POPULATION STATUS, HABITAT PREFERENCE AND EXISTING THREATS TO HISPID HARE (*Caprolagus hispidus* Pearson, 1839) IN SHUKLAPHANTA NATIONAL PARK, KANCHANPUR, NEPAL

Submitted by:

Dipendra Joshi

T.U. Registration No.: 5-2-0061-0110-2011

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Submitted to

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

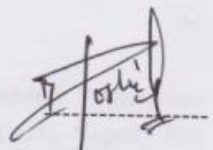
Kirtipur, Kathmandu

Nepal

May 2019

DECLARATION

I hereby, declare that this thesis work entitled **"Population Status, Habitat Preference and Existing Threats to Hispid Hare (*Caprolagus hispidus* Pearson, 1839) in Shuklaphanta National Park, Kanchanpur, Nepal"** is my own otherwise as acknowledged. I have not submitted it or any parts of it to any other academic institutions for any degree.



Mr. Dipendra Joshi

Date: 2076/02/06

TRIBHUVAN UNIVERSITY
01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

RECOMMENDATION

This is to recommend that the thesis entitled **"Population Status, Habitat Preference and Existing Threats to Hispid Hare in Shuklaphanta National Park, Nepal"** has been carried out by Mr. Dipendra Joshi for the partial fulfillment of Master's Degree of Science in Zoology with special paper Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

.....

Supervisor

Dr. Daya Ram Bhusal

Associate Proffessor

Central Department Zoology

Tribhuvan University

Kirtipur, Kathmandu, Nepal

Date: 2076/02/06

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CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

LETTER OF APPROVAL

On the supervision of Associate Prof. Dr. Daya Ram Bhusal, this dissertation submitted by Mr. Dipendra Joshi entitled **"Population Status, Habitat Preference and Existing Threats to Hispid Hare in Shuklaphanta National Park, Kanchanpur, Nepal"** is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirement for Master's Degree of Science in Zoology with special paper Ecology.

Prof. Dr. Tej Bahadur Thapa
Head of Department
Central Department of Zoology
Tribhuvan University
Kirtipur, Kathmandu, Nepal

Date: 2076/02/07

TRIBHUVAN UNIVERSITY
01-4331896
CENTRAL DEPARTMENT OF ZOOLOGY
Kirtipur, Kathmandu, Nepal.

Ref.No.:

CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mr. Dipendra Joshi entitled **"Population Status, Habitat Preference and Existing Threats to Hispid Hare in Shuklaphanta National Park, Kanchanpur, Nepal"** has been accepted as a partial fulfillment for the requirement of Master's Degree of Science in Zoology with special paper Ecology.

EVALUATION COMMITTEE

Dr. Daya Ram Bhusal	Prof. Dr. Tej Bahadur Thapa
Supervisor	Head of Department
Associate Professor	Central Department of Zoology
Central Department of Zoology	Tribhuvan University
Tribhuvan University	Kirtipur, Kathmandu, Nepal
Kirtipur, Kathmandu, Nepal	
External Examiner	Internal Examiner

Date: 2076/04/06

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Mr. Dipendra Joshi

Email: dipendrajoshi101@gmail.com

T.U. Registration No.: 05-02-0061-0110-2011

Examination Roll No.: 24

Batch: 2072/73

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF APPENDICES

LIST OF ABBREVIATIONS

Approx	Approximately
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
DFO	District Forest Office
DNPWC	Department of National Parks and Wildlife Conservation
gm	Gram
GPS	Global Positioning System
ha	Hactare
IUCN	International Union for Conservation of Nature
km	Kilometre
m	Metre
NTNC	National Trust for Nature Conservation
ºC	Degree Celcius
SNP	Shuklaphanta National Park
NOP	Number of Pellets
NOPG	Number of Pellet Groups
DW	Distance from Water
DV	Distance from Village
DR	Distance from Road
DMPL	Dominant Plant
HCT	Habitat Cover Type

ABSTRACT

Hispid Hare is one of the endangered mammals distributed in the foothills of Indian subcontinents. The present study was carried out in the Shuklaphanta National Park (SNP) to explore the present status, preferred habitat and potential threats to Hispid Hare. In order to explore these aspects of the biology of the species, a total number of 97 strip transects were laid in the field. Indirect observations were carried out within the transects and a questionnaire survey was conducted to find the conservation attitude of the local people. The pellet survey method was carried out to observe the presence of the species in the field and through the pellet density, the population density of the species was estimated of the study area. The population density of Hispid Hare was 0.156 individuals/ha during the study period. The preferred habitat of the species was found to the one having *Narenga porphyrcoma* (61%)) followed by *Impereta cylindrica* (18%) and *Sacchharum spontaneum* (10%) on the basis of pellet presence in the respective dominant vegetation. In SNP, unplanned grassland fire was the major threat to the species followed by poaching, overgrazing, flood and habitat fragmentation. Further study needs be conducted in SNP to explore the reproductive behavior, survival threats as well as genetic study is necessary about Hispid Hare.

CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1 Hispid Hare

Hispid Hare belongs to the order Lagomorpha and family Leporidae in which there are about 90 living species including 29 pikas, 32 hares and 29 rabbits. The order Lagomorpha is divided into two families: One is Ochotonidae that includes a single genus, *Ochotona* (the pikas) and the other, Laporidae includes the true hares (also called jackrabbits). The lagomorphs with greatest global distribution are the pikas and hares, although the rabbits express the greatest evolutionary diversity in the order. The genus *Caprolagus* is monotypic having only a single species, the Hispid Hare (Maheswaran 2002).

Hispid Hare (*Caprolagus hispidus*) is cited as an Endangered species (IUCN 1978) and is listed on Appendix I of CITES & DNPWC Act-1973 (Tandan 2009). It has been nationally listed as Critically Endangered due to restricted extent of occurrence and area of occupancy, single location with major threats affecting habitat area and quality (Sadadev 2018). Destruction of habitat because of overgrazing, thatch grass cutting, annual dry season burning (Maheswaran 2002), perennial invasion, invasion by exotic plants and local traditional hunting are increasingly the major threats to Hispid Hare. Also, the lack of knowledge and expertization is the reason behind the low conservation activities and status assessment of this endangered species. Hispid Hare is also called as Assam Rabbit or Bristly Rabbit. It is native to South Asia but it is facing the endangerment even in its home range.

1.1.1.1 Morphological features

The coarse, bristly coat is dark brown on the dorsal surface, due to a mixture of black and brown hairs, ventrally brown on the chest and whitish on the abdomen (Pearson 1839).This is also the reason it is also called the “Bristly Rabbit”. The tail is short (approx 30mm) brown throughout. The ears are also short, approximately 56mm (Bell 1986). This species has strong claws and large teeth. The hind legs of the species are short and stout, not often exceeding the length of the forelimbs **(**Ghose 1978, Burton and Burton 1988, Nowak 1999b).

The mean body weights recorded from the four sexually mature male and three female Hispid Hare was 2,248g (1,810-2,610g) and 2,518g (1,885-3,210g) respectively. The female weighing 3,210g was found pregnant while recorded (Bell 1987).

1.1.1.2 Distribution

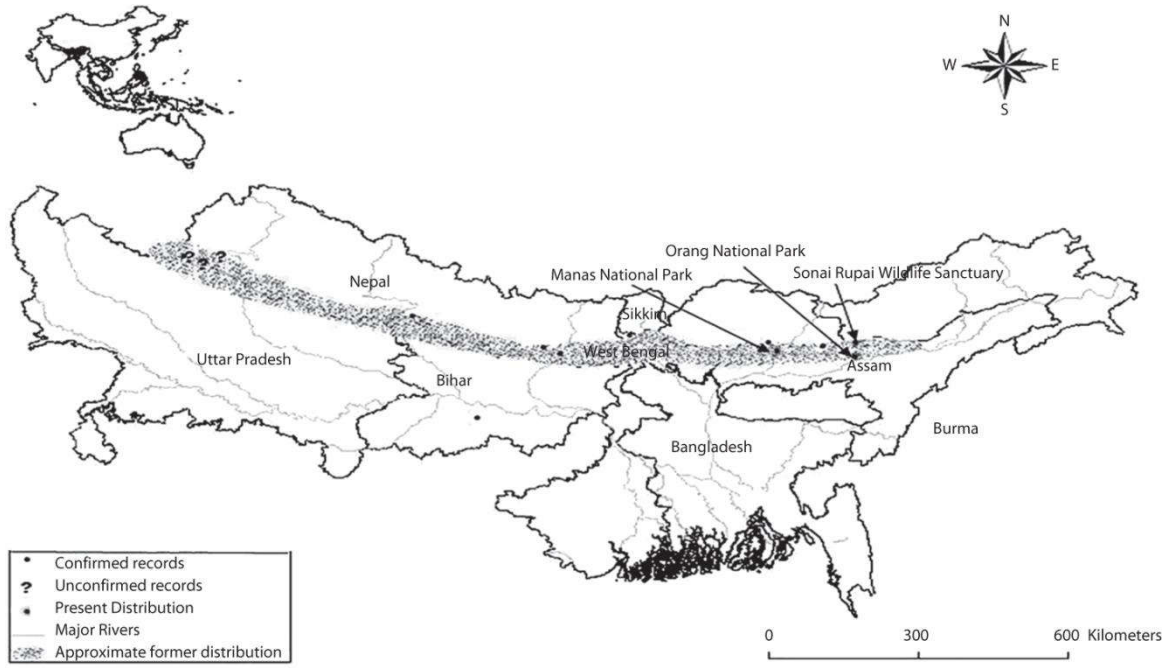

Fig.1.Map showing the approximate former geographical distribution of Hispid Hare (Chapman et al. 1990)

Hispid Hare was found to be distributed throughout the southern lowland of Nepal to Uttar Pradesh, West Bengal to Assam of India including Bhutan and Bangladesh; however the present distribution range is not known (Jordan et al. 2005). In the present day, it is known to exist only in a few isolated pockets across the formal range of its tall grassland habitats in India and Nepal. The extent of occurrence of Hispid Hare is estimated to be between 5,000 and 20,000 km², and the area of occupancy is estimated to be between 11 and 500 km², in highly fragmented populations (Jordan et al. 2005). In the context of Nepal, it is found to be distributed in Chitwan National Park, Bardiya National Park and Shuklaphanta National Park (SNP) in the terai area of Southern and Southwestern Nepal (Chapman et al.1990).

1.1.1.3 Habitat

The Habitat of Hispid Hare is the early successional riverine communities, typically comprising dense tall grasslands, commonly referred to as elephant grass or thatch land. Tall grassland may also form an under storey during later stages of the succession, particularly near rivers, or in forest clearings and abandoned cultivation and village sides (Chapman et al. 1990). In the early months of the year (January through April)**,** the grassland and nearby forests are set on fire in an attempt to control the faunal composition of the region. Hispid Hares move to cultivated fields and shelter on the banks of dried up streams. Once the monsoon reaches its peak, the thatch becomes waterlogged and *C. hispidus* moves to the forested areas of nearby foothills **(**Ghose 1978).

1.1.1.4 Reproduction

It is reported that young ones are seen from January to March. However, a little information is known about the reproduction of *C. hispidus*. There is no available information about the mating systems of *C. hispidus* as well. The species is monogamous and breeds during the winter (Bell 1987). Members of the family Leporidae are known to have a gestation of 25 to 50 days. Within the family, females usually give birth to between two and eight young ones. Although, there can be as many as fifteen young per litter in some species. Females are typically polyestrous, and can give birth to several litters per year (Nowak 1999b).

1.1.1.5 Parental Care

Most lagomorphs exhibit little or no parental care. Males have never exhibited any form of parental care, but females feed the young for about 5 minutes every 24 hours. This is the only contact between the mother and young (MacDonald 2001).

1.1.1.6 Behaviour

Hispid Hares are usually solitary, although members of the species have been seen in pairs. They are nocturnal animals that are most often seen by vehicle headlights. Hispid Hares have shown no evidence of burrowing or nest building. The only physical evidence of *C. hispidus* activity are thatch cuttings and fecal deposits that are characteristic of the species. The cuttings and fecal deposits show resting and feeding locations, but may also have territorial significance (Ghose 1978, Oliver 1980). Other members of the family Leporidae are known to drum their hind feet when they are threatened (Nowak 1999b).

1.1.1.7 Lifespan/Longevity

Hispid hares are hard to find. So, little information is known about their natural lifespan. In captivity, these animals do not survive very long. There were four or five Hispid Hares captured for the Gauhati Zoo during 1975, but they all died during transport. Another pair was captured in 1976 and was kept for two to three months until one escaped and the other was released. One captured hare wanted to avoid humans so much that he fractured his skull by dashing his head against the wire enclosure (Oliver 1978, Oliver 1980).

1.1.1.8 Home Range

The mean home range of the male Hispid Hare is found to be 8,204 sq. m. but for female it is only 2,786 sq. m. within the dense cover provided by unburned tall grassland (Nowak 1999b).

1.1.1.9 Communication and Perception

It is known that all rabbits and hares (members of the family Leporidae) secrete scent from glands in the groin area and under the chin. The scent is apparently used in sexual communication. Many rabbits and hares use foot drumming as a means of communication (MacDonald 2001, Nowak 1999b). There is tactile communication between mates, as well as between mothers and their offspring, although most lagomorphs mothers do not provide extensive parental care (MacDonald 2001, Nowak 1999b).

1.2 Objectives of the study

1.2.1 General Objective

To study the population status, habitat preference and threats to Hispid Hare in Shuklaphanta National Park (SNP)

1.2.2 Specific Objectives

- To investigate the present population status of the Hispid Hare in Shuklaphanta National Park
- To assess the habitat preferred by the Hispid Hare in Shuklaphanta National Park
- To find out the potential threats to the Hispid Hare in the park

1.3 Significance of the study

Shuklaphanta National Park harbours significantly a huge number of flora and fauna. It supports the world's most of the species that are under the threat of disappearance. Hispid hare (*C. hispidus*) is one of them. There have been only a few studies on this rare and least studied lagomorph species in Nepal including SNP. Therefore, the present study is aimed to investigate its present population status, the habitat preferred by the Hispid Hare and the threats it suffers in the park. With the help of overall information, suitable conservation action plans can be formulated in SNP area for the conservation of the poorly recognized species.

1.4 Hypothesis

The degrading grasslands of SNP posing threat to the Hispid Hare habitat will directly affect the population of the target species.

CHAPTER 2: LITERATURE REVIEW

a. Population Status of Hispid Hare

The world population of Hispid Hare is approximately 300 individuals throughout its distribution range scattered over fragmented landscapes (Aryal and Yadav 2010).

Chand et al. (2017) showed the average population density of Hispid Hare in SNP was found to be 0.1820/ha in winter and 0.2208/ha in summer which was found to be low as compared to the studies done before in SNP. A study carried out in Bardia National Park (Pramod et al. 2014) suggests that the pellet density was 4.07/ha before burning season and 8.71/ha after burning season. Tandan (2009) also studied distribution and habitat utilization of Hispid hare in both on summer and winter seasons in Bardiya National Park. A total of seven Phantas were selected for study. The population density of the hare was found to be 0.45/ha in winter and 0.976/ha in summer. Aryal et al. (2012) studied about the diet and habitat use of Hispid Hare (*Caprolagus hispidus*) in Shuklaphanta National Park. The population density was found 0.06 individuals/ha. Maheswaran (2002) studied the status and ecology of endangered Hispid hare in Jaldapara Wildlife Sanctuary West Bengal, India during which the population density of the species was found to be 0.087/ha. Nath and Machary (2015) studied the ecological assessment of Hipsid Hare in Manas National Park, India. They found population density of Hispid Hare to be of 3.81 individuals/ha. In 1982, Hispid Hare was first time reported in Chitwan National Park, Nepal (Inskipp and Collar 1984). After its discovery in Nepal, a detailed survey on biology of Hispid Hare was conducted in SNP in the late 1980s (Bell 1987). The study revealed many interesting facts of behavioural ecology, population density, home range and potential predators. During the survey of overall biodiversity exploration conducted in the Indo-Nepal border area by Wilson (1924) reported the presence of a good Hispid Hare population.

b. Habitat Preference of Hispid Hare

The Hispid Hare inhabits tracts of early successional tall grasslands and takes refuge in marshy areas or grasses adjacent to river banks during the dry season, when these areas are susceptible to burning.

Nath and Machary (2015) studied the ecological assessment of Hipsid Hare in Manas National Park, India. They reported that Hispid Hare preferred dry savannah grasslands to wet alluvial grasslands during winter and avoided recently burned patches due to lack of cover and food. The distribution pattern observed was clumped with more evidence of Hispid Hare presence in areas where ground cover was dense, dry and away from water sources. Aryal et al. (2012) studied about the diet and habitat use of Hispid hare (*Caprolagus hispidus*) in Shuklaphanta National Park and suggested that Hispid Hare primarily use tall grassland habitat. Nath (2009) conducted study in Manas National Park during 2009-2010. Field survey which was carried out in 2.65 hectare area. Study revealed the random distribution of Hispid Hare are within tall grasslands. The number of transects was 265 and 330 quadrates were laid for pellet and vegetation. Pellets occurred

in grasslands dominated by *Imperata cylindrica* followed by *Saccharum narenga*. Few pellets occurred in grasslands with *Arundo donax* and *Phragmitis karka* suggesting wet alluvial grasslands are preferred less during winter. Tandan (2009) studied distribution and habitat utilization of Hispid Hare in both on summer and winter seasons in Bardiya National Park of West Nepal. A total of seven Phantas were selected for study. The study revealed that the species mostly preferred open area, rather than tall bushy grassland habitat. It mostly preferred riverine and open grassland in winter and open tall grassland in summer season. Yadav et al. (2008) conducted a study to find out the present status, distribution and habitat use of Hispid Hare in Shuklaphanta National Park, Nepal. After interviewing local forest staff, 20 grassland patches within a survey area of 2.65 ha were selected and transects (50x2 m) laid randomly to determine the presence/absence of Hispid hare by recording pellets and other indirect evidence. Hare presence was recorded in 17 grassland patches within transects dominated by *Imperata cylindrica and Saccharum narenga*. Hispid hare preferred dry savannah grasslands to wet alluvial grasslands during winter and avoided recently burned patches due to lack of cover and food. Yadav (2005) studied about the status distribution and habitat utilization of Hispid Hare in Shuklaphanta National Park (SNP) and found that hare preference was *Narenga sp*. in tall grasslands and no pellet closer to 290m with an average of 600m from nearest water sources. Whereas, the most of pellets were found to be in the distance less than 50m and population density found to be (1.01/ha) and showed zero preference for short grassland, riverine forest and broadleaved forest. Maheshwaran (2002) studied about habitat preference of Hispid Hare and found that it preferred tall grasslands more frequently than in short grasslands. Hispid Hare is dependent on the early successional riverine communities, typically comprising dense tall grasslands commonly referred to as elephant grass or thatch land (Oliver 1984).

c. Threats to Hispid Hare

Hispid Hare is mainly threatened by habitat loss due to un-systematic and un-controlled burning of grasslands during dry season which coincide with the breeding season of the species (Bell, 1987).

Sadadev (2018) found out that the unscientific burning practices pose an immense threat to the habitat of Hispid hare. In the very study, it was observed that the species more abundantly preferred the non-fired plot area than the fired plots. Aryal et al. (2012) conducted a study in Shuklaphanta National Park and suggested that grassland burning, flooding was found as major threats to the habitat of hispid hare since grassland fire is the major problem for the survival of this wild population as it affects the soil structure, plant diversity, causes death of juvenile and adult Hispid Hare. Tandan (2009) also revealed that the uncontrolled park burning, poor park management, predation and flooding were found as major threats to this species in Bardiya National Park, Nepal. Yadav (2005) found that the existing threats to Hispid Hare were unestimated grassland firing, overgrazing, flood, predation and thatch collection. Maheshwaran (2002) conducted a study in Jaldapara Wildlife Santuary (India) revealed that uncontrolled burning of grassland, overgrazing, weed invasion, unsustainable thatch harvesting, traditional

hunting are major threats of Hispid Hare. Bell (1987) studied the Biology and conservation problems of the Hispid hare in the Shuklaphanta National Park, she concluded that grassland areas are universally one of the most threatened ecosystem with grazing, grass-cutting, agriculture and burning reducing the available habitat for grass-dependence species. She concluded the dry season grassland burning coincides exactly with the hares breeding season which in turn creates a significant threat to the species.

CHAPTER 3: MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location

Shuklaphanta National Park is situated between longitudes 80^0 06' 04" and 80^0 21' 40" E; latitudes 28^0 45' 16" and 28^0 57' 23"N, altitudinal range from 80m-600m and covers an area of 305 sq. km. The area of 243.5 sq. km. surrounding the reserve was declared as the buffer zone in 2004. The Park is bounded by the Syali River in the east, Mahakali River in the west, Siwalik Hills in the north and east and Luggabhugga Florican Reserve of India in the south (DNPWC 2017). The park contains many different ecosystem and habitat types, that includes the Siwalik hills, grasslands, and flood plains created by various river systems (Mahakali, Bahuni, Syali and Chaudhar). The Siwalik ridge links the hills with the terai forests by maintaining a natural corridor and allows for vertical migration of wild animals.

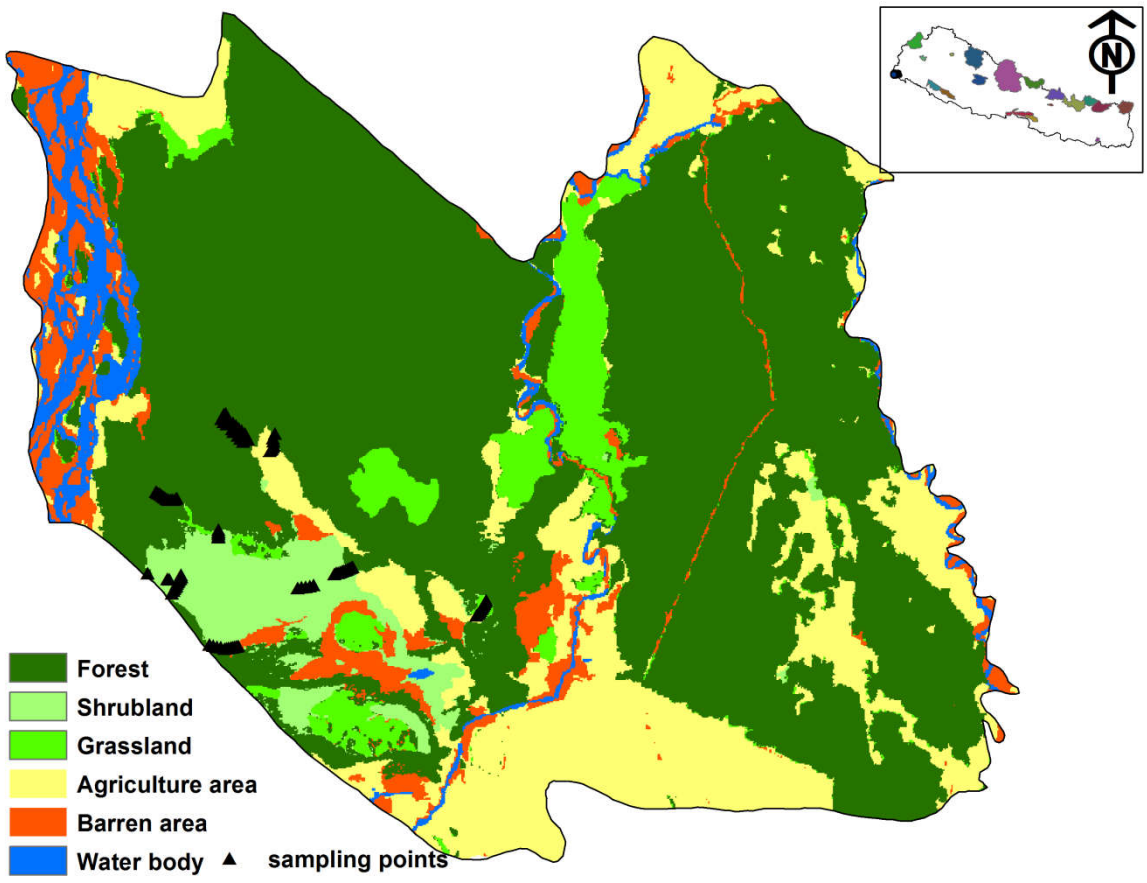

Fig.2. Shuklaphanta National Park

3.1.2 Climate

The climate of the region is sub-tropical monsoon type. The mean annual rainfall in this area is 1,579 mm (62.2 inch). The rainfall occurs from June to September and is highest in August. The winter months of December and January are fairly cold. The daytime temperature during this time of year is 7–12 °C (45–54 °F). Sometimes frost can also be seen. From February onwards temperatures rise up to 25 °C (77 °F) in March. The temperature reaches upto 42 °C (108 °F) by end of April. When the first pre-monsoon rains reach the area in May, humidity increases (Timilsina and Heinen 2008).

3.1.3 Biological Feature

3.1.3.1 Flora

DNPWC (2006) studied about the area of the park and found that it is composed of forest (65.02%), left agriculture land (7.87%), grassland (16.1%), shrubland (3.76%) and water bodies (7.25%). Around 700 species of plants are there in the park. They include 553 vascular plants, 18 pteridophytes, 410 dicots and 125 monocots (Bhuju et al. 2007). The grasslands of Shuklaphanta National Park cover almost half of the vegetation of the park. The main grass species are *Imperata cylindrica*, *Phragmites karka* and *Saccharum spontaneum*. They grow in the marshes around the seven small lakes. The main forest type is Sal (*Shorea robusta*) in association with Khair (*Acacia catechu*) and Sissoo (*Dalbergia sissoo*) that grow by the side of rivers. The grassland being invaded by trees is a major threat to the long-term existence of the main plants. Trees outcompete any grasses growing under them, especially those that need plenty of sunlight, e.g. *Bombax ceiba*. Trees cover any grasses growing under them, mainly those that need more sunlight. Tree seeds are spread all over the grasslands. They mostly germinate near existing trees. Also, trees help in the growth of shade-loving grasses and prevent the growth of sun-loving species. This process of succession usually converts grassland into woodland over time (Baral and Inskipp 2009).

3.1.3.2 Grassland

The grasslands are the most important ecosystems in nature in order to support a huge biodiversity that inhibits in it. The grasslands of SNP covers approximately half of the vegetation of the park. The protected area is part of the Terai-Duar savanna and grasslands ecoregion. It is one of the best-conserved examples of floodplain grassland (Dinerstein 2003). It is included in the Terai Arc Landscape (Bhattarai 2013). The grasslands are commonly called as “phanta”. The major grassland of the SNP is Shuklaphanta grassland. The other grasslands comprise of Barkaula phanta, Singhapur phanta, Sundarpur phanta, Hirapur phanta. The main grass species of the phantas include *Imperata cylindrica* and *Heteropogan contortus* which are used for thatching. The largest herd of Swamp deer in the whole world is seen in the grasslands of SNP. Grassland is seem to be invaded by tree and shrub saplings which pose major threats to the long-term existence of the main phantas.

3.1.3.3 Fauna

The open grasslands and wetlands covers large area around the lakes. This area is home to different kinds of animals (Majupuria and Kumar 1998). In the rivers, lakes and ponds 28 fish species 5 reptile species and 12 amphibian species were recorded (Baral and Inskipp 2009). These include Mahaser, Rohu, Magar Crocodile, Indian Rock Python, Monitor Lizard, Indian Cobra, Common Krait and Oriental Ratsnake (Baral and Inskipp 2009). The current checklists include 46 mammal species. Among them 18 are protected under CITES such as the Bengal Tiger, Indian Leopard, Sloth Bear, Swamp Deer, Asiatic Elephant and Hispid Hare. Great One Horned Rhinoceros were moved from Chitwan National Park (Bhuju et al. 2007). The gathering of Swamp deer in the grasslands of the park is the largest in the world. The population of Hispid Hare may be of international significance (Baral and Inskipp 2009). In spring 2016, a Rusty Spotted Cat was photographed by a camera trap for the first time in the protected area (Lamichhane et al. 2016). In case of birds a total of 423 species has been recorded. The park supports the highest population of Bengal floricans in Nepal. It is the western limit of Swamp Francolin, Jerdon's Bushchat, Rufous Rumped Grassbird, Chestnut Capped Babbler and Jerdon's Babbler. For Yellow Eyed Babbler, it is the north-western limit and it is the eastern limit of Finn's Weaver. It is also the most important regular wintering site of Hodgson's Bushchat. Forest birds include Spot Bellied Eagle Owl, Dusky Eagle Owl, Rufous Bellied Eagle and Oriental Pied Hornbill. The forests are also important for Great Slaty Woodpecker and White Naped Woodpecker. The White Rumped Vulture, Slender Billed Vulture, Lesser Adjutant, Grey Headed Fish Eagle, Darter and Rufous Rumped Grassbird are breeding residents. Sarus Crane, Painted Stork and Bristled Grassbird are summer visitors. Greater Racquet Tailed Drongo, White Capped Water Redstart, Rusty Tailed Flycatcher and Rufous Gorgeted Flycatcher are winter visitors but they are not common (Baral and Inskipp 2009).

3.2 Materials

- GPS (Global Positioning System)
- Camera
- Binocular
- Measuring Tape
- Vegetation Identification Book
- Data Sheets
- Notebook, Pen

3.3 METHODS

3.3.1 Research Design

Taking into consideration the size of the Hispid Hare and its habitat of tall grassland makes it impossible to even see them. Therefore, pellet count method has been chosen for the completion of my research study (Yadav 2006). The survey was conducted only in possible habitat sites of Hispid Hare as described by Aryal and Yadav (2010). A total of 97 plots were established. Global Positioning System (GPS) coordinates of confirmed hare locations was measured using a hand held GPS unit. Habitat characters, dominant vegetation species in each plot with reference to pellets presence was studied randomly.

3.3.1.1 Preliminary Survey

A preliminary survey was carried out to know the potential sites of Hispid Hare. It was carried out by the field visit, discussion with experts, District Forest Office (DFO) authorities, park staffs, National Trust for Nature Conservation (NTNC) staffs and people in the buffer zone and through relevant literatures. This survey was conducted for 2 days.

3.3.1.2 Questionnaire Survey

Semi structured questionnaire were prepared for understanding people's perception on the habitat preference and the threats to Hispid Hare in and around the park area. Snow ball sampling technique was used to select the respondent for questionnaire survey and 60 respondents who know about hispid hare like elephant staffs, park staffs, NTNC staffs, local people in the buffer zone and who frequently visit the park were asked. Each respondent took a minimum of 15 to 20 minutes in answering the questionnaire.

Field Methods

The grasslands of Shuklaphanta National Park were found to be dry and swamp both. Hence we considered these two habitat types for the data collection. Out of surveyed sites, the 24th Pillar site and 26th Pillar site, the Barkaula Phanta and the Singhapur Phanta were dry and the Silalekh site, Hattikunda and the Sundarpur Phanta were swamp. 72 transects were laid in dry sites and 25 transects were laid in the swamp sites for the Hispid hare presence / absence data and for vegetation survey.

3.3.1.3 Pellet Survey

Strip transects having transect length 50 m and strip width 2 m was laid in the grasslands within the study sites in search of indirect evidences (pellets) of Hispid Hare (Aryal et al. 2012). Each transect was surveyed only once. During data collection, following parameters were noted: pellet group size and number of pellets in each plot was also counted. During the transect survey whenever we encountered Hispid Hare pellets, we counted all the pellets within the pellet pile. For the identification of the pellets we followed field expert. Observations were recorded in a standard datasheet and all the relevant information such as general habitat, grass species composition and dominant plant species, distance from water body, distance from village, distance from road and habitat cover type were noted including GPS location and the level of threats to the

animal like fire, overgrazing, invasion of weed species, thatch extraction etcetera in the sampled area.

3.3.1.4 Vegetation Survey

For the vegetation sampling we laid 5m X 5m quadrates. Quadrates for vegetation were laid in the same strip transect which were laid for Hispid Hare sampling. The plant species along with the weeds present within the plots were noted down. The numbers of each plant present in the plot were recorded so as to find out the population size of the plant species. Those species that we could not identify in the field were photographed and then identified with the help of seniors and the friends at Central Department of Botany.

3.4 Data Analysis

Hispid Hare presence/absence (based on indirect evidence) data obtained from the transects were calculated and analyzed. To calculate pellet pile density we followed the methodology of Aryal et al. (2012).

Pellet density (N/ha) = (Total number of pellet groups observed /

Area of transect X Total number of transects) X 1000

Population density = Observed pellet density during the study / Estimated defecation rate for same time period for single animal

Similarly, the habitat preference was calculated following Yadav et al. (2008).

Habitat preference = (Pellet present in each dominant vegetation type / Total pellet present in all the dominant vegetation type) X 100

Vegetation Analysis:

Frequency of species A = (Number of quadrates in which species A occur / Total number of Quadrates) X 100

Relative Frequency = (Frequency of species A / Sum of frequency of all species) X 100

Density of species A = Frequency of species A in all quadrates / Total number of quadrates X Size of quadrates

Relative Density of species A = (Number of individuals of species A / Total number of individuals of all species) X 100

CHAPTER 4: RESULTS

The survey includes 80 days of field work from to Feb to April 2019. A total of 97 transects were surveyed for pellet and vegetation survey. Out of the total 97 transects laid, 28 had Hispid Hare pellets. A total of 49 pellet groups were found in these 28 transects. The occurrence of pellet groups varied significantly between the transects. We found 37 old pellet groups in 20 transects and 12 fresh pellet groups in only eight transects. Hispid Hare pellets were recorded in all the surveyed grassland areas but fresh pellets were found only in two sites, the Barkaula and the Hattikunda. The number of old pellets in each sites also varied. Apart from the sightings of pellets, feeding signs of Hispid Hare both fresh and old were also recorded. Evidence of Hispid Hare feeding on two different species of grasses were recorded during the survey. These are *Narenga porphyrcoma* and *Imperata cylindrica*. Hispid Hare consumes the inner core of the stem after carefully removing the outer bark. During the field survey, nests like structures were sighted in Barkaula, Sundarpur and Tintale area in majority than in other sites. The soil condition where evidences (pellets) of Hispid Hare were found was dry and there were no water source nearby in most of places but we encountered some evidences near water body as well in Sundarpur phanta, Hattikunda and near forest in Barkaula phanta.

4.1 Pellet Survey

Fresh Evidences:

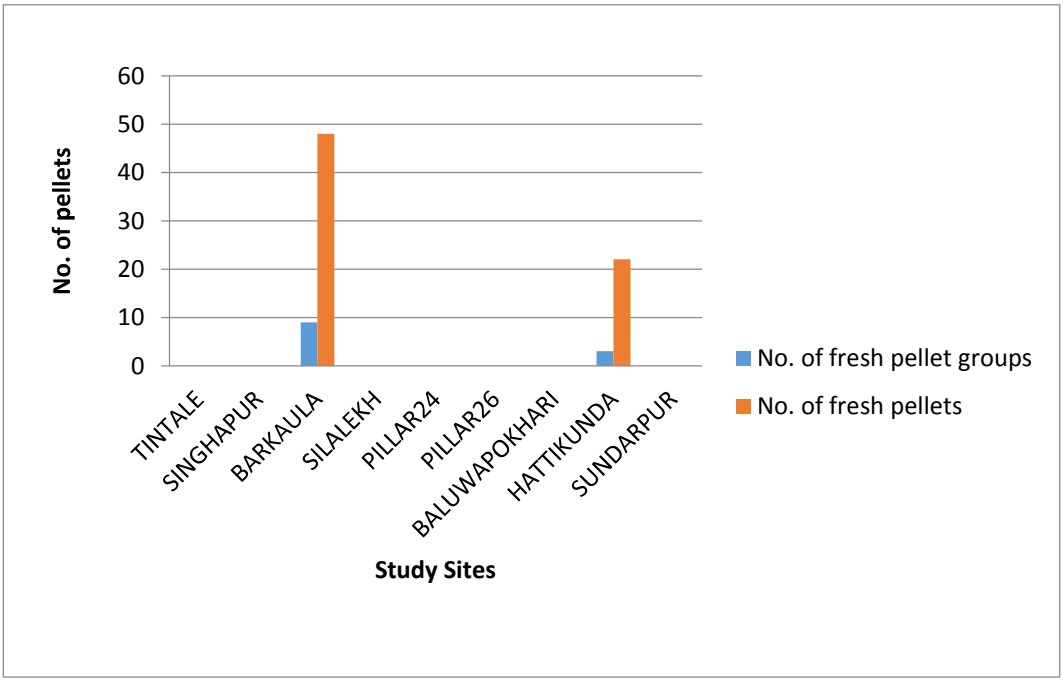

Fig.3.The number of fresh pellets observed in the study sites within SNP during the study period

The fresh pellets of Hispid Hare were only observed in two sites out of nine of them and Barkaula phanta had comparatively higher number of fresh pellets than in the Hattikunda phanta.

Pellet density and Population density

The pellet density was calculated by dividing the number of pellet groups by the area of transect multiplied by the number of transects laid. And the population density was calculated by dividing the observed pellet density during the study by the defecation rate of single individual at the same study period.

The pellets were present in the 28.87% of the studied transects (28 out of 97transects). The average pellet density during the study period was found to be 1.403 /ha (average old pellet density = 1.059/ha and fresh pellet density = 0.343 /ha) and the average population density was found to be 0.156 individuals/ha (average population density from old pellets = 0.117 individuals/ha and population density from fresh pellets = 0.038 individuals/ha)The fresh and old pellet density as well as the population density both were calculated for each study sites and is represented by the graph below:

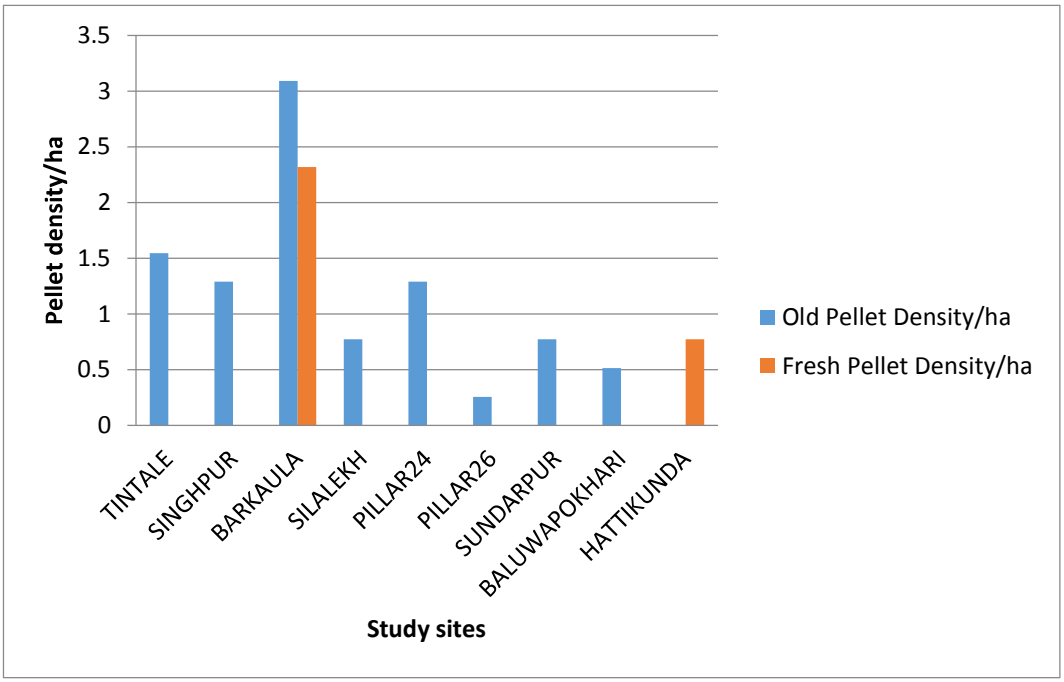

Fig.4.The pellet density in different study sites of SNP during the study period

Table.1. Population density (from old pellets and fresh pellets) in the study sites

Study Sites	Population Density/ha From Old Pellets	Population Density/ha From Fresh Pellets
TINTALE	0.172	0
SINGHPUR	0.143	0
BARKAULA	0.344	0.601
SILALEKH	0.086	0
PILLAR24	0.143	0
PILLAR26	0.029	0
SUNDARPUR	0.086	0
BALUWAPOKHARI	0.057	0
HATTIKUNDA	0	0.086

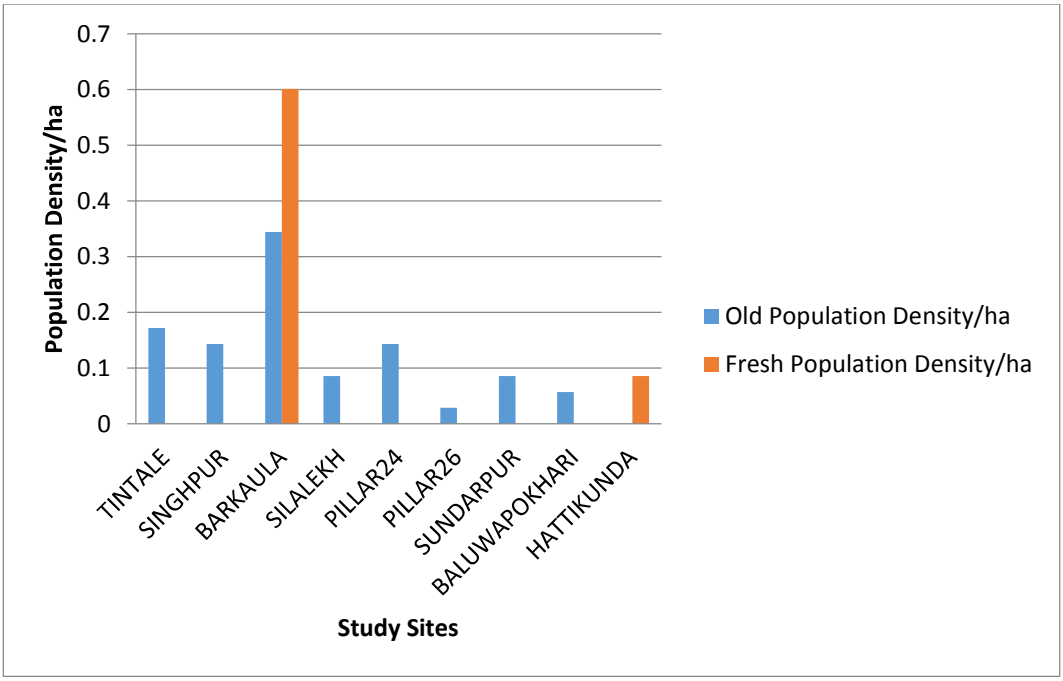

Fig.5. The population density from old pellets and fresh pellets in different study sites of SNP during the study period

The pellet density and population density of Hispid Hare was found low in the study sites during the study period. The data was only taken after burning of the grassland and there was still fire in some areas of the grassland which set limitations for this study. Out of observed sites, Barkaula was found to have higher pellet density for both fresh and old pellets while the other phantas were completely open and had very low habitat cover. Barkaula and Hattikunda had a good cover for the Hispid Hare to hide and feed. Pellets

were found very near to forest (old) and near Barkaula post (fresh) inspite of being a very secretive animal. Tintale area, Pillar 24, Pillar 26 and Baluwapokhari were of completely open habitat type and no fresh evidences (pellets) were seen. Singhapur, Silalekh and Sundarpur were half burnt areas with no new grasses in them and this restricted the availability of the evidences.

4.2 Pellet Presence in Response to Distance from Water, Village and Road

The pellet survey was conducted taking into consideration the distance from the nearest water body, village and road so as to observe the effect of these variables on the occurrence of the species. The field observation did not find any significant difference except that the distance from the village. The pellet density was observed more as the distance increased from the village. But unlike the former studies, the pellets were even observed at around 200m distance from the water body and at around 250m distance from the road with cover and food resources for the Hispid Hare. Therefore, this study unveils that the harsh conditions drive the species to live in the habitats it might avoid in normal situation. The grassland fires compel the species to hide in the areas with water and even near roads but they found to be avoiding the village areas very strictly on the basis of this current study.

4.3 Vegetation Survey

Vegetation survey was conducted within the transects laid for Hispid hare pellet survey. The size of the quadartes laid for vegetation survey was 5m X 5m. A total of 97 quadrates were laid to see the grass species composition. A total of 3,184 individuals belonging to 9 species were enumerated. Among all the species, the weed *Oxalis corniculata* and *Cynodon dactylon* were observed abundantly spread followed by *Narenga porphyrcoma* in the grasslands as shown by the graph below:

Table.2. The frequency, relative frequency, density and relative density of the grass species in the study sites

Name of the grass species	Frequency	Relative requency	Density/m²	Relative density/m²
Oxalis corniculata	72.16	16.12	1.85	21.19
Sacchharum munj	56.7	12.67	1.46	10.8
Narenga porphyrcoma	61.85	13.82	1.59	24.59
Impereta cylindrica	54.63	12.21	1.4	12.46
Sacchharum spontaneum	48.45	10.83	1.24	5.55
Demostachys binnata	42.26	9.44	1.08	3.59
Grewia asiatica	12.37	2.76	0.31	0.56
Cynodon dactylon	72.16	16.12	1.85	20.1
Cymbopogan flexuosus	26.8	5.99	0.69	1.13

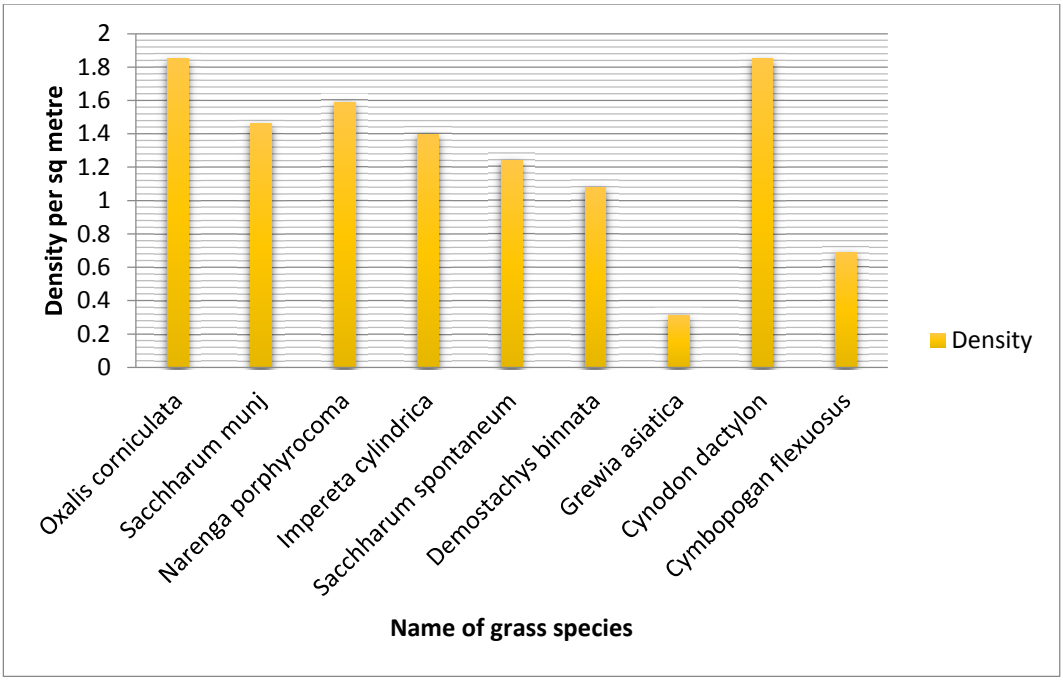

Fig.6. Density of the grass species in the study sites per sq metre during the study period

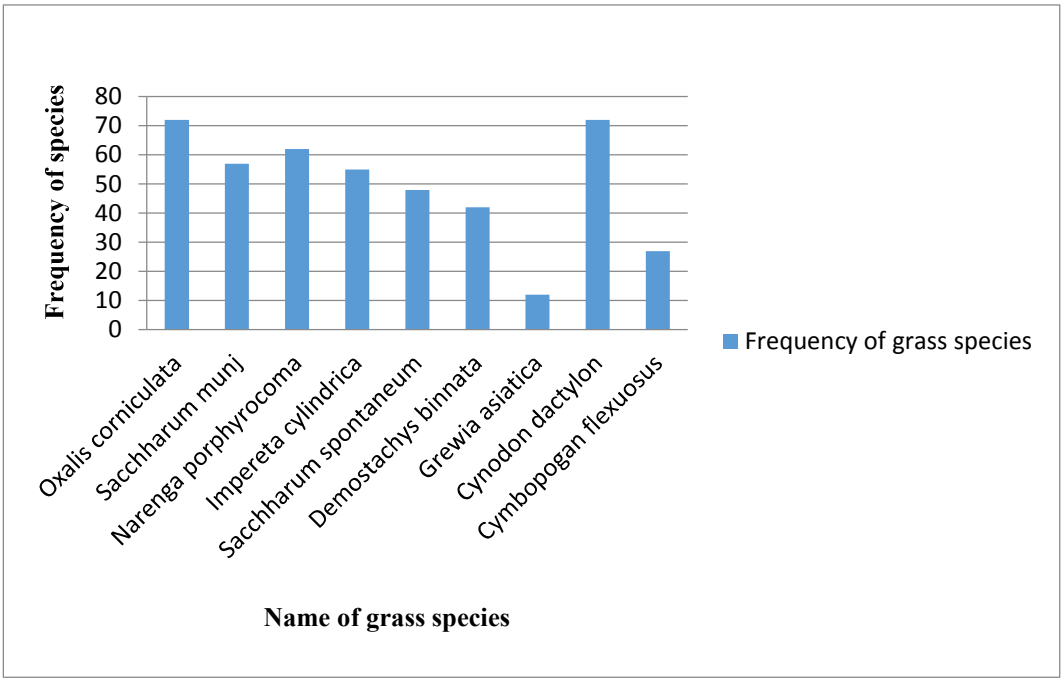

Fig.7. Frequency of occurrence of grass species in different study sites during the study period

The most frequent grass species in the field were *Oxalis* and *Cynodon*, probably because some areas were growing new grasses after burning.

Habitat Preference:

For habitat preference, the dominant vegetation and the number of pellets observed in the quadrates were recorded. The pellet numbers seen in each dominant vegetation type were then compared. This resulted a graph as shown below:

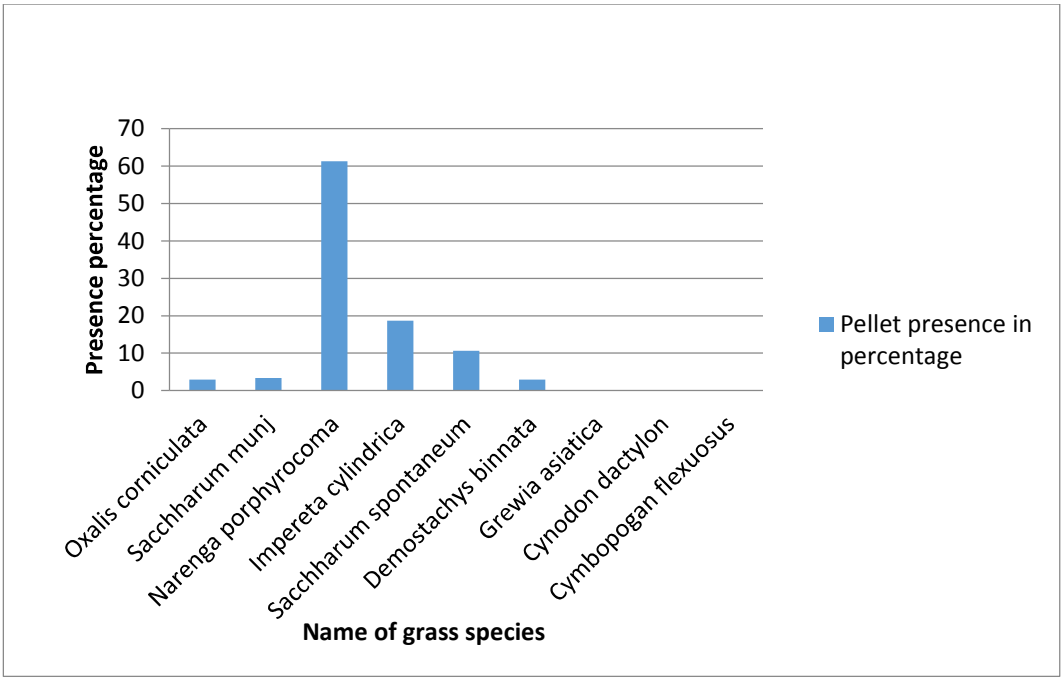

Fig.8. Pellet presence in dominant vegetation type during the study period

The more number of pellets were observed in the *Narenga porphyrcoma* dominated areas followed by *Impereta cylindrica* and then *Sacchharum spontaneum*. Only a few pellets were observed in the areas of *Sacchharum munj* and *Demostachys binnata*. This implies that Hispid hare prefers the habitat with the presence of *Narenga* and *Impereta* to a greater extent.

4.4 Potential Threat Assessment

Threat to Hispid Hare that were observed during field visit and through questionnaire survey were found to be the unplanned and unscientific grassland annual burning, conversion of forest area into agricultural lands and human settlements in buffer zone, habitat fragmentation, overgrazing by freely roaming cattle, perennial invasion along with exotic plant invasion, poaching, traditional hunting and yearly heavy rainfall resulting flooding in lowlands. Besides the direct observation in the field, the questionnaire survey method was also used so as to find out the people's perception on Hispid Hare regarding the threat this species has to face in the very park. Six wards around the park were selected for the survey. Only 10 % of the total households were selected for the survey which make up around 10 houses from each ward. Altogether 60 respondents were questioned the prepared semi-structured questionnaire to fulfill our queries related to Hispid Hare.

1. People's Knowledge About Hispid Hare
2. Number of People who have seen Hispid Hare
3. People's Perception on Threat to Hispid Hare

1. People's Knowledge About Hispid Hare

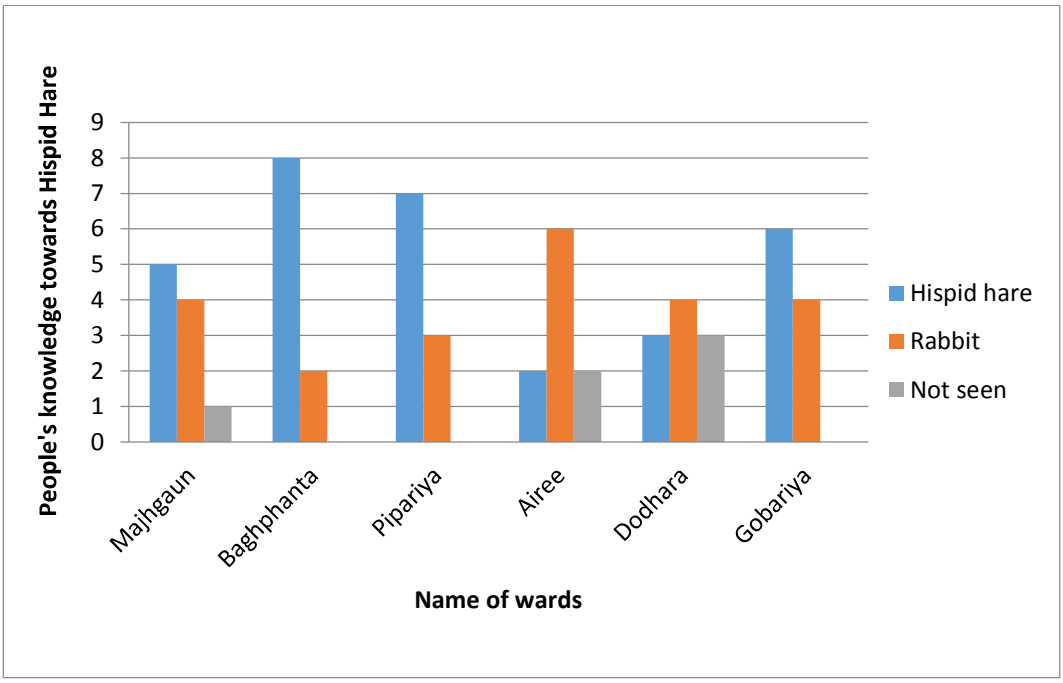

Fig.9.Graph showing the people's knowledge towards Hispid Hare

The graph shows the number of people who know Hispid Hare, who mistake it as a rabbit and those who have never seen the animal before. The residents nearer to the park have better ideas about the animal than the other residents. It implies that they encounter the animal often. As the nearby residents often visit the park area for resource collection they have better encounter possibilities of the animal in comparison to those who visit the park less often.

2. Number of People who have seen Hispid Hare

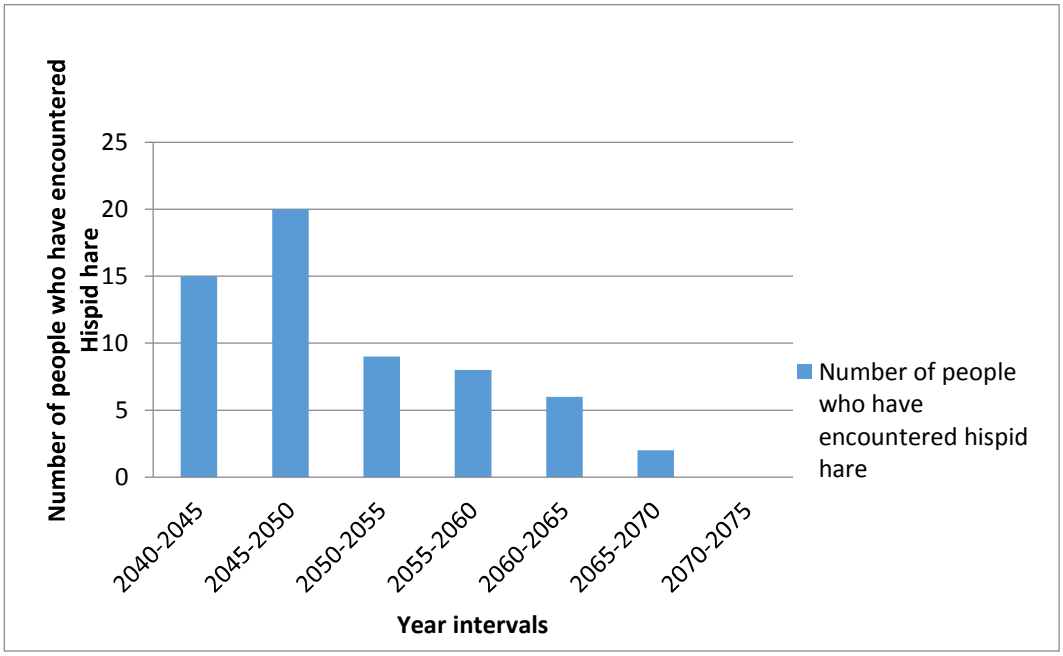

Fig.10.Graph showing the number of people who have seen Hispid Hare in the respective year intervals

The graph shows the number of people who have encountered Hispid Hare in the given year intervals. It is clear from the graph that the number of Hispid Hare has gradually decreased. The higher number of encounter rate was in 2040 – 2050 BS and not any direct sighting of the animal by the nearby residents in the recent years. The houses with older people recognized the species whereas the houses with the young people mistook it with the rabbits.

3. People's Perception on Threat to Hispid Hare

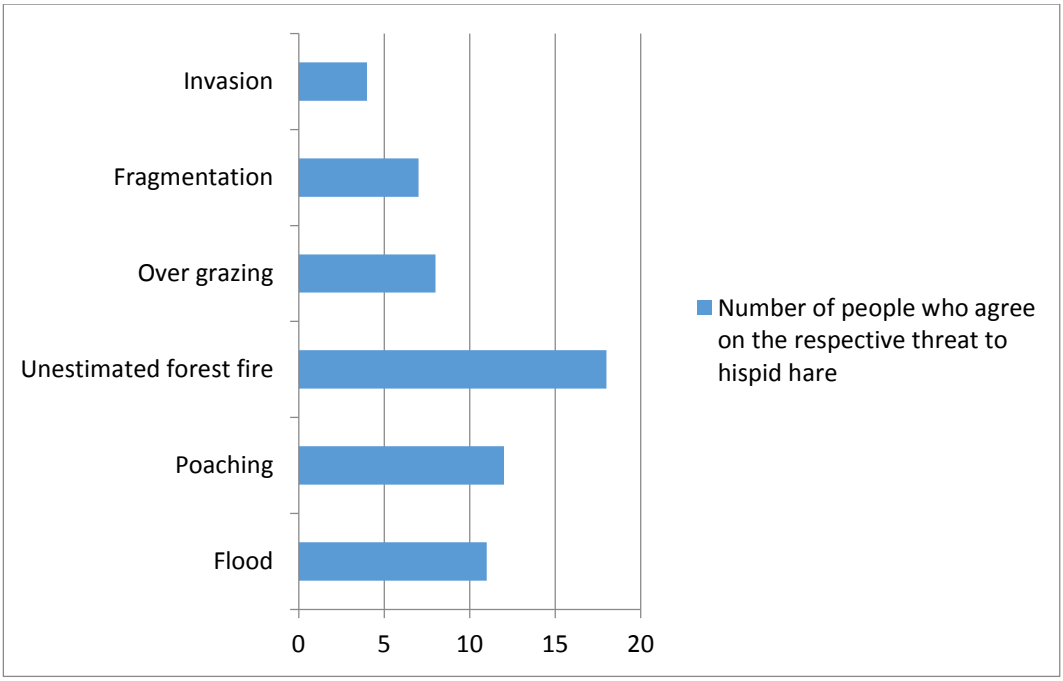

Fig.11.The number of people who agree on the respective threat to Hispid Hare

The majority of people believed that the animal is facing threat due to the unplanned and unestimated annual grassland burning. Poaching and flood were next major threats according to the surveyed people. Overgrazing was directly observed during the field visit. The freely roaming cattle that are abandoned by the local residents enter the park for grazing. This results in the habitat loss of the species.

Existing Threats in the Park:

1. Unestimated forest fire

Unscientific grassland burning practice is a major threat to Hispid Hare. The Park authority does not follow systematic patch burning of grassland. Moreover, fire is sometimes also set by the local graziers from the fringe villagers to create new patches of grassland for their cattle to graze which is detrimental to Hispid Hare as its breeding season coincides with this annual dry season grassland burning. Thus, there is very high possibility of casualties of young hares during this devastating fire. During the field survey, we found that due to disturbances of fire in the grassland the Hispid Hare even shifts towards forest and near water which has cover and food availability.

2. Overgrazing

In the absence of grazing reserves, the local people also let their unproductive cattle inside the Park for grazing, which degrades the habitat and cover for wild animals particularly the cover dependent species like Hispid hare. This practice is observed during our field as well. A large number of freely roaming cattle seem to be grazing in the periphery of the park. This overgrazing by the cattle has also added up to the threats to this species.

3. Flood

In monsoons, far western receives a huge rainfall which swipes away the most of small mammals like Hispid Hare. The young ones are especially affected by this natural disaster occurring annually in the lowlands.

4. Invasion of exotic plants

The grassland habitat of Hispid Hare SNP is being degraded due to invasion of weeds like *Parthenium hysterophorus*, *Lantana camara* and *Solanum viarum*. Moreover, perennial invasion by the tree species like *Bomax ceiba* is also observed in the park during the field. In many areas within the Park the grassland patches becoming invaded by *B. ceiba.* Urgent management practices need to be carried out otherwise these invasive species will soon replace the grasslands area.

5. Poaching

On the basis of the survey, people assumed that the major threat to the species after the grassland fire was poaching. People added, some of the local tribes hunt wild animals for meat and Hispid Hare is one of them. The poaching rate was found to be higher in the year 2060-2065, according to the survey. Therefore, involvement of the local people in the awareness campaigns can be a strong measure to control poaching of the species.

6. Fragmentation

The unsustainable thatch collection has fragmented the habitat of the Hispid Hare. The thatch collection practice was directly observed in the park during the field work. Besides this, walking or vehicle roads built in the park create the fragmentation of the habitat of the species.

CHAPTER 5: DISCUSSION

5.1 Population Status of Hispid Hare

The average population density of the Hispid Hare during this study was estimated to be 0.156 individuals/ha and according to Chand et al. (2017) the average population density of Hispid hare in SNP was found to be 0.2208/ha in summer. Similarly, Aryal et al. (2012) discovered that the population density was 0.06 individuals/ha which indicates that the population density of the species is on the pace of increment gradually. Pramod et al. (2014) also estimated the population density of Hispid Hare in Bardiya National Park, 8.71/ha after burning which is comparatively higher than both the studies, our present study and the study done by Chand et al. (2017). The population density of Hispid Hare as per the studies done till date show that SNP has comparatively low population density of the species than that of Bardiya National Park. Population density of hispid hare was 5.76 individuals/km^2 and we estimated a population size of 219 ± 40 hispid hare within the 41 km^2 grasslands of SWR (Aryal et al. 2012) which is comparatively higher than the above studies. The pellet density was 4.07/ha before the burning season and 8.71/ha after it in Babai valley, Bardiya National Park (Tandan, 2013).

According to an ecological study of the Hispid Hare *Caprolagus hispidus* conducted at Jaldapara Wildlife Sanctuary, West Bengal, by Maheshwaran, the density of Hispid Hare in Jaldapara was 1/2.35 sq. km. in which strip-transects (n=107) were laid randomly in tall grassland patches (number of transects depended on the extent of pellets available) where fresh and old pellets of Hispid Hare were found. Also a study of the Hispid Hare *Caprolagus hispidus* in the tall grassland habitat of Manas National Park, Assam, the first detailed assessment in northeastern India by Nath et al. (2010) found out that the population density was estimated at 381.55 individuals/km^2, which in comparison with other studies indicates that Manas National Park currently holds the highest density of Hispid Hare.

From the above, it is understood that the species may be doing well locally (given the abundance of fresh and old faecal pellets) within Protected Areas (Maheshwaran, 2002; Nath, 2008) but the extent of habitat fragmentation (including loss of grassland areas outside PAs) and the impact on limited dispersal and breeding constraints during flooding (wet season) may be few factors for their disjunct distribution.

5.2 Habitat Preferred by Hispid Hare

It was observed during the study that Hispid Hare preferred the tall grasslands composed of especially with *Narenga porphyrcoma* followed by *Impereta cylindrica* and *Sacchharum spontaneum*. From the study of Maheshwaran (2002) about habitat preference of Hispid Hare, similar results were obtained in which it was found that it preferred tall grasslands more frequently than short grasslands. Oliver (1984) also claimed that Hispid Hare is dependent on the early successional riverine communities,

typically comprising dense tall grasslands commonly referred to as elephant grass or thatch land which supports this study.

Yadav (2005) also studied habitat utilization of Hispid Hare in SNP and found that hare preferred *Narenga sp*. in tall grasslands and no pellet closer to 290m with an average of 600m from nearest water sources but during this study the pellets were observed even within 200m distance from the nearest water body in Sundarpur Phanta. The pellets were even observed over the burnt root tuft of the *Narenga porphyrcoma* where there was swamp area in Sundarpur Phanta. According to Chand et al. (2017) also the pellets were not observed near water resources but this present study result contradicts the former findings. This was probably because during the harsh burning in the grasslands the species runs for cover near water bodies. The Hispid Hare signs were even observed at around only 100m distance from the road (Barkaula Phanta, near the post) in this study which indicates that the grassland burning compels the species to escape out, be it forest or near water body and even near the settlement areas. Hispid hare primarily used tall grassland habitat. Nineteen plant species were identified in hispid hare pellets with *Saccharum spontaneum* and *Imperata cylindrica* having the highest frequency of occurrence (Aryal et al. 2012). The diet of the hispid hare consisted of 23 plants species, of which Saccharum spp., Imperata cylindrica, Desmostachya bipinnata and Cynodon dactylon were most preferred. These plant species were also more abundant in the hispid hare habitat (Tandan et al. 2013). Similar study on Endangered Hispid hare was first of its kind in the country and has confirmed the presence of this poorly known species in Royal Manas National Park (RMNP), Bhutan. The study was conducted along the southern foothills of RMNP during Sept. 2014- August. 2015. According to preliminary sign survey and information from local people, camera was placed in three different locations to capture the live image of the animal and captured live image from one location. More signs and pellets occurred in tall grasslands along the river beds dominated by tall Imperata cylindrica. Uncontrolled burning of grassland, overgrazing, weed invasion and collecting fodder for elephant were major the threats that need to be addressed for conservation of Hispid hare and its habitat. Maheshwaran (2002) found that Indian and hispid hare rarely utilise the same grass patches and that nests (or warrens) were constructed by hares in the breeding season. During winter, the hares usually inhabited higher areas where the grass was very dense, but not tall. In the summer, they moved closer to tall grass patches near streams and waterlogged areas. In Manas, Nath (2010) found 11 nest-like structures which were shallow depressions of about 7.5–10.5cm deep and 17.5–25.4cm wide. The nest bed was carpeted with finely chopped grasses and fresh pellets of both small and large sizes were present nearby indicating active usage of such areas. Pygmy hogs, which share habitat with Hispid Hare, occupy typical floodplain habitats, such as secondary successional forests, dense tall grasslands and mixed scrub associations. Grasslands dominated by *Narenga porphyrocoma, Saccharum spontaneum, S. bengalensis, Imperata cylindrica* and *Themeda villosa*, forming characteristic grass associations of 2 to 3 m height is their favourite habitat (Mary et al. 2013).

5.3 Potential Threats to Hispid Hare

Present study revealed that the major threats to the Hispid Hare was the unestimated annual grassland burning which is similar to the study carried out by Sadadev (2018) in which it was found out that the species more abundantly preferred the non-fired plot area than the fired plots. Similar study by Aryal et al. (2012) in SNP suggested that grassland burning, flooding was found as major threats to the habitat of hispid hare since grassland fire is the major problem for the survival of this wild population as it affects the soil structure, plant diversity, causes death of juvenile and adult Hispid Hare which supports the present study. Tandan (2009) also revealed that besides the uncontrolled grassland burning, poor park management, predation and flooding were found as major threats to this species in Bardiya National Park, Nepal.

Also the thatch collection practice, one of the known threats to Hispid Hare was directly observed in the field during the study which is also supported by Maheshwaran (2002). The former studies have not mentioned about the threat posed due to the poaching which was found to be one of the major threats in SNP on the basis of local people's perception during this study. This was probably because of the traditional hunting by the local people living in a large number near the park. Similarly, habitat loss due to overgrazing, unsustainable thatch harvesting, burning of grassland, weed invasion, encroachment and hunting were identified as key threats which must be addressed to ensure survival of this threatened species in the Park (Nath et al. 2010).

Being an obligate grassland species, the primary threat to *C. hispidus* population is the loss of the habitat itself. These can be due to several factors such as encroachment and subsequent land use conversion (to agriculture), extensive grass burning, grass cutting, livestock grazing and spread of invasive species. The natural spatial and temporal dynamics of the tall grassland habitat, particularly the fire cycles, are critical factors that are important to the conservation of this species (Bell et al. 1990, Maheswaran 2002). Fires may be considered as the necessary evil, as they naturally arrest the succession of grasslands into woodlands, although an uncontrolled late burning that coincides with their breeding season may also be quite fatal. Besides, habitat loss, hunting for meat can also be a potential threat in non-protected areas, although any direct correlation has not been made.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

The present study conducted after burning in February to April, 2019, concludes that the Hispid Hare population seems to be highly affected by the grassland burning in the SNP. The average population density of the species was 0.156 individuals/ha during this study period. During the study, the old pellet density was seen higher in comparison to the fresh pellet density indicating immense effect of burning on the species. The Hispid hare seemed to inhabit near water body as well as near the roads and near the forest areas. When the grasslands are under fire this little mammal, in search of food and cover reaches near water bodies, near roads and forests that are less burnt areas which probably pushes them towards the other threats such as predation by the other animals and poaching by the local people. The species preferred *Narenga porphyrcoma, Impereta cylindrica, Sacchharum spontaneum* and *Sacchharum munj* as the most of the evidences were recorded in the habitat with the above vegetation. The major drivers of the habitat loss for the species were observed the haphazard grassland fire, poaching, flood, overgrazing and fragmentation of the grassland areas due to the unsustainable thatch collection by the local people. Hispid Hare in SNP can be conserved by planning a proper annual grassland burning, proper park management and public awareness and implementing strict laws against illegal poaching of the species.

RECOMMENDATIONS

The following recommendations were drawn from the present study which might be helpful for the further studies about the species in SNP:

1. The study inside the park alone is not enough for the conservation of the species, the local people living near the park which depend on the resources from the park need to be necessarily included in the awareness campaigns for Hispid Hare in the further related projects.
2. Further study on the reproductive behavior and genetic study of the species is recommended in SNP.

REFERENCES

Amin, R., Baral, H. S., Lamichhane, B. R., Poudyal, L. P., Jnawali, S. R., and Joshi, D. et al. 2018. The status of Nepal's mammals. Journal of Threatened Taxa, **10**(3):11361-11378.

Aryal, A., Brunton, D., Ji, W., Yadav, H. K., Adhikari, B., and Raubenheimer, D. 2012. Diet and habitat use of hispid hare *Caprolagus hispidus* in Shuklaphanta Wildlife Reserve, Nepal. Mammal Study, **37**(2):147-155.

Baral, H. S., and Inskipp, C. 2009. The birds of Shuklaphanta wildlife reserve, Nepal. Our Nature, **7**(1):56-81.

Bell, D. 1984. The behaviour of rabbits: implications for their laboratory management. Standards in Laboratory Animal Management. UFAW, pp. 151-162.

Bell, D. 1986. A study of the Hispid Hare *Caprolagus hispidus* in Royal Suklaphanta Wildlife Reserve, western Nepal: A summary report. Dodo, Journal of the Jersey Wildlife Preservation Trust, **23**:24-31.

Bell, D. J. 1987. Study of the biology and conservation problems of the Hispid Hare. Final Report. University of East Anglia, England, 38pp.

Bell, D. J., Oliver, W. L. R., and Ghose, R. K. 1990. The Hispid Hare (*Caprolagus hispidus)*. Rabbits, Hares and Pikas: Status Survey and Conservation Action Plan, 128-136.

Bhuju, U. R., Shakya, P. R., Basnet, T. B., and Shrestha, S. 2007. Nepal biodiversity resource book: protected areas, Ramsar sites, and World Heritage sites. International Centre for Integrated Mountain Development (ICIMOD).

Blanford, W. T.1888. The Fauna of British India, Mammalia.Taylor and Francis, London. Vol.91.

Burnham, K. P., Anderson, D. R., and Laake, J. L.1980. Estimation of density from line transect sampling of biological populations. Wildlife monographs, **72**: 3-202.

Burton, J., and Burton, V.1988. The Collins Guide to Rare Mammals of the World. Lexington, Massachusetts; The Stephen Greene Press.

Chand, D., Khanal, L.,and Chalise, M.K. 2017. Distribution and habitat preference of Hispid Hare (*Caprologus hispidus*) in Shuklaphanta National Park. Tribhuvan University Journal. **31**(1/2)

Chapman, J. A., Flux, J. E. C., Smith, A. T., and Bell, D. 1990. Conservation action needed for rabbits, hares and pikas. Status Survey and Conservation Action Plan. IUCN, Gland.

Dinerstein, E. 2003. The return of the unicorns: the natural history and conservation of the greater one-horned rhinoceros. Columbia University Press.

Ghose, R. K. 1978. Observations on the ecology and status of the Hispid Hare in Rajagarh Forest, Darrang District, Assam, in 1975 and 1976. *Journal of the Bombay Natural History Society*, **75**(1):206-209.

Inskipp, C. and Collar, N. J. 1984. The Bengal florican: its conservation in Nepal. Oryx, **18**(1):30-35.

Jordan, M., Bhattacharyya, T. P., Bielby, J., Padmanabhan, P., Pillai, M. and Nameer, P.O. et al. 2005: *Caprolagus hispidus* Pearson, 1839. Status of the South Asia

Non-volant Small Mammals: Conservation Assessment and Management Plan. Zoo Outreach Organisation/CBSG-South Asia, Coimbatore, India Workshop Report. Pp 618.

Khadka, B. B., Yadav, B. P., Aryal, N., and Aryal, A.2017. Rediscovery of the hispid hare (*Caprolagus hispidus*) in Chitwan National Park, Nepal after three decades. *Conservation Science,* **5**(1).

Macdonald, D. 2001. The new encyclopedia of mammals, Rabbits and Hares. Oxford University Press, Oxford. Pp. 693-702.

Maheshwaran, G. 2002. Status and ecology of endangered Hispid Hare *Caprolagus hispidus* in Jaldapara Wildlife Sanctuary. Final Report. Wildife Conservation Society and Bombay Natural History Society.

Maheswaran, G. 2006. Ecology and conservation of the endangered Hispid Hare *Caprolagus hispidus* in Jaldapra wildlife sanctuary, West bengal, Iindia. Journal-bombay natural history society, **103**(2/3):191.

Majupuria, T. C., and Kumar, R.1998. Wildlife, national parks & reserves: resources, management & wildlife safaris (No. 11). S. Devi.

Nath, N. K. and Machary, K. 2015. An ecological assessment of Hispid Hare *Caprolagus hispidus* (Mammalia: Lagomorpha: Leporidae) in Manas National Park, Assam, India. *Journal of Threatened Taxa*, **7**(15):8195-8204.

Nath, N. K. 2009. Status survey of Hispid Hare *Caprolagus hispidus* in the North Bank Landscape (Assam and Arunachal Pradesh), India. A Technical Report, Aaranyak, 58pp.

Nepal, W. W. F. DNPWC. 2006. Factsheet: Wetlands of Nepal. Department of National Parks and Wildlife Conservation and WWF Nepal, Kathmandu.

Nowak, R. 1999. Hares and Rabbits. Walker's Mammal of the World. The John Hopkins Press. Baltimore, Maryland. **2**:1720-1721.

Oliver, W. L. and Roy, S. D. 1993. The pygmy hog. Seals, Fur Seals, Sea Lions, and Walrus: Status Survey and Conservation Action Plan, 121.

Oliver, W. L. R. 1980. The Pigmy Hog: the Biology and conservation of the Pigmy Hog, *Sus salvanius* and the Hispid Hare, *Caprolagus hispidus*. Special scientific report, (1).

Oliver, W. L. R. 1984. The distribution and status of the Hispid Hare *Caprolagus hispidus* the summarized findings of the 1984 pigmy hog/hispid hare field survey in northern Bangladesh, southern Nepal and northern India. Dodo. Journal of the Jersey Wildlife Preservation Trust, **21**:6-32.

Pearson, J. T. 1839. Note on Darjeeling. Bound newspaper article.

Phillips, A. and World Conservation Union. 2002. Management guidelines for IUCN category V protected areas: Protected landscapes/seascapes (Vol. 9). IUCN-the World Conservation Union.

Sadadev, B.M. 2018. Effect of grassland fire on the distribution of Hispid Hare (*Caprologus hispidus*) in Shuklaphanta National Park. BSc. Thesis. Institute of Forestry, Pokhara, Campus. Tribhuvan University.

Tandan, P. 2009. Population Status, Habitat Utilization, Distribution and Conservation Threats of Hispid Hare (*Caprolagus hispidus*) In Bardia National Park of Western Nepal. Few saying of session chairs, 161.

Tandan, P., Dhakal, B., Karki, K., and Aryal, A. 2013. Tropical grasslands supporting the endangered Hispid Hare (*Caprolagus hispidus*) population in the Bardia National Park, Nepal. Current Science, 691-694.

Timilsina, N., and Heinen, J. T. 2008. Forest structure under different management regimes in the western lowlands of Nepal. Journal of Sustainable Forestry, **26**(2):112-131.

Yadav, B. 2005. Status, distribution and habitat use of Hispid Hare (*Caprolagus hispidus*) in Royal Suklaphanta Wildlife Reserve, Nepal. *B. Sc.* Thesis, Institute of Forestry, Tribhuvan University.

Yadav, B. 2006. Status, distribution and conservation threats of Hispid Hare (*Caprolagus hidpidus*) in Royal Suklaphanta wildlife Reserve, Nepal. Doctoral dissertation, A Thesis submitted to Institute of Forestry, Pokhara, T.U.

APPENDICES

1. DATASHEET FOR HISPID HARE:

Sites	NOP	NOPG	DW	DR	DV	DMPL	HCT	LAT	LONG

2. QUESTIONNAIRE SURVEY SHEET:

HISPID HARE QUESTIONNAIRE SURVEY SHEET
MAHENDRANAGAR, KANCHANPUR – 2019

DATE**:**

Name of the respondent: Age:
Sex:
Municipality/Rural municipality: Ward:
Education: Occupation:
Religion:

I. Have you seen this animal before? A) YES B) NO
If yes then,
   a. What do you think it is?
   b. What do you call it? / What is its local name?
   c. What kind of habitat does it use?

II. When / where / how many in number have you seen this animal?
   a. Year:
   b. Day / Night
   c. Forest / Farmland / Grassland / Near water bodies
   d. Settlement areas (where exactly):
   e. Number:
   f. Not seen yet

III. Have you seen any signs that indicate the presence of Hispid Hare?
   a. Pellets
   b. Direct observation

IV. Since when Hispid Hare is present in this area and what have you observed regarding its population?
   a. Year:
   b. Increasing / Decreasing / Stable / Not known
   Reasons:

V. Where do you go for resource collection?

Area	Timber	Fuel	Fodder	Grasses	Others
Park					
C. F.					
O. L.					

VI. Do you rear any livestock? A) YES B) NO
If yes then,

Livestock	Cattle	Buffalo	Goat	Chicken	Others
Stall-fed					
Total					

VII. Do you think livestock disturb the habitat of Hispid Hare?
If yes then,
a. How? :
b. Which month / season of the year? :

VIII. What are the natural predators of Hispid Hare in this area?
a. Eagle / Hyena / Fox / Dog / Jackal
b. Python / Tiger

IX. What do you think which are the current major threats for Hispid Hare in this area?
a. Habitat destruction / Habitat fragmentation / Livestock
b. Forest fire / Natural predation / Natural disaster
c. Illegal killing
d. Others

X. Have you seen anyone catching the Hispid Hare? A)YES B)NO
If yes then, what methods do they use for killing?
a. Trap
b. Bhala
c. Stones
d. Others

XI. Have you known anyone involved in illegal poaching of Hispid Hare? A) YES B)NO
If yes, do you know where do they belong to?
a. Same village
b. Another village
c. Not known anyone such
d. Place of poacher unknown

XII. Why do you think people kill Hispid Hare?
a. Flesh
b. Others

XIII. Do you know any ecological benefits of Hispid Hare?
Please explain:

XIV. Do you know Hispid hare is a protected animal in Nepal and anyone found guilty in illegal poaching is punished by the government authorities? A) YES B) NO
If yes, how did you know?
Please explain:

XV. What do you think, which steps should be taken by the government to protect Hispid Hare?
a. Enforcing strict law
b. Habitat management
c. Raising awareness
d. Managing fire periods in grassland
e. Others

XVI. Do you think Hispid Hare needs to be protected?

a. Strongly agree
b. Agree
c. No idea
d. Disagree
e. Strongly disagree

If so, why?

3. RESULTS OF VEGETATION AND PELLET SURVEY

Table1. Frequency, Relative frequency, Density and Relative density of the grass species

Name of the grass species	Frequency	Relative frequency	Density/m²	Relative density/m²
Oxalis corniculata	72.16	16.12	1.85	21.19
Sacchharum munj	56.7	12.67	1.46	10.8
Narenga porphyrcoma	61.85	13.82	1.59	24.59
Impereta cylindrica	54.63	12.21	1.4	12.46
Sacchharum spontaneum	48.45	10.83	1.24	5.55
Demostachys binnata	42.26	9.44	1.08	3.59
Grewia asiatica	12.37	2.76	0.31	0.56
Cynodon dactylon	72.16	16.12	1.85	20.1
Cymbopogan flexuosus	26.8	5.99	0.69	1.13

Table2. Number of grass species in each study sites

Name of the grass species	TLM	SGP	BKP	SLP	P24	P26	SRP	BLP	HKP	TOTAL
Oxalis corniculata	175	0	117	74	150	148	0	11	0	675
Sacchharum munj	33	39	97	58	44	23	22	21	7	344
Narenga porphyrcoma	125	213	221	68	2	0	99	34	21	783
Impereta cylindrica	55	26	195	57	4	8	18	6	28	397
Sacchharum spontaneum	19	14	71	20	16	13	4	6	14	177
Demostachys binnata	14	14	17	8	19	38	2	2	0	114
Grewia asiatica	5	3	6	2	0	0	1	4	0	18
Cynodon dactylon	60	14	82	111	116	125	67	36	29	640
Cymbopogan flexuosus	2	5	7	6	8	3	0	5	0	36

Table3. Population density at each study sites

Study Sites	Population Density/ha From Old Pellets	Population Density/ha From Fresh Pellets
TINTALE	0.172	0
SINGHPUR	0.143	0
BARKAULA	0.344	0.601
SILALEKH	0.086	0
PILLAR24	0.143	0
PILLAR26	0.029	0
SUNDARPUR	0.086	0
BALUWAPOKHARI	0.057	0
HATTIKUNDA	0	0.086

Table4. Pellet density at each study sites during study period

Study Sites	Pellet Density/ha From Old Pellets	Pellet Density/ha From Fresh Pellets
TINTALE	1.546	0
SINGHPUR	1.289	0
BARKAULA	3.092	2.319
SILALEKH	0.773	0
PILLAR24	1.289	0
PILLAR26	0.258	0
SUNDARPUR	0.773	0
BALUWAPOKHARI	0.515	0
HATTIKUNDA	0	0.773

4. PHOTOES PROVIDED TO THE RESPONDENTS

Source: shutterstock.com

5. GPS CO-ORDINATES:

S.N.	SITES	LAT	LON
1	TINTALA	28.82272	80.187333
2	TINTALA	28.822521	80.186919
3	TINTALA	28.82233	80.186445
4	TINTALA	28.822078	80.18601
5	TINTALA	28.821881	80.185551
6	TINTALA	28.821783	80.185027
7	TINTALA	28.821527	80.184606
8	TINTALA	28.821381	80.184114
9	TINTALA	28.821214	80.183631
10	TINTALA	28.821134	80.183108
11	TINTALA	28.820903	80.182648
12	TINTALA	28.818249	80.177323
13	TINTALA	28.817931	80.176303
14	TINTALA	28.817763	80.175257
15	TINTALA	28.817595	80.174209
16	TINTALA	28.81737	80.173225
17	SINGHPUR	28.815943	80.222496
18	SINGHPUR	28.815556	80.222276
19	SINGHPUR	28.81516	80.222049
20	SINGHPUR	28.814764	80.221812
21	SINGHPUR	28.81433	80.221619
22	SINGHPUR	28.813944	80.221351
23	SINGHPUR	28.813567	80.221062
24	SINGHPUR	28.81317	80.220805
25	SINGHPUR	28.812802	80.220514
26	SINGHPUR	28.812472	80.220126
27	BARKAULA	28.85594	80.151888
28	BARKAULA	28.85592	80.152944
29	BARKAULA	28.85547	80.153916
30	BARKAULA	28.85503	80.154888
31	BARKAULA	28.85444	80.155694
32	BARKAULA	28.85392	80.156444
33	BARKAULA	28.85342	80.157222
34	BARKAULA	28.85267	80.158166
35	BARKAULA	28.851833	80.158666
36	BARKAULA	28.851361	80.159027
37	BARKAULA	28.850888	80.157722
38	BARKAULA	28.851527	80.156972
39	BARKAULA	28.852194	80.15625

40	BARKAULA	28.853083	80.155166
41	BARKAULA	28.853625	80.154722
42	BARKAULA	28.854722	80.153277
43	BARKAULA	28.85525	80.1525
44	BARKAULA	28.85535	80.15263
45	BARKAULA	28.85696	80.15241
46	BARKAULA	28.857197	80.152934
47	SILALEKH	28.837107	80.140857
48	SILALEKH	28.836857	80.140496
49	SILALEKH	28.836774	80.13983
50	SILALEKH	28.836774	80.13933
51	SILALEKH	28.836718	80.13877
52	SILALEKH	28.836885	80.138246
53	SILALEKH	28.837246	80.137691
54	SILALEKH	28.837496	80.13719
55	SILALEKH	28.837802	80.13677
56	SILALEKH	28.838028	80.136272
57	SILALEKH	28.838255	80.13583
58	SILALEKH	28.838453	80.135367
59	PILLAR24	28.815277	80.140468
60	PILLAR24	28.81587	80.140751
61	PILLAR24	28.816314	80.140943
62	PILLAR24	28.816674	80.14123
63	PILLAR24	28.817052	80.1415
64	PILLAR24	28.817515	80.141629
65	PILLAR24	28.817892	80.14194
66	PILLAR24	28.818288	80.142133
67	PILLAR24	28.818637	80.142477
68	PILLAR24	28.819035	80.142724
69	PILLAR24	28.81955	80.142675
70	PILLAR24	28.819662	80.133941
71	PILLAR26	28.80375	80.150611
72	PILLAR26	28.803527	80.151638
73	PIILLAR26	28.803333	80.152666
74	PILLAR26	28.803277	80.153666
75	PILLAR26	28.802972	80.154638
76	PILLAR26	28.803057	80.155145
77	PILLAR26	28.803142	80.15566
78	PILLAR26	28.803236	80.156175
79	PILLAR26	28.803311	80.15669
80	PILLAR26	28.803442	80.157173
81	PILLAR26	28.803537	80.157678

82	PILLAR26	28.80365	80.158174
83	SUNDARPUR	28.852944	80.165916
84	SUNDARPUR	28.851916	80.1655
85	SUNDARPUR	28.851138	80.165583
86	SUNDARPUR	28.85025	80.165722
87	SUNDARPUR	28.849854	80.165539
88	SUNDARPUR	28.849461	80.16526
89	SUNDARPUR	28.849066	80.165028
90	SUNDARPUR	28.848719	80.16475
91	BALUWAPOKHARI	28.828472	80.152145
92	BALUWAPOKHARI	28.82887	80.152068
93	BALUWAPOKHARI	28.829321	80.15206
94	BALUWAPOKHARI	28.8297	80.152081
95	BALUWAPOKHARI	28.830246	80.15208
96	HATTIKUNDA	28.81853	80.13912
97	HATTIKUNDA	28.818435	80.139607

6. SNAPSHOTS OF THE FIELD:

1. TINTALE MACHAN, SHUKLAPHANTA GRASSLAND

Tintale area, open and with newly growing grasses

The old degenerated pellets of Hispid Hare in the Tintale area

Grassland fire practice observed during field

Overgrazing by the cattle

2. SINGHAPUR GRASSLAND

Burnt area in Singhapur, old pellets of Hispid Hare

Feeding signs and half burnt pellets of Hispid Hare

3. BARKAULA GRASSLAND

Fresh pellets in Barkaula

Fresh pellets of Hispid Hare and Swamp deer

Old pellets of Hispid Hare near forest

Fresh pellets of Hispid Hare near Barkaula post

Feeding signs of Hispid Hare

Fresh pellets of Hispid Hare

4. SILALEKH, SHUKLAPHANTA GRASSLAND

Old pellets of Hispid Hare

Old pellets and feeding signs of Hispid Hare

5. PILLAR No. 24, SHUKLAPHANTA GRASSLAND

Old burnt pellets of Hispid Hare

Perennial invasion by *Bombax ceiba* in the grassland

6. PILLAR NO. 26, SHUKLAPHANTA GRASSLAND

Old pellets of Hispid Hare

Lantana camara observed near Shuklaphanta post

7. SUNDARPUR GRASSLAND

Heap of old pellets in the roots of *Narenga porphyrcoma*

8. BALUWAPOKHARI, SHUKLAPHANTA GRASSLAND

Old pellets and feeding signs of Hispid Hare

9. HATTIKUNDA, SHUKLAPHANTA GRASSLAND

Fresh pellets of Hispid Hare

Fresh pellets of Hispid Hare

Collecting fresh pellets of Hispid Hare

With Field Expert, Mr. Phiru Chaudhary