HABITAT PREFERENCE AND GENERAL BEHAVIOR OF BLUE BULL *(Boselaphus tragocamelus)* IN LUMBINI DEVELOPMENT AREA, RUPANDEHI, NEPAL

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Submitted to

Central Department of Zoology

Tribhuvan University

Kathmandu, Nepal

September, 2022

DECLARATION

I hereby declare that the work presented in this thesis entitled "**Habitat preference and general behavior of blue bull *(Boselaphus tragocamelus)* in Lumbini Development Area, Rupandehi, 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).

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mrs. Priyanka Pandey entitled **"Habitat preferences and general behavior of blue bull (*Boselaphus tragocamelus*) in Lumbini Development Area, Rupandehi, Nepal"** has been accepted as a partial fulfillment for the requirement of Master's Degree of Science in Zoology with special paper Ecology and Environment.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
DDC	District Development Community
DNPWC	Department of National Park and Wildlife Conservations
GIS	Geographic Information System
GPS	Geographic Positioning System
IUCN	International Union for the Conservation of Nature
LDT	Lumbini Development Trust
Min	Minute
VDC	Village Development Community

ABSTRACT

Blue bulls (*Boselaphus tragocamelus*) are found near human settlements and crops and fields outside the protected areas in lowland of Nepal. The study was conducted with main purpose to find out habitat preference and diurnal activity pattern of blue bull in Lumbini Development Area, one of the UNESCO World Heritage Sites from Nepal during the month of 29 February to 31 March 2022. The land use land cover type of the area was classified to determine the available habitat types and habitat preference of blue bull were studied by direct observation of blue bull population in the area. A total of 73 individuals of blue bull were recorded during the study period along the 20 line transects each of 200 m – 300m length were surveyed. Major population of blue bull were found in grassland while less found in cultivated or agricultural land. The activities of the individuals of blue bull were recorded by using focal animal sampling and scan sampling methods to determine the diurnal time budget of blue bull in three observational phases 7:00am–10:30am, 10:30am–2:00pm, and 2:00pm–5:30pm (morning, afternoon and evening). The behavioral states recorded were grazing, locomotion, resting, alerting and other activities (running fighting). Blue bull spent maximum time in grazing, resting and locomotion, and no records of grooming and ruminating activities were recorded during the study period. Blue bull engaged maximum time in feeding during 7:00–10:30am and 2:00–5:30 pm when the temperature was low, while blue bull spent the greatest amount of time in resting in between 12:00 to 3:30pm as temperature increases during the day time, hence blue bull spent more time in resting, rather than feeding. There was no significant difference in time spent in basic activities between male and female individuals.

1. INTRODUCTION

1.1 Background

Blue bull (*Boselaphus tragocamelus*), a bovid species, is one of the largest antelopes in Asia and is endemic to Peninsular India and small parts of Pakistan and Nepal (Leslie 2008). Globally, it is a 'Least Concern' species. However, in Nepal, it is vulnerable and is often considered as a problem animal for its crop raiding habit. The blue bull is a member of the Bovidae family and falls under the *Boselaphu*s genus. Peter Simon Pallas, a German zoologist, provided an explanation of this species first occurred in 1766. It is very common in the northern and central regions. It is a non-native ungulate species, was initially introduced to South Texas in 1924 for hunting purposes (Sheffield Jr et al. 1971). Blue bull have developed a free-roaming population of more than 37,000 since their introduction people that extend from northeastern Mexico to coastal South Texas. Nearly all of India, parts of Pakistan, and Nepal are home to blue bull (Dinerstein 1979).

The animal has intermediate appearance between cow and horse, especially male. The name 'Nilgai is said to come from a combination of Nepali and English 'nil 'means 'blue' and ' gai' means 'cow. They are associated with the cow, through its name and loosely similar physical features. The animal is considered as a religiously protected animal, and it is not harmed by local people even though it is a serious pest of their crops. Blue bull is sexually dimorphic; adult males are dark gray varying from bluish to brownish gray except mane (Prater & Barruel 1971) while females, calves and young males are pale brown with the same white markings as male (Schaller 2009). Both sexes have a mane on the neck and develop a tuft of long hair on the throat (Sclater & Thomas 1900). Males are larger than females and body measures 1.4 meters (m) whereas tail measures 1.75 m. Male has a cone like horn about 20 cm long while females are hornless and noticeably small (Pandey et al. 2021). The animal is shy and sensitive in nature. They have strong eyesight and hearing but don't have a good sense of smell. They are social animals, found in small herds and sometimes large herds also. They are found in single or mixed sex herds. The distribution patterns of blue bull is clumped or sometimes coast with an average herd size of 5-6 individuals per herd, average weight

of the adult blue bull range 200 kg (Nowak & Walker 1999) and the weight of the adult male ranges from 130 – 140 kg (Prater 1965).

They are herbivorous animals so that they feed on various types of grasses, leaves, shrubs, herbs, buds, seeds, and fruits. They are also one of the threatened animals living in close proximity to human settlement (Mallon 2017). They avoid densely wooded area sand inhabits undulating plains with grass and patches of scrub (Schaller 2009), and often encountered in agricultural crop fields raiding crops (Chauhan & Singh 1990). They are both grazer and browser, but grasses constitute bulk of its diet (Mirza & Khan 1975, Sankar & Vijayan 1992). Blue bull is one of the most commonly seen wild animals in agricultural land. It prefers area with short bushes; scrub forests with scattered trees, grassy plain and hilly areas with shrubs but hardly occurs in dense forest, though they commonly eat woody plants in the dry tropical forests. The highest population of blue bull was in the forests community and is lowest in cultivated land. In open field they feed throughout the night and during the day retreat to the cover of forests in agricultural areas (Bohra et al. 1992). Blue bulls are found in the plains, hillsides, arid areas, grassy steppe woodlands, scrub areas, flood plains, dry deciduous forests, and agricultural areas outside of Nepal's protected area network; where they compete for resources with human populations (Aryal 2007). In Rupandehi District of central lowland Nepal, they are found in riverine forest, community forest, grassland and agricultural field. In Nepal, especially in the districts of Rupandehi and Kapilvastu, they were distributed in open vegetation types (Aryal 2001). Destruction and lack of food, the no of blue bull were much reduced in Lumbini as well as surrounding areas further reported by (Aryal et al. 2016).

Behavioral studies focus on how an organism responds to their physical, social and biological environments and the reactions they realized to shape up their survival strategy through the action of natural selection and sexual selection. Behaviors are variable between individuals in terms of forms and frequencies. Blue bull are tolerant to their ungulates and can be seen feeding with cow and buffalo. These animal frequent between open grassland and light jungle, seldom penetrating into heavy forest. Blue bull (*Boselaphus tragocamelus*) is considered a pest animal as it is destroying many crops both by trampling and eating plants and its damage is more in fields that are close to forest areas. Blue bull harshly affects trees and timber resources by feeding upon tree bark and flowers.

Rupandehi and Kapilvastu districts are possible for blue bull habitats but conservation measures have not been taken which leads higher decline in the population of blue bull (Subedi 2001). It is necessary to figure out blue bull habitats and their carrying capacity. A translocation program may even be needed to move the animals to other favorable places in the country, if the population overreach the habitats carrying capacity. This activity will help to reduce the crop damage caused by blue bulls that is faced by local people. The aim of this study was to explore the habitat preference and the activity patterns of blue bull in various hours of the day in Lumbini Development Area (LDA), Rupandehi, Nepal.

1.2 Research objectives

The general objective of this study were to determine the habitat preference and general behavior of blue bull (*B. tragocamelus*) in Lumbini Development Area, Rupandehi District, Nepal.

The Specific objectives were

i. To determine the dry season habitat utilization of blue bull in Lumbini Development Area.
ii. To assess the behavioral activity time budget of blue bull in Lumbini Development Area.

1.3 Significance of study

Blue bull is one of the important wildlife species and is not a protected species. Blue bulls are found near human settlements and crops and fields outside the protected areas. There are much important flora and fauna are found but less understood by local people. Day by day the flora and fauna are being exhausted due to over exploitation, pollutions, habitat destructions, poaching and human and livestock pressure in their habitat. Blue bull preference to the open farmland has produce the major challenges for the wildlife managers and local farmers. Blue bull human conflict increases, if human settlement continues unabated. The local people were quite proactive about guarding their fields with all the potential damage caused by blue bull. Few research has been done about blue bull in Nepal and research activities on blue bull outside the National parks and wildlife reserve almost negligible. Thus the present research are very important baseline for the identification and prediction of the blue bull activities, Habitat

preferences by blue bull and try to find out the management strategy used by local people to stop crop depredation in this area.

1.4 Limitations

Research was done for thesis work in limited budget. For the research, equipment's like Binoculars, cameras, GPS were used. Mostly mobile camera was used. High quality zoom lens camera was not used. Behavior activities and habitat of blue bull was done for one season only. Night observation could not be done. Heavy rainfall limits the access of all area inside the LDA.

2. LITERATURE REVIEW

2.1 Habitat preference of blue bull

Blue bull is a habitat generalist but tends to occur in thin bush with scattered low trees or alterations of scrub and open grassy plains, rarely in thick forests but often on cultivated areas (Blanford 1888). They can be found in a range of habitats, including as flat ground, undulating hills, thin brush with scattered trees, and cultivated plains, but they cannot be found in deep forests or on steep slopes (Blanford 1888). The largest Asian antelope, the blue bull is native to Peninsular India, (Leslie 2008). The portion of Pakistan, and a small portion of Nepal; Bangladesh no longer has any blue bulls. They were also introduced to Mexico, South Africa, Italy, and Texas in the United States (Texas). The blue bull inhabit scattered shrub lands and open grasslands in their natural habitat in India, and they are infrequent visitors to densely wooded regions (Blanford 1888). According to previous research in South Texas, they are frequently found in open pastures, scrublands, and coastal prairies (Ables & CW 1974).They can be found in a range of environment, such as flat land, undulating hill, thin bush with scattered trees and cultivated plains but are not found in dense forests and steep slope (Blanford 1888). (Khursid A. Khan 2016) found that the numbers of nilgai reported by villagers in their areas in each location were compared with the observed data in each locality. The results were found insignificant ($Z=-2.547$, $p=0.01$) because the number of nilgai reported by people was found substantially higher than that of observed in the field. This suggests that the figures reported by villagers appeared to be exaggerated.

In agricultural areas, it will feed throughout the night in open fields and retreats to the cover of forests during the day (Prajapati & Singh 1994). They have a direct effect on the local livelihoods of the farmers in land; destroy large quantities of agricultural crops and vegetables due to which Human blue bull conflict arises (Aryal 2007). Outside of protected areas, blue bulls can be seen close to populated areas, farms, and fields. Blue bull is one of the largest Asian antelope, prefers open habitat. In Nepal they are distributed throughout Terai. Khatri (1993) estimated total 57-86 individuals in nine different semi-isolated sub- population in and around RBNP during 1992-1993, reflecting a decline of 80-90%, since the 1970's whereas (Dinerstein 1979) estimated about 200 blue bull in 45 km^2 of savanna grassland in Karnali Bardiya using line

transect method. Chinkara and blue bull are two major competitive antelope species and are distributed in scrubland, open woodland, dry deciduous forests and dune areas (Goyal & Rajpurohit 2000, Rahmani et al. 2001). This is because of similarity in their resource use (Bagchi et al. 2003). Outside of Nepal's network of protected areas, the blue bull (*Boselaphus tragocamelus*) can be found in plains, hillsides, arid regions, grassy steppe woodlands scrub areas, flood plains, dry deciduous forests, riverine forests, and agricultural areas, where they compete with human populations for resources (Aryal 2007). They are also present in lowland protected areas such as Bardia National Park (BNP), Parsa Wildlife Reserve (PWR), Suklaphanta Wildlife Reserve (SWR), and Koshi Tappu Wildlife Reserve (KTWR). Blue bull has a substantial habitat in Nepal's Rupandehi District. Here, the species utilizes agricultural fields, plains, grasslands, and riverine and community forests (Aryal 2007). Bagchi et al. (2003) reported the blue bulls are frequently seen foraging in agricultural areas and are commonly dispersed along woodland boundaries. Gajera et al. (2014) found that out of the total population of blue bulls that have been observed, 73.07% have been found in forests, 23.7 % in grasslands, 2.8 % in agriculture, and one has been spotted in a wetland found that the highest number of blue bull were spotted in the community forestry (107), followed by cultivated land (71), riverine forest (85), and grassland. (Aryal 2007) found that 79% of the potential habitat of Blue bull is covered by forest and the other 21% is grassland or open land. During the field survey, all blue bulls were seen in the forest and not in open land. Generally Blue bulls use open grassland for grazing. Approximately 43% of the study area had dense crown cover (75-100%), 27% had moderate crown cover (50-75%), 14% had sparse crown cover (25-50%) and the remaining 16% had very sparse crown cover.

2.2 Ecology and behavior of blue bull

Very few studies have been done on the blue bull's activity habits in natural condition (Oguya & Eltringham 1991, Goyal & Rajpurohit 2000, Rahmani et al. 2001). Bawri and Saikia (2014) found that a scan animal sampling was used for sampling the activity budgeting. All herds' diurnal activity patterns were examined, and it was showed that feeding activities took up a disproportionately larger amount of time than other activities. The concept of activity time budget in social animals, especially of diurnal nature, based on the hypothesis, that the daylight time available is a limiting factor to

carry out the maintenance activities as well as social activities (Altmann & Samuels 1992).

Regmi and Chalise (2019) found that animal spent more than 55% of diurnal time in grazing, 29% in rest and 12% of the time in wallowing. Open land (grazing) and forest area (rarely-grazing) are the significant difference in food item present. They prefer to graze on open land near the bank of river. Their local people are positive for the conservation of blue bull. Shah et al.(2017) found that they spent most time grazing and looking for food, followed by resting and wallowing, while sleeping was the activity with the least individuals (15), as well as the shortest duration of time. Prabhakar and Prasad (2020) found that some degree of nocturnal activities has been observed as Nilgai migrate for food and water towards agricultural lands and periphery of the village's areas during dusk and returned to places with less human activities during dawn.

3. MATERIALS AND METHODS

3.1 Study area

Lumbini is one of the best world heritage sites of Nepal which occupies 7.7 km^2 area. Lumbini is located in Rupandehi District, Lumbini Province in the Terai region of Nepal. Lumbini Development Area lies in the Lumbini Sanskritic Municipality. LDA was formed by the Lumbini Development Trust Act 1985 for the purposes of restoring the Lumbini Garden under the master plan. Geographraphically, Lumbini Development Area (LDA) lies at longitude 83 48’72’’E and latitude 27.48’72’’N. The elevation of LDA is located 150 m (490 ft.) above sea level.

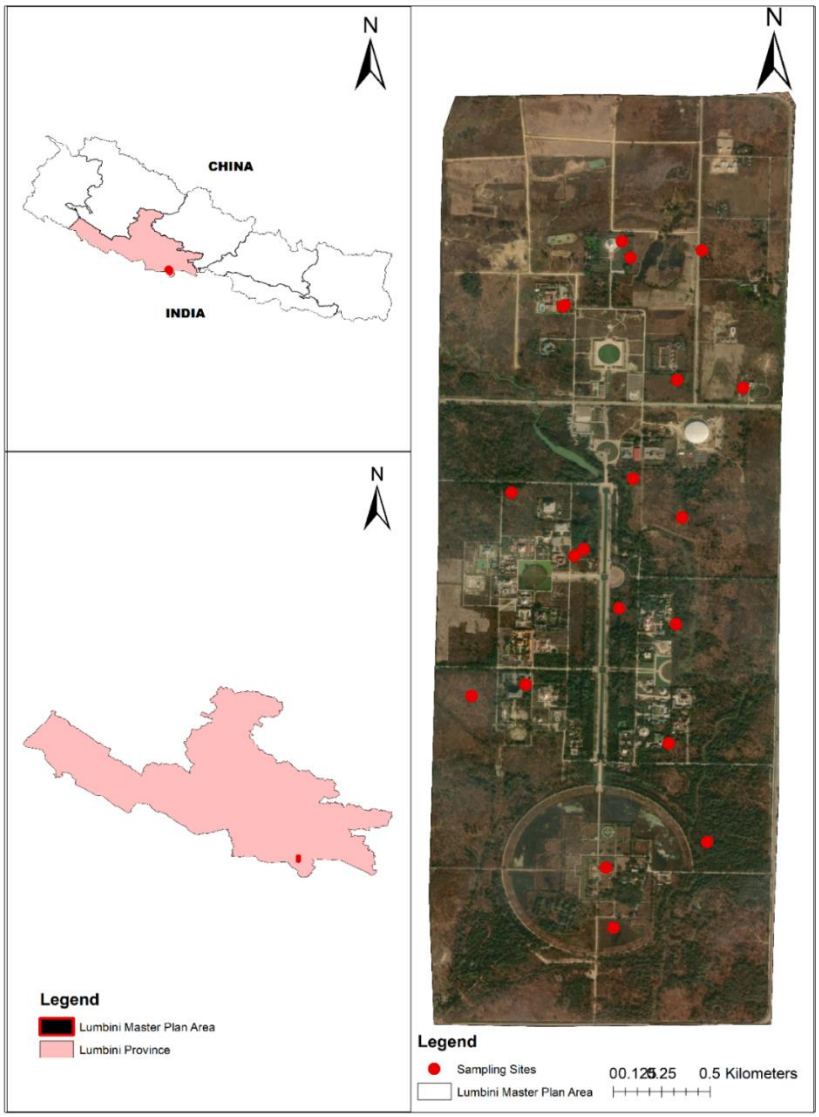

Figure 1. (a) Map of Nepal showing Rupandehi District; (b) Map of Rupandehi showing LDA; (c) Map of LDA showing sampling survey

3.1.1 Physical features

The LDA is 4.8 kilometers long and 1.6 kilometers wide. The Lumbini site was originally bordered by a large monastery zone, in which only monasteries may be constructed. However, after the master plan's implementation, the area was divided into three sections: the Scared Pond Zone, the Lumbini Village Zone, and the Monastic Zone. In the Lumbini village zone, hotels, restaurants, a helipad, and public parking have grown. The holy site of Lumbini has ruins of ancient monasteries, a scared Bodhi tress, an ancient bathing pond, the Ashoka pillar and the Mayadevi Temple, where the supposed place of birth of Buddha is located. From early morning to evening many pilgrims from different countries perform chanting and meditation at the site.

3.1.2 Climatic features

Lumbini has a humid subtropical, dry winter climate. Lumbini typically receives about 106.2 millimeters (4.18 inches) of precipitation and has 80.55 rainy days (22.07 % of the time) annually.

3.1.3 Biological characteristics

The garden of LDA contained a total of 65 different tree species (angiosperms and gymnosperms), nine of which were unnamed. *Callistemon citrinus* and *Albizzia lebbek*, which accounted for 2.8 percent and 1.98 percent of the total number of tree stands, respectively, and *Dalbergia sisoo*, which accounted for 85 percent of all tree stands, are the next two most prevalent tree species (Bhattarai et al. 2007). In LDA, 79% of the potential habitat for the blue bull is covered by forest, while the remaining 21% is grassland or open land. Roughly 43% of the study area had dense crown cover (75-100%), 27% had moderate crown cover (50-75%), 14% had sparse crown cover (25-50%), and the remaining 16% had very sparse crown cover. The garden has a diverse range of flora and wildlife, with both terrestrial and aquatic vegetation present.

The terrestrial habitats of the garden are characterized by grasslands and areas of wooded wood land. Forested areas primarily consist of *Dalgergis* and *Sisoo* (DDC, 2000). A total of 238 bird species, including the endangered sarus crane, 30 reptile species, 13 mammalian species, and 6 amphibian species have been identified (DDC, 2013). Blue bulls and jackals (*Canis aureus*), which are animals, are widespread.

3.1.4 Land use and cropping pattern

In Rupandehi, 87.37 percent of the land is used for farming, forestry, and pastures, and an additional 10 percent is set aside for other uses including residential construction and real state. The entire 85,122 hector of cultivable land is khet (low land), and it is farmed. Seasonal irrigation is used to irrigate 56 percent (3387.80 hector) of the cultivable area. Only 3.98 percent of the land is permanently irrigated; the remainder (34067.20 hector) is fed by rainfall.

The majority of the land outside the area is used to grow agricultural crops, however after the conflict between the Moist and the government, many people migrated to that area from the hills, changing the land use pattern slightly while still occupying many agricultural fields. In the summer, the majority of crops are grown, including rice (*Oryza sativa*), while in the winter, the majority of crops are grown, including wheat (*Triticum aestivum*), mustard (*Brassica compestries*), peas *(Pisum sativum),* gram *(Cicer arietinum*), and vegetables.

21.56 percent (30484 hector) of the district is covered by forest. The district's forestland is shrinking; over the past 21 years, 6,000 hectares of forest have been lost. In the district right now, 49 community forests organizations are functioning (District profile, 2014/15).

3.1.5 Agriculture

Agriculture is the major occupation of people living in Rupandehi District. In 2011, Rupandehi District produced more rice than any other district of Nepal, contributing to 15.7% of the total rice production of the country.

The district's main agricultural products include paddy, wheat, corn, finger millet, and pluses. Mango, banana, litchi, and jackfruit are the main /horticulture crops, and onion, cabbage, tomatoes, radish, cauliflower, potatoes, cucumber, and pumpkin are the main vegetables.

3.2 Materials

Following equipment’s were used during the field study.

- GPS
- Ethogram

- Measuring tape
- Field guide book
- Map of the study area

3.3 Methods

Primary data were collected to assess the habitat utilization and general behavior of blue bull in Lumbini. The primary data was collected through direct field observation, indirect evidence collections.

3.3.1 Preliminary survey

Before starting the survey, a field visit of the study area was carried out. Main objective of the visit was to become familiar with different features of the study area such as geography, local community, types of flora and fauna found. The direct observation was done with unaided eye and further observation was done with the help of camera and binocular. The study area was visited by bus, motorcycle and on foot. Preliminary survey was done in February, 2022.

3.3.2 Data collection for habitat preference of blue bull

The study area was divided into the blocks of each 500 x 500 m^2 and was assigned the numbers from 1 to 20. Total 10 of those blocks were randomly selected. Blocks were digitized by using ArcGIS 10.4. Line transect method was used as the tool for finding out the population of blue bull. Altogether 20 line transect were made ranging from 200m–300m which covers blue bull habitat areas. Data on habitat use, time budget, activity pattern and movements of free ranging blue bull were recorded. The data collection was conducted in 29 February 2022 to 31 March 2022. During research time they were found active in grazing in the morning and evening so direct observation method was done based on fresh plants being eaten, and fresh clipping by blue bull.

3.3.4 Behavior sampling of blue bull

Behavior was observed daily from 7:00 AM in the morning to 5:30 PM dividing into three shifts of each three hours- 7:00–10:30; 10:30–2:00; and 2:00–5:30 PM. During this study, behavioral data were obtained by the ‘Focal Animal Sampling’ and ‘Scan Sampling’ method (Altmann 1974) were employed to record the blue bull behavior. In

focal sampling method an individual from a group of animals is selected and all behavior is recorded for specific period of time. During the observations, the activity of a focal animal was recorded for 10 minutes using focal animal sampling technique (Altmann 1974). A well identified animal was observed for an observational shift of three hours as mentioned above and all interactions involving that animal were recorded during this specific period while activities of other animal of the group were not recorded. Total duration of focal sampling of blue bull was 154.5 hours. This process was repeated daily during the field study that lasts for approximately 10:30 hours from Feb 29, 2022 to Mar 31, 2022. Behavior was broadly divided and further regrouped into five major categories of behavior such as feeding (grazing), locomotion (moving), resting (standing, sitting, lying, sleeping), alert, and also other activities such as running, fighting etc. encompassed a category of other activities. The proportion of time spent in each category of behavior is referred to as the activity budget. The data on time spent on different activities such as grazing, locomotion, resting, alert and other activities were recorded using the ethogram as specified in the Table 1. An individual of blue bull was recognized by sex (male, female, juvenile and infant) was distinguished by their body color, size and genital parts. Observations were done from hidden points in bushes and trees in potential areas to avoid direct disturbance to the animals.

Table 1. Ethogram of behaviors sampled during the study

Behavior	**Definition**
Resting	Animal is lying on the ground and in inactive state.
Alert	Standing, ears raised to perceive some external stimuli
Locomotion	Animal is moving/walking without any accompanying behavior
Running	Moving at a speed faster than a walk
Grazing	A condition in which animal feeding on grass in the field
Fighting	Engage in physical combat with another member of the herd

3.4. Data analysis

3.4.1 Land use land cover analysis and habitat preference

Using Google Earth, a polygon was drawn to cover the entire Lumbini Master Plan area. The extracted kmz file was converted to a layer and then to a shape file. The classified land use land cover data of 10m resolution from Microsoft and ESRi 2021was used to quantify the habitat types. A land use map for the study area was extracted and classified into seven major categories: water bodies, forest, grassland, flooded vegetation, agricultural land, shrub land and built up areas. All of the different types of habitats in the study area were colour- coded to make a land use map.

Microsoft excel (2016) was used to analyze the obtained data on animal population statistically. Charts, tables, bar diagrams, pie chart etc. were used to present the data in most simplified and understandable form. ArcGIS version 10.4 was used to construct the geographical map.

3.4.2 General behavior

ANOVA test was done to test the similarity of behavior in different observational phases of day. ANOVA test was used to determine whether there is a statistically significance difference in foraging/ grazing, resting, locomotion and alert behavior of blue bull in different phase of a day. $P < 0.05$ was considered for significant results.

$$F=MST/MSE$$

Where,

F= ANOVA Coefficient

MST= Mean sum of squares due to treatment

MSE= Mean sum of squares due to error

T- Test was used for comparing focal animal sampling and scan animal sampling to test the differences of behavior in different time period.

$$t = \frac{m - \mu}{s/\sqrt{n}}$$

Where, t= students t- test

m=mean

u= theoretical value

s= standard deviation

n= variable set size

4. RESULTS

4.1 Habitat of blue bull in the Lumbini Development Area

4.1.1 Available habitat types in the area

The Lumbini Development Area (LDA) had seven major land cover types- were forest, shrub land, built up area, agricultural land, grassland, flooded vegetation and water body (Fig. 2). The highest land area of the LDA was occupied by the forest with 44.4%. It was followed by shrub land with 18.92%, built up area with 17.73%, agricultural land with 8.88%, grassland with 7.14%, flooded vegetation with 1.93% and water body with 1%, respectively.

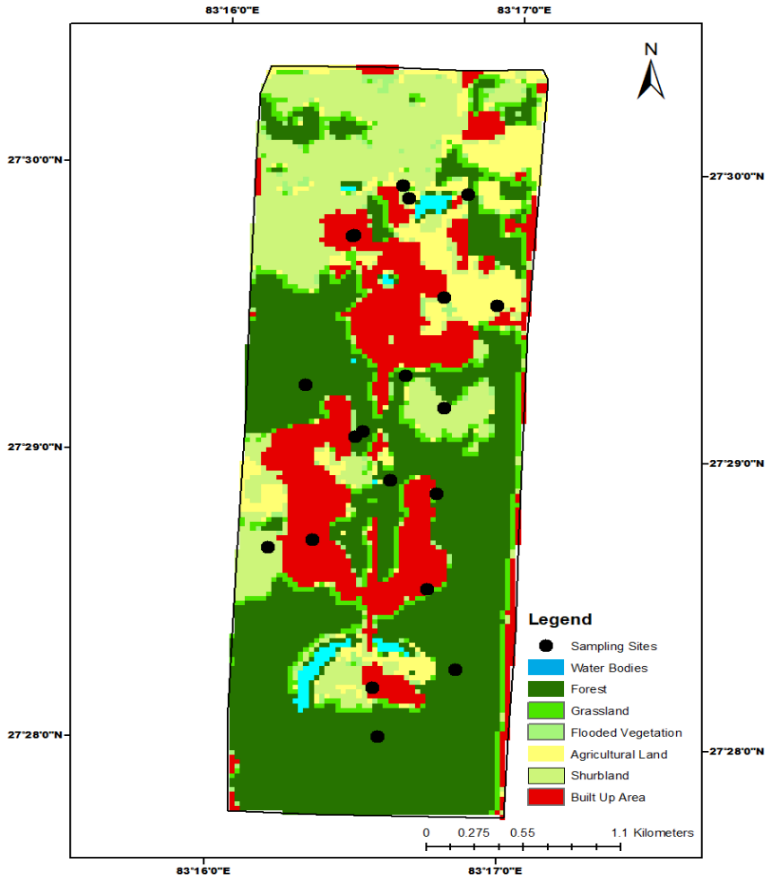

Figure 2. Land use land cover analysis of the LDA showing the major habitat types in the study area

4.1.2 Habitat use by the blue bull in the LDA

A total of 73 individuals of blue bull were recorded during the study period along the 20 line transects. Among which, 24 were males, 29 were females and 20 were calves.

Out of total recorded population of blue bull, more than half (52.05%) were observed in the grassland followed by the forest and agricultural land (Fig. 3).

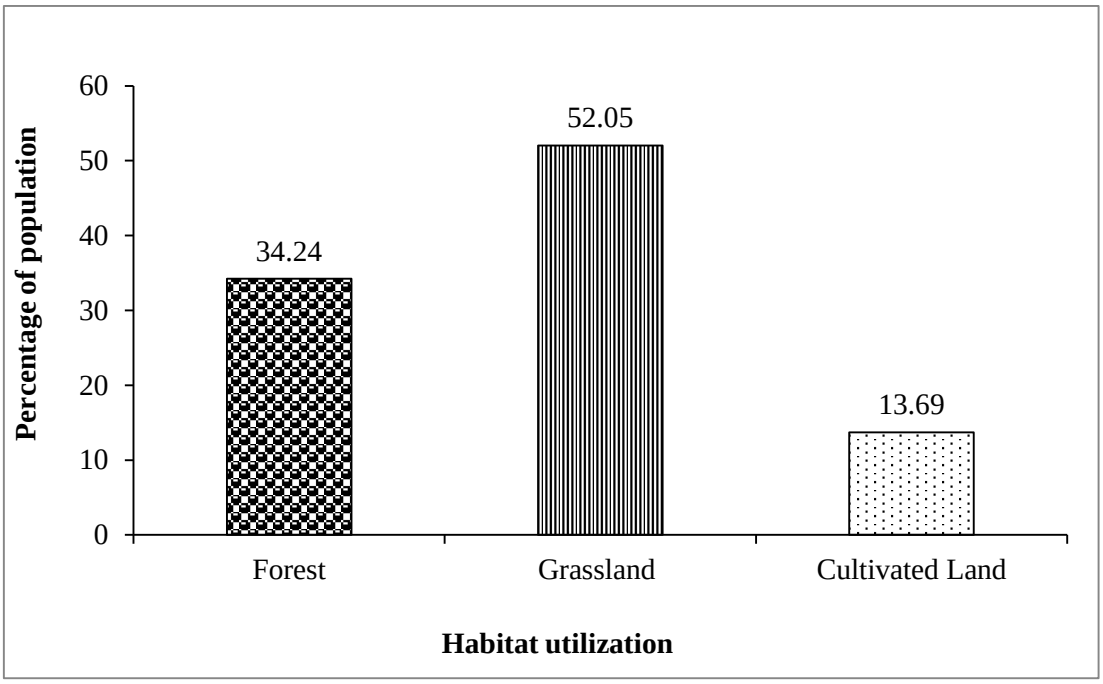

Figure 3. Percentage of population of blue bull in different habitat.

4.1.1 Habitat preference of blue bull by the gender

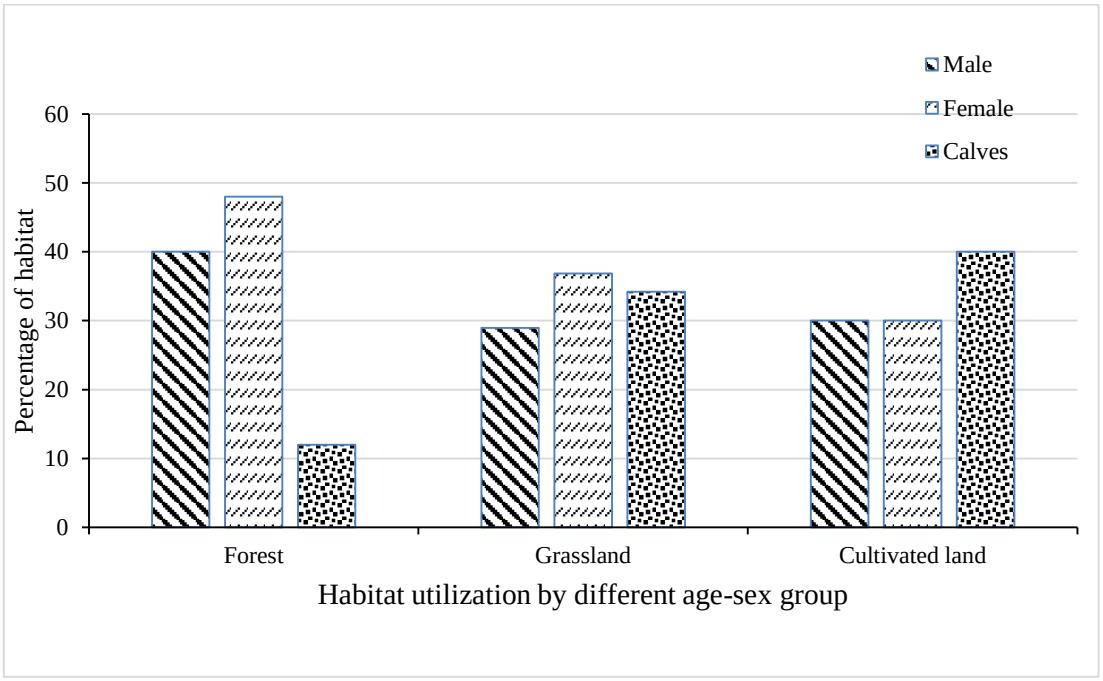

Figure 4. Habitat utilization by different age-sex groups of blue bull in the LDA

4.2 Diurnal activity pattern of blue bull

Blue bull spent more time on foraging/grazing behavior which occupies 39% of total behavior of blue bull. Similarly this study found that blue bull spend 27% time on resting behavior, 23% in locomotion. They spend quite similar time for alerting behavior accounts 8% of total time while they spent less time (3%) on other behaviors (running, play, fighting etc.).

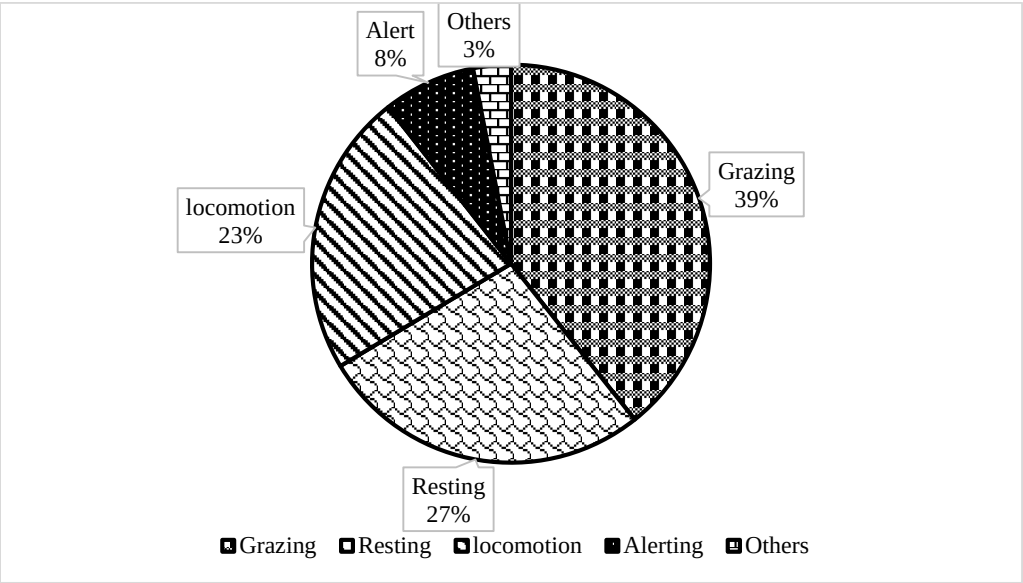

Figure 5. Percentage of time spent in major activities by blue bull as observed by the focal animal sampling method

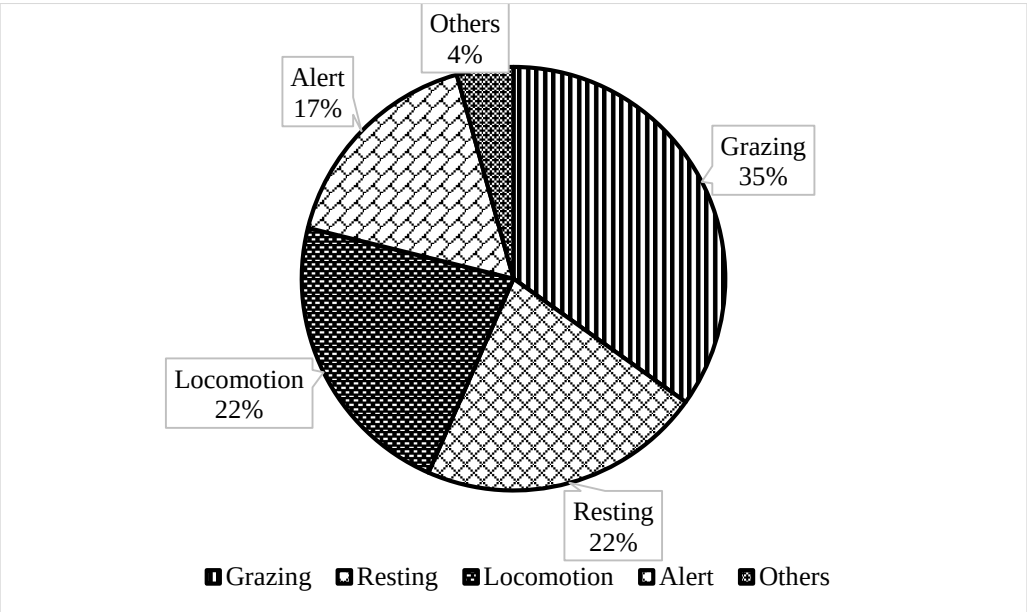

Figure 6. Percentage of time spent in major activities by blue bull as observed by the scan animal sampling method

Comparison between focal animal and scan sampling methods revealed that there is significant difference in the observation of blue bull behavior by two methods (Paired two-sample t-test, t= 2.641, P= 0.022).

4.2.2 Behavior of blue bull in different observational phases of day

Foraging/grazing was the highest behavior shown by blue bull in morning (7:00 – 10:30) which accounts for nearly 27.14%. Blue bull spent 26.03% time on locomotion, 24.60% on resting, 22.91% on alert respectively.

In afternoon time (10:30 to 2:30) alert is the highest behavior shown by blue bull accounts for 44.47% followed by resting (41.48%), grazing (33.72%) locomotion (31.97%) and respectively. In evening time (2:30 to 5:30), blue bull spent more time on grazing behavior (nearly 40.98%) followed by 40.12% on locomotion 33.90% on resting, 32.61% on alert respectively.

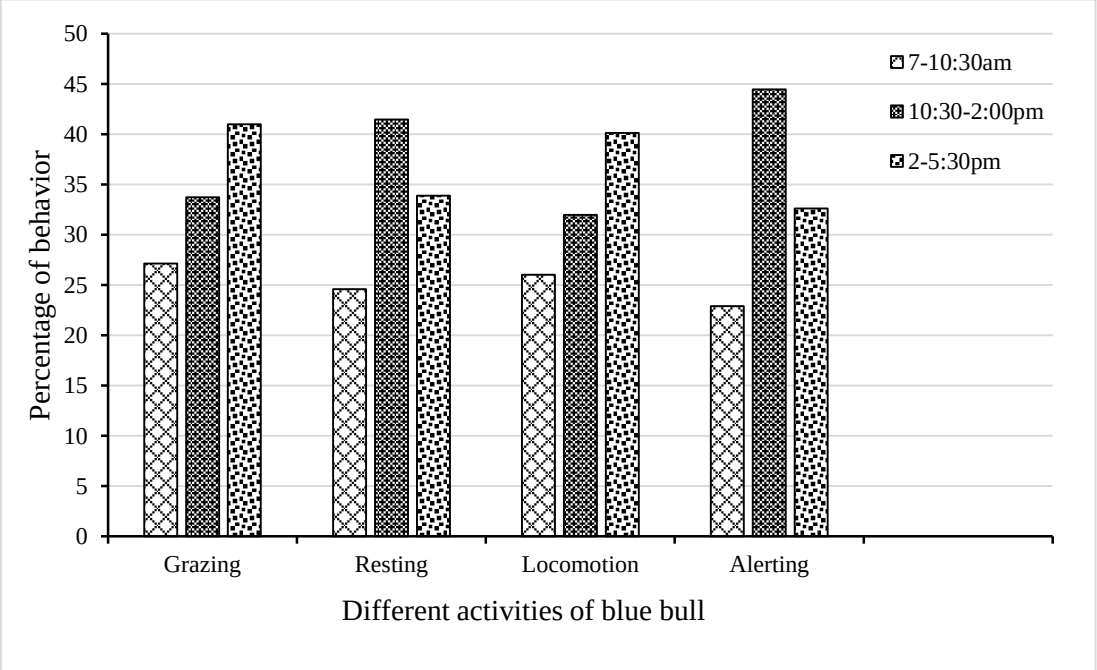

Figure 7. Percentage behavior of blue bull during different observational phases of the study period.

ANOVA revealed significant difference on locomotion of blue bull of three observational phases (f=5.002, df =2, 42, p=0.01). However, difference were not significant in the behaviors.

Table 2. Result of ANOVA test of different behaviors during three observational phases of the days

Behavior	Df	F	P-Value	F crit
Grazing	2,42	27.64995	2.177E-08	3.219942
Resting	2,42	22.37663	2.422E-07	3.219942
Locomotion	2,42	5.002004	0.011258	3.219942
Alert	2,42	2.148356	0.1293249	3.219942

5. DISCUSSION

5.1 Habitat availability and utilization by the blue bull

Blue bull's use of a place was strongly positively influenced by the amount of forest area and human disturbance. The present study shows that while carrying out the behavioral studies of blue bull, based on the total number of animal observation (73), the patterns of habitats use at LDA found that the grassland was most utilized by the blue bull (52.05%). This present study indicated that out of the total population of blue bull, 34.24 % recorded in forest, 52.05% in grassland and only 13.69% in agricultural land. The most preferred habitat of blue bull was grassland with less disturbance of any kind due to human activity rather than forest and agricultural land because of fencing work, was carried out in forest area as well as due to chances of predation especially by fox and Jackal in dense area. Likewise in cultivated land harvesting of mustard pant and some other activities related to crop harvesting (wheat, potatoes etc.) was going on by the local people as well as also some of the farmers were grazing their cattle's around the agricultural field according to observations made during the field survey. Nearly 70% of the habitat used by the blue bull in Lumbini area of Central Lowland Nepal, is composed of forest area followed by grassland (Aryal 2007). Additionally, blue bulls were observed in farmed regions in the Rupandehi district of central lowland Nepal as well (Khanal et al. 2018), showing their broad tolerance to human disturbance. The positive relation between the human disturbance measure and site use may be explained by the adaptability to human use areas and cultural tolerance seen in previous studies (Karanth et al. 2009). Sheffield et al. (1983) reported that blue bull prefer open grassland with patches of cover and scattered ponds for feeding which is similar to my present study. (Gajera et al. 2014) found that out of the total population of blue bulls that have been observed, 73.07% have been found in forests, 23.7 % in grasslands, 2.8 % in agriculture, and one has been spotted in a wetland which is quite different from the present study.

5.2 Diurnal activity budget of blue bull

Behavior is the response of both the physical as well as habitat condition of animals. It varies from habitat to habitat depending up on the resource availability. The ecological functions of blue bull are distinctive and may be advantageous in a variety of ways. In

LDA Area, Nepal, a study was done to learn more about the behavior of blue bull (*Boselaphus tragocamelus).* The present study indicated that blue bull spent maximum time in grazing, resting and locomotion activities, and there was no records of grooming and ruminating activities during the study period. The present result of diurnal activity pattern of blue bull of behavioral time budget shows that the grazing time was highest (39%) followed by resting (27%), locomotion (23%), alert (8%) etc. On the other hand, comparatively the behavior of blue bull in different observational phases of day show that blue bull spent maximum time on alert (44.47%) in afternoon (10:30 -2:00 pm) followed by resting (41.48%) in afternoon, grazing (40.89 %) and locomotion (40.12%) in evening (2- 5:30 pm). In this present study time spent on different activities showed significant difference on locomotion of blue bull of three observational phases (f=5.002, df= 2, 42, p=0.01). The basic activities like feeding, resting, locomotion, fighting, alert, running differ according to different observational phases of the day. Feeding activity was found the major activity profile i.e. maximum feeding activity was found in morning and evening while minimum was found in day light time. Similarly, maximum locomotion was recorded in evening and minimum was in day time. Afternoon holds the maximum resting and morning and evening time period hold the minimum. For alert, maximum time was found in afternoon and evening and minimum was in morning time. Blue bull engaged maximum time in feeding during 7:00 to 10:30 am and 4:00 to 5:30 when the temperature was low, while blue bull spent the greatest amount of time in resting in between 12:00 to 3:30pm as temperature increases during the day time. It is found that the walking activity pattern was maximum during the evening hours in both male and female. The present study shows that the pattern of docility indicates that females graze with young ones (calves). Females and calves in the current study did not engage with males very much. Male blue bull was seen in a scattered form, whereas females were relatively social and grazing in groups with calves.

Regmi and Chalise (2019) found that animal spent more than 55% of diurnal time in grazing, 29% in rest and 12% of the time in wallowing which is similar to the present study. Intense feeding or grazing and locomotion or moving of blue bull as like in most of the diurnal herbivores in tropics occur early in the morning and later part of the day with a long resting period at the noon (Chivers 1969).The present studies indicated activity budget would have implication to habitat management with respect to animal

behavior and food requirements. They are found to perform daily activities such as grazing, resting, locomotion, alert etc. interactions around the territories mainly at open areas with tall and short grasslands mostly in proximity to water-logged sites, and scrub or forests. Habitat condition is also a factor for variations in behavioral time budget at different observational phases which was noted to differ with the opening of the dense grassland. There were some observations of the daily active period of blue bull that was affected by other factors such as human disturbances so blue bull become highly sensitive and change the activity spontaneously. Besides that, the presence of other species such as domestic buffaloes, cattle, and cow affect on behavioral activities pattern in long run through the sympatrism because sympatric species share the diet, space and intervene in social activities. Since blue bull's day hours consists of portions of time to spend in grazing, resting, locomotion between food sources and essentially the social interactions, this is also true for many of the diurnal animals in performing such behaviors. Behavioral activities of the blue bull are directly related to the nature and frequency of the anthropogenic activities which affect the natural behavior of blue bull as like in other herbivorous animals.

6. CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The major land use and land cover type of the Lumbini Development Area (LDA) is forest (44.4%) followed by shrub land (18.92%), built up area (17.73%), agricultural land (8.88%), grassland (7.14, flooded vegetation (1.93%) and water body (1%). In the present study blue bulls were observed mainly in patches of grassland inside the forest. The most preferred habitat of blue bull in the LDA was grassland (52.05%) despite the major available habitat. Higher population of blue bull were found in grassland. Low preferences to dense area could be associated to the adaptive behavior of the blue bull against predation.

Adult animals were selected for sampling as a focal animal since it has influences upon others in performing their activities including ranging behavior. ANOVA was applied to evaluate the activity budgets of the different focal animals. Different categories of behavioral activities were tested for significance of time budget with the percentage of time devoted to each of the activities. Significance was set at $p < 0.05$ for all statistical tests. The data on time spent on different activities were analyzed for observational phases among different activities.

This present results showed that blue bull highly graze in evening rather morning and afternoon. Feeding activity was found the major activity profile of the blue bull and that peaked during the evening. The peak hours of walking were evening. The activity of blue bull was also affected or dependents on the human presence. This indicates that human presence is also one of the element which regulate basic activities of the animal. To turn the blue bull into a domestic animal rather than an agricultural pest, more thorough research is needed to understand the ranging pattern, feeding, migrating, reproduction, milking, and parental care in the wild state.

6.2 Recommendation

The population of blue bull at LDA is decreasing day by day. Based on the present research and its conclusion, following recommendations are made for the consideration by concerned authorities for the long term survival of blue bull in LDA.

1. Develop a project plan with the community to improve an understanding of blue bull, their importance for religious, ecological and environmental reasons which may help the local people to be motivated about the awareness for blue bull conservation.
2. For the behavioral study of blue bull, nocturnal activities could not be recorded due to technical and security problems for night observation.
3. Behavior activities and habitat of blue bull could not be studied seasonally but it could be studied which may be helpful for further research study.

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PHOTO PLATES

Photo a. Female blue bull standing

Photo b. Blue bull grazing on grassland

Photo c. Blue bull browsing parts of a plant

Photo d. Female blue bull with calve

Photo e. Male blue bull standing

Photo f. Male blue bull grazing in grassland

Photo g. Female blue bull resting along with the calf

fig .h. Dung of blue bull

APPENDIX

Day 1 **Focal Animal Sampling**

Date: Feb 29-2022

Start Time	End Time	Behavior (if anything extra)	Time

Focal animal sampling data per day

DAY 1							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	36min	15min	28min	12min	O	0	0
10:30 a.m. to 2:00 p.m	46min	42min	22min	34min	0	10min	0
2:00 p.m to 5:30 p.m.	57min	35min	62min	12min	0	12min	0
DAY 2							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	42min	18min	18min	12min	0	10min	0
10:30 a.m. to 2:00 p.m	38min	34min	22min	7min	0	0	0
2:00 p.m to 5:30 p.m.	55min	24min	30min	8min	0	7min	0
DAY 3							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	32min	35min	21min	5min	0	0	0
10:30 a.m. to 2:00 p.m	52min	46min	25min	29min	0	16min	0
2:00 p.m to 5:30 p.m.	37min	32min	37min	15min	0	9min	0
DAY 4							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	42min	18min	32min	8min	0	0	0
10:30 a.m. to 2:00 p.m	48min	45min	23min	15min	0	7min	5min
2:00 p.m to 5:30 p.m.	36min	38min	38min	6min	0	12min	0
DAY 5							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	28min	36min	34min	6min	0	0	0
10:30 a.m. to 2:00 p.m	52min	46min	38min	18min	0	18min	0
2:00 p.m to 5:30 p.m.	56min	28min	36min	7min	0	0	0
DAY 6							

Time Period	Grazing	Resting	Locomotion	Alert	Ruminating	Running	Fighting
7:00 a.m to 10:30 a.m.	42min	24min	22min	12min	0	0	0
10:30 a.m. to 2:00 p.m	39min	28min	35min	20min	0	0	0
2:00 p.m to 5:30 p.m.	52min	38min	37min	9min	0	0	0
DAY 7							
Time Period	**grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	32min	24min	10min	0	0	0	0
10:30 a.m. to 2:00 p.m	51min	32min	19min	12min	0	6min	0
2:00 p.m to 5:30 p.m.	55min	33min	15min	8min	0	4min	0
DAY 8							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	34min	22min	23min	5min	0	4min	0
10:30 a.m. to 2:00 p.m	42min	36min	42min	10min	O	0	0
2:00 p.m to 5:30 p.m.	57min	39min	32min	14min	0	0	0
DAY 9							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	34min	26min	26min	0	0	3min	0
10:30 a.m. to 2:00 p.m	44min	39min	35min	0	0	6min	0
2:00 p.m to 5:30 p.m.	59min	29min	19min	0	0	11min	0
DAY 10							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	29min	19min	15min	8min	0	6min	0
10:30 a.m. to 2:00 p.m	42min	34min	18min	4min	0	0	0
2:00 p.m to 5:30 p.m.	53min	24min	27min	12min	0	2min	0
DAY 11							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	23min	14min	16min	7min	0	0	0

10:30 a.m. to 2:00 p.m	48min	34min	13min	0	0	0	0
2:00 p.m to 5:30 p.m.	42min	23min	32min	0	0	0	0
DAY 12							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	36min	23min	12min	0	0	0	0
10:30 a.m. to 2:00 p.m	28min	34min	19min	8min	0	0	0
2:00 p.m to 5:30 p.m.	52min	23min	24min	7min	0	3min	0
DAY 13							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	23min	16min	23min	0	0	0	0
10:30 a.m. to 2:00 p.m	39min	38min	16min	0	0	0	0
2:00 p.m to 5:30 p.m.	56min	22min	25min	6min	0	0	6min
DAY 14							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	38min	22min	12min	5min	0	0	0
10:30 a.m. to 2:00 p.m	43min	37min	16min	0	0	0	0
2:00 p.m to 5:30 p.m.	58min	32min	23min	10min	0	0	0
DAY 15							
Time Period	**Grazing**	**Resting**	**Locomotion**	**Alert**	**Ruminating**	**Running**	**Fighting**
7:00 a.m to 10:30 a.m.	36min	16min	14min	5min	0	2min	0
10:30 a.m. to 2:00 p.m	42min	28min	19min	8min	0	0	0
2:00 p.m to 5:30 p.m.	55min	32min	27min	7min	0	6min	0

Sample Area	Male	Female	Calves	Total	Habitat Types
Beside Thai Monastery	1	2	0	3	Forest
Near Korean Temple	1	4	2	7	Grassland
East to Myanmar Golden Temple	1	1	0	2	Forest
East side to White Stupa	3	1	3	7	Grassland
Near to Kashi Hotel	1	1	2	4	Cultivated Land
Near to Chidiya Khana	1	1	1	3	Cultivated Land
Near Shanti Deep	1	3	0	4	Forest
Near Crane Santury	2	1	2	5	Forest
West side to Srilanka Temple	1	3	1	5	Grassland
East side to Srilanka Temple	1	1	0	2	Grassland
West side to Maya Devi Temple	1	1	3	5	Grassland
West side to white Stupa	1	1	1	3	Grassland
Beside Lumbini Electricity office	2	2	0	4	Forest
West to Kashi Hotel	1	1	1	3	Cultivated Land
Near Lumbini Hokke Hotel	1	1	2	4	Grassland
Near Lumbini Museum	1	1	0	2	Grassland
East side to Maya Devi Temple	1	1	1	3	Grassland
East to Linh Son Monastery	1	2	1	4	Forest
Beside France Buddhist Temple	1	1	0	2	Forest
Near Nepal Vajrayana Mahavihara	1		0	1	Forest
Total	**24**	**29**	**20**	**73**	