Ecological Study of the Snow leopard *Uncia uncia* (Schreber, 1778) in Langtang National Park. Nepal

By

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A Dissertation Submitted in Partial Fulfillment of the Requirement for the Degree of Master's of Science in Zoology (Ecology)

Central Department of Zoology

Ecology Program

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APPROVAL

These dissertations submitted by Mr. Jagan Nath Adhikari entitle **"Ecological Study of the Snow leopard *Uncia uncia* (Schreber, 1778) in Langtang National Park. Nepal"** has been accepted as a partial fulfillment of Master's Degree in Zoology Specializing in Ecology.

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RECOMMENDATION

It is my pleasure to mention that **Mr. Jagan Nath Adhikari** has carried out the Dissertation entitled **"Ecological Study of the Snow leopard *Uncia uncia* (Schreber, 1778) in Langtang National Park, Nepal"** under my supervision and guidance. This is the candidates' original work, which brings out important findings essential for biodiversity conservation in remote mountain region. To the best of our knowledge, this dissertation has not been submitted for any other degree in any institution. I recommend that the dissertation by accepted for the partial fulfillment of the requirement for the Degree of Master of Science in Zoology Specializing in Ecology.

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APPROVAL

On the recommendation of supervisor Dr. Mukesh Kumar Chalise, this dissertation submitted by **Mr. Jagan Nath Adhikari** has carried out the Dissertation entitled **"Ecological Study of the Snow leopard *Uncia uncia* (Schreber, 1778) in Langtang National Park, Nepal"** is approved for examination.

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INTRODUCTION

1.1 Background

Nepal is a country of great natural beauty and of a rich cultural heritage. Nepal has always been a source of great attraction for her beautiful gifts mountains, landscapes, lakes, waterfalls, hillsides and green villages serrated in the form of an endless series of terraces. The entire northern border has silvery peaks of Himalayas and the country is the home of perpetual snow (Majupuria and Majupuria 1999) while southern flank is green mountains of Mahabharata with different size valleys and river duns. Even further south lays fragile lower mountains of Churiya and a little Bhavar and Tarai flat land adjoining to India.

Nepal, a country having peculiar diverse fauna and flora lies between China on the north and India on the east, west and south. It stands on latitude 26°22' to 30°27' N north and its longitude is between 80°4' to 88°12'E east. Its altitude varies from 60 - 220 m in the south rising to north up to world highest peak of Sagarmatha (Mt. Everest) 8848 m. Nepal covers of 141,577 sq km land mass with a mean breadth of 200 km provides an opportunity of diverse climate zones from subtropical to nival with sharp microclimatic condition due to its topography. Within this small area, the country has all possible landform features of the earth except the volcanic and coral islands and marine (Sharma 1999). The country experience difference in climate, wild flora and fauna as variation bestowed to physiographic condition.

Nepal lies at the transition between the Palearctic and Indo-Malayan biogeographical realms that contributed a large biological diversity in the country. More than 144 species of spiders, 5052 species of insects, 635 species of butterflies, 2,253 species of moths are on the record. The vertebrates fauna also in diverse form; 184 species of fishes (31 families and 11 orders); 43 species of amphibians (one salamander, four toads and 38 frogs Species); 100 species of reptiles (24 lizards, 4 turtle, two crocodiles and 60 snakes species); 861 species of birds (18 orders); 181 species of mammals (12 orders and 39 families) (BPP 1995 (h), Chaudhary 1998, Majupuria and Majupuria 1998, Shrestha 2003).

There are 16 protected areas in Nepal and among them 3 conservation areas and 5 National Parks lies on northern mountainous zone. Langtang National Park (LNP) is in the central Himalayan region of Nepal, 132 km north of the capital, Kathmandu, bordering, in the northeast, Tibet autonomous region of China. Langtang Lirung (7,245m) is the highest point in the park while lowest elevations drop to about 1,000m on the banks of the BhoteKoshi-Trisuli River. LNP is the second largest mountain National Park of Nepal, which covers 1710 km^2 in three districts: Rasuwa, Nuwakot and Sindhupalchowk of Bagmati zone in Nepal. LNP recorded 46 species of mammals including those typical of the area, such as pika, Himalayan black bear, Himalayan Thar, leopard, ghoral, serow, snow leopard, clouded leopard, musk deer and three species of monkeys; Rhesus monkeys, hanuman langur and Assamese monkeys (Chalise 2003). Besides above, 345 species of Birds, 11 species of Herpetofauna, 30 species of fishes, 58 species of butterflies and 10 species of spiders are also recorded (BPP 1995, Khatiwada 2002). My study is focused on one of rarest and protected mountain species, the Snow Leopard.

1.2 Snow Leopard *(Uncia uncia)*

The Snow Leopard (*Uncia uncia,* formerly *Panthera uncia*), is rare and thinly populated through the Himalayas and mountains of central Asia (Kattel and Bajimaya 1995, Jackson 1996). This beautiful and shy species is a striking symbol of the world's highest places and good indicator of the mountainous ecosystems (Shrestha 1997, Shrestha 2003, Jackson 1996). It is considered and ranked as a top-level species of the food chain in the Himalayan range. Because of its rarity and extremely harsh and often impassable terrain where it is found, little is known of its behavior in the wild state (Yaksha 1999).

If the Lion is the 'King of the Beasts' and the Tiger the 'King of the Jungle', the Snow Leopard is surely 'Queen of the high mountains of Asia'. Queen ? Somehow that title seems more appropriate than 'King' when applied to the Snow Leopard. The Lion and the Tiger evoke power and ferocity. But the Snow Leopard's image is gentler. Its ethereal beauty has attracted the admiration of people from all over the world and around their interest in its homeland and varied cultures who live there (Jackson 1995).

1.2.1 Taxonomy

There is some difference as to the taxonomy of Snow Leopard in the so far publish literature. Two scientific names have been given to the species e.g. *Uncia uncia* and *Panthera uncia* (Shrestha 2003). The Snow Leopard is the only member of the genus *Uncia*. Its classification in a separate genus from the other big cats is justified by its unique hyoid apparatus (Theile 2003). In different countries, the animal has go different names such as Ounce, Snow Leopard (English); Panthere des Neiges. Leopard des Neiges, Once (French); Schneelopard, Irbis (German); Leopardo Nival, Pantera Las Nieves (Spanish); Xue Bao (Chinese); Palang-i-berfy (Dari-Afganisthan); Bharal he, Barfani Chita (Hindi, Urdu, Pakistan); Shan (Ladakhi, India); Hiun Chituwa (Nepali); Irbis, Irvis (Russia, Mongolia); Chen (Bhutan), Sarken (Tibetan) (IUCN/SSC, Cat Specialist Group 1996).

Classification of Snow Leopard (Toriello 2002)

Kingdom	-	Animalia
Phylum	-	Chordata
Subphylum	-	Vertebrata
Class	-	Mammalia
Order	-	Carnivora
Family	-	Felidae
Sub Family	-	Pantherine
Genus	-	*Uncia*
Species	-	*uncia uncia*

1.2.2 Morphology

The Snow Leopard exhibits superb camouflage for its mountain environment of bare rocks, mosses and snow, being whitish-gray (tinged with yellow) in color and patterned with dark gray rosettes and spots. Further adaptations for high altitude life includes an enlarged nasal cavity, shortened limbs (adult shoulder height is about 60

cm); well developed chest muscles (for climbing); long hair with dense, wooly under fur (belly fur grows as long as 12 cm) and a tail up to one meter long, 75-90% of head body length (IUCN/SSC Cat Specialist Group 1996, Jackson 1996, WWF 2001, Shrestha 2003). These adaptive features not only assists balancing in steep terrain movement but the thick tail can be wrapped around the body to protect the animal from the cold (Theile 2003).

Males are larger than female, with average weights between 45-55 kg as opposed to 35-40 kg for females (Jackson 1992, Fox 1994, Jackson 1996, Yaksha 1998, Shah 1998, WWF 2001, Theile 2003). The pugmarks of adults are 9-11 cm, in length and 7-9 cm in width, but variation in cubs (Jackson 1996, WWF 2001, Shrestha 2003).

1.2.3 Social Behaviour

Social behaviour of the Snow Leopard is generally solitary but it is social animal. Male and female of the Snow Leopard have been hunting together. Generally, one chased the prey from one side while another Snow Leopard is waiting for the frightened prey in other end. They are found eating together their kill (Shrestha 1997, Shrestha 2003).

Snow Leopards are known to live up-to 21 years in captivity but are unlikely to reach half of this age in wild (Blomquist and Sten 1982, Theile 2003). Snow Leopards are sexually matured at 2 - 3 years (Prater 1993). In captivity, estrus has been observed to occur in late winter or early spring (Witt 1977, Jackson 1996, Jackson and Chundawat 1999, WWF 2001). Cubs are born in late spring or early summer. The litter size is usually 2 -3 (Witt 1977, IUCN/SSC Cat Specialist Group 1996, WWF 2001, Shrestha 2003). Cubs stay with their mother until they reach 18-22 months of age.

It is reported that home range size varies from 12 - 39 km^2 (WWF 2002) which is within the size range of winter season home range in Annapurna Conservation Area (Oli 1997). In Mongolia, it varies from 12-39 km^2 in prime habitat to 1000 km^2 in marginal habitat in Mongolia, which has lower prey densities (WWF 2001).

1.2.4 Prey Species

The principal prey of the Snow Leopard is Blue Sheep *(Pseudois nayaur)* in many parts of Nepal and it also preys on Markhor *(Capra falconeris),* Serrow *(Capricornis sumatraensis)*, Himalayan tahr *(Hemitragus jemlahicus)*, Musk deer *(Moschus moschiferus)* (Chundawat & Rawat 1994, Jackson 1996, Shrestha 1997). Further more, the Snow Leopard preys on small mammals like Pikas (*Ochotoma* Sp.), Hares (*Lepus olustolus*) etc and birds like Chuckor Partridge *(Alectonis chukor)*, Tibetan Snowcock *(Tetraogallus tibetanus)* etc. Sometime, Snow Leopard makes their diet to domestic Goat, Sheep, Calves and sub-adult Yak, Colt and sub adult Horse (Jackson and Chundawat 1999, WWF 2001). An adult Snow Leopard kills 20-30 adult Blue Sheep or Tahrs per year on average. It kills a large animal every 10-15 days or around twice a month (Shrestha 1997, WWF 2001).

1.2.5 Status and Distribution

The Snow Leopard has an extremely patchy and fragmented distribution, consisting of a mix of long narrow mountain systems and islands of mountain habitat scattered throughout a vast territory of Tibet (Xizang) Autonomous region, Altai mountain ranges and other parts of China. Their range includes territories in eleven other countries: Afghanistan, Pakistan, India, Nepal, Bhutan, Mongolia, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and The Russian Federation (Table: 1). The species is extinct in several areas of its former distribution globally (Theile 2003).

Table 1: Status and Distribution of the Snow Leopard in the World

Country	**Jackson & Hunter 1996, WWF 2001**		**Theile Stephanie 2003**	
	Potential Habitat (km^2)	Population	Area of Habitat (Km^2)	Estimated Population
Afghanistan	80,000	Unknown	50,000	100-200
Bhutan	10,000	100	15,000	100-200
China	4,00,000	2000-2500	11,00,000	2000-2500
India	95,000	500	75,000	200-600
Mongolia	1,30,000	1000	1,00,000	800-1700
Nepal	30,000	300-500	30,000	300-500
Pakistan	80,000	300	80,000	200-420
Russia	1,31,000	120	1,30,000	150-200
Kazakhstan	71,000	100-120	50,000	180-200
Kyrgyzstan	1,26,000	650	1,05,000	150-500
Tajikistan	78,000	<200-300	1,00,000	180-220
Uzbekistan	14,000	<50	10,000	20-50
Total	**12,45,000**	**5320-6140**	**18,46,000**	**4360-7240**

Snow Leopards have extremely patchy distribution and although their range extends over a large area (more then 2-3 millions km^2), their fragmented population occupy an area of no more than 1.6 million km^2 (Jackson and Hunter 1996). Eighth International Snow Leopard symposium 1995, held in Pakistan declared the habitat of Snow Leopard as follows –

Total potential habitat	:	30, 24,728 km^2
Total Good Habitat	:	5, 49,706 km^2
Total fair habitat	:	24, 75,022 km^2
Total protected potential habitat	:	1, 81,547 km^2
Percentage of potential habitat Protected	:	5.9%

Estimates of the total Snow Leopard population vary from 4500 to 7500 individuals (Jackson 1992, Fox 1994). Earlier lower estimates e.g. 1500 by Green 1988 and 4000 by Fox 1989 reflected a lack of field information from the large area of Snow Leopard range.

Estimates of Snow Leopard density ranges from 0.8 animals 100/km^2 to 10/100 km^2 (IUCN/SSC Cat Specialist Group 1996). In Nepal, its density is 5-7/100 km^2 (Oli 1991). Snow Leopards are generally found at elevations between 3000 to 4500m, although they occasionally go above 5,500m in the Himalayas and can be found between 600 to 1500 m of northern limit of their range (Jackson 1996, Theile 2003, WWF 2001).

Snow Leopards are thought to occur in about 120 Protected Areas located across their entire range in Central Asia (WWF 2001). In Nepal, they reportedly occur in eight Protected Areas, but the actual number present in each Protected Area is unknown. The total Area within the Protected Areas is about 22,000 km^2 including forested and non-habitat areas. The potential areas for the Snow Leopard occurrence from Nepal can be listed as follows.

a. Shey - Phoksundo National Park (3,555 km^2)
b. Langtang National Park (1,710 km^2)
c. Sagarmatha National Park (1,148 km^2)
d. Makalu Barun Conservation Area & National Park (1,500 km^2)
e. Annapurna Conservation Area (7,629 km^2)
f. Kanchenjunga Conservation Area (2,035 km^2)
g. Manaslu Conservation Area (1,663 km^2)
h. Dhorpatan Hunting Reserve (1325 km^2)

The largest Snow Leopard population is thought to exist in the Shey-Phoksundo National Park and Annapurna Conservation Area (Oli 1994, Jackson 1996, WWF 2001). Nepal's population is roughly estimated at 300-500 but this figure must be confirmed by field surveys, using standard methods like the Snow Leopard Information Management System (SLIMS) developed by the International Snow Leopard Trust (ISLT).

1.2.6 Legal Status

The Snow Leopard is legally fully protected under the National Park and Wildlife Conservation Act 2029 (1973) of Nepal, which lists this animal in Appendix I of CITES since September 1975. A workshop/training session on "The

implementation of CITES in Nepal" was held in Kathmandu in May 1995, it was attended and well received by senior law enforcement officials from ten different agencies. The Snow Leopard is listed on the IUCN's Red Data list and in Appendix I as an endangered and fully protected animal (IUCN 1994, Chapagain and Dhakal 2003).

1.3 Threats to Snow Leopard

Historically, habitat remoteness served to insulate the species from human but Snow Leopards are no longer present in many areas that they formerly occupied. The species continues to suffer due to fragmentation across more disturbed mountain range habitat and its low population density (Fox 1994, Jackson 2000).

According to the survey of more than 60 Snow Leopard specialists, undertaken by the Snow Leopard survival strategy, direct killings of Snow Leopards and loss of their natural prey base are considered the most significant threats to the long-term survival of the species (McCarthy and Chapron 2003). It is difficult to identify baseline causes and effects in many cases due to the different types of threats are closely inter-woven and complexly related.

1.3.1 Poaching

Until recently, the killing of Snow Leopards for their valuable fur represented the single most important threat to the species. On the black market, a furrier may get a high price from selling a good quality coat. In Nepal, the fur trade is centered in Kathmandu, operating under the control of Kashmiri traders and sold under the counter at tourist stores and hotels (WWF 2001). The bones of the cat used for making ornaments by Himalayan dwellers.

1.3.2 Livestock Depredation and Conflict with Local Herders

Domestic animals commonly far outnumbered natural mainstay food items such as Blue Sheep, Himalayan tahrs or Ibex and they are easier to kill. Livestock forms even higher proportion of the Snow Leopard's winter diet when marmots are hibernating (Jackson 2000). Oli et al (1994) found herders to have strongly negative feelings towards Snow Leopard and Wolf owing to loss of livestock. Historically herders suffering from excessive depredation solicited help from Shikaris and professional hunters, who were rewarded with gift, food, alcohol and livestock for trapping habitual stock predators (Jackson, Ahlborn, Gurung, and Ale 1995, Jackson 2000). For examples, over grazing by domestic livestock may lead to competition with and eventually loss of wild ungulates, a major prey source for Snow Leopard. In turn, such reduction of wild prey often leads Snow Leopards to prey on domestic livestock's, which sets up a negative perception of the cat among herders, who then become motivated to kill Snow Leopard in retaliation for or prevention of attacks on livestock (Theile 2003).

1.3.3 Loss of Natural Prey

Wild ungulates, such as Argali, Himalayan tahr, Musk deer are adversely affected by overgrazing of land through increased with domestic livestock in parts of

the Snow Leopard's range. In Nepal, livestock may compete with natural prey for forage and grazing space leading to overgrazing and rangeland deterioration. As habitat quality declines prey finds its easy way to kill livestock which are being poorly guarded by their owners (Oli et al 1994, WWF 2001, Theile 2003). Poaching of prey species reduces the amount of food available to Snow Leopard that might result the increase the predation on domestic livestock, which in turn may provoke herders to kill Snow Leopards (Mc Carthy and Chapron 2003, Theile 2003). Today, the situation has become more deadly for Snow Leopards because of erosion in traditional religious beliefs against the hunting or killing of wildlife (WWF 2001).

1.3.4 Habitat Loss and Fragmentation

Habitat fragmentation, degradation and loss affect Snow Leopards but owing to the remoteness and inaccessibility of the preferred habitat, such influences Snow Leopards have been relatively limited until recently. Habitat alternations occur because of human encroachment into the species ' range'- for resource extraction, new grazing grounds living space excessive tourists flow or road building. Human conflicts may also contribute to habitat degradation or loss (Theile 2003, WWF 2001).

1.3.5 Tourism

The impacts of tourism may be encapsulated in the following well-known phrases coined by reporters, visitors and Nepalese observers.

'Tourism is a goose that lays golden eggs, but it can also foul its own nest' (Gurung 1995). A phrase widely used to explain the present state of tourism in Nepal. Tourism leads to pollution and deforestation problems in Kathmandu and Pokhara valley and in Everest, Langtang and Annapurna regions. The pollution and deforestation to high land spoils the mountain habitat, which affects the survival of Snow Leopard and its prey.

1.3.6 Lack of Awareness

Local people depend upon animal husbandry and its extension through out the highland pasture for their livelihood. They will be happy if there is no loss of their livestock by the wild predator and population increment of cattle naturally will enhanced their standard of livelihood. Thus, they might see no advantage to co-existing with Snow Leopards, which are a major source of their livestock remover and no means of their use too. Understandably, they are reluctant to support snow leopard conservation unless depredation losses are reduced or concern authorities for any livestock killed by predators compensate them (WWF 2001).

1. 4 Objectives

The main objective of this study was to collect basic ecological data on habitat, distribution and general threat to Snow Leopard in LNP.

The specific objectives were

i. To explore the present habitat and distribution of the Snow Leopard in Langtang Valley.

ii. To explore the basic threat to Snow Leopard.

iii. To find the livestock depredation.

1. 5 limitation of the Study

* The study was based on indirect survey method. (e.g. investigation from pugmarks, scrapes, scats, etc). It is very difficult to follow the signs of Snow Leopard to very steep Mountain, rocky and stony ground.

* Frequent heavy snowfall covered the signs and track of Snow Leopard.

* Flexible weather conditions of mountain ecosystem such as landslide, high velocity cold wind and unpredictable snowfall disturbed the study.

* Less information of the study area in previous literature.

* Short study to fulfill the Master degree does not allow doing continuous research. In between, we have to attend our university classes.

1. 6 Significance of the Study

1. There is no previous study on the Snow Leopard in LNP, so, this exploration will establish status and availability of the species for LNP.

2. This will help to the relevant governments, researchers the planners and associated agencies for conducting their research and plan about Snow Leopard conservation in that area.

2. STUDY AREA

2.1. Physical Description

2.1.1 Background

The study area, Langtang National Park was designated as the first Himalayan National Park in 1970-71 and was gazetted in 26 March 1976 by His Majesty's Government of Nepal with assistance from the UNDP/FAO. This Park covers 1710 km^2 and the altitude ranges from 792 m on the Bhote Koshi to 7245 m on the peak of Langtang Lirung. In 17 April 1998, an area of 420 km^2 in and around the park was declared as a buffer zone.

Bhote Koshi and Trishuli Ganga define this region to the west, Tibetan Autonomous region of China to the north and east. It is located in between the Latitudes 28˚00' - 28˚20' N and longitudes 85˚15' - 86˚00'E. Its southern border lies Rasuwa, Nuwkot and Sindhupalchowk districts of Bagmati Zone. It bisects east - west

Gosainkunda Lake and Dorje Lakpa Range in the North. Langtang Lirung (7245m) dominated the peaks, Gosaikunda Lake (4380m) lies in the east. The park with diverse altitudinal range supports life zones from upper tropical forest to the permanent snow (Chaudhary 1998, DNPWC 2002).

It is most accessible among the mountain national parks of Nepal and a motorable road leads to Dhunche/Syaprubesi via Trishuli from Kathmandu in any season of the year. Then one should start trekking into interior part of the park including Langtang valley and Kyanjing Gumba. Alternate trek routes are from Sundarijal or Panchkhal via Goshainkund or Ganjala pass (5,122m).

Present study focused on Langtang valley and Kyanjing area, located between the latitudes N 28˚11'87.5" to N 28˚12'28.6" and longitude E 85˚ 27'31.6" to E 85˚42'16.9". The elevation varies from 3000m to 5125m.

Main study sites were Ghodatabela, Langtang valley, Kyanjing valley, Langtang Khola, Numthan, Chyandan, Langsisa Kharka, etc. These area are surrounded by Langtang Lirung, Kyanjing Ri, Yala peak, Cherkori, Langtang, Ganjala, Lakpa Dorje, Nayakyang Himals. The Langtang valley is rich in glacier such as Langtang glacier, Langtang Lirung glacier, Yala glacier.

2.1.2 Topography

Dominantly rugged, steeply dissected terrain is the typical features of the central Himalayan Region. The study area represents the great Himalaya Range (i.e. Langtang, Jugal Himal, Langsisa Himal, Nayakhyang Himal, Yalapeak Himal) and the valley of the inner Himalaya (i.e. Langtang valley).

The region to the south of the Kyanjing, Lakpa Dorje range and Langsisa range comprises the Northeast - Southwest curving watershed which separates the Langtang Khola catchments. The western end of the Langtang Himal rises steeply to Lanagtang Lirung 7245m, the highest point in the park.

2.1.3 Drainage

All the rivers in the park are torrential. There are two major source types: those fed partly by glaciers (e.g. Langtang Khola, Bhote Koshi) and those, which do not have glacier origins but fed by lake system (e.g. Trishuli River and Tadi Khola). The discharge volume is greatly affected by the rainfall especially to the increase monsoon rain in June to September.

2.1.4 Geology and soil

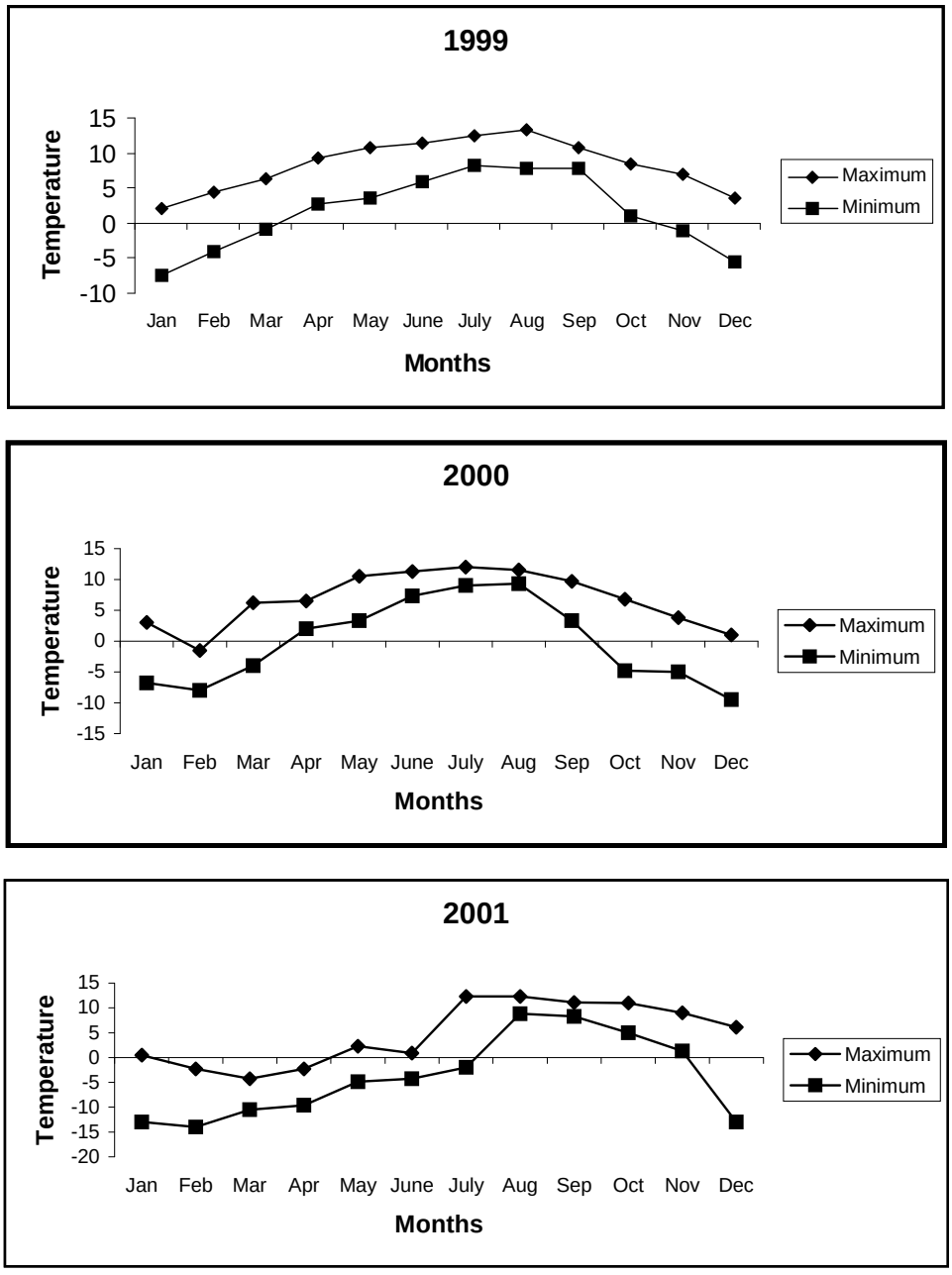
No economically viable mineral concentrations are reported to occur in Langtang. Topography, vegetation, cultivation, severely affects the local soil patterns. However, it is difficult to generalize the area. Mature soils occur in the lower forested regions, mainly fertile loams. In the upper Langtang valley, the most common textural component is sandy - loam with a large proportion of rocks. The mean proportion of sand decreases with elevation and loamy-sands become predominant below 2440m, where the practice of pasture burning occurs. The soils are generally fairly acidic, pH 5-6 (Shrestha 1988).

2.1.5 Climate

Park represents the graded climate condition from subtropical to alpine. The local climate is dominated by the southerly monsoon. The incidence and type of

precipitation related to aspect, altitude and the presence of rain shadow effect (DNPWC 2002).

Figure 1: Monthly maximum and minimum temperature (1999-2001) recorded at Kyanjing Gumba, LNP.

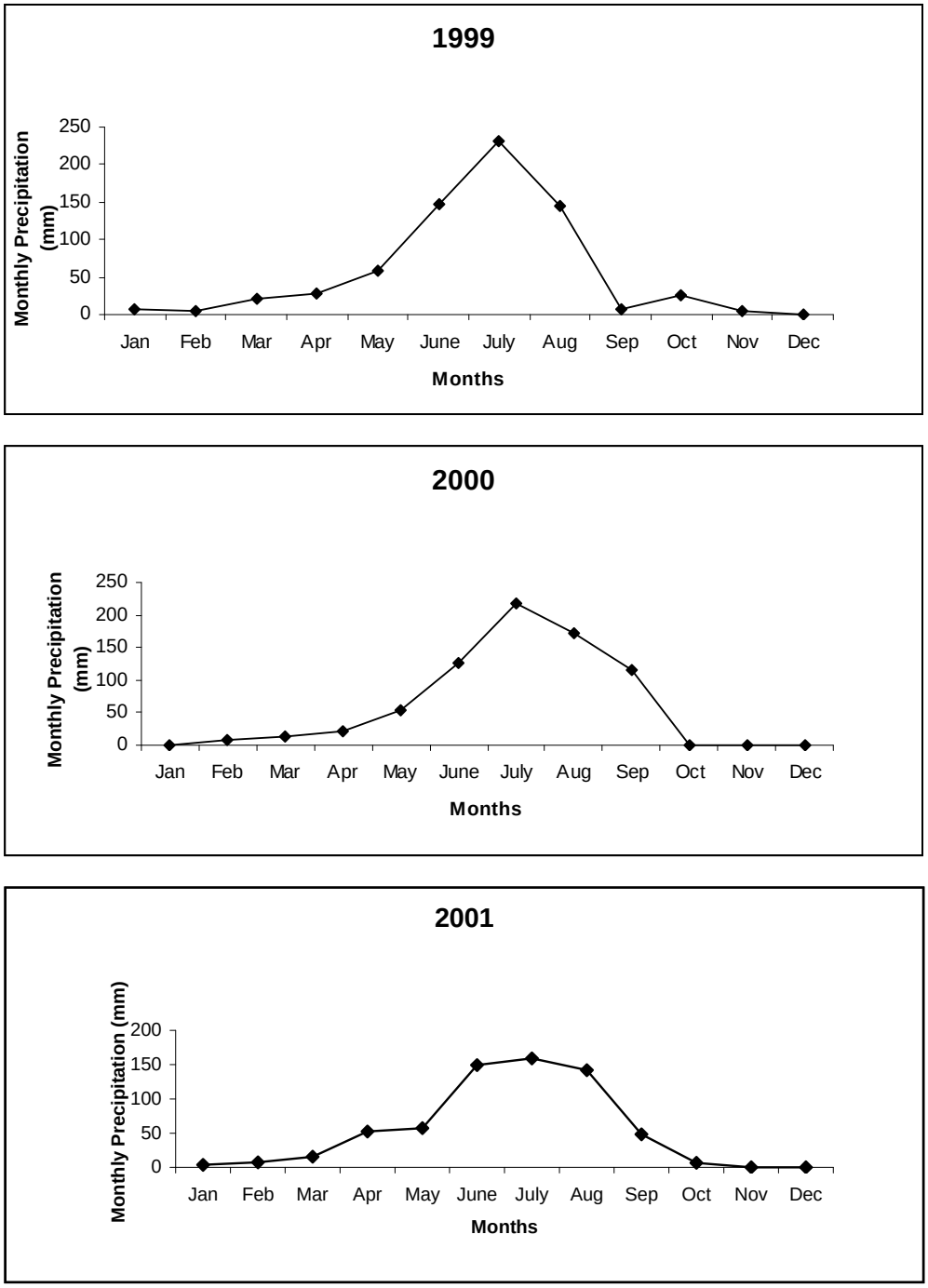


Summer snow only accumulates above 5500m; storms in the autumn from the northwest bring deep snow down to 4000m. During the winter, precipitation is generally in the form of snow above 3000m. In general, north and west facing slopes tend to be more protected, allowing snow to accumulate. The temperature varies considerably with aspect, altitude and cloud cover. The coldest months are December to February and the maximum temperature reaches between May and July. Humidity and cloud cover increase with the onset of monsoon. The temperature data clearly

shows that December, January and February are very cold months and June, July and August are warm months. The figure 1 and Annex-1 (a and b) shows that 2001 year was very cold year in comparison to others.

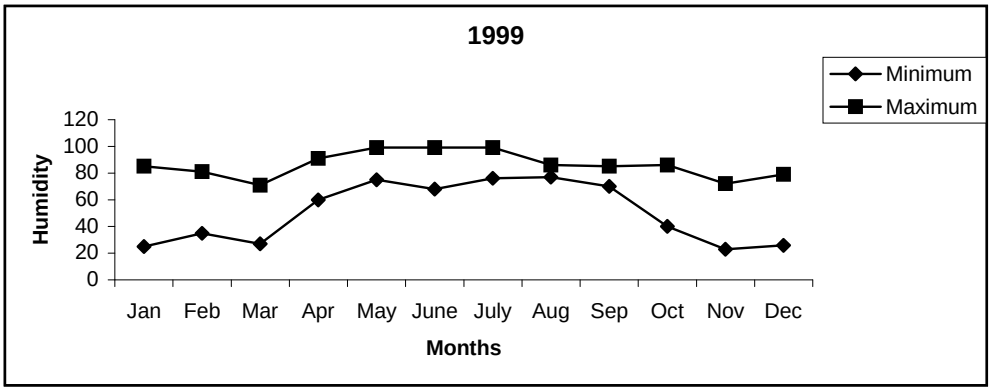
The figure 2 and Annex-1(f) shows that June to September are rainy months; where precipitation rate is high and less precipitation during October, November, December and January. From the comparison of precipitation data, more precipitation was recorded in 1995 (i.e. 1041.5 mm).

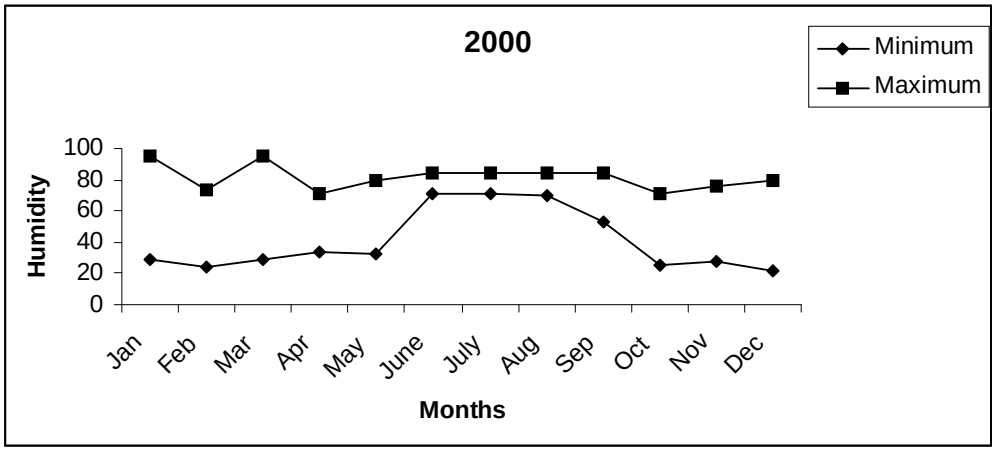
Figure 2: Monthly Precipitation (1999-2001)

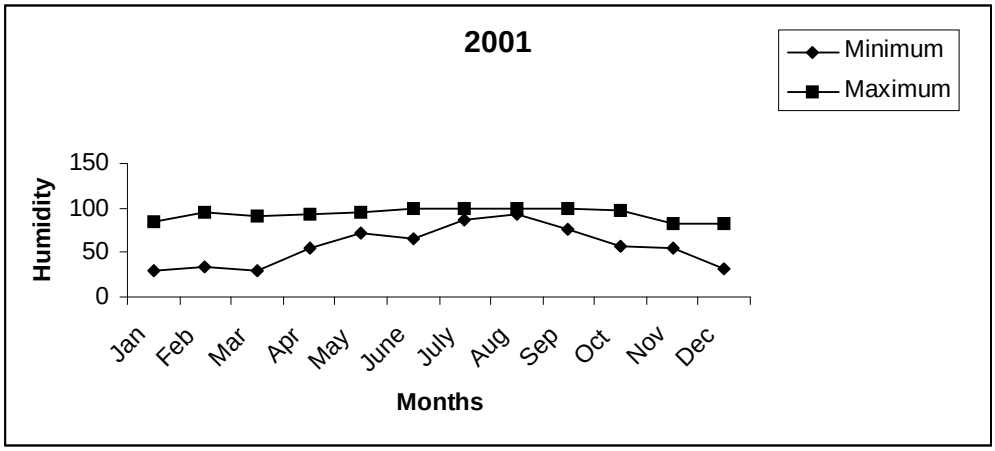


The figure 3 and Annex-1 (c, d, e) shows that, 1997 AD was most dry year and 2001 was wet year between 1993 to 2001. During the whole year, June, July and August experienced the most humid months.

Figure 3: Monthly Minimum and Maximum Relative Humidity (1999-2001)







2.2 Biological Description

2.2.1 Flora

Altogether more than 1000 plant species including tree, climber and shrubs, are recorded in Langtang National Park. Twenty-one species were found to be endemic for that area. Land use classification revealed 29.87% forest area, 4.94% shrubland, 60.73% Rock and Ice, 4.94% grassland and 1.70% cultivated land. (Khatiwada 2002). The description and classification of the vegetation in the park has been described in detail in management plan (DNPWC/DHUE 1977). Different vegetation zones of the LNP are as follows -

a.	Upper Tropical Zone	(Below 1000m)
b.	Sub tropical zone	(1000 - 2000m)
c.	Hill zone	(2000 - 2600m)
d.	Montane zone	(2600 - 3000m)
e.	Lower sub-alpine zone	(3000 - 3600m)
f.	Upper sub-alpine zone	(3600 - 4000m)
g.	Lower Alpine zone	(4000 - 4500m)
h.	Upper Alpine zone	(4500 - 5000m)
i.	Nival zone	(Above 5000)

My study area was limited to different strata of alpine zone e.g. lower sub-alpine zone, upper sub-alpine, lower alpine zone and upper alpine zone.

a. Lower sub-alpine zone. (3000 - 3600m)

This zone mainly characterized by the dominance of coniferous and rich variety associate species. *Rhododendron barbatum* is often present in pure stand on steep north-facing slopes. At the lower altitudes in this zone, *Acer* sp. is important associate on the North-facing slopes. *Abies spetabilis*, the high altitude fir is common in the upper forest. The Rhododendrons occurring in *Abies* forest are limited to *Rhododendron barbatum*, *R. campanulatum*. *R. arboreum* and in few places the Nepalese endemic *R. cowanianum* occur. Other associate species are *Betula utilis*.

This zone corresponds to Alpine Fir-Birch forest, Birch-Rhododendron forest. Moist temperate deciduous forest and Eastern oak Hemlock forests occur in this area (NARMSAP 2002).

b. Upper sub-alpine zone (3600 - 4000m)

Betula utilis is the characteristic tree species of this zone. On the north facing slopes, *B. utilis* is associated with *Rhododendron campanulatum*, the latter being scatter and stunted above the tree line. In drier habitats (Southern face), *B. utilis* is absent and *R. campanulatum* is associated with *Juniper indica* and *J. recurva.* This zone corresponds to the alpine Fir-Birch forest and Birch- Rhododendron forest (Champion 1968, Shrestha 1988, NAPMSAP 2002).

c. Lower alpine zone (4000m - 4500m)

Above the tree line, scrub species such as *Rhododendron*, *Lonicera*., *Juniperus*, *Ctoneaster* are found. This zone corresponds to the dry alpine scrubs, moist alpine scrub and grassland (Champion 1968, NARMSAP 2002).

d. Upper Alpine zone (4500 - 5000m)

Species vary depending on the soil, aspect and degree of shelter, grasses, herbs and cushion plants occur in the favorable microhabitats. This region is dominated by four important grass species - *Carex* sp., *Calamogrostis* sp., *Agrotis micantha, Festuca leptogonum* with a large number of alpine flowering plants belonging to the families of Primulaceae, Rununculaceae, Rosaceae, Gentianaceae, Polygonaceae and so on (NARMSAP 2002).

e. Nival Zone (Above 5000)

This is an area with permanent snow and ice without any recognizable vegetation except some lichens and mosses on exposed rocks.

2.2.2 Fauna

a. Mammals

Forty-six species of mammals are found in LNP (Khatiwada 2002). The common primates are Rhesus macaque *(Macaca mulatta)*, Assamese monkey *(Macaca assamensis)* Common Langur *(Semnopithecus entellus)*. The carnivorous mammals include Fox *(Vulpus vulpus)*, Wild dog (*Cuon alpinus)*, Himalayan black bear *(Selenarctos thibetanus)*, Red panda (*Ailurus fulgens*), Marten *(Martes foina, M. flavigula*), Leopard cat *(Felis bengalensis),* Clouded leopard *(Neofelis nebulosa)*, Leopard *(panthera pardus)* Snow Leopard *(Uncia uncia)*. The common ungulates are Wild boar (*Sus scrofa*), Himalayan musk deer *(Moschus chrysogaster),* Barking deer *(Muntiacus muntjak)*, Ghoral *(Naemorhedus goral)*, Himalayan tahr *(Hemitragus jemlahicus)*. Small animals include Royle's pika *(Ochotoma roylei)*, Himalayan squirrel (*Dremomys lokriah*), and Indian porcupine *(Hystrix indica)* (DNPWC 2002, NTB 2001).

b. Birds

The avifauna diversity is rich in LNP covering 345 bird species. The notable bird species: Dark-rumped rose finch (*Carpodacus edwardsii*), Satyr tragopan (*Tragopan satyra*), Ibisbill *(Ibidorhyncha struthersii)*, Orange- rumped honey guide *(Indicator xanthonotus)*, Bay woodpecker *(Blythipicus pyrrhotis)*, Snow pigeon *(Columba leuconota)*. Spotted dove *(Streptopelia chinensis)*, Golden eagle *(Aquila chrysaets)* Tibetan snowcock *(Tetraogallus tibetanus)*, Snow partridage *(Lerwa lerwa),* Blood pheasant *(Ithaginis cruentus)*, Impeyan pheasant *(Lophophorus impejanus),* etc. (Karki and Thapa 2001, DNPWC 2002, Shrestha 2003).

c. Reptiles and Amphibians

Eleven species of herpetofaunas are found in LNP. Some reptiles are Himalayan rock lizard, Green pit viper, Himalayan matrix, Keel back snakes, etc and

amphibians such as Toad *(Bufo himalayanus),* Frog *(Rana polunini)* is common (Chaudhary 1998, Shrestha 1998).

Beside these 30 species of fish, 10 species of spiders (Khatiwada 2002) and 70 species of butterfly are recording in LNP (Karki, Poudel, Khanal and Shrestha 2002).

2. 3 Socio-Economic Aspects

Langtang National Park and its buffer zone covers whole or part of 15 village development committees (VDC), among them 11 VDCs lies in Rasuwa district, 3 in Nuwakot and 1 in Sindhupalchok. My study area covers only one VDC of Langtang with six villages (i.e. Ghondatabela, Thangseps, Langtang village, Sindum, Mundum, Kyanjing Gumba). Altogether, there are 60 households, 44 hotels, and 13 teashops with a population of 530 individuals (VDC record 2003).

The majority of the people living in Langtang belong to Sherpas (Bhotias), Lamas, and Tamang. There is no other ethnic group in Langtang valley. The cultures are discernible in Langtang through house style, dress, ornaments and customs. Almost all of the Bhotias and Tamangs are Buddhist. Losar, Kyanjing Gumba Mela, Langsisa Kharka Mela, Buddha Jayanti are the major festivals of Sherpas (personal communication: Renjen Dorje Sherpa).

Livestock farming is the main occupation of people of Langtang for subsistence economy. Agriculture is the alternative occupation to make the living of people; however, the crop production is low. Besides these, some people make tourism for their occupation and source of economy.

Livestock movement is between 3000 to 5000m elevations and is held from May to September. In winter, they come down to lower elevation at 2000m. Sheep and goats are grouped into several herds for the summer grazing. Theses animals are usually grazed in the meadow or Kharka, which is the habitat of many wild ungulates like Himalayan tahr, musk deer, etc. In the summer, the herders make temporary shed or Goth for herding the Yaks, Sheep, Horses and Goats to their respective Kharkas.

Dairy Development Corporation opened the Nepal's first cheese factory in LNP. One lies in Sign Gumba (Chandanbari) and other in Kyanjing Gumba. The cheese factory of Kyanjing Gumba collects the milk from 60 farmers and used to make 6,000 kg cheeses in a year (Personal communication with members of cheese factory).

The cheese factory established the deposit camp to their Kharkas to collect the milk. The depots keep on shifting according to the shifting of Goth. Farmers also receive loan from cheese factory. Agricultural Development Bank provides credit facilities to the farmers on cheese factory's recommendation (Personal communication, member of cheese factory).

3. METHODOLOGY

3.1. Reconnaissance Survey

The reconnaissance survey on Snow Leopard was conducted from February 14 to March 4, 2003 in Langtang National Park. During this period, general survey was done for Snow Leopard habitat its sign and prey species. A fresh pugmark was found near the Kyanjing Gumba and was conformed as of a Snow Leopard by International Snow Leopard Trust, ISLT (Chalise et al 2004).

Participatory Rural Appraisal (PRA) method was applied during the survey on February 2003 before starting the actual fieldwork. The survey was done with yak herders, local people, and hotel owners to collect information on the Snow Leopard and its prey in LNP.

3.2 Survey Block Design

The study was focused on Ghondatabela to Langsisa with an area of 25 km^2. The study area was divided into five survey blocks, having an area of 5 km^2. The study blocks had given the names as A, B, C, D and E. The first block A lies in Ghondatabla (N28º11.875' /E 85º27.316' and elevation 3080m). B lies in Langtang village (GPS recording: N28º12.955'/E 85º30.465' and elevation 3328m). C lies in Kyanjing Gumba (GPS recording: N28º12.768'/85º35.235' elevation 3972m). D block lies in Numthan (GPS recording: N 28º11.793'/E 85º36.783' and elevation 4000m). E block lies in Langsisa Kharka (GPS recording: N 28º12.286' /E.85º42.169' and elevation 4070m), (Map 1).

3.3 Snow Leopard Sign Transect

The Snow Leopard survey was done according to SLIMS (The Snow Leopard Information Management System) developed by ISLT (International Snow Leopard Trust). After selecting general survey areas for this study, a topographic map of 1:50000 was utilized to layout transect routes. Transects were placed along landforms where cats are most likely to caste sign, i.e. ridge lines, cliff bases, crest of cliff, streambed, human track, v- shaped valley, etc. Transects were 500m in length, 5m breadth in left and 5m in right from the centerline. The total area of each transect was 0.5 km^2. The length of transect was measured by the pedometer and confirmed by the survey tape. Each transect was walked and searched for sign of the animal. At each detected Snow Leopard sign, site and the type of sign (Scrapes, Feces, Pugmarks, Sent Spray, etc) were recorded. The size of the sign was measured and the tentative date was estimated. For each site, habitat features was recorded based on the dominant condition. These included Longitude, Latitude, elevation, habitat type, rangeland use, landform ruggedness, dominant topographic feature and substrate. Altogether 25 transects were placed inside the 4 study blocks (B, C, D and E). Due to lack of sings of Snow Leopard, no transects were placed in Block A (Ghoatabela). Transects were not randomly distributed within Snow Leopard range rather these are placed in habitats where the Snow Leopard's signs were likely to find. In Block B (Langtang) 5 transects were laid down followed by 8 in Block C (Kyanjing), 8 in Block D (Numthan) and 4 in Block E (Langsisa Kharka).

3.4 Identification of Pugmarks (Track Survey)

To assess the Snow Leopard status in the study area, the pugmarks or tracks were surveyed on dusty footpath, muddy trail, sandy streambed and snow covered

area. When the fresh and fine tracks or pugmarks were found, the pugmark total length (PML) and pugmark breadth (PMB) was measured by the help of survey tape and recorded digitally on photographs and by a still camera. Different set of tracks were examined based on measurement and individual Snow Leopard identified according to shape and size of pugmark.

3.5 Camera Trapping Method

The automatic heat sensor cameras (manufactured by Goodson and Associates, Inc. of Lexix, Kansas, USA collaboration with China) were used to photograph the Snow Leopard. Each Camera Trap unit consists of one Trail Master (TM) -35 Cameras (modified Olympus waterproof 28 x 80mm lens containing compact camera with auto focus supplied by 8 dry cell A1 batteries). Whenever an animal passes in front of the beam, the TM -35 camera attached to the system to take photograph of the animal, records the action with the time and date (plate ...). The camera devices were kept (wooden posts or on the stone) in a strategic locations and trail frequently used by Snow Leopard.

Three cameras were used at a time to photograph the Snow Leopard. The camera traps were placed for 2 to 4 days at every trapping station. The devices pulled out during daytime to avoid the risk of theft. The color print films with ASA-200 Kodak were used to take the shots. The camera delay was normally fixed at 1.0 minute.

3.6 Questionnaire Survey

Two sets of the questionnaires were prepared for the presence/absence, status of the Snow Leopards and their prey and Live stock depredation. (Annex 3-4) The first set of questionnaire was related to the Snow Leopard and prey species survey contained three different sections.

The first section contained questions that related to personal information and location. The second section related to Snow Leopard sightings and status. The third section related to threats and conservation issues.

The second set of questionnaire also contained three different sections. The first section contained personal information or family background; second section related to Livestock Ownership and Trend; third section related to Livestock Husbandry.

Following consideration were made during questionnaire survey.

People were briefed about the purpose of the study prior to survey. Interviews were taken from local people, herders and hotel owners. All together 55 questionnaires were taken meeting 60 household in group visiting in their herd side and in high meadow (Kharkas).

In the field, before actual data collection from the locals, we were acquainted with their feeling about Snow Leopard and shed light of our main aim of study. Afterward, with the support of local opinion leader and Lamas, we were able to collect our questionnaire form completely and satisfactorily.

3.7 Prey Species Survey

3.7.1 Himalayan Tahr Survey

The direct observation was done by searching in the slopes of the study area. Total herd count method was applied by using 10×40 binocular (made in USSR). In every observation the altitude, location, time, date and GPS recording was noted down.

3.7.2 Pika Survey

Quadrate sampling method was applied to find out the density and abundance of Pika. 10×10m sized 10 quadrates were fixed in different places using random sampling. The date, time, GPS recording, elevation and total head count of Pikas were noted down during field survey.

3.8 Data Analysis

The primary data were collected from the fieldwork from February 2003 to May 2004; spending more than 143 days and 769.15 hours (Table: 2).

Secondary data were collected from VDC office Langtang; LNP office Dhunche; DNPWC, Kathmandu; Department of Hydrology and Meteorology, Babarmahal ; different Journals; Newspapers and Books.

The collected data have processed by statistical methods. Microsoft Excel was used to analyze the data and the results were presented in tables and charts. To examine the significance of data, χ^2- test (chi-square) was employed at 95% confidence limit and (n-1) degree of freedom.

$$\chi^2 = \Sigma \frac{(O-E)^2}{E}$$

Where, O = Observed value

E = Expected value

3.9 Study Period

Total working schedule in the field is described in Table 2.

Table 2: Schedule of field in Langtang Valley study area (2003-2004)

S. No.	Field Duration	Total working Days	Total working hours
1.	14 February to 4 March 2003	20	Preliminary Survey
2.	5 April to 8 June 2003	62	402.66
3.	23 August to 18 Sept. 2003	25	151.61
4.	10 February to 27 Feb 2004	17	72.50
5.	9 May to 28 May 2004	19	132.38
	Total	**137**	**769.15**

4. RESULT

4.1. Habitat and Distribution

4.1.1 Sign distribution according to transect

Total 90 signs (feces, scrapes, pugmarks) were recorded in the survey area of 25 km^2, where 25 transect was laid down, dividing into 5 study blocks. Highest number of sins were recorded in transect C_5 (Langtang glacier, 13 signs) followed by D_1 (Chyandan, 11 signs), C_3 (Ganjala base camp, 10 signs) and C_4 Tharchepisa, 10 signs) (Table 3). There was significant difference in the signs distribution between the transects, ($\chi^2 = 113.18$, $p \geq 0.05$, at 24 d. f.) was observed statistically.

Table 3: Signs Recording According to transects

Block	Transect No.	Location	GPS recording			Total No. of Sign
			Longitude	Latitude	Elevation	
B	B_1	Yamphu	N28°12.419' N28°12.492'	E85°33.261' E 85°32.992'	3980m 3930m	0
	B_2	Opposite to Mundu Village	N28°12.627' N28°12750'	E85°31.438' E85°31.416'	3660m 3830m	0
	B_3	Falls side Mundu Village	N28°13.125' N28°12.917'	E85°31.468' E85°31.620'	3720m 3690m	0
	B_4	Down side of Mundu Village	N28°12.727' N28°12.60'	E85°31.845' E85°32.107'	3660m 3680m	1
	B_5	Way to Yamphu	N28°12.610' N28°16.600'	E85°32.335' E85°32.634'	3700m 3720m	5
C	C_1	Langtang Khola Basin	N28°12.480; N28°12.501'	E85°33.810' E85°33.784'	3758m 3727m	4
	C_2	Cherkori Basecamp	N28°12.829' N28°12.929'	E85°35.405' E85°35.583'	4515m 4606m	8
	C_3	Ganjala Pass Basecamp	N28°12.107' N28°11.705'	E85°33.550' E85°34.977'	4160m 4310m	10
	C_4	Tharchepisa	N28°12.578' N28°12.499'	E85°35.153' E85°34.630'	4240m 3950m	10
	C_5	Langtang Glacier	N28°12.974' N28°13.307'	E85°33.975' E85°34.058'	4000m 4040m	13
	C_6	Langtang Lirung Basecamp	N28°14.030' N28°13.755'	E85°33.571' E85°13.560'	4350m 4300m	1
	C_7	Langtang Glacier Lakeside	N28°13.348' N28°13.090'	E85°33.640' E85°33.667'	4220m 4160m	1
	C_8	Glacier Kharka	N28°13.214' N28°13.657'	E85°34.013' E85°34.286'	4350m 4220m	0
D	D_1	Chyadan	N28°11.800' N28°11.781'	E85°36.705' E85°36.430'	3910m 3980m	11
	D_2	Yala Basecamp	N28°12.920' N28°12.214'	E85°35.123' E85°36.487'	4606m 4485m	5
	D_3	Thungchung	N28°11.711' N28°11.706'	E85°35.973' E85°36.50'	4279m 4249m	7
	D_4	Yalakharka	N28°12.768' N28°12.957'	E85°36.926' E85°36.739'	4750m 4810m	1
	D_5	Way to YalaBase	N28°13.177' N28°13.314'	E85°36.344' E85°36.392'	4800m 4750m	0
	D_6	Way to Yalapeak kharka	N28°12.146' N28°12.199'	E85°35.928' E85°36.458'	4400m 4510m	1
	D_7	Numthan Kharka	N28°11.790' N28°11.797'	E85°36.780' E85°37.075'	4000m 4010m	0
	D_8	Kinggurchen Kharka	N28°11.741' N28°11.709'	E85°35.535' E85°35.811'	3950m 3980m	0
E	E_1	Langsisa Kharka (1)	N28°12.926' N28°13.192'	E85°40.521' E85°40.681'	4091m 4152m	6
	E_2	Langsisa Kharka (2)	N28°12.286' N28°12.176'	E85°39.169' E85°39.421'	4070m 4060m	4
	E_3	Langsisa Kharka (3)	N28°12.275' N28°12.467'	E85°39.816' E85°39.978'	4170m 4130m	1
	E_4	Langsisa Kharka (4)	N28°12.912' N28°13.155'	E85°40.518' E85°40.672'	4200m 4240m	1

4.1.2 Sign distribution according to block

In present study, out of total 90 signs, 2.4 signs / km^2 was recorded in Block B (Langtang valley), 11.75/km^2 in Block C (Kyanjing valley), 6.25/km^2 in Block D (Numthan and Chyandan) and 6/km^2 in block E (Langsisa Kharka). Therefore, the distribution of the Snow Leopard was more in Block C (Kyanjing Valley). No sign was recorded in block A (Ghodatabela). There was significant difference in the sign distribution between the bocks (χ^2 = 7.969, P$\geq$0.05, at 3 d. f.) was observed statistically.

Table 4: Signs Recording According to Blocks

Blocks	No. of Transects	Total no. of Signs	Signs Density/km^2
B	5	6	2.4
C	8	47	11.75
D	8	25	6.75
E	4	12	6

4.1.3 Sign Distribution According to Altitude

Among 25 transects, 9 transects were laid down between the attitude 3700 - 4000 m. where 28 signs were recorded and the sign density was 6.21/km^2; 16 transect were laid down between the altitude 4000 - 4810m, where 62 signs were recorded and signs density was 7.74/km^2 (Table 5). So the habitat above 4000 justified the more favorable habitat. There was significantly more signs in an altitude 4000 to 4810m (χ^2 = 12.84, P$\geq$0.05, at 1 d.f).

Table 5: Sings Recording According to Altitude

Altitude	No. of Transects	Total No. of Signs	Sign Density/km^2
3700 - 4000m	9	28	6.21
4000 - 4810m	16	62	7.74

4.1.4 Signs Distribution According to Topography

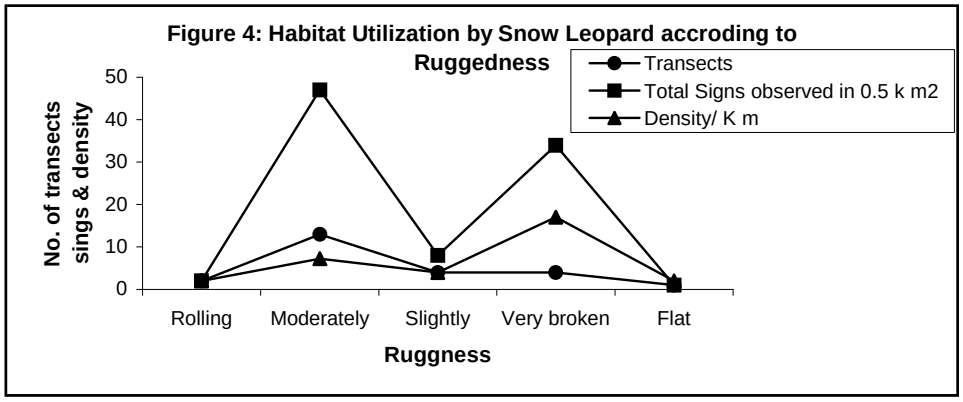
As the topography, 8% transects were laid down on valley bottom, 24% on stream bed, 28% on cliff base, 28% on hillside, 8% on human track and 4% on ridge line where more signs density were recorded on cliff base and hillside (i.e. 10/ km^2 and 9.14/ km^2 respectively).

Table 6: Signs Distribution According to Topography

Topography	No. of Transects	No. of Signs	Signs Density/km^2
Valley bottom	2	0	0
Streambed	6	16	5.33
Cliff base	7	32	9.14
Hillside	7	35	10
Human track	2	6	6
Ridgeline	1	1	2

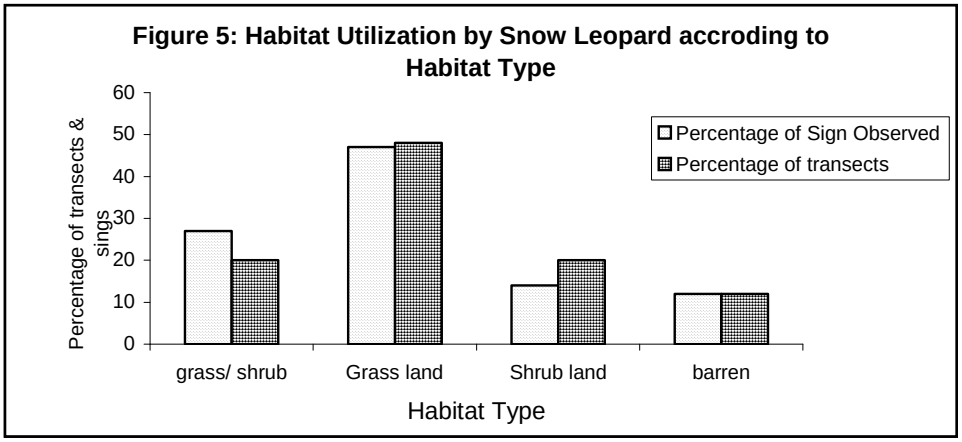
4.1.5 Habitat Utilization

Snow Leopard showed as marked preference forwards the very broken and moderately broken land from or ruggedness in Langtang national park. More signs of the Snow Leopard were observed in moderately broken and very broken ruggedness than rolling and flat ruggedness (Plates.....).



Out of total transects, 25 in the study area, 13 were laid in moderately broken ruggedness, in these transect areas 7.230/km^2 signs were observed. Likewise four transects were laid on very broken ruggedness, where the sign density was 17/ km^2 (Figure 4).

Due to availability of more prey species in grassland and scrubland, the Snow Leopard preferred these habitats in LNP. Snow Leopard signs were observed most (47%) in grassland habitat followed by 14% in shrub land, 27% both grass and shrub mixed land and 12% in barren habitat (Figure 5).



4.1.6 Pugmark/Track Seen

Pugmarks of Snow Leopard were seen in the snowy surface as well as mud, sand and loose soil around the ground and river banks. During the field study, the different sizes of pugmark were recorded inside our study block. The size of the adult

pugmark size recorded 9×11, 8×10, 7×9, 7×8, 10×11 cm respectively, which clearly shows that, there could be more than four Snow Leopards. (Table: 7, Plates...).

Table 7: Pugmark Recorded on Study Area

S.N.	Date	Location	Size of Pugmark (cm)
1.	8 April, 2003	Airport	9×11
2.	10 April, 2003	Glacier	7×9
3.	15 April, 2003	Glacier	7×9
4.	29 April, 2003	Cherikori	9×10
5.	30 April, 2003	Cherikori	7×9
6.	3 May, 2003	Airport	7×8
7.	14 May, 2003	Airport	7×9
8.	18 May, 2003	Yala base	7×8
9.	20 May, 2003	Ganjala	9×11
10.	27 Aug, 2003	Sindhum	8×10
11.	27, Aug, 2003	Mundum	7×9

4.1.7 Snow Leopard Fecal Samples

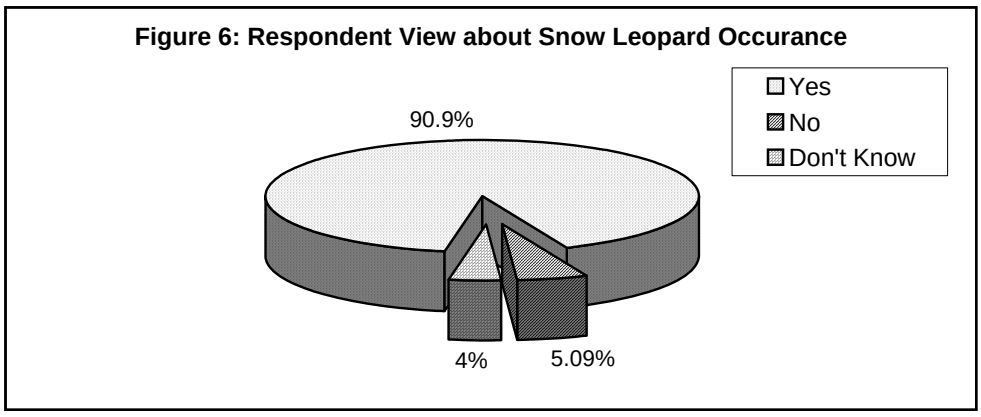
The scats observed were noted down along with transects. The scats samples were mostly from the cliff base, water, snow, grassland, etc (plate….).

Table 8: Snow Leopard Fecal Samples

Sample	Date	Location	Long/Lat	Elev (m)	Age
1	8-Apr-03	Kyanjin - near bridge	N28°12'621 / E085°33'675	3850	old
2	10-Apr-03	Kyanjin - near river	N28°12'621 / E085°33'810	3850	old
3	11-Apr-03	Yamphu	N28°13'125 / E085°31'468	3720	old
4	2-May-03	Cherkori kharka	N28°12'522 / E085°34'940	4200	old
5	2-May-03	Cherkori kharka	N28°12'597 / E085°35'740	4250	old
6	3-May-03	Near Cherkori kharka	N28°12'578 / E085°35'153	4320	old
7	11-May-03	Way to Yala Peak	N28°12'540 / E085°35'210	4250	new
8	11-May-03	Way to Yala Peak	N28°12'528 / E085°35'100	4200	old
9	16-May-03	Gangala Pass base camp	N28°12'170 / E085°33'550	3950	old
10	21-May-03	Cherkori kharka	N28°12'884 / E085°35'483	4555	new
11	24-May-03	Near Chyandan	N28°11'710 / E085°36'505	3875	old
12	27-May-03	Langtang Lirung	N28°12'886 / E085°33'704	3920	new

4.1.8 Snow Leopard Occurrence

Out of 55 households interviewed 90.9% of them responded on the support of Snow Leopard occurrence in LNP (Figure 6).



4.1.9 Place Where the Snow Leopard Seen

Out of 55 respondents, 7 respondents didn't see the Snow Leopard and its signs to their locality. Among 48 respondents, 22.91% respondents saw the Snow LEOPARD on the rocky mountain of Lantang, 14.5% respondents on Yala peak Khaka and Langtang Lirung Kharka Respectively. The details is presented in table 9.

Table 9: Respondents Response on Sighting Place of Snow Leopard

S. No.	Name of place (Location)	Respondent's Response (%)
1.	Langsisa Kharka	6.20
2.	Langtang Lirung	14.58
3.	Ghonda tabela	2.08
4.	Rocky mountain of Langtang	22.9
5.	Near Sindum	6.20
6.	Thangsep	2.08
7.	Chamki	8.33
8.	Langtang glacier Kharka	4.16
9.	Airport	2.08
10.	Yala peak Kharka	14.58
11.	Numthang	4.16
12.	Cherikori	4.16
13.	Nayakhyang	2.08
14.	Kinggurchen	4.16

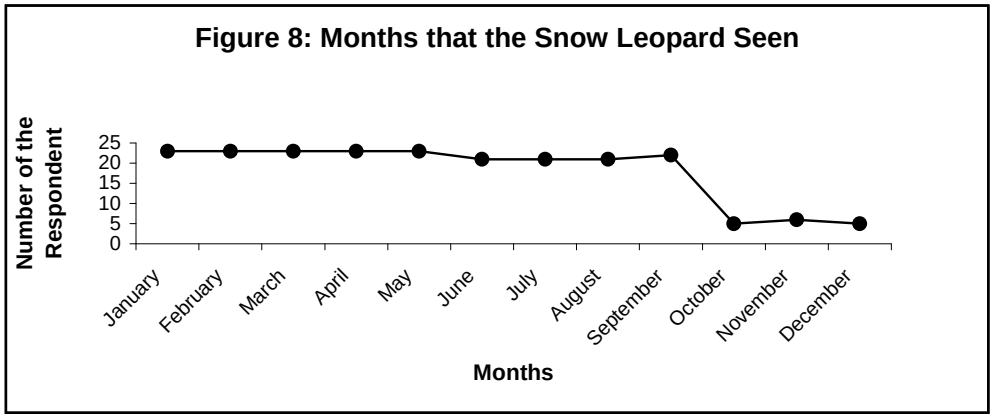
4.1.10 Kinds of Evidences

As per the interviews result, 64% of respondents sighted the Snow Leopard, 18% of respondents saw at livestock kill, 8% heard its voice and 6% of respondent saw pugmark of Snow Leopard (Figure 7).

According to respondents, the pugmark was about the size of fist (8-11cm). Indirect evidences support that the animal of that particular elevation with 8-11 cm pugmark could be the Snow Leopard.

4.1.11 The Month that the Animals or Signs Seen

According to respondents, from January to April and June to September were the most favorable months in which many signs as well as Snow Leopard can be seen. January to April are the breeding months of Snow Leopard and June to September, local herders take their cattle to high Kharkas (Figure 8).



4.2. Threat to Snow Leopard

4.2.1 Livestock Ownership

100 % of the 55 respondents (Households) residing in Langtang own livestock. According to interviews, in 2003, the villagers owned about 858 heads of cattle with Yak and Chauri comprising 63.37%, sheep and goats 31.12% and horses 5.01%. Most of the herders owned less than 15 cattle. The average livestock holding per household was 15.6 (Table 10).

Table 10: Current Livestock Holdings.

Cattle	Number of Livestock Holding	Percentage
Yak	547	63.37
Horse	268	31.12
Sheep	43	5.01
Total	858	100.00

4.2.2 Herding Pattern

The herding pattern varied according to season, types of livestock and agricultural activities. The pattern was branch practiced since the immemorial, with traditions those demand a high degree of cooperation among community members.

Table 11: Pastureland use System in LNP.

S. No.	Kharka	No. of Respondent	Percentage
1	Langsisa	13	23.36
2	Langtang glacier	3	5.45
3	Yala peak	17	30.90
4	Chherpari / Chhoma	2	3.63
5	Langtang lirung	13	23.36
6	Nayakhyang	1	1.81
7	Kinggurchen	3	5.45
8	Numthan	2	3.63
9	Chyandan	1	1.81

Out of 55 herders, 51 (92.27%) herders shared the pastured land where as four (7.27%) did not share with their villagers. Men were responsible on majority the task related to animal husbandry. From the months of June - September, the herders took their cattle to their respective Kharkas. Among 55 respondents, 30.90% herders used Yala peak Kharka, 23.36% used Langtang Lirung and Langsisa respectively while Chyandan and Nayakhyang were least used (Table 11). Yalapeak and Langsia were most favorable habitat of Snow Leopard.

4.2.3 Conflict with Herders

4.2.3.1 Livestock Loss

Loss rates differed according to the kind of livestock involved, with sheep, goats, calves, sub adult Yaks, Colts, being most vulnerable because they are either small or are left up attended on the open range for extended period of time. Loss of livestock was more by predations, followed by lack of forage, cold or winter snow, accident and disease. From the interview, it was recorded that 273 cattle were loss in one-year duration by predation (Table 12).

Table 12: Livestock Loss

S. No.	Source	Yak	Sheep	Horse	Goat	Total
1	Lack of forage	78	21	1	-	100
2	Cold (winter show)	17	2	-	-	19
3	Accident	20	3	-	-	23
4	Disease	17	8	-	-	25
5	Predation	145	120	4	4	273

4.2.3.2 Costs of Depredation (Economic Loss)

Snow Leopards attack on domestic livestock can make considerable economic loss for herding communities. Predation ultimately while affects local economy, it can

lead to even negative attitudes towards wildlife conservation among herders. A survey in Langtang and Kyanjing valley in LNP found that the average loss by predators per household in 2003, was NRS 40,046 (Table 13).

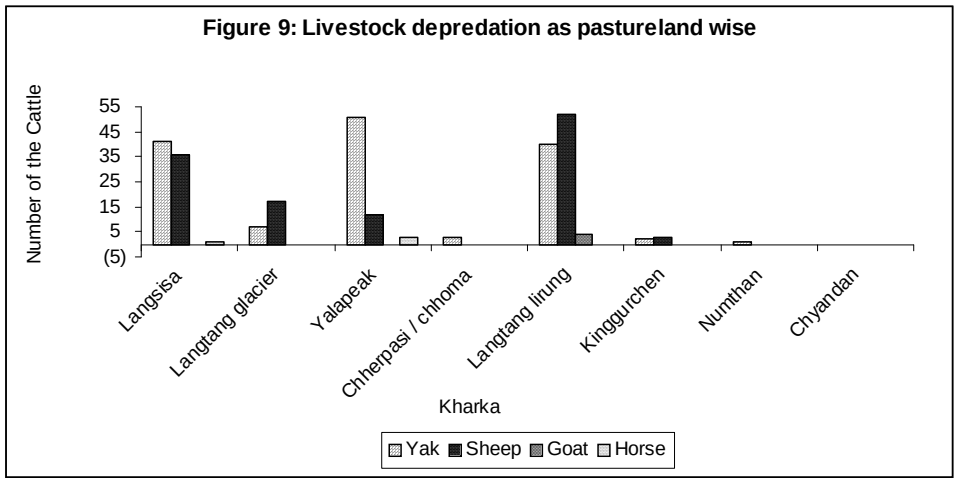
Table 13: Economic Loss (Price in Nepali currency NRS)

(Price of a Yak = 12,500. A Sheep and Goat = 2500. A Horse = 20,000).

S. N.	Sources	Economic Loss	Per Household
1	Cold	2,17,500	3,955
2	Disease	2,32,500	4,227
3	Accident	2,57,500	4,682
4	Lack of forage	10,47,500	19,046
5	predation	22,02,500	40,046
	Total	**39,57,500**	

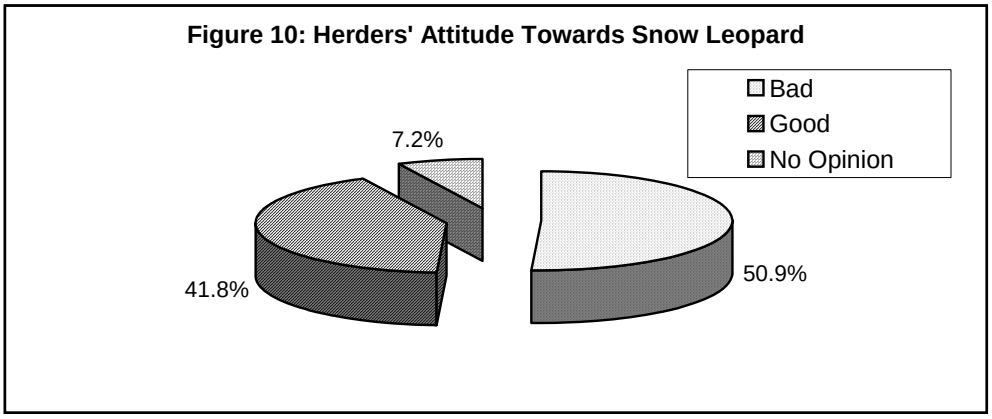
4.2.3.3 Livestock Depredation by Predator

Depredation was not evenly distributed in the area, but rather associated with the presence of cliffs, rocky areas and good cover. From the interview, it was found that more losses was in Langtang Lirung, Yala peak and Langsisa, which are relatively farther for from human settlements (Figure 9).



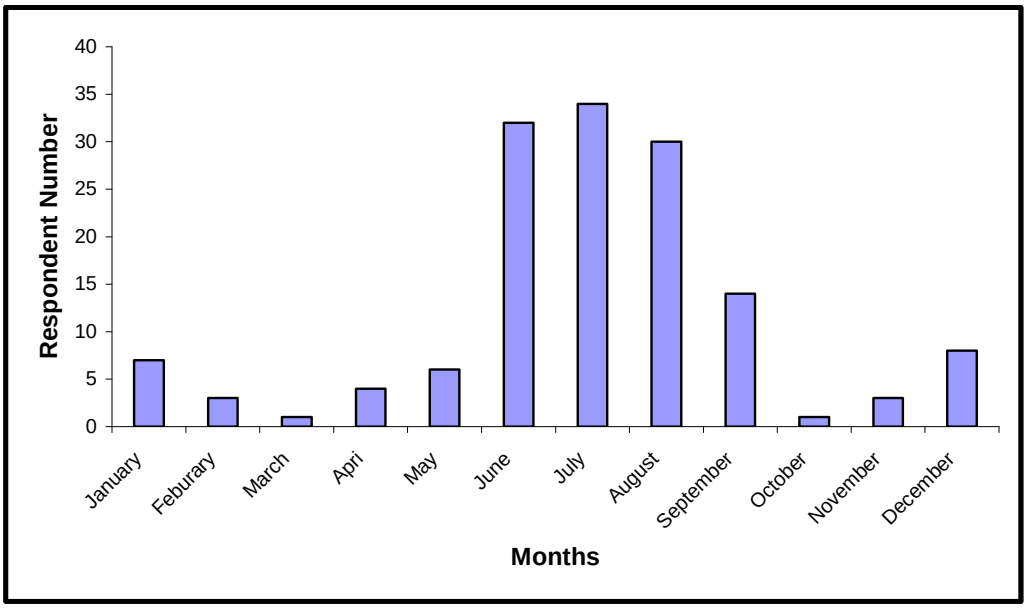
4.2.3.4 Herders' Attitude towards Snow Leopard

Public attitude towards the Snow Leopard, greatly affects the Snow Leopard conservation. In the interview, it was found that, the public attitude was greatly affected by livestock depredation. Among 55 respondents, 50.9 % respondents replied as bad (Figure 10). These herders wanted to eliminate the Snow Leopard, which is the great threat to Snow Leopard and main issues of conflict between herders and Snow Leopards.



Most of the losses occurred on the months of June to September. In Three months herders took their cattle to high pastureland (alpine meadow) which is the good habitat of Snow Leopard and its prey. Therefore, there is great possibility of livestock loss (figure 11).

Figurer 11: List Months of Years with Most Livestock Losses



4.2.4 Loss of Natural Prey

4.2.4.1 Poaching

Hunting of Snow Leopard prey species, for sub subsistence or for financial gain, also affects their number and poaching of wild ungulates. Illegal hunting of Snow Leopard and its prey species such as Musk deer, Himalayan tahrs and Ghoral was in Langtang valley. The fresh killing of these animals was not observed during the study period, but more than 20 kill traps (Snares) were found in Musk Deer Conservation Area (Block-C) at the GPS N 28°12.133'/E 85°33.488' on May 2003.

According to local people, 26 Musk Deer were found on hanging condition on Musk Deer Conservation Area in 2001. The government official persons also killed 14 Himalayan tahrs on Langtang area in 2002. According to a Swiss tourist, the

government authorities tried to kill Ghoral near Sybrubesi on 12 May 2004. These examples proved the vulnerability of poaching and conservation status of Snow Leopard and its natural prey.

During interview, 62.27 % of respondents agreed about on going hunting (Table 14) of Snow Leopard and its prey species (Musk deer, Tahr).

Table 14: Opinion the villagers on the present situation of hunting in LNP

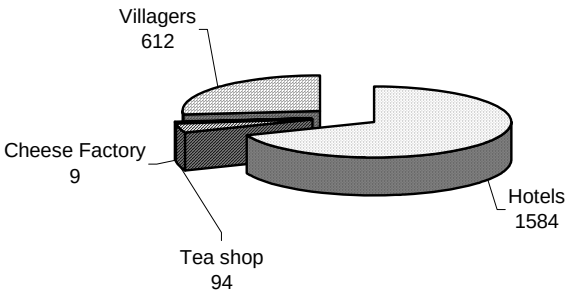
Opinion	Respondents	Percentage
Hunting of Snow Leopard and its prey	37	67.37
No Hunting	13	23.63
Don't know	5	9.09
Total	55	100.00

The respondents confirmed that several hunting groups used to come from Helambu by crossing Ganjala and from Dhading as tourists. These poachers commonly used snares (plate...), bow and arrow (plate....) and guns to kill these rare animals. According to respected Lamas skin, bones and paws of Snow Leopard (Sharkin) is used for Chinese Traditional Medicine (CTM). So, the poachers used to sell them to China via Tatopani pass with high price.

4.2.5 Habitat Destruction

4.2.5.1 Deforestation

Figure 12 : Firewood Utilization



A total of 44 hotels, 13 teashops, one cheese factory and 60 households were recorded inside the study area from Ghondatable to Langsisa. All these hotels, houses, teashops are dependent upon the Jungle for timbers and firewood. From the interview taken in hotel, teashop, households and cheese factory, it was found that altogether 2,344 trees were utilized in one year (Figure 12). Beside these, tourists and porters also used firewood which comes annually 14 tons (LNP, head quarter Dhunche).

4.2.5.2 Pasture System

Habitat alternations occur because of human encroachment into the species range. In the Langtang Area, the herders take their cattle to high Kharkas above 4800m. From which grazing pressure or livestock pressure was more to the habitat of

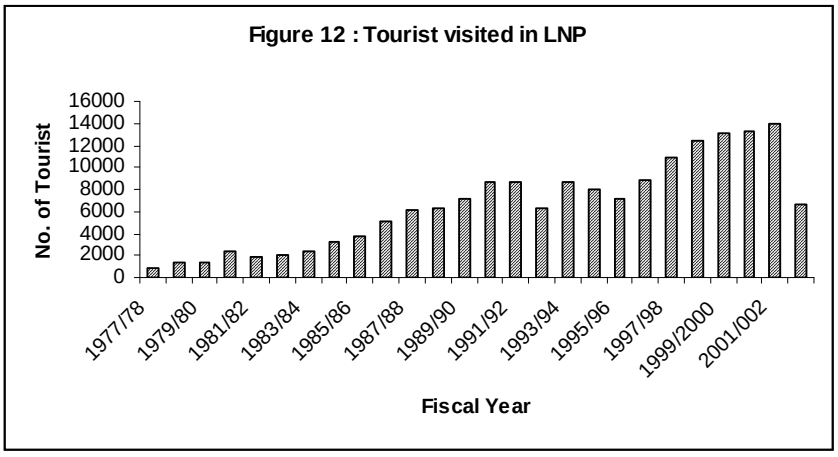
Himalayans tahr and Snow Leopard. Therefore, they might have shifted to new place. The herders used rotational grazing system around Langtang, thus the conflict between herders and wildlife is inevitable.

4.2.5.3 Tourism

In Langtang National Park, there is no restricted area for tourists. Tourists can roam everywhere and every place. The rate of flow of tourist was increasing in Langtang area (Figure 13) which cause the habitat disturbance.

Table : Tourists Visited in LNP.

Year	No. of tourist	Year	No. of Tourist
1977/78	833	1990/91	8674
1978/79	1377	1991/92	8677
1979/80	1398	1992/93	6342
1980/81	2376	1993/94	8637
1981/82	1865	1994/95	7934
1982/83	2107	1995/96	7066
1983/84	2448	1996/97	8808
1984/85	3151	1997/98	10889
1985/86	3796	1998/99	12493
1986/87	5089	1999/2000	13166
1987/88	6162	2000/001	13215
1988/89	6318	2001/002	13982
1989/90	7180	2002/003	6660



(Source : DNPWC)

5. DISCUSSION

5.1 Habitat and Distribution

Snow Leopard, once plentiful in northern mountains has now heading towards crisis and vanishing from many parts of their former areas due to habitat encroachment and habitat fragmentation. Snow Leopard is nocturnal and very shy animal, so, the population status estimation and direct census is very difficult. Therefore, in the present study, Indirect Sign Transect method applied to estimate roughly Snow Leopard population status, habitat and distribution in Langtang National Park.

In the present study five survey blocks were visited regularly and explored 25 transects with a total length of 12,500m (mean transect length = 500m). Inside transects, Ninety total signs were identified in one visit. Beside this, 5 places of killing site (plate), 5 different sizes of pugmarks (Table, plate…) were recorded. The Snow Leopard was sighted on 26th April 2003 at Cherkori area (GPS recording N28^{0}12.598'/E 85^{0}35.811' and elevation 4570m). Sign transect method was applied by McCarthy and Munkhtsog (1995) in Monglia. Between October 1992 and September 1995, they visited 23 survey sites and walked 102 transects with a 100.1 km. total length. They recorded 933 scrapes, 623 fecal piles, 62 scent spray and 21 instances of pugmarks. Dr. J. L. Fox and R. S. Chundawat (1995) evaluated the Snow Leopard sign abundance in upper Indus valley and recorded 1.3 - 2.9 scrapes/km.

The Snow Leopard population and distribution were estimated by radio-telemetry and camera trap methods. Shah (1983), Jackson (1996), Jackson and Ahlbom (1998) used radio-telemetry to explore home range, movements and habitat use of Snow Leopard in North Western Himalaya of Nepal. Snow Leopard has been radio tagged in other parts of Nepal (Oli 1994), India (Chundawat 1992) and Mongolia (Schaller et al. 1994). However, information has been severely limited by a small sample size (1-3 individuals) or short periods of monitoring (all less than 3 months).

Camera trap method also used for estimating the population of the animals, photo capture technique are being increasingly used to study solitary and secretive (Carbon et al. 2001), but little effort has been invested in seeing whether such techniques could be employed successfully to study Snow Leopard (Spearing 2002). In the present study, three camera traps were used to capture the photos of Snow Leopard habit. In our case, out of 6 film roll (216 print) camera captured 7 pictures of Red Fox, 2 of Marmots, 13 of domestic horses, 20 of Yaks, some with curious scenes and remaining pictures were of snowfall. Many biologists had used camera trap method for tiger census too.

Many biologists (e.g. Chauduary 1971, Mc Dougal 1977, Tamang 1982, Sagar and Singh 1990) used pugmark method to estimate the rough figure of tiger population. The pugmark identification method is reliable, easier, cheaper and more precise. In the present study too, pugmark/track measurement method was used to estimate rough Snow Leopard abundance of Langtang National Park. Different types of five pugmarks of Snow Leopard were observed in this study. McCarthy and Munkhtog (1995) also applied this method in Mongolia and found 21 instances of pugmarks. The fecal sample, collected randomly from the different places inside the study area showed that more scats were observed above the altitude 4000m (Table 8). This indicates the availability of the Snow Leopard was more frequent above the altitude 4000m.

In 1981, Green reported Snow Leopards living within Langtang National Park near Gasainkunda 3900m and Langsisa 4540m (Shrestha 2003). During the present study period, it was reported by the locals that Himalayan tahr was found killed by Snow Leopard in May 2003. Similarly, local hotel owner (pers. Comm. with Renjen Dorje Lama) found two carcass of Snow Leopard in 1985 near the Langsisa glacier. In August 2003, the local herders killed one snow leopard cub on the way of Yalapeak (pers. Comm. Thile Sherpa). These events are scientifically unreported and outsiders do not have information but urge and emphasize the existence of Snow Leopard in LNP. It also shows that illegal killing and retaliatory attacks of local people interest (livestock) are the major cause of decline of Snow Leopard in Langtang National Park. Similar cases have been reported from other parts of Nepal.

The sign distribution was associated with topographic features. Most of the sings were found on rough terrain of hillside (30.79%), followed by cliff base (28.14%), human track (18.47%) and other landforms. In ridgeline, the sign density was very low (6.1%). In Mongolia, McCarthy and Munkhtsog (1995) found that 76.6% of signs were found in ridgelines followed by valley bottom (16.5%) hillsides (4.7%) and other landform 2.2%. The less sign in valley floor in LNP and especially along Kyanjing and upper ridge reveals that the area is much disturbed, unsafe and not suitable for frequent movement of shy and elusive Snow Leopard. We could not found signs and tracks along ridge land in Langtang valley because of displacement of this wild animal by the tourists flow, human and livestock pressure for wild resources

Ruggedness of the topography was common feature in breaking the sing of Snow Leopard in present study and in Mongolia too. Present study showed that 52.5% of signs found in moderately broken followed by very broken ruggedness (36.6%), slightly broken (8.8%), rolling (2.2%) and flat (1.1%) which is approximately similar and near about to the study of McCarthy and Munkhtsog (1995) in Mongolia. They found 57.3% signs in moderately broken terrain, followed by very broken (24.5%) and slightly broken (13.8%). Transects were not randomly distributed within Snow Leopard range, rather these are placed in habitats where Snow Leopard signs were likely to find. The depredation hotspots were most likely to be located in moderately broken terrain within 100m of a cliff, near a vegetation edge (Jackson 1996). Present study also suggested that Snow Leopard properly used moderately broken and slightly broken ruggedness.

5.2 Threat to Snow Leopard

Majority of the research projects investigating the ecology of a number of endangered wildlife species have been focused largely to population studies. Quantification of the habitat types inhabited by them has not received in equal attention. This Snow Leopard study has been and effort in providing base line data describing complexities of the habitat and interaction between wildlife and human. With a better understanding of the relationships that exist between the habitat and wildlife, it would be a pragmatic approach in habitat management for the conservation of endangered fauna. Specially, when we discussed on carnivore species, then the prey species characterization needed. So the habitat of the Snow Leopard and its prey species need to protect because overgrazing and the consequent cattle trails have been found to have adverse effect on its habitat. It is then likely that prey species is being affected in their abundance and mobility.

Livestock farming has been found to be the main source of the economy of the local inhabitants. Dairy Development Co-operation has done a major investment for

the production of cheese inside the park area. Every year, in summer, the locals take the cattle gradually higher up in search ample of grazing land. Thus, there is no place at any elevation that is untouched by the cattle and the people (plate….).

The villages in the park (Langtang Valley) also play a very important role in the habitat destruction. In Ghondatabela, Lantang valley, Kyanjing valley, there are currently 44 hotels, 13 teashops with 60 household. The hotels, teashops, cheese factory and village houses were found piles of fire wood for cooking purpose and heating the house. It was estimated that to submit their annual needs at least 2, 344 trees should be cut down per year (Figure 12). Furthermore, pole sized tree logs were found scattered all around the forest which is cut down to use as supporting poles for the huts building.

The teashops and hotels inside the LNP facilitate the general tourists, trekkers, pilgrimage and mountaineers. It definitely enhances the economy of locals but this income seems not equivalent to the cost of the native vegetation that the teashops and hotels used as timbers and firewood. Such activities directly affect the habitat of many endangered and protected species ultimately loosing them permanently. Every year, local herder practices the shifting of the grazing ground for their cattle, which are located in distance from previous one. This practice compelled them to cut down trees for creating the cowshed (Goth) that is actually a highland shelter for the local herders. Therefore, the highland meadows and forested areas perceive double pressure, grazing and deforestation. The depletion of grazing land and its volume effects the survival of wild grazer species while deforestation causes the loss of hide out to many animals. Loss of grazing land means less food for grazers, it directly affect the number and health of herbivore of the area. Thus, their number will decline rapidly which is also the loss of prey food, e.g. Himalayan tahr, musk deer, Ghoral, Serrow, etc. The depletion of these prey species ultimately will deflect natural survival of Snow Leopard. In the present study, however, we could not reveal more on this system in a limited time; however, the low number of Snow Leopard and continuous habitat loss in the Langtang area had alarmed us toward the inevitable loss of ‘Queen of mountain’.

Large ungulates have been hunted out of many areas of the high Central Asian Mountain (Jackson 1992). Pika and marmot-poisoning program on and large scale of have been conducted on Tibetan plateau. Livestock population trends to be grater in areas of Tibetan Plateau where Wild Sheep and Goats population have been depleted (Millar and Jackson 1994). According to locals in my study areas, poachers crossing the Ganjala hunted the large ungulates, Himalayan tahrs, Musk deer, Ghorals and captured once were from Dhading district of Nepal. They were using bow and arrow (Plate...) and snares (Plate...). Taking benefit of less communication due to remoteness, silent nature of locals and misusing of bureaucratic power sometime even government officials were found engaged in illegal hunting activities. Therefore, natural prey population is declining in LNP and its impact can be visualized by the depredation of domestic calves of Yaks, colts, subadult Yaks, Sheep and Goats. Snow Leopard alone could not blame for the cattle hunting in such situation. It is actually trying its last strategy for its species survival in the LNP. In this reference, the Snow Leopard conservation is likely to receive strong negative reflection from the local peoples. Therefore, out of 55 respondents 50.9% wanted to eliminate the Snow Leopard, an expression rooted in the heart of the local people due to its killing. Oil et al. (1994) noted similar pattern expressing (52%) in total eradication of Snow Leopard as the only remedy worth considering.

Seasonal factors can affect strikes on livestock by Snow Leopard. Sumiya and Bugantsog (2002) found that livestock losses in Uvs province, Mongolia, were more likely in winter (December to February). Oli (1991) reported that Snow Leopard predation in Annapurna Conservation Area of Nepal was higher in winter. In the present study, we found that depredation of cattle occurred throughout the year but peaked in the summer rain months of June to September. Because in those months (June to September), locals took their cattle in the high Kharkas (Pasturelands) where the security is insufficient by unarmed herd boy for the cattle and no nighttime enclosures are used. So, predator causes greater lost. Jackson *et al.* (1996) has reported the depredation rate peaked in spring and early summer (April-June) with secondary peaks in late October through mid December from Qumolangma Nature Reserves, Tibet. In the winter herders keep their stock in the well fenced shed.

In terms of economic losses my present study shows more economic losses by predation than other sources. NRs. 40046 was lost per household by predation of domestic livestock. In Quomolungma Nature Reserves Tibet. Jackson (1991) found that $25 was lost per household for affected communities. Losses rate differed according to the kind of livestock involved with Sheep, Goats Young Yak and Horses being most vulnerable, because they are small, can't self defense with predator.

6. CONCLUSION

Langtang National Park Provide good habitats for Snow Leopards and its prey and other endangered wildlife species. 5 instantaneous pugmarks and 90 other signs of Snow Leopard and 5 hotspot killing sites were recorded during the study period. More signs were recorded above 4000m; on terrain rocky hillside (10/km^2) and cliff base (9.14/km^2). Ganjala base camp, Tharchepisa, Langtang glacier, Chyandan, Cherkori base camp were more favorable habitats, where more signs of Snow Leopard were recorded. (Table :3) This present study shows that the occurrence of Snow Leopard in Langtang Valley of LNP.

Snow Leopard was found to livestock depredator of Langtang village. Questionnaire survey revealed that Snow Leopard was responsible for the livestock depredation. The economic loss by the predator, per household was NRs. 40046 (table 13). This greater losses was due to overlapping of the habitat of Snow Leopard and its prey with domestic livestock.

The future of Snow Leopard in Langtang National Park seems uncertain. Because of livestock depredation by Snow Leopard, local people have negative attitude and wanted to eliminate it. To rise the positive attitude about Snow Leopard, Conservation education was conducted in the local schools and even to herders to their herd sides (Plate ...). Illegal hunting of Snow Leopard and its prey species (i.e. Himalayan Thar and Musk deer), overgrazing, habitat destruction for fire wood and timbers, shifting grazing practices were the major threat to this endangered species the Snow Leopard and its prey species. Clear cut decision about the status of Snow Leopard and its prey species inside the LNP, specific policies and plan for the management of this species are essential to reduce the conflicts and maintain harmony between Snow Leopard and local herders.

7. RECOMMENDATION

The information presented in this report relates to Snow Leopard and its threats. From the present study one can suggest the following recommendation as a solution to the problems.

1. Strengthening national legislation and conservation policies

   The government should address any gaps in legislation to ensure that Snow Leopards are fully protected by law. To provide full legal protection for Snow Leopard, government should ensure that legislation specifically out laws hunting. Possession, sale are trade of Snow Leopards including all their parts, derivatives and products made from these and that the legislation is applicable to all regions of the country, including those where Snow Leopards do not occur.

2. CITES parties, the CITES secretariat inter governmental organizations and NGOs should offer advice and assistance to relative authorities in revising or drafting legislation relevant to the protection of Snow Leopards.

3. Strengthen trade controls on known trade routes, at black markets and cross border points.

   Field patrolling is difficult in many areas of Snow Leopard's range however known trade rotes, wildlife black markets and important border crosSigns e.g. Nepalese Chinese border, Nepalese Indian border, should be regularly controlled by efficiently equipped and trained staff.

4. Illegal hunting from the park security person should be stopped.

5. Regular monitoring of major markets and known trade centres Governments in co-operation with NGOs, should regularly monitor markets and other locations where Snow Leopard skins and other products have been frequently offered, most notably markets and tourist stops in Nepal (Kathmandu) and china.

6. Herding practices : Government should co-operate with communities and NGOs at local level to encourage herding and guarding practices that reduce depredation Snow Leopards and other predators.

7. Assistance should be made to local communities in the construction of predator proof corrals night shelters and other means of livestock protection.

8. Governments resource managers, conservation NGOs and development agencies should undertake efforts that will help to promote livestock grazing practices that reduce impacts on native wildlife.

9. Scientific and other relevant institutions should compile information on the levels and impact of illegal hunting and or unregulated hunting of wild ungulates and other Snow Leopard prey species.

10. The local communities should be assisted in the design, establishment and implementation of schemes that provide economic incentives to protect Snow Leopards and wild ungulates.

11. The establishment of conservation based tourism program should be promoted to bring additional income to local communities through the establishment of conservation trust funds.

12. Public awareness program

Education will facilitate local people's understanding their environment and wildlife, and discourage poaching, hunting encroachment of them. Massive formal and non formal education program is recommended to conserve the Snow Leopard and their habitat in the wild. Inter - school debates or conservation education, consent should be encouraged.

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ANNEX-I

Meteorological data on temperature, relative humidity, precipitation for 1993-2001 recorded at Kyanjing Gumba, Rasuwa. (Source: HMG/N Department of Hydrology and Meteorology).

a. Monthly mean Air Maximum Temperature (°C) Altitude: 3920m

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1993	-1.3	6.3	-1.5	4.5	7.6	9.3	9.6	9.3	8.0	5.1	3.3	5.1
1994	2.3	-2.3	5.0	1.6	7.0	9.3	10.0	9.3	8.8	7.9	3.0	4.3
1995	0.8	3.0	4.8	6.5	10.8	12.0	11.8	12.0	10.5	7.8	5.8	3.3
1996	3.7	3.5	7.3	9.0	12.2	12.4	13.9	12.9	12.2	9.7	9.3	8.8
1997	3.3	2.0	4.5	6.0	7.8	11.3	12.3	12.0	10.7	7.0	8.3	0.5
1998	2.5	3.5	3.8	7.5	11.8	14.0	11.6	12.3	11.0	8.8	7.5	6.8
1999	2.0	4.5	6.3	9.3	10.8	11.5	12.5	13.3	10.8	8.5	7.0	3.5
2000	3.0	-1.5	6.2	6.5	10.5	11.3	12.0	11.5	9.7	6.8	3.8	1.0
2001	0.5	-2.3	-4.3	-2.3	2.3	0.9	12.3	12.3	11.1	11.0	9.0	6.1

b. Monthly Mean Air Minimum Temperature (°C)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1993	-9.5	-11.6	-8.0	-3.6	-0.5	4.4	6.8	5.8	4.3	-2.5	-2.8	-7.3
1994	-14.3	-10.0	-5.0	-3.3	-3.4	4.3	5.8	5.8	4.5	-2.0	-4.5	-7.5
1995	-9.5	-7.6	-3.5	-1.8	4.5	7.5	8.8	8.5	6.5	3.0	-3.5	-5.3
1996	-7.6	-6.5	-2.4	-0.6	2.9	2.8	8.2	7.3	5.7	1.4	-1.3	-2.5
1997	-10.0	-8.0	-3.4	-4.3	2.8	5.3	9.5	4.5	4.8	-3.8	-4.3	-8.3
1998	-6.8	-7.0	-3.8	0.3	2.3	8.3	8.8	9.3	6.3	3.5	-1.3	-3.5
1999	-7.5	-4.0	-0.8	2.8	3.5	5.8	8.3	7.9	7.9	1.0	-1.0	-5.5
2000	-6.8	-8.0	-4.0	2.0	3.3	7.3	9.0	9.3	3.3	-4.8	-5.0	-9.5
2001	-13.0	-14.0	-10.5	-9.6	-4.9	-4.3	-2.0	8.8	8.3	5.0	1.3	-13.0

c. Monthly Mean Relative Humidity (%)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1993	36	43	40	43	49	64	66	62	62	41	28	27
1994	32	38	42	44	54	60	62	64	63	47	47	30
1995	36	43	40	43	49	64	66	62	62	41	28	27
1996	63	68	70	68	74	88	91	90	87	74	55	48
1997	21	29	28	37	34	40	47	45	44	32	23	-
1998	70	81	81	67	73	70	81	81	76	66	47	38
1999	47	51	46	47	92	91	87	82	81	60	46	47
2000	59	44	59	54	67	79	79	79	73	57	50	41
2001	49	63	63	72	88	94	96	97	91	80	57	46

d. Monthly Maximum Relative Humidity (%)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1993	77	73	73	80	79	79	82	81	81	78	67	46
1994	60	55	60	61	68	66	70	70	84	78	66	56
1995	64	66	66	54	62	70	69	68	70	63	57	53
1996	78	88	93	84	92	94	95	95	96	88	73	57
1997	40	47	48	45	44	50	51	50	51	45	37	-
1998	85	85	85	83	85	85	85	85	85	85	83	63
1999	85	81	71	91	99	99	99	86	85	86	72	79
2000	95	73	95	71	80	84	84	84	84	71	76	79
2001	85	95	90	92	95	99	99	99	99	98	83	82

e. Monthly Minimum Relative Humidity (%)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1993	20	21	25	26	30	58	57	-	54	17	15	13
1994	13	20	13	30	34	40	52	57	47	26	24	12
1995	20	21	25	26	30	58	57	-	54	17	15	13
1996	50	52	49	52	56	70	77	76	69	56	43	42
1997	9	13	12	20	23	26	38	32	29	16	13	-
1998	42	72	70	53	58	42	72	70	63	34	23	30
1999	25	35	27	60	75	68	76	77	70	40	23	26
2000	29	24	29	34	32	71	71	70	53	25	28	22
2001	30	34	30	55	71	65	86	92	76	58	54	32

f. Monthly Precipitation (mm)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Yearly
1993	13.0	22.5	27.4	36.0	73.8	28.8	74.0	124.3	127.0	0.0	0.0	0.0	526.8
1994	5.6	5.9	13.2	15.1	32.5	26.7	-	141.7	87.7	-	-	-	-
1995	42.7	53.0	65.0	40.6	29.3	82.7	124.8	139.3	87.1	0.0	5.7	5.9	1041.5
1996	25.7	9.2	0.0	18.1	17.7	84.7	140.6	175.3	67.8	66.7	0.0	0.0	605.8
1997	6.9	11.3	21.5	24.5	29.6	119.6	153.7	111.7	65.2	17	35.7	0.0	596.7
1998	0.0	38.4	40.8	14.9	35.5	97.7	149.0	183.6	43.1	21.0	4.2	0.0	628.2
1999	6.9	4.0	21.8	27.0	59.3	147.8	232.4	145.6	6.3	26.7	4.2	0.0	682
2000	0.0	8.9	13.0	22.6	54.5	125.9	216.6	172.1	115.8	0.0	1.2	0.0	730.6
2001	3.5	7.5	15.7	52.3	57.1	149.3	158.9	142.1	48.1	6.5	0.0	0.0	641

ANNEX II

Snow Leopard Sing Transect

Observaer (s) _____ Date : _____ Transect No. : ____

Start Time : _____ Weather (Temp. and Conditions) _____

GPS (Lat/Long at beginnig)_____ /_____ Elev. (at beginning__

EPS (Last Long at end): _____-/_____ Elev. (at. end): _____

length of Transect : _____

Country : _____- Province : _____ Prefecture : _____- Country : ___

Protected area : _____ Location : _____

Sign Codes : PU =Pug mark, SC = Scrapes FE = RC = feces Seent spray, CL = Claw rake

Age Codes: Old = 1, Fresh = 2.

Obs	Sign Type					Age	Obs	Sign Type					Age
	PU	SC	FE	RC	CL			PU	SC	FE	RC	CL	
1							26						
2							27						
3							28						
4							29						
5							30						
6							31						
7							32						
8							33						
9							34						
10							35						
11							36						
12							37						
13							38						
14							39						
15							40						
16							41						
17							42						
18							43						
19							44						
20							45						
21							46						
22							47						
23							48						
24							49						
25							50						

Transect Summary

Total Sign _____ (a)

Total Length of Transect _____ (b)

Sign per km (a/b) _____

Dominant topographic feature (circle), Cliff base, Ridgeline, hillside, valley bottom, Terrace; Stream bed

Other (Specify) _____

General comments on topography

_____

Primary Habitat type (circle): Barren: grass; Shrub: forest

General Comments on habitat :

_____

Grazing Status (Circle): Year-round: Seasonal: Non-Grazing

General comments on Grazing.

_____

Ruggedness (Circle): Flat: Rolling: Slightly broken: Moderately broken: very broken general comments on ruggedness:

_____

Overall aspect of transect: _____

_____

Other wildlife seen and numbers : _____

_____

_____

Other comments on conservation concerns (recent depredatin in area, human impacts, etc):

_____

_____

Should this transect be repeated on a regular basis ? Yes ____ No. ____

If yes, clearly mark on map and note GPS location.

Recommendation for re-survey (Season, support required, etc).

ANNEX III

Snow Leopard and Prey Species Survey Questionnaire

(For interviewing local residents on presence/absence and status of Snow Leopard and their prey in Nepal)

This questionnaire is being given to find out what people know about Snow Leopards. You do not have to answer these questions if you do not want to. I will not write your name on the questionnaire and no one will know which answers are yours. Answering the questions will take about 30 minutes. You can skip any questions you like by saying "skip" or stop answering anything at any time you choose. If you have any questions you can ask me now or after you anything at any time you choose. If you have any questions you can ask me now or after you finish answering questions. Do you have any questions for me right now about the survey ?

Would you like to participate in the survey ? (If Yes, Proceed to ties #1)

1. Name of interviewer : Interview Date :
2. Name of Park:
3. Village name (or approximate location):

   GPS reading :

   Elevation (m) :
4. Respondent's Gender : Age : Occupation :
5. Total village Populaiton (number Persons /households) :

Snow Leopard Sightings and Status

6. Do Snow Leopards coccur here or in nearby areas ? Yes ____ No. ____

   (If respondent answers "No" or to question # 22).
7. If so, Where ? (list name of place (s) where seen in the past year).
8. Where was one (or evidence of one) last seen ? (Month/Year).
9. How far from the village/this location (km) ? _____
10. Indicate kind of evidence found with tick below:

    Pugmark ____ Scrape ___ feces ____ Sighting ____ a livestock kill ___
11. Indicate Size of Sign (Pugmark, scrape, feces):
12. Describe the place where the sign was found (e.g., trail, base of cliff, strem - bed, ridge, wooldlan, rocky area, other):
13. What habitat type ? (Forest, Pasture, rock, shrub):
14. If a sighting, how many Snow Leopards were seen in the group and what was their age class (indicate number below)?

    Male _____ female ____ young ____ Unknown age ____
15. Describe distinctive physical Feature :
16. How big was it ? (indicate height as shoulder)
17. How many Snow Leopards do you think use this area ?
18. Do you see their sign: very often commonly uncommonly rarely
19. During which months are they or their sign seen ? (list each moth and circle the month when most are seen):
20. How long do you remain in the area (days, weeks, or months) ?
21. Are they here all year or seasonally ? All year Seasonally only
22. What is your opinion about Snow Leopards ? Good Bad No. Opinion
23. Should they be protected or eliminated and why ?

24. Do local people and any kinds of beliefs about the Snow Leopard ?

Threats and Conservation Issues

25. Do Snow Leopards kill livestock in your area ? Yes No. Don't Know

(If **No** or **Don't Know**, go to Question #30)

26. If yes, which kind of livestock are killed ? (Please list in order from most to least commonly killed) ?

27. How many were killed in the last 12 months (Specify type of livestock killed ?

28. List months of year with most losses

29. How many in winter ? _____ How many in summer ? _____

30. Is there any poaching in your area ?

(If **No** or **Don't Know**, go to question #3).

31. If yes, which wildlife species ?

32. Kind f Weaspons/methods used for poaching ?

33. Have other persons visited and inquired about Snow Leopard petlts or body parts ?

Yes No Don't Know

(If **No** or **Don't Know**, go to question #40).

34. If yes, when and how many ? (Mention day, month, year, and number of persons).

36. Were they interested in (circle all that apply):

Seeing a now leopard buying a pelt purchasing its bones.

37. How much we they willing to pay (price in Rs) ?

38. Did they offer any incentive or money for information about Snow Leopard parts ?

39. If so, was it is cash ? _____ or in Kind ? (e.g., cigarettes or goods) ____

Other Wildlife Present In the Area

40. What other predators occur here (circle all that apply) ?

Tiger Common leopard Lynx Wolf Wild dog other

41. What prey species like blue sheep occur here ? (list in order of abundance).

42. Are blue sheep seen (Circle one).

Frequently Sometimes Never

43. Please indicate how often you see other species of their sign like Musk deer, Argali, or Himalayan tahr ?

Species	**Frequency**		
	Frequently	**Sometimes**	**Never**

44. Have number declined over the past 5-10 years ? If so, for which species ?

45. Have numbers increased over the past 5-10 years ? If so, for which species ?

48. Are any of these species hunted or poached ? Yes No. Don't know

(If **No** or **Don't Know**, go to End of Interview)

49. If so, which species ?

50. Who are the main persons responsible for poaching but no individual names please ?

51. Places list areas you think have the most poaching.

52. During What seasons does poaching occur ?

(End of Interview): Thank you very much for answering these question for me. I appreciate your ability to help gather information.

********* Interviewer comments - Do not Read Aloud **********

53. (Do not read aloud) How would you rank the informant's reliability (circle one):

0 1 2 3

Very Unreliable Very reliable

54. Comments and other observations: Use the back of the page to add any comments of observations you my have.

ANNEX IV

Livestock Depredation Report Data Form

1. Name of Interviewer

2. Name of Park

3. Name of Village (or approximate locations)

4. Number in household:

   (a) Adult male __ (b) Adult female __(c) Children __

5. Primary Source (s) of livelihood.

Livestock Ownership and Trend:

6. Current livestock holdings

Type	Total Number	Adult male	Adult female	Juvenile
Yak/Dzo (hybrid)				
Cattle				
Buffalo				
Sheep				
Goats				
Horse				
Other				

Has your herd increased or decreased from last year or is it about the same size ? Please indicate what your herd size was last year, preferably by kind of livestock.

7. Livestock holdings last year

Type Total Number Adult male Adult female Juvenile

Yak/Dzo (hybrid)
Cattle
Buffalo
Sheep
Goats
Horse
Other

Livestock Husbandry: Please Describe your annual husbandry Cycle

8. Do you use separate pastures during the Winter and Summer ? Yes _ No

Please indicate the number, approximate size, and location (name) and the distance (hours walked) of each major pasture from your home village in the following table.

Pasture Name	Months Used	Approximate size	distance (hours)	Type of livestock using pasture

9. Do you share use of this pasture with other villages and/or outside herders" ___ Yes ___no.

   If yes, describe who and explain how pasture use is allocated among authorized users:

10. Are you able to obtain enough summer and winter forage of your animals ? Have supplies become more or less available in recent years ? Please explain.

11. Which Person (Men, Women, Or Children) are responsible for looking after the animals in your household, and how is this I accomplished (explain day - time and seasonal herding patterns) ?

12. has your income from livestock herding increased or decreased in recent years ? If there is a change, pleases explain.

13. Sources of Mortality

Type of Mortality	Ranking (1-5)	Comments
Lack of forage		
Winter Snow		
Diseases		
Accident		
Predation		
Other (Describe)		

14. Enter the number of animals lost last year to each type of mortality. If Possible, record the number of adults and young separately:

Source of Mortality	Number lost by kind of livestock					
	Yak/hybrid	Cattle	Buffalo	Sheep/Goats	Horse	Other
Lack of forage						
Winter snow/cold						
Disease						
Accident						
Predation						
Other						

15. Describe what actions you take to minimize losses to each mortality source:

Mortality Source	Precaution of Actions (s) taken
Lack of forage	
Winter snow/cold	
Disease	
accident	
Predation	
Other (specify)	

Thank you very much for answering these questions. Your responses will help us in understanding the problems villages face.