An assessment of

STATUS, DISTRIBUTION AND HABITAT PREFERENECE OF HIMALAYAN MUSK DEER (*Moschus chrysogaster)* IN API NAMPA CONSERVATION AREA.

(A case study of Byas Rural Municipality)

Submitted to:

Api Nampa Conservation Area (ANCA)

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Abbreviations:

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 Park and Wildlife Conservation

IVI: Important Value Index

IV: Ivelv's electivity Index

RD: Relative Density

GPS: Global Positioning System

GIS: Global Information System

IUCN: International Union for Conservation of Nature and Natural Resources

Abstract

The research was entitled **"An Assessment of Status, Distribution and habitat preference of Himalayan Musk deer** *Moschus chrysogaster* in **Byas Rural Municipality** of **Api Nampa Conservation Area".** Study was done by population/pellet count, direct field inventory, vegetation analysis and questionnaire survey.

The study suggests that the population of musk in study area is 1.95/Km2 which shows nominal increase in population than previous research of Neupane (2016), albeit 33.92% of people believe it is decreasing in the last 10 years. And the study also revealed that the pellet group was 455/ km2. Habitat parameters from field i.e. slope, altitude, crown cover, ground cover and land features were recorded on both of the use (U) and availability (A) plots by using random sampling. The quadrate type plots of 10m×10m, 4m×4m and 1m×1m were taken to sample vegetation (tress, shrubs and herbs respectively) analysis on both plots.(Schemnitz,D.S.1980) Habitat preference of musk deer was analysed through Ivelv's electivity index (IV) having value from -1 to +1. HHs survey (N=32) using semi-structured questionnaire and field observation were used to identify the major conservation threats.

Musk deer was found to preferred Betula (IV=0.36) and Rhododendron shrub (IV=0.32) and mostly dwell in moderate crown of 26-50% (IV=0.23) and ground cover of 26-50% (IV=0.075) dominated by Betula spp. tree (IVI=146.66).

Nomadic pastoralism, livestock grazing, firewood and timber collection and destruction of habitat by Yarshagumba collectors are major threat to the survival of this species.

key words: Endangered species, Habitat degredation, Ivlev's Electivity Index, Pellet group count, Poaching, status, Use plots, Availability plots, Habitat parameters.

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INTRODUCTION

1.1General Background

The government of Nepal, on historic cabinet meeting of kala pathar in 2009 decided to establish Api Nampa conservation area as a part to extend network of protected areas for conservation of unique biodiversity that prevails in nation. It covers the area of 1903 square kilometers which includes 21 VDCs of Darchula district. The major wildlife species consists of Snow leopard, musk deer, clouded leopard, Red Panda, Goral, Himalayan Black bear, Himalayan thar, Grey wolf and Himalayan serow. It is also habitat for some of the charismatic birds of 243 species as Daphne (*Lophopherus impejanus*), Munal (*Crimson* spp), Snow Chock, Blood pheasant, Red billed chough, and Yellow-billed chough. The conservation area is well known for some endangered medicinal and high price NTFPs as Jatamansi, Yarshagumba, Panchaule, Kutki, Sugandhwal, Talis patra,etc

The Himalayan musk deer is a member of primitive deer family Moschidae. Musk deer have previously been classified in the family Cervidae, but are now generally classified within their own separate family, Moschidae (Groves and Grubb, 1987; Whitehead, 1972). Absence of facial gland differs them from other deer. It is one of six deer species of Nepal and is also found in Afghanistan, Bhutan,China, India, Myanmar, Nepal, and Pakistan. The species is Classified as *Endangered* in IUCN Red List Data (IUCN 2014) and is also listed in Appendix I of CITES (2003). *M. chrysogaster* is widely but discontinuously distributed throughout the Himalaya from about 3,000m to 4,400m (Green, 1985). Musk deer in Nepal is found within altitude of 2300m-4300m in forests dominated by birch and rhododendron (Green, 1980; Shrestha, 1998). The Himalayan musk deer are distributed throughout the mountainous region of the country, which covers 30177.19 Km2 with 5815.08 Km2 of the potential habitat used inside the protected area (Aryal and Subedi, 2011). It is protected by the Department of National Park and Wildlife Conservation Act since 1973 and is found in the Annapurna Conservation Area (ACA), Kanchenjunga Conservation Area (KCA), Sagarmatha, Langtang, Shey Phoksundo, Rara, Khaptad and Makalu Barun National Parks, Manaslu Conservation Area and Api Nampa conservation area. Population of Musk deer is declining due to poaching, high human and domestic livestock pressure, consequent degradation of habitat and, in respect of poaching, it has been estimated that for every

male deer that yields one musk pod, four deer are killed (Green, 1986). Poaching of musk deer inflated during insurgency period (1996-2007) due to lack of regular patrolling (Aryal and Subedi, 2011). The species is characterized by presence of musk glad (pod) which is found only in male (Shrestha, 1989). The research will be conducted in Tinker and Chhangru of Byas Rural Municipality where the largest number of musk deer expected to found (Chalise, 2010).The study of status, distribution and potential habitat of musk deer in the region which boarders China and India will assist to evaluate population and status of habitat along with poaching and trading pattern in transboundry region. The output of study will help for this newly established conservation area to protect musk deer and associated species through effective management activities.

1.2 Literature Review:

The entire Himalayan region is rich in high altitude wildlife diversity. This diversity is result of the extreme altitudinal differences and climate and soil conditions creating differences in natural vegetation. The information on biodiversity such as animal status (abundance, distribution, home range, ecological habitat etc.) a population and community interaction along with the contribution to the development of ecosystem is essential for the conservation and management of wildlife and protected areas (Basnet, 1998).

Green, (1985) studied the aspects and ecology of Himalayan musk deer in kedarnath sanctuary of Utter Parades India between February 1979 and December, within an area of 2.5 km sq. that comprises green oak and conifer forest, birch- rhododendron scrub and pasture. There are many threats to population of musk deer, of which two are most important; the first is hunting to obtain musk (Wemmer, 1998;Green, 1986; Jackson. 1979) which can be estimated by trade in musk product(Green, 1986; Homes, 1999) and loss of habitat(Yang et al.,1989; yang and fang 1998). In Asia, including china it has long been used in traditional medicine as a sedative and as a stimulant treat varieties of elements (Green, 1985, Sheng,1998,Homes,1999).

The study on the musk deer was followed by the kattel (1992) with the topics named ecology of Himalayan musk deer in sagarmatha national park Nepal 1986 to 1989. He recorded the twenty three musk deer phortse village wit the ratio of adult to juvenile was 4:1 and male to female was 1:3. Further Rachel R. (2005) reported twenty five musk deer were found on the same area on his report; population status distribution, management, threats and mitigation measures of himalayan musk deer(*Moschus chrysogaster*) in sagarmatha national park".

The distribution of musk deer is described in detail by Flerov (1930, 1952). In general the genus *Moschus* is distributed sporadically throughout the forested, mountainous parts of asia, form just north of artic circle southward to the northern edge of mongolia Korea. Further south but avoiding the Gobi desert, musk deer occurs in china, northern Vietnam (Dao, 1977) Burma, Assam, and the Himalayan region. In Nepal Himalayan musk deer is widely but discontinuously distributed at altitude of 3050-4250 m.(Blower, 1974).populations are low and continue to decline due to intense hunting.

Nepal does not have concrete data about the population of musk deer till the date. Not only in Api Namap Conservation Area but also to Nepal (except few locations), musk deer conservation status is unknown due to scanty information throughout the country (Karki, 2008). At present, musk deer can be found in Himalayan range of different national park. Musk deer found throughout the Glob. They have good reproductive capacity. However Human activities over exploitation and habitat loss have jeopardized survival of musk deer in the world (Jiang 1995 cited in karki, 2008)

1.3 Rationale of the study

Musk deer is also kown as "Kasturi mirgha" in Nepali where "kasturi" means musk and "mirgha" stands for deer. The shy solitary musk deer is listed as endangered animal under the IUCN category and is listed in CITIES Appendix I for Afghansistan, Nepal, India and Pakistan, and in Appendix II for China (IUCN red data book, 2016). Musk deer is protected mammal and listed as endangered species by the National Park and Wildlife Conservation Act 1973 in Nepal.

The musk produced by musk deer is highly valued for its cosmetic and alleged pharmaceutical properties, and can fetch U.S. $ 45,000 per kilogram in international market. Although this musk, produced in a gland of the males, can be extracted from the live animals, most "musk-gatherers" kill the animals to remove the entire sac, which yield only about 25 grams of brown waxy substance. Such poaching is relatively easy to accomplish and difficult to stop using only leagal means (Harris 1991, 2007).The estimated number of musk deer killed during 1970s and 1980s vary between 5350 and 1600 every year (Green 1985, 1989). Before the 1970s, Japan imported much raw musk from India and Nepal (Green, 1989).

It was once continuously distributed all along the southern side of the Greater Himalaya, between 2500m and tree line, but as a result of human habitations, habitat alterations and poaching, it is now restricted to a few isolated pockets throughout its former range (Green 1985, 1986).

In Nepal population of musk deer is decreasing due to poaching and habitat destruction but there are lack of researches to understand the population decline (Sathyakumar, 1993). In Nepal the population of musk deer with the protected areas are increasing but decreasing outside the protected areas (Aryal, 2010).

Detailed study to understand the eocology of musk deer and its interactions with environment rarely have been done in Nepal, the only research being done by Kattel in 1992 in Sagarmatha National park.

Api Nampa conservation area being of the recently established protected areas of Nepal in 2010 have not carried out the detailed study of musk deer the only research done by Chalise in 2012. The study area is chhangru (3048m) and Tinker (4500) of Byas Rural municipality bordered by India and Tibet. So this research will also help to understand the status and distribution of musk deer and poaching activities in the Trans boundary region. This research will help to understand the population and habitat of musk deer, livestock pressure in the poaching activities in the study area which will assist for formulation of programs and management activates designated for long-term survival of musk deer in Api Nampa conservation area.

1.4 Objectives

General objective: To assess the status, distribution, habitat preference and conservation status of musk deer in Api Nampa Conservation Area

Specific objectives

1. Appraise the current status of Himalayan musk deer in study area.
2. To find out the distribution of Himalayan musk deer in study area.
3. To analyze the habitat preference of musk deer.

1.5 Research Questions

What is the trend of musk deer availability in the study area?

Does the musk deer is widely distributed in the study area?

Does the study area provide good habitat for the Musk Deer?

What are the conservation threats of musk deer?

1.6 Limitations of the study

1. Some of the people hesitate to participate in questionnaire survey.
2. Musk deer is shy and solitary animal so a longer research period can be more effective but due to time and budget constraints we couldn't spend more time in field.

3. The timing of the study was bounded by the schedule of the Institute of forestry. Therefore, the study was conducted in unfavorable season(winter season) making the fieldwork much harder and time consuming and the finding may not represent for the other season.

1.7 Taxonomy

Taxonomy of musk deer has always been a debatable subject (Green and kattel, 1997). Previously classified in Cervidae (Flower, 1875 and Heptner and Naumov, 1961) but later on it got its own seprate family Moschidae (Brooke, 1878; Flerov, 1952; Groves and Grubb 1978 and Whitehead, 1972). One to three species was reckoned to be under this (Green 1986; Grooves, 1975 and Grubb, 1982), which later on was modified to four to five species (Green 1998; Grooves and Grubb 1987, and Grooves et al., 1995_ and even are more are assumed to be under to musk deer family. The taxonomy was further on redefined into seven species (Groves and Grubb, 2011). These are listed below.

1. ***Moschus Chyrsogaster***: This alpine musk deer is distributed in mountaineous region of India, Nepal, Bhutan, Tibet and Central China (Hodgson 1839).
2. ***Moschus cupreus***: Previously treated as sub-species of M. chryogaster this species is distributed along Afghanistan, Pakistan and Kashmir (Grubb, 1982).
3. ***Moschus leucogaster***: This species inhabits places in Nepal, India, Bhutan and Sikkim (Hodgson, 1839).
4. ***Moschus fuscus***: This is also known as black musk deer and is distributed in India, China, Myanmar, Tibet, Sikkim, Bhutan and eastern Nepal (Li, 1981)
5. ***Moschus anhuiensis***: This is distributed in southwest of Anhui (Wang et al. 1982).
6. ***Muschus moschiferus***: Also known as Siberian Muskdeer this is distributed in eastern Siberia, Mongolia, China, Kazakhstan and Korea.
7. ***Moschus berezovskii***: This is also known as dwarf musk deer and is found in some provinces of China and Vietnam (Flerov 1929).

1.7.1 General characteristics

Musk deer is strongly built, shy, solitary and nocturnal mammal. It differs from other deer in not having antlers and facial gland. Its ears resemble to hare, typically have small head with arched back and bounding gait (Sathyakumar et al., 2015). They are known to attain the height of 40-50 cm at shoulder having head to body length of 86-100 cm and weight of 13-18 kg (Zhivotshenko, 1988, Shrestha, 1997). The hind limbs are 5cm longer than the fore legs. Musk deer do not have antlers instead they have elongated upper canine teeth, which in males can be up to 10cm long and

protrude beneath upper lip. In females upper canine are small, never protrude below the lip of the lower jaw. Therefore musk deer are not true deer, but primitive deer like ruminants (Green, 1985). The dental formula is: i0/3, pm3/3, m3/3 X2= 34. The canines are movable in sockets, and adaptation that facilitate feeding and cud chewing (Cooke and Farrell 1983). Musk deer have facial gland, gallbladder, caprine gland in between the hoves that reveal that deer is more closely to goat than to deer (Shrestha, 1997)

The musk deer is of dark brown colour and its body is covered over with coarse and brittle hairs. Individuals' hair have air filled compartment arranged like a honeycomb, which assists for better insulation in cold habitat (Green 1985). The genital region are white and tail is naked except for the tuft of hair at the tip. Musk deer movement resemble to more like jumping than running. Their toes are larger comparative to their body size and assists in secure footing in snow in mountainous region. The long pointed central hooves and enlarged lateral hooves that provide a firm grip on the steep ground, this even assists in climbing slanting trees for forge. Only male musk deer have 'musk' and 'caudal' gland. The caudal gland situated below the tale have pores in each side, through which a yellow viscous secretion with offensive odour is secreted (Sathyakumar and Rawat, 2015). The word 'musk' derives from the Indian ancient word for testicles. This probably suggests musk sac of male musk deer locating close to the male genitals. A mature musk deer bears a musk 'pod' between genitalia and umbilicus, which exudes a strong smelling, dark brown semifluid substance for attraction of females during the onset of rut. Male musk deer produce musk from the age of 12-18 months onwards (Green, 1989). Most musk is produced by animals between three and eight years of age, averaging 25 gm of musk, per animal, per year (Green, 1989).

1.7.2 Habitat preference

Musk deer prefers altitude of 3000m-4500m in the temperate climate (Green, 1986; Shrestha, 1997). In Nepal musk deer is found in birch and rhododendron forest at an altitude of 2400-4300 meters with the marked preference in steep slopes (Green, 1980; Shrestha 1998; Kattel, 1992). Thick blanket of pines leaves on the ground provides warmth and presumably reduces the thermoregulatory cost (Dussault et.al, 2004; Maloney, Moss, Cartmell and Mitchell, 2005) in high altitudes. Bark of Abies sp. also contribute to portion of diet in winter (Green, 1980). The use of habitat is governed by cover, food and others factors. They occur in upper temperate, subalpine region, alpine scrub and meadows. Body size is dominant for determination of the energy requirements in ruminants (Bell, 1970; Jarman, 1974). Energy requirement is proportional to body

weight raised to the power of 0.75 (Kleiber, 1961). This results musk deer having lager energy requirement/ unit body weight than larger species. It is predominantly a browser, feeding mainly on shrubs, forbs, leaves, moss, lichens, shoots, grasses and twigs (Green, 1987). Musk deer are 'nibblers' rather than browser, as they selectively feed on young leaves, buds, fruits and flowers of dicotyledonous plants (Green, 1985). Groups are usually consists of mother and her offspring. They are more active during dawn and dusk, resting during the day and often sighted grazing in open area in night. Deer species serve as the best indicator of forest health. The understanding their food preferences and changes due to biotic influences are important in interpreting relationship between environment and the consumer i.e., (Leopold and Krausman 1987). Studies in India revealed musk deer preferred alpine scrub forest because the species is associated with the tree line which is considered to be optimum habitat (Green, 1985; Sathyakumar, 1994). During summer time deer spend most of their time in birch-rhododendron forest (43% of the time) and rhododendron shrub areas at higher elevations (24%), while the rest of the time was evenly divided among several micro-habitat areas and village fields. Durig the winter the deer spend greater percentage of their time in birch rhododendron forest (49%) and rhododendron shrub areas (33%), likely because of the availability of the arboreal lichens. Musk deer seem to prefer the areas characterized by the presence of stands of Pinus spp. and Abies spp. trees with relatively dense canopy-cover (≥ 42%) on higher elevation zone (≥3529m) on the southern aspect and selection was found to be consistent throughout the year (Khadka and James, 2016). The cover preference is vital for musk deer (Green, 1985). They used mostly no or low tree cover, moderate to high shrub cover and low or high grass/ herb cover (Sathyakumar 1994).

1.7.3 Home range

Inhibiting the steep, forested or shrub covered slopes, mainly in the sub-alpine zones, undergrowth rhododendron, bamboo and shrubs forms its typical habitat (Bannikov et l., 1978 and Green, 1987). Musk deer are shy and solitary and primarily becomes active at night primarily on exposed alpine meadows (Green, 1998).Home range is governed by the size of an animal as larger animal requires more energy compared to the smaller ones (Kleiber, 1975; McNab, 1963). McNab (1963) developed an equation which was later on modified by Harestad and Bunnell for the large herbivorous.

HR=0.002W^1.02

Where HR is the home range and W is body mass in gm.

The home range for small-bodied Himalayn musk deer, having the average body masses of 10.3 and 10.7 Kg for males and females from the Harestad and Bunnell equation were 21.58 ha and 22.44 ha, respectively. This contradicted as Green (1985) estimated home range of 15-31.6 ha (n=3) based on track of known individuals. Kattel (1992) estimated 14.24 ha for males (n=2) and 13.36 ha for females (n=6) based on radio telemetry in Sagarmathe national park. The contradiction of result that of Harestad and Bunnell is that they require larger sample size. Harris and Guiquan (1993) suggested home range to be 17.6 ha from the one radio tracked individual musk deer.

Males are strongly territorial and strongly defend their territory from other intruding males while female territories may overlap (Green, 1998; Kattel, 1992). Kattel (1992) from his studies in Sagarmatha national park suggested that, in regions where population of musk deer is high (23 individuals to 50ha), the home range of males overlapped with parts of home range of females but not with the home range of another male. However in studies in northern India (Green, 1995 and 1998) in cases where the population density was low (five to six individuals/km^2) the home ranges did not overlap as much as densities were high. Musk deer cover large portion of their home range on regular basis with 28% of their winter home range being covered in one day (Green, 1985). However, on the day with poor weather, they temporarily confine their movements to small areas as 0.01 ha (Green, 1987). There wasn't any evidence on seasonal movements of musk deer, such as to lower altitudes in winter, in previous studies (Green, 1998; Harris and Guiquan, 1993; Kattel, 1992). However, Bannikov et al. (1978) reported that musk deer in Russia may migrate up to 35km when snow in the winter deprives them of their usual food and shelter.

1.7.4 Communication between animals

The musk deer is solitary animal existing within dense cover so it depends on olfaction for communication; visual contact and vocalization are less important (Sathyakumar, 2015). Olfactory signaling between musk deer is highly developed (Lai and Sheng, 1993). So called "latrine sites" (areas of droppings), urine markings and musk scent of males, as well as scent rom other glands found around the hoof and tail are used for marking (Green, 1987c and Sokolovand Prikhod'ko, 1979 and 1983).

After defecation they cover fresh pellets with mud, old pellets and litter to keep it moist to retain the odour and also to impregnate the feet with scent of feces. While some defecation are used exclusively by one animal, others may be shared (Green 1985, Sathyakumar, 1991).

The function of musk scent in chemical communication is not entirely understood. Obervations of red-or-pink-stained and sweet-smelling patches of urine in snow indicate that the musk of male is probably emitted in the urine, while the urine of females, by contrast, is amber-colored and does not have any noticeable smell to humans (Green, 1987). The scents can be used for territorial marking by animals and at the same time express something about the individual status of animals. Fights between rivals would in this way to be kept to a minimum and females would learn more about potential reproductive partners (Homes, 1999).

Musk deer are rarely seen vocalizing expcept when alarmed. They make a non-vocal alarm hiss and stot on sensing danger or when they see a predator or human (Sathayakumar, 2015).

1.7.5 Reproduction

Musk deer breed seasonally where the rut extends from November to early January and young are born from May to June after a gestation period of 178-198 days (Homes, 1999). The period of gestation increases with the size of the species, from the Forest musk deer, the smallest musk deer to the Siberian musk deer, to the Himalayan musk deer, the largest species and with longest gestation period (Green, 1989). Litter sizes ranges from one to three young.

The birth weight of musk deer varies between abut 400g and 600g, depending on the species. In first two months, the young musk deer, like all deer species, are “nursed offering” concealed in the undergrowth and suckled by their mothers. At the age of two months they began to follow their mothers and are weaned (Green, 1987).The young grow rapidly, become independent of their mothers by the age of the six months and reach sexual maturity at 18 months of age (Green, 1987 and 1989).

The relatively high reproductive rate of musk deer has probably been an important factor in preventing extinction of the species (Homes, 1999).

1.7.6 Food

Musk deer feed on herbaceous and woody plants, leaves, flowers, twigs, lichens, moss, shoots and grass. In winter arboreal lichens and some terrestrial lichens make up about 70% of the content of musk deer’s stomach (by weight). In summer herbaceous plants are the main diet Green and Kattel, 1997; MacDonald, 1995).

They have preference for the easily digestible nutritious food that are high in energy content, rich in protein and low in fibre (Green, 1987 and Kholodova and Prikhod’ko 1984). Musk deer can climb trees to graze on lichens and leaves otherwise out of reach (Kattel, 1992).

1.7.7 Predators

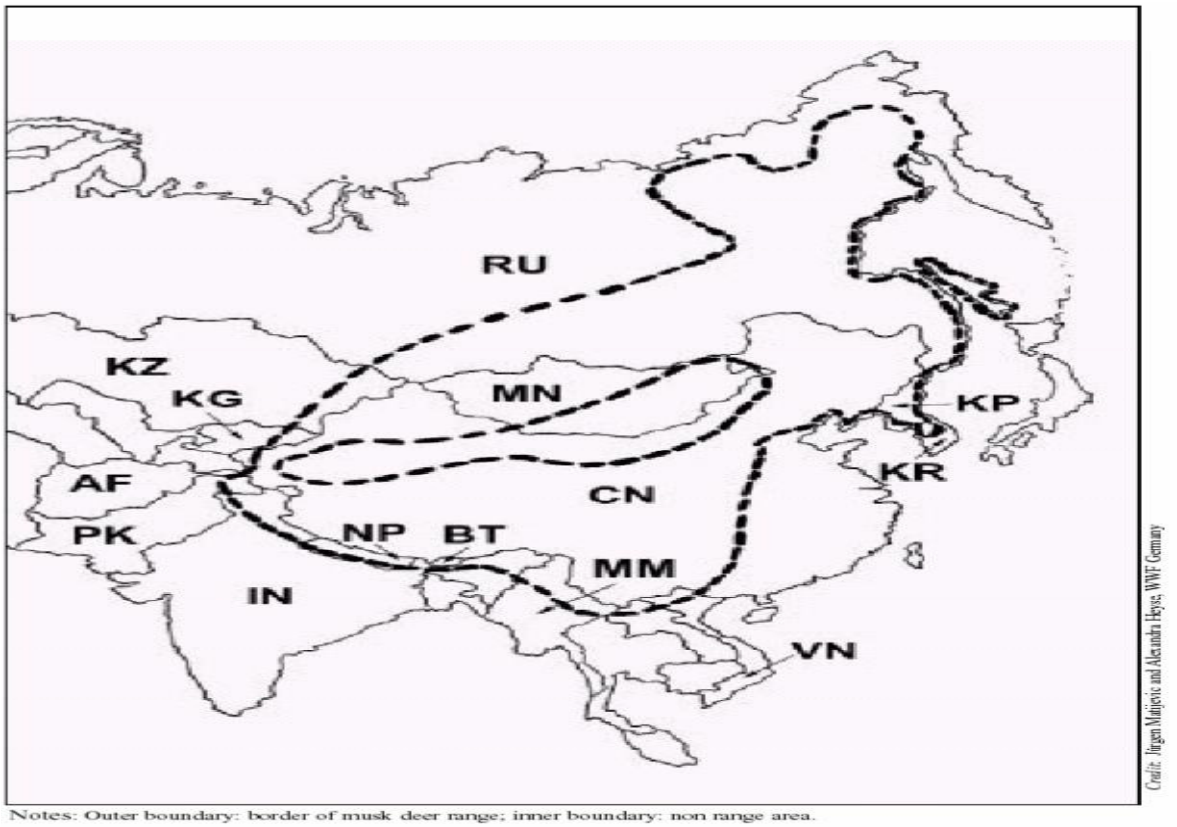
Musk deer prefer large rocky places which provide shelter from predators. Musk deer have number of natural predators. Depending upon their range, their main predators may include the Wolverine *Gluo gluo*, Grey wolf *Canis lupus*, Leopard *Panthera pardus*, Tiger *Panthera tigris*, Snow leopard *Unica unica*, Lynx *Lynx lynx,* Fox *Vulpes vulpes*, Yellow-throated Marten *Martes flavigula*. The young are also attacked by large birds of prey such as Large billed crow *(Corvus macrohynchus*) and Upland Buzzard *(Buteo hemilasius*) (Green, 1987a, Kozhechkin, 1994 and Zhivotshenko, 1998). Predators' do not have the significant impact on size of the musk deer population (Homes, 1999). Musk deer detect approaching in part through their sense of hearing (F.Mers, pers.comm., 1998 and Zhivotshenko 1988).

1.7.8 Distribution of Musk deer

The distribution of musk deer extends through the forested mountains of eastern Asia, from the Arctic Circle in Siberia in north, to the north-edge of Mangolia and Korea and further Southwards towards China, away from the Gobi Desert, to Vietnam, and Myanmar continuing as far as the Southern Himalaya in Afghanistan, Pakistan, India and Nepal. In Central Asia, Musk deer occur in Kazakhstan, possibly in Krygzstan and South of Russia (Dao, 1977; Flerov, 1952; Green, 1986 and Whitehead, 1972). Musk deer mainly inhabits altitude above 100m. In the Himalayas, the animal range extends in parts up to the tree line at an altitude of 4200m, but in the northern parts of their range, Musk deer occur at lower altitudes.

The accuracy of the estimates of the size of Musk deer populations varies greatly in the different regions (Wemmer, 1998). Only in very few countries are population estimates based, at least in part, on systematic counts carried out in selected areas and extrapolated to larger distribution ranges: this method of estimating population sizes was used in the Soviet Union. Overall the population of all Musk deer species may be estimated to be between 400 000 and 800 000 individuals.

Figure 1: Range of Musk deer (*Moschus* sp.) according to Corbet and Hill (1992); Dao (1977); Flerov(1952); Green (1986); Wemmer (1998) and Whitehead (1972).



Notes: Outer boundary: border of musk deer range; inner boundary: non range area.

AF: Afghanistan; BT: Bhutan; CN: China; IN: India; KG: Kyrgystan; KP: North Korea; KR: South Korea; KZ: Kazakhstan; MM: Myanmar; MN: Mongolia; NP: Nepal; PK: Pakistan; RU: Russia; VN: Vietnam

1.7.9 Distribution of Musk deer in Nepal

M. chryogaster is widely but discontinuously distributed throughout the Himalaya from about 300m to 4400m (Green, 1985). In Nepal musk deer is found in 12 protected area (6 national parks, 5 conservation areas, 1 hunting reserve) which covers only 19.26% of the potential habitat in the country (Aryal and Subedi, 2011).

There is more potential habitat outside the protected but due lacks specific management activites (Aryal and Subedi, 2011) and the population of musk deer is decreasing outside the protected areas (Aryal, 2010).

Musk deer is found in following protected areas in Nepal.

1. Sagarmatha National park
2. Rara National park
3. Langtang National park
4. Khaptad National park
5. Shey Phoksundo National park
6. Makalu Barun National park

7. Annapurna Conservation Area
8. Manaslu National park
9. Kanchanjunga Conservation Area
10. Api Nampa Conservation Area
11. Gauri Shankar Conservation Area
12. Dhorpatan Hunting Reserve

In Api Nampa Conservation Area Musk deer are distributed in Ghusa, Khandeshwori, Byas, Sunsera, Hikila and Airkot VDCs which covers 574.84 Km2 of potential habitat where byas VDC containing the highest number of musk deer (Chalise, 2012).

2 METHODOLOGY

2.1 STUDY AREA

Api Nampa conservation area is one of the recently established protected area of Nepal which is named after two famous peak Api and Nampa. Envisioned with the protection of flora and fauna of Far Western Nepal this was established in 12th July, 2010. The study was done in Tinker and chingaru village of Byas Rural Municipality of ANCA. ANCA is located between N29°30' to N30°15' and E80°22' to E81°09', in the Far-Western Development Region of Nepal. It covers an area of 1903 km2 within 21 Village Development Committees (VDCs) of Aairkot, Bramhadev, Byaas, Chhapre, Dhari, Dhaulakot, Ghusa, Guljar, Hikila, Huti, Katai, Khandeswori, Khar, Latinath, Piparchauri, Rapla, Seri, Sitola, Sipti, Sunsera and Tapoban in Darchula District, and ranges in altitude from 539 to 7132 (Api himal) metres above sea level. ANCA is delineated by Bajhang District in the east, the Mahakali River (International borders with India) in the west, the border with Tibet in north and Lasku and Naugaad Khola to the south (ANON, 2012).

Local climate is generally characterised by high rainfall and humidity which varies from sub-tropical to alpine climate.This is governed by geographic position and altitude of the area. 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. In the north, most of the region remains under snow and has an alpine climate, whereas the mid-hills are of a temperate type. The average maximum temperature is 18.6ºC and the minimum temperature is 7.7ºC.Byas, Rapla, Ghus and khandeswori experience extreme cold alpine climate in the region. About 80% of the total annual rainfall occurs during the monsoon period (June to September) where the average rainfall is 2129mm (ANON, 2012).

The area is dominated by forest 30% coverage while Grassland covers 23%, barren land 23%, shrub land 6%, cultivated land 5%, snowglacier 2%, rocks 2% and other 10%. The study area comprises temperate and sub-alpine forest .This encompasses *Pinus wallichiana*, Oak forest and Abies forest respectively. The alpine forest in Tinker village was dominated by *Betula utilis* and Rhodendron.

The Byas area and its forest is separated from Indian side by Mahakali River. The forest of Byas area is dominated by *Abies* and *Cupress* spp. There are about 15 households in Chhangru and 17 households in Tinker. The population was constituted of people in their late 50s as young people migrated to Darchula headquater Khalanga bazaar for job opportunities and education for their children. The Tinker village is 7 day walk from Khalanga and borders with India and Tibet. Tinker is near is connected with Tibet through Taklakot entry point which once was a trade route to India, Nepal and Tibet. The temperature in Tinker reaches to -4 degree celcius in winter with heavy snowfall. In both Tinker and Chhangru people migrate to lower region around Kahalnga bazaar to escape the cold temperature and snow fall during September- March.

Settlement is fragmented where most of people rely on livestock, agriculture and seasonal NTFP trade for their livelihood.

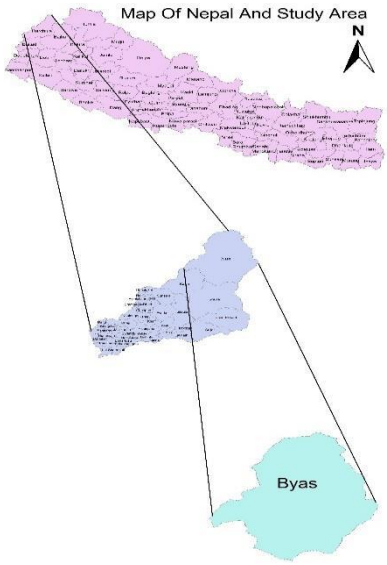


Figure 2: Map of study area and study sites

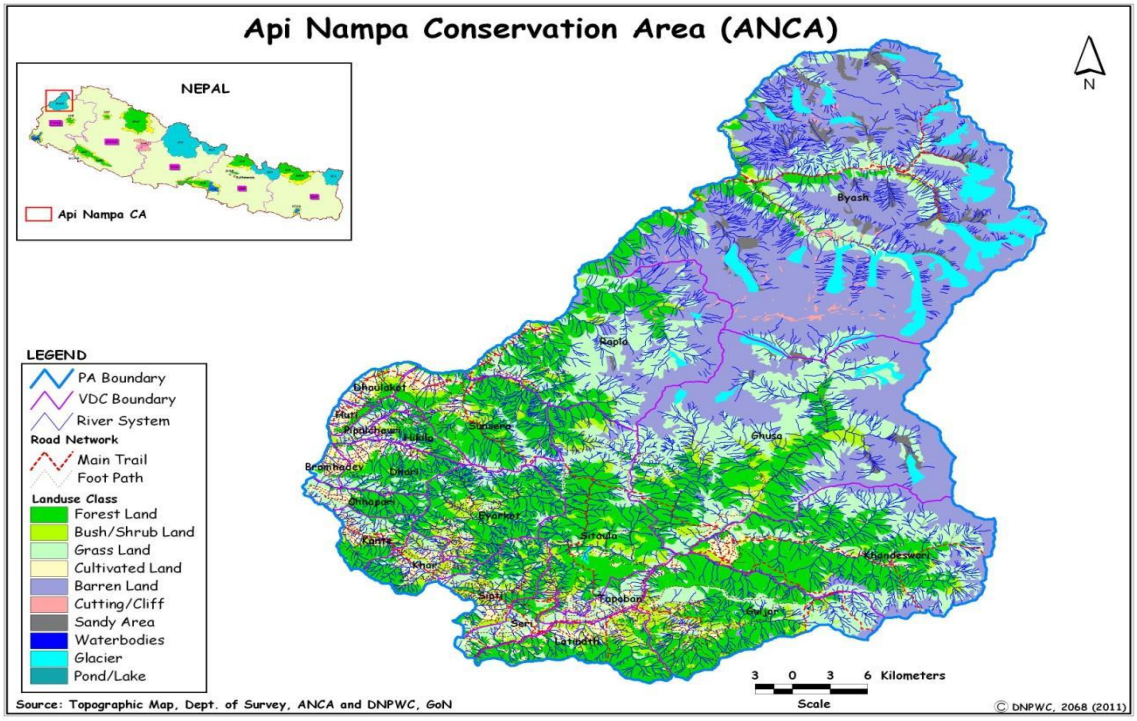


Figure 3: Map of Api Nampa Conservation area (ANCA)

Preliminary survey

Concerned local people, herders, local leader and park staffs were consulted before field work to find out potential musk deer habitat.

2.2 Status and Distribution

Pallet count was done in transect line of 500m long and 20m wide (10m on each side) was laid out in potential musk deer habitat. Musk deer defecate pellet in same place which made it easier to distinguish older and newer layer. Number of pellet groups is used to calculate the population status of the musk deer. Whenever lower and upper layer are less than 30 days old, it was counted as two pellet groups (Aryal, 2005). This was based on experience of local person and park staffs. GPS points of places where musk deer paw marks, scents, resting place and undigested hair of musk deer in scat of prey were taken. Status of physical feature where pellet was found was noted within 50m of pellet such as open or closed canopy, cliff, cave, rocks, water sources, etc.

$$\textbf{Pellet density:} \quad \frac{\text{Total pellet numbers}}{\text{Transect area X Transect Number}}$$

Regression model

Regression model for the prediction of population density/km2 from pellet density/km2 was adopted that of Aryal, (2005).

Regression equation: X = a + bY

Where X= Population density/Km2 (dependent variable)

Y= Pellet density/Km2 (Independent variable)

Regression equation for the estimation of Population density/km2 (X) is

(X) = 0.59+0.003Y

Where a = 0.59

b = 0.003

Silent drive count was used to determine the population density of musk deer in certain area. This method was introduced by Green (1985) for Serow and musk deer and was later adopted by Kattel (1992); Sathyakumar (1994) and Vinod & Sathyakumar (1999). In this method potential area is identified and divided into small blocks based on natural features as ridges, river and tracks as boundries. Five men were at interval of 30m were deployed to drive musk deer towards two observer who were strategically at vantage point to record musk deer. Five blocks (plots) each of suitable size according to geography was established in various forest in study area.

2.3. Data Collection

2.3.1 Primary Data Collection

2.3.1.1 Vegetation analysis

Vegetation survey was conducted by laying plots in musk deer habitat based on random sampling. Plots were laid in both places of presence and absence of pellets. Sample plots size of 10m*10m for tree (Species above 3m height and 10cm DBH), 4m*4m for shrub (woody plants below 3m height) and 1m*1m for herb (Plants upto 1m height) was taken (Schemnitz, D.S, 1980). Plots were taken where latrine was present and also where it was not recorded with most of plots taken were in former.

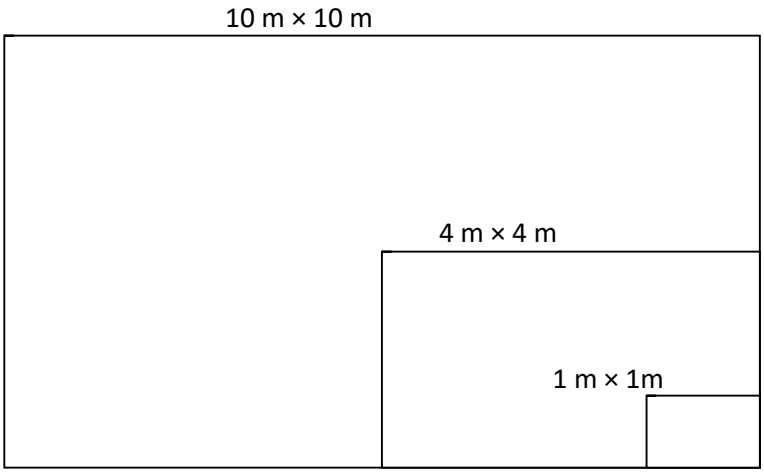


Figure: 4 Sampling design

Plant density, frequency and abundance were calculated by using following formula.

1) Density and Relative density (RD):

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

$$\text{Relative density of species A} = \frac{\text{Total number of individual of species A} * 100\%}{\text{Total number of individuals of all species}}$$

2) Frequency and relative frequency (RF)

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

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

3) Relative dominance (Rdom.):

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

$$\text{Basal area} = \pi (d / 2)2$$

Where, d= diameter of tree at breast height

Important value index (IVI):

Important value index of tree species was calculated via following formula.

IVI = relative density + relative frequency + relative dominance

2.3.1.2. Habitat ecology

Random sampling was used to collect different habitat parameters from the field. Habitat use and availability plots were laid throughout the study area. Habitat use plots (U) were laid out at 50m from musk deer sign as indicated by presence of scats, hair, foot prints, resting sites, etc. 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 100-150m between each plot (Aryal and Kreigenhofer, 2009) and the same parameters noted above were also recorded in these plots. Where signs of musk deer 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 musk deer .

Ivelv's electivity index (IV)

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

The habitat preference of musk deer was analyzed using Ivelv's electivity index (IV) which ranges from -1.0 to +1.0. The positive value suggests preference where negative suggests avoidance, 0 value indicates random use. Formula for habitat prefer ace as IV is follows.

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

Where "A" represents "availability plots" and "U" represents "use plots". Habitat preference was analyzed on the basis of various parameters as trees, elevation, cover, herbs and shrubs. Habitat preference based on different habitat parameters such as elevation, slope, trees, shrubs, herbs was analyzed..

2.3.1.3Dropping counts

Dropping were categorised into random droppings, relic sites and bedding sites (Pandey, 2006).

Random droppings: A deposits of faeces excreted single time anywhere in the study area.

Relic sites: A huge deposits of faeces as the latrine of musk deer.

Bedding site: It is the place where musk deer dwells. Deposits are observed scattered in its dwelling place.

The faecal deposits were further categorized into Very fresh, Fresh, Old and Very old (Pandey, 2006)

Very fresh: Shiny black and great amount of moisture content faecal pile.

Fresh: Shiny black but very less amount of moisture content, recent one.

Old: No shine but greyish black; faeces have normal shape without moisture content presumably of past season.

Very old: Losing shine and not in normal form and shape.

2.3.1.4Questionnaire survey

Previous and current trade of musk deer were find out through questioner survey with villagers, hunters, park officials and security personal. Anthropogenic pressure through grazing and firewood collection was taken account. The study area is near Taklakot which border to Tibet and is infamous for wildlife trade point.

Moreover status of concerned musk deer predators in the habitat was studied through locals, park officials and field observation. The signs of predators in musk deer habitat were recorded and past research done on such predators were studied.

2.3.2 Secondary Data collection

Secondary data were collected from Api Nampa Conservation Office, Different journals, research papers, articles and from different websites.

3 RESULTS

The forests of chhangru and Tinker were studied and potential habitat of musk deer were identified through locals, park officials and signs recorded. In Darchula district they are distributed Byas, Rapla, Khandeswori, Ghusa and Sitaula VDC with high number in Byas and Rapla (Chalise, 2012). The potential habitat for musk deer in Api nampa conservation area is 574.84 km2 (Aryal and Subedi, 2012) out of which 60 km2 (Chalise, 2012) is suitable in Byas and Rapla VDC.

3.1 Population Status and Distribution of Musk deer

Transect line of 500m long and 20m wide (10m on each side) was laid out in potential musk deer habitat. Whenever the upper and lower layer were less than 30 days old it was counted as two layers. Transects were laid from the altitude of 3000m to 4500m with the study area. Silent drive count was conducted in both the forests of Chhangru and Tinker. The pellet group of 82, in total transects of 18 were counted in the habitat where pellet group density was derived by the following formula.

$$\textbf{Pellet density:} \quad \frac{\text{Total pellet numbers}}{\text{Transect area X Transect Number}}$$

Pellet group density in the studied area was 4.55/ha.

Regression model

Regression model developed by Aryal, (2005) was used for the estimation of population density/km2 from the pellet density/km2.

Regression equation: $X = a + bY$

Where X= Population density/Km2 (dependent variable)

Y= Pellet density/Km2 (Independent variable)

Regression equation for the estimation of Population density/km2 (X) is

$(X) = 0.59+0.003Y$

Where $a = 0.59$

$b = 0.003$

On the basis of this equation and through pellet density derived above the population density/km2 in the studied habitat was 1.95/km2. The population status was found be increased from that of previous study where Neupane (2016) reported musk deer population density in Byas Rural

Municipality as 1.92 musk deer/km2. This newly established protected area in 2010 has recently been able to establish offices in remote areas and tighten the security. The silent drive count was done in both the forest in early morning and evening in but none musk deer were sighted.

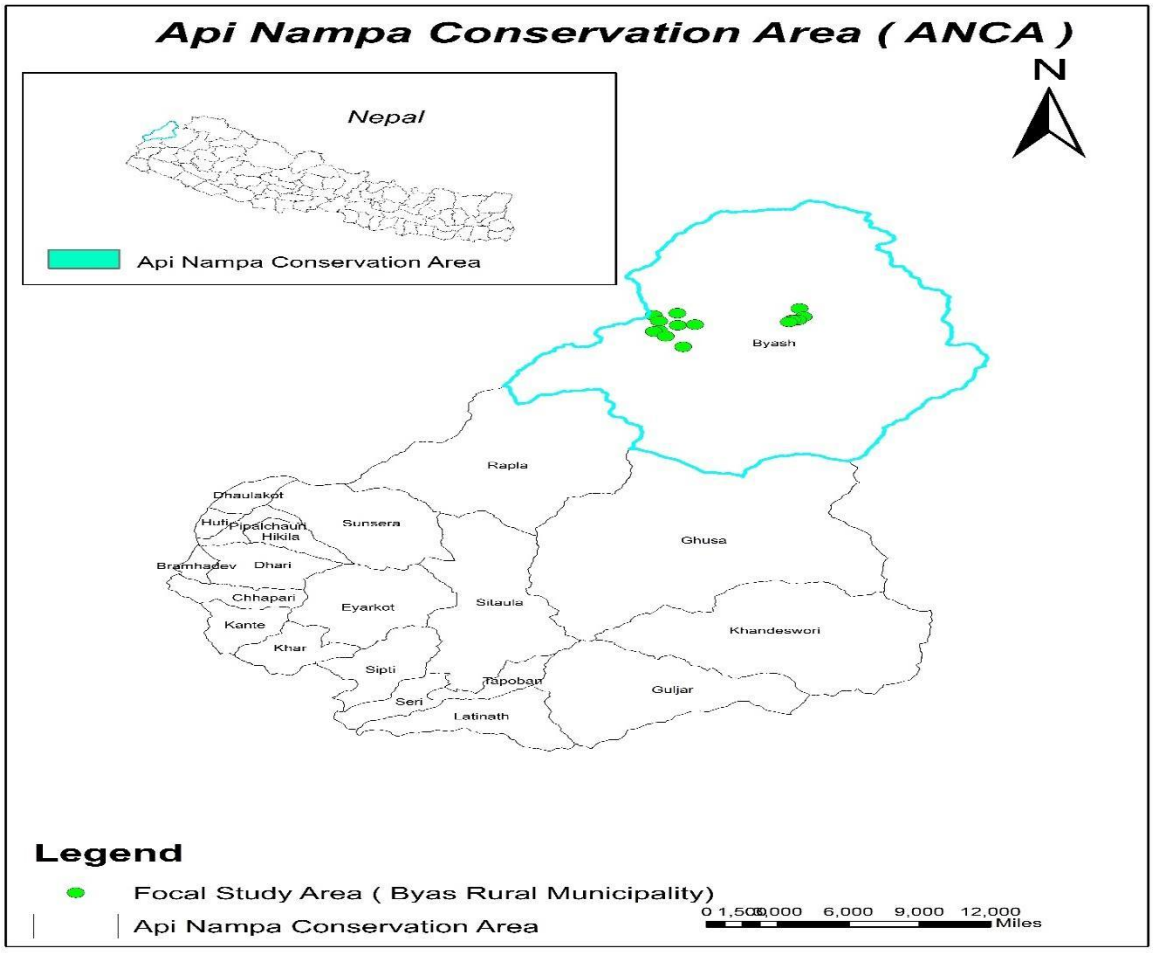


Figure 5: Distribution map Himalayan Musk deer *(Moschus chrysogaster*) in chhangru and Tinker village in Byas Rural Municipality of (ANCA).

3.1.1. Droppings counts

Droppings of various status as classified were found during the field survey. Out of the reported droppings 39.42% were random droppings. Such types of droppings were near forest nearby of rangeland possibly excreted during browsing of musk deer. About 20.85% of droppings were found in relic sites, majority of which were reported deep inside the forest area. Bedding site constitute about 39.73% of musk deer found inside forest and some near the cliff.

3.1.2 Types of faecal deposits

Out of 82 faecal deposits found in the study area, 59.57% were old where 19.42% of deposits were very old. Fresh deposits of musk deer constitute 14.85% where very fresh deposits accounted 6.16% of total deposits.

3.1.3 Faecal deposits on various forest types

Musk deer faceal deposits were found in various forest types where 59.42% of deposits were found in Betula forest. Mixed forest of various spp like juniper, Cupress, Betula and Abies spp. constituted about 30.57% of deposits followed by Abies forest (4.81%) and Rhododendron forest (5.2%). Betula forest was found to be prominent site for faecal depositions the very tree which is used for firewood in the region.

3.2 Habitat preference

Vegetation analysis

Floristic survey was conducted in potential musk deer habitat where random sampling method was adopted.

3.2.1 Tree preference

Trees were studied in 58 plots (29 habitat use and 29 habitat availability plots) each 10m*10m size. The total 11 tree species were recorded and their IVI was calculated to access their status in the habitat. The *Betula utilis* (IVI=146.66) was dominant species followed by Juniper spp. (IVI=49.36) and *Taxus bacata* (IVI=44.39)

Table 1: The important value index (IVI) of recorded tree species in studied habitat.

Tree scientific name	**IVI**
Betula utilis	146.66
Juniper spp.	49.36
Taxus bacata	44.39
Oak spp.	25.04
Abies spectabilis	8.74
Pinus wallichiana	8.007
Cupress torulosa	5.6
Rhododendron arbatum	4.03
Rhododendron barbatum	3.87
Rhododendron campantulum	2.53
Tsuga Dumosa	1.73

3.2.2 Shrub preference

Shrub were studied in 58 plots (29 habitat use plots and 29 habitat availability plots) in the sample plot of size 4m*4m.

Table 2: Status of shrub in the habitat.

Shrub name	Relative density	Frequency	Relative frequency
Rhododendron spp.	21.70	79.84	19.14
Abies spp.	14.13	58.69	14.27
Betula spp.	16.5	62.46	13.60
Tsuga spp.	8.75	37.46	9.84
Ratanaulo spp.	7.5	25.92	7.19
Ganaune	11.94	54.84	13.38
Cupress spp.	9.75	52.92	11.94
Acer spp.	8.30	31.79	9.084
Berberis spp.	1.43	13.69	1.556

Table 3: Shrub species preference by musk deer.

Shrub	Ivlev's value	Status
Rhododendron spp.	0.32	Prefer
Abies spp.	0	Random use
Betula spp.	0.36	Prefer
Tsuga spp.	-0.23	Avoid
Ratanaulo spp.	-0.2	Avoid
Ganaune	-0.11	Avoid
Cupress spp.	0.03	Prefer
Acer spp.	0.049	Prefer
Berberis spp.	0	Random use

A total of nine species of shrub were identified in the study area, of which 4 species were preferred, 2 species were randomly used and remaining 3 species were avoided by musk deer. The species like Betula (IV=0.36) and Rhododendron (IV=0.32) were highly preferred where species like Abies (IV=0) and Berberis (IV=0) were randomly used and the species of Tsuga (IV= -0.23) and Ganaune (IV= -0.11) were avoded.

3.2.3 Herb preference

Status of herb were examined in 58 plots (29 habitat use and 29 habitat availability plots) in the sample plot of 1m*1m.

Table 4: Status of herb in the study area.

Herb name	Relative density	Frequency	Relative frequency
Lekpati	14.50	58.61	14.09
Pemba	11.35	54.76	13.25
Ratnaulo	7.73	33.61	6.605
Abies spp.	6.16	26.5	5.04
Fern	12.02	52	11.98
Rhododendron	13.18	51.84	12.83
Moss	5.64	25.92	6.91
Usnea	12.66	41.38	7.87
Rhea spp.	10.23	52.92	12.40
Rosa spp	4.98	12.64	3.99
Tinpate	13.87	14.30	4.225

Table 5: Herb preference in the study area.

Herb	Ivlev's value	Status
Lekpati	0.5	Prefer
Pemba	0.5	Prefer
Ratnaulo	-0.007	Avoid
Abies spp.	0.3	Prefer
Fern	0.0326	Prefer
Rhododendron	0.054	Prefer
Moss	0	Random use
Usnea	0.087	Prefer
Rhea spp.	0	Random use
Rosa spp	0	Random use
Tinpate	-0.0466	Avoid

The total of 11 species were identified in the study area where six species were preferred by musk deer. The species like Lekpati (IV=0.5) and Pemba (IV=0.5) were highly preferred and species as Moss (IV=0), Rosa (IV=0) and Rhea (IV=0) were randomly used. The species such as Tinpate (IV= -0.0466) and Ratnaulo (IV= -0.007) were avoided by the musk deer.

3.2.4 Altitude preference

Habitat of musk deer was studied from the altitude of 3000 to above 4500m at the interval of 300m where the signs of musk deer were recorded. Musk deer highly preferred the altitude of 3601-3900 (IV=0.24). It moderately preferred the altitude of 3901-4200 (IV=0.18) followed by 3000-3300m (IV=0.014). It randomly used the altitude of 3301-3600m (IV=0) and 4201-4500m (IV=0). It avoided the altitude above 4500m (IV=-0.11) The musk deer of Tinker village which is well above 4500m were reported to be migrated during winter to lower altitude near Changru to escape the freezing temperature. Above tree line of 4200m, the absence of trees and vital shrub with rugged and dry terrain made the habitat unsuitable for it.

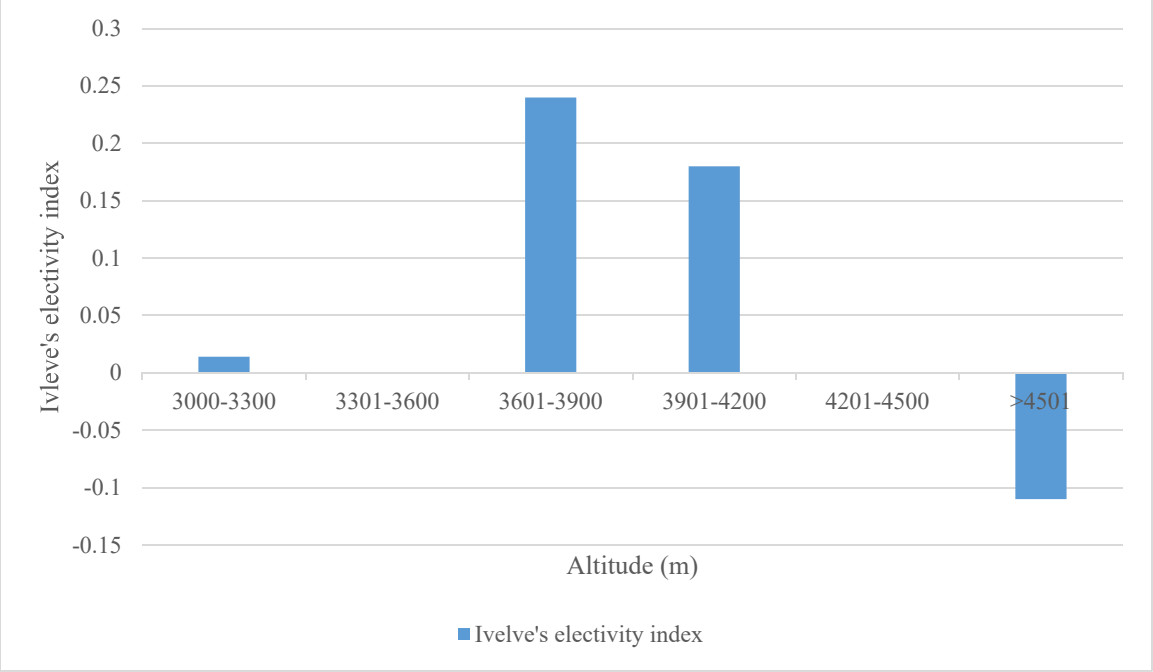


Figure 6: Altitude preference by Musk deer.

3.2.5 Slope preference

The slope was divided into five categories at the interval of 10 degree. The slope of resting and grazing places were meticulously studied. Musk deer highly preferred the slope range of 21-30 degree (IV=0.14) followed by above 40 degree (IV=0.11) and 31-40 degree (IV=0.036). It randomly used the slope of 11-20 (IV=0) and avoided the slope of 0-10 degree (IV=-0.0768). It

used the gentle slope (21-30) degree for grazing and steep slope 31-40 and above 40 degeree for resting. It generally avoided the plain slope 0-10 degree as that area was used for livestock grazing and had high human anthropogenic pressure.

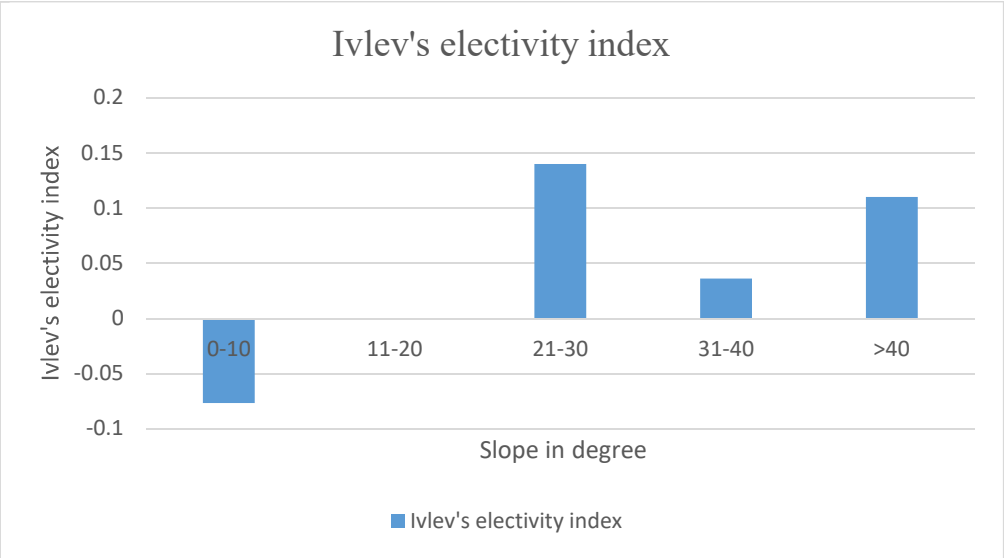


Figure 7: Slope preference by Musk deer.

3.2.6 Crown preference

Crown preference was divided into four categories with interval of 25%. Musk deer highly preferred highly moderate cover of 26-50% (IV=0.23) followed by 51-75% (IV=0.036). It randomly used dense cover of above 75% (IV=0) and avoided sparse cover of 0-25% (IV=-0.035). Musk deer was found to use cover for hiding and thermoregulation. The sparse cover of 0-25% have significant number of livestock and the presence of dung and was avoided by the musk deer.

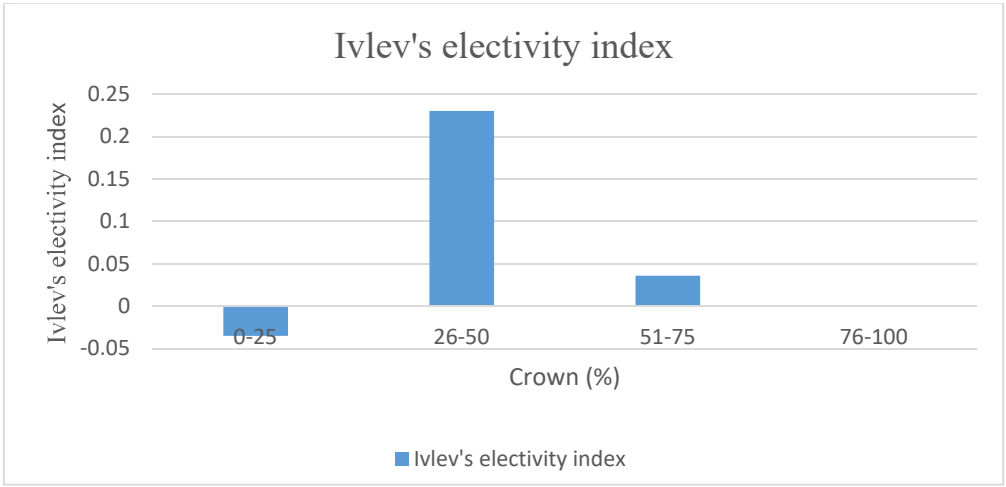


Figure 8: Crown preference by Musk deer.

3.2.7 Ground preference

Ground cover was divided into four categories with interval of 25%. The musk deer had used the ground cover primarily for grazing, hiding and thermal regulation. It highly preferred moderate ground cover of 26-50% (IV=0.075) followed by sparse cover of 0-25% (IV=0.0374). It randomly used the ground cover of 51-75% (IV=0) where it avoided the dense cover above 75% (IV=-0.15). The dense cover was found to less friendly for rapid movement of musk deer which is utmost to escape the predators.

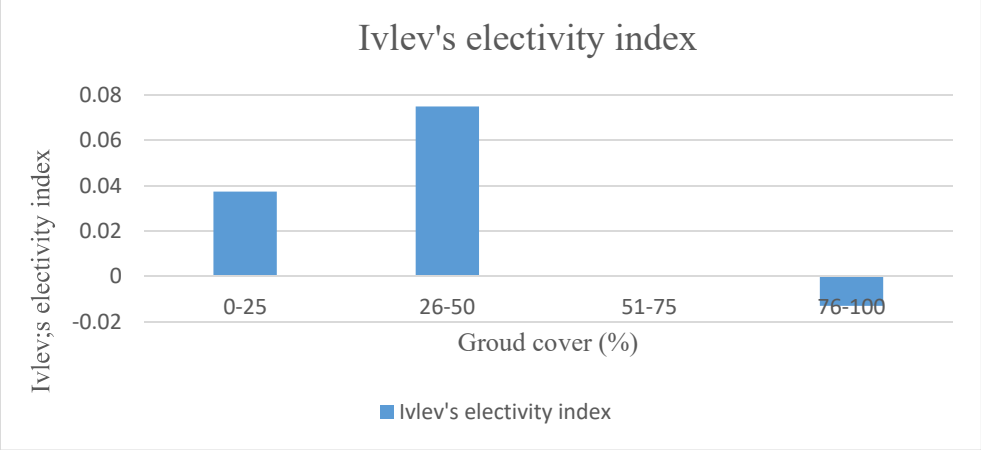


Figure 9: Ground preference by Musk deer.

3.2.8 Ground feature preference

The various ground feature responsible for the impact in musk deer habitat and behaviour were studied throughout the study area. It was imminent that it preferred forested areas (IV=0.14), rocky area(IV=0.037) and caves (IV=0.037). It randomly used Cliff (IV=0) and avoided gullies (IV=-0.07) and streambeds (IV=-0.0759). It used rocky areas for resting and caves for escaping predators. The high preference of forest floor was as a result of proximity to grazing and escape cover.

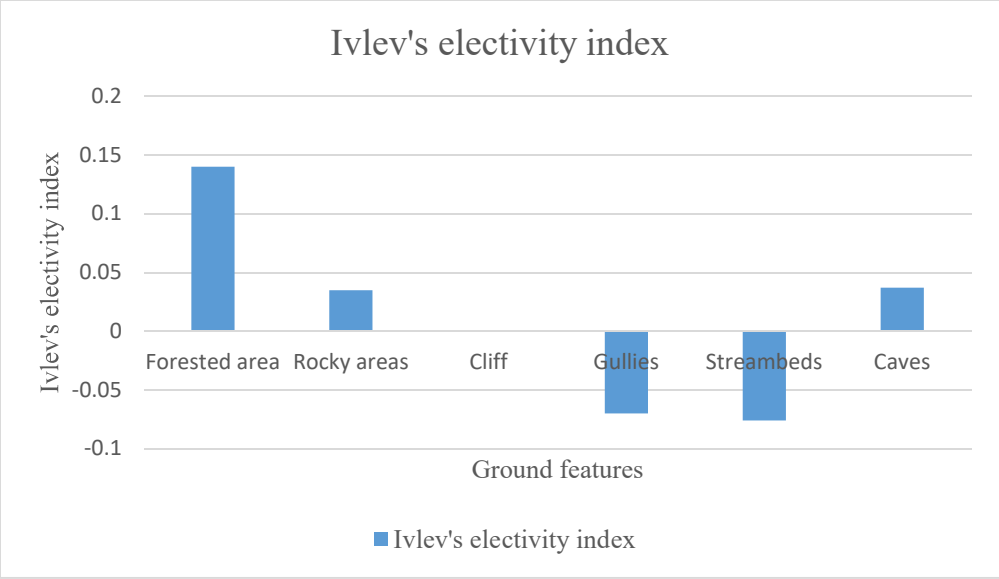


Figure 10: Ground feature preference by Musk deer.

3.2.9 Water sources preference

Musk deer sign and pellets were found from 50m to 500m away from the nearest water sources. It highly preferred the distance of less than 100m (IV=0.014) followed by 101-200m (IV=0.055) and 201-300m (IV= 0.037) .It randomly use the distance of 301-400m (IV=0) and avoided the distance above 400m (IV=-0.036). In the Tinker area the stream was near the human settlement and surprisingly numerous musk deer signs were recorded within 100m from the stream despite the human pressure.

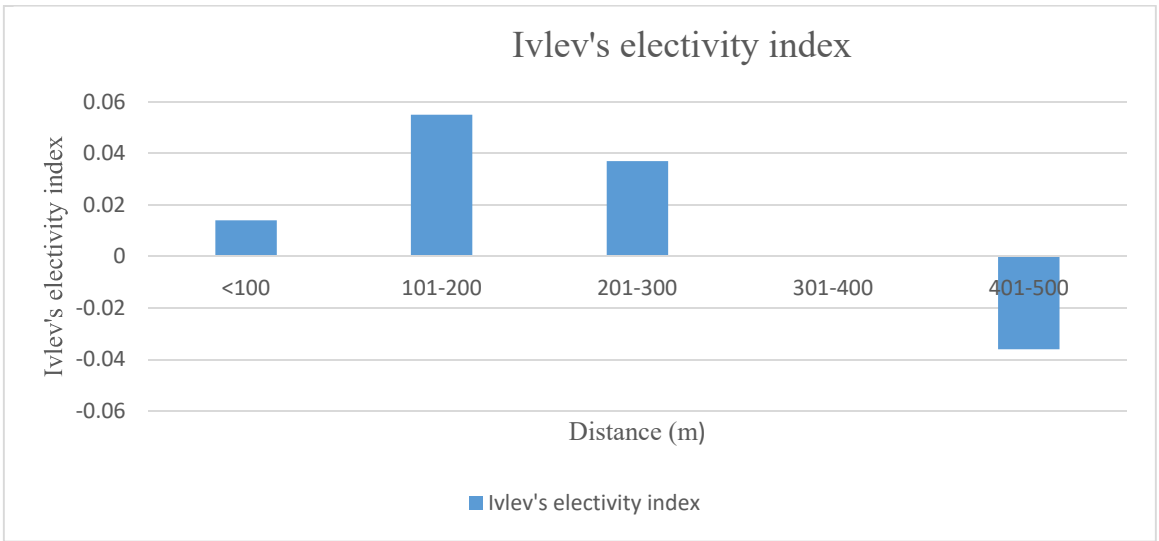


Figure 11: Water sources preference by Musk deer.

3.3 Respondent's results

There are about 15 households in changru and 17 in Tinker village and majority of population is constituted of people aged above 50 as youth mostly dwell in Darchula district for employment, health facility and education for their children. The respondents were progressively and randomly chosen where 96 people of diverse background and age groups as farmers, tea house owner, traders and shepherds were interviewed.

3.3.1 Occurrence of musk deer

About 55 respondents of 96 people interviewed confirmed the occurrence of musk deer in the study area of Api Nampa conservation area. Most of them sighted in forest during the firewood collection and grazing the cattle.

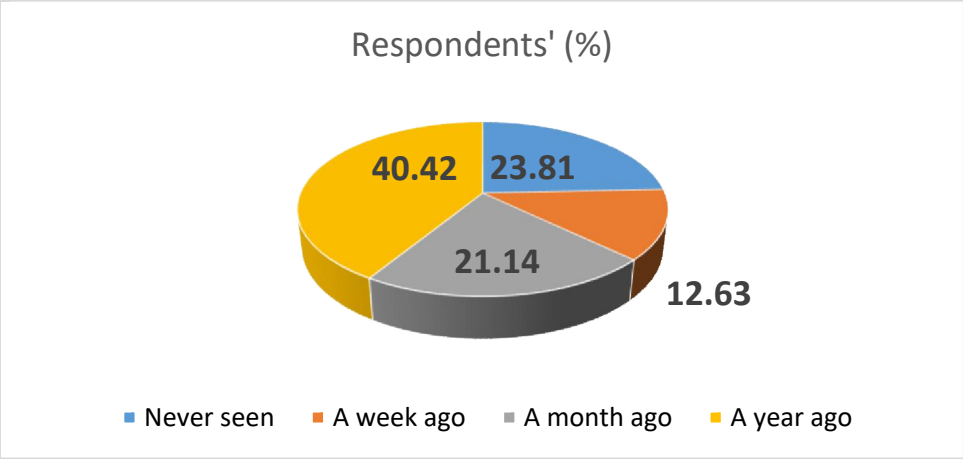
3.3.2 Time of sighting

People were found to be frequently sighted musk deer where 42.42% of the respondents revealed that they have seen musk deer a year ago and 12.63% reported they have sighted it in a week ago. About 21.14% people reported that they have sighted musk deer in month ago which is positive sign of increasing musk deer populations.

Table: Musk deer sighted at different times by respondents.

S.N	Time	Respondents' (%)
1.	Never seen	23.81
2.	A year ago	42.42
3.	A month ago	21.14
4.	A week ago	12.63

Figure 12: Respondents' view on time of sighting of Musk deer.



3.3.3 Place of musk deer sighted

Musk deer were found to be reported in forest of chhangru and Tinker where people 42.15% of people in chhangru sighted in nearby forest. About 34.04% people have reported to have sighted musk deer in Tinker forest where 27.54% of respondents' have never sighted musk deer.

Table: Musk deer sighted at different places.

S.N	Location	Respondents' (%)
1.	Chhangru forest	42.15
2.	Tinker forest	34.04
3.	Nowhere	23.81

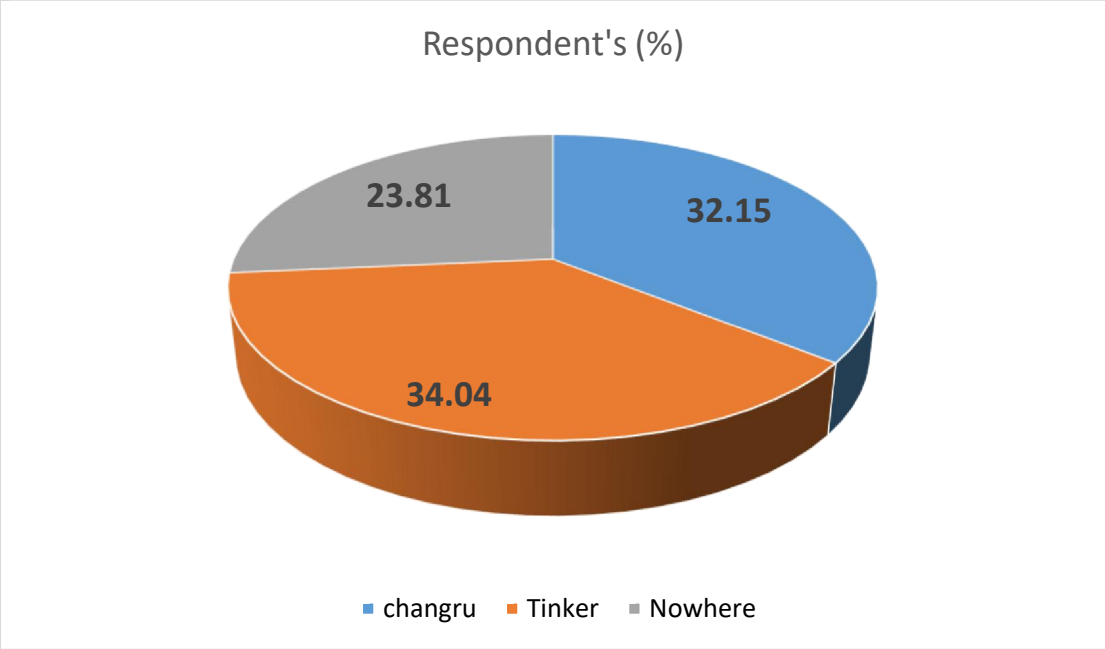


Figure 13: Respondents' view on place of sighting of Musk deer.

3.3.4 Frequency of sighting

People were found to have sighted musk deer during numerous visit to forest for firewood collection and livestock grazing. About 36.29% people interviewed reported to have sighted musk deer once while 27.18% sighted twice and 14.89% more than twice.

Table: Musk deer sighted at various times.

S.N	Frequency	Respondents' (%)
1.	Once	46.29%
2.	Twice	29.18%
3.	More than twice	24.53%

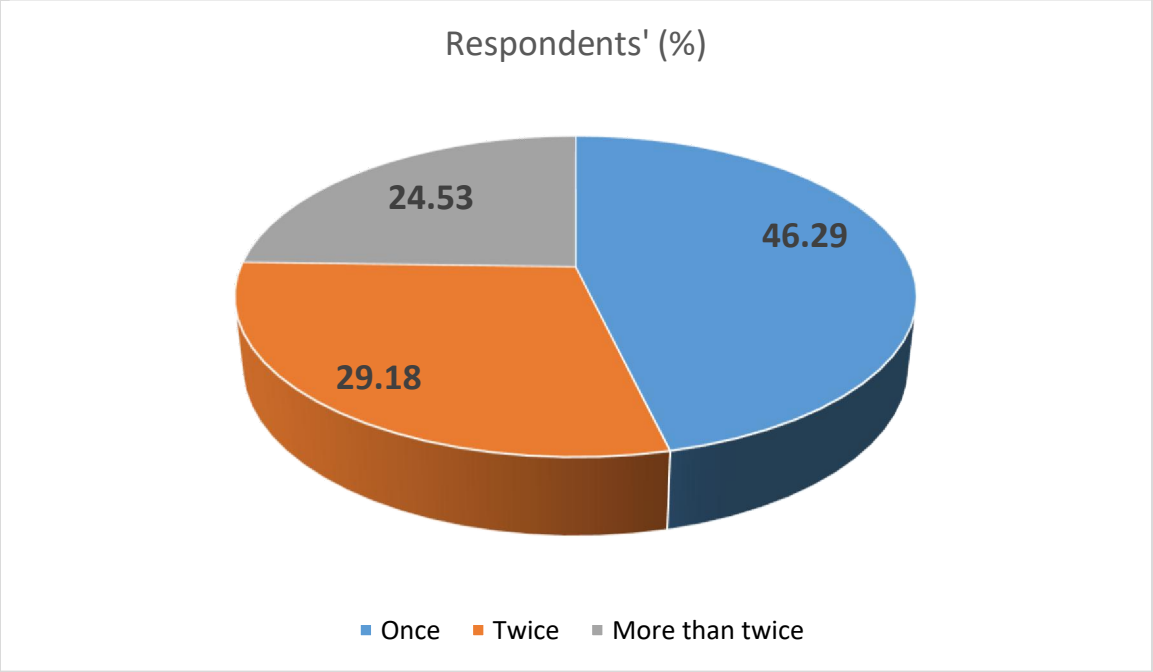


Figure 14: Respondents' view on frequency of sighting of Musk deer.

3.3.5 Musk deer habitat

Interviewed people reported to have sighted about 30.78% of musk deer in forested habitat followed by in grassland (16.02%) where least were reported to be in human trail (2.13%). Musk deer were found to have avoided places of human presence but they were often sighted because of heavy presence of people in musk deer habitat.

Table: Musk deer sighted at various habitat.

S.N	Place of sighting	Respondents (%)
1.	Forested area	40.56
2.	Grassland	16.02
3.	Caves	32.78
4.	Riverbed	8.51
5.	Human trail	2.13

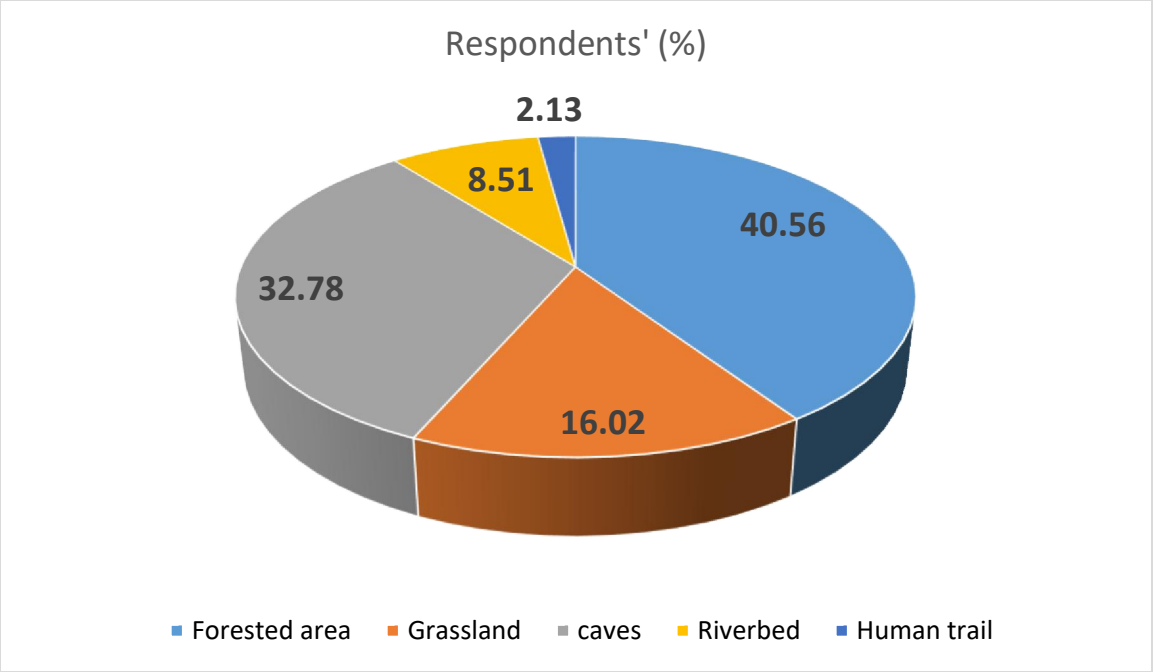


Figure 15: Respondents' view on place of sighting of Musk deer.

3.3.6 Poaching activity

The poaching of musk deer were reported by about 71.26% which was facilitated with remoteness and high price of musk pod in neighbouring Tibetan market. People revealed that most of the pochers are from neighbouring Tibet. Poachers were found to come during November to March where villagers migrate to Khalanga bazar to escape winter and heavy snowfall. About 21.28% people were reluctant to speak about poaching and 7.44% refuted that poaching in the park area.

Table: Respondents' perception about poaching.

S.N	Perception	Respondents' (%)
1.	Yes	71.26
2.	Don't know	21.28
3.	No	7.44

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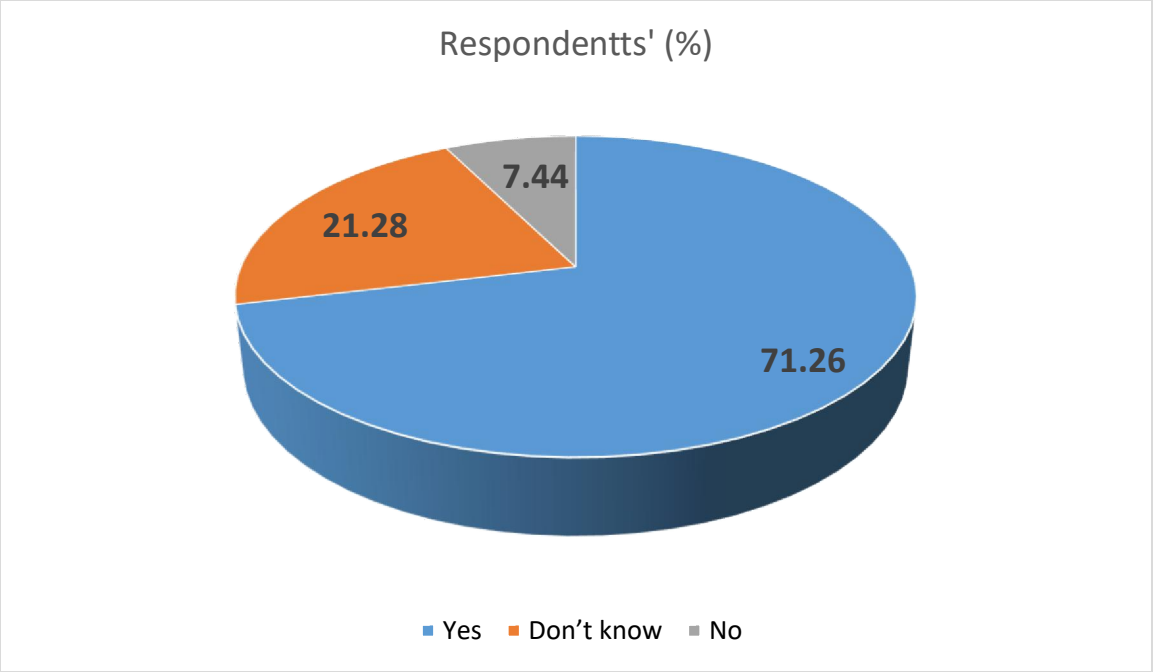

Figure 16: Respondents' view on poaching of Musk deer.

3.3.7 Peoples' perception on musk deer populations

People were asked about the trend of musk deer populations for the last 10 years in the study area. Specific age group of locals and shepherds dwelling in considerable amount of time in the study area were chosen for this purpose. Majority of about 33.92% of people reported decreased in musk deer populations where 47.52% found to be increasing and 18.56% were unaware.

S.N	Population trend	Respondents (%)
1.	Increasing	47.52
2.	Decreasing	33.92
3.	Don't know	18.56

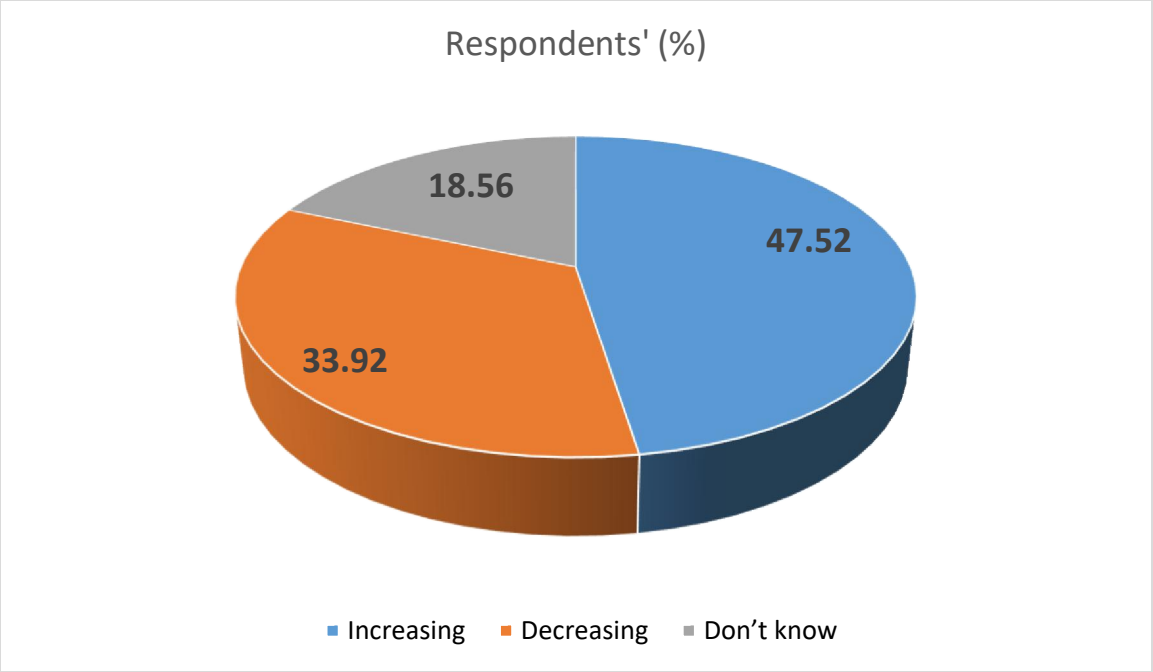

Figure 17: Respondents' view on trend of Musk deer populations.

3.3.8 Threats to musk deer

About 32.97% of people interviewed reported that poaching was responsible for decrease in musk deer populations where livestock grazing and habitat loss were other prominent factors. Habitat loss was attributed mainly through anthropogenic activities which fuels the natural calamity like landslide and forest fire in forests'. People were found to have spotted corpse of musk deer killed usually by snow leopard, Grey wolf and wild dog. People also reported the illegal collection and smuggling of firewood to India from the forests of Budi. Budi and Tinker is also on a route to famous Mansarover shire in Tibet. Large number of Hindu devotes, mostly from India, make their way to Mansarover during August which accelerates the demand for firewood. People in Tinker village rely on only source nearby forests and due to year round low temperature in the area firewood consumption is high. The hill slopes of Budi is one of the prominent site for Yarshagumba collection where people from Nepal, India and Tibet gather during the month of April-May. People dwell in those areas for about a month in temporary makeshift. They are all dependent on nearby forest for firewood and frequent human presence may affect the reproduction and ranging behaviour of musk deer.

S.N	Activities	Respondents' (%)
1.	Poaching	32.97
2.	Livestock	26.78
3.	Habitat loss	23.27
4.	Timber and firewood collection	8.57
5.	Predators	4.19
6.	No threat	4.22

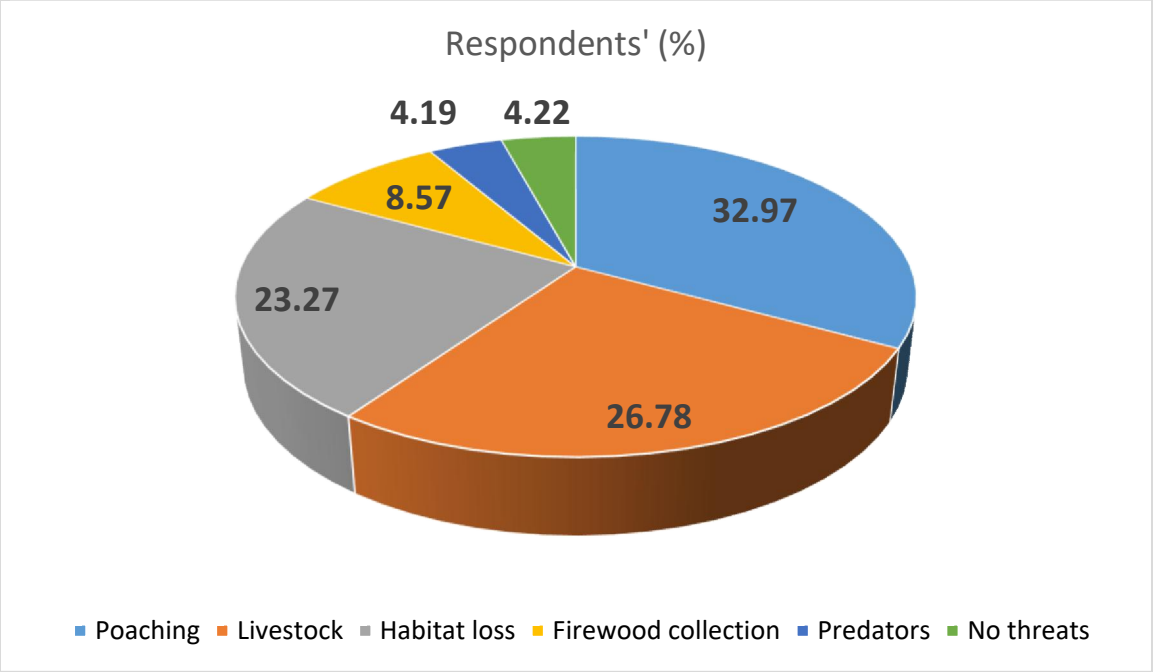

Figure 18: Respondents' view on threats of Musk deer populations.

3.3.9 Conservation of musk deer

People were positive for the conservation of musk deer, about 35.10% wanted to protect because of religious belief where most of the population followed Buddhism. Albeit tourism in this area has not grown despite having potential, more than 13.89% of people are optimistic for tourism through its conservation. The study area near Tinker and Chhangru have low human presence due to isolation and extreme weather condition. Out of interviewed people 33.91% wanted to conserve musk deer for their future generation. About 8.57 of people were in favour of conservation simply they wanted to roam it in their Jungle as it have done since ages. Some of 9.53% of interviewed people wanted for conservation bit unware of the reasons behind it.

S.N	Activities	Respondents' (%)
1.	Religious belief	34.10
2.	For future generation	33.91
3.	For tourism	13.89
4.	Looks good	8.57
5.	Don't know	9.53

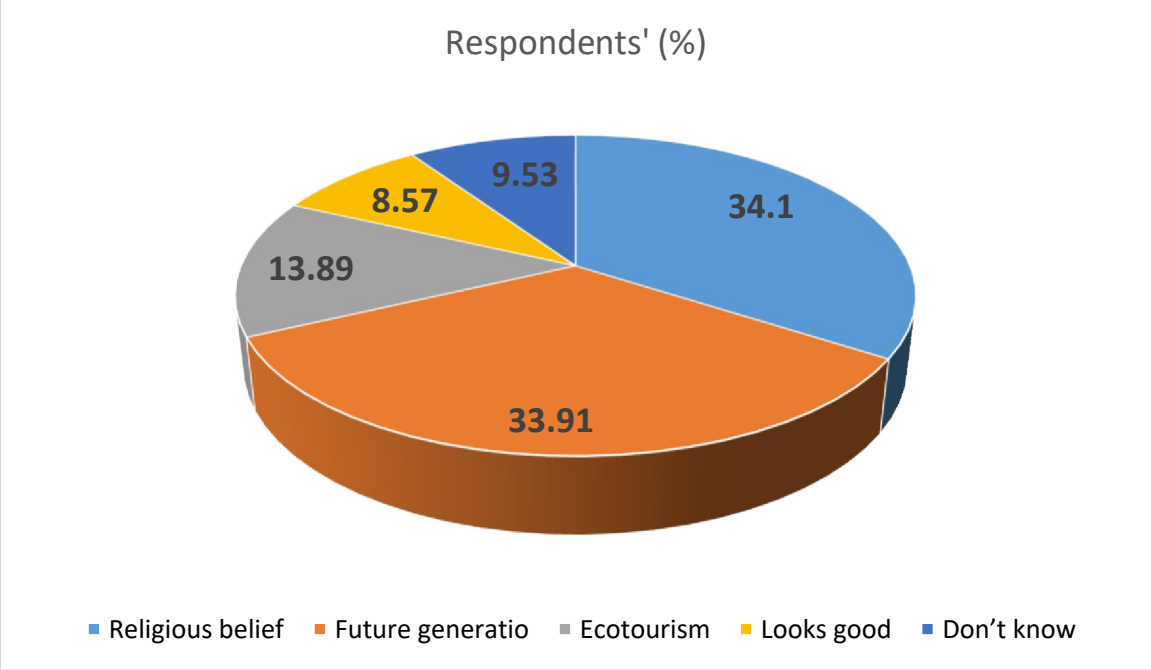

Figure 19: Respondents' view on conservation of Musk deer populations.

3.3.10 People perception towards musk deer conservation

People were voice and attitude towards the needs of musk deer conservation were taken. Out of the interviewed people 30.78% believe conservation education is needed to protect musk deer. About 29.65% of people reported protection of habitat is utmost where 24.65% recognizes the immediate need of regular patrolling and 14.92% are in favour of strict law enforcement for the musk deer conservation. The literacy rate during the interview was found to be low which emphasizes the dire needs of conservation education in the area. Illegal and large amount of firewood and timber collection, grazing and poaching have tigers landslide in many regions so habitat management and protection is must. The study area is not connected by roads so the law enforcement and regular patrolling is challenging.

S.N	Activities	Respondents' (%)
1.	Conservation education	30.78
2.	Protection of habitat	29.65
3.	Regular patrolling	24.65
4.	Strict law enforcement	14.92

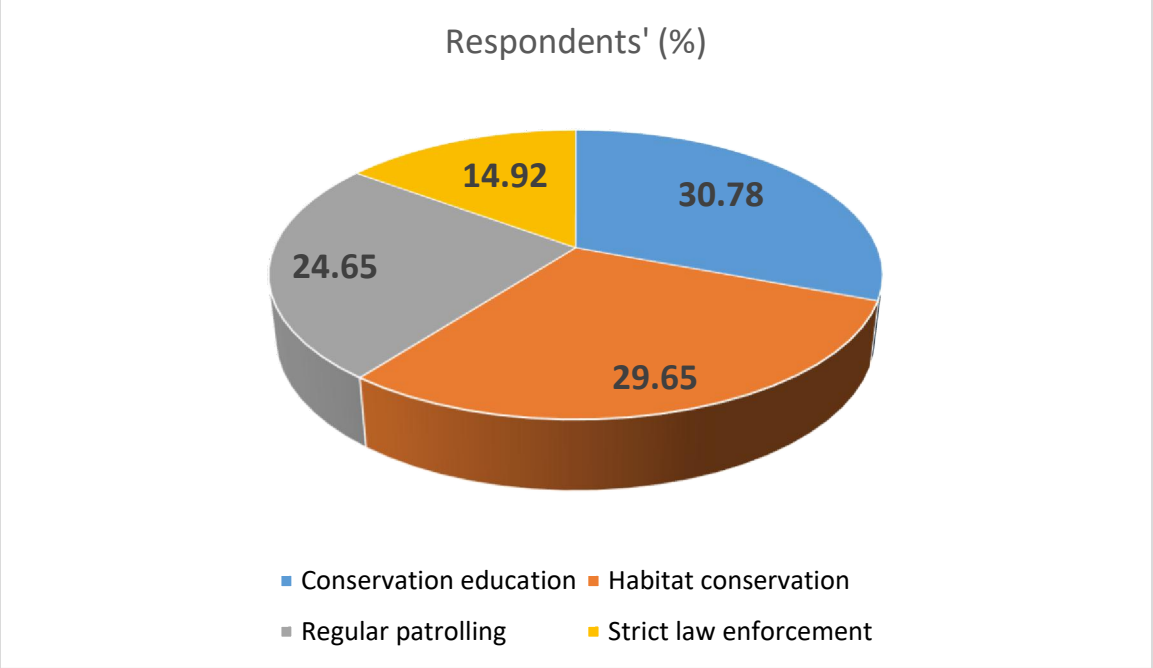

Figure 20: Respondents' view on measures for conservation of Musk deer populations.

3.4 Poaching

The study area is one of the remote region in Nepal which is not connected by the road and is 7 day walk from the Khalanga bazaar where the main office of Api Nampa conservation area is situated. The trade of musk deer in Nepal is restricted by CITIES by Appendix I. Nepal have ratified the two international treaties,CITIES and CBD and being signatory to both, it is responsible, under international law, for the implementation and enforcing their provisions including those to protect musk deer (Belbase, 1999, Homes,1999). Nepal have listed the Moschus spp. as schedule-1 protected species in National Parks and Wildlife Conservation Act 1993 to provide the additional protection for populations under this Act. Article 10 provides protection to schedule-1 species as

"The wildlife mentioned in the schedule-1of this act shall be considered to be protected wildlife and their hunting has been prohibited."

Article 10 forbids any form of musk extraction, for any purpose, from any musk deer from anywhere in Nepal. Impeachment of this law can results fine from 50,000-1, 00,000 NRs and up to 15 years of imprisonment.

Unfortunately this have not been suffice to curb the growing illegal trade of musk pod. The active chemical substance in musk is known as muscone and find use in perfumes and medicine or as aphrodisiacs and fertility drugs (Green, 1985; Shrestha, 1997) where it is prominently used as Traditional East Asia Medicine (TEAM,1999). It is also reckoned to be effective against snake venom and anti-inflammatory agent (Gaski and Johnson, 1994). Captive breeding, primarily for commercial musk production, occurs in various places in China, and might have some conservation benefit. However, to date, there is little evidence that the availability of musk from captive-bred animals has had positive conservation impact (Parry-Jones and Wu 2001, Green et.al, 2007, Harris 2007). In Nepal musk deer farming has been practiced in Godvari of Lalitpur with an objective of developing artificial breeding of musk deer (Rajchal, 2006).

In china it is used in traditional medicine as a simulants to treat variety of ailments (Green, 1985, Sheng, 1988, Homes, 1999) and is vital ingredients for 300 pharmaceutical preparations (Sheng, 1998). The total demand for musk deer in China is 500-1000kg per year with increased demand in domestic use (Sheng, 1998, Green, 1999) where it significantly covers 66% of total world market (WCMC, 1988, Homes, 1999). China is the largest exporter of musk deer products (>200 kg/annum) and Japan is the largest importer (Green, 1985, 1989). The musk generates attractive amount in the international market as $45000 per kg making it more expensive than gold (Green, 1986). The earnings from selling 50gm of musk pod were reported to be sufficient as year income for the people in mountainous region of Nepal (Blower, 1974, Green, 1989). In Nepal musk deer was found to be poisoned by bamboo *Arundinaria* spp. (Jackson, 1979). The maximum illegal activities (64%) of poaching of musk deer was recorded in Sagarmatha National park (Rajachal, 2006).

3.4.1 Trade pattern in study area

The absence of alternative income to rural people, poverty and lack of awareness in the region have led to in surging killing of musk deer in this area. The Changru and Tinker village where the research was done is on the way to Taklakot boarder point of Nepal and Tibet. This border point is infamous as one of the illegal trade route of wildlife, its parts and endangered plants. The Tinker village consists of only 20 houses where they have to migrate to Khalanga Bazaar in the winter to

escape the cold. It was found that locally the musk pod have been traded in 'tola' wher one musk deer were found to yield 1-4 tola (1 tola=11.64 gm of musk) where one musk deer produces 3 tola of musk (Aryal, 2006). At least 3-5 individuals which constitutes many female musk deer and juvenile are killed during the process of hunting to secure one male with sufficiently large musk gland (Green, 1986, Jackson, 1979 and Phrikhod'ko, 1997). About 160 musk deer would be killed to secure one Kg of musk where 3-5 musk deer are killed to secure eone male musk deer which would yield 15-25 grams of musk (Homes, 1999).The price of musk pod was NRs 20,000 per tola (1 tola=11.64gm) in Tibetian and Indian border which is far more than what an average Nepali income was. The only Police check post near this village is also closed during winter which made the poaching and killing even easier. According to local people during this winter hunter from Tibet and China come to Nepal side with modern guns, snow adoptive boots to kill the musk deer. The high demand of musk pod in Tibet, it's astounding price and lack of law enforcement with regular patrolling and its remoteness have been a boon for hunters. Although there lacks the statistics of poached musk deer in Api Nampa conservation area, local people and ground park staffs estimates that every year 6-8 musk deer are being killed. It was reported the above figure is decreased one with the improved security after Maoist insurgency and establishment of the Api Nampa conservation area. Musk deer used the fixed place for defecation and its resting place can also be recognised. This make this species vulnerable to poachers as it is easier to predict the path of musk deer to lay snare. Poachers use number of technique ranging from guns to poison spears (Jackson, 1979). Poachers set up several hundred traps in the forested area and then came back several times over the period of weeks to check at them (Green, 1986). When the musk deer steps in wire trap it gets its leg trapped and is unable to move. The people in Tinker accepted that about two decade ago the musk deer was one of the prominent source of income where it could fetch a handsome amount in nearby Tibetian market. Interestingly hunting technique resembled as that silent drive counting used in musk deer population count. A group of people would be on vantage point in hill armed with gun while other would drive musk deer towards top of hill accompanied by their ferocious Tibetan mastiff dog. Though some of the people denied such practice as being Buddhist killing is prohibited by religion. The study revealed that the musk pod was sold to Tibet whereas skin was used as horse seat cover. The intestine was eaten without sun drying for treating diseases. Park staff and locals reported that two musk deer were killed in Guljar in past year.

Herders were aware of the conservation of musk deer and denied any involvement in killing and poaching. The small number of house hold in Budi have been difficult to form the conservation and anti-poaching unit as a result they are often outplayed by poachers from cross border. Surprisingly, Nepalese side allows Yarshagumba collection to people from India and Tibet in Budi. Many of the locals believe that some of the hunter come during Yarshagumba collection to know the bedding, resting and potential habitat of musk deer so that hunting is easier in winter when villagers migrate to Khalanga bazaar due to snow. According to information from locals poaching was high in Budi than Tinker. This may be due to presence of Police check post in Tinker and awareness programme being launched for snow leopard as flagship animal. The people also reported that there have been significant reduction in poaching with the establishment of Api Nampa conservation area and introduction of local based Community forest programme. The unlicensed gun is prohibited and even the registered gun were seized during Maoist insurgency by authority which have been a bright side to conserve this fauna. There needs to be strong and sufficient presence of park staffs for the better law enforcement. The coordination with security officials, patrolling and formation of local anti-poaching unit is must in this area to protect the musk deer.

3.4.2 Alternatives to Musk

There are various plants and animal products, albeit differs in chemical composition they produce similar aromas or substances and some also have similar properties (Rajchal, 2006). The following are some of the plants whose derivatives products can replace use of musk in traditional medicine and perfume industry which can reduce the poaching of musk deer for poaching. However the detailed study for their ecological range, amount to be harvested and artificial plantation for commercial use along with market and technology needed is to be explored and addressed.

Jagat pet *Delphinium tichophorum* Ranunculaceae occurs in the Himalayas and it has been reported in Sagarmatha National park. It has been used as an alternative medicine of musk pod in Tibet (Amje Sherpa, Namche, pers.comm. 2005).

Musk Mallow *Hibiscus abelmoschus* Malvaceae produces seeds that smell of musk and from which oil is obtained (Falbe and Regitz, 1995). It is also used as musk scent in perfume industry.

3.5 Threats

Musk deer poses immense threat living in high altitude most of them as a result of anthropogenic pressure. Conversion of musk deer habitat for human settlement and agriculture have been a growing threat for this species. The prominent threat of musk deer are loss of habitat (Yang 1989, 1999) and second is the hunting (Wemmer 1998, Green 1986, Jackson 1979) in addition to natural predation. At present alpine musk deer has been endangered world-wide because of hunting and habitat loss (Homes, 1999, 2004).

5.5.1 Hunting

Musk pod have been only reason that human keep hunting this animal from ages as meat is not tasty and hairs fall out easily from hide (Heptner and Naumov, 1961). Although musk can be extracted from musk deer without killing, the poaching still continues (Sathyakumar and Rawat, 2015). In some parts of Nepal selling of few musk gland was enough to support the year round living cost of whole family (Jackson, 1979). Poachers have been using modern guns and snares made of wire (Liu 2000), the latter in particular offering easy skills. Although, this musk, produced in the gland of males, can be extracted from the live animals, most "musk- gathers" kill the animal to remove the entire sac, which yields about 25 grams of the brown waxy substance (Green, 1986, Knowler, 2000). Out of interviewed people 34% reported hunting as a problem. Lucrative high prices have resulted in poaching of musk deer even in mountainous region where they should be difficult to hunt. A significant increase in price of the musk in the international market has led to parallel increase in poaching and smuggling from the Himalayan habitat in different parts of the world, particularly in Hongkong, China and Japan (Xiuxianga et al; 2006, Aryal et al.,2006; Aryal and Subedi,2011). The Tinker and Budi area being in isolated parts with proximity to Tibetan trade hub where musk pod is high valued is one of the reason on increased hunting in the region.

3.5.2 Loss of habitat as a threat

Habitat degradation and fragmentation (Green, 1986) due to increased human pressure owing to rapidly growing population where the habitat is converted into agriculture and other types of landform have resulted in decline in musk deer habitat (Sathyakumar 2015, Homes 1999).). About 70% of potential musk deer habitat on Southern side of Greater Himalaya has already been lost (Green 1985, 1986). Habitat selection by an animal may be affected while fulfilling the ecological needs of food and water resources, avoiding from predator, mating and breeding (M. Hebblewhite et.al, 2009).

Local of Chhangru and Tinker are fully dependent on firewood derived from nearby forest in the habitat of the musk deer. In Budi people have stocked the wood of Abies spp. and Betula spp, in Tinker. Due to the year round cold temperature in Tinker village people consumed more firewood from the prime habitat of musk deer. The extraction of NTFPs as Sunpati, Sarpagandha and Pachaaule particulary in Tinker village have posed threat to its survival. In Budi the Indian side is rugged and devoid of trees so the illegal firewood and Timber collection of firewood from was reported by the villagers of Budi. A comparative field survey indicated that the density of musk deer in virgin forest reached 9.15/km2 while in clearing by artificial fire have reduced density to 5.81 animals/km2 (Sheng, 1998).In forests of Budi there were two large landslides and trees grown of mudslide were crooked with no undergrowth vegetation.

3.5.3 Predators

Musk deer are natural prey for predators such as common leopard (*Panthera pardus)*, Snow leopard *(Unica unica*), Himalayan yellow-throated marten (*Martes flaviguala*) red fox (*Vulpes vulpes),* Wolverine *(Gulo gulo*), Lynx *(Lynx lynx)* (Green, 1985). The young are also attacked by large birds of prey such as Large billed crow *(Corvus macrohynchus*) and Upland Buzzard *(Buteo hemilasius*) (Green, 1987a, Kozhechkin, 1994 and Zhivotshenko, 1998). Predators however do not have significant impact in size of the musk deer population which is even prominent with recent declination of mammalian predators due to various reasons (Bannikoz et.al, 1978, Phirkhod'ko, 1997, Wang 1996). But the study in Tinker area revelead that the killing of musk deer by snow leopard is high. The population is decreasing through poaching and anthropogenic pressure and preference of musk deer as a prey by snow leopard could decrease the population of musk deer in the region. Yellow-throated Marten killed 15 juvenile of musk deer in 3 years in Manang (Aryal, 2005). Musk deer detect approaching danger in part through their sense of hearing (F. Meyer, 1998, Zhivotshenko, 1998).

Local people reported that snow leopard is responsible for most of the killing of musk deer. Two carcasses of musk deer most likely killed by snow leopard were found near Tinker village two years ago. During field survey two scats of Snow leopard with musk deer hair and bone were found each in Tinker and Budi. In forest of Tinker around 0.5 Kg of musk hair possibly of musk deer killed about 6 months ago was found. The pawmarks of snow leopard was found near Tinker forest which had series of paw marks in human trail up to 3 Km, and the scat of wild dog was found near Tinker village. Most of the local have Tibetan mastiff dog but they denied any killing of musk deer

by dog. The forest of Tinker have sparse vegetation with nearby grassland which is covered by snow after the month of October and such land cover are the predicted habitat of snow leopard (Jackson and Ahlborn 1984; Forrest et al. 2012; Aryal et.al, 2014).

Local people and park official reported that the population of musk deer is outnumbered by blue sheep population in Tinker village. People of Tinker revealed that musk deer is usually preferred by snow leopard over blue sheep.

The photos from the camera trap in Tinker village set up for study of snow leopard in 2015 and wild dog in 2016, placed 200-400m of recorded signs of musk deer were studied. It revealed that a Golden jackal and Grey wolf were captured in 2015 and 2016 respectively.

3.5.4 Grazing

Increasing livestock have significantly reduced the musk deer density in the Western Himalaya (Sathyakumar 1993b, 1994 Sathyakumar et.al 1993b). Due to high seasonality and low primary productivity, the Himalyan region supports low ungulate/herbivore biomass. It is therefore obvious that the increase in biomass of domestic animals, wild ungulates such as musk deer suffered competitive exclusion Sathyakumar et.al, 1993).

The nomadic pasturing was found to be practiced in Budi. There were instances of fire particularly in Abies forest in this region where shepherd would clear parts of forest to grow forage for sheep. The place for fire is usually altered every year which have led to more fragmented and reduced habitat for musk deer. There were 9 sheds of sheep in Budi where 3 such abandoned sheds were found in those forests. Shepherds were found to be aware of punishment of killing musk deer but were unknown about the habitat destruction done by grazing their sheep and goats in the region. In Budi about 40 sheep and 7 horses were found to be grazed inside the forest area. There were 3 sheep sheds built near forest. In forest of Tinker about 11 yaks and 8 horses were found to be grazed in open areas near forest while their dung were found inside the forest area. The camera trap set up for snow leopard study in 2015 captured the images of 14 yaks and 6 horses and 10 yaks and 5 horses in 2016 set up for wild dog research. During the field survey more than 17 sheep and 9 goats were found in Tinker forest and their dung were reported about 100-200m from pellet or signs of musk deer. Local reported that their sheep showed high preference for Lekpati (IV=0.4), a medicinal herb highly preferred by musk deer. Local people and shepherds interviewed were unaware and reluctant to grow grass in their field for the livestock. In both Tinker and Budi livestock was major source of income for people and was precedence over maintaining habitat of

wild animals like musk deer. In the study area the forest where the domestic animals grazed were found to have understory destroyed and their frequent presence may hinder movement and breeding behaviour of musk deer.

4 DISCUSSION

The population density derived from Aryal (2010) equation was 1.90/km2 in the study habitat which was increased from previous study in Byas Rural Municipality by neupane (2016) as 1.92 musk deer/km2 attributed to people centric approach, awareness program with establishment of Api Nampa Conservation area in 2010. Poaching of musk deer, livestock grazing, unsustainable firewood collection and futile law enforcement have affected the sustainable increase of musk deer populations. Musk deer is distributed within the altitudinal range of 3000m-4500m from Changru to Tinker. Himalayan Musk deer is reported in Nepal within altitude of 2300m-4300m in birch and rhododendron forests (Green, 1980; Shrestha, 1998). Subedi and Ayal (2010) reported the distribution of musk deer within altitudinal range of 3200-4000m while Kattel (1992) found the distribution range within 3000-4100m elevation in Sagarmatha National park. Habitat preference is increased from 3000m-42000m where the most preferred altitude was 3901m-4200m (IV=0.18), the lowest altitude being in Changru and highest in Tinker village. The musk deer populations in this area is relatively lower as Kattel (1992) reported density of 4.6 musk deer/km2 in Phortse while Aryal (2005) reported 3.4 musk deer/km2 in Pisang area of Manang conservation area in 2010. People were also found to be motivated towards the conservation of musk deer with the establishment of community forestry. This was due to sustainable products of firewood and fodder that people can obtain from forest without legal constraints and revenue they get from selling products of community forest. It is unclear to what extent these protected areas contribute to preserving musk deer but, in Nepal, musk deer populations in protected areas are steadily increasing while the species decrease elsewhere in the country (Wemmer, 1998).

Majority of droppings were random (41.42%) old deposits (58.57%) and were found in Betula forest (61.42%). Some of the old deposits have some trace of livestock paw marks but it is unclear whether it is the only reason to abandon latrine sites by musk deer. Musk deer preferred forested areas (IV=0.14) and caves (IV=0.037) where it spent most of time in foraging and browsing in forest.

The dominant tree species in the habitat was Betula utilis (IVI=146.66) followed by Juniper species (IVI=39.36). Betula utilis was found to be prominent tree in musk deer habitat in Sagarmatha national (Gurung, 1991) park and around Manang (Aryal, 2005). The forest shrubs of Betula (IV=0.36) and rhododendron spp. (IV=0.32) were found to be preferred by musk as also preffered in Sagarmatha national park (Kattel, 1992). This was likely because of availability of lichens in winter season (Kattel, 1992).

Musk deer in the study area was found to prefer moderate crown cover of 26-50% (IV=0.23), moderate ground cover of 26-50% (IV=0.075) and moderate slope range of 21-30 degree (IV=0.14). The dense cover ground was found to less friendly for rapid movement of musk deer which is utmost to escape the predators, sparse crown and steep slope have high number of livestock and was avoided by musk deer. They used mostly no or low tree cover, moderate to high shrub cover and low or high grass/herb cover (Sathyakumar, 1994).

Musk deer have numerous natural predators and depending upon their range their main predators may include Wolverine (*Gulo gulo),* Grey wolf (*Canis lupus*), Snow leopard (*Unica unica*), Tiger (*Panthera tigris*) and Yellow throaten marten (*Martes flavigula*). The preference of musk deer over snow leopard in Tinker was reported. Musk deer were found in forest area where livestock graze and livestock lacks advanced instincts and escape capability than blue sheep so it is lucrative and easy prey for snow leopard. Snow leopard must have been making frequent visit to kill livestock and during the course it can also kill musk deer found in the same region. Snow leopard reportedly preys on musk deer in Nepal (Aryal, 2010).Local people reported recent insurgence of snow leopard in the area and absence of predators for long time may cause the loss of some anti-predators behaviours (Diamond, 1990). The pellets of wild dog, paw marks of snow leopard and photos of predators like golden jackal and Grey wolf near forest area shows the significant number of presence of predators. Photo capturing technique are being used increasingly to capture solitary animal (Carbon et.al, 2001).

People dependency in livestock, unsustainable grazing and nomadic pastoralism, habitat destruction by yarshagumba collection in some areas have the serious threat for musk deer survival in study area. In North-western China, the nomadic husbandry practices plays a key role in influencing the seasonal migration of Alpine musk deer (Xiuxiang, 2010).There are more than 10,000 sheep and large number of yarshagumba collectors and their more than 6 month stay causes

the significant negative effect in musk deer habitat in Api Nampa conservation area (Chalise, 2010).

Presence of large animals such as yaks and horses, as captured in camera trap and seen during field visit, not only increase the competition for forage to musk deer but also destroys herbs and small vegetation through trampling effects. The firewood collection and intensive grazing in musk deer habitat results in removing understory vegetation vital for food and protection against its predators (Harris, 1991, Green, 1986). About 99.4% of depends on firewood as the fuel energy (Chalise, 2012) where people reported collection of firewood and timber from Indian side in some places.

Local people reported seasonal migration of musk deer from Tinker to Chhangru region during winter to escape snow but further more research is needed to claim it scientifically. This was contradictory to findings by Kattel, 1992, who reported Himalayan musk deer do not undertake any seasonal migration remaining in same location despite harsh weather conditions.

The study area of Changru and Tinker is isolated and remote region of Nepal which have low populations. The poaching, for musk pod, is one of the main reasons for the reduction in musk deer as reported by 32.97% , 33.92% people believe population is decreasing. Musk deer poses immense threat due to hunting for musk (Wemmer 1998, Green 1986, Jackson 1979) and habitat loss (Yang 1989, 1999).Musk extracted from musk is used in traditional Tibetan and u as a sedative and to treat ailments and it also got its immense use in perfume industry (Green, 1985, Sheng, 1988, Homes, 1999) making it one of the most valuable scented animal, even more expensive than gold (Green, 1986, Shrestha, 1998). The vicinity of Tibetan border, futile law enforcement with low security presence in Tinker and Budi has escalated the trade of musk pod where each tola (1 tola=11.64gm) cost around NRs 30,000 which was found to be significantly higher than in Manang where each tola cost NRS 5,000 (Aryal, 2006). The poachers from Nepal can deal directly with dealers and absence of middlemen with easy border passage resulted in fetching more amount than others parts of Nepal. The price of musk is governed by time of the year, the hunting season and the region as well as the level of demand (Homes, 1999).

People were found positive towards conservation of musk deer where majority of population follow Buddhism and as many as 34.10% want it to conserve from religious point of view where the 30.78% people pointed out the needs for conservation education.

It is evident from the study that conservation program driven with vested interest to support people livelihood through sustainable use of forest products is essential to conserve musk deer.

Establishment of community forest, compensation to livestock depredation by wild animals and initiation of tourism in the area have some positive results in musk deer conservation in this newly established Api Nampa conservation area.

5 CONCLUSION

The study suggests that the population of musk deer have increased from 1.92/Km^2 (Neupane, 2016) to 1.95/ Km2 though 33.92% of people believe it is decreasing in the last 10 years. The establishment of conservation area, awareness programs, and intensive program launched to protect snow leopard in the area and incentives to local people with establishment of various security posts after Maoist insurgency have made possible for nominal increase in musk deer population in the last few years.

The overall pellet group density of musk deer was found to be 455 /km^2, which had indicated the presence and moderate distribution of musk deer around Byas Rural Municipalty.

Musk deer was found to preferred Betula (IV=0.36) and Rhododendron shrub (IV=0.32) and mostly dwell in moderate crown of 26-50% (IV=0.23) and ground cover of 26-50% (IV=0.075) dominated by Betula spp. tree (IVI=146.66).

The migration of musk deer towards lower altitude and preference of snow leopard as it prey over Blue sheep as reported by local, which is supported as most of carcasses found were killed by snow leopard needs but it further research to understand it effectively.

Nomadic pastoralism, livestock grazing, firewood and timber collection with illegal collection from India, destruction of habitat by yarshagumba and being important tourist route Hindu shrine of Mansarover needs collectors have been a challenging factors for musk deer conservation.

Musk pod fetches more than NRs 20,000 per tola (1 tola=11.64gm) which is found to be larger amount than than others parts of Nepal due to absence of middlemen and easy border passage to Taklakot of Tibet. Most of the people depends on livestock, seasonal trade of NTFPs and seasonal crops where the minimal profit is earned and musk pod provides alternative ways to earn more income to sustain their livelihood.

The remoteness of the region, lack of transboundry co-operation, disputed border boundary political commitment, decision and implementation from upper level between Nepal, China, and India to protect musk deer and its habitat.

6 RECOMMENDATIONS

This research aims to study the population and status of habitat in Chhangru and Tinker village of Buyas Rural Municipality in Api Nampa conservation area. Based of findings of the research following are the recommendations for the conservation of the musk deer.

1. Api Nampa conservation area is newly established conservation area in 2010 so it needs to decentralize the offices throughout the parts of the conservation area for effective law enforcement.
2. Shepherds were found to practice nomadic pastoralism so separate plans and programs are needed to limit or eliminate the disturbance caused by them to musk deer habitat.
3. During winter people along with security personal come down to Darchula district headquarter to escape winter, security personal were found to be deprived of modern necessities items so that they could stay and patrol in winter season in snow.
4. Separate blocks can be separated for livestock grazing and grass and tree plantaion can be done in open areas.
5. Alternative energy and sustainable collection of firewood, community forestry and strict law enforcement for illegal collection of timber from Indian side is necessary to protect musk deer habitat.
6. Poaching is one of the threat in for musk deer in the region so strict law enforcement, regular patrolling and Trans boundary co-operation is needed.
7. Several plants as alternative to musk should be encouraged to be planted and market should be explored.
8. Anti-poaching unit should be established with the help of local people.

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APPENDIX I

Field survey in Musk deer habitat:
Data Collection Sheet
Plot No: _____ Rural Municipality/ site name……
Investigator: Date: Time:
Altitude:
GPS data No:
Pellet condition: □ fresh □ Very fresh □ old Very old
Hoof mark: **Very fresh/Fresh/old**
Cover (within 50m radius)
□ Cliff □ Rock □ Cave □ Gully □ Streambed □ No covers □
Others…….
Anthropogenic Pressure
1. Grazing □ No □ Light □ Heavy □ Types of
livestock…….
2. Fire □ No □ occasional □ Regular
3**.** Approximate distance from Human Settlements ……
4. Hunting…..
5. Trails: Human trails…. Trekking routes…..Grazing trails……others….
6. Wilderness □ No □ Yes
7. Forest Product Collection: □NTFPs…….. □ fuel wood □ others……..
Habitat / Vegetation
1. Habitat type
□ Forest □ Shrub land □ Grassland □ Open land □ Others…….
2. Crown Cover
□ 0-25% □ 26-50% □ 51-75 % □ 76-100%
3. Ground cover
□ 0-25% □ 26-50% □ 51-75 % □ 76-100%
Land feature: Rolling terrain…….. Bowl….. Summit or top…… Broken terrain….
Stream bed…. Swampy/marshy….. Level ground……..
Water source: River P/T….Stream P/T….Pound P/T…. Spring P/T…Ditches, distance...
4. Dominant Species: ……..

Tree inventory (10m × 10m)

SN SPECIES DBH HEIGHT REMARKS

S.N	Species	DBH	Height	Remarks

Shrub layer (4m ×4m)

SN SPECIES FREQUENCY REMARKS

S.N	Species	Frequency	Remarks

Herb layer (1m × 1m)

SN SPECIES REMARKS

S.N	Species	Frequency	Remarks

Sign of Other Mammals

S.N	Species	Sign Types

Any other specific / important notes:

Interview form for Musk deer Format No:….

1. Respondents/Name: Age: Rural Municipality/village/district:….
2. Occupation:……
3. Information Based on Musk deer:…….

♦ Do You know Musk deer?…..Y/N □like □dislike □don't know

♦ Have you seen the Musk deer?

- Where……
- How many……..Male…. Female…….
- When…….
- Do you know its legal status? □Yes □No

4. Do you know about traded of Musk deer?..... what product and where they supply……
5. Do you know about Musk deer potential poaching area of your VDC?.....
6. What they use to poach the Musk deer?
7. Do you know Musk deer being killed by human/animal in your area? If yes…….
8. How often you see other species there?
9. Have musk deer's number declined over the past 5-10 years?

Appendix II

Some GPS point of the study are

GPS Point:

S.N	Name	GPS coordinate		Altitude (m)
		X-cordinate	Y-cordinate	
1.	Nomadic Pasture	498898	3333793	3666
2.	Abies Forest	498984	3333334	3793
3.	Betula and Rhododendron Forest	497084	3333276	3724
4.	Livestock Grazing Area	489225	3332162	3105
5.	Scat of musk deer	489071	3331642	3349
		488637	3331535	3547
		488270	3331678	3329
6.	Hair of musk deer	489102	3330935	3590
7.	Pug mark of snow leopard	489863	3330248	3760
8.	Landslide	488637	3332067	3209

PHOTO PLATES

Plate 1: A study area in Chhangru region

Plate 2: A study area in Tinker region

Plate 3: Cedrus deodar forest of Chhangru village

Plate 4: Vegetation of Tinker region

Plate 5: Researcher in questionnaire survey

Plate 6: Researcher Team

7: very old pellets

8: old pelllets

9: Very Fresh pellets

10: Fresh pellet deposits

11: Hair of musk deer left after killing by snow leapord

12: Pug mark of snow leapord

Plate13: Vegetation in Chhangru area

Plate 14: Vegetation in Tinker area

Plate 15:Village in Chhangru

Plate16: Landscape of Chhangru