DISTRIBUTION AND HABITAT UTILIZATION OF HIMALAYAN GORAL (*Nemorhaedus goral*) IN DAILEKH DISTRICT, KARNALI PROVINCE, NEPAL

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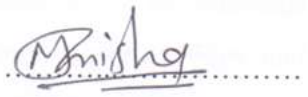
DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any other degree. All the sources of the information have been specifically acknowledged by references to the author(s) or institution(s).

Date: 16 August, 2021



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LETTER OF APPROVAL

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CERTIFICATE OF ACCEPTANCE

This thesis submitted by Manisha Karki entitled "Distribution and habitat utilization of Himalayan Goral (*Nemorhaedus goral*) in Dailekh District, Karnali, Nepal" has been approved as a partial fulfillment of the requirements of Master's Degree of Science in Zoology with special paper Ecology and Environment.

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Manisha Karki

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LIST OF ABBREVIATIONS

Abbreviated form	Details of abbreviations
CRA	Cliff rock area
E	East
GLM	Generalized linear model
GPS	Global Positioning System
IQR	Interquartile range
MHF	Mixed hardwood forest
N	North
NW	North-west
PiF	Pine Forest
QuF	*Quercus* Forest
S	South
SE	South-East
SW	South-west
STF	Sal-*Terminalia* forest
W	West

ABSTRACT

The study was conducted aiming at determining the distribution and habitat utilization of Himalayan goral (*Nemorhaedus goral)* in Dailekh District, Karnali Province, Nepal in January/February 2020. Line transects of 0.5 - 1.0 km were laid on the field to assess the status and distribution of this species. Direct observation of goral, fecal pellets in different habitat types and records of other topographic variables were used to find out distributions and habitat utilization of Himalayan goral. Interviews and a questionnaire survey with locals were used to assess level of threat. A total of five individuals and 122 fecal deposits of goral were recorded. Results suggested an uneven distributed pattern of goral. The survey through sign showed that gorals were distributed from 700 m to 1250 m asl, in study area. Five habitat types were used by the goral: cliff rock area, mixed hardwood forest, Pine Forest, *Quercus* Forest, Sal-*Terminalia* forest. The highest number of Himalayan goral was recorded on cliff rock area followed by *Quercus* forest and Sal-*Terminalia* forest. Presence of goral declined with the vicinity of villages and increased with distance to nearest village. Gorals also preferred south facing steep slopes and top of cliffs. Himalayan goral was recorded in areas with a highly rugged and steep terrain. Himalayan gorals are facing a serious local threat of poaching for meat. Other threats include habitat destruction, fragmentation and various anthropogenic activities such as fire, wood collection, fuel wood collection, overgrazing.

1. INTRODUCTION

1.1. Background

The mid-hill region is a major portion of Nepal and an intermediary landscape between low-lying Himalayan region in the north and Tarai in the south. This region is centrally located which is extending from the southern slopes of the Himalayan ranges to Mahabharat ranges. Mid-hill region are shelters for highest species diversity in the country (Paudel et al. 2012, Primack et al. 2013). The mid-hill zone is of generally rugged topography. However, ecosystems in the mid-hills were poorly studied, there is almost no information on their biodiversity and consequently they are very poorly represented in the protected area network (Hunter and Yonzon 1993, Paudel and Heinen 2015). The forest areas of mid-hill are highly fragmented due to human exploitation for firewood, fodder and timber including agricultural lands (Paudel and Sipos 2014).The relationship between distribution of animals and their habitats plays an important role in conservation and management of threaten species (Lecis and Norris 2003). They are small ungulates with a goat-like or antelope-like appearance. The Gorals belongs to the genus *Nemorhaedus* or *Naemorhedus*, with four species *Nemorhaedus goral, Nemorhaedus baileyi, Nemorhaedus caudatus, Nemorhaedus griseus*.

Distribution pattern show the spatial relationship between the members of population within its habitat. Pattern is often characteristics of a species. Himalayan gorals are generally found on hilly cliff at mountainous region (on higher, steeper slopes with less vegetation). Goral is diurnal and most active in the early morning and late evening. The diet of Himalayan goral was grasses, leaves, fruits, twigs, and nuts. Males are normally found single otherwise in pairs or with in small groups of four- twelve individuals. Males and females reach sexual maturity at three, with a lifespan of up to fifteen years; the gestation period is within 170-218 days, with single births (Poudel 2009).

The Goral often found in hilly cliff of mid-hill of Nepal. Goral is a cliff dwelling, sexually mono-morphic mountain ungulate with size 65–70 cm and weighing about 25–30 kg (Prater 1980). The Himalayan goral is represented by two sub species, gray goral (*Naemorhedus goral bedfordi*) of the western Himalaya and the brown goral

(*Naemorhedus goral goral)* occupying the eastern Himalaya (Sathyakumar 2002). Grey goral is considered to be a goat antelope which are distributed in middle slopes of Himalayas and is endemic to Asia (Zhiwotsechenko 1990). According to (Schaller 1967) Gorals are distributed along the southern foothills of Himalayan Mountains in Pakistan, India and Nepal, through Assam, Bhutan, and Sikkim into northern most Thailand and Burma.

In Nepal, Himalyan Goral occurs in nine National Parks (DNPWC 2020) such as Khaptad, Rara, Makalu Barun, Langtang, Bardia, Chitwan, Parsa, Sagarmatha and Shey Phoksundo (Wegge and Oli 1997), as well as within the Annapurna Conservation Area, Kanchenjunga Conservation Area, Gaurishankhar Conservation Area, Manaslu Conservation Area, Api-Nampa Conservation Area and Dhorpatan Hunting Reserve (2020). Next to national parks and conservation areas also found in mountain region of mid-hill human-dominated landscape of Nepal (Adhikari et al. 2019) but there is very low investigation (Adhikari et al. 2019) and the status or condition of Himalayan goral is still unknown. Goral is listed as near Threatened on the IUCN red list because the population is declining due to habitat loss and illegal hunting/poaching for meat (IUCN 2019). Hunting, overgrazing, poaching, habitat destruction, disturbance, and competition with livestock were the major declining factors of gorals in different areas (IUCN 2019).

Habitat preference is the habitat most likely to be chosen by a species or which habitat is the best suited for these species. Himalaya Goral inhabits the heavily forested habitats (Sathyakumar 1994, Mishra et al. 1994). A habitat meets all environmental conditions an organism needs to survive. Open habitats at higher elevations; such as sub-alpine rhododendron scrub, alpine meadow and grassland were preferred by Goral (Green 1985). Due to complex terrain, steep topography and dense vegetation, it was difficult to carry field research and monitoring activities. Gorals are widely distributed in different parts of Mahabharat range. Himalayan Goral are also reported in Mahabharat range and rocky mountainous areas which are outside protected area system. A fecal pellet was the main sign used to determine the habitat, distribution and habitat utilization of animals. Individuals of populations can be distributed in one of three patterns such as uniform, random or clumped. Based on sign survey, goral wasn't evenly distributed and were found distributed between 964 m to 1591 m (Thapa et al. 2011).

1.2. Objectives

1.2.2. General objective

The main objective of this study was to know the distribution and habitat utilization of Himalayan goral (*Nemorhaedus goral*) in Dailekh District, Karnali Province, Nepal.

1.2.3. Specific objectives

The specific objectives were:

- To investigate the distribution of Himalayan goral in the study area.
- To assess the habitat utilization of Himalayan goral in Dailekh District.

1.3. Rationale of the study

Investigate the distribution pattern and habitat utilization of Himalayan goral in Dailekh District. 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. The gorals inhabiting these areas are threatened by habitat degradation from overgrazing, human disturbances and poaching. So this study aimed to provide information about status, distribution, habitat, and existing threats of goral in a focused study area. Results of this study are expected to play vital role for the proper management of goral. Himalayan ungulates are widely distributed the Himalayan landscapes, but they exhibit distinct habitat affinities. This study has important applications not only for the conservation of these species, but also because these species as indicator species of healthy mountain ecosystem.

2. LITERATURE REVIEW

2.1. Distribution of goral

Goral generally inhabit rugged, wooded mountainous area between 1000 m and 4000 m elevation (Schaller 1967). The distribution of goral reported from elevation between 800 m to 1200 m (Anwar and Chapman 2000) also between 1800m to 3700m with abundance peak in 2200 to 3400m (Glaston 1981). Schallar (1977), Johnsingh (1992) found from range 200 m above in the Shiwalik Hills to 4000 m in the main Himalayan range. Information on goral is mostly dealing with natural history and morphology (Mead 1989). According to Duckworth and MacKinnon (2008), 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. In Nepal and India, gorals are present in elevations from 900 to 2,750m (2,950 to 9,020ft) altitude.

Srivastava and Kumar (2018) reported gorals inhabit in varying elevation and distributed in a wide range of habitats (Xiong et al. 2013), encompass ambiguity in their species taxonomy (Mori et al. 2019). Interestingly, number of species in the genus *Naemorhedus* has been evaluated but still, no single consensus on the number of goral species exist (Shukla et al. 2018, Li et al. 2020). Valdez (2011) reported genus *Naemorhedus* exist six species. However, the International Union for Conservation of Nature (IUCN) still recognizes only the four species i.e. Himalayan goral (*Naemorhedus goral*), Chinese goral (*Naemorhedus caudatus* and *Naemorhedus griseus*), and Red goral (*Naemorhedus bailey*) (Duckworth and MacKinnon 2008). Three species of gorals *Naemorhedus caudatus, Naemorhedus griseus* and *Naemorhedus bailey* are listed as Vulnerable whereas Himalayan goral, *Naemorhedus goral* is classified as Near Threatened under the IUCN red list category (Duckworth and MacKinnon 2008).

The Himalayan goral (*Naemorhedus goral*, 35–42 kg) has a far greater elevational distribution from 200 m to about 4000 m and Himalayan musk deer (Moschus chrysogaster,11–18 kg), occurs within an elevational range of 2400 m to 4750 m the

(Mishra and Johnsingh 1996). Goral in general are solitary (Green 1987) but group size can vary from one to twelve (Vinod and Sathyakumar 1999). Both sexes are similar in appearance and of about equal size. Goral is predominantly a grazer (Ilyas and Khan 2003) and resident. The Himalayan goral (*Naemorhedus goral*, 35–42 kg) has a far greater elevational distribution from 200 m to about 4000 m (Mishra and Johnsingh 1996). The species is sexually monomorphic, has short and sharp black horn that diverges slightly and curve backward. Grey goral is generally yellowish grey suffused with black in colour except the chin, however upper lip, underside of jaws and throat are white (Prater 1980).

2.2. Habitat utilization

The goat-antelopes, goral and serow may have similar food and covers requirement as detected in the same temperate and subalpine forests of the study area (Sathyakumar 1994, Awasthi et al.2003).

Goral and serow share similar type of habitats of their activity patterns which may elucidate about their likely differential strategy of resource use (Sathyakumar 2002). Traditional field survey methods based on direct observation, such as transect counts and behavioral observations, are difficult to undertake due to the inaccessibility of remote areas and lack of visibility in dense vegetation and the species extreme sensitivity to human disturbance. Bowkett et al. (2007) conducted study in mountainous landscapes, a key factor that has limited quantitative habitat modeling for forest antelope is the difficulty in estimating density or relative abundance. Due to low detection rates from methods based on direct sightings (Feer 1995) and methodological problems, indirect signs such as dung or tracks were extrapolated (Struhsaker 1997, Lunt et al. 2007).

Thapa et al. (2011) recorded a total of five individuals and 197 fecal deposits of goral and results suggested a clumped distribution pattern of goral. Five habitat types were used by the goral. The highest number of fecal deposits was recorded on rocky cliffs followed by *Shorea* mixed forests and *Schima* mixed forests. Himalayan gorals also preferred south facing steep slopes and top of cliffs and gorals are facing a serious local threat of illegal hunting for meat. Other threats include destruction of habitat, degradation, habitat fragmentation, changes in land use pattern, anthropogenic

activities (fire, fodder collection, fuel wood collection, overgrazing) (Yang et al. 2013, Challender et al. 2015).

Musk deer and goral's sympatric competition between both is avoided because of the differences in their feeding habits (Green 1985) Himalayan goral (*Naemorhedus goral*) (Mishra and Johnsingh 1996) do not show any elevation migration. Based on traditional field survey with methods direct observation, such as transect counts and behavioral observations are difficult to undertake due to lack of visibility in dense vegetation, the inaccessibility of remote areas, and the species extreme sensitivity to human disturbance (Sathyakumar 1997, 2002).

Green (1987) conclude ecological separation between Sambar, Goral, Serow (*Naemorhedus sumatraensis*) and Muskdeer (*Moschus chrysogaster*) in Himalayas. Bagchi et al. (2003) studied dry tropical ungulates in India. Shivalik or Himalayan foothills are ranges where chital, sambar, nilgai and goral co-exist together. Johnsingh and Sankar (1991) found sambar and goral both preferred deciduous forest and their maximum overlap occurred in this habitat where goral preferred high grass cover but low shrubs, whereas sambar showed affinity with dense understory. The preference for different habitat characteristics ensures that there was no direct competition between nilgai and goral. Goral was most abundant in higher altitude and steep slopes.

Mishra and Johnsingh (1996) reported that, goral fed largely on grass in the both seasons such as cold and warm seasons. The diet composition of goral, Graminoids constituted 98.3% (number of composites = 12) in summer, 92.2% of the diet in winter (number of fecal composites = 12) and goral were seen browsing on the leaves of *Trigonejla grucilis, Rubus ellipticus, Indigqferri Ireteromella, Debregeasia hypoleuca, Lespedeera gerardiana, Inulucappa, Buddleia leircotrichophora, Cornus ohlonga, Aechnianthera pctlata, Phoenixsjhestris,* and flowers of *Humiltonia suarrolens.*

Green (1987) found that goral in Kedarnath Wildlife Sanctuary, India fed dominantly on grass and found more open areas. Goral, a primitive Caprine is expected to be a forest dwelling browser. Latitude, elevation, aspect and precipitation are the factors mediated by body size, with larger species having greater energy requirements and mobility moving over longer distances (Hein et al.2012). The ecological separation of

goral with other ungulates in Kedarnath Wildlife Sanctuary and estimated a density of 2.6 gorals/km2 in the sub-alpine zone. There is sympatric competition between Goral and musk deer are avoided because of the differences in their feeding habits (Green 1985).

Lovari & Appolino (1994) conducted a study on the habitat use, group size and activity pattern of goral in Majhatal Sanctuary. Sathyakumar (1994) studied the abundance, status, and habitat use of goral in Kedarnath Sanctuary and estimated a density of 15.5 groups/km2 for low altitude oak-pine mixed forests and 3.8 groups/km2 for middle temperate scattered tree and scrub forest, with a mean group size of 1.96. Paudel et al. (2012) quantified area coverage of *N. goral* (67%), *M. muntjak* (57%) and *C. thar* (41%). There are suitable habitats for all three species throughout the study area, the availability of high-quality habitats for these species varied considerably. Suitable habitats for goral and thar were fragmented and mostly confined to the southern and northern parts of the study area.

Gaston et al. (1981) resulted that, the number encountered per hour search while the others indicated the encounter rate as number per km walk. Goral in general and the adult males outside the rut in particular, are solitary (Mead 1989). Group size of goral reported to vary from one to twelve. Other ecological studies were carried out below 2000 m or above 3000 m altitudes except for (Sathyakumar 1994).

3. MATERIALS AND METHODS

3.1. Study Area

The study area covers the forest of Chamunda-Bindrasaini and Aathbish Municipality and located between 28.93^0 N 81.56^0 E to 29.06^0 N 81.46^0 E in Dailekh Districts of Nepal. Dailekh is a high hilly district out of ten districts of Karnali Province. The elevation ranges of from 544m above sea level to 4,168m. The study area has covered 80% of mid-hill land and 21% of high-hill land. The total area of the district is 1,505 square kilometers (581 square meter). Upper Tropical to temperate climate is found in this study area. This Municipality is well connected to the road network. Karnali highway and Mid-hill highway can be used to access this municipality.

Vegetation composition of study area reflects *Shorea robusta*, *Shima wallichii*, *Castonopsis indica*, *Semecarpus anancandria*, *Anacardium occidentale*, *Qurecus* forest and pine forest as major vegetation. Other wildlife species of study area includes jackal, bats, birds, herpeto-fauna etc. The gorals inhabiting these areas are threatened by habitat degradation from overgrazing, human disturbances and poaching. This is due to its elevations in the mid-hill area.

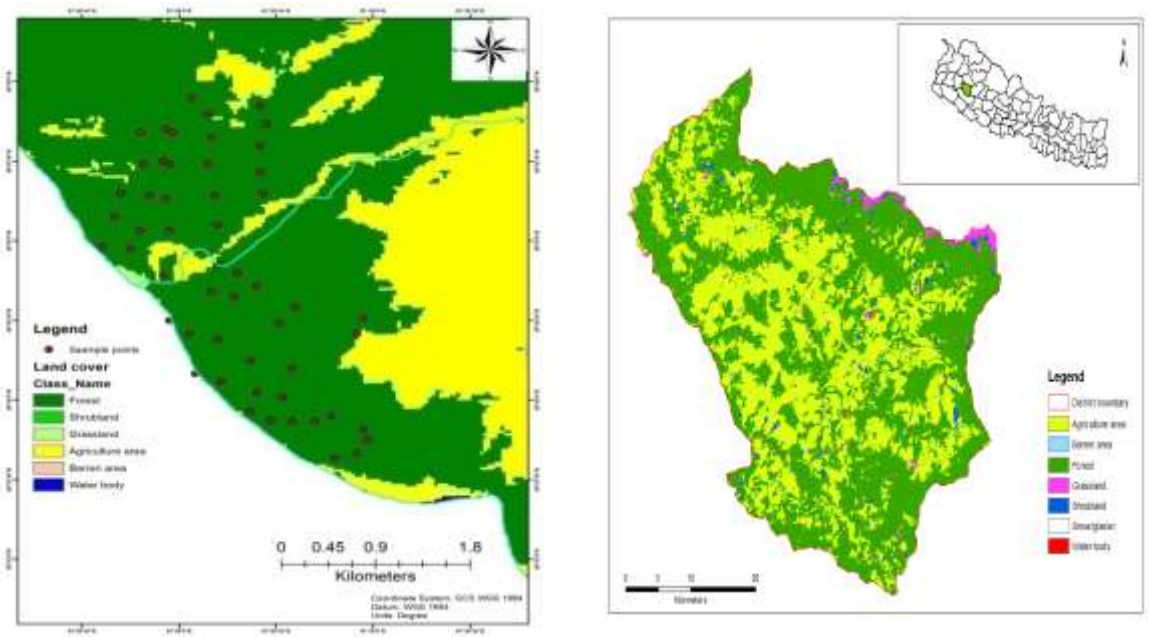

Figure 1. Map of the study area with sampled points (Points along the transects and vantage points).

3.2. Methods

3.2.1. Data collection

The data collection was carried out in January/February 2020. Information on the condition, distribution, status; threats were collected from the review of secondary sources like books, reports, thesis, journals. 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 presence and potential habitats of goral.

3.2.2. Species studied

Himalayan goral is associated with a wide variety of habitats throughout the mountains (Wegge and Oli 1997). It prefers open plant communities with good grass cover and avoids shrub rich patches (Cavallini 1992), feeds primarily on grass in all seasons (Mishra and Johnsingh 1996) and is adapted to steep and rugged mountain terrain (Paudel and Kindlmann 2012). Thus, the steep slope is an important factor preferred by goral (Cavallini 1992, Mishra and Johnsingh 1996, Paudel and Kindlmann 2012a).

3.2.3. Line transect method

Field Methods a different sampling design was adopted to sample for animal occupancy and habitat parameters. This part of the study was Dailekh District. Sampling site was chosen randomly that was based on nested grids (1x1 km). In each sampling site one transect (approx.1km length) was established. In each transect goral, habitat and disturbance related data was collected. The coordinates were entered into a hand held Global Positioning System unit which helped locate them during the sampling. This systematic random sampling design ensured that the sampling points could be treated as a set of independent data points. Around each of these random points at least 100-m distance between two transects based on the accessibility and availability of the forests. Transects were encompass riversides and plains, ravines, mountain ridges and steep cliffs. At each sampling point, plots laid to quantify goral occupancy as well as habitat parameters as Presence of goral (number

of individual, no. of pellets and other signs), Habitat type (e.g., forest and grassland), Habitat cover (Dense, mild dense, open land), Disturbance (number of people, livestock, livestock dung, cut trees lopped trees and fodder collecting areas, distance to road and villages) and distance to waterhole.

Fecal pellet Density: Pellet density was used as the indicator of goral habitat occupancy. Pellet counts have been widely used to estimate parameters such as absolute ecological densities, relative densities and habitat occupancy by numerous animal species, in a variety of climatic and vegetation conditions and used the line transect method estimate pellet densities. In each transect, the presence of species was assessed on the basis of the presence or absence of footprints and feces within a circular plot with a radius of 5 m and by direct sighting at 100-m intervals along the transect henceforth referred to as 'sampling points'. Mostly local people acquainted with the forest were involved in searching for signs of the presence of the species in question at each sampling point.

Habitat use**:** Habitat use was studied by the pellet group count method first described by (Bennet et al. 1940) and has subsequently been used by several investigators (Eberhardt and Van Etten 1956, Kirchhoff and Pitcher 1988, Khan 1993, Mayle et al. 1999, Marques et al. 2001, Patterson et al. 2002, Bagchi et al. 2003, Rivero et al. 2004, Hebble white et al. 2005, Forsyth et al.2007, Noor et al. 2010). Presence of pellet groups was indirect evidence of habitat use by the species.

3.2.4. Vantage point count

Besides line transects, direct observation of goral was performed by wait and observe method in the vantage points. These points covered the scanning views of most study areas and allow the access of clear and wider view of the observation area within the catchment at various elevations and all directions (Ashraf et al. 2015). There were altogether seven vantage points were identified while walking along the line transects and human trails. In each vantage point, 30 minutes time allocated to scan, observe and count the number, age and sex of goral by using binoculars.

3.2.5. Environmental variables

Based on documented species-habitat associations (Prater 1990, Cavallini 1992, Wegge and Oli 1997, Roberts 1999, Grubb 2005, Odden and Wegge 2007, Paudel and Kindlmann 2012a, 2012b), field experience and models developed for similar species

(Kushwaha et al.2000), used various numbers of categories of main environmental variables: slope, topographic ruggedness, habitat type (i.e. vegetation) and human influences (i.e. distance to the nearest village) based on the documented habitat.

Environmental variables were classified into a number of classes. Such classes were important when associations between species and Class boundaries were based on ecological requirement of species or types of data:

- Slope (Gentle slope, Moderate slope and Steep slope)
- Topographic ruggedness (Broken, Large and Rolling)
- Habitat type (cliff rock area, Mixed hardwood forest, Pine Forest, *Quercus* Forest, Sal-*Terminalia* forest
- Distance to the nearest village.

The environmental data were based on the presence/absence data. The geographic coordinates of the training areas were determined in the field, using GPS mapping. As some types of vegetation have identical spectra (e.g. cliff rock area, mixed hardwood forest, Pine forest, *Quercus* forest, Sal-*Terminalia* forest). The topographic ruggedness divided broken, large and rolling type. Other variables such as distance to village, distance to road, distance to water resources livestock presence, and sign of human presence were measured in relation to presence of fecal pallets of Himalayan goral. Generalized linear model was performed using R-program. To analyzed relation between GLM with distance to village and road. The relation of GLM with livestock presence and sign of human presence were identified. Generalized linear model (GLM) is a flexible generalization of ordinary linear regression that allows for response variables that have error distribution models other than a normal distribution.

3.2.6. Distribution pattern and habitat utilization

Distribution pattern of goral is a how the goral individuals are distributed in space at a given time. The individual organisms that make up a population can be more or less equally spaced, dispersed randomly or clustered in groups. Data on animal's location such as number of individuals and pellets recorded in each habitat types were used to determine distribution pattern. Calculation distribution pattern based on fecal pallet recorded. The distribution pattern of the goral was calculated by variance to mean ratio (Odum 1971) Poisson distribution, is the variance (S^2) is equal to the mean ($\bar{x}$).

If $S^2/\bar{x}<1$, distribution is uniform

If $S^2/\bar{x}=1$, distribution is random

If $S^2/\bar{x}>1$, distribution is clumped

A habitat is a place where an organism makes its home. Habitat utilization of Goral was determined by using direct observation of animals, fresh fecal pellets and footprints along transects method followed by (Joyon 1999). Habitat utilization is determined according to fecal pallet recorded in which habitat. Habitat usage is a species manipulates its surroundings to better of survival and how it interacts with its habitat. Comparatively similar amount of time was spent in each point for data collection. Number of individuals, footprints and fecal pellets seen in each habitat type were recorded for the purpose. Habitat utilization of Himalayan goral for each habitat type was calculated as (Zhao et al. 2013)

$Ui=Ni/N$

Where, Ui is the utilization rate of the specific habitat type by Himalayan goral.

Ni is the number of signs of Himalayan goral in the specific habitat type.

N is the total number signs of Himalayan goral in all habitat types.

3.2.7. Threat assessment

Habitat disturbances of goral were predicted with general observation of its habitat and through interviews with the local people and different conservation stakeholders in the area. Causes of habitat disturbance such as fire, tree felling, number of livestock dung as well as livestock grazing encountered in transect was counted to calculate disturbance index. Interview with herders and villagers were undertaken to know the livestock number. Key informants survey was conducted to assess the threats. A sample questionnaire survey was carried out to understand perception about goral and threats of goral. Household survey in villagers to near the field was done. Interviews were held with key people.

4. RESULTS

4.1. Distribution of goral

A total of 53 sampling point in 11 transect, in which 122 fecal samples, two footprints were recorded during the study period. Gorals were found mostly in the cliff areas followed by *Quercus* forest, Sal-*Terminalia* forest, Mixed-hardwood forest and least in Pine forest (Figure 2). The indirect evidences of goral (fecal groups and foot print) and direct observations of Himalayan goral were recorded in between 700 m and 1250 m above sea level. The variance is greater than arithmetic mean. Therefore, the distribution pattern of goral fecal groups was clumped in the study area ($S^2/\bar{x} = 1.12 > 1$, $\chi = 6.76$, $p \leq 0.05$). The Goral are uneven distributions pattern in study area.

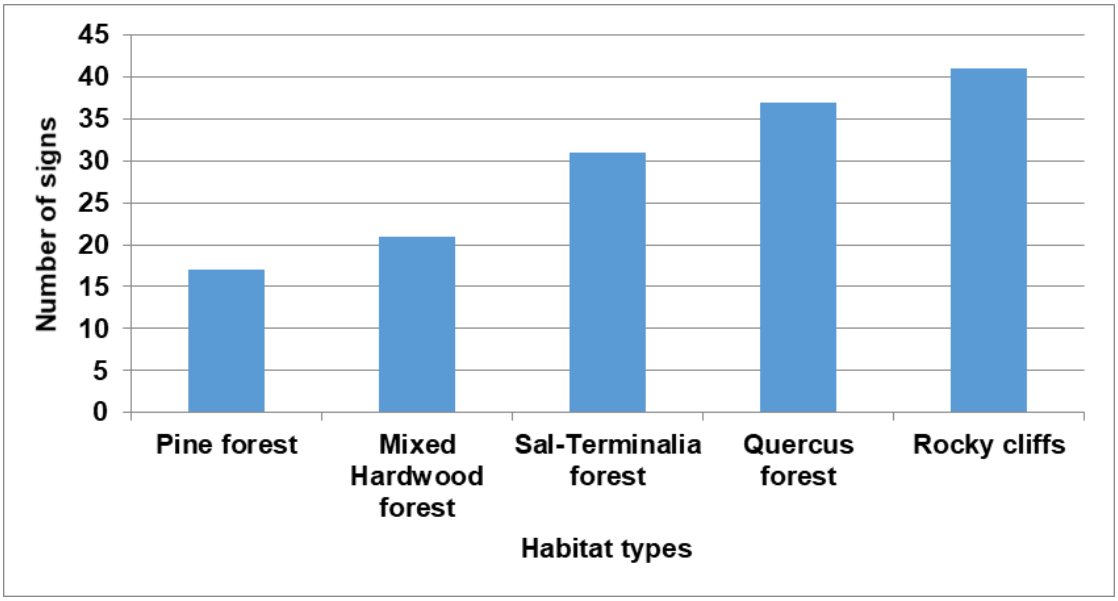

Figure 2. Signs of Himalayan goral recorded with different habitats.

The study reported Himalayan gorals in four out of seven vantage points. There were five individuals of Himalayan goral (Four adults and one calf) recorded from the vantage points located in the Najur and Nangre community forests.

4.2. Habitat utilization

Himalayan goral was recorded in areas with a highly rugged and steep terrain. Habitats of study area were classified into five categories namely cliff rock area, Mixed hardwood forest, Pine Forest, *Quercus* Forest, Sal-*Terminalia* forest. Different variables such as altitudes, aspects, slope, and topography were recorded during

transect walk in field. Habitat utilization of Himalayan goral showed (28%) in the rocky cliff area, followed by *Qurecus* forest (25%) Sal-*Terminalia* forest (21%) Mixed hardwood forest (14%) and pine forest (12%).The results showed that goral preferred rocky cliff area followed by *Quercus* forest and Sal-*Terminalia* forest, compared to and mixed Hardwood forest and pine forest. Himalayan goral occurred mainly in cliff rock area, mixed hardwood forest, Pine Forest, *Quercus* Forest, Sal-*Terminalia* forest. Distances to the nearest village were more significance of the presence than Topographic variables for this species (Figure 3, Table 1).

The large number of signs of goral recorded in the steep slopes. Signs of goral encountered increased with increase in slope. The signs recorded, 45% of was recorded from the steep slope. About 34% were observed from moderate slope and 21% was recorded from gentle slope. Sign survey could not be recorded top of cliff due to more steepness for transect walk. The results showed that goral preferred more steep slopes. Most of the signs were also recorded in the southern and northern aspect of the steep slope. Slope is one of the major factors to determine the goral presence in this area.

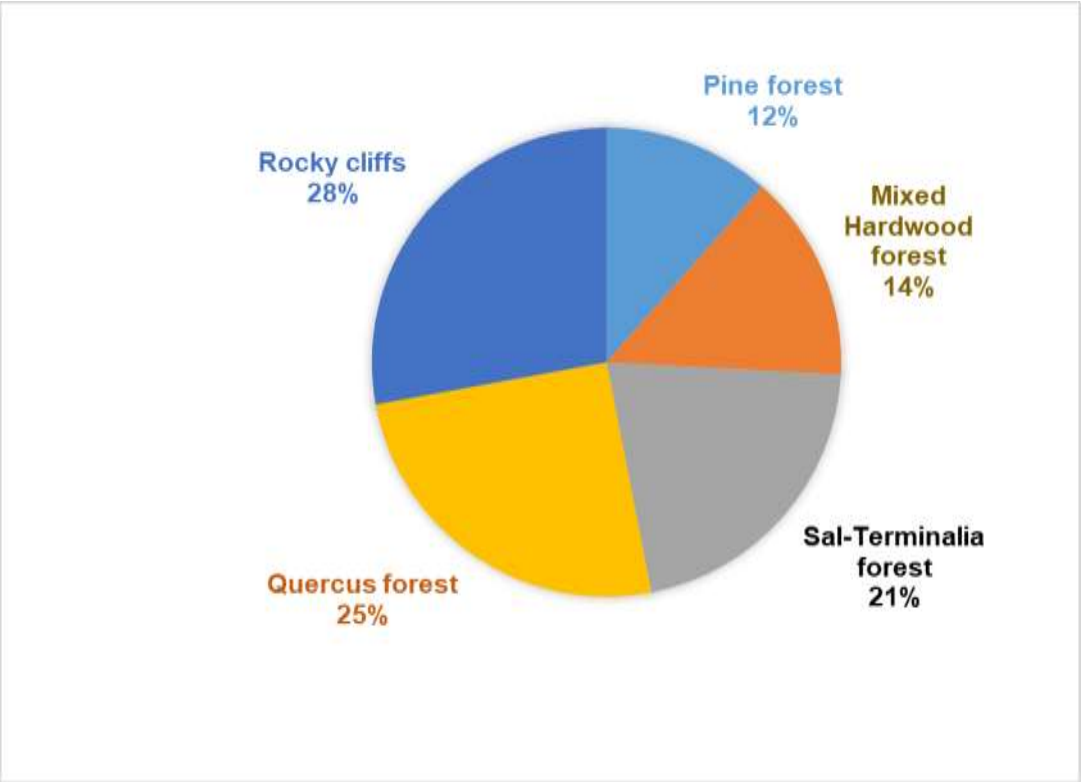

Figure 3. Habitat utilization (Ui) of Himalayan goral in the study area.

Table 1. Generalized linear model (GLM) between the goral presence with different habitat and disturbance variables.

Model Parameters	Estimate (β)	Std. Error (SE)	z –value	Pr(>|z|)	Significance
(Intercept)	1.2166	0.7672	1.586	0.1127	
DR	0.0003	0.0003	1.06	0.2892	
DV	0.0009	0.0002	4.342	<0.0001	***
DW	-0.0007	0.0008	-0.926	0.3542	
Elevation	-0.0004	0.0006	-0.643	0.5199	
HumP	-0.1648	0.0538	-3.058	0.0022	**
Livs	-0.0733	0.0561	-1.305	0.1919	
Slope	0.0072	0.0032	2.219	0.0264	*

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Here, DR= Distance to road, DV= Distance to nearest village or settlements, DW= Distance to water sources, HumP= signs of human presence, Livs= number of livestock presence

The presence of goral was highly affected by slope, topographic ruggedness, Habitat type and distance to the village. Distribution of Himalayan goral was highly affected by disturbance variables such as distance from villages, sign of human presence and slope. The number of goral fecal was found to be low close to villages or roads. As the distance from roads increased, the abundance of goral was found to significantly increase. There was a significance relation between the distances from villages and number of goral sign (<0.0001) similar type of human pressure was the major cause of habitat disturbance of Himalayan goral. Collection of grasses and wood, forest products were the major activities of the people that disturbed the Himalayan goral. Presence of livestock caused a significantly negative effect on presence of goral.

The GLM shows a significance relation between signs of human presence and number of goral signs (0.00223). These empirical findings showed that there was a negative

impact of settlements and sign of human presence on Himalayan goral of this area. There for these variables are important in comparison to other variables when predicting goral presence in study area. Human disturbances were the major threats to goral in study area mainly affected habitat which are located nearer to human settlements. The presence of people in the habitats of the goral caused a significantly negative effect on the occurrence and abundance of Himalayan goral in Dailekh. The GLM shows a significance relation between slope and number of goral fecal (0.02645). These finding shows that there was significant impact of slope on presence of Himalayan goral.

This results shows that the highest number goral presence in west part followed by south-west, south and south-west. Very low signs of gorals recorded in eastern part of the study area. Most of the fecal groups with higher number of fecal were also noted in the southern aspect of the steep slope. The goral signs recorded of Himalayan goral increased from southern aspect. The habitat preference for goral is scattered throughout the study area but occurs mainly in the south and the north of the study area (Figure 4).

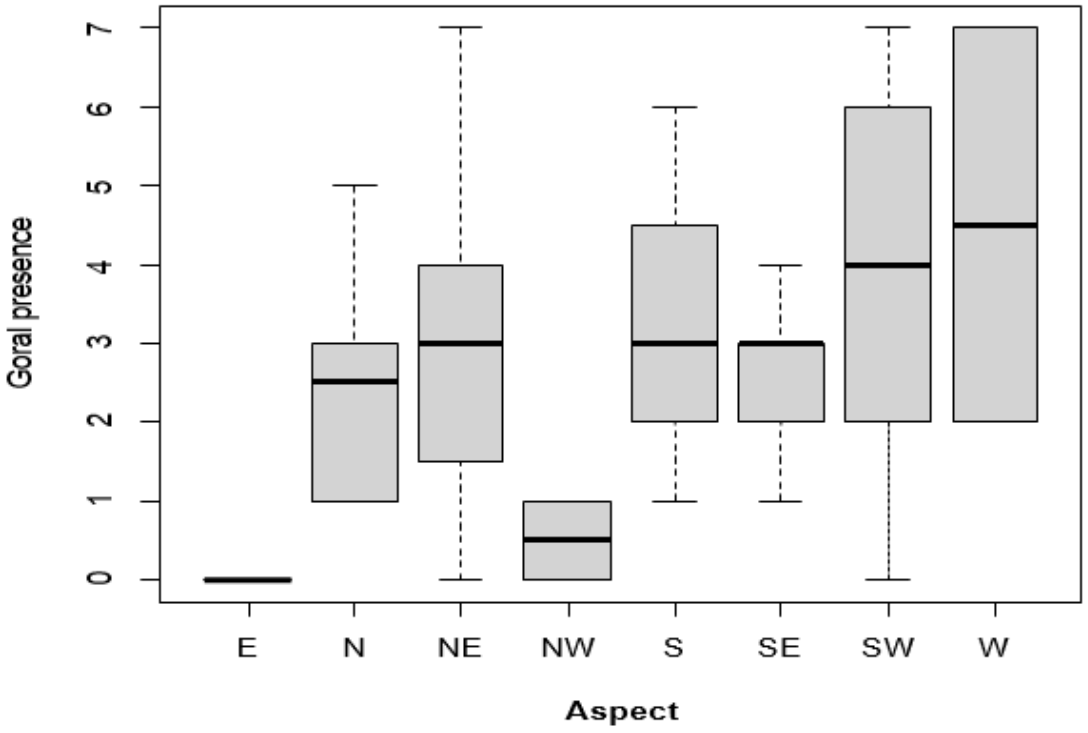

Figure 4. Goral presence in different aspects, here, E= East, N=North, NW=North-west, S=south, SE= South-east, SW=South-west, W=West.

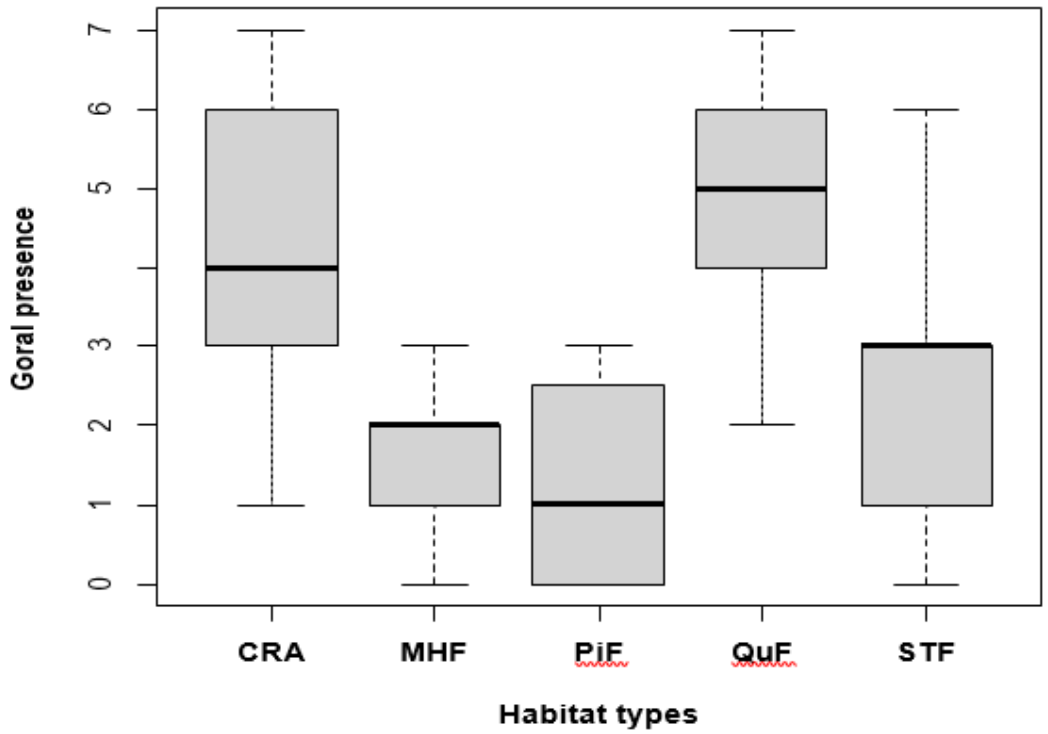

Figure 5. Goral presence in different habitat types, here, CRA= cliff rock area, MHF= Mixed hardwood forest, PiF= Pine Forest, QuF= *Quercus* Forest, STF= Sal-*Terminalia* forest

Habitats of study area were classified into five categories namely cliff rock area, Mixed hardwood forest, Pine Forest, *Quercus* Forest, Sal-*Terminalia* forest. This result showed that the higher number goral presence in cliff rock area and *Quercus* forest followed by, Sal-*Terminalia* forest, mixed hardwood forest and pine forest. The highest IQR of box in Rocky cliff area means less concentrated in that area-it has more variability of data. The lowest IQR of box in mixed hard wood forest means more concentrated in that area as it has less variability of data. Both cliff rocky area and Sal-*Terminalia* forest has equal with highest range of data presence followed by *Quercus* forest. The small range of data presence in mixed hardwood forest and Pine forest. The highest of the fecal with their higher number fecal were recorded at cliff rocky area and *Quercus* forest.

Ruggedness of study area was classified into three categories namely broken, large and rolling. The result showed that higher number fecal was recorded in large rugged area followed by rugged rolling and rugged broken area (Figure 6). Himalayan goral was recorded in areas with a highly rugged and steep terrain. Large ruggedness area lies steep slope.

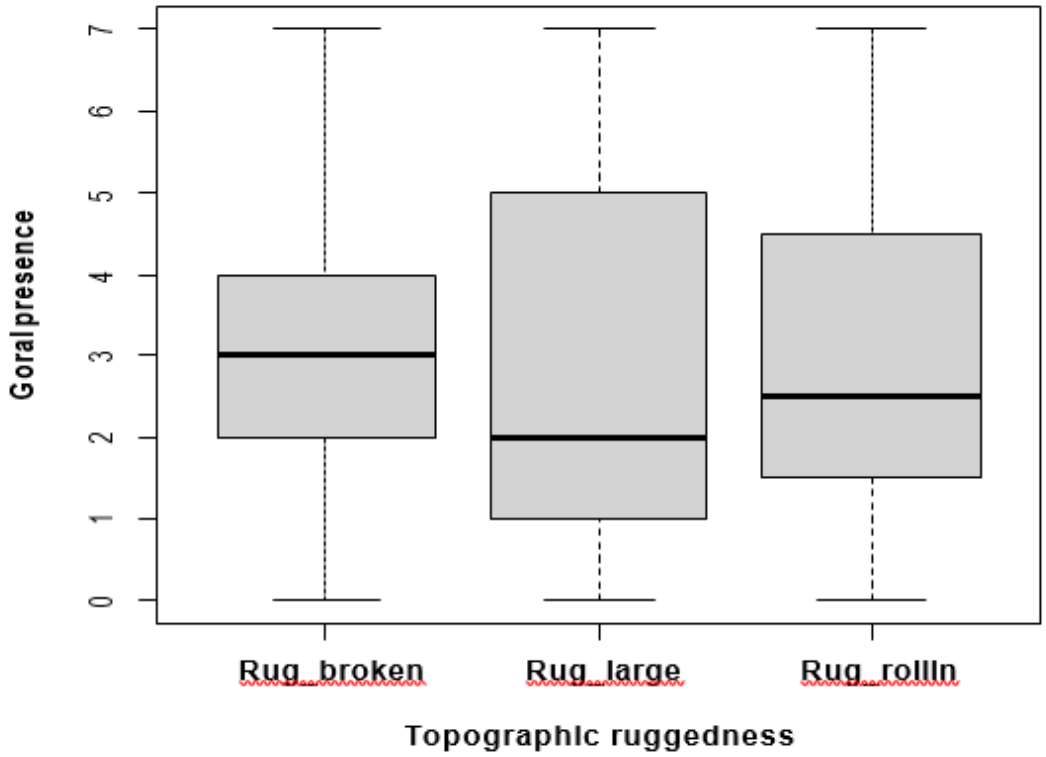

Figure 6. Goral presences in different topographic ruggedness.

4.3. Threat assessment

Among the total 100 respondents 60% were male and 40% were female in households near to study area. Around 98% of the respondents reared the livestock near the community forest. The most preferred livestock species was goat buffalo, ox and cow. According to respondents, poaching, habitat loss and human disturbance were major perceived threats observed for Himalayan goral in study area.

According to respondents, the threats to the Himalayan goral included poaching (70%), habitat loss (18%), human disturbance (10%) and others (2%).During the questionnaire survey, poaching is the major threat for the goral in study area.

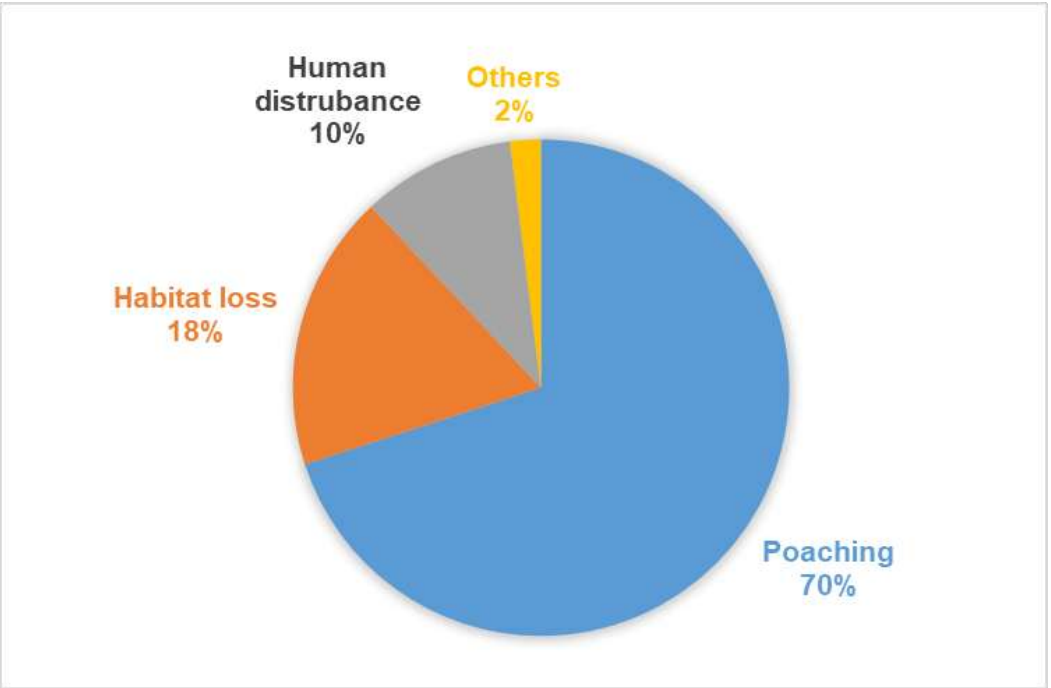

Figure 7. Major threats on Himalayan goral in the study area.

About 70 % of the respondent's confirmed poaching of goral in different parts of the study area. They said that the poachers come from outside. According to local community, June to September is the most vulnerable period. Twenty-one percent of the respondents didn't dare to answer about poaching activity and simply said 'I don't know'. Only nine percent of the respondents denied about the poaching activity.

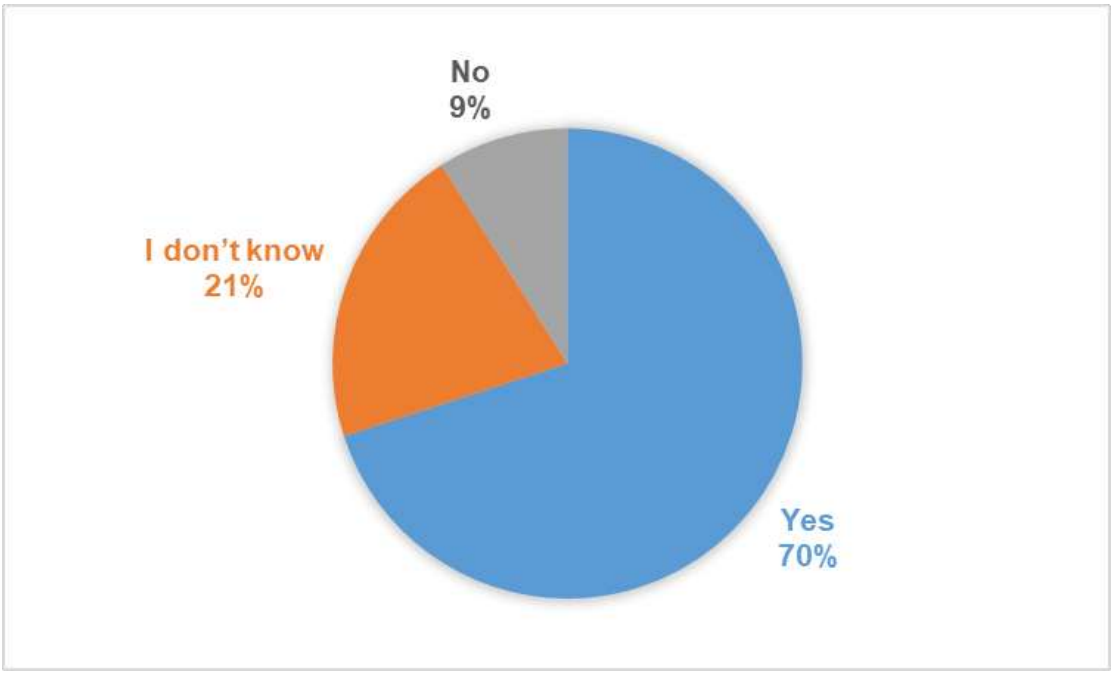

Figure 8. Respondent's view about poaching of goral.

5. DISCUSSION

The identifying areas for conservation are important to know the spatial distribution of good-quality habitat for the target species. Fecal samples were the most reliable signs used to determine the habitat, distribution and habitat preference of animals. Habitat is the natural home or environmental of organisms. Habitat utilization is part of organism life history pattern. A place where an organism makes its home also called habitat. Goral preferred rocky cliff area followed by *Quercus* Forest. Gorals are cliff dwelling mountain ungulates reported by (Prater 1971, Mead 1989). Rocky cliff area lies in the southern slopes of study area result in highly used area.

The suitable habitat for goral is scattered throughout the study area but occurs mainly in the south and the north of the region which is lies in steep and rocky area. The steep grassy slopes, which are the most preferred habitat of goral (Cavallini 1992, Mishra and Johnsingh 1996) Similar result was also found in the study of (Mishra 1993) found that group of goral species use mostly steep and rocky areas where sufficient cover and food plants (Lovari 1986). Among the five habitat categories identified in the study area, Pine forest was least preferred habitat as less number of fecal depositions was recorded there. Pine forest was frequently used by domestic livestock from the nearby villagers. While Sal-*Terminalia* forest and *Quercus* forest were used by goral as this habitat as hiding places during day times. This forest habitat provided food for goral during season when all ground cover grasses were dry and accidently burned by fire called accidental fire. Slope is also one of the major components for suitable habitat of Goral. This study showed that Himalayan goral mostly preferred steep slopes and rugged area. Slope areas provide safe place for the animals from different human activities as well as from predators.

Himalayan goral occurs abundantly in small, highly fragmented and patchily distributed habitats, as reported by (Hajra 2002), who found that less than 1% of the area is highly suitable for goral in the Sivalik hills in Uttaranchal, India. They could not use hunting data in developing the model as such data are difficult to obtain because of the mobile nature of hunting. Habitat loss and wildlife hunting were the main challenge for wildlife conservation in Nepal's mountains (Jackson 1979, Paudel 2012). The long-term survival of wildlife depends on sufficiently large areas of suitable habitat and opportunities for dispersal between such areas (Harrison 1991,

Hanski 1999). The quantity and quality of habitat of area to decrease due to human activities such as collecting wood for fuel, grass collection, grazing of wildlife from villagers and clearing forest for agriculture. Habitat loss and wildlife hunting pose an intense challenge for wildlife conservation in Nepal's mountains (Paudel 2012). Long-term survival of wild life depends on sufficiently large areas of suitable habitat (Harrison 1991) and opportunities for dispersal between such areas (Hanski 1999).

Questionnaire survey with locals also confirmed the presence of goral in the study area. Respondents suggested that poaching is major threat to goral in the study area. They illegally hunted Goral for the purpose of meat. Poachers mostly come from other villages of area. Poachers used mostly gun and other traditional tools for hunting. Major economic sources of local peoples of this area were agriculture, livestock rearing. Respondents also shared information that some level of illegal hunting/poaching has been controlled after conservation efforts by municipality. During field survey, farm of goat was observed inside the study area. These all activities create direct and indirect threats to Himalayan Goral and their habitat. Major threats of gorals were habitat degradation; Human disturbance and habitat loss (tree cutting, fuel wood collection and fire) were threats of Himalayan Goral.

The presence/absence of goral species is determined by the level of human disturbance and habitat requirements. Human presence and livestock presence in this area showed significant relation with presence of goral. Distance from village and road also affect in presence of Himalayan goral. This result showed that goral preferring flat areas covered by dense forest are less human disturbances, and rugged areas. Abundance of species studied declined with the number of villages in the vicinity and increased with distance to nearest village. Therefore, increasing human presence may affect to wildlife population in the region. To protect this region, community forestry program, land-use strategy along with local people participation aimed at reducing further encroachment of forest should be implemented in the region.

6. CONCLUSION

It was conformed that the goral is uneven distributed in study area in Dailekh District. A total of three Himalayan gorals with single calf were sighted in the Najur and one was sighted in the Nangre forest. A total of three Himalayan gorals with single calf were sighted in the hilly Cliffs, one was sighted in the *Quercus* forest and one was sighted in the Sal-*Terminalia* forest but there was no encounter of goral in the Pine forest and mixed hardwood forest. Distribution of this species was, concluded from indirect evidences (fecal groups, foot prints) and direct observation. Higher fecal deposits were recorded in the Hilly cliffs and *Quercus* forest while least in the pine forest of study areas.

The study also suggested that Himalayan goral preferred steep slope in southern, northern aspect and mostly preferred rocky cliffs along with other habitats such as *Quercus* forest Pine forest, Sal-*Terminalia* forest Mixed hardwood forest and pine forest. In this area, gorals are facing serious threat of illegal hunting for the purposes of meat by the people from surrounding Study area. Himalayan goral is unevenly distributed, with high-quality habitats confined in the southern and northern part of the area, which is a relatively inaccessible area with a rich cover of grass. Hence, conservation of high-quality habitats should be the main focus of the conservation of Himalayan goral.

7. RECOMMENDATIONS

- Regular monitoring with detail study on distribution and its habitation should be carried out for its long term conservation success.
- Conservation policies along with awareness program should be conducted at local level.
- Extensive and a large scale study is suggested to initiate the establishment of protected area for goral conservation.
- The livestock grazing should be managed properly.
- Conservation awareness program should be conducted.

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Appendix I

Questionnaire sheet

Name of the Respondent:

Age: Gender:

Village: Municipality/VDC, Ward No:

Socio-economic condition Occupation:

Education: House Type:

1. What animals visit around your Area?
2. Had they seen in Last year or not?
3. At what times were they seen?
4. How many times have you seen them this year?
5. In which places the sign of Himalayan goral were found more?
6. What types of Habitat do the like?
7. What color and size do they like?
8. How many have you seen the Himalayan goral at once?
9. How many Himalayans gorals may be in this area?
10. Which place do they visit more?
11. Are they useful or harmful?
12. Do local people have any special thought about Himalayan goral?
13. What are the Predators of Himalayan goral?
14. Should we protect them or not?
15. Is there any Poaching in your area?
16. If yes, which wild life species?
17. What weapons do they use for poaching?
18. People of which class are responsible for poaching?
19. Are the poachers local or not?

20. Why do they kill them?

21. Do they sell the goral?

22. What is the suitable time for poaching?

23. Which season is better to poach goral?

24. For what reason, Himalayan gorals are poached?

25. Are local people interested in conserving Himalayan goral?

26. What are the reasons for conserving Himalayan goral?

27. Are they used locally or exported?

28. What are the threats to Himalayan goral?

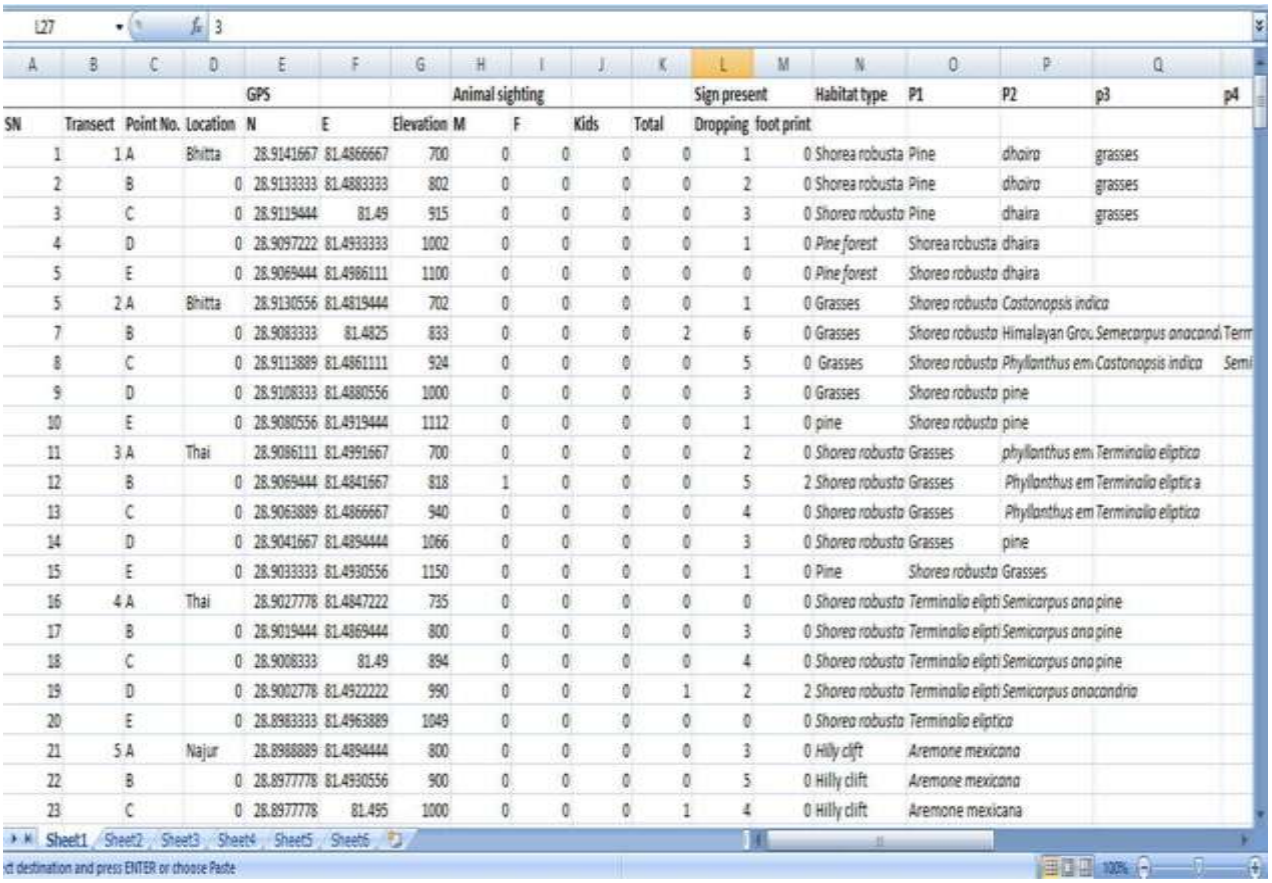
29. Does goral destruct your crop/agriculture field?

30. Do other animals occur in this area? If so can you name them?

31. How often you seen other species there?

Appendix II

Data collection sheet



				GPS			Animal sighting				Sign present		Habitat type	P1	P2	p3	p4
SN	Transect	Point No.	Location	N	E	Elevation	M	F	Kids	Total	Dropping	foot print					
1	1	A	Bhitta	28.9141667	81.4866667	700	0	0	0	0	1	0	Shorea robusta	Pine	dhaira	grasses	
2		B	0	28.9133333	81.4883333	802	0	0	0	0	2	0	Shorea robusta	Pine	dhaira	grasses	
3		C	0	28.9119444	81.49	915	0	0	0	0	3	0	Shorea robusta	Pine	dhaira	grasses	
4		D	0	28.9097222	81.4933333	1002	0	0	0	0	1	0	Pine forest	Shorea robusta	dhaira		
5		E	0	28.9069444	81.4986111	1100	0	0	0	0	0	0	Pine forest	Shorea robusta	dhaira		
5	2	A	Bhitta	28.9130556	81.4819444	702	0	0	0	0	1	0	Grasses	Shorea robusta	Castonopsis indica		
7		B	0	28.9083333	81.4825	833	0	0	0	2	6	0	Grasses	Shorea robusta	Himalayan Grou	Semecarpus anacardi	Term
8		C	0	28.9113889	81.4861111	924	0	0	0	0	5	0	Grasses	Shorea robusta	Phyllanthus emi	Castonopsis indica	Semi
9		D	0	28.9108333	81.4880556	1000	0	0	0	0	3	0	Grasses	Shorea robusta	pine		
10		E	0	28.9080556	81.4919444	1112	0	0	0	0	1	0	pine	Shorea robusta	pine		
11	3	A	Thai	28.9086111	81.4991667	700	0	0	0	0	2	0	Shorea robusta	Grasses	phyllanthus em	Terminalia elliptica	
12		B	0	28.9069444	81.4841667	818	1	0	0	0	5	2	Shorea robusta	Grasses	Phyllanthus em	Terminalia elliptica	
13		C	0	28.9063889	81.4866667	940	0	0	0	0	4	0	Shorea robusta	Grasses	Phyllanthus em	Terminalia elliptica	
14		D	0	28.9041667	81.4894444	1066	0	0	0	0	3	0	Shorea robusta	Grasses	pine		
15		E	0	28.9033333	81.4930556	1150	0	0	0	0	1	0	Pine	Shorea robusta	Grasses		
16	4	A	Thai	28.9027778	81.4847222	735	0	0	0	0	0	0	Shorea robusta	Terminalia elipti	Semicarpus ana	pine	
17		B	0	28.9019444	81.4869444	800	0	0	0	0	3	0	Shorea robusta	Terminalia elipti	Semicarpus ana	pine	
18		C	0	28.9008333	81.49	894	0	0	0	0	4	0	Shorea robusta	Terminalia elipti	Semicarpus ana	pine	
19		D	0	28.9002778	81.4922222	990	0	0	0	1	2	2	Shorea robusta	Terminalia elipti	Semicarpus anacandria		
20		E	0	28.8983333	81.4963889	1049	0	0	0	0	0	0	Shorea robusta	Terminalia elliptica			
21	5	A	Najur	28.8988889	81.4894444	800	0	0	0	0	3	0	Hilly clift	Aremone mexicana			
22		B	0	28.8977778	81.4930556	900	0	0	0	0	5	0	Hilly clift	Aremone mexicana			
23		C	0	28.8977778	81.495	1000	0	0	0	1	4	0	Hilly clift	Aremone mexicana			

Appendix III

Photoplates

Photo 1. *Nemorhaedus goral*

Photo 2. Fecal Pellets groups

Photo 3. Fresh fecal pellet

Photo 4. Old fecal pellet

Photo 5. Fecal pellets with GPS