical with heavy monsoonal rains from July to September/October.

Shorea robusta forest, interspersed with patches of *Imperata cylindrica*-dominant grasslands, riverine forest and tall grass flood plains are the primary floral associations. The altitude ranges from 100 m in river valleys to 815 m in the Churia hills. The park is well known for its biodiversity with recording of approximately 53 mammals, over 407 birds and 839 species of flora. BNP is dominated by forest habitat (70%) including majority of Sal (*Shorea robusta*) forest followed by balanced mixture of grassland, savannah and riverine forest. Although our purposed study area was inside the BNP area initially, after group discussion with local stakeholders, we found that the blue bull populations were less sighted inside park area. So, we took four potential locations outside the park namely Neulapur, Bhudkaiya, Bantariya and Sukhad Village Development Committees (VDCs) and only one location inside (near the park border) i.e., Gobrella. All these five locations lie in southwest region of BNP around Orie River (Figure 1).
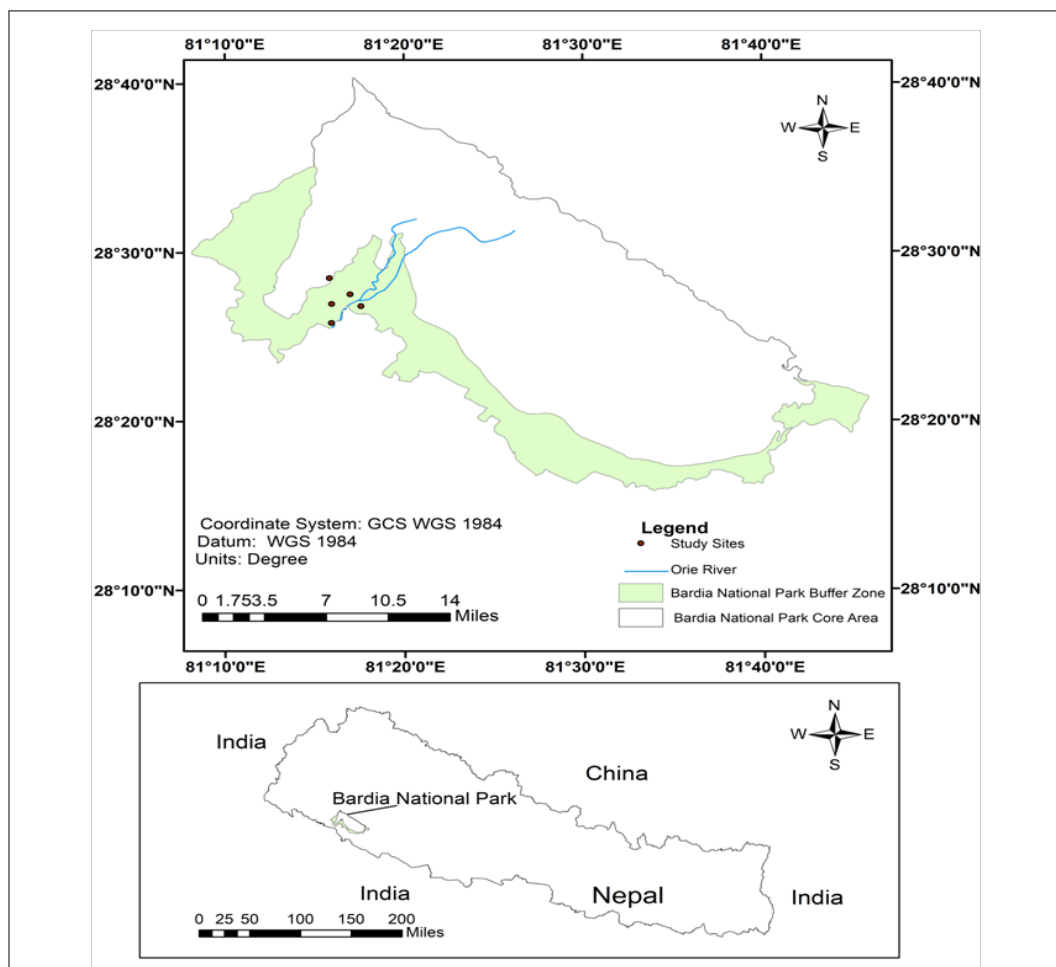

Figure 1. Map of the study sites showing BNP and its buffer zone area

Field Survey for Recording Presence Points

We conducted our field work from December 2016 to January 2017. At first, blue bull potential area was selected through discussion in a group consisting of 5 staff members (1 officer, 2 rangers, 2 game scouts) of BNP, who have worked in BNP for more than 5 years and few elite people representing each study site. The present information was mainly based on recording of indirect signs (pellets and hoof marks) within the selected area. Pellet count method can easily determine the areas used intensively by the animals (Julander, 1958). Such field-based evidence was collected using transect survey during the morning hours (6:00 a.m. to 11 a.m.) of the winter season for 10 days. We walked along the trails (n=100, 20 in each site) inside the forest representing the entire selected area with the help of forest guard and game scouts following the method mentioned by Winstead (1980). During the survey, each trail was walked 50 m distance for observing the direct and indirect signs. The animals sighted directly within 50 m in each side of transect while the evidence of its presence such as pellets and hoofmarks observed within 5 m on each side of transect were recorded (Pokharel and Chalise, 2010). Additionally, the shortest distance from the observation to the centerline of transect was recorded using a measuring tape and/or range finder (Model: RANGING 400) (Buckland *et al.*, 1993). The GPS co-ordinates were recorded at particular point where the direct sighting and indirect signs were observed. We assumed that the recorded GPS co-ordinates represent blue bull's presence within 5 m radius area.

Threat Assessment

The existing threats of blue bull were assessed through focus group discussions and a small workshop. One focus group discussion was conducted in each study site with an additional focus group discussion including park staff. Checklist was prepared and implemented to collect the information on threats that have existed at least for the last five years period (2013 to 2017). For the focus group discussion, people who have been residing there for more than 20 years with good knowledge of blue bull species and their habitats were encouraged to participate. Similarly, on behalf of BNP office, the participants included were park warden, game scouts, army and field technicians who were more familiar with our intended species. After listing all the survival threats existing throughout the study area, 8 major threats were selected for ranking them using relative threat ranking method (WWF, 2007; Chhetri *et al.*, 2020; Neupane *et al.,* 2020). Finally, a half-day mini-workshop was organized involving 25 members representing participants from each focus group discussion and park staff were invited to rank the selected threats based on the 3 pre-determined criteria that included scope, severity and urgency.

Data Analysis

Data were analyzed using descriptive statistics through MS Excel 2010 and the results are presented in the form of tables and diagrams. Besides, distribution map of blue bull was prepared using ArcGIS software (ESRI, 2017). For the threat assessment, the selected 8 major threats were ranked relative to one another. As there were 8 threats, the highest ranked threat in each criterion was given the highest point, i.e., 8, and least ranked threat was given the least point i.e., 1 (WWF, 2007; Chhetri *et al.,* 2020; Neupane *et al.,* 2020). At the end, those ranked and final weighed threats were classified at 4 levels for identifying the severity of threats, i.e., Very High, High, Medium and Low as shown in Table 2.

Results

Distribution of Blue Bull

The distribution of blue bull is shown in Figure 2. Throughout the field survey, we could not sight any blue bull individual directly, so we observed and recorded the indirect signs for finding their distribution. The sign distribution was denser within the buffer zone area (outside BNP) than inside the park area. Among the four selected sites of the buffer zone, the indirect signs were observed mostly in Neulapur and Bhudkaiya with Sal (*Shorea robusta*) dominated forest and Sissoo (*Dalbergia sissoo*) dominated forest respectively (Table 1) and both these sites were closely connected with Orie River. Similarly, the indirect signs of animal like spotted deer, tiger and wild boar were recorded near the locations of indirect signs of blue bull. With regard to plant species, the tree species including *Shorea robusta, Dalbergia sissoo, Terminalia tomentosa, Mallotus phillippinensis* and *Ficus glomerata*, shrub species including *Callicarpa macrophylla, Flemingia spp., Murraya koenigii* and grass species including *Imperata cylindrica, Saccharum spontaneum*) were recorded in the region where blue bull signs were present.

Table 1 : Indirect signs of blue bull, forest types and signs of other animals found in the study area

| Sites	Number of pellet groups	Number of hoof marks	Dominant plant species	Number of other animals' sign found nearby
Bhudkaiya	10	2*	*Dalbergia sissoo*	Wild boar scarp (4)
Neulapur	19	3*	*Shorea robusta and Acacia katechu*	Wild boar scarp (2), spotted deer pellet (5) and their hoof marks with blue bull hoofmark in same mulch.
Sukhad	2	1	*Shorea robusta*	Spotted deer pellet (3), wild boar scarp (1)
Gobrella (Inside BNP)	5	1	*Shorea robusta*	Tiger pug mark (2), spotted deer direct sighting (10 herd)
Bantariya	3		*Shorea robusta*	Tiger scat and pug mark (1/1), spotted deer pellet (4)

* Hoof marks of herd of blue bull
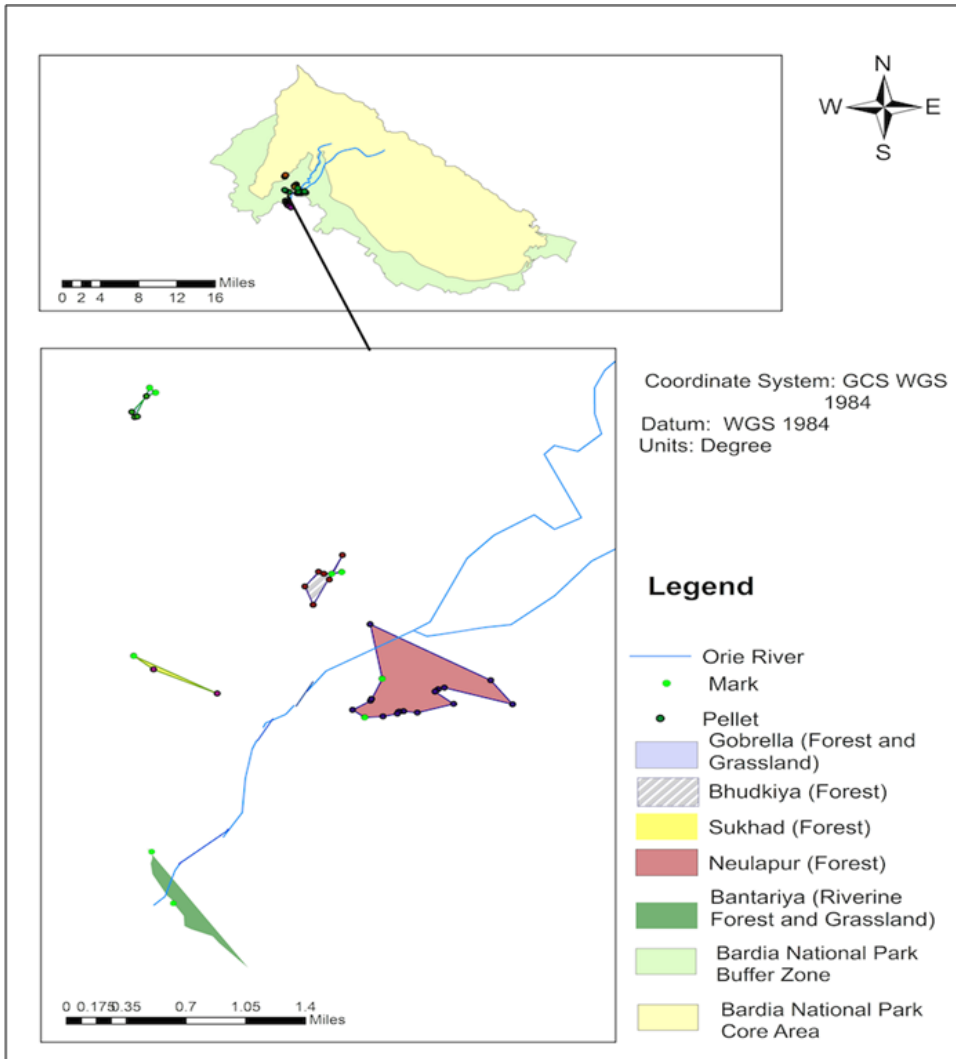
Figure 2. Distribution of signs (pellet and hoof marks) of blue bull

Conservation Threats to Blue Bull

According to the preliminary information obtained from the park staff and buffer zone people, the sighting of blue bull inside the BNP was decreasing while it was increasing in the buffer zone area, resulting in the dispersal of blue bull from park area to human settlement areas. From the relative threat ranking, we found that the open grazing and invasive species were the foremost conspicuous issues being very high threat in the study area (Table 2). Similarly, flash flood and increase in predator number, especially tiger population, were ranked as high threats while NTFPs collection, infrastructure development and illegal poaching were ranked as medium threats and finally disease and parasites were ranked as low threats.

Table 2 : Threats to blue bull in the study area

S.N	Issue	Scope	Severity	Urgency	Total	Threat Classification
1	Open grazing	8	8	8	24	Very High
2	Infrastructure development	2	1	4	7	Medium
3	Increase in predator number (Tiger)	5	6	6	17	High
4	Invasive species	7	7	7	21	Very High
5	Flash flood	6	5	5	16	High
6	NTFP collection	4	4	2	10	Medium
7	Illegal poaching	3	3	1	7	Medium
8	Disease and parasites	1	2	3	6	Low
		36	36	36	108	

It was surprising that although blue bulls affected local people, their response towards conservation was highly supportive (Figure 3). Besides, the farmers were practicing mitigation measures likes fencing, crop guarding,

Discussion

This study employed both qualitative and quantitative methods in the field to document information regarding distribution and threats of blue bull.
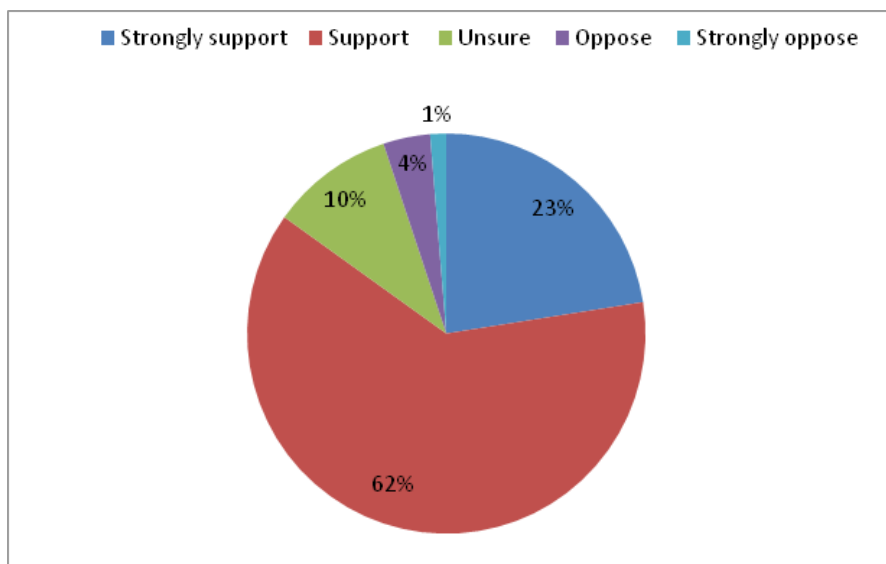

Figure 3 : Response of local people towards the conservation of blue bull

night light, beating drums and using pet dog for guarding their crops. Among different mitigation measures adopted in the study area, they expressed fencing as one of the most effective measures.

According to our finding, the population of blue bulls has decreased inside the park but increased in the buffer zone area in the last 5 years. Similarly, a study conducted by Nagarkoti (2012) in

Koirala *et al.,* 2020

BNP and Khata corridor did not locate blue bull pellets inside the park area and Jnawali *et al.* (2011) also found that the majority of blue bulls were outside the protected area of Nepal and their distribution was more in *Shorea robusta* dominated forest and grassland. Additionally, a study revealed that the highest relative abundance was found for the blue bulls in Laljhadi Mohana Biological Corridor (Kafle *et al.,* 2020). Our study also supported their findings, as the distribution was more in Neulapur and Bhudkaiya Forest sites having *Shorea robusta* and *Dalbergia sissoo* dominated forests and both sites were connected with Orie River. The reason behind the less occupancy of blue bulls inside park area might be degradation of their habitat due to over grazing by domestic cattle and intrusion by invasive species. In similar studies, Karki *et al.* (2000) and Bhatta *et al.* (2020) have identified livestock and invasive species as main causes of habitat loss and degradation in the study area. Higher detection of blue bull population in buffer zone area may be due to lower forest density and presence of very few tigers indicated by indirect signs observed outside the park area during the field survey. Lima and Dill (1990) have also mentioned that predators may indirectly influence ungulates by changing their distribution towards less risky habitat types. However, we could not clearly assess whether the blue bulls moved to the buffer zone area due to the attraction of agricultural crops or they felt it safe outside the core area. Thus,

further investigation is required to fulfill this information gap.

People living in the buffer zone of BNP have adopted agriculture and livestock farming as their major occupation. They are highly dependent on the park area for fulfilling the forest resources for livelihood. They graze their livestock inside the park area, which has ultimately increased the competition between livestock and blue bulls and other wild animals. Similarly, the establishment and aggregation of invasive species in the park has exploited the major native grass species preferred by blue bulls. Kafle *et al.* (2020) have reported open grazing as high threat and invasive species as the low threat to wild animals in Laljhadi Mohana Biological corridor (LMBC); but our study has shown that open grazing and invasive species are the foremost conspicuous threat to blue bulls in BNP. The pressure of livestock and establishment of invasive species has degraded the suitable habitat of blue bulls by limiting the quality and quantity of vegetation inside the forest as blue bulls require more nutritious diet (Sankar *et al.,* 2004). With this situation of lack of sufficient food resources inside the park area (Khatri, 1993), people claimed that blue bulls usually visit their agricultural fields and damage huge area of cultivated land by trampling and consuming crops. So, this species is regarded as a problem animal for the farmers. Despite such damages, buffer zone people are positive towards the conservation of blue bulls in our study area because the revenue of the

national park supports them and they are well aware of wildlife conservation.

Further, blue bull population is believed to be threatened, being one of the major preys of increasing tiger population. Though few signs of tigers are observed outside the park area during the field survey, there are always possibilities of tiger's coming to the buffer zone area inducing high predation risk. Similarly, in monsoon season, Orie River changes its course and cuts off the suitable habitat of blue bulls and flash flood sweeps away their calves every year. Harvesting of NTFP products, construction of highways, army camps or boots, high-tension lines, etc. have also increased pressure on BNP, while poaching of blue bulls for meat and hides is prevalent to some extent. Finally, diseases and parasite transfer from livestock were ranked as low threat during the study, however, they might be a serious problem in future not only for blue bulls but also for other wild animals. All these severe threats for blue bulls should be minimized by the concerned authorities for sustaining the threatened population and preventing their extinction in the study area. In addition, appropriate mitigation measures such as fencing should be used for reducing crop damage by blue bulls in the study area as suggested by some similar studies (Aryal, 2007; Meena *et al.,* 2014).

Conclusion

Blue bull individuals move from the park area towards the buffer zone area, which increases the chance of human wildlife conflict as well as risk of tiger attack in the buffer zone area. Open grazing, invasive species, predation by tiger and flash flood are the major threats to blue bulls as perceived by the local people and park staff in study area. However, further scientific studies are required to assess the habitat quality of blue bull to help concerned authorities to plan and implement appropriate management strategies. Furthermore, over-grazing is found to be one of the major threats to blue bulls; it increases competition between blue bull and livestock for forage. Thus, appropriate measures should be taken to stop livestock grazing in the study area.

Acknowledgments

Conflict of Interest

The authors declare no conflict of interest.

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