DISTRIBUTION AND HABITAT PREFERENCE OF GORAL

(*Naemorhedus goral*)

IN

API NAMPA CONSERVATION AREA, NEPAL

THESIS

SUBMITTED TO THE

FOREST RESEARCH INSTITUTE (DEEMED) UNIVERSITY

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BY

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UNDER THE SUPERVISION OF

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2014-2016

DECLARATION

I hereby declare that the thesis entitled "Distribution and habitat preference of Goral (Naemorhaedus goral) in Api nampa conservation area, Nepal" is a record of bonafide work carried out by me under the guidance of ***Dr. S. Sathyakumar,*** *Scientist G, Wildlife Institute of India, Dehradun and no part of this work has been submitted for any other degree or diploma to any institution or university.*

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This is to certify that the thesis entitled "Distribution and habitat preference of Goral(Naemorhaedus goral) in Api nampa conservation area, Nepal" is an original record of confide research work carried out by Mr. Pemba Sherpa, student of M.Sc. Forestry (2014-2016) of Forest Research Institute (Deemed) University, Dehradun and submitted in partial fulfillment of the requirement for M.Sc. Forestry Degree Programme.

This work has been carried out under the supervision of Dr. S. Sathyakumar, Scientist G, Department of Endangered Species, Wildlife Institute of India, Dehradun. No part of this thesis has been submitted for any degree or diploma to any other institute or university.

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ABSTRACT

This study was conducted aiming at determining distribution and habitat preference of Himalayan Goral (Naemorhedus goral) in Api Nampa Conservation Area, Darchula, Nepal in April/May, 2016. Line transects (n=12, 48 km effort) were sampled to assess the distribution of this species. Direct observations of animals, fecal pellets in different habitat types and records of other topographic variables were used to assess habitat preference of goral. A total of five individuals and 31 pellet groups of goral were recorded. The survey through faecal pellets showed that gorals were distributed from 1115 m to 3400 m asl, in ANCA. Six Forest types / habitat types were used by the goral: Subtropical forest, Chirpine forest, Quercus forest, grassland and rocky cliffs. The highest number of fecal deposits was recorded on grassland followed by rocky cliff and subtropical forests. Gorals preferred south facing steep slopes of $>50^0$ and most preferred elevation range was 2000 m to 3000 m.

Key words: Api Nampa Conservation Area, Ivlev's Electivity Index, habitat preference, rocky cliffs, faecal pellets, elevation.

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ABBREVIATION

ANCA	Api Nampa Conservation Area
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DBH	Diameter at Breast Height
DNPWC	Department of National Parks and Wildlife Conservation
GIS	Geographic Information System
GoN	Government of Nepal
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
IV	Ivlev's Electivity Index
IVI	Important Value Index
KCA	Kanchanjunga Conservation Area
KSL	Kailash Sacred Landscape
MFSC	Ministry of Forest and Soil Conservation
N.E.	North East
NTFP	Non Timber Forest Product

CHAPTER 1: INTRODUCTION

1.1 Background

The Himalaya has many magnificent mountain ungulates that are widely known for their diversity and splendor. They have always been admired by explorers, adventurers, naturalists, hunters and the common man for their beauty, sure-footedness, and their ability to survive in steep and rugged terrain under harsh climatic conditions. Mountain ungulates have remained least studied as their habitats are in the remote high altitudes of the Himalaya where conditions are inhospitable. The rapid human and livestock population growth in the Himalaya in the last five decades have led to habitat loss, habitat degradation, poaching, trade, wildlife-human conflicts and consequently have seriously threatened several mountain ungulate species and their habitats in their natural environment. Conservation of these mountain ungulates is crucial as they form the prey base of the elusive snow leopard and other large carnivores, and some of them are of international importance. Undoubtedly, protection to these mountain ungulates and their habitats is of prime concern and also the need for efficient wildlife management based on scientific information (Sathyakumar & Bhatnagar, 2002).

Goral (*Naemorhedus goral*) is listed in Appendix I (threatened with extinction) of CITES and listed as Near Threatened in IUCN Red List of Threatened Species (Duckworth & MacKinnon, 2008). Goral is diurnal, and are most active in the early morning and late evening. Males usually single; otherwise found in pairs or small parties. They typically live in small groups of 4-12 individuals. Goral feed on grassy ridges and steep rocky slopes. The diet consists of grasses, leaves, twigs, fruits, and nuts. The gestation length is 170-218 days, with single births. Males and females reach sexual maturity at three, with a lifespan of up to 15 years (Prater, S. H., 1971 & Poudel, 2009).

Goral occur in seven National Parks in Nepal including Khaptad National Park, Rara National Park, Langtang National Park, Makalu-Barun National Park, Bardia National Park, Sagarmatha National Park and Shey-Phoksundo National Park, as well as in the Annapurna Conservation Area, Dhorpatan Hunting Reserve and Parsa Wildlife Reserve (Duckworth & MacKinnon, 2008). Goral are also widely distributed and locally common in the Kanchenjungha Conservation Area and also known to occur outside KCA in Taplejung district (Poudel, 2009). It is believed that they are also distributed in Mahabharata Range of country along with Mahabharata Goral Conservation Area, notified by local communities. Population and distribution of goral in Nepal is still unknown due to lack of scientific studies,

but their numbers are thought to be small. There is not any scientific study on ecology and biology of this species in Nepal (Thapa *et. al.,* 2011). So this study aimed to provide information on distribution and habitat preferences of goral in a focused study area. Results of this study are expected to play vital role for the proper management of goral in Api Nampa Conservation Area, Nepal.

1.2 Rationale for the study

The Goral is native to Asia, but its population continues to decline due to habitat fragmentation, competition and habitat overlap with livestock. The conservation of goral is therefore a global concern. The Government of Nepal is protecting endangered flora and fauna, including goral, which is reported in the different parts of the alpine regions of Nepal. The Government of Nepal has established the Department of National Parks and Wildlife Conservation for the conservation of endangered flora and fauna. These flora and fauna are being depleted day by day due to over exploitation, pollution, habitat destruction, poaching and human and livestock pressure (HMGN/MFSC, 2002).

People in the Himalayas have hunted goral for commercial purposes since the early 1970's and continued habitat destruction and overgrazing remain the main causes of the decline in goral populations. There are high pressures on goral populations due to heavy poaching, habitat use by livestock, grazing and non-timber forest product collection in its habitats. High rates of poaching in the ANCA have been reported (Aryal & Kreigenhofer, 2009 & HMGN/MFSC, 2002). Grazing, illegal poaching and habitat fragmentation are the most significant threat to the gorals habitat in Nepal, however detailed information on population declines and interactions with ecological parameters is lacking in Nepal (Thapa *et. al.,* 2011).

Detailed information on its status is unknown, with information on feeding, habitat use and influence of human and livestock activity on its distribution and survival lacking (Thapa *et. al.,* 2011). Very few studies have been conducted in Nepal on this species. This study was therefore conducted to establish detailed information on the distribution and habitat preferences of goral in the study area. This study in the Api Nampa Conservation Area therefore provides an important addition to the existing database of knowledge regarding the distribution of goral in Nepal. The findings of the study would be useful to the proper management of the goral population, and provide management prescriptions to ensure long-termed survival in its natural habitat.

1.3 Objectives

The objectives of the present study are:

1. To assess the distribution of goral in Api-Nampa Conservation Area.
2. To assess the habitat preference of goral in Api-Nampa Conservation Area.

Himalayan Goral **(***Naemoraedus goral goral***)**

CHAPTER 2: REVIEW OF LITERATURE

Goral (*Naemorhedus goral*) is listed in Appendix I (threatened with extinction) of CITES and listed as Near Threatened in IUCN Red List of Threatened Species (Duckworth & MacKinnon, 2008). Goral is diurnal, and are most active in the early morning and late evening. Males usually single; otherwise found in pairs or small parties. They typically live in small groups of 4-12 individuals. Goral feed on grassy ridges and steep rocky slopes. The diet consists of grasses, leaves, twigs, fruits, and nuts. The gestation length is 170-218 days, with single births. Males and females reach sexual maturity at three, with a lifespan of up to 15 years (Prater, S. H., 1971 & Poudel, 2009). Goral, also called Himalayan goral is closely related in sharing the characteristics of true goat, sheep, and antelope. Two subspecies of goral are recognized *Naemorhedus goral goral*, *and Naemorhedus goral bedfordi* (Wilson & Reeder, 1993). Grey goral (*Naemorhedus goral*) is considered to be a "goat-antelope" which are distributed in middle slopes of Himalayas and is endemic to Asia (Zhiwotsechenko, 1990; Singh & Singh, 1986). They are distributed along the southern foothills of Himalayan Mountains in India, Pakistan and Nepal, through Sikkim, Bhutan, and Assam and into northernmost Burma and Thailand (Hayman, 1961 & Schaller, 1967).

Two subspecies of goral occur in India, *viz*., the **Grey goral** (*N.g.goral*) distributed in the Western Himalaya (upto 3,300m) and Shiwaliks in the states of Jammu & Kashmir, Himachal Pradesh, Uttaranchal and Haryana; and the Brown goral (*N.g.hodgsni*) in the Eastern Himalayas and the hills of N.E. India in the states of Sikkim, northern West Bengal, Arunachal Pradesh, Nagaland, Meghalaya and Mizoram. Another species, the Red goral (*Nemorhaedus baileyi*) is reported to occur in a small region in Arunachal Pradesh at the junction of Tibet, Yunnan and Myanmar (Sathyakumar & Bhatnagar, 2002).

In India, gorals are distributed in Jammu and Kashmir, Himachal Pradesh (Cavallini, 1990), Uttaranchal Pradesh (Singh & Singh, 1986), Kedarnath Wildlife Sanctuary (Green, 1987), Sikkim and Arunachal Pradesh (Sathyakumar, 2003).

In China, goral are distributed throughout central and eastern part of the country although they live in many provinces of the country (Dolan, 1963).

In Bhutan, gorals are distributed in Jigme Singye Wangchuk National Park, Royal Manas National Park (Green, 1987), Thrumsingla National Park and Jigme Dorji National Park (Johnsingh, 1989).

Goral occur in eight National Parks in Nepal including Khaptad National Park, Rara National Park, Langtang National Park, Makalu-Barun National Park, Bardia National Park, Sagarmatha National Park, and Shey-Phoksundo National Park, as well as in the Annapurna Conservation Area and Dhorpatan Hunting and Parsa Wildlife Reserve (Duckworth & MacKinnon, 2008). Goral are widely distributed and locally common in the Kanchenjungha Conservation Area and also known to occur outside KCA in Taplejung district (Poudel, 2009). It is believed that they are also distributed in Mahabharata Range of country along with Mahabharata Goral Conservation Area, notified by local communities (Thapa *et. al.,* 2011). Population and distribution of goral in Nepal is still unknown due to lack of scientific studies, but their numbers are thought to be small. There is not any scientific study on ecology and biology of this species in Nepal (Thapa *et. al.,* 2011).

Goral reportedly occurs in several protected areas, Mahabharat range and steep mountainous areas outside protected area system in Nepal. A good population of goral believed to occur in Mahabharat Goral Conservation Area in Nawalparasi and Palpa Districts of Nepal (Thapa *et. al.,* 2011).

Goral inhabit sparsely wooded slopes with open grassy patches in a wide range of habitats that includes alpine meadows, subalpine forests, temperate forests, subtropical pine forests, tropical moist deciduous forests of Shiwaliks, and Montana wet temperate and evergreen forests in N.E. India (Sathyakumar & Bhatnagar, 2002).

Goral's habitat choice is liberal. Schaller (1967) and Mishra (1993) found that group of goral species use mostly steep and rocky areas having sufficient cover and food plants (Lovari, 1986; Green M. J., 1981 & Cavallini, 1992). Slope is also major component for suitable habitat of goral. Goral mostly preferred steep slopes and top of hills. Slope areas provide safe place for the animals from different human activities as well as from predators (Thapa *et. al.,* 2011).

Study area: **Oak forest** (1800 masl)

CHAPTER 3: STUDY AREA

Study Area

Api-Nampa Conservation Area is newly established conservations area of Nepal. It is established in 2010 and located between N29°30' to N30°15' and E80°22' to E81°09', in the Far-Western Development Region of Nepal. With coverage of 1,903 km^2 (735 sq. mi) encompassing 21 Village Development Committees in the Darchula District. ANCA is delineated by Bajhang District in the east, the Mahakali River (which borders India) in the west, the border with Tibet, China to the north and Lasku and Naugaad Khola to the south. It ranges in elevation from 539 to 7,132 m (1,699 to 23,399 ft) at the Himalayan peak Api, and is within the circumscribed area of the Kailash Sacred Landscape (2013) (GoN/MFSC, 2015).

The local climate is generally characterized by high rainfall and humidity. However, the climatic conditions of vary widely with elevation from subtropical to alpine. Within the elevation range of 1800 to 6500 meters there are limited subtropical valleys in the south, as most of the area is ecologically temperate or high-land. A cold, generally dry climate exists in the high alpine valleys just north of the southern arm of the Himalaya that cuts across southern Darchula (GoN/MFSC, 2015).

ANCA lies within Himalayan Biodiversity Hotspots due to its diverse array of eco-regions, ecosystems, and biomes where many endangered and endemic species of flora and fauna are inhabited (Conservation International, 2005). Among 200 globally important eco-regions, ANCA represents Western Himalayan temperate Forest, which occurs between 1500-2600m and comprises of varieties of oak species *(Quercus semecarpifolia, Q. dilatata, Q. lamellosa and Q. incana)* with Pinus, Abies, Picea and deodar species at higher altitude (Zomer *et. al.,* 2013). Major eco-regions which represent unique habitat types in ANCA are as follows:

Himalayan subtropical broadleaf forest: This eco-region lie form 500 m to 1000 m and extends from east to west. Subtropical broadleaf hill forest comprising Sal *(Shorea robusta)* occurs in the lower altitude while early-successional species such as *Alnus nepalensis* occur along the landslide areas and forms mono-specific stands with *Albizia species* (Zomer & Oli, 2011).

Himalayan subtropical pine forest: It extends between 1000-2000 m and *Pinus roxburghii* is the major forest type found in the region (HMGN/MFSC, 2002).

Western Himalayan temperate/broadleaf forest: This eco-region is one of the 200 globally important eco-regions which lie between 1500-2600 m altitudes. The species of Oak *(Quercus semecarpifolia, Q. dilate, Q. lamellosa and Q. incana)* are dominant on the north-facing slopes and along the higher elevations, sometimes mixed with conifers such as *Pinus, Abies, Picea* and *Cedrus* (Zomer *et. al.,* 2013).

Western Himalayan subalpine conifer forest: This eco-region extends between 3,000 m to 3,500 m where extensive conifer forests with species such as blue pine, silver fir, Himalayan fir, spruce mixed with oaks are more dominant. Moreover, this region is very rich in economically valuable NTFPs (Zomer & Oli, 2011)

Western Himalayan alpine shrub and meadows: It extends between 3000 m and 5000 m altitudes where alpine scrub flora such as dwarf *Rhododendron species* is dominant along with shrubby species *Hippophae tibetana, Cotoneaster microphyllus, Juniperus spp.* whereas herbaceous species such as *Anaphelis spp., Aster spp., Cyananthus spp., Jurinia spp., Morina spp.,* and *Potentilla*, etc. are dominant in alpine meadow (HMGN/MFSC, 2002).

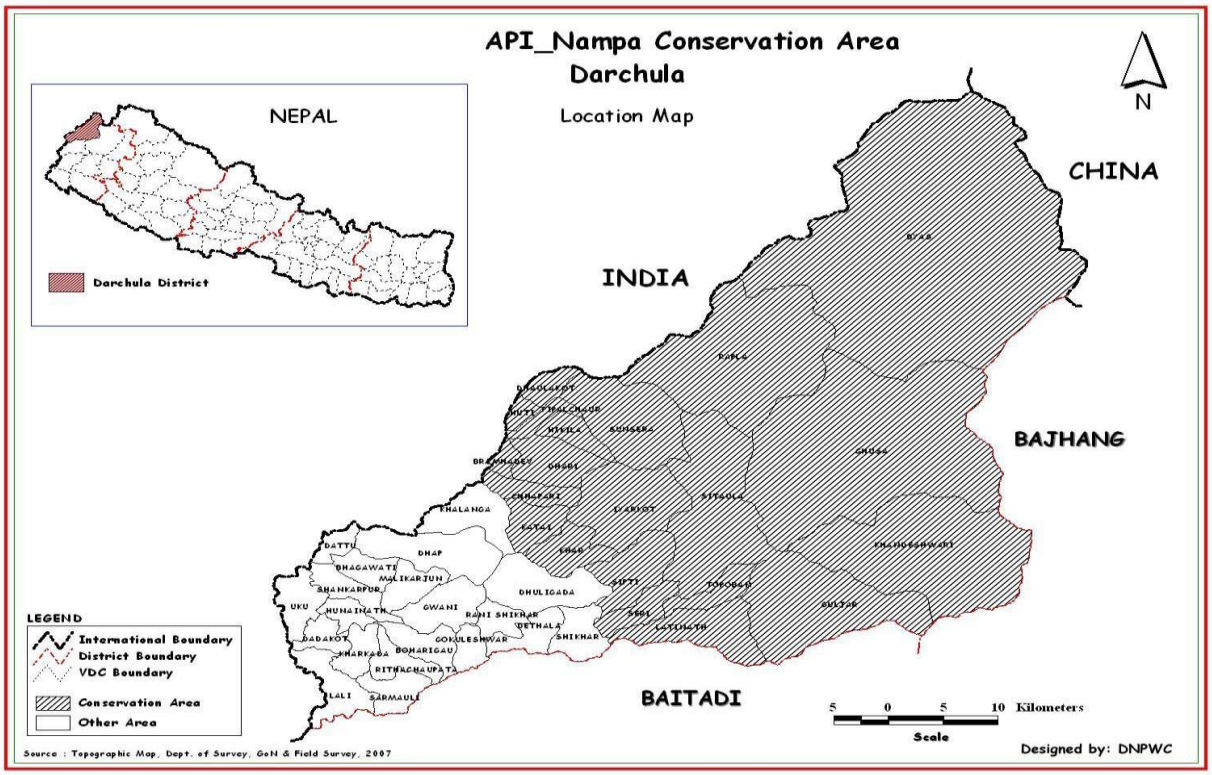

Figure 1: Location map of Api-Nampa Conservation Area

CHAPTER 4: METHODOLOGY

Information on the existing physiographic condition, distribution, status, threats were collected from the review of secondary sources like books, reports, thesis, journals, etc. Primary data were collected directly from field through direct observation, habitat strata, fecal pellets, footprints as well as consultation with key informants and locals. A preliminary field survey backed by semi-structured questionnaires and informal interviews with local villagers, herders, forest ranger and hotel staff was done to identify potential habitats of goral.

4.1 Distribution Map

A distribution map was prepared on the basis of ground truth GPS data. Local knowledge was used to identify potential goral habitat. A questionnaire survey was conducted with the local people to establish areas of presence and absence throughout the Conservation Area. Twelve transect of 1 km in length were randomly laid out in the transect layout map. Elevation was the main base for transect layout in the study area. Four elevation zones were mapped out as below 1000m, 1000-2000m, 2000-3000m and above 3000m. During primary data collection, each transect were surveyed twice with 24 km of total effort.

Presence-absence of goral was verified in each elevation zone and forest area and locations recorded with GPS. At each potential site, general habitat characteristics including elevation, slope, land use, crown cover and ground cover were noted. Arc GIS-10 software and Landsat ETM images were utilized to produce a goral distribution map of the study area based on the current distribution area, forest types and habitat use.

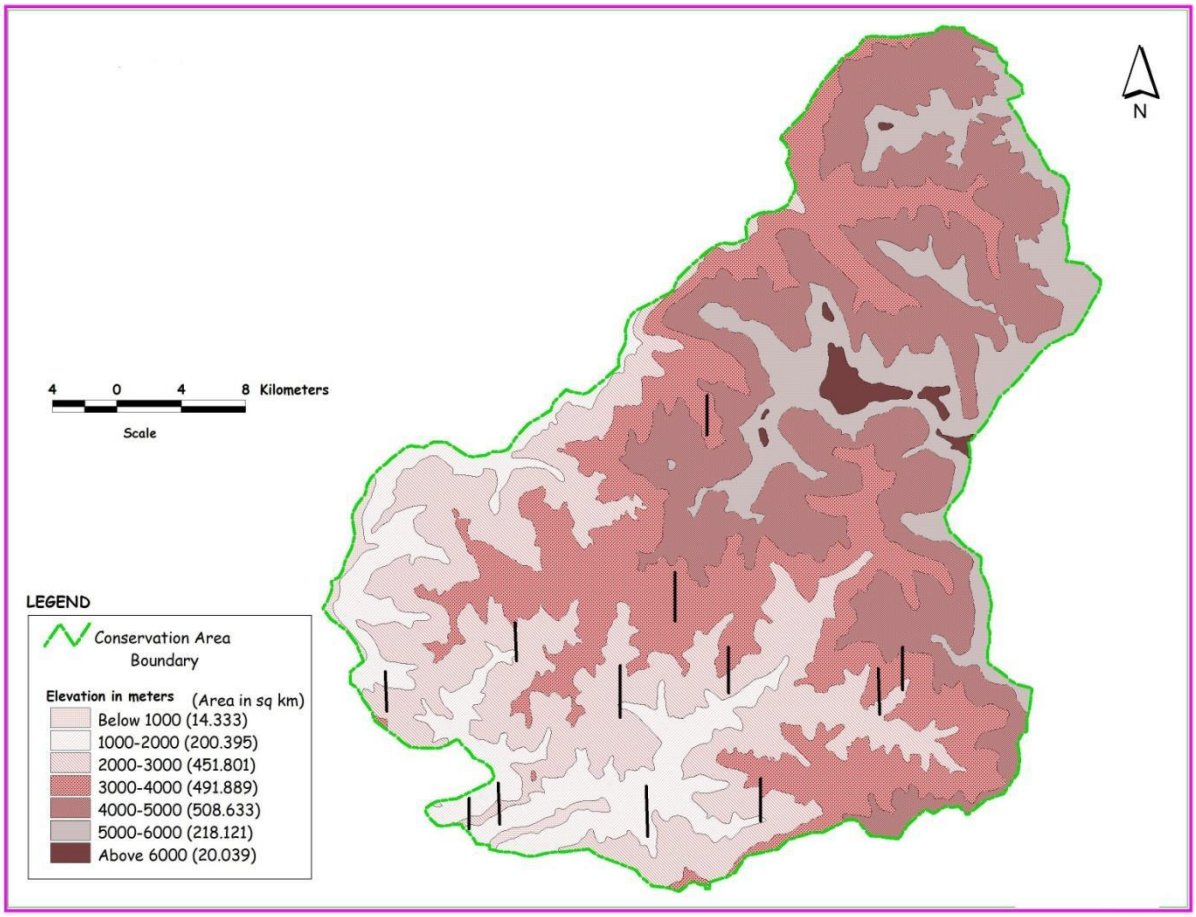

Figure 2: Location of transects on elevation profile of ANCA

4.2 Habitat Preference

Hall, Krausman, & Morrision (1997) defined "habitat use" as the way an animal uses (or consumes in a generic sense) a collection of physical and biological components (i.e., resources) in a habitat. Hall, Krausman, & Morrision (1997) defined "habitat availability" as how accessible and procurable physical and biological components of a habitat are to animals.

Habitat use and availability plots were laid throughout the study area. Habitat use plots (U) were laid out in areas where goral signs (direct sighting, scats, hair, foot prints, resting sites, etc.) were found. Parameters including slope, altitude, crown cover, ground cover and land features were recorded for these plots. Simultaneously, habitat availability plots (A) were laid out in a random direction with a distance of 100 m between each plot (Aryal & Kreigenhofer, 2009) and the same parameters as mentioned above were also recorded in these plots. Where signs of goral were observed in the habitat availability plots, those plots' status were changed to "habitat use" as "habitat availability" plots should not contain any signs of goral.

Habitats of study area were classified into five forest type categories namely Himalayan subtropical broadleaved forest which comprises *Shorea* forest in lower altitude and *Alnus* stands in landslide areas, Chir pine forest, Oak forest, Sub-alpine conifer forest and rocky cliffs. Habitat variables such as altitudes, aspects, slope, and topography were recorded during transect walk.

The quadrat size was selected as suggested by (Schemnitz, 1980) for vegetation analysis in both the use and availability plots, being: 10m ×10m for the tree layer, (plants above 3m height and 5 cm DBH), 4m × 4m for the shrub layer (woody plants below 3m in height), and 1m × 1m plots for herbs (plants up to 1m in height). In each plot DBH, height and crown cover of trees were recorded as well as ground cover, number of trees, frequency of shrubs and herbs, signs of other animals, and any anthropogenic pressures. Different livestock signs were recorded in each plot to analyze any habitat overlap between other livestock and goral.

4.2.1 Ivlev's Electivity Index

The habitat preference of goral was analyzed using Ivlev's electivity index (IV) where positive values indicate preference, negative values indicate avoidance, and 0 values indicate random use. Values of this index range from -1.0 to +1.0. Following the IV, the following formula was used to calculate of habitat preference of goral:

IV= (U - A) / (U + A) (Ivlev, 1961).

Where "A" represents "availability plots" and "U" represents "use plots". Habitat preference based on different habitat parameters such as elevation, slope, trees, shrubs, herbs was analyzed. A one-way ANOVA was used to test for significant levels of preference for the different habitat parameters with the null hypothesis being that all habitats are used in proportion to their availability.

Forest type preference was analyzed by percentage of fecal recorded to each categories forest types.

4.2.2 Vegetation Analysis

The vegetation data collected was used to calculate species richness, density, relative density, frequency, and relative frequency of the trees and shrubs in the study area by using the following calculations:

$$\text{Density of species A} = \frac{\text{Total number of individuals of species A}}{\text{Total number of plots surveyed} * \text{Area of plot}}$$

$$\text{Relative density of species A} = \frac{\text{Total number of individual of species A}}{\text{Total number of individuals of all species}}$$

$$\text{Frequency of species A} = \frac{\text{Number of plots in which species A occurs} * 100}{\text{Total number of plot samples}}$$

$$\text{Relative Frequency of species A} = \frac{\text{Frequency value of species A} * 100}{\text{Total frequency value of all species}}$$

$$\text{Relative dominance of species A} = \frac{\text{Total basal area of species A} * 100}{\text{Total basal area of all species}}$$

Importance Value Index (IVI) was calculated as**:** IVI = Relative density + Relative frequency + Relative dominance (Panthi, 2009).

CHAPTER: 5 RESULTS

During the study period, Rapla, Sunsera, Ghusa, Bramhadev, Sitaula, Gulzar, Latinath and Khandeswori village development committee areas were visited located in elevations ranging from 1300 m to 3400 m for sampling. The study area represents Himalayan subtropical broadleaved forest to western Himalayan sub-alpine conifer forest zone habitats suitable for goral. Tree species occurring are oak, pines, alder, deodar, fir, spruce, birch and rhododendron. The area is used by grazing livestock and highly disturbed due to movement of local people and others who roam in the jungle for NTFP collection.

5.1 Distribution of goral in ANCA

Goral were found to be distributed in the lower belt of ANCA between 1000 m to 3400 m. Out of 12 transects laid, goral sign was found in 10 transects, means there is high potentiality for goral in ANCA. Goral preferred elevation range was between 1000 m to 3000 m among which 2000 m to 3000 m elevation range (16 signs) was most preferred followed by 1000 m to 2000 m elevation range (11 signs). 4 signs of goral was recorded in a single transect above 3000 m. They avoided elevation range below 1000 m and above 3500 m.

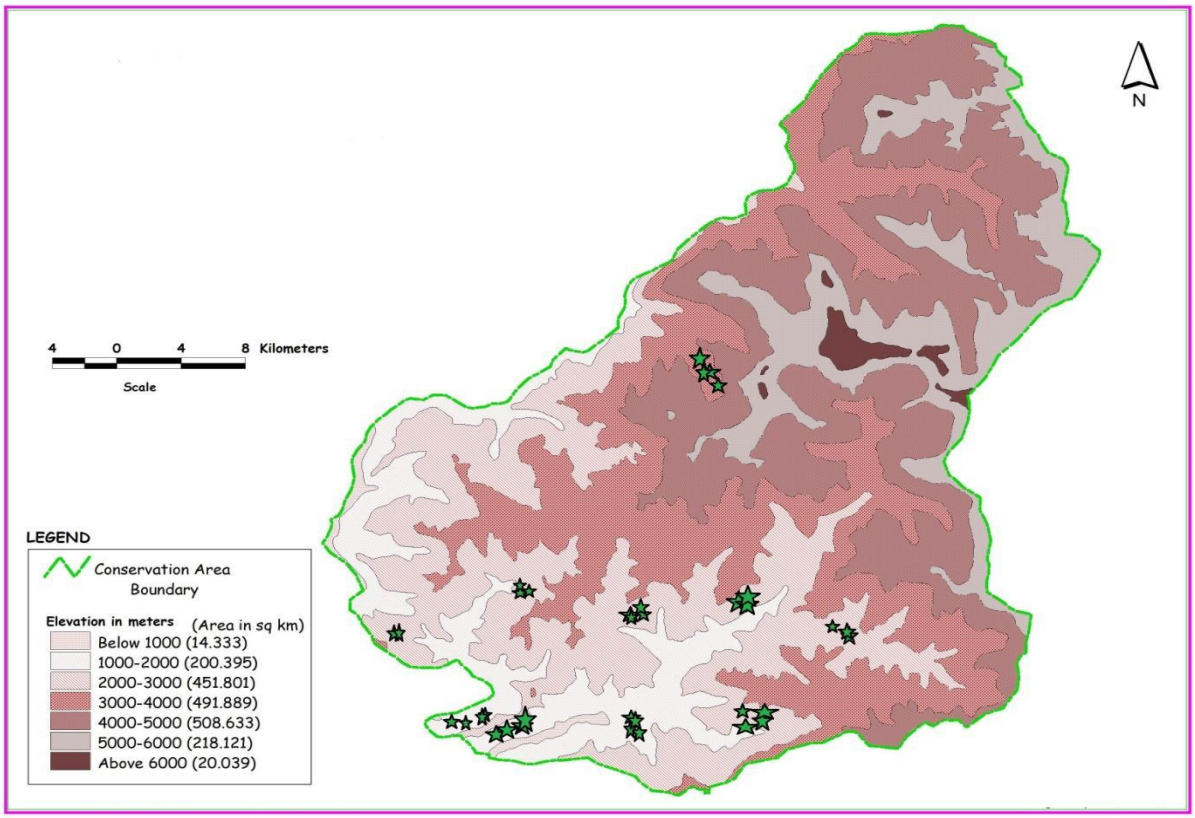

Figure 3: Elevation wise distribution map for goral in ANCA

Land use wisely goral preferred grassland with 13 signs of goral presence followed by forested land (10 signs present) and rocky cliff with 8 signs recorded. They avoided the barren land and shrub land in the study area.

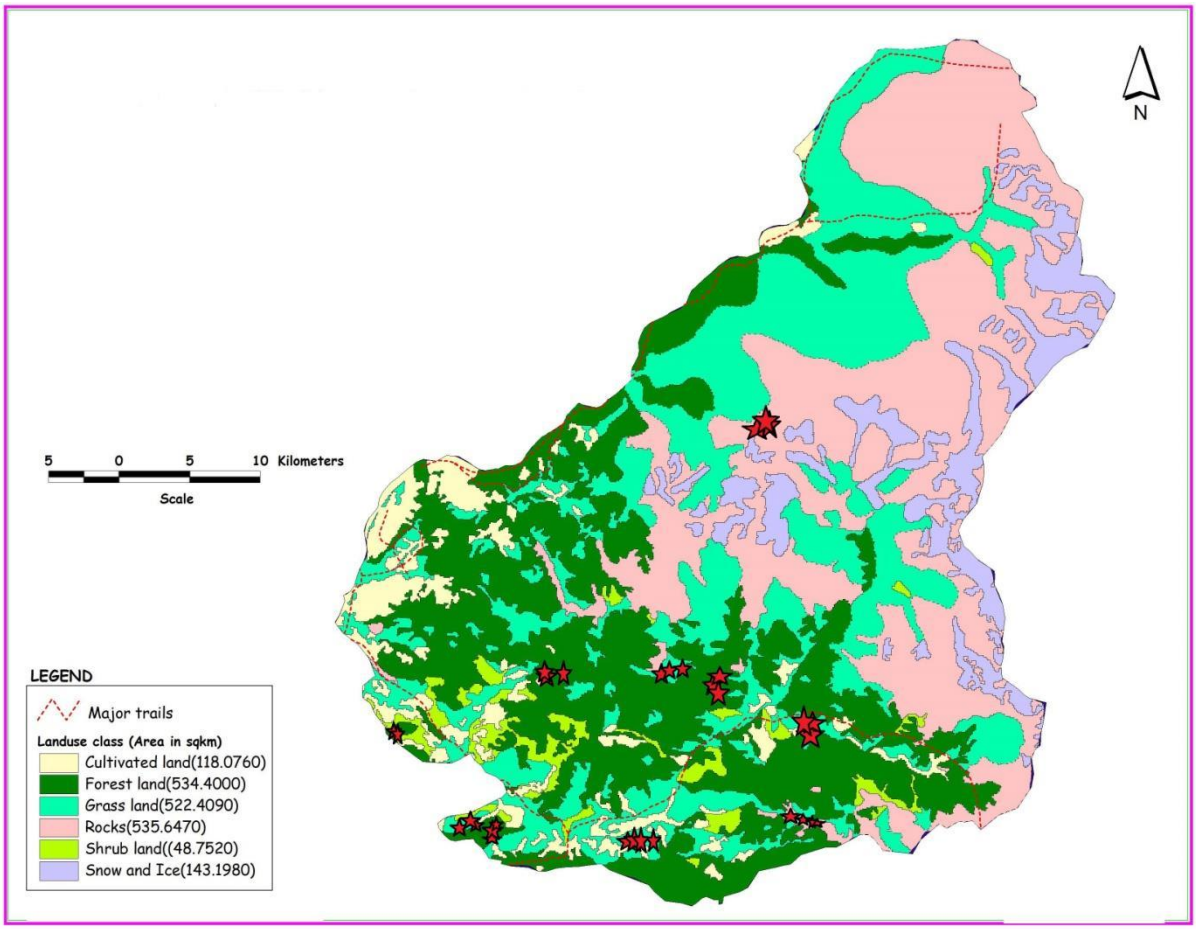

Figure 4: Distribution map of goral by land use in ANCA

5.2 Habitat preference

5.2.1 Elevation

Goral signs were recorded at elevations between 1000 m and 3400 m in ANCA (fig 4). Goral avoid the elevations below 1000 m and preferred areas that gradually increased in altitude from 1000 m to 3000 m. Goral avoided areas at an altitude of >3500 m in the study area and mostly preferred areas from 1000 to 3000 m in altitude (IV = 0.33) (Figure 5). It is observed that gorals in ANCA preferred the elevation as (2000-3000) > (1000-2000) > (>3000) > (<1000).

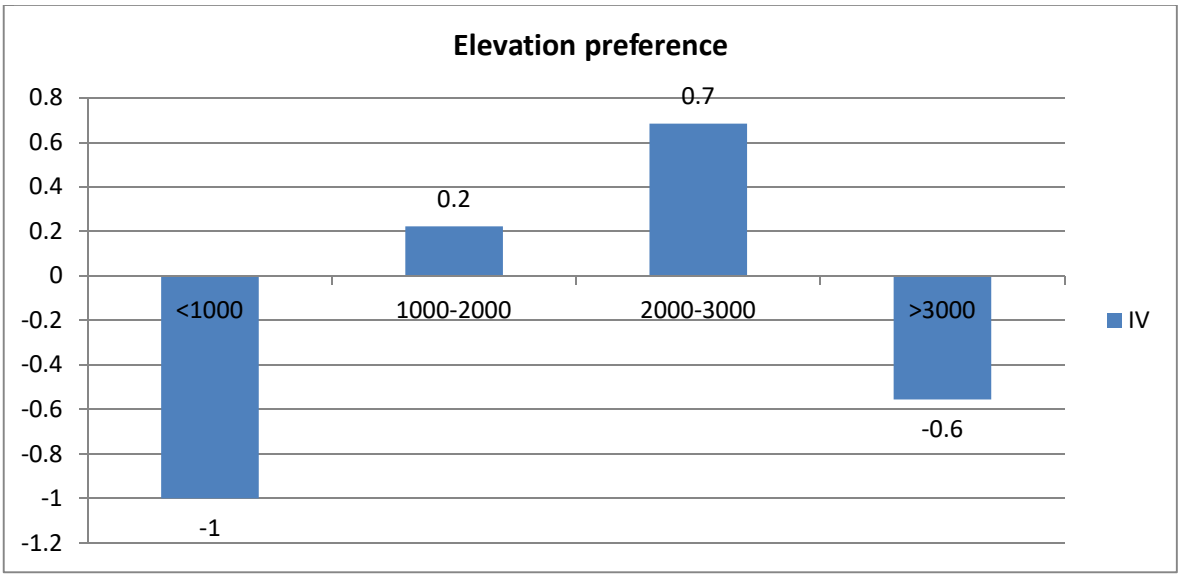

Figure 5: Elevation preference of Goral in Api Nampa Conservation Area, April-May 2016

5.2.2. Slope

Goral signs were recorded along slopes between 10 to 90% slopes (Fig. 6). Goral preferred the slope range of 25-75% and avoided areas with a slope above 76% (IV = -1.0). While they randomly used areas with a slope below the 25%. Steep slope areas (51- 75%) were randomly used by goral as a resting place while gentle slope areas (26- 50%) were much suitable for *Quercus spp, Rhododendron* spp and *Themeda spp.* and these areas were used by goral for feeding and resting (Fig. 5). It is observed that gorals in ANCA preferred the slope as (25-50%) = (50-75%) > (0-25%) > (75-100%).

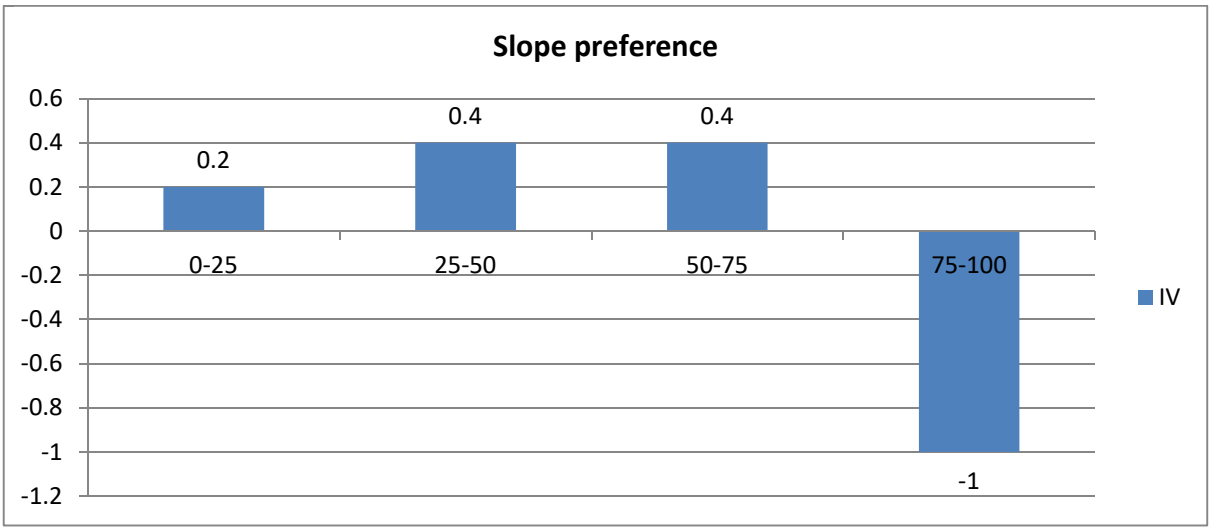

Figure 6: Slope preference of Goral in Api Nampa Conservation Area, April-May 2016

5.2.3. Land use types

Goral preferred grassland (IV = 0.6), followed by cliff (IV = 0.50), and forests with gullies (IV = 0.3). Goral completely avoided barren land (IV = -1.0) and shrub land (IV = -1.0) (Figure 7). It is observed that gorals in ANCA preferred the land use types as Grassland > Rocky cliff > Forest with gullies > Shrub land = Barren land.

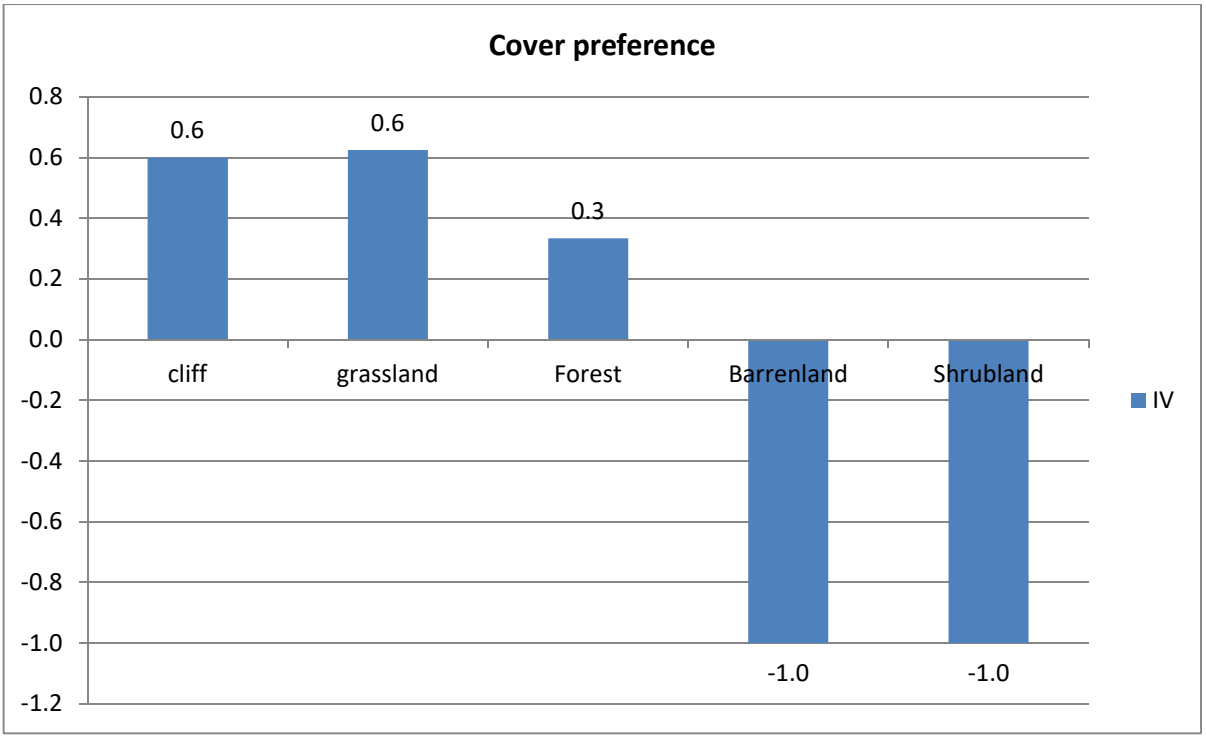

Figure 7: Cover preference by Goral in Api Nampa Conservation Area, April-May 2016

5.2.4 Canopy Cover

Goral uses crown cover for resting, hiding and thermoregulation. Two goral appeared at high crown cover. It highly preferred 51%-75% crown cover (IV= 0.21) followed by 76%-100% (IV=0.08) and 26%- 50% (IV=0.06). It totally avoided 0%-25% (IV= -0.031). The low crown cover was highly disturbed by grazing animals so it was avoided by goral. Several livestock entered into the area from June to September annually for grazing and they were settled at grazing. There was no significant difference in the use of different crown cover proportional to availabilities (F=1.25, p= >0.05). Habitat with 0-25% crown cover was used by goral in ANCA as per its availability. It is observed that gorals in ANCA preferred the crown cover as (25-50%) > (50-75%) > (0-25%) > (75-100%).

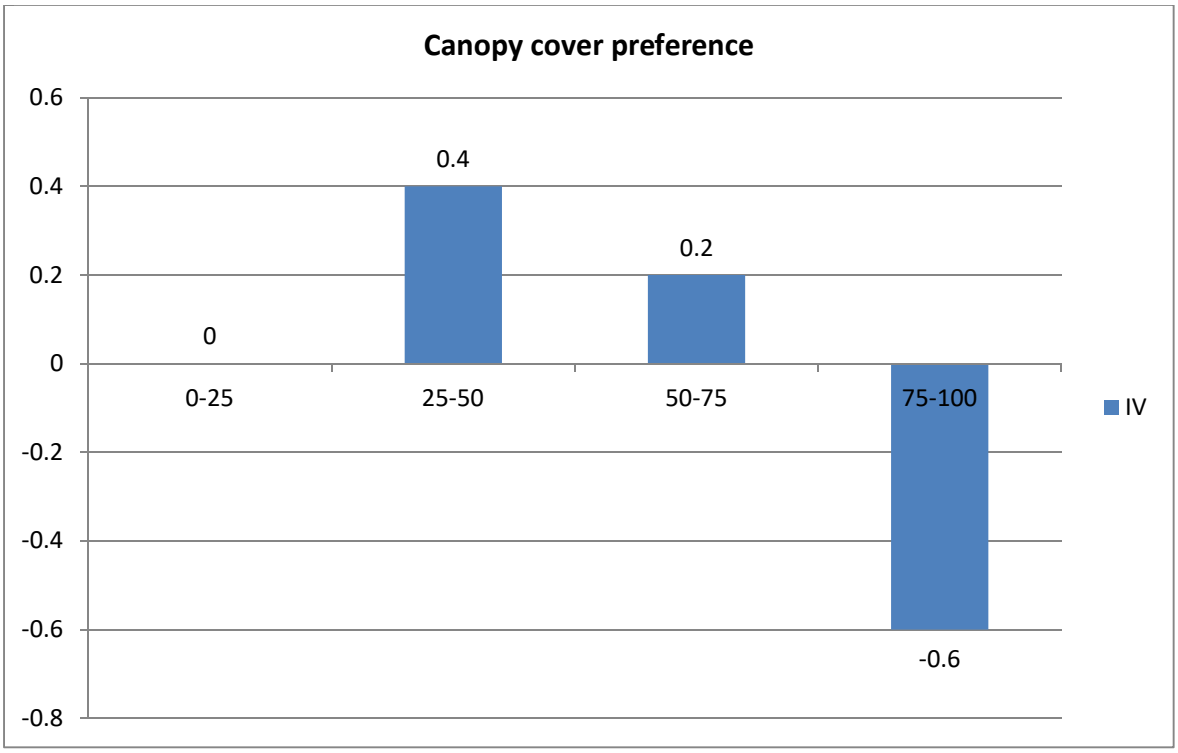

Figure 8: Canopy cover preference by Goral in Api Nampa Conservation Area, April-May 2016

5.2.5. Ground Cover

Goral preferred 25-50% (moderate) ground cover (IV = 0.51) but it avoided low ground cover (IV= -0.35). *Chrysopogan spp and Themeda spp*, the main food of the goral was recorded at moderate ground cover areas. The high ground cover area used by goral for hiding only but low ground cover area wasn't used by it according to its daily schedule. Sometimes it used low ground cover areas for movement. It is observed that gorals in ANCA preferred the ground cover as (25-50%) > (0-25%) > (50-75%) > (75-100%).

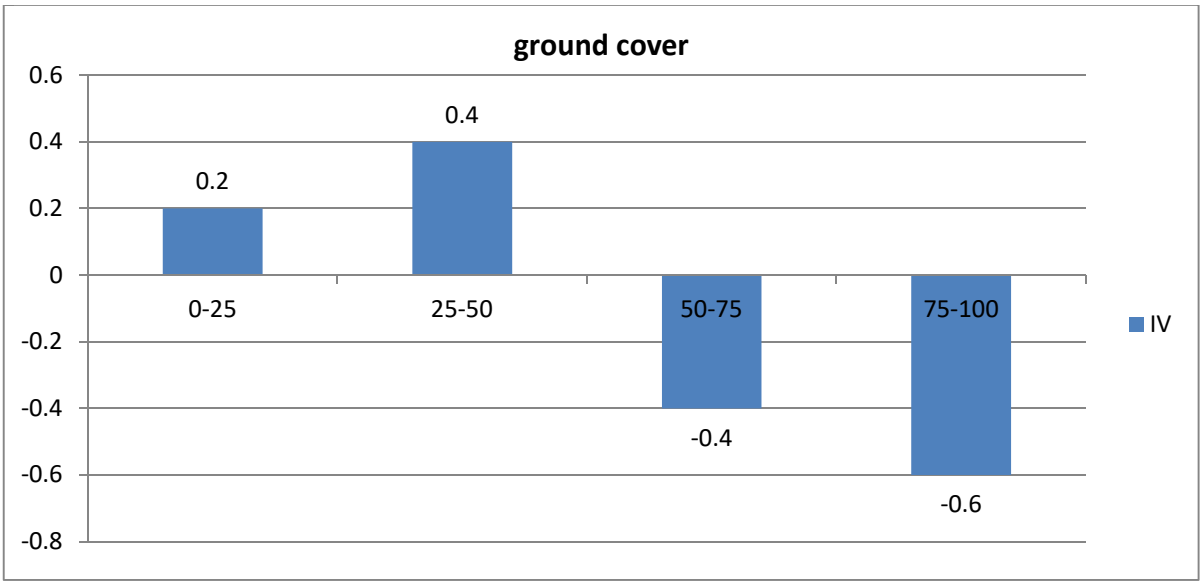

Figure 9: Ground cover preference by Goral in Api Nampa Conservation Area, April-May 2016

5.2.6 Forest/ land use type preference

Out of 31 fecal groups recorded, 28.48% occurred in the grassland followed by rocky cliff (24.93%), Sub tropical forest (20.40%), *Quercus* forest (12%), *Chirpine* forest (7.02%) and Sub-alpine Conifer forest (5.02%). The results showed that goral preferred grassland and rocky cliff area (Figure 10).

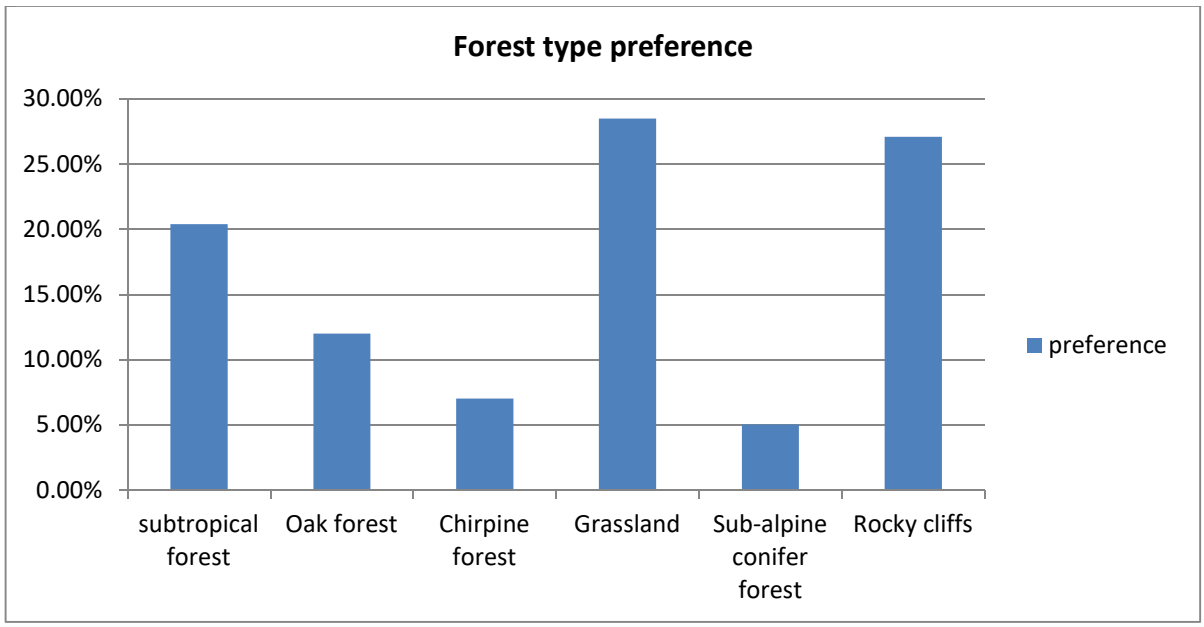

Figure 10: Forest types preference by Goral in Api Nampa Conservation Area, April-May 2016

5.3 Discussion

Goral reportedly occurs in several protected areas, Mahabharat range and steep mountainous areas outside protected area system. A good population of goral believed to occur in Api Nampa Conservation Area. From present study, it appears that gorals are widely distributed in different parts of ANCA. Fecal dropping was the main sign used to determine distribution and habitat preference of Gorals. Based on sign survey, it suggests that goral weren't evenly distributed in all zones. Gorals were found distributed between 1115 m to 3400 m during study period (April-May) with most preferred elevation zone (2000-3000) followed by (1000-2000). They avoided the zone below 1000 m and above 3000 m. Anwar and Chapman (2000) suggested the distribution of goral reported from elevation between 800 m to 1200 m while Schaller (1967) reported that they generally inhabit rugged, wooded mountainous terrain between 1000 m and 4000 m elevation. Glaston (1981) suggested that goral are distributed between 1800m to 3700m with abundance peak in 2200 to 3400m. The results of this study are in line with the findings of Glaston (1981).

Highest fecal droppings were recorded between 2000 m to 3000 m elevation range compared to other elevation zones. This site consists of more steep topography, rocky cliffs, temperate grasslands and Oak forests that support hiding places for goral as well as other human activities such as fodder, fuel wood collection, grazing intensity are least. This may also perhaps be due to availability of escape cover from hunters and natural predators. Apart from these, this site is difficult for hunters to search goral for hunting due to steep topography. On the base of the lower ridges, adequate water resources are also present.

Habitat is a place occupied by specific animal population within the community. Habitat selection or preference is part of organism life history pattern. Goral preferred grassland and rocky cliffs in the study area. Gorals preference for grassland is due it prefers grasses and avoid trees and shrubs for feeding, hence a perfect grazer. Also gorals are cliff dwelling mountain ungulates as earlier suggested by Prater (1971), Mead (1989), Lovari and Apollonio (1993). Rocky cliff area lies in the southern slopes of study area resulting in highly used area. Similar result was also found in the study of Gaston *et al*. (1981). Goral's habitat choice is liberal. Schaller (1967) and Mishra (1993) found that group of goral species use mostly steep and rocky areas having sufficient cover and food plants (Lovari 1986, Green 1981, Cavallini, 1992). Among the six forest type/habitat categories identified in the study area, grassland was the most preferred habitat as more number of fecal depositions was recorded there. Being temperate grassland, it wasn't frequently used by grazing domestic livestock because being distant from nearby villagers and also due to declaration of conservation area which restricts

local herders to graze their livestock inside conservation area without preapproval from Api Nampa Conservation Area Office. Sub tropical forest was more preferred compared to Oak forest, Pine forest and Sub alpine Conifer forest. This may be because of higher diversity of palatable grasses in Subtropical forest *viz., Themeda anathera and Chrysopogan spp.* compared Pine forest and Oak forest. This forest habitat provided food for goral during spring season when all ground cover grasses were dry and accidently burned by fire because different parts of conservation areas are practiced for burn practice for good grasses for livestock grazing illegally. Shrubland and barrenland was avoided by goral because of avoidance of shrubs as food by goral. Also these habitat doesn't have enough cover and food for goral to graze and hide.

Slope is also major component for suitable habitat of goral. Present study showed that goral mostly preferred steep slopes (50-75%) and top of hills. Slope areas provide safe place for the animals from different human activities as well as from predators. Thapa *et. al.,* (2011) also suggested, in his report, goral preference of slope as high degree slope (50-75%). Crown cover and ground cover preference by goral both were moderate (25-50%) in the study area. Present study showed avoidance of high crown cover and high ground cover by goral. This is in line with Schaller (1967) and Mishra (1993) that they reported avoidance of high crown cover and ground cover. Besides this study was conducted in April when there was not much crown cover and ground cover due to disturbance by fire in early period.

CHAPTER: 7 CONCLUSIONS

- The preferable altitudinal range of Goral is 1000 m- 3000 m avoiding areas below 1000 m and above 3000 m.
- Goral prefers moderate slope (26%-50%) with 51-75% crown cover and 26- 50% ground cover.
- Goral prefers grassland, forested land and rocky cliffs for foraging and resting avoiding shrub land and barren land.
- ANCA has potential areas suitable for goral and its habitats.

CHAPTER: 8 RECOMMENDATIONS

The following recommendations are made based on the study.

- Stable isotopic and/or genetic lab for diet analysis should be established in Nepal.
- The population survey of the Goral should be conducted in ANCA.
- The diet analysis of the Goral of different season should be conducted in ANCA.
- For effective conservation of goral, conservation awareness is much needed in the study area.
- Periodic monitoring of goral should be included in management plan of the conservation area.

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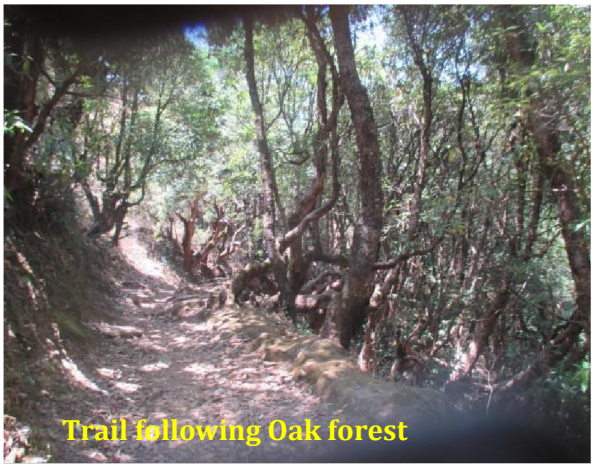
PHOTO PLATES

Uncontrolled Livestock Grazing



Trail following Oak forest

Goral faecal deposit