

**POPULATION STATUS, DISTRIBUTION AND THREATS TO THE  
BLUE BULL (*Boselaphus tragocamelus*) IN KOSHI TAPPU WILDLIFE  
RESERVE, NEPAL**



Ankushree Mallik

Entry	27
M.Sc. Zoo Dept.	Ecology
Signature	<i>Ankushree</i>
Date:	2076/5/22 sep 8, 2019

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Nepal

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Ref.No.:

TRIBHUVAN UNIVERSITY

01-4331896

**CENTRAL DEPARTMENT OF ZOOLOGY**

Kirtipur, Kathmandu, Nepal.



### RECOMMENDATIONS

This is to recommend that the thesis entitled “Population Status, Distribution and Threats to the Blue Bull (*Boselaphus tragocamelus*) in Koshi Tappu Wildlife Reserve, Nepal” has been carried out by Ms. Ankushree Mallik for the partial fulfillment of Master’s Degree of Science in Zoology with special paper Ecology. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis has not been submitted to any other degree in any institutions.

Date: 2019-9-8

Dr. Bishnu Prasad Bhattarai

Asst. Prof.

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal



Ref.No.:

TRIBHUVAN UNIVERSITY

☎ 01-433 1896

**CENTRAL DEPARTMENT OF ZOOLOGY**

Kirtipur, Kathmandu, Nepal.



### LETTER OF APPROVAL

On the recommendation of supervisor **Dr. Bishnu Prasad Bhattarai**, this thesis submitted by Ankushree Mallik entitled **“Population Status, Distribution and Threats to the Blue Bull (*Boselaphus tragocamelus*) in Koshi Tappu Wildlife Reserve, Nepal”** is approved for the examination, ~~and submitted~~ in partial fulfillment of the requirements for Master’s Degree of Science in Zoology with special paper Ecology.

Date: 2019-9-8

Dr. Tej Bahadur Thapa

Prof. and Head of Department

Central Department of Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal



Ref.No.:

TRIBHUVAN UNIVERSITY 01-433 1896  
**CENTRAL DEPARTMENT OF ZOOLOGY**  
Kirtipur, Kathmandu, Nepal.

Central Dr.

### CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Ms. Ankushree Mallik entitled "Population Status, Distribution and Threats to the Blue Bull (*Boselaphus tragocamelus*) In Koshi Tappu Wildlife Reserve, Nepal" has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper **Ecology**.

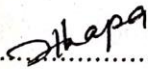
### EVALUATION COMMITTEE

  
.....

Supervisor

Dr. Bishnu Prasad Bhattarai

Assistant Professor

  
.....

Dr. Arjun Thapa

Research Director

SMCRF, Kathmandu, Nepal

  
.....

Head of Department

Dr. Tej Bahadur Thapa

Prof. and Head of Department

  
.....

Dr. Hari Prasad Sharma

Associate Professor

Date: 23/9/2019



Ref.No.:

TRIBHUVAN UNIVERSITY

01-4331896

**CENTRAL DEPARTMENT OF ZOOLOGY**

Kirtipur, Kathmandu, Nepal.



### DECLARATION

I hereby declare that the work presented in this thesis entitled **“Population Status, Distribution and Threats to the Blue Bull (*Boselaphus tragocamelus*) in Koshi Tappu Wildlife Reserve, Nepal”** has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

Date: 2019-9-8

Ms. Ankushree Mallik

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## ABSTRACT

Blue Bull (*Boselaphus tragocamelus*) is the largest Asian antelope and is endemic to the Indian subcontinent. Blue Bull, considered as browsers or mixed feeder, prefers open grassland scattered with short trees and shrubs than dense forest. In both their native range and in Texas, the distribution of Blue Bull is limited by the availability of drinking water. Globally, Blue Bull populations are secure. There are around 100,000 Blue Bull in India and a handful in Pakistan; they have been extirpated from Bangladesh. The introduced population in southern Texas includes around 37,000 individuals. Insufficient study on the Blue Bulls have been carried out in KTWR, the Eastern Nepal, which can't cover conservation status and threats to Blue Bulls in KTWR, hence this study was carried out in KTWR to ascertain the population status, distribution and threats to the Blue Bull. Twenty-four line transects were laid down in six selected sites for collecting population and environmental variables such as habitat types, proximal variables, disturbance variables information. A total of 28 Blue Bulls were recorded in the six selected sites along transects. The sex ratio of the Blue Bull was 1:4. The distribution of Blue Bull was not uniformly distributed in all the five types of habitats of the KTWR ( $\chi^2 = 7.9516$ ,  $df = 3$ ,  $p = 0.047$ ). Results of Generalized Linear Model (GLM) between distribution of Blue Bull with different variables was mostly significant, likewise, the distribution of the Blue Bull in all six selected was also significant. The major threats to the Blue Bull in KTWR were flood, livestock grazing, human wildlife conflict, firewood/dung collection, fodder collection and road accidents.

# CONTENTS

	Pages
DECLARATION .....	<b>Error! Bookmark not defined.</b>
RECOMMENDATIONS .....	<b>Error! Bookmark not defined.</b>
LETTER OF APPROVAL .....	<b>Error! Bookmark not defined.</b>
CERTIFICATE OF ACCEPTANCE.....	<b>Error! Bookmark not defined.</b>
ACKNOWLEDGEMENT .....	vi
LIST OF TABLES .....	ix
LIST OF FIGURES .....	x
LIST OF PHOTOGRAPHS .....	xi
LIST OF ABBREVIATIONS.....	xii
ABSTRACT.....	xiii
1. INTRODUCTION .....	1
1.1. Background .....	1
1.2. Distribution.....	2
1.3. General Description of the Blue Bull.....	2
1.4. Ecology and Behaviour .....	3
1.5. Threats and Conservation.....	3
1.6. Objectives.....	4
1.6.1. General Objective .....	4
1.6.2. Specific Objectives .....	4
1.7. Rationale of the study.....	5
2. LITERATURE REVIEW .....	6
2.1. Population Distribution .....	6
2.2. Population Status.....	6



2.3. Threats .....	7
2.4. Research Gaps .....	8
3. MATERIALS AND METHODS.....	9
3.1. Study Area.....	9
3.1.1. Topography.....	9
3.1.2. Geology and Soil .....	10
3.1.3. Climate.....	10
3.1.4. Vegetation.....	11
3.1.5. Wildlife.....	11
3.2. Materials.....	12
3.3. Methods .....	12
3.4. Data Analysis .....	17
4. RESULTS .....	19
4.1. Population Status.....	19
4.2. Distribution Pattern .....	20
4.3. Other Threats.....	22
.....	23
5. DISCUSSION.....	24
6. CONCLUSION and RECOMMENDATIONS .....	27
6.1. Conclusion.....	27
6.2. Recommendations .....	27
7. REFERENCES .....	28
PHOTO PLATES.....	35

## LIST OF TABLES

Table 1. The selected Six sites from east and west of KTWR.....	13
Table 2. Sex composition of the Blue Bull in selected stations of KTWR.....	19
Table 3. Age and Sex Composition of the Blue Bull in KTWR.....	19
Table 4. Total Number of individuals and pellet groups of the Blue Bull observed in KTWR .....	21
Table 5. Generalized Linear Model (GLM) comparing the blue bull's presence and absence data with given selected variables.....	21

## LIST OF FIGURES

Figure 1. Map of the Study Area showing various habitats.....	9
Figure 2. Map Showing division of six different sites insides KTWR.....	13
Figure 3. Different age groups and sex of the Blue Bull (A-D). .....	16
Figure 4. Map of study area showing Blue Bull’s distribution in different sites.....	20
Figure 5. Pie-Chart showing the responses of Key-Informants related to the Threats to the Blue Bull.....	23

## LIST OF PHOTOGRAPHS

Figure 6. Habitat of KTWR (A-F) .....	35
Figure 7. Habitat of KTWR (G-L).....	36
Figure 8. Pellet groups of the Blue Bull in KTWR (A-D).....	37
Figure 9. Blue Bull's seen inside KTWR (A-E).....	38
Figure 10. Livestock Grazing in KTWR (A-F) .....	39
Figure 11. Miscellaneous (A-D).....	40

## LIST OF ABBREVIATIONS

BNP	Bardia National Park
df	Degree of Freedom
DHM	Department of Hydrology and Meteorology
DNPWC	Department of National Parks and Wildlife Conservation
DTR	Distance to Road
DTV	Distance to Village
DTW	Distance to Water
GLM	Generalized Linear Model
Km	Kilometers
KSF	Khair-Sisoo Forest
KTWR	Koshi Tappu Wildlife Reserve
m	Meters
OWL	Open Wooded Land
PA	Protected Area
SGL	Short Grassland
SL	Shrubland
TGL	Tall Grassland

# 1. INTRODUCTION

## 1.1. Background

The Blue Bull (*Boselaphus tragocamelus* Pallas, 1766) or Nilgai is the largest Asian antelope found in the Indo-Malayan Realm belonging to the family Bovidae. The sole member of genus *Boselaphus*, the species has a reflection of the primitive lineage and mixed appearance, whose scientific name translates, in Latin and Greek, to the ox (*bos*, Latin)—deer (*elaphos*, Greek) and goat (*tragos*, Greek)—camel (*kamelos*, Greek). Sexual dimorphism is prominent in the Blue Bull; while females and juveniles are orange to tawny; adult males have a bluish-grey coat. Only males possess horns about 20 cm long. Males have a pronounced “pennant” or beard of coarse hair directly beneath the gular patch which is rudimentary in females. The Blue Bull has two white circular rings near the fetlocks and hence called White-Footed Antelopes.

Problems associated with locally overabundant wildlife species have emerged as important management issues for reason of some species losing their natural habitat and adapting themselves to the man-altered situation (Chauhan 2011). The Blue Bull are a crop menace, causing large-scale damages, especially along the Gangetic belt, especially in the Rohilkhand division of Uttar Pradesh. They have been declared as vermin in northern India, and they may be legally hunted after obtaining a permit. In Nepal, the locally overabundant populations of the Blue Bull has been reported in many lowlands of Nepal (Aryal 2007). After the establishment of DNPWC and NPWC act, the population of wildlife species have increased considerably, and few of them have become locally overabundant. This has resulted in the approach of the wildlife species to the man-altered habitats increasing Human-Wildlife conflict and in case of the Blue Bulls, have become serious pests of the agricultural crops (Khatri 1993).

Hindus, hold the Blue Bulls peculiarly sacred from its fancied kinship to the cow, and on this account, its destructive inroads upon the crops are tolerated. Agricultural crop damage by Blue Bull and Blackbuck has been widely reported from the lowlands of Terai (Khatri 1993, Aryal 2007).

Koshi Tappu Wildlife Reserve (KTWR) provides significant habitat for the Blue Bull. KTWR provides 37% grassland and only 10% forest area for the Species (KTWR 2018). KTWR has

no predators targeting the Blue Bull. There are many villages on the fringes of the KTWR where farming is done intensively followed by the livestock grazing inside the KTWR. Grazing competition between livestock reduces the amount of palatable species available to Blue Bulls. This has encouraged the introduction of unpalatable species in the area, causing the Blue Bull to move to private lands in search of food (Aryal 2007).

## 1.2. Distribution

*Boselaphus tragocamelus* is endemic to the Peninsular Indian and Indus divisions of the Indian Sub-region in the Asian Indomalayan Region (Corbet and Hill 1992). Native range of *B. tragocamelus* in Asia includes the foothills of the Himalayas in Nepal (Dinerstein 1980), northeastern Pakistan (Mirza and Khan 1975), and almost all of India, except eastern Bengal, Assam, east of the Bay of Bengal, and the Malabar Coast (Blanford 1888, Ellerman and Morrison-Scott 1966, Prater 1980).

Introduced *B. tragocamelus* also exist in southern North America, where latitude, climate, and habitat characteristics are comparable to those of India (Ables and Ramsey 1972, Sheffield et al. 1983). They have been extirpated from Bangladesh.

## 1.3. General Description of the Blue Bull

A sturdy thin-legged antelope, the Blue Bull is characterized by a sloping back, a deep neck with a white patch on the throat, a short mane of hair behind and along the back ending behind the shoulder, and around two white spots each on its face, ears, cheeks, lips and chin (Padhi et al. 2004). The ears, tipped with black, are 15–18 centimeters long (Leslie 2008). A column of coarse hair, known as the "pendant" and around 13 centimeters long in males, can be observed along the dewlap ridge below the white throat patch (Schmidly 2004). The tufted tail, up to 54 centimeters (Eldredge 2002) has a few white spots and is tipped with black chin (Padhi et al. 2004). The forelegs are generally longer (Eldredge 2002), and the legs are often marked with white "socks" (Leslie 2008).

While females and juveniles are orange to tawny, males are much darker – their coat is typically bluish grey. The ventral parts, the insides of the thighs and the tail are all white (Eldredge 2002). A white stripe extends from the underbelly and broadens as it approaches the rump, forming a patch lined with dark hair (Schmidly 2004). Almost white, though

not albino, individuals have been observed in the Sariska National Park (Rajasthan, India) (Ranjitsinh 1987) while individuals with white patches have been recorded at zoos (Smielowski 1987). The hairs, typically 23–28 centimeters long, are fragile and brittle (Koppiker et al. 1981). Males have thicker skin on their head and neck that protect them in fights (Padhi et al. 2004). The coat is not well-insulated with fat during winter, and consequently severe cold might be fatal for the Blue Bull (Deal 2011). The Blue Bull has sharp ears and eyes (Goetze 1998), though its sense of smell is not as acute (Brown 1936).

#### **1.4. Ecology and Behaviour**

The Blue Bull is diurnal (active mainly during the day). Females and juveniles do not interact appreciably with males, except during the mating season. Groups are generally small, with ten or fewer individuals, though groups of 20 to 70 individuals can occur at times (Schmidly 2004).

The Blue Bull prefers areas with short bushes and scattered trees in scrub forests and grassy plains. They are common in agricultural lands, but hardly occur in dense woods (Leslie 2008). In southern Texas, it roams in the prairies, scrub forests and oak forests. The Blue Bulls are a generalist animal as they can adapt to a variety of habitats (Leslie 2008). Though sedentary and less dependent on water, Blue Bulls may desert their territories if all water sources in and around it dry up (Sheffield 1983).

#### **1.5. Threats and Conservation**

The Blue Bull is categorised as Least Concern by the International Union for the Conservation of Nature and Natural Resources (IUCN 2016). The Blue Bull has been associated with Indian culture since the Vedic period (1500–500 BCE). Hindus revere the Blue Bull as sacred and associate it with the cow, the mother animal in Hinduism, through its name and slightly similar physical features. The Blue Bull has been considered a pest in several North Indian states, as they ravage crop fields and cause considerable damage. In Bihar, authorities have classified the Blue Bull as vermin.

In Nepal, the Blue Bulls are found in the different Protected Areas (PAs): Koshi Tappu Wildlife Reserve, Parsa National Park, Chitwan National Park, Banke National Park, Bardia National Park and Sukla Phanta National Park; and non-protected areas of lowlands of Terai: Banke,



Bardia, Kailali, Kanchanpur, Kapilvastu (Taulihawa), Nawalparasi, Parsa and Rupandehi districts (Lumbini forests) (Baral 2014). The majority of Blue Bull population in Nepal exist outside protected areas of Taulihawa (Kapilvastu district) and Lumbini forests (Rupandehi district). The population size of the Blue Bull were estimated to be 289-324 and predicted that the species and its associated habitat will continue to decline (Jnawali et al. 2011).

According to the National Redlist series of mammals of Nepal (Jnawali et al. 2011), the Blue Bull is categorized as Vulnerable. Total 517 Blue Bulls were counted outside and inside the protected areas of Nepal (Baral 2014). The major reasons behind its demolishment in two countries along with the extinction in Bangladesh are rampant hunting, deforestation and habitat degradation (Jnawali et al. 2011).

The conservation moment that started in Nepal in early 1970s has favored the conservation of many species, but the management regimes currently practiced in the existing PA networks clearly does not favor the Blue Bull (Baral 2014). The species benefits from its association with cows, which are considered sacred in Hindu religion, and therefore has a limited amount of social and cultural protection (Jnawali et al. 2011). The species is declining at a national scale (Jnawali et al. 2011).

Blue Bull is the largest wild animal in lowland Nepal, also present outside the protected areas of Nepal where they are mostly dependent on marginal habitats and cultivated lands. Diurnal in nature, the Blue Bull raids crops in evening and at night (Chauhan and Singh 1990). The Blue Bull causes extensive damage to the agricultural crops leading to negative perception of the people towards them resulting in Human-Wildlife Conflict.

## **1.6. Objectives**

### **1.6.1. General Objective**

The general objective of this study is to determine the population status, population distribution and threats to the Blue Bull (*Boselaphus tragocamelus*) in Koshi Tappu Wildlife Reserve (KTWR), Nepal.

### **1.6.2. Specific Objectives**

a) To investigate the population status and distribution of the Blue Bull in KTWR.

b) To explore the conservation threats to the Blue Bull in KTWR.

### **1.7. Rationale of the study**

Wildlife conservation is the major problem of today. Many wildlife species have been extinct from the world and others are reducing day by day. Blue Bull is also not an exception. Worldwide Blue Bull is few in number. Numbers in India total about 100,000 but have always been low in lowland Nepal (Dinerstein 1979). The main threats to Blue Bull include poaching for both subsistence and trade in their hide, retaliatory killings in response to crop raiding and habitat loss and degradation due to human encroachment as well as the fragmented habitat (IUCN 2016).

Only few works on the Blue Bull in KTWR has been recorded till now. Further work is needed for maintaining good population status of the Blue Bull. Several aspects like the behavioural study of the blue bulls are unexplored in Nepal, creating large gaps in our knowledge about the species in KTWR as well, to ensure effective management for their conservation. Thus, this study will determine the population status, distribution, and potential threats to the Blue Bull in the KTWR. This study aims help to identify and remove the possible threats to the Blue Bull and help in their conservation.

## 2. LITERATURE REVIEW

### 2.1. Population Distribution

Eisenberg (1980) revealed that large mammalian terrestrial herbivores tend to show peak densities in grassland, grass scrub and savannah biomes, with the lowest densities found in severely arid conditions or at the other extreme in tropical evergreen forests. Bagichi et al. (2008) studied social organisation and population structure by Transect line method of Chital, Sambar, Blue Bull and Chinkara showed in dry tropical forest of Ranthambore Tiger Reserve in semi arid western India, that population structures in ungulates is inclined towards female due to sexual selection. Gautam (2013) reported the population of ungulates depended on the habitat factors and prey-predator interaction and the study also aimed to explore the habitat preference of ungulates in the Bardia National Park, Nepal. The study was based on the transect survey and indirect observation of ungulates. Spotted deer recorded the highest density and Blue Bull recorded the lowest. Hog deer preferred mostly flood plains habitat and barking deer preferring mixed hardwood forest and tall grass flood plains. However, barking deer completely avoided the riverine forest and flood plain habitats. Swamp deer preferred Phata (grassland) and Blue Bull was recorded only in flood plains. The higher concentration of ungulates' pellet groups were found in areas close to water sources. Bista (2011) studied the distribution and population size of ungulates in Pilibhit forest division, Uttar Pradesh. Total 713 spotted deer, 209 blue bull, 70 wild boar, 62 hog deer, 3 sambar and 2 barking deer were encountered along the transect walk, with estimated global density of ungulates in the forest to be 40.5 animals/km<sup>2</sup>. Spotted deer and blue bull showed biasedness towards the female. Wild boar and spotted deer were distributed well across the area while hog deer in grassland only. Blue bulls were sighted along the edges of the grid of the transect walk with plausible explanation that blue bull prefers open and scrub type vegetation for refuge during day time adjacent to agricultural crop.

### 2.2. Population Status

Subedi (2001) stated the population of Blue Bull has been declining over the last five years in Nepal and therefore, conservation of Blue Bull is a national and global concern. He counted 11 Blue Bulls in the Lumbini Development Area (LDA), where the number was estimated using the transect method in accessible roads from Bhairawaha-Taulihawa. Aryal (2007)

studied the sex ratio of Blue Bull male to female was 2:3 in Lumbini Development Trust (LDT) with a total population 41 in 7.51 km<sup>2</sup> including 10 males, 15 females and 16 juveniles with population density of 8 individuals/km<sup>2</sup>. Gosai (2007) found 17 Blue Bull in the same area through direct observation method. Shurter (2014) reported the population of Blue Bull in protected areas to be 174 and outside protected areas to be 343 with a total population of 517 in Nepal. Khanal et al. (2016) counted 303 Blue Bull within 38 transect lines in Rupandehi District. Dinerstein (1979) estimated about 200 Blue Bulls in 45 km<sup>2</sup> of savanna grassland in Karnali Bardiya using line transect method. Aryal et al. (2016) carried out a study along the Tinau River at Rupandehi District in Western Nepal along six transect lines and found 40 Blue Bulls. Bagale (2003) estimated population status of Blue Bull and Blue Bull-livestock-people interaction in Lumbini and found total 37 Blue Bull in 3 square miles.

### **2.3. Threats**

Ungulates are among the most globally affected groups of mammals (Macdonald 2001, Baillie et al. 2004) and they have suffered severe contractions in their distributional range, particularly in human dominated landscapes of southern Asia (Karanth et al. 2010). Aryal et al. (2016) reported the potential threats to the Blue Bull along the Tinau river were habitat destruction, overgrazing, conflict, flooding and accident. Khatri (1993) reported seven species of crop raiding animals including Blue Bull in BNP. During 1992-1993, Blue Bull was responsible for about 8.3% of the total loss caused by all the park animals, which has developed negative attitude among local people towards Blue Bull. Gautam and Bissa (2016) reported human population growth and activities like deforestation, agriculture and urbanization lead to an ever increasing encroachment of wildlife habitats and reduction of wild animals' natural habitats altered into small marginal patches, resulting in high crop damage in Rajasthan. In India proximate threats to ungulate species emanate from human activities that range from illegal hunting to agricultural encroachment and extraction of forest resources. These are known to directly affect abundance as well as distribution of several ungulate species (Karanth et al. 2009). Mathur (1991) studied ecological impacts of livestock grazing on wild ungulates in Sariska National Park, India. This study showed that the impact varies with the ungulate species: Blue Bull has no adverse impact due to cattle presence, while Sambar and Chital members decline in habitat where livestock graze intense. The tropical dry deciduous forest of Rajasthan have a dense layer of herbaceous vegetation during the rainy season which plays an

important role in nutrient conservation and as a source of food for herbivores. Anthropogenic disturbances have adversely affected the composition of herbaceous vegetation; it is, therefore, imperative to conserve the herbaceous vegetation of these forests. Chauhan and Singh (1990) carried out observation related to crop-raiding by locally overabundant wild populations of Blue Bull and Blackbuck in Haryana, where Blue Bull causes extensive damage to agricultural crops; among these, gram, wheat seedlings and moong are the most preferred ones. Blackbuck nibble mainly on young shoots of various cereal and pulse crops and the damage is much less than caused by Blue Bull. Aryal (2007) counted 200 Blue Bulls, most of which perished in the following year possibly due to foot-and-mouth disease and retaliatory killing by local people, as Blue Bulls are notorious for raiding crops.

#### **2.4. Research Gaps**

More studies of the Blue Bull has been done in Rupandehi district, some in BNP and less in the Eastern Part of Nepal. Few behavioral studies on Blue Bull has been done in Nepal. For the proper conservation of the species, one should be aware of the nature of the species in relation to their habitat. There is very low study of Blue Bull in context to population dynamics, their threats and conservation initiatives and issues. Hence, this study will provide the basic information for planners and other researchers to conduct and design the research in KTWR.

### 3. MATERIALS AND METHODS

#### 3.1. Study Area

The study was conducted in KTWR. KTWR lies in the alluvial flood plains of Saptakoshi River, with an area of 175 sq. km located within 86°55'15'' - 87°05'02''E longitude and 26°33'57'' - 26°43'40''N latitude covering Sunsari, Saptari and Udaypur districts. The Reserve is almost rectangular in shape measuring 17.5 km North-South and 10 km East-West (KTWR 2018).

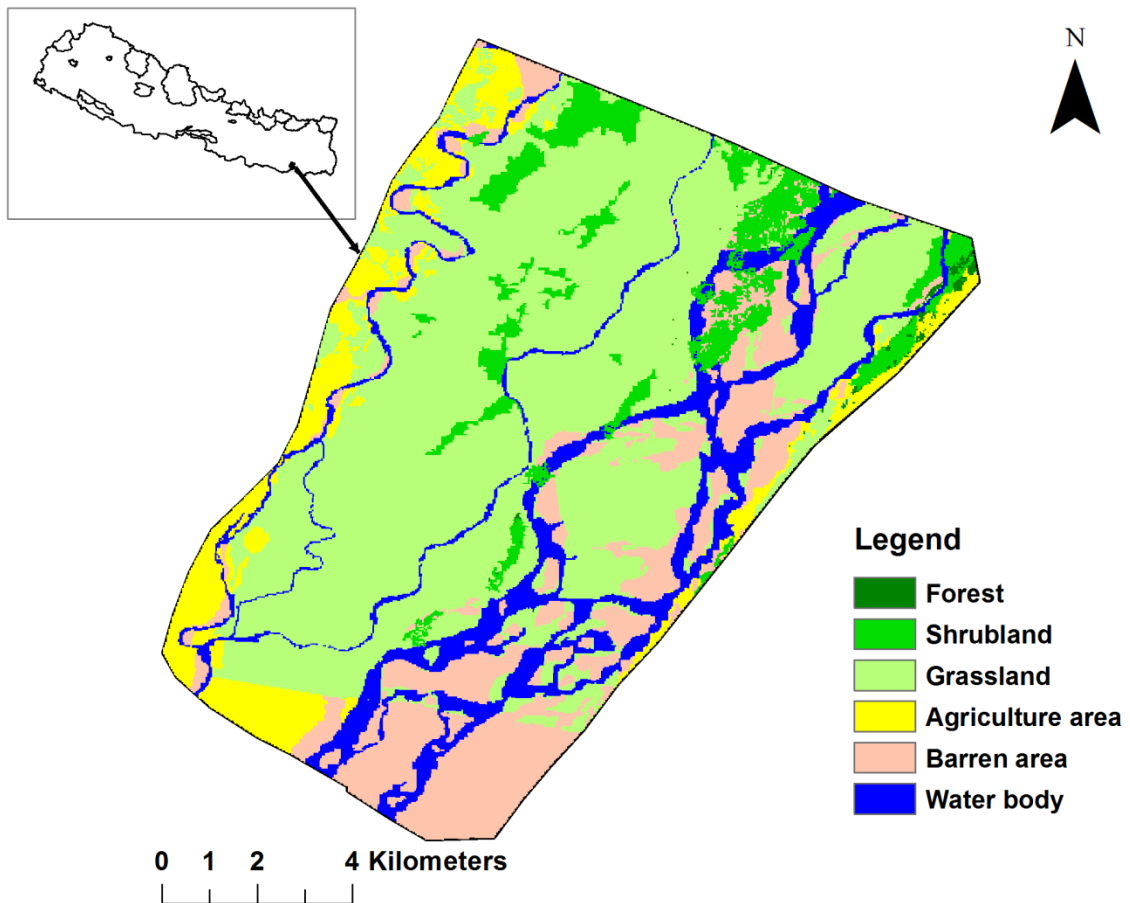


Figure 1. Map of the Study Area showing various habitats.

#### 3.1.1. Topography

KTWR is roughly a flat and rectangular area stretched out in floodplain of Koshi River which is also known as Saptakoshi in the lowland as it is fed by seven major tributaries - Arun, Tamor,

Likhu, Tamakoshi, Indrawati, Dudhkoshi and Sunkoshi. Its elevation ranges from 80 m- 95 m from the main sea level with a gradual increase from south to north. Afflux bunds of 5-7 m high were constructed on both eastern and western banks of the River to contain its water and control monsoon floods. The terrain of buffer zone is flat with mainly agriculture field and human settlements (KTWR 2018).

### **3.1.2. Geology and Soil**

The reserve lies in the northern part of the Gangetic plain in a low-lying area. Its alluvial deposits are mainly composed of thin fine sand, silt and clay, which frequently alternate in different proportions (DNPWC 2009). The nutrient content in the soil varies greatly, depending upon the time of sedimentation and the establishment of vegetation on it in the subsequent years. Five different types of soil such as sandy, sandy loam, loam, sandy clay loam and clay loam were described in and around the Reserve with soil pH ranging from 5.2 - 8.1 and fertility ranging from low to high (Sah 1997, DNPWC 2009).

The Reserve's floodplains are characterized by sand and silt soil with varieties of grasses, patches of shrub and deciduous mixed riverine forest. There are not many large trees inside the reserve due to frequent changes of Koshi River course and annual monsoon flood.

### **3.1.3. Climate**

The Reserve has subtropical monsoon climate with four distinct seasons: spring, summer, autumn and winter. Spring (February-April) has pleasant warm temperature and strong silt laden wind. Summer (May) is intensely hot with minimal precipitation and maximum temperature up to 40°C. In recent years monsoon starts towards the end of June with frequent and violent thunderstorm and lasts normally up to July. Autumn commences on August and continues till October. Due to moisture-laden winds from the Bay of Bengal, 80-85% of the total rainfall occurs from June to September. Winter set in from November through January with clear sky, cold mornings and warm days having lowest temperature 3.3°C in January. The area receives small amount of winter rain due to south-westerly winds occasionally. The average annual rainfall is 2019 mm and average daily maximum temperature ranges from 23.5°C - 33.4°C, the minimum from 7.8°C - 25.3°C and the mean monthly temperature between 15.7°C - 29.2°C. Humidity remains high all year round with the monthly average 76% - 94% (DHM 2016).

### 3.1.4. Vegetation

Diverse assemblages of 514 species of plants belonging to 110 families have been recorded from the Reserve (IUCN 1998). Out of the total species, 502 belong to 99 families of flowering plants and 12 belong to the 11 family of Pteridophytes. The family Gramineae is dominant. The successional forest of primary and intermediate seral stage exists in patches in the Reserve. The forests are mostly open and degraded and form isolated patches of woodlands, dominated by one or more of the three species: Khair (*Acacia catechu*), Simal (*Bombax ceiba*) and Sissoo (*Dalbergia sissoo*).

### 3.1.5. Wildlife

The Reserve supports about 45% of total vertebrate species of the country (IUCN 1998). The wild water buffalo (*Bubalus arnee*), prominent species of KTWR, has increased from 63 in 1976 (Dahmer 1976), to 441 in 2018 (KTWR 2018). Among other mammals, Wild elephant (*Elephas maximus*), Wild boar (*Sus scrofa*), Blue Bull (*Boselaphus tragocamelus*), Hog deer (*Axis porcinus*), Spotted deer (*Axis axis*), Smooth coated otter (*Lutrogale perspicillata*), Fishing cat (*Prionailrus viverrinus*), Jungle cat (*Felis chaus*), Indian fox (*Vulpes bengalensis*) and Jackal (*Canis aureus*) are common (IUCN 1998). The wetlands harbour several aquatic fauna like insects, fishes, amphibians, reptiles, birds and mammals.

The reported vertebrates of the Reserve include 127 species of fishes, 45 species of herpetofauna (amphibians and reptiles) and 32 species of mammals (IUCN 1998). Around 77 species of butterflies are reported from the Reserve (IUCN 1998). Among the 45 species of herpetofauna, 11 are amphibians (2 toads and 9 frogs), 34 reptiles (2 crocodiles, 9 turtles, 1 tortoise, 6 lizards and 15 snakes).

A total of 526 species of bird species including residents and migrants has been listed that represent 63 bird families of the world. The most numerous birds come from Muscicapidae (57 spp.), closely followed by Accipitridae (44 spp.), Sylviidae (43 spp.), Passeridae (31 spp.), and Anatidae (31 spp.) (Baral 2016). KTWR avian fauna is dominated by migrants as only 35 % of birds are resident here, and the rest 65% are largely migratory in nature. Of the currently listed 39 species of globally threatened species in Nepal, 26 species have been recorded at KTWR. At least 126 species breed in the Reserve and 191 species are winter visitors (Inskipp et al. 2016).



The total number of migratory birds has dropped from around 50,000 in 1990s to less than 7000 in 2018 and among them migratory waterfowl including Ruddy Shelduck (*Tadorna ferruginea*) is the highest in number (KTWR 2018).

### **3.2. Materials**

- GPS
- Meter tape
- Camera

### **3.3. Methods**

#### **3.3.1. Preliminary Field Survey**

The preliminary field survey was carried out in 19 July- 26 November, 2018. The staffs, officials and the local people (40 individuals) were interviewed about the Blue Bull's presence in and around the fringes of KTWR. The field was surveyed by vehicular travelling and transect.

#### **3.3.2. Field Survey**

The detailed field survey was carried out between February 18 – April 10, 2019.

#### **3.3.3. Site Selection**

The Saptakoshi River divides the KTWR into two parts- East and West part. Three sites from each part with a total of six sites were surveyed.

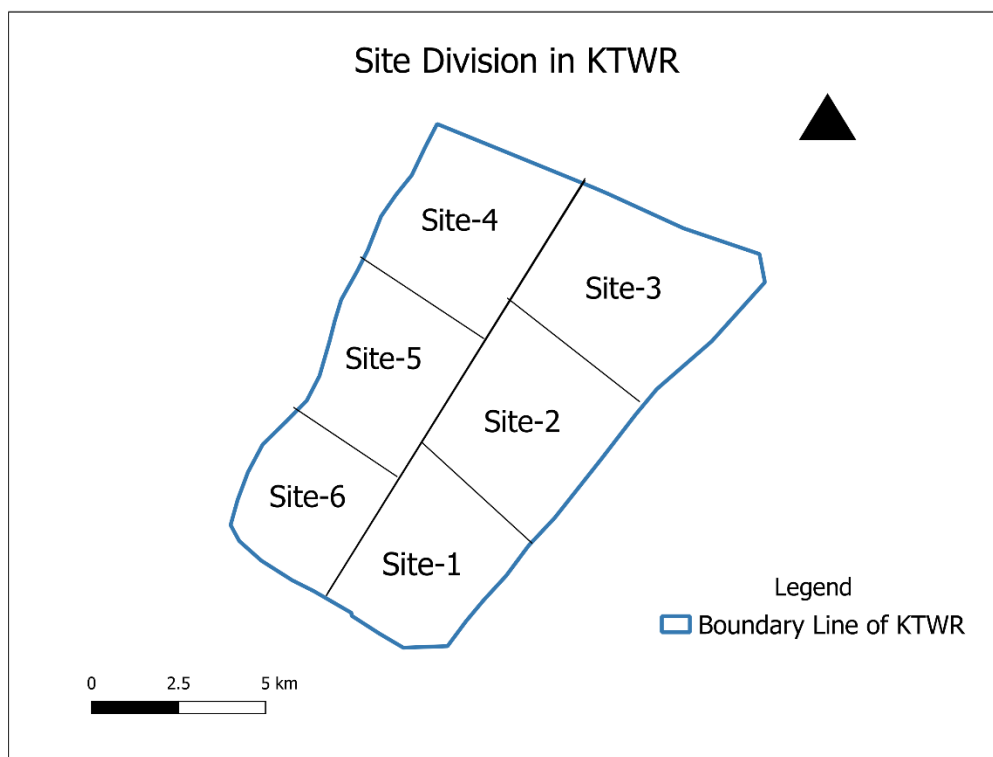


Figure 2. Map showing division of six different sites inside KTWR

Table 1. The selected six sides from east and west of KTWR.

S.N.	Sites	Location (KTWR)	Habitat
1.	Haripur	East	Open grassland ( <i>Sacchram</i> sp.) interspersed with small patch of <i>Dalbergia/Acacia</i> sp.
2.	Kusaha	East	Open grassland ( <i>Sacchram</i> sp.) interspersed with small patch of <i>Dalbergia/Acacia</i> sp. with Tall Grassland
3.	Prakashpur	East	Khair/Sisso forest, Tall Grassland of <i>Sacchram</i> sp. and <i>Typha</i> sp. (pater)

4.	Pathari	West	Open grassland with small patches of shrub areas, Khair/Sisso forest
5.	Bhagalpur	West	Open Grassland and small patches of Khair/Sisso forest
6.	Badgamma	West	Open Grassland and small patches of Khair/Sisso forest

A total of 24 line transects of 20.4 km with 204 transect points were laid in total six sites of the KTWR.

#### **3.3.4. Data Collection**

The data was based on primary and secondary sources. The primary data was collected using direct observation and line transects method for the population status and distribution accordingly. For the potential threats to the species, the study area was assessed carefully and the Reserve officials along with the locals were questioned following the secondary data collection.

#### **3.3.5. Line Transects**

A total of 24 line transects were placed in the six different sites of KTWR. For a single line transects, a circular quadrat of 10 m radius was laid at the interval of 100 m. The area was assessed thoroughly for any direct or indirect signs of the Blue Bull. The distance between two line transects was 300 m- 500 m. The length of the line transect varied between 700 m-2500 m in each site. GPS points were taken at each 100 m interval of the line transects. The sites were visited from 6 AM in the morning to 4 PM in the evening (10 hours).

The sightings of the Blue Bulls were noted following the line transects along with their GPS points for the population estimation of the species.

### **3.3.6. Pellet Count**

The Blue Bull have a characteristic habit of defecating repeatedly in the same location, resulting in the formation of large faecal piles or lavatory sites of nearly a meter in diameter (Brander 1923; Kumarsinghji 1959, Schaller 1967). Schaller (1967) suggested that these piles might function as territorial markers, since the behaviour is characteristic of several species of African antelopes (Leuthold 1977). Hence, Pellet groups were found to be the most reliable indirect evidence and were used for assessing the distribution of the species.

While walking the line transect, GPS points were recorded where the pellets of the Blue Bulls were sighted. These points were used for the preparation of thematic maps of the distribution of Blue Bull in KTWR.

### **3.3.7. Age and Sex Composition:**

Age and sex of the animal was determined by direct observation using the following body characteristics (Sankar and Goyal 2004)

Females have a short yellow-brown coat. Male-coat gradually darkens to grey-blue and has white spots in the cheeks and white ring at the edge of the lips. Females are hornless and noticeably smaller than male.

**1. Sub-adult individuals:** Individuals of 1 to 2 years are classified as sub-adults. The body size of sub-adult is remarkably large than the calves.

**a) Sub-adult female:** Sub-adult female reach above the central body line of the adult female. Color is same as sub-adult male but do not pose horn.

**b) Sub-adult male:** They are larger than female sub-adult and body colour starts to darken from yellow/light brown to grey-blue, they possess noticeable horns, neck with white neck hair tuft.

**2. Adult individuals:** Adults of the both sexes are estimated to be over 2 years of the age and are distinguished from sub-adult by their body size and color.

**a) Adult female:** Adult female could be distinguished from the sub-adult females, as they have longer snouts, large head and yellow-brown in color.

**b) Adult Male:** Could be distinguished easily from the sub-adult male as they have large head with conical and smooth longer horns, dark grey-blue color and black leg.



A: Female Blue Bull with her young calves



B: Adult and sub- adult female Blue Bull



C: Sub- adult male Blue Bull



D: Adult male Blue Bull

(A- ©New Indian Express, B- ©Jon Arden, C- ©A N, D- ©David Behrens).

Figure 3. Different age groups and sex of the Blue Bull (A-D).

### **3.3.8. Questionnaire Survey**

Upon interviewing, it was found that the local people living in the fringes of KTWR were not aware of the Blue Bull's presence or mostly confused it with deer. The study was not done previously in the Reserve and it was difficult to select sites for the assessment. Key informant interview with Reserve Officers, Rangers and local leaders was performed to know the present and past status of the Blue Bull and major threats to them. A total of 40 semi structured questionnaires related to threats were prepared and asked to the local people who entered the Reserve area for livestock grazing and fishing and surrounding villagers who are suffering from crop depredation by ungulates.

### **3.4. Data Analysis**

All the collected information were categorized and tabulated according to the objectives of the study. Data were manually processed and analyzed in descriptive way as well as statistical measure using R- Studio (v 3.4.1, The R Core Group) and PAST (v 3.14).

#### **3.4.1. Distribution Pattern**

##### **3.4.1.1. Variance-to-mean ratio ( $S^2/\bar{X}$ )**

Data on animal location such as number of individuals, footprints and pellets recorded in each habitat type were used to determine the distribution pattern. The distribution pattern of the Blue Bull was calculated by variance-to-mean ratio (Odum 1971) which is based on the fact that is Poisson distribution; the variance ( $S^2$ ) is equal to the mean.

If  $S^2/\bar{X} > 1$ ; Distribution is clumped

If  $S^2/\bar{X} < 1$ ; Distribution is uniform

If  $S^2/\bar{X} = 1$ ; Distribution is random

##### **3.4.1.2. Chi-square Test ( $\chi^2$ - test)**

A chi-square test performed by setting hypothesis that the Blue Bull was uniformly distributed in all habitat type in KTWR. The hypothesis was tested at 99% and 95% significance level.

Another chi-square goodness of fit test was carried out to find if there was any significance distribution in all the selected six sites of KTWR comparing with the habitat.

### **3.4.2. Generalized Linear Model (GLM)**

To perform GLM, the response variables and environmental variables were selected. For the response variable, species presence and number of pellet along the line transects were noted accordingly.

For the environmental variable: habitat, disturbance variables and proximal variables were selected. The habitat included open shrub areas (shrub land and Open wooded land), grassland (tall and short grassland) and Khair-sissoo forest. The disturbance variables included number of people, number of livestock. Finally, the proximal variables included distance to road (DTR), distance to village (DTV) and distance to water (DTW).

## 4. RESULTS

### 4.1. Population Status

The study area was divided into six sites for generalization and easier data collection. Twenty-eight individuals were recorded in the different sites of the study area (Table 2).

Table 2. Sex composition of the Blue Bull in selected stations of KTWR

S.N.	Sites	Observed Blue Bull				Total
		Adult Male	Adult Female	Sub-Adult Female	Young	
1.	Haripur	2	5	4	-	11
2.	Kusaha	1	-	-	-	1
3.	Prakashpur	1	2	-	-	3
4.	Bhagalpur	-	2	2	-	4
5.	Pathari	2	4	2	-	8
6.	Badgamma	-	1	-	-	1
<b>Total</b>						28

Out of 28 individuals observed in the study area, 21.43% were males and 78.57% were females (Table 3). Among all sex and age groups, male to female ratio was computed at 0.21:0.78 that is 6 males and 22 females.

Table 3. Age and Sex Composition of the Blue Bull in KTWR

Sex	Age	Number	Percentage
Male	Adult, Sub-Adult, Young	6	21.43%
Female	Adult, Sub-Adult, Young	22	78.57%
<b>Total</b>		28	100%

With 28 total Blue Bulls sighted in KTWR, the highest number of blue bulls were sighted in Haripur, i.e. 11 (2 male and 9 female), 8 in Pathari (2 male and 6 female), 4 in Bhagalpur (female), 3 in Prakashpur (1 male and 2 female), 1 male in Kusaha and 1 female in Badgamma.



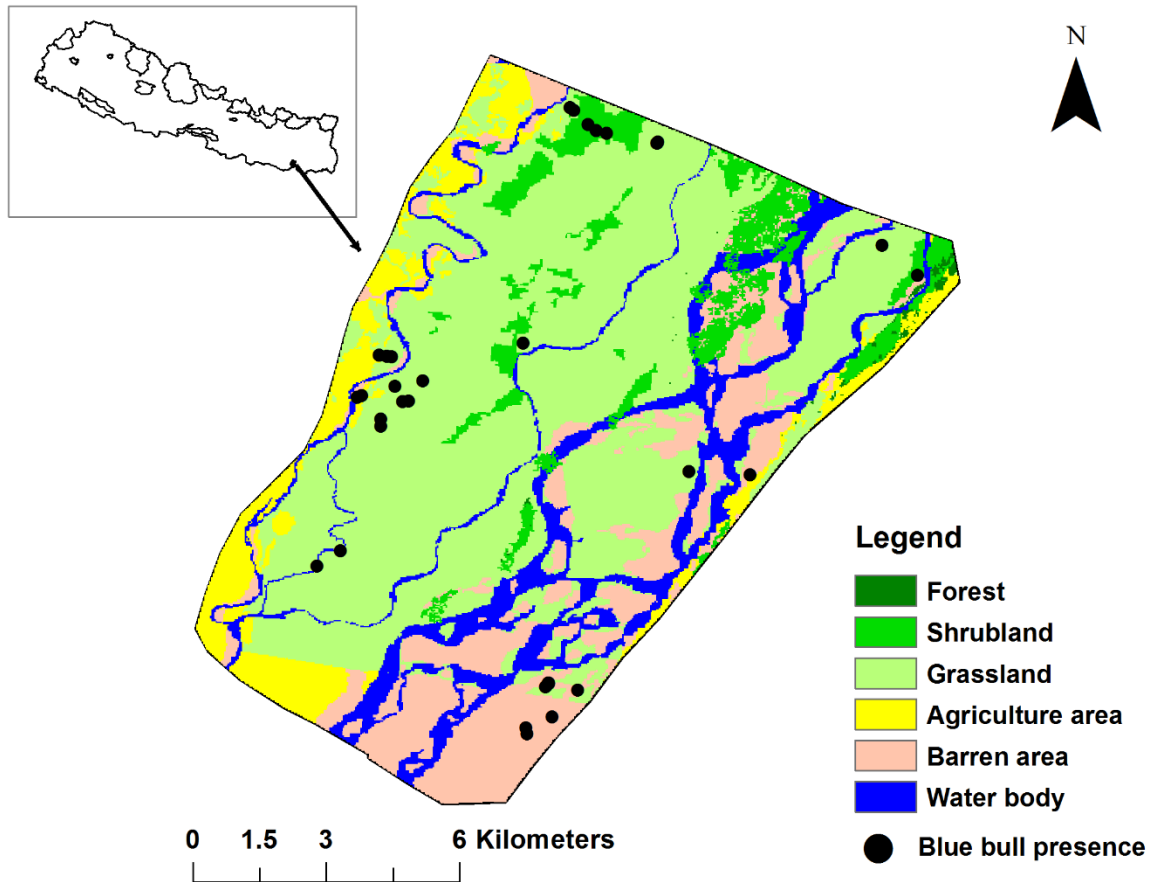


Figure 4. Map of study area showing Blue Bull's distribution in different sites

#### 4.2. Distribution Pattern

There were 28 individuals (6 males and 22 females) and 38 pellet groups recorded from the six selected sites of the study area. The study area consisted of five major habitats: Short Grassland (SGL), Tall Grassland (TGL), Shrub Land (SL), Open Wooded Land (OWL) and Khair/Sisoo Forest (KSF). Among these, two individuals and six pellet groups were found in SGL; no individuals and pellet groups were recorded in TGL; five individuals and no pellet groups were found in SL; fifteen individuals and twenty-three pellet groups were found in the OWL; six individuals and nine pellet groups were found in KSF (Table 4).

Table 4. Total Number of individuals and pellet groups of the Blue Bull observed in KTWR

Number	Habitats (%)				
	SGL	TGL	SL	OWL	KSF
Number of Individuals	7.14	-	17.85	53.57	21.43
Number of Pellets	15.78	-	-	60.53	23.68

Different Fecal pellet groups were recorded from all the habitat types available in KTWR. Out of 38 fecal pellet groups, highest frequency of pellets were recorded from OWL which was found to be 23 (60.53%) followed by KSF 9 (23.68%) and lowest frequency was observed in SGL 6 (15.79%). No pellets were observed in the TGL and SL (Table 4).

The variance to mean ratio was used to determine the distribution pattern of the Blue Bull among six sampled sites of the study area. The calculated value of variance to mean ratio was found to be 2.7. Since, the value of  $S^2/\bar{X} > 1$ , the result showed clumped or uneven type of distribution of the Blue Bull in KTWR.

Chi-Square Test was used to test the hypothesis that the Blue Bull was uniformly distributed in all habitat types in KTWR. Thus, this study revealed that the Blue Bull was uniformly distributed in different habitats ( $\chi^2 = 7.9516$ ,  $df = 3$ ,  $p = 0.047$ ).

Chi-Square Test was also used to test the hypothesis if there was significant distribution of the Blue Bull in all the six selected sites of KTWR in relation to the habitat. Thus, this study concludes that there was no significant distribution of the Blue Bull in the selected six sites of KTWR ( $\chi^2 = 90.3$ ,  $df = 20$ ,  $p = 0.00001$ ) in relation to the habitat.

Table 5. Generalized Linear Model (GLM) comparing the blue bull's presence and absence data with given selected variables.

	Estimate	Std. Error	t value	Pr (>  t  )	
KSF	-0.09226	0.07671	-1.203	0.231	

Open Shrub area	0.32188	0.06458	4.984	0.000	***
Grassland	-0.27909	0.07057	-3.955	0.000117	***
DTW	0.000	0.000	0.396	0.692	
DTV	0.000	0.000	5.011	0.000	***
DTR	0.000	0.000	3.378	0.000929	***
No. of Livestock	0.008921	0.002089	4.270	0.000	***
No. of People	0.07418	0.02842	2.610	0.00997	**

Significance Codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Using the Generalized Linear Model (GLM), it was concluded that: Open shrub area, DTW, DTV, DTR, Number of Livestock and Number of people had positively affected the presence of the Blue Bull while KSF and grassland negatively affected the presence of the Blue Bull. We can also see that the coefficient of Open shrub area, grassland, DTV, DTR, Number of livestock and Number of people were all-significant i.e. ( $p < 0.05$ ) while KSF and DTW were non-significant ( $p > 0.05$ ).

#### 4.3. Other Threats

The other threats to the Blue Bull in KTWR were flood, livestock grazing, Human-Wildlife Conflict and Firewood/Dung collection and grass cutting.

- a) **Flood:** Every rainy season, the Saptakoshi River floods Koshi Tappu. The water level rises and mainly the young calves are swept away by the flooded river.
- b) **Livestock Grazing:** Livestock grazing was the serious problem in KTWR. Local people carried their livestock (N=907) inside the reserve for grazing every day, which is the major threat to Blue Bull as they share same grazing grounds. This also increases the risk of introduction of unpalatable species in the reserve area. During the study period, 907 individual of livestock (281 from eastern part and 626 from western part) of the KTWR.

- c) **Human-wildlife Conflict:** People living and cultivating lands on the fringes of the reserve area suffer crop damages. These conflicts have developed negative attitude of people towards the Blue Bull, which may lead to retaliatory killings more often in the future.
- d) **Firewood/Dung collection and fodder collection:** The local people living on the fringes of the reserve area enter the reserve for firewood (cut/fall trees), dung collection and fodder collection for their daily use. This creates a disturbance to the Blue Bull's habitat resulting in the displacement of the species from their habitat.
- e) **Road Accidents:** According to the yearly report of KTWR, road accident was found to be the major cause for the mortality of the Blue Bull. In the 2074 B.S., two accidents were recorded in Saptari District and Haripur. In the same year, two more Blue Bulls were found dead- one young calf being separated from its mother and the other was stuck in the canal in Sunsari District (KTWR 2018).

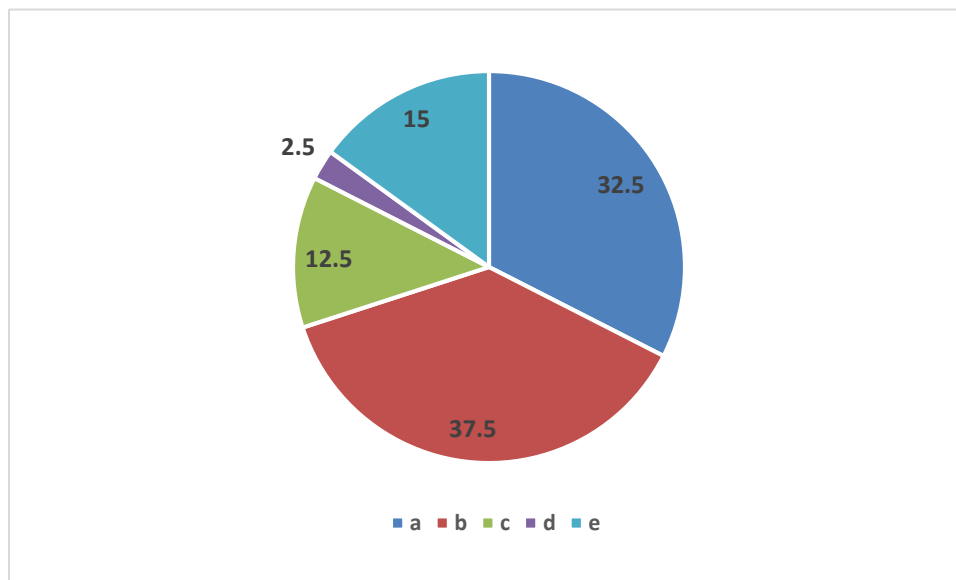


Figure 5. Pie-Chart showing the responses of Key-Informants related to the Threats to the Blue Bull.

Forty key informants were questioned about the potential threats to the Blue Bull in KTWR. 37.5% responded that livestock grazing was the major threat to the blue bull followed by flood (32.5%), road accidents (15%), human-wildlife conflict (12.5%) and firewood/dung collection and grass cutting (2.5%).

## 5. DISCUSSION

### 5.1. Population Status and Distribution of the Blue Bull

KTWR provides an ideal habitat for the Blue Bull. According to the report of KTWR in the year 2072 B.S., the total number of Blue Bull in the reserve was estimated to be 24. This study revealed that the number of Blue Bull currently in KTWR is 28 (dry season). The number of Blue Bulls in the reserve area has slightly increased than the previous year. Das (2019) noted 41 Blue Bulls with the survey carried in the summer season. The number of Blue Bulls has significantly increased, given that Aryal (2007) recorded the decline in the population of the Blue Bull from the Terai Arc Landscape due to hunting and habitat destruction. The number of Blue Bulls altered in the dry and summer season as in the dry period the water sources were almost dried up and there were signs of forest fire within the reserve.

The sex ratio of the Blue Bull in KTWR was 1:4, which was different to the findings of Aryal et al. (2016) who estimated the sex ratio of Blue Bull along the Tinau river of Rupandehi District to be 1:3; Khanal et al. (2017) found the sex ratio to be 81:100; Aryal (2007) found 2:3; 92 males:100 females in Haryana (Singh 1995); 89 males:100 females (Berwick and Jordon 1971); 59 males:100 females (Schaller 1967) from two different populations; and 109 males:100 females from Cristal and Rosital Pastures (Fall 1972). Four different census made in the same pastures showed 88, 107, 100 and 99 males: 100 females respectively (Sheffield et al. 1983). The reports of some zoological gardens indicate almost 1:1 ratio of males and females (Jarvis 1966, 1967 and 1968, Lucas 1969 and 1970) which contradicts with the study results.

The highest number of Blue Bulls and their pellet groups were found in Haripur and Pathari sites. The major habitat of these two sites are open grassland with small patches of shrub areas and Khair/Sisoo forest. These sites were rich in dense bushy or shrub areas and no tall grasslands. These two sites mostly consisted of OWL.

Out of the surveyed five habitat types in different sites of the KTWR- SL, OWL, TGL, SGL and KSF; the number of pellets and individual Blue Bulls abundance was seen high in the OWL followed by KSF, SGL and SL with no signs of the Blue Bull in the TGL. The Blue Bulls enjoy open thin bush with scattered low trees or alterations of scrub and open grassy

plain with either level or undulating topography, rarely in thick forest but often on cultivated areas (Blanford 1888, Prater 1980). This result also corroborates with the findings of Shrestha (2004) who found that riverine and grassland habitat supported higher relative abundance of ungulates as compared to sal forest. Karki et al. 2012 in Bardia National Park Nepal found high ungulates abundance grassland with mean of 0.56 pellet group of Chital, Blue Bull and Sambar. Bhat et al. 2012-studied faecal pellet used for the determination of habitat use by Blue Bull in Van Vihar National Park, whose result showed that

the grassland and scrubland were highly preferred by the Blue Bull while as savanna woodland were less preferred. *Boselaphus tragocamelus* is non-migratory, although individuals and groups are capable of considerable movement if ambient conditions (e.g., drought) dictate (Berwick 1974, Kumarsinghi 1959, Sheffield et al. 1983).

The distribution of the Blue Bull in the KTWR was found to be clumped ( $S^2/\bar{X} > 1$ ) which was similar to Khanal et. al. (2016) who also found clumped distribution in the Rupandehi District. Aryal (2016) found clumped distribution in Tinau River of the Rupandehi district. Chauhan and Singh (1990) found random distribution of the Blue Bull in Uttar Pradesh. The clumped distribution in KTWR might be due to the wide spread presence of livestock and limited availability of water and food resources during the dry period (February and April month).

## **5.2. Potential Threats to the Blue Bull in KTWR**

The possible threats to the Blue Bull in KTWR were identified as Livestock Grazing, Flood, Human- Wildlife conflict, firewood/dung collection and grass cutting and road accidents.

The Blue Bulls found in the reserve during this study period revealed that Blue Bull's stay at least 50 m away from the livestock and do not intermingle with them. According to Gautam and Bissa (2014 C), the domestic cattle refuse the water and fodder, which Blue Bull uses. The domestic cattle also reject the grasses grown by farmers, if Blue Bull uses it. The main reason of this rejection is smell of saliva of Blue Bull in grasses, fodder and water; which might also be the reason for the results seen in KTWR. There are a large number of cows and buffaloes in and around the KTWR. As there is no system of stall feeding of cattle, almost all the cattle

go for grazing inside the core throughout the year. The west part of KTWR has intensive grazing pressure compared to the east part.

Like in most part of the Indo Gangetic Plains, where Blue Bull is widely distributed, the species has successfully adapted to agricultural habitats. This has been a consequence of the changing land use practices and the almost complete disappearance of the natural habitat of Blue Bull. Crop raiding by Blue Bull in Sirsa, Hissar, Bhiwani, Rohtak and Mahendragarh districts of Haryana has been reported by Schultz (1986), Chauhan and Sawarkar (1989) and Chauhan and Singh (1990). The animals are particularly active after dusk when they cannot be easily be seen by the farmers guarding their fields. Reacting to the prevailing conditions, the Blue Bull populations have undergone some adaptive behavioral changes from basically diurnal to partially nocturnal and partially diurnal mode (Sheffield et al. 1983).

An opinion survey of 222 local inhabitants of the nearby villages and farmhouses has also revealed that 50.45% interviewees complained about Blue Bull problem in the agricultural fields and out of which only 10.72% interviewees strongly considered Blue Bull as a pest of agriculture (Girish and Deepak 2010).

Habitat destruction or “elimination of habitat” (Schaller 1967) is an ongoing process and it is here, in the cycle of events, that anthropogenic influences play a key role in modifying and often degrading the habitat by diverting a substantial quantum of the biomass towards human and livestock needs. Anthropogenic disturbances take the form of cattle grazing, lopping and cutting for fodder, fuel wood and other biomass requirements, fires, large-scale extraction of non-timber forest products (NTFPs) and drastic alterations in the physio-chemical quality of the terrain. The direct effects of such disturbances include loss of cover, change in vegetation communities, species composition, forage abundance and quality (Dinerstein 1987); all of which have a direct effect on the ungulate habitat use (Dinerstein 1979a).

## 6. CONCLUSION and RECOMMENDATIONS

### 6.1. Conclusion

The presence of large number of individuals and the pellet groups suggests that OWL are good habitat for the Blue Bulls within the Reserve. Even if the Blue Bulls are not uniformly distributed in all habitat types of KTWR (4 out of 5); KTWR highly provides ideal habitat for the Blue Bulls and could be of great help to increase the number of existing Blue Bulls. Among the six selected sites, Haripur and Pathari comprises of important suitable habitats for Blue Bull. If these habitats are strictly managed and lowering the number of livestock KTWR, it would be fruitful for the conservation of these wild ungulate species. People living in the fringes were not quite aware about the Blue Bull's presence inside the reserve area. Awareness program about the Blue Bulls and helping the people understand their nature might aid in developing positive attitude of the people towards the crop raiding issue by the Blue Bulls.

### 6.2. Recommendations

- I. Periodic standardized population surveys to monitor changes in its population
- II. Limiting the number of livestock inside the reserve area or separating them from the Blue Bull's habitat might be an effective management plan to increase the Blue Bull's population.
- III. Implementation of stricter enforcement of law outside the reserve area with regular monitoring and engagement with local communities.
- IV. Awareness about the presence of Blue Bull inside the Reserve and not harming them if they reach the fringes of the reserve area.
- V. Keeping in view the interest of the farmers as well as protection of the Blue Bull, which is necessary for biodiversity conservation, devising a strategy for damage control might come in handy.



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**PHOTO PLATES**



**A**



**B**



**C**



**D**



**E**



**F**

**Figure 6. Habitat of KTWR (A-F)**





**G**



**H**



**I**



**J**



**K**



**L**

Figure 72. Habitat of KTWR (G-L)



**A**



**B**



**C**



**D**

Figure 8. Pellet groups of the Blue Bull in KTWR (A-D)



**A**



**B**



**C**



**D**



**E**

Figure 9. Blue Bull's seen inside KTWR (A-E)



A



B



C



D



E



F

Figure 10. Livestock Grazing in KTWR (A-F)



**A**



**B**



**C**



**D**

Figure 11. Miscellaneous (A-D)