Technical Report
On
Assessment of Status of Red Panda and its habitat in Sagarmatha National park and Buffer-zone area.

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Red panda is one of the elusive and endangered species in Nepal. The existing status of red panda *Ailurus fulgens* in Nepal is poorly known. None of the previous studies have produced reliable baseline information on their distribution, abundance, habitat quality and conservation threats. There is a huge gap on the estimated population and available red panda habitat. Sagarmatha National Park Office has initiated this study whose prime objective was to assess the status, distribution and community perception on red panda in Sagarmatha National Park and its buffer zone.

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ACRONYMS AND ABBREVIATIONS

ACA	Annapurna Conservation Area
ANCA	Api Nampa Conservation Area
BZUC/UG	Buffer Zone User committee/ User group
CI	Critically Endanger
CITIES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DFO	Division Forest Office/ Division Forest Officer
DHR	Dhorpatan Hunting Reserve
DNPWC	Department of National Parks and Wildlife Conservation
GoN	Government of Nepal
GPS	Geographical Position System
Ha.	hectare
ICIMODE	International Center for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
KCA	Kanchenjunga Conservation Area
KII	Key informants' interview
Km	Kilometer
LNP	Langtang National Park
m	meter
M	MUNICIPALITY
MBNP	Makalu Barun National Park
MoFSC	Ministry of Forestry and Soil Conservation (now Ministry of Forests and Environment)
NBSAP	National Biodiversity Strategy and Action Plan
NPWC	National Parks and Wildlife Conservation
PA	Protected Area
RM	RURAL MUNICIPALITY
RNP	Rara National Park
SNP	Sagarmatha National Park
UNESCO	United Nations Educational, Scientific and Cultural Organization
VDC	Village Development Committee
WWF	World Wildlife Fund

Executive Summary

Red Panda is one of the elusive mammals listed as endangered in IUCN Red List of Threatened Species, Appendix I of CITIES. This report provides brief description status of Red panda and its habitat in Sagarmatha National Park (SNP and Buffer-Zone area (BZ). Sagarmatha National Park, enlisted in world heritage property since 1979, due to rich in mountains, landscape, biodiversity it has been as an example of superlative and exceptional natural beauty, which is embedded in the vivid mountains, glaciers, deep valleys and majestic peaks including Sagarmatha (Mt. Everest), the world's highest peak. SNP is a home to some of the endangered wildlife species including Snow Leopard, Musk Deer and Red Panda.

The status and distribution knowledge of Red panda is not encouraging. In Nepal, it is found in the protected areas only. Though it has been sighted in Sagarmatha National Park its status and habitat distributions are not well defined. Therefore this study included the reconnaissance comprising KII, survey, FGDs and consultation for the most potential area identification, opportunistic survey comprising the direct observation and indirect sigh count method for the presence of species in the study area, habitat condition, conservation issues, people's perception, threats assessment consisting vegetation sampling status of Red panda in Sagarmatha National Park and its buffer zone.

To assess the habitat characteristics of Red panda, vegetation assessment was carried out through systematic sampling based on the altitude. Square plots of 10m*10m, 4m*4m and 1m*1m were laid out to assess trees, shrubs and herbs. Threats signs were assessed during field visits and also through key informants' interview with project staffs, and herders. Household survey on to access the perception of local villagers on the status and threats to red panda population.

The study revealed the presence of Red panda in Buffer zone of SNP namely (Himalayan BZCF, Kongdey BZCF, Pemacholling BZCF, Dudhkunda BZCF and Red Panda BZCF) of SNP respectively. Red Panda mostly preferred the altitudinal range between 3000-3200 m. Total of 64 pellet groups were found and 2 Red Pandas were directly observed. Total 38 transect lines were made. The average abundance was found to be 1.7 signs/km. It mainly preferred southwest aspect with 26-30-degree slopes associated with water sources at less than 100 m. In the present study it was found that Red Panda preferred tree species like *Litsea monopetala*, *Abies spectabilis*, *Betula utilis*, *Acer sterculiaceum* and *Quercus semicarpilofia*. Red Panda preferred shrub species like *Viburum erubescens*, *Rubia cordifolia*, *Arundinaria maling* and *Drepanostachyum intermedium*. Red panda preferred herb species like *Dryopteris sps*. and *Fragaria nubicola*. Red panda preferred moderate ground cover between 25-50% and dense crown cover. On the basis of Focus Group Discussion 35% respondents stated that collection of bamboo was the main cause behind the decline of Red Panda population. Other causes included Grazing (25% respondents), Predation (15% respondents), Poaching (10% respondents) and collection of Forest products (15% respondents). Out of 47 Habitat Use plots, wildlife droppings were found in 44 plots (93.6% of the total plots) and livestock droppings were found in 11 plots (23.4% of the total plots).

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1. INTRODUCTION

Nepal's diverse topography, altitude and climatic variation provides suitable habitat for an extraordinary diversity of wildlife. Red panda is such wildlife species which is adapted primarily in temperate forests with abundant bamboo in the understory (Yonzon & Hunter, 1989).

The word panda comes from the Nepalese "poonya" means bamboo eater (WWF,2004). Red panda is a carnivore under family Ailuridae. Though the genus Ailurus has only one species, it has two sub-species, *Ailurus fulgens fulgens* (the Indian Red Panda) and the *Ailurus fulgens styani* (the Red Panda of China) (Chakraborty, 1999; Wei et al., 1999). The only species found in Nepal is the Indian Red Panda (*Ailurus fulgens fulgens*). Globally threatened red panda occurs in the isolated high mountain's bamboo- forest patches in Nepal, India, Bhutan, China, and Burma (Yonzon, 1989, Yonzon et al. 1997, Choudhury 2001, Pradhan et al. 2001). The national population size of red panda has been estimated to be 317-582 individuals (Jnawali et al. 2011). However, Population and Habitat Viability Assessment on red panda (Jnawali et al. 2012) suggested total population ranging from 237 to 1061 individuals the national red panda survey 2016 documented the potential red panda habitat available across 23,977 km^2, out of which, almost 70% of the total habitat lies outside the PAs network (Bista et al. 2016).

Red panda is an inhabitant of Eastern Himalayas Ecoregion. It extends from the Eastern Nepal through Sikkim, Bhutan, Arunachal Pradesh in India, up to the high mountains of Burma and in Sichuan and Yunan of Western Chiba (Chakraborty, 1999). It is found in the temperate forests of Himalayas at altitude between 2200 to 3800 m (Thapa et al., 2018). Panda are habitat specialists that prefer forest with Ringal bamboo under-storey (Yonzon, 2000). It is associated with the occurrence of temperate forest with bamboo thickets. Its habitat is characterized by presence of mixed deciduous and coniferous forest (Chakraborty, 1999).

Though panda is a carnivore, it is adopted to bamboo feeding (Yonzon & Hunter, 1989). The bulk of its food consists of leaves and shoots of Ringal bamboo (*Arundinaria spp)* commonly known as Jhapra and Raate. Red panda is nocturnal in nature, and are more active at early morning and evening. It is usually sedentary but may travel a linear distance of 1.75 km. (Yonzon & Hunter, 1989). It is more active during January to mid-March because of its breeding season. The birth occurs during the monsoon in the months of June to August. Its gestation period is between 120 to 160 days. Home range size varies between 1.02 to 9.62 sq. km. Males home range tends to overlap. (Yonzon & Hunter, 1989).

Red panda is called by different names in different places. Commonly used name in Nepal is *Rato Habre*. The different names of red panda according to the places are given in the table 1 below:

*Table 1**: Vernacular names of red panda in difference places of Nepal***

District	**Local Name**
Panchthat, Ilam & Taplejung	Niga `lapo` nya (Limbu), pundekundo
Khotang	Kundo (Rai)
Solukhambu	Pungur (Rai)
Ramechap	Phulnayan (Sherpa)
Sindhupalchok	Syaudo & Taarebhaalu, Phop (Tamang), Hoprpa, (Sherpa)

Nuwakot	Machyang (Tamang
Rasuwa	Hope
Dhading	Khop & Phonichha
Gorkha	Punksim (in Gurung)
Lamjung	Lita-Sayala (Gurung) Cherrha (Tamang)
Kaski	Nyakarau
Manang	Wah, Lheete & Meta-Sayal (Gurung)
Myagdi	Okra
Dolpa	Khanche
Central Nepal	Habre
Western Nepal (Karnali Region)	Nautoto

Red panda is classified under Ailuridae family. It has two sub species called-*Ailurus fulegens* and *Ailurus styani.* The detail taxonomical classification of red panda is given in the Table 2 below:

Table 2: Classification of Red Panda (Ailrus fuelgens)

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Carnivora
Family	Ailuridae
Scientific Name	*Ailurus fulgens*
Sub -species	A.f.Fulgens & A.f.styani

1.2 RATIONALE OF RESEARCH

The Red panda *Ailurus fulgens* is the only species of Family Ailuridae distributed in the five Himalayan range country, namely, Nepal, Indra, Bhutan, China and Myanmar. Red panda is highly endangered. It is placed in the *critical* category of the IUCN Red Data List and in the Appendix I of CITIES. The main threat to the survival of this animal arises from habitat fragmentation and reduction and its high mortality rate. Poaching and trapping is other well-known threat to the survival of this animal.

According to the "Red Panda Conservation Action Plan for Nepal 2019-2023" developed by the Department of National Parks and Wildlife Conservation under the Ministry of Forests and Environment, Red Panda is usually poached for their furs and meat. Seventy-four cases of trafficking of Red Panda hides were reported in Nepal during the nine-year period from 2008 to 2016. However, the market, where Panda hides are in demand, remains unknown. Also, lack of awareness, unsustainable developmental activities, bamboo die-off, climate change and transfer of diseases from livestock and dogs are some other threats to the survival of Red Panda (Himalayan News Service, 2019)

The status and distribution knowledge of red panda is not encouraging. In Nepal, it is found in the protected areas only. Though it has been sighted in Sagarmatha National Park its status and habitat distributions are not well defined. The study conducted in five BZCFs (Himalayan, Kongde, Dudhkunda, Pemachholing and Red Panda) of SNP to estimated population of red panda based on the field monitoring in the Chaurikharka VDC in March, 2012 was 105 individuals (SNP, 2012). Information and status of red panda is not updated; therefore, this study will contribute to the Habitat distribution and its status in Buffer zone of Sagarmatha National and Sagarmatha National park itself.

2. OBJECTIVES OF THE RESEARCH

The major objective of this research is to assess the habitat condition and status of red panda in Sagarmatha National Park and its buffer zone.

2.1 Specific objectives

- To assess the habitat condition and status red panda in Sagarmatha National Park and its buffer zone
- To identify the threats and conservation issues towards red panda and its habitat
- To analyze peoples' perception on red panda conservation and document all the red panda conservations initiatives in the area

3. LIMITATIONS OF THE STUDY

The research has been conducted applying all the research methodologies as prescribed. However due to changing weather patterns and different un-anticipated situations, the research had to bear with certain limitations.

Some of the major limitations that prevailed during the study were as follows:

- Due to the rugged terrain, we were not able to cover all the potential habitat of Red Panda.
- Monsoon started little early this year which created difficulty in data collection.
- Many plant species could not be identified in the field.
- The length of transects was not uniform due to the sloped terrain.
- Global pandemic situation brought by COVID-19 also hampered the field movement to some extent

4. SPECIES DESCRIPTION

Red Panda also called as Lesser Panda, Red Cat-bear in English while in different parts of Nepal it is known as Habre, Rato Panda, Sano Bhalu, Punekudo, Pudin, Namchhaba, Mau, Hobrakhpa, Chyanba, Tomu etc. (Chalise, 2009; Williams, 2004).

The Red Panda (*Ailurus fulgens*) is one of the flagship species in worldwide conservation. Previous molecular and morphological phylogenles were inconclusive and varied among placement of the Red Panda within the raccoon family (Procyonidae), within the bear family (Ursidae), or in a separate family of carnivores equidistant between the two, but later by carefully considering the dental and cranial similarities to, and differences from, Ursidae and the Procyonidae; genus *Ailurus* was allocated to a separate family, Ailuridae (Flynn et al., 2000; Groves, 2011). Red Pandas are classified into two subspecies: the Himalayan Red Panda (*A. fulgens*) and the Chinese Red Panda (*A. styani*). The Red Pandas found in Nepal are classified as Himalayan Red Panda (*Ailurus fulgens)*(Thapa et al., 2020)

The head and body length of Red Pandas ranges from 56 to 62.5 cm, tail length ranges from 37 to 47.2 cm and there is no sexual dimorphism in the size and color. Wild red pandas weigh between 4 to 5 kg with lifespan ranging from 8 to 10 years (Makungu, 2018). They have long, soft, reddish-brown fur on the upper parts, blackish fur on the lower parts, and a light face with tear markings and robust cranio-dental features which has remarkable contribution for identifying individual Red Panda. They have long, bushy tails (28-59 cm) with 12-18 alternating rings that provide balance and excellent camouflage against their predators. The legs are black and short with thick fur on the soles of the paws which provide thermal insulation on snow-covered surfaces and conceals scent glands, which are also present on the anus. It has a "false thumb" similar to giant panda, which is an extension of the wrist bone. When descending a tree head-first, the Red Panda rotates its ankle to control its descent, one of the few climbing species to do so (Cuvier,F,1825, Fisher et al ., 2008; Robert & Gittleman,1984; Shrestha et al ., 2015).

Red pandas are nocturnal and crepuscular whose activity rate is higher in spring and summer–autumn than winter due to seasonal changes in diet (Reid et al., 1991; Roberts & Gittleman, 1984; Z. Zhang et al., 2011). They are solitary creatures; males are territorial and will mark their territory with strong odor from the scent gland at the base of their tail. They also like to lie on branches to sunbathe as they sleep. It can get a bit chilly at night where the Red Pandas live, so to keep warm, they wrap themselves in their fluffy tails and become dormant. Their metabolic rate gets lower and increases only every few hours to wake them up so they can look for food. When they wake up, Red Pandas groom themselves like cats by licking their front paws and use them to wipe down their fur instead of a full tongue-to-fur bath, though (Bradford, 2016).

Red panda is solitary species during non-breeding season and found in small groups during breeding season during which scent marking rates for both sexes increase, mostly in males and males spend significantly greater amount of time examining the trails and faecal and urine marking of females (Hu.J, 1991; Roka et al., 2015). Red Panda displayed a dramatic increase in activity,

rubbing, licking, sniffing (anal glands section, urine, feces) and urination in response to odorants of other individuals (Chun & Xiaoming, 2006). Red pandas are able to reproduce at second breeding season i.e. around 18 months of age, and are fully mature at two to three years. Both sexes may mate with more than one partner during the mating season from mid-January to early March. After a gestation period of 112 to 158 days female Red Panda begins arranging nesting material in the base of the hollow tree about two weeks before the birth. Red Panda gives birth in the early summer months from June to August to small litters of one to two blind and deaf cubs weighing 110 to each, occasionally three to four in a litter (Bista et al., 2017; Roberts, 1975; Roberts & Kessler, 2009).After birth, the mother cleans the cubs, and can then recognize each by its smell. The young leave their mother to become independent at about 8 months of age, when the mother begins new breeding season (Cuvier. F, 1825).

The Red Panda feeds primarily on bamboo (*Thamnocalamus sp.*) species. Followed by minute consumption of *Abis spectabilis, Rhododendron arboreum, Rhododendron campanulatum, T. aristatus, Quercus semecarpifolia, Betula utilis, Tsuga dumosa, Acer acuminatum* and *Texus wallichiana*. Seasonal fruits of *Aconogonum sp., Juniperus indica, Sorbus cuspidate, Rubus* are nutritious and digestible and mushrooms were found only in the post-monsoon season (Sharma H.P, 2013; Thapa & Basnet, 2015; Zejun Zhang et al., 2009). They ate mostly bamboo *Arundinaria maling* and *A. aristata* , and may eat birds, eggs, fruits, shoots and flowers (Pradhan et al., 2001; Roberts & Gittleman, 1984; Wei & Zhang, 2011). Bamboo shoots are more easily digested than leaves, exhibiting the highest digestibility in summer and autumn, intermediate digestibility in the spring, and lowest digestibility in the winter. These variations correlate with the nutrient contents in the bamboo (Wei et al., 1999).

The taxonomical, morphological, behavioral and all associated features of red panda are given in the table 3 below:

Table 3: Species description

Features	**Description**
Taxonomy	Earlier it was placed under the family procyonidae because to its superficial similarities in teeth, round skull, ringed tail and other behavioral similarities with raccoons (Glatston 1994). The family is further sub-divided into the sub-families Procyoninae, now called Procyonid and Ailurinae known as Ailuridae with the single genus Ailurus.
Morphology	The length of adult red panda including head and body (excluding tail) is approximately 50 to 64 cm and the weight of males varies from 3.7 kg to 6.2 kg while that female is 3 to 6 kg, the length of tail ranges from 28 to 59 cm. The face is rounded and predominantly white with radish brown 'tear marks ' running from the corner of each eye to mouth. Legs of red panda are black and soles of feet are covered with thin white hair to provide warmth serving as thermal insulation on the snow-covered surface. There is no sexual dimorphism in color or size between males and female (Roberts and Gittleman 1984; Flynn et al.2000)
Behavior	Red panda is solitary animal except during the mating seasons. It is usually sedentary but may travel a linear distance of 1.75 km with high mobility during

	January and February, for breeding (Yonzon and Hunter 1989). It marks its territory with urine and a weak – musk smelling secretion from its anal gland (Robert and Gittleman 1984). Home range size varies from 1.4-11.6 km^2 while average total home range size is 5.12 km^2 for male and 2.37 km^2 for female (Yonzon and Hunter 1989)
Food Habit	Bamboo leaves and shoots contribute more than 83% of total red panda diet (Yonzon & Hunter 1991).Red panda is classified as carnivore, but it is found to adopt pure herbivore diet, primarily consisting of leaves and shoots of bamboo species. However other dietary includes berries, fruits, mushroom, acorns and lichens (Yonzon and Hunter 1989). Diet includes tender leaves and shoots of bamboo in large quantities (over 1.5 kg of fresh leaves and 5 kg of fresh shoots daily) which passes through red panda's gut quit quickly taking about 2-4 hour, in order to maximum nutrient intake (Wei et al. 1999). Red panda usually leaves a group of pellets at feeding site with 8-15 pellets in a single defecation known as defecation site, however, they repeatedly use same site for defecation called latrine site which consists of 15- 30 pellets or sometimes more than 100(Yonzon & Hunter 1991
Reproduction	Red panda is capable of reproduction at the age of 18 months. It attains full maturity at 2 to 3 years of age. the mating seasons starts from middle of January and ends to early March. The gestation period is 112 to 158 days and birth occur during mid -June to late July. The average life span is between 8 to 10 years while in the capacity, it was found to live up to 14 years (Roberts and Gittleman 1984)

4.1 Distribution of Red Panda in Nepal

In Nepal, red pandas are distributed within a narrow elevation range between 2500 m and 4200 m in the northern part of the country and are confirmed to occur in seven protected areas (PAs), including Langtang National Park and Buffer zone (LNP BZ) (Yonzon and Hunter 1989; Karki 2009; Thapa 2010), Kanchenjunga Conservation Area (KCA) (Mahato 2003), Makalu Barun National Park and Buffer Zone (MBNP BZ), (Suwal and Verheugt 1995), Sagarmatha National Park and Buffer Zone (SNP BZ), Annapurna Conservation Area (ACA), (Suwal and Verheugt 1995), Dhorpatan Hunting Reserve (DHR), (Kandel 2008; Sharma and Belant 2009; Panthi 2011) and Rara National Park and Buffer Zone (RNP BZ) (Sharma 2012) and doubtfully in Api Nampa Conservation Area (ANCA) (Chalise 2012).

The national population size of red panda has been estimated to be 317-582 individuals (Jnawali et al.2011). However, Population and Habitat Viability Assessment on red panda (Jnawali et al. 2012) suggested total population ranging from 237 to 1061 individuals.

4.2 Status and Distribution

The subspecies *A. fulgens* is found in the Himalaya in Nepal, India, Bhutan, northern Myanmar and south-west China, and the subspecies *A. styani* occurs further to the east in south-central China. The Red Panda is an animal of subtropical and temperate forests. The estimated potential habitat of about 142,400 km² was found. Based on the density one panda per 4.4 km², he estimated the global population 16,000-20,000 individuals in the wild (Choudhury, 2001).

In India, the elevational range for Red Panda is 2800-3600 m however Tawang District, Arunachal Pradesh, India documented presence information of Red Panda in remote sub-alpine mountain slopes at 4325 m above sea level inside a Community Conserved Area, discovered during a monitoring trip by the villagers (Dorjee et al., 2014; Pradhan et al., 2001). Occurrence of red panda in Bhutan has been confirmed within the altitudinal range of 2000 to 4300 m above sea level but are most common at 2400-3700 m c). China has the major quantity of Red Panda habitat worldwide (Thapa et al., 2018). Red Panda was found in the northernmost sites, Hkakaborazi National Park and Hponkanrazi Wildlife Sanctuary between the elevation of 3000-3900 (Zaw et al., 2008). China and Nepal have a wider elevational range in Red Panda distribution (2000–3800 m) compared to other countries.

The national Red Panda survey 2016 documented the potential Red Panda habitat available across 23,977 km2, out of which, almost 70% of the total habitat lies outside the PAs network. Red panda has been reported from including Langtang National Park and Buffer Zone (LNP and BZ), Kangchenjungha Conservation Area (KCA), Makalu Barun National Park and Buffer Zone (MBNP and BZ), Sagarmatha National Park and Buffer Zone (SNP and BZ) , Annapurna Conservation Area (ACA), Dhorpatan Hunting Reserve (DHR), Rara National Park and Buffer Zone (RNP and BZ) and Gaurishankar Conservation Area (GCA). The districts inside and outside the protected areas include Ilam, Panchthar, Taplejung, Sankhuwasabha, Bhojpur, Khotang and Solukhumbu; Ramechap, Dolakha, Sindhupalchowk, Rasuwa, Nuwakot and Dhading; Gorkha, Lamjung, Kaski, Manang, Myagdi and Baglung; Rolpa and East Rukum and West Rukum, Dolpa, Jajarkot, Jumla, Mugu and Kalikot (DNPWC & DFSC, 2018).

About 86% of its resting sites are on trees, mostly *Abies spectabilies* in summer and Junipers, *Betula* spp., *Rhododendron* spp. and *Acer* spp. trees with surrounding temperature between 4-25°C, and annual rainfall of 350 cm). Currently, 14.23% (21,680 km^2) of Nepal is a climatically suitable habitat for the Red Panda (Thapa et al., 2020).

4.3 Habitat Preference

Study conducted by (Thapa et al., 2020), strongly suggests that Red Panda occurrence is broadly influenced by a group of variables, including habitat, climate and geography, as well as by disturbance. Mixed broadleaf forest, East Himalayan oak-laurel forest, canopy cover >20%, ground substrate use, bamboo cover >20%, tree stump presence, fallen logs of small trees and grazing absence are important variables in habitat of the Red Panda (Figure 1).

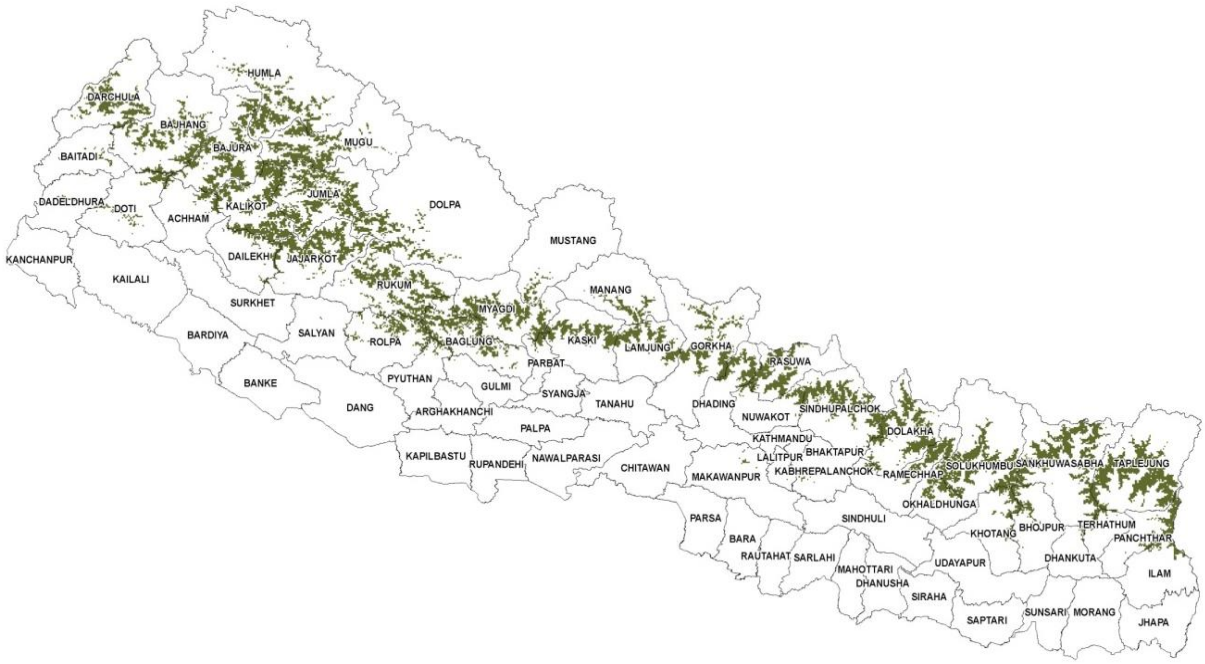


Figure 1: Map showing Potential distribution of Red panda in Nepal

Red panda in Jumla District mostly preferred the habitat in the elevation range from 2900 to 3000 m with southwest facing steep slopes (36˚ - 45˚), associated with water availability (at distance ≤100 m). In addition, Red Panda mostly preferred the tree species of *Acer spp., Betula utilis and Quercus semecarpifolia*, shrub species of *Elaeagnus parvifolia*, *Drepanostachyum spp.* and *Jasminum humile*, and herbaceous of *Polygonatum cirrhifolium*, *Fragaria nubicola* and *Galium asperifolium*. The Red Panda preferred the habitat with dense crown coverage (>20% - 100%) and 31% - 50% ground cover. Moreover, fallen logs (39%) were mostly preferred to use by Red Panda for defecation (Bhatta et al., 2014).

The most preferable altitude of the Red Panda in Dhorpatan Hunting Reserve is 3200m- 3400m. It prefers the moderate slope (26%-50%). Red Panda prefer tree species of *A. caesium, A. spectablis* and *Q. semicarpifolia*, shrub species of *U. dioica, R. campanulatum*, and *Rubus spp.* and other herb species. Red Panda preferred forested areas with gully (IV = 0.33). They preferred 51- 75% crown cover and 26- 50% ground cover.

In the study conducted in China, Red Panda preferred the aspect of south, southwest and northwest, and avoided the southeast- and northeast-facing aspect, habitat closer to a water resource, bamboo habitat with 45–60% cover of bamboo density, bamboo forest 1.5–2.5 m in height, mostly mixed broadleaved and coniferous forest with relatively dense canopy cover, and avoided evergreen fall broadly mixed forest and miscellaneous shrub. They preferred relatively high tree density (> 60/400 m²) and shrub density, habitat with fallen logs and high canopy cover (Zhou et al., 2013). The research conducted in Rara National Park showed that Pandas were living in narrow elevational range due to vegetation structure and physiographic structure of the area. The fecal

pellets were found only from 3,117 to 3,591 m of elevation. The fecal pellets density of Red Panda was higher in the areas, where *Abies, Rhododendron, Betula, Quercus* and bamboo were dominant. *Abies* was important for providing shelter, Rhododendron and *Betula* for movement, rest and bamboo as source of food. New area of Red Panda habitat in Jumla district at the Buffer zone of Rara National Park was identified during this period (Sharma, 2012).

4.4 Threat and challenges in red panda conservation

Disturbances caused by livestock grazing, herders and dogs, direct harvest from the wild, bamboo collection are considered as a key attributable factor for the habitat degradation and deforestation that result in habitat loss of Red Panda, a species that is probably on the verge of extinction. (Glatston, A.R 2011; Lama.S et al., 2020; Yonzon & Hunter, 1991). Bamboo is collected for fodder, roofing, baskets, and for many other household items which is the most important source of income (Daniggelis, 1997).

Deforestation can inhibit the spread of Red Pandas and exacerbate the natural population subdivision by topography and ecology, leading to severe fragmentation of the remaining wild population. Fewer than 40 animals in four separate groups share resources with humans in Nepal's LNP, where only 6% of 1,710 km^2 (660 sq. mi) is preferred Red Panda habitat. Livestock 0can depress bamboo growth by trampling (P. B. Yonzon & Hunter, 1991).

Wild animals serve as definitive and reservoir host of wide range of parasites like *Ancyclostoma duodenale, Ascaris lumbricoides, Entamoeba histolytica*, etc. might be a significant problem for the health of the Red Pandas. Livestock herding and contact with the snails is a detrimental threat to Red Panda conservation as they seem to be frequent carriers of Gastro-Intestinal (GI) parasites. The Wildlife Crime Pillar under the Central Investigation Bureau (CIB) of Nepal Police reports that between 2008 and 2019 there were 102 seizures of Red Panda hides— six confiscated by authorities in Western Nepal and one in Kathmandu in 2019—and 170 people arrested in the country for trafficking (RPN, 2019). Nonetheless, insufficient knowledge about Red Panda-related crime, miscommunication during awareness-building campaigns, investigators' influence indicating a demand for pelts with a high price, and poverty-induced, easy money-making motives could be possible drivers for increasing trafficking (Bista et al., 2020).

The top five wildlife species that are illegally traded are Common Leopard (*Panthera pardus*), Rhino (*Rhinoceros unicornis*), Birds, Tiger (*Panthera tigris*), and Red Panda (*Ailurus fulgens*) (Dangol, 2015). Red pandas are poached for their fur which is used to make hats and clothing in China for giving as wedding present because they are seen as good luck charms or sold as pets (Wei et al., 1999).

Study conducted by (Panthi et al., 2019) presented a significant conservation challenge; on the one hand, the people living in the high-altitude regions of Nepal depend on livestock and tourism for their livelihoods. On the other hand, human activities are threatening the Red Panda and its habitat.The National Park and Wildlife Conservation Act, 1973 of Nepal lists the species in Schedule I of the Act which restricts and prohibits hunting, possession or owning/trading in any part or product of the species without a permit issued by the Ministry certifying lawful acquisition. An offence under the Act can lead to a fine ranging from NPR 50,000–1,00,000 or an imprisonment ranging from 5 to 15 years or both (Pilia et al., 2020).

The legal provisions made for the conservation of Red Panda seems to be sufficient, however, there is yet to bring change in the scenario by implementing the provisions. To avoid extinction of Red Pandas in Nepal in the short to mid-term future, it is vital to fully restore habitats between subpopulations and immediately address human caused threats. The available information is not sufficient, therefore, an intensive research on population dynamics, status and distribution, home range size and resource requirements of wild Red Panda should be immediately initiated to disclose the exact information of this animal from the country. Furthermore, it is also necessary to change the people's attitude by new initiatives for awareness building and conservation friendly alternatives for the enhancement of their livelihood with high valued incentives via eco-tourism and sustainably living practices (Bista & Paudel, 2014).

5 LEGAL EFFORT OF CONSERVATION OF RED PANDA

The red panda is listed as ‘endangered in the IUCN Red Data book and as an Appendix species in CITIES, the international trade of live or its body part in strictly prohibited.

Some policies and legislation are help to conservation of Red Panda

- The IUCN listed red panda as " Vulnerable CI" in the IUCN global red list of the threatened species due to its declining population.
- The CITES enlisted Red Panda in Appendix I, which exclusively bans its international trade
- The NBSAP 2014-2020 emphasizes priority actions in conserving endangered species including the red panda.

- The Red panda being limited small population in Nepal, it has been listed as "Endanger C2a(i) in the Status of Nepal's Mammals: The National Red List Series 2011 (Jnawali et al.2011)

- Sagarmatha National Parks made the constitutional provision for the rare wildlife species

- Nepal has strong legal provisions to control wildlife crimes particularly for protected priority mammals. The NPWC Act provisions ‘a fine ranging from NPR 500,000 to NPR 1,000,000, or an imprisonment ranging from five years to 15, or both, for off enders and accomplices convicted for illegal trade in red panda body parts.

- Forest Sector Policy (2000) highlighted on the conservation issues of biodiversity, ecosystem and genetic resources.

- The first national red panda survey was conducted in 2016 which is the only study carried out at national level in the entire distribution range

- This study provided the baseline scenario on red panda distribution and habitat status in Nepal which will be critical for taking conservation effort forward in the country.

- GoN has published a protocol on red panda survey and community-based monitoring (MoFSC 2015).

6 MATERIALS AND METHODS

6.1 Study Area

This research was conducted in Sagarmatha National Park and its Buffer zone which lies in the Solukhambu district in of Prvince No.1 of Nepal. The district with Salleri as its Headquarter covers an area of 3,312 square kilometers (1,279 sq.mi). It is situated between Latitude 27°20'39" to 28°6'24" North and Longitude 86°0'21" to 87°0'1" East. The highest elevation of district is 8,848 meters (29,029 Ft.) (Mt. Everest) and the lowest elevation is 600 meters (2,000 Ft.) (Tuintar) above sea level. The district is surrounded by Sankhuwasabha in east, Bhojpur in south-east, Khotang and Okhaldhunga in south, Bagmati Pradesh in west and Tibet (China) in north (Statoids, 2000) (Figure 2).

Sagarmatha National Park extends over an area of 1,148 square kilometers of the Himalayan ecological zone in Khumbu region of Nepal.

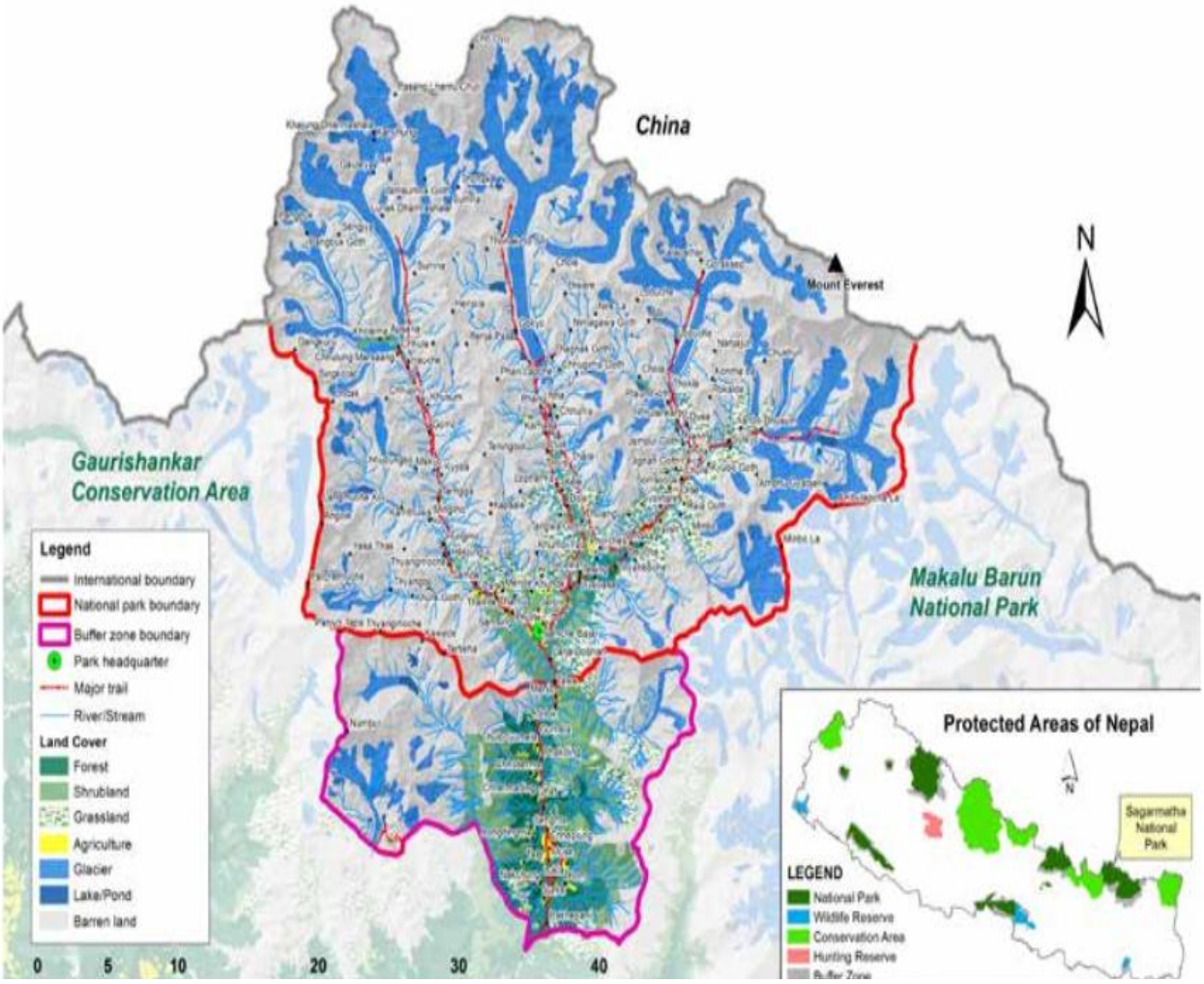


Figure 2: Sagarmatha National Park and BufferZone

Study was conducted in Sagarmatha National park and Buffer –zone to find out the key issues, opinion and suggestion raised in the discussion. Consultation meetings and Questionnaire survey were carried out in the settlement around most potential forests and surrounding settlement.

Table 4: Physiographic description of the study area

Descriptions	**Sagarmatha National Park and Buffer – Zone**
Location	Northern mountain of Eastern Nepal
Geographic locations	between 27°45′-28°07′N latitudes and 86°28′-87°07′E longitudes
National Park Designation Year	19 July 1976
World Heritage Site Declaration	1979 (UNESCO)
National Park Area	1,148 km^2
Buffer Zone Area	275km^2
Buffer Zone District	1
Buffer Zone User Committees	3
Buffer Zone User Groups	28
Buffer Zone Households	1619
Buffer Zone Population	7745
Major Ethnic Group	Sherpa
Major Religion	Buddhism
Major Glaciers	Khumbu,Imja,Ngozumpa,Nangpa
Ramsar Enlisted Site	Gokyo,and the associated wetlands
Major Peaks	Sagarmatha (8,848 m), Lhotse (8,501 m), Cho Oyu (8,153 m) , Nuptse (7,896 m)
Bioclimatic zones	Lower Temperate, Upper Temperate , Sub-alpine , Alpine and Nival
Climate	Temperate to Arctic
Elevation Range	2300m to 8848m
Main Mammals	Snow Leopard, Musk Deer and Red Panda
Major Trees	Pine, Hemlock, Fir, Juniper and Birch
Rivers and tributaries	Bhotekoshi river, Machherma river, Thesebu river, Dudhkoshi river, Naktok river, cholo river, Niyan river, Mingmo River ,Phungi River , Kyasar river, Inkhu river, Phakding river, Kamsyawa river, Muse river Sure River. These river drainage flow in SNP.

Source: SNP Management Plan 2016-2020

The Park includes the upper catchments areas of the Dudhkoshi and BhoteKoshi Rivers and is largely composed of rugged terrain and gorges of the high Himalayas, ranging from 2,845m at

Monjo to the top of the world's highest peak- Sagarmatha at 8,848m above the sea level. Other peaks above 6,000m are Lhotse, Cho Oyu, Thamserku, Nuptse, Amadablam and Pumori. The park has also been enlisted as a World Heritage Site in 1979.

The study was carried out in Himalayan BZCF, Kondey BZCF, Pemacholling BZCF, Dudhkunda BZCF and Red Panda BZCF located at ward numbers 3 and 2 of Khumbu Pasanglhamu rural municipality in Solukhumbu district. This site was confirmed as potential habitat for Red Panda according to the information of Sagarmatha National Park staffs, representatives from rural municipality, Buffer Zone User Committee, Buffer Zone user group, Buffer zone community forest user group, herders and local villagers. The area of Himalayan BZCF is 3,400 ha, Kongdey BZCF is 2,089.2 ha, Pemacholling BZCF is 8,364.8 ha, Dudhkunda BZCF is 4,850.1 ha and Red Panda BZCF is 1,602 ha. The major tree species found in the study area are *Betula utilis, Rhododendron arboretum, Abies spectabilis, Ilex dipurena*, etc. whereas the major shrub species is Pieris floribunda and the major bamboo species is *Arundinaria maling*.

6.2 Literature review

Literature review of following kinds were done:

- Review related published and unpublished literature on red panda
- Method and techniques for Red panda Distributions in different National parks were viewed
- Review related strategies, Policies and Guidelines: This include the review of National Park and Wildlife Conservation Act 1973, Forest Act 1993, National Parks and Wildlife Conservation Regulation 1974, Buffer Zone management Regulation 1996, Conservation Area Management Regulation 1997, Red Panda Conservation Action Plan for Nepal 2019-2023 etc.

6.3 Method of data collection

Various method was used to comprised desk work and field work in order to attain the objectives. Literature review was the most important part of the study that gave the foundation to study and help for concept development.

6.4 Household survey and Focus group discussion

House Hold survey and Focus group discussion is the primary basis for obtaining qualitative data on red panda conservation. This research conducted different focus group discussion community members involved in red panda conservation, youth clubs, individuals house, Aama samuha . A checklist including key questions and questionnaire form were developed (Annex II).

Meetings with different community-based organization who are working in the conservation of red panda and their habitat was conducted and all the conservation initiatives done in the area were documented.

Consultation meeting were held with the villagers that includes Forest User Group, Women and representative of District forest Office. A very poor sense of identification of this species was observed during the survey. Consultation different levels were done to gather information on red panda in Sagarmatha National Park.

6.5 Key Informants Interview

KII with red panda conservation experts, professionals, park wardens, scientist, local community people and community leaders was conducted to understand the status and conservation issues of red panda. Key questions were developed to facilitate the key informants' interview. (Annex III)

Consultations were done with different stakeholders:

- Sagarmatha National Park officers and community based anti-poaching units
- Trekking guide
- Youth club / school teachers and students
- Hotels association Solu and BZ area

6.6 Analysis of distribution of Red Panda

Recently, Ministry of Forests and Environment has conducted the National Red Panda Survey throughout Nepal in 2016. The spatial data on species occurrence was accessed to find out the distribution of red panda in Sagarmatha National Park and its buffer zone. A habitat map was prepared which also helped to set the specific points or places for conducting red panda survey. The survey also used the government approved Red Panda Field Survey and Community Based Monitoring Protocol, 2016.

6.7 Methodology

To assess the habitat characteristics of Red Panda, vegetation assessment was carried out through systematic sampling based on the altitude (Karki 1999; Mahato 2003; Shrestha 1988). Square plots of 10m*10m, 4m*4m and 1m*1m were laid out to assess trees, shrubs and herbs Gysel and Lyon, 1980; Poudel, 2009), respectively along the contour lines at an altitudinal interval of 200 m between 2800 m and 3400 m and the plots were spaced at a distance of 100 m. Diameter at breast height (DBH) of major species was measured in the plots. Threats signs were assessed during field visits and also through key informants' interview with project staffs, and herders. House hold survey on to access the perception of local villagers on the status and threats to red panda population.

6.7.1 Red Panda Survey

The survey was conducted in the most potential forests as identified by local people and Division Forest Office. The main purpose of the survey was to verify the presence and explore the distribution of red panda in Sagarmatha National Parks and its Buffer Zones. For getting representative and reliable information sampling strategy were applied as well as direct and indirect methods of wildlife survey were applied.

6.7.2 Direct Species Observation Method

The most potential area of National Park was searched opportunistically for direct sighting of red panda.

6.7.3 Indirect sign count method

In this sampling followed by systematic quadrate method, the quadrate 10m*10m was laid in reference with pellet encountered point besides this, other parameter including number, average diameter, length of the pellet and types were recorded and GPS also use for specific location.

6.7.4 Habitat Survey

Habitat survey includes vegetation sampling. The details vegetation analysis was carried out to determine the floral composition of habitat.

6.7.5 Abundance indices

The signs of Red Panda were plotted on the base map using ArcGIS 3.2 software to show their status and distribution in the study area.

6.7.6 Vegetation analysis

For analysis of vegetation, SPSS and Microsoft Excel were used. The following derivations (Shrestha and Ghimire, 1996 Poudel, K. 2009) were calculated to assess habitat characteristics.

A. Density and Relative density (RD)

a. Density of species A = $\frac{\text{Total no. of individuals of species A}}{\text{Total no. of Area surveyed} \times \text{Area of the plot}}$

b. Relative density of species A = $\frac{\text{Density of species A}}{\text{Total Density}} \times 100$

B. Frequency and Relative frequency (RF):

a. Frequency of species A = $\frac{\text{No. of plots in which species A occurs}}{\text{Total no. of plot sampled}} \times 100$

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

C. Relative dominance (R. dom.):

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

Total basal area of a particular species is a sum of basal area of all trees of that species which was calculated using the following relation:

Basal Area= π (d2/ 4); Where, d= diameter at breast

D. Importance value index (IVI)

IVI was obtained by summing relative density, relative frequency, and relative dominance (Dinerstein, 1979; Poudel, K. 2009).

IVI = Relative density + relative frequency + relative dominance

E. Threats analysis

Using SPSS and MS Excel, data were presented in pie-charts to interpret the assessed threats in Red Panda habitat.

7. DATA ANALYSIS

7.1 Land Use and Land Cover

Land use and land cover data of the study suggest that the area of study is 1467.5 sq. km. The different land cover can be classified into Forest, Non-Forest, Other Wooded land and Shrub land. It was found that majority of the land cover is occupied by Non-Forest, which is almost 60% of the total land area of the Sagarmatha National Park and its buffer zones. Only 4.84% of the study area, which is 71 sq. km is covered by forests. The following table and figure show the land cover data and land cover map of the study sites (Table 5; Figure 3).

Table 5: Land cover of Sagarmatha National Park and buffer zones

Land cover class	Area (sq. km)	Percentage
Forest	71.0	4.84
Non Forest	1308.1	59.4
Other Wooded Land	65.7	4.48
Shrub	22.5	1.54
Grand Total	**1467.5**	**100**

Source: Field survey, 2020

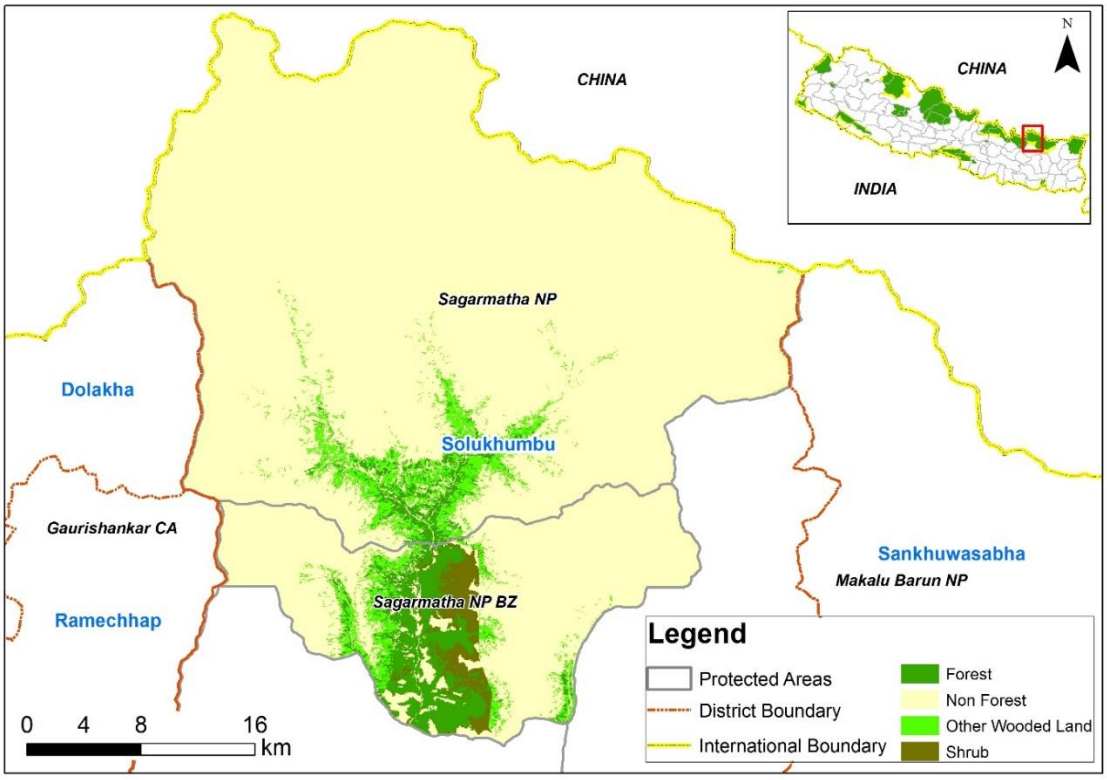


Figure 3: Land cover map of the study area

7.2 Elevation:

Elevation in Sagarmatha National Park and Buffer Zones ranges from 1913 m to 7000 m and above. The majority of the land area has an altitude of 5000-6000 m which is almost 48.9%, whereas 2.4% of land area has an elevation of 1913-3000 m followed by elevation of 7000 m and above.

The following figure 4 shows the elevation map of the study sites:

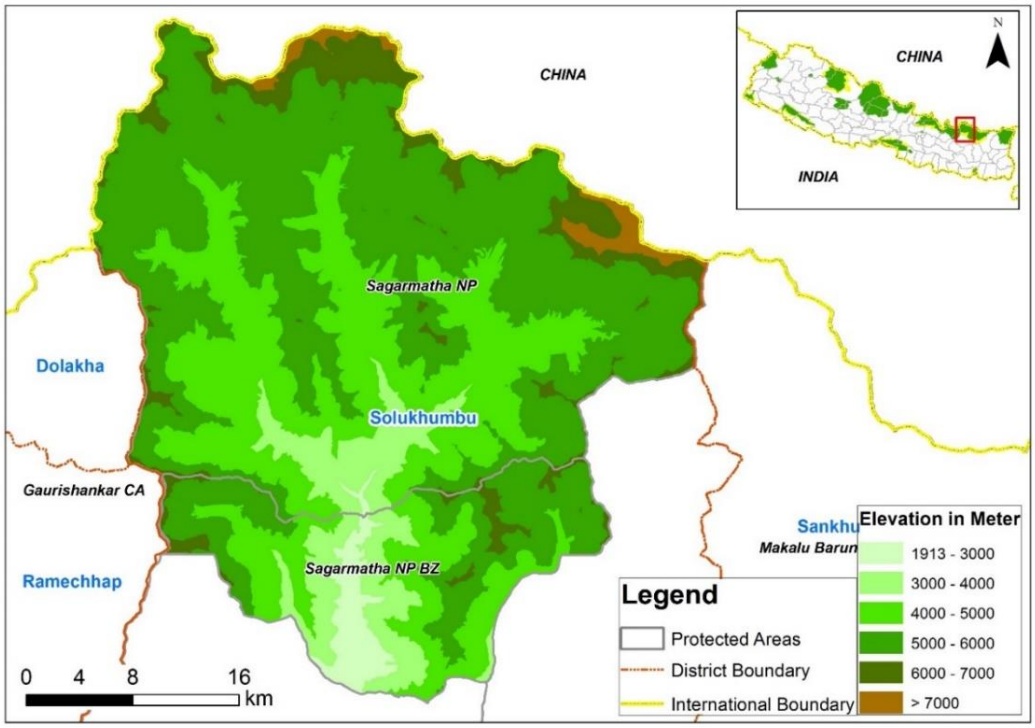


Figure 4: Elevation map of study area

7.3 Forest type map

According to the data it shows that Rhododendron represent the major quantity that is 95% in SNP followed by *Alnus spp*, whereas *Pinus roxburghii* and *Cupressus torulos* represent the least that is 0.3 % each of the total tree species (Table 6 and Figure 5).

Table 6: Forest types map of the study area

Forest types	**Area (sq. km)**	**Percentage**
Abies spectabilis	0.48	0.7
Cedrus deodar	1.09	1.6
Cupressus torulosa	0.21	0.3
Himalayan Hemlock	0.36	0.5
Juglans regia	0.87	1.3
Pinus roxburghii	0.2	0.3
Rhododendron	63.37	95.2

Total	66.58	100.0

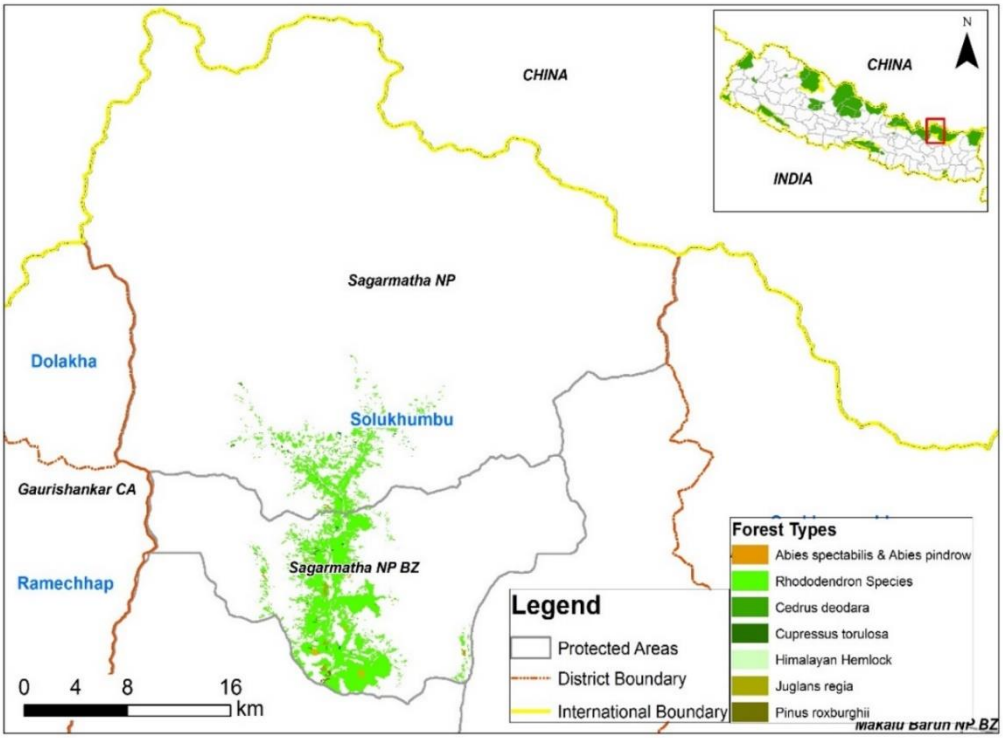


Figure 5: Forest Type in SNP

The above map shows the distribution of forest types in Sagarmatha National Park and Buffer Zone the green colour shows the presence of *Rhododendron spp.*

7.4 Slope

The slop map of Sagarmatha national park was classified according to range from less than 9 degree to slope greater than 60 degree. According to the map land cover is higher in the slop between 30-60 degree whereas sum of area covered above 60 degree have is less area.Map showing the classified Red panda according to slop category (Figure 6)

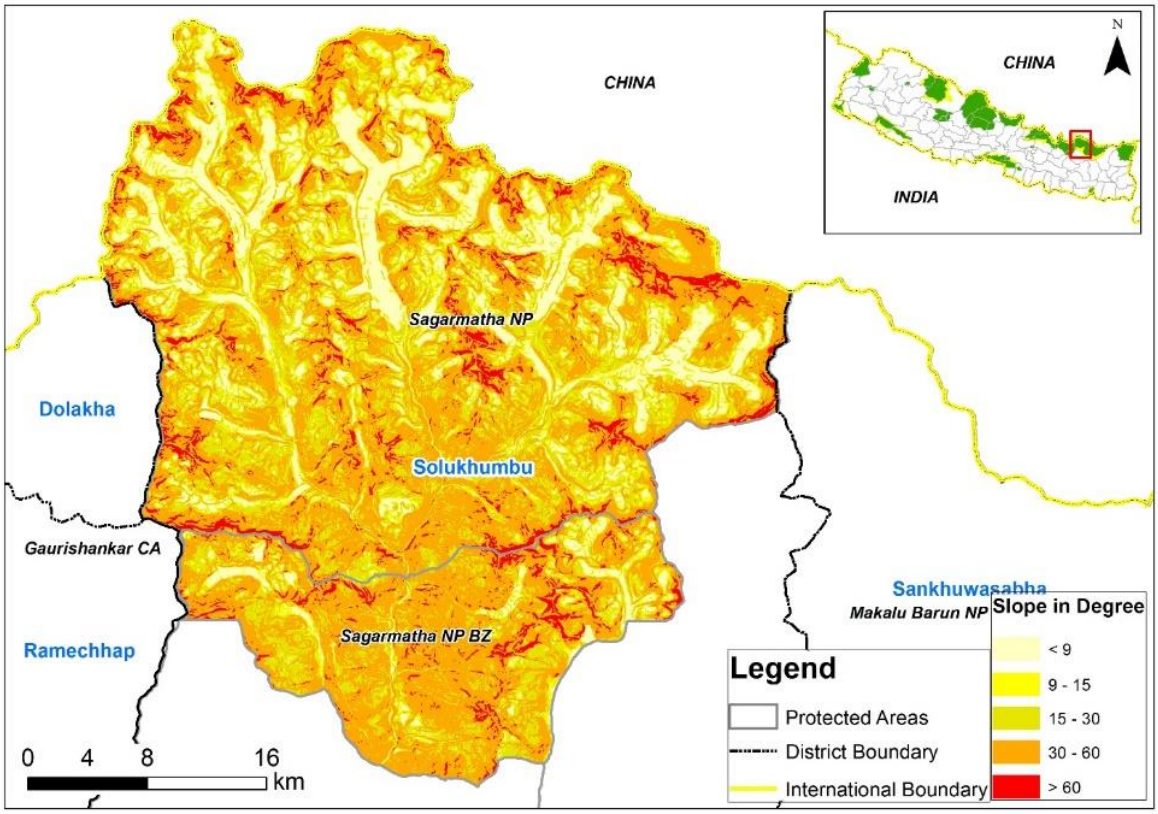


Figure 6: Slope map of the study area

7.5 Aspect:

It was observed the red panda showed their presence towards southwest aspect (16%) followed by south aspect (15%) and south east 14%. The least preference was north west (9%) and North 10% (Figure 7).

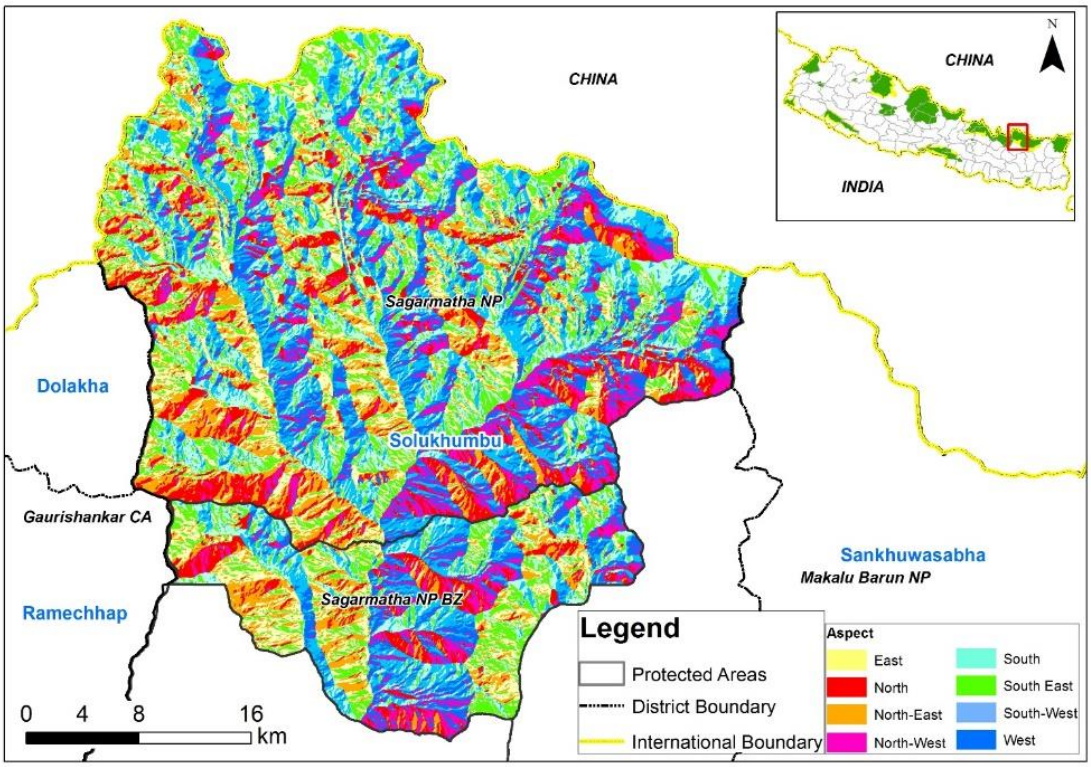


Figure 7: Aspect map of the study area

7.6 Drainage

The above map shows the differs drainage in the SNP that includes Bhotekoshi river, Machherma river, Thesebu river, Dudhkoshi river, Naktok river, cholo river, Niyan river, Mingmo River ,Phungi River , Kyasar river, Inkhu river, Phakding river, Kamsyawa river, Muse river Sure River. These river drainage flow in SNP (Figure 8).

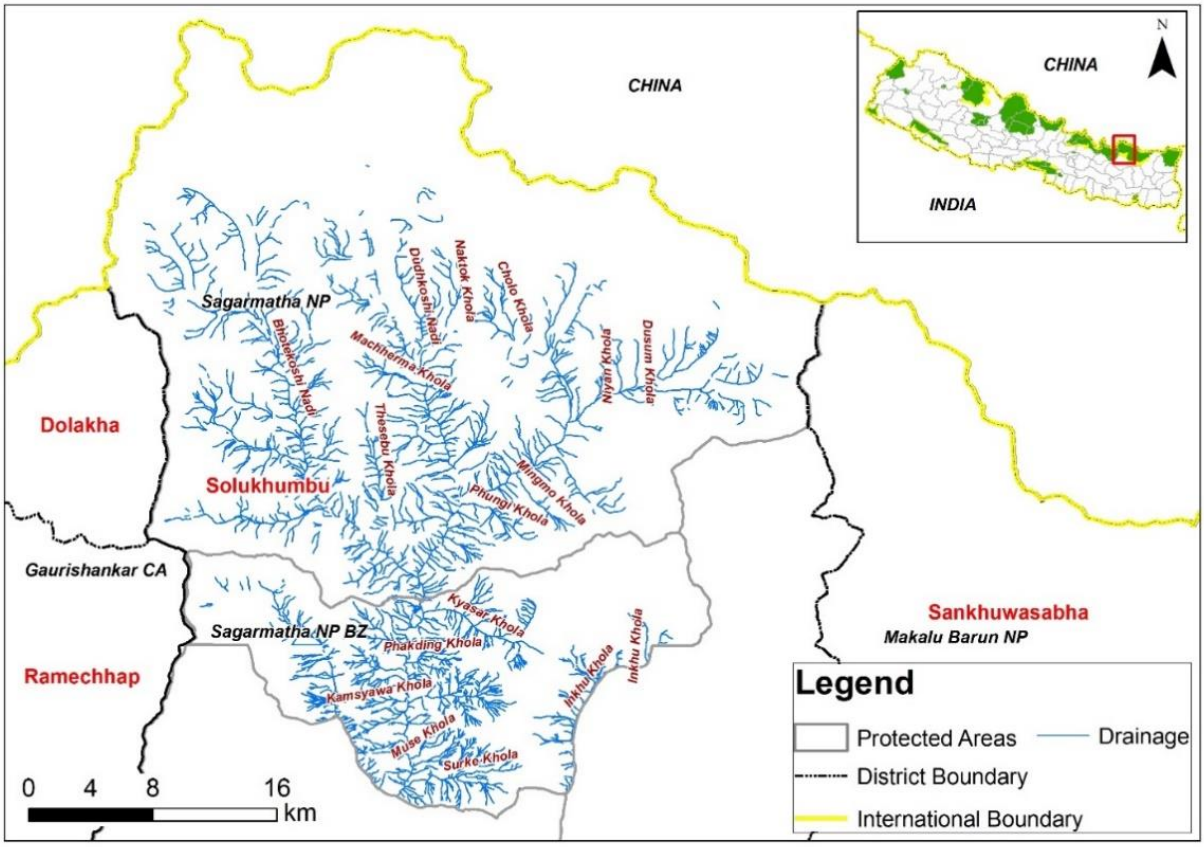


Figure 8: Drainage map of the study area

7.7 Habit Preference

Red panda prefers to live in the forests with close proximity to water sources (within 100-200 m) with moderate tree canopy (>30%), bamboo cover (> 37%) and an average bamboo height greater than 2.9 m (Yonzon et al. 1991, Pradhan et al. 2001, Williams 2006, Dorji et al. 2012). They also prefer gentle to steep slopes with fallen logs, tree stumps, and snags (Zhang et al. 2008, Bista et al. 2017a). Red panda shows preference for north, north-west and south-west aspect slopes (Yonzon & Hunter 1991, Pradhan et al. 2001). Their altitudinal distribution ranges from 2000-4800 m (Roberts & Gittleman 1984, Yonzon et al. 1991).

Bamboo leaves and shoots contribute more than 83% of total red panda diet (Yonzon & Hunter 1991). They use elevated objects, such as shrub branches, fallen logs, or tree stumps to reach bamboo leaves (Wei et al. 2000). Red panda also forages on other foods such as leaves and berries of plants: Sorbus spp., *Acer spp*., *Quercus semi-carpifolia*, *Berberis spp.*, *Actinidia strigosa, Rhododendron campanulata, Rosa sericera, Abiesspectabilis, Juniperus spp., Rubusspp, Schllerifl ora spp*. etc (Yonzon & Hunter 1991, Pradhan et al. 2001, Sharma 2008, Panthi et al. 2012, Thapa & Basnet 2015, Panthi et al. 2015). They also feed on birds, eggs, and insects (Yonzon & Hunter

1991). Being primarily a bamboo eater, red panda has a very low metabolic rate (Wei et al. 2000), which reduces its energy requirements (McNab 1988).

Fresh droppings of red panda are spindle-shaped, soft, moist, and light green. Red panda usually has a cluster of 1-15 pellets in a single defecation pers. observation, (Bista.D, 2012), and use the same site for defecation, i.e. latrine sites, where more than 100 pellets can amass (Yonzon 1989). Red panda breeds in the late winter months, from January to March, and the cubs are born during the monsoon, from June to August (Yonzon & Hunter 1991, Northrop & Czekala 2011). They normally have their nests in a hollow tree or a rock crevice. Red panda gives birth to one to four blind cubs with an average clutch size of two cubs, each weighing 110 to 130 gm. They start to venture out of the nest when they are 3 months old (Robert & Gittleman 1984). The young one leaves mother at about 8 months of age, when the mother begins a new breeding season (Schaller 1994). The young become sexually mature at 18 to 20 months of age and give first birth at 24 to 26 months after 135 days of gestation period (Northrop & Czekala 2011).

The Figure 11 illustrates the potential habitat for Red panda. The colour Red indicate the presence the high no of Red panda whereas green colour indicate medium potential where are the cream colour indicate that there is no Red panda in the area.

Potential habitat distribution modelling is done by using MaxEnt software which is one of the most used. It is based on continuous or categorical environmental data layers (Franklin and Miller, 2009). The model implements a relation between environmental variables and species occurrence based on the maximum entropy principle (Elith et al., 2011). This modelling was chosen due to one of the best modeling techniques, MaxEnt is useful for modeling species with only-occurrences data and in environments variables. It provides species distribution after providing strong parameters. To run the best, we need sufficient species occurrence locations.

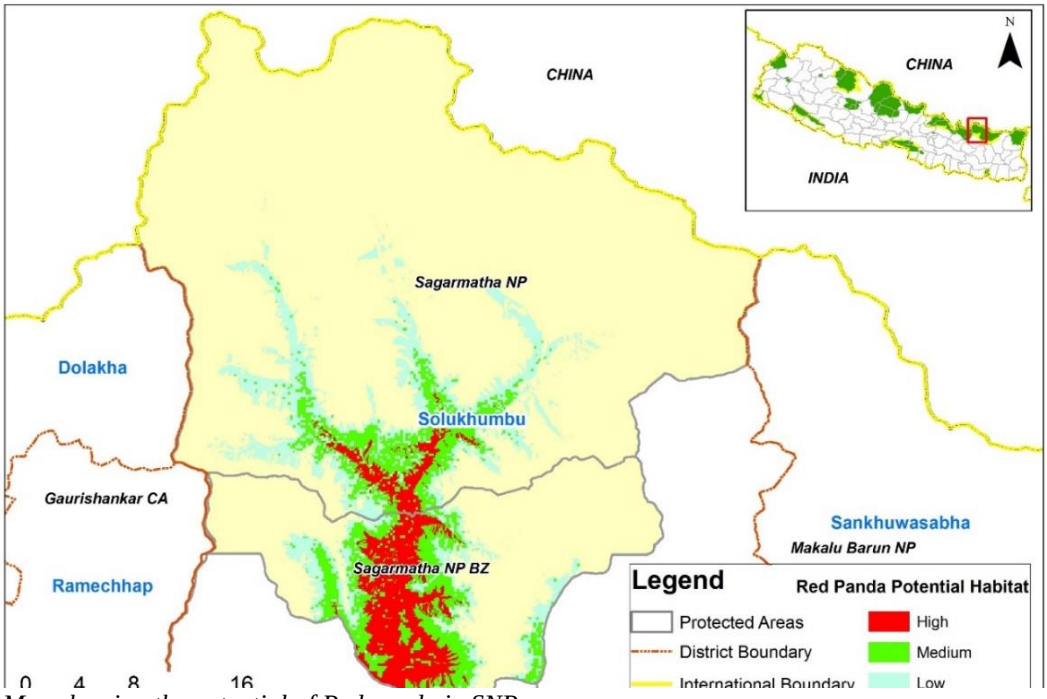


Figure 11: Map showing the potential of Red panda in SNP

7.8 Presence or absence map

For the study 5 BZCF of Sagarmatha National Park namely Himalayan BZCF, Kongdey BZCF, Pemacholling BZCF, Dudhkunda BZCF and Red Panda BZCF were selected with the help of Chief Conservation Officer of SNP, Staffs, etc. After reconnaissance survey potential site for Red panda was listed.

Red Pandas were sited in Pemacholling BZCF. First was found resting in Siltimur tree (*Litsea monopetala*) at an elevation of 2,838 m and second was found resting in Fir tree (*Abies spectabilis*) at an elevation of 2,735 m. Both were encountered in the East facing slopes. We were able sight and capture Red panda for the first time in our research but the second Red Panda got disturbed by our presence and suddenly escaped from the site and vanished in the Malingo (*Arundinaria maling*) forest.

The study result shows the sign of Red Panda between the elevation of 2,600 m to 3,400 m. Out of 47 Habitat Use plots, 6 plots were in Himalayan BZCF, 12 plots in Kongdey BZCF, 7 plots in Pemacholling BZCF, 14 plots in Red Panda BZCF and 8 plots in Dudhkunda BZCF (Figure 12). 64 pellet groups were found in 47 Habitat Use Plots.

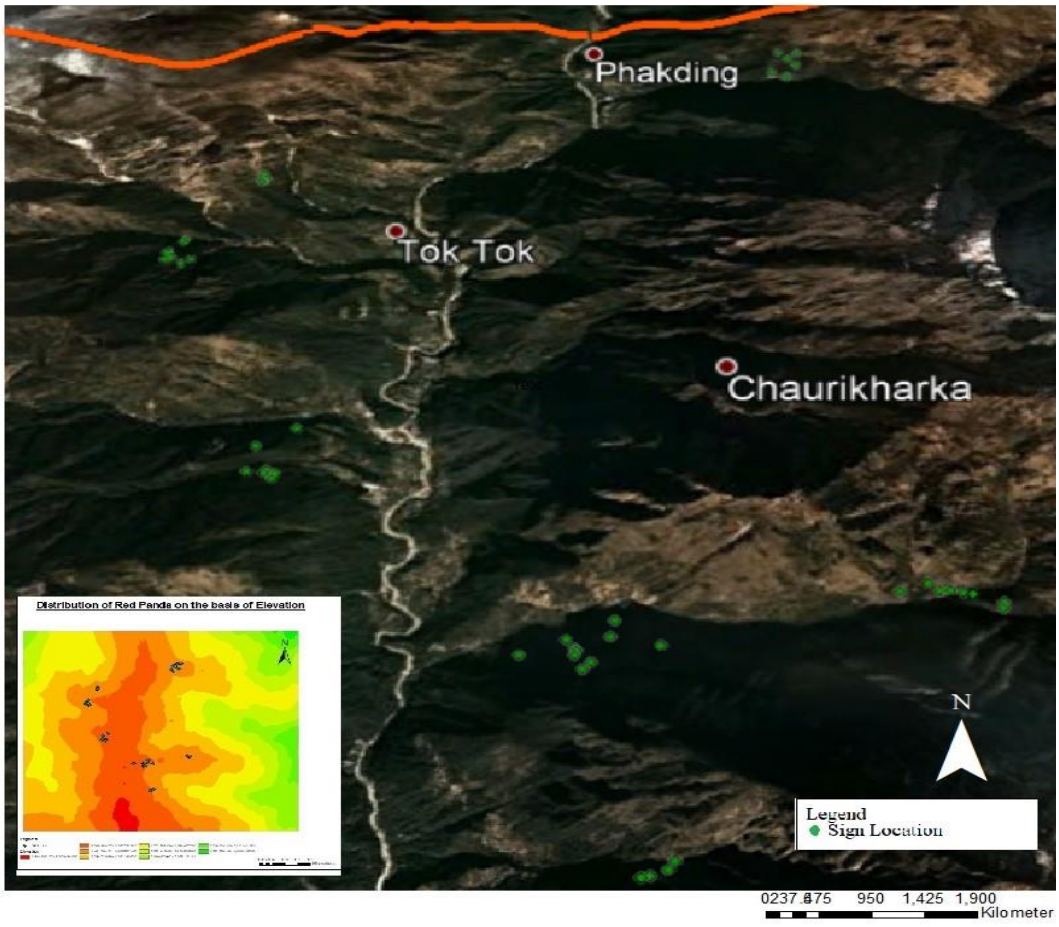


Figure 9: Distribution of Red Panda in 5 BZCFs of SNP

7.9 Abundance

Encounter rate was found to be 0.75 sign/km in Himalayan BZCF, 2.3 signs/km in Kongdey BZCF, 2.5 signs/km in Pemacholling BZCF, 2.3 signs/km in Red Panda BZCF and 1 signs/km in Dudhkunda BZCF.

Table 7: Pellet Group encounter of Red Panda in 5 different BZCFs of SNP.

Name of BZCFs	Transect Length (km)	Pellet Group Encountered	Direct Observation	Abundance
Himalayan	8	6		0.75
Kongdey	8	19		2.3
Pemacholling	4	8	2	2.5
Red Panda	10	23		2.3
Dudhkunda	8	8		1
Total	**38**	**64**	**2**	**66/38 = 1.7 signs / km**

The average abundance of Red Panda in study area was estimated to be 1.7 signs/km ranging from lowest 0.75 signs/km in Himalayan BZCF to highest 2.5 signs/km in Pemacholling BZCF respectively.

7.10 Habitat Preference

7.10.1 Elevation

Red Panda signs were found between 2,600-3,400 m. Red Panda preferred elevations between 2,800-3,000 m (IV= 0.13) and 3,000-3,200 m (IV= 0.15). Red Panda avoided the elevation between 2,600-2,800 (IV= -0.06) and randomly used elevation between 3,200-3,400 (IV= 0). Red Panda signs were not found below 2600 m and above 3400 m (Figure 10).

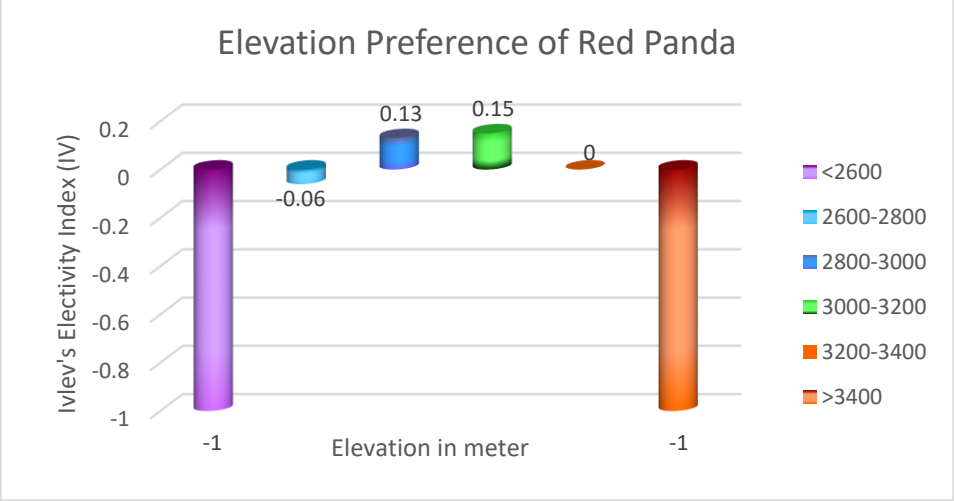


Figure 10: Elevation preference of Red panda

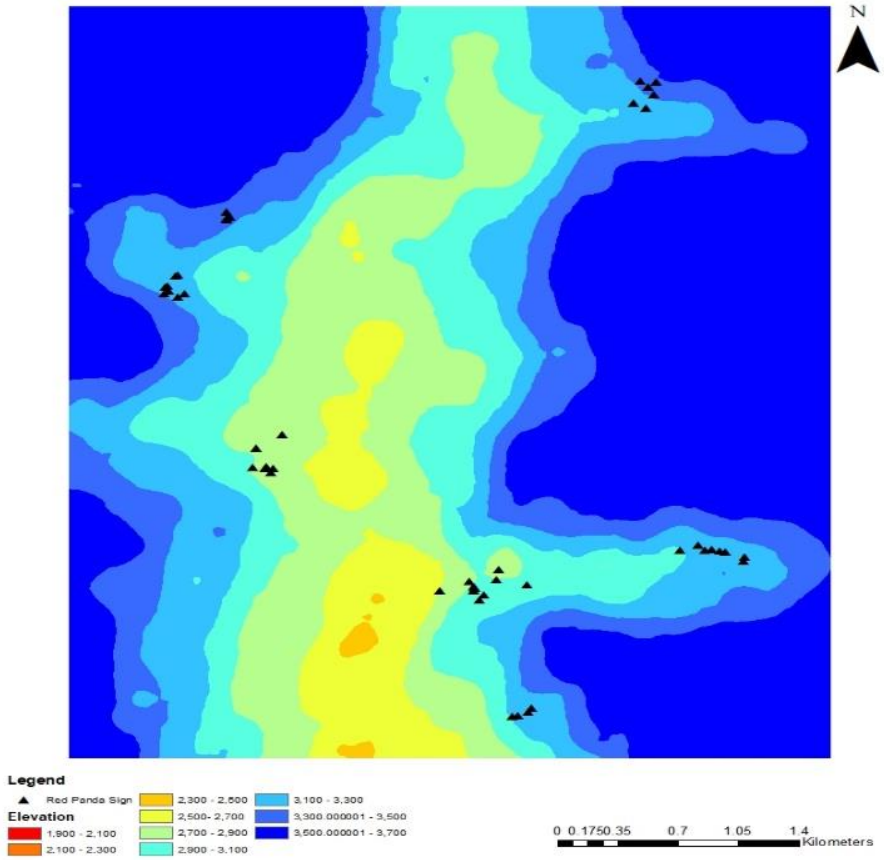


Figure 11: Elevation Distribution of Red Panda in Study Area

7.10.2 Slope

Red Panda signs were found between 16-45-degree slopes. They avoided slopes between 16-20 degree (IV=-0.38) and 41-45 degree (IV= -0.7), moderately preferred slopes between 21-25 degree (IV= 0.05), 31-35 degree (IV= 0.04), randomly used slopes between 36-40 degree (IV= 0). Red Pandas mostly preferred slopes between 26-30 degree (IV= 0.36) (Figure 12).

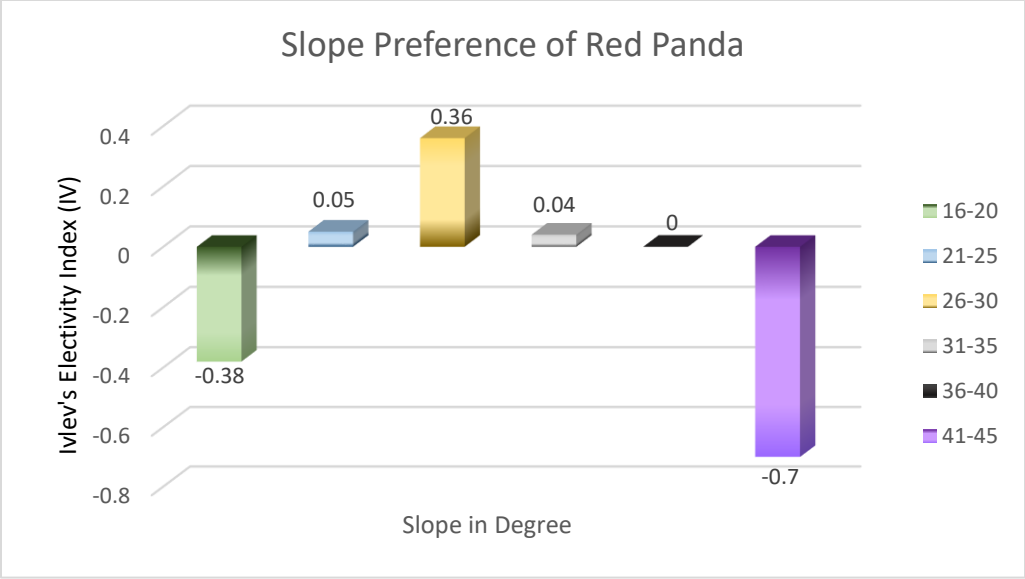


Figure 12: Bar diagram showing slope preference of Red Panda

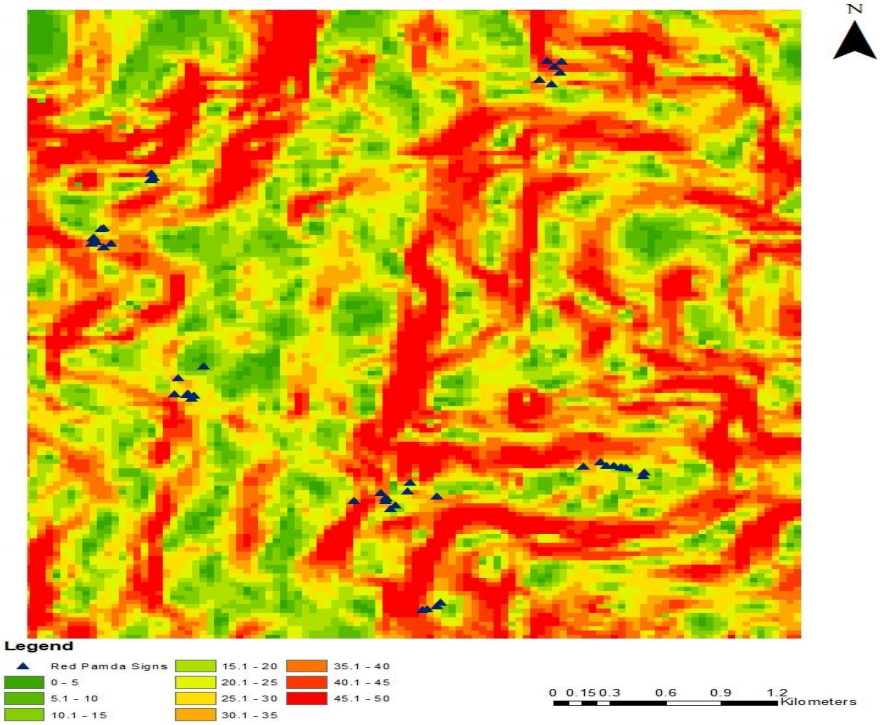


Figure 13: Slope use of Red Panda in Study Area

7.10.3 Aspect

Red Panda mostly preferred South-West aspect (IV= 0.18), moderately preferred North-East aspect (IV= 0.067) and randomly preferred East, North-West and South aspect. Red Panda avoided North aspect (IV= -0.2) and South East slopes (IV=-1) (Figure 14).

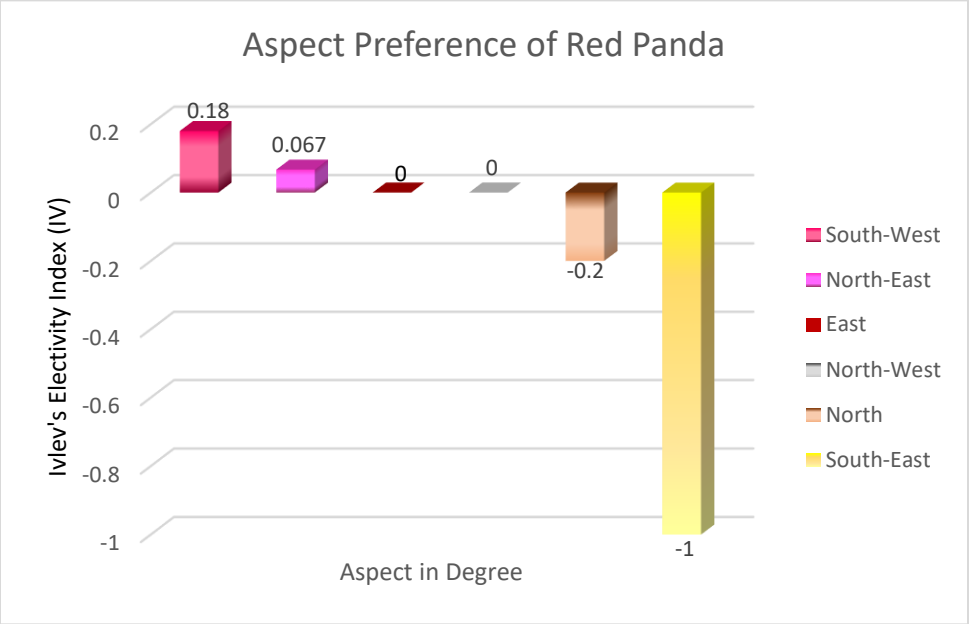


Figure 14: Bar diagram showing aspect preference of Red Panda

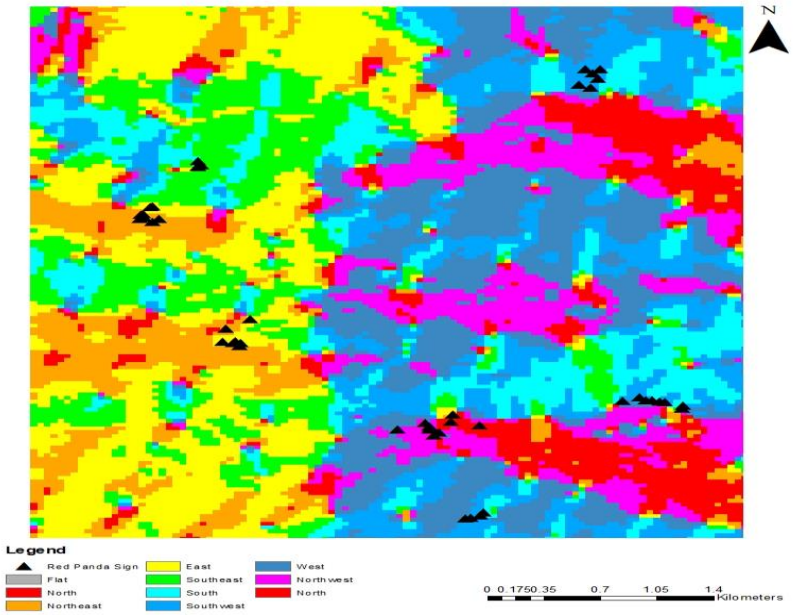


Figure 15: Aspect use of Red Panda in Study Area

7.10.4 Water Source

Red Panda signs were found at a distance of 4 m to 200 m from the water source. It mainly preferred places that are at a distance less than or equal to 100 m (IV= 0.13), randomly use distance from 101 to 200 (IV= 0.06) and avoided the distance greater than 200 m (IV= -1) (Figure 16).

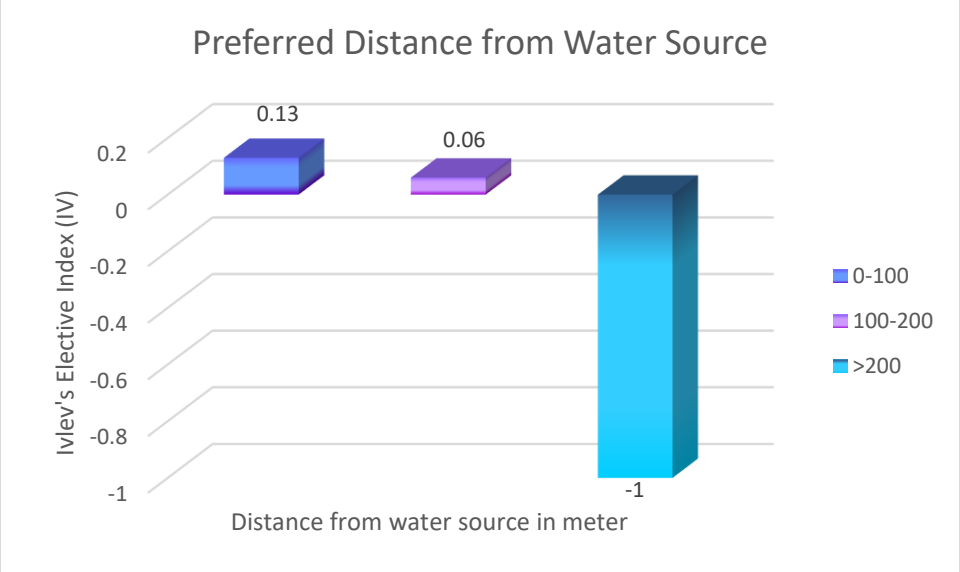


Figure 16: Bar diagram showing preferred distance from water source by Red Panda

7.10.5 Substrate

Out of 64 pellet groups seen, 24 groups were found in Ground, 16 groups were found in trees, 14 in tree stumps and 10 in fallen logs (Figure 17). Red Panda prefers moist places.

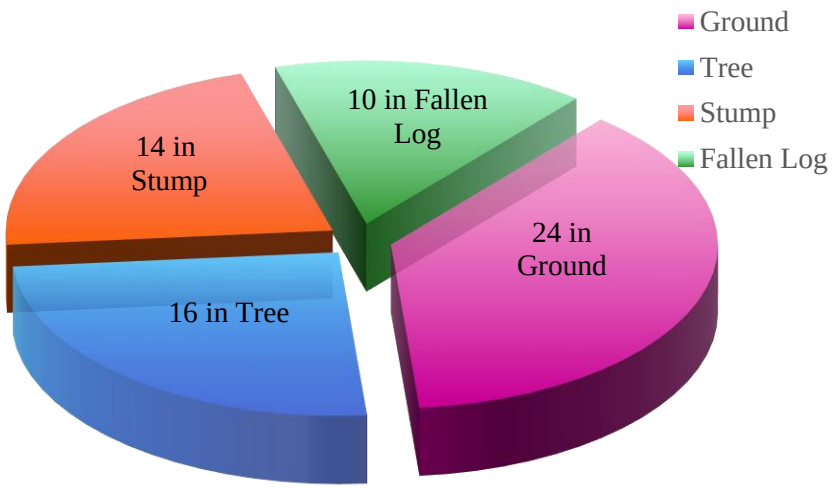


Figure 17: Pie-chart showing the number of signs found in different substrate

7.10.6 Vegetation Analysis

- Tree

Important Value Index (IVI) shows the dominancy of one species to other species. *Abies spectabilis* was most dominant (R.D=14.31, R.F= 16.2, R.Do= 26.008 and IVI= 56.518). Rhododendron has the highest Relative Density of 28.52% and Relative Frequency of 17.78% (Table 8).

Table 8: Relative Density, Relative Frequency, Relative Dominance, Important Value Index and Ivlev's Electivity Index of tree species found in study area

S. N	Scientific Name	Local Name	Relative Density (%)	Relative Frequency (%)	Relative Dominance (%)	IVI (%)	IV	Status
1	*Abies spectabilis*	Thaasing	14.31	16.2	26.008	56.518	0.03	Preferred
2	*Rhododendron arboretum*	Laliguras	28.52	17.78	5.37	51.67	-0.02	Avoided
3	*Ilex dipyrena*	Liso	7.47	7.5	20.64	35.61	0	Randomly Used
4	*Lyonia ovalifolia*	Angeri	17.09	12.64	4.95	34.68	-0.04	Avoided
5	*Pinus wallichiana*	Gobre Salla	5.87	7.5	12.41	25.78	-0.24	Avoided
6	*Betula utilis*	Bhojpatra	6.623	10.67	3.79	21.083	0.03	Preferred
7	*Quercus semicarpifolia*	Khasru	6.08	7.11	6.74	19.93	0.05	Preferred
8	*Acer sterculiaceum*	Kukurpailey	5.44	5.13	7.32	17.89	0.13	Preferred
9	*Prunus cornuta*	Aarupatey	5.44	3.55	5.37	14.36	-0.14	Avoided
10	*Quercus glauca*	Falat	2.67	4.74	4.54	11.95	-0.17	Avoided
11	*Juniperus sps.*	Dhupi	3.2	5.13	1.68	10.01	-0.07	Avoided
12	*Litsea monopetala*	Siltimur	2.13	1.97	1.23	5.33	0.11	Preferred

- Shrub

Red Panda preferred species like *Viburum erubescens* (IV= 0.2), *Rubia cordifolia* (IV= 0.05), *Arundinaria maling* (IV= 0.1) and *Drepanostachyum intermedium* (IV= 0.07). Species like *Pieris floribunda* (IV= 0.03), *Rhododendron anthropogon* (IV= 0.06) and *Berberis sps.* (-0.1) (Table 9).

Table 9: Shrub species preference by Red Panda

S.N.	Species	Local Name	IV	Status
1	*Viburum erubescens*	Asarey	0.2	Preferred
2	*Pieris floribunda*	Bulu	-0.03	Avoided
3	*Rhododendron anthropogony*	Sunpati	-0.06	Avoided
4	*Rubia cordifolia*	Majitho	0.05	Preferred
5	*Arundinaria maling*	Malingo	0.1	Preferred
6	*Drepanostachyum intermedium*	Nigalo	0.07	Preferred
7	*Berberis sps.*	Chutro	-0.1	Avoided

- Herb

Red Panda preferred *Dryopteris sps.* (IV= 0.03) and *Fragaria nubicola* (IV= 0.3). It avoided species like *Urtica dioica* (IV= -1) and *Centella asiatica* (IV= -0.2) (Table 10).

Table 10: Herb species preference by Red Panda

S.N.	Species	Local Name	IV	Status
1	*Urtica dioica*	Sisnu	-1	Avoided
2	*Dryopteris sps.*	Wunniu	0.03	Preferred
3	*Centella asiatica*	Ghodtapre	-0.2	Avoided
4	*Fragaria nubicola*	Bhui Kafal	0.3	Preferred

7.10.7 Ground Cover

Red Panda preferred moderate ground cover between 25-50% (IV= 0.2), randomly used ground cover between 50-75% (IV= 0.05) and 0-25% (IV= 0.04) and avoided ground cover of 75-100% (IV= -0.3) (Figure 18).

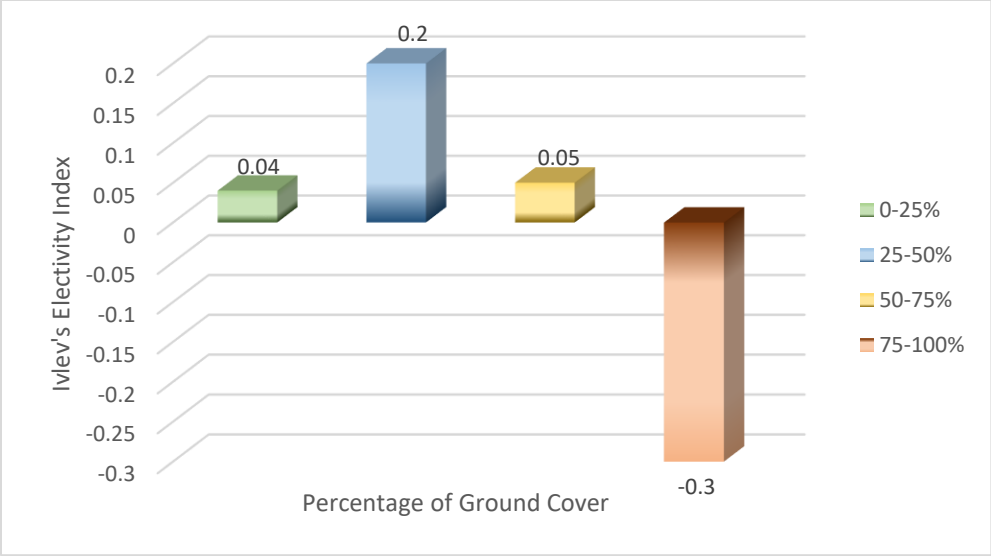


Figure 18: Bar diagram showing ground cover preferred by Red Panda

7.10.8 Crown cover

Red Panda preferred moderate crown cover (IV= 0.16), randomly preferred dense crown cover (IV= 0.04) and avoided open (IV= -0.2) and sparse crown cover (IV= -1) (Figure 19).

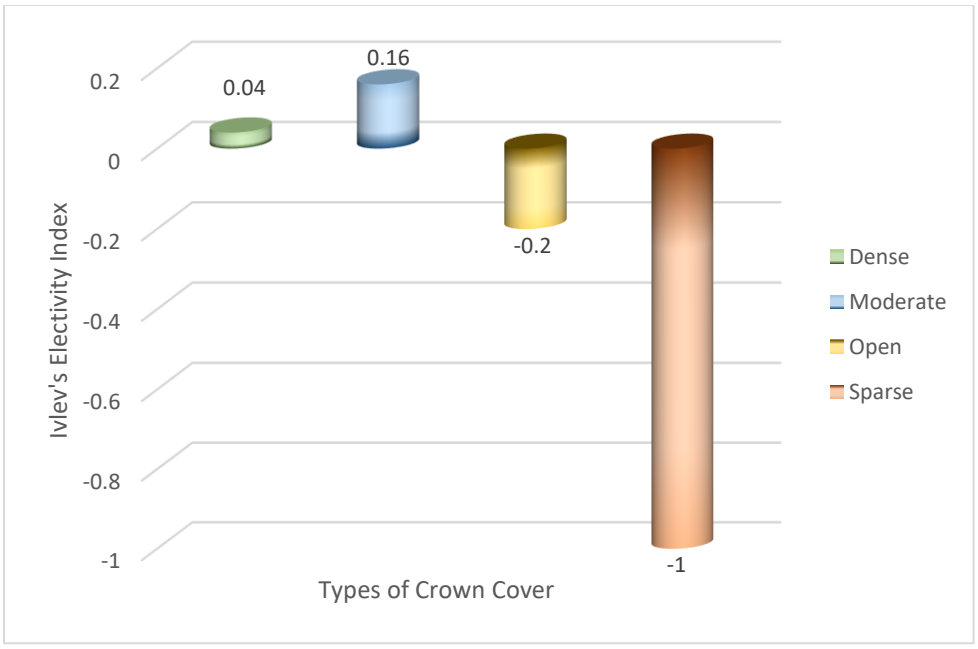


Figure 19: Bar diagram showing crown cover preferred by Red Panda

7.10.9 Factors affecting the abundance

By the help of field visit and social survey, factors that might be responsible for affecting the abundance of Red Panda was analyzed. The people of BZCF strongly believed that the number of

Red Panda in the area was decreasing. According to them the factors that might be responsible for their decline are as follows:

- Grazing
- Collection of Bamboo for food and making items
- Predation
- Poaching
- Collection of forest products

During the field visit, threat signs such as grazing, bamboo cutting, signs of wildlife, livestock, human trails were observed. At Lukla BZCF, we observed dead Red Panda at elevation of 3,016 m (Picture is shown in Annex 1). Though it didn't fall under our study area, people and park staffs believed that the Red Panda was killed by its predator, Marten *(Martes flavigula).* Red Pandas were never reported in that place, so the Red Panda might have come from Red Panda BZCF.

Out of 47 Habitat Use plots, wildlife droppings were found in 44 plots (93.6% of the total plots) and livestock droppings were found in 11 plots (23.4% of the total plots) (Figure 20).

On the basis of FGD 35% respondents stated that collection of bamboo was the main cause behind the decline of Red Panda population. Other causes included Grazing (25% respondents), Predation (15% respondents), Poaching (10% respondents) and collection of Forest products (15% respondents).

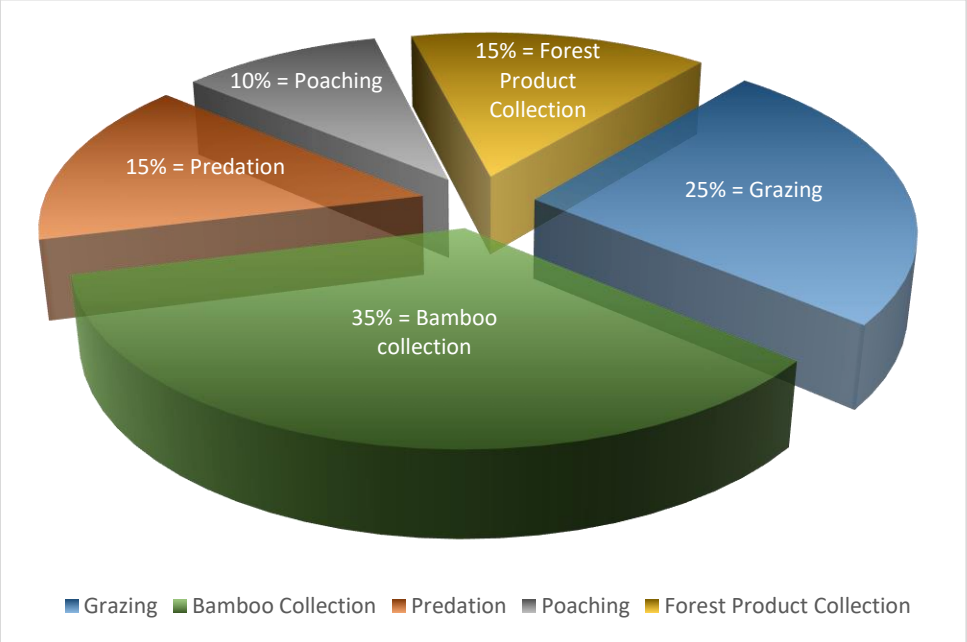


Figure 20: People's perception on factors responsible for decline in population of Red Panda

According to the Key Informant Survey, the President of Red Panda BZCF told that he had seen *Martes flavigula* chasing the Red Panda and killing it. Other people like staffs from the park, representatives from rural municipality, BZUC, BZUG, BZCFUG told that grazing and collection of Bamboo from the forest was major threat to Red Panda.

8. THREATS AND CHALLENGES IN RED PANDA IN STUDY AREA

Habitat loss, degradation and fragmentation along with poaching and illegal trade are the most pressing anthropogenic threats to red panda conservation (DNPWC and DFSC, 2018). Anthropogenic pressure, activities along with poaching triggers in habitat loss, degradation, destruction of red panda in SNP and BZ area and weak legal enforcement are the major factor causing threats to red panda. According to local people climate change is also likely to possess some impact on red panda. Impact of forest fires on small mammals like red panda has not been well documented; however, anecdotal observations and notes suggest that the forest fire has negative effects on red panda due to its direct effect and contribution in habitat loss. Forest fire that took place during April-May 2009 killed three red pandas in Taplejung district (Williams et al. 2011). Despite of this fact, forest fires also have some good aspects as these fires create more space for bamboo growth.

8.1 Habitat Destruction

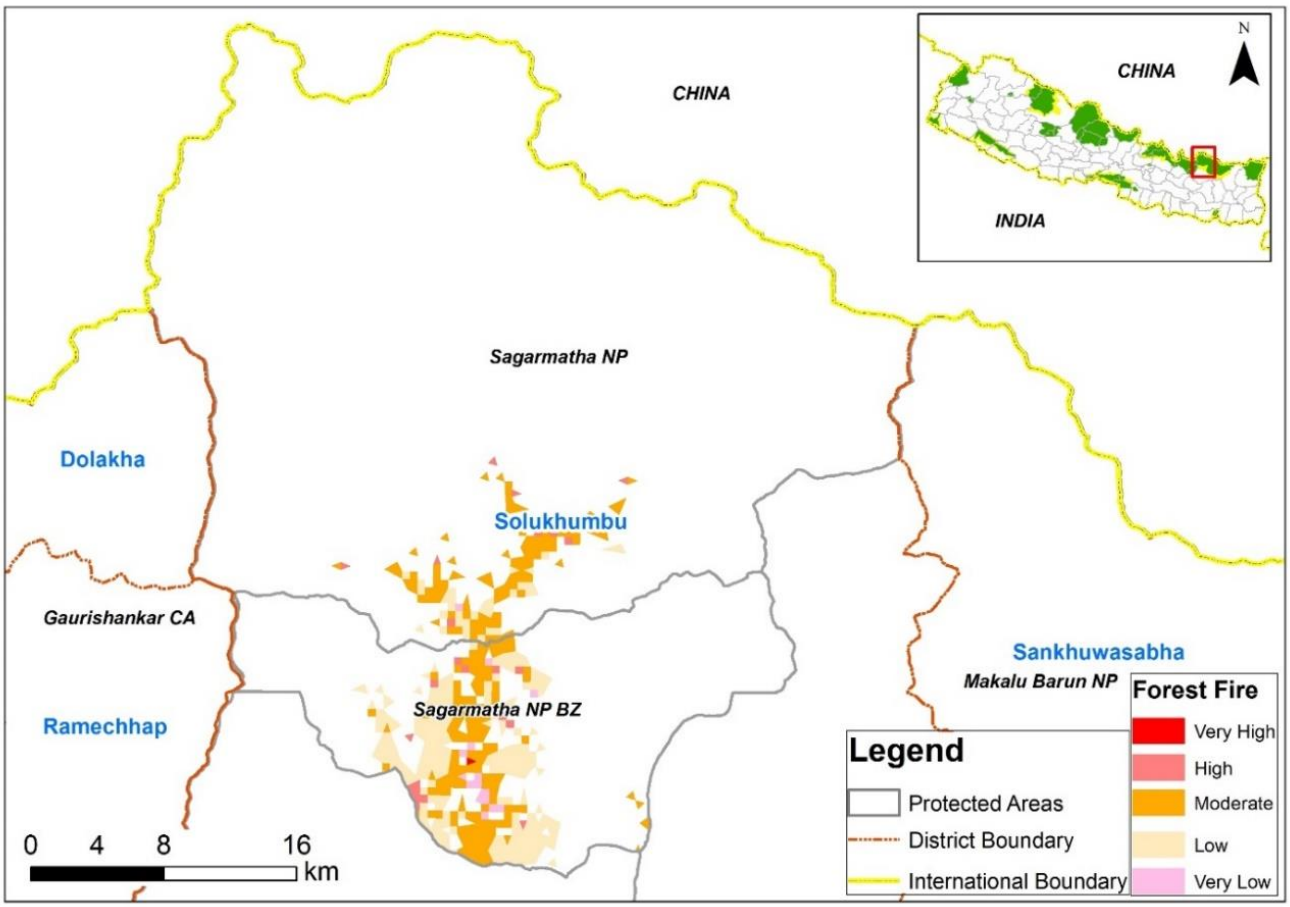
8.1.1 Habitat Loss and Degradation

Increase in human pressure and activities there is most likely of wildlife species including Red panda being threatened due to habitat alteration. The impact of habitat loss and degradation for red panda varies throughout the country (Jnawali et al. 2012).

Augmented habitat loss, degradation, and fragmentation due to anthropogenic activities are the main causes of decline in red panda populations and its habitat in Nepal (Acharya et al. 2018). Annual human population growth and infrastructure developmental activities are fueling deforestation, forest fragmentation and habitat loss. Forest fires, the traditional transhumance system of livestock herding, firewood collection, bamboo and non-timber forest products (NTFP) collection, and slash and burn cultivation are important underlying causes for habitat loss and degradation in the Himalayan region (Williams et al. 2011, Panthi et al. 2017, Acharya et al. 2018).

Mass flowering and dying-off of bamboo is also one of the major causes behind habitat loss and degradation which could also extirpate a local population of red panda from a particular habitat (Steffens 2004, Paudel 2009). Extirpation of red panda due to this effect has been already reported from some areas in Manang district (Bista et al. 2017a). Due to its small body size, limited movement, and high natural predation, the species is believed to be more susceptible to this problem (Wei & Zhang 2011).

Impact of forest fires on small mammals like red panda has not been well documented, however, anecdotal observations and notes suggest that the forest fire has negative effects on red panda due to its direct effect and contribution in habitat loss. Forest fire that took place during April-May 2009 killed three red panda in Taplejung district (Williams et al. 2011). Despite of this fact, forest fires also has some good aspects as these fires create more space for bamboo growth (Figure 21) shows the forest fire map of Sagarmatha National park and buffer zone area.



8.1.2 Poaching and Illegal Trade

Red panda is poached for their furs and meat. This trade-induced threat is also reported in other red panda range countries (Glatston et al. 2015). Red panda's meat is consumed in Arunachal Pradesh, India, and Hong Kong, China. During the 9-year period from 2008 to 2016, 74 cases of trafficking red panda hides were reported in Nepal. However, the market where exactly is the demand coming from is yet to be revealed. Consumption of red panda meat has been reported from central and western Nepal (Bista et al. 2016). Although deliberate poaching of red panda is minimal in Nepal, red panda has been found trapped and killed, accidentally, in the traps set for other wildlife (Bista & Paudel 2014).

8.1.3 Small and Isolated populations

Small and isolated populations have a greater tendency towards extinction due to inbreeding depression and natural catastrophes. The potential Red Panda habitats in Nepal have been fragmented into more than 400 patches indicating Red Panda occurring in small island populations (Bista. et al. 2016). Biological corridors connecting sub-populations are still inadequate and are not sufficiently managed. It is likely that some of the red panda populations in Nepal will face inbreeding problems, due to very small isolated populations, followed by a loss of genetic diversity

Figure 21: Forest fire map of SNP

in the near future. Extinction risk in the mammalian order Carnivora is predicted more strongly than by exposure to rest of anthropogenic effects which is applicable for red pandas as well indicating their vulnerability to extinction risk (Cardillo et al. 2004, Jnawali et al. 2012).

8.1.4 Inadequate Awareness

Although the red panda is on the protected list in Nepal, many people are unaware about its protection and ecological role. Despite some awareness activities carried out in some areas, there is yet a very limited awareness level amongst different stakeholders. However, local people generally have positive attitudes towards Red panda conservation, given their cultural beliefs and that red panda do not come into conflict with people (Sharma et al. 2017).

8.1.5 Climate Change

Climate change is a more critical issue because it is causing more frequent droughts, snow falls, and floods, all resulting in shifting vegetation zones in the Himalayas (Shrestha et al. 2012). Given the red panda's narrow ecological niche, a habitat specialist in nature and feeding primarily upon a single food source (bamboo), the risks due to climate change are greatly increased. Panthi (2018) has predicted the reduction of current suitable habitat by 0.5% in 2070 due to combined effect of climate change, land use and land cover. Many bamboo species are vulnerable to climate change because of their unusual extended reproduction intervals, ranging from 10 to 120 years (Janzen 1976), along with limited seed dispersal ability (Tuanmu et al. 2013). Therefore, climate change is likely to have prominent negative effects on red panda habitat. In addition, change in plant phenology has been observed in many parts of the country, including the mid-montane forests which could be further fragmented into smaller patches (Thapa et al. 2016). In order to cope with this changing scenario, the species is likely to alter its feeding and day-to-day habit. These climate induced changes are likely to invite serious threats on its survival in the wild.

9. PEOPLE'S PERCEPTION TOWARDS RED PANDA IN SAGARMATHA NATIONAL PARK AND BUFFER ZONE

Respondents from different profession like security personnel, BZCM, CBAPU, Government officials (park/DFO officials), tourism entrepreneurs (hoteliers/nature guides), guide trekkers, student and teachers were included in this survey.

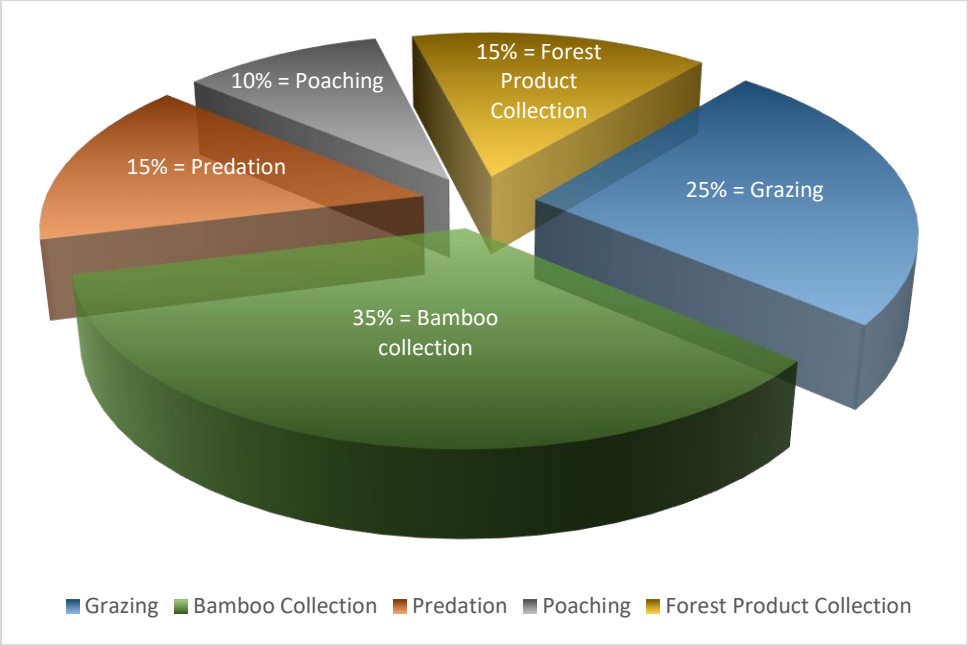


Figure 22: People's perception on factors responsible for decline in population of Red Panda

The survey revealed more than two third of these aware respondents were involved in conservation work in some way. Those people were the staff of park, BZCM, CBAPU and district forest offices along with the local people involved with some forest user groups (Figure 22).

10. CONCLUSION AND RECOMMENDATION

10.1 Conclusion

It was concluded that the presence of Red panda was found in Buffer zone of SNP namely (Himalayan BZCF, Kongdey BZCF, Pemacholling BZCF, Dudhkunda BZCF and Red Panda BZCF) of SNP respectively. Red Panda mostly preferred the altitudinal range between 3000-3200 m. Total of 64 pellet groups were found and 2 Red Pandas were directly observed. Total 38 transect lines were made. The average abundance was found to be 1.7 signs/km. It mainly preferred southwest aspect with 26-30 degree slopes associated with water sources at less than 100 m. In the present study it was found that Red Panda preferred tree species like *Litsea monopetala*, *Abies spectabilis*, *Betula utilis*, *Acer sterculiaceum* and *Quercus semicarpilofia*. Red Panda preferred shrub species like *Viburum erubescens*, *Rubia cordifolia*, *Arundinaria maling* and *Drepanostachyum intermedium*. Red panda preferred herb species like *Dryopteris sps*. and *Fragaria nubicola*. Red panda preferred moderate ground cover between 25-50% and dense crown cover. On the basis of Focus Group Discussion 35% respondents stated that collection of bamboo was the main cause behind the decline of Red Panda population. Other causes included Grazing (25% respondents), Predation (15% respondents), Poaching (10% respondents) and collection of Forest products (15% respondents). Out of 47 Habitat Use plots, wildlife droppings were found in 44 plots (93.6% of the total plots) and livestock droppings were found in 11 plots (23.4% of the total plots).

Red Panda signs were found between 2,600-3,400 m. Red Panda preferred elevations between 2,800-3,000 m (IV= 0.13) and 3,000-3,200 m (IV= 0.15). It wasn't found below 2,600 m and above 3,400 m. The average abundance of Red Panda in SNP was found to be 1.7 signs/km.

Red Panda mostly preferred South-West aspect (IV= 0.18) and slopes between 26-30 degree (IV= 0.36). Red Panda preferred places that were at a distance less than 100 m from water source. Red Panda preferred tree species like *Abies spectabilis, Betula utilis and Acer sps*. etc., shrub species like *Viburum erubescens* (IV= 0.2), *Rubia cordifolia* (IV= 0.05), *Arundinaria maling* (IV= 0.1). Herb species like *Dryopteris sps*. (IV= 0.03) and *Fragaria nubicola* (IV= 0.3) were preferred by Red Panda. It preferred moderate ground cover and dense crown cover. The Red Pandas encountered during the field visit were found resting in a dense crown cover.

According to the social survey and field observation, major threat to Red Panda were Grazing and Bamboo collection.

10.2 Recommendation

Some of the recommendations are as follows:

- Unregulated grazing practice must be regulated. Separate site can be allocated for grazing and rotational grazing, stall feeding, etc. can be effective.
- Habitat restoration can be done in order to prevent their extinction. Various kinds of plant species preferred by Pandas can be planted.
- Overexploitation of local resources must be stopped and collection of bamboo from the forest must be stopped. Separate site and time must be allocated for bamboo collection.
- Anti-poaching groups must be formed in the communities so that regular patrolling can be done.
- Conducting detailed field studies on red panda ecology, behavior, habitat and distribution range is necessary to improve its conservation and suitable Red Panda habitat must be recognized in order to protect the species.
- Budget must be allocated by the NP to the BZCFs in order to conduct Conservation Programs related to Red Panda.
- Training related to Community Based Red Panda monitoring must be given and conducted in various BZCFs.
- Although various legal provisions had been made for the conservation of Red Panda, they have not been implemented properly. Hence, these kinds of provisions must be strictly implemented.
- Awareness programs must be conducted related to Red Panda to make local people more aware about the significance of this species.
- Like in Red Panda Protected Forest of Illam, BZCFs of SNPBZ may be encouraged to take up tourism measures in Red Panda habitat, where they could take small groups of tourists who are interested to know about Red Panda.

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ANNEX

Annex 1: Photo Gallery

Figure : Ghat during Lhosar for oppurtunistic survey

Figure : Program organized by REED Nepal regarding Community Based Red Panda Monitoring

Figure : Field visit to different BZCFs

Figure : Human Disturbances in the Red Panda habitat

1- *Centella asiatica,* 2- *Pieris floribunda* 3- *Arundinaria maling*

5. *Drepanostachyum intermedium* 4. *Abies spectabilis*

Figure : Some Herb, Shrub and Tree species seen in the Study area

Figure : Droppings of Red Panda in different substrate

Figure : Red Panda seen in Pemacholling BZCF, SNP

Figure : Dead Red Panda found in Lukla BZCF, SNP

1: Livestock and Red Panda droppings

2: Wildlife and Red Panda droppings

Annex II: Questionnaire for the Household survey

Date: ……..
Full name of the respondent: …….
Age: …….. Sex: ……..
Occupation: ……. Education: …….
Address of the respondent: Municipality: …… Ward No.: …….. Tol: ……

1. Do you think wildlife is important? Yes/No. Why?

2. Do you think red panda is important? Yes/No. Why?

3. Is worth to conserve Red panda? Yes/No

4. Are red pandas increasing/decreasing/stable in this region within five years?

5. What was the status of red panda?
    a) Before the initiation of community based red panda monitoring? (Increasing/stable/decreasing)
    b) During the project? (Increasing/stable/decreasing)
    c) After the project? (Increasing/stable/decreasing)

6. What was the status of red panda conservation?
    d) Before the initiation of community based red panda monitoring? (Increasing/stable/decreasing)
    e) During the project? (Increasing/stable/decreasing)
    f) After the project? (Increasing/stable/decreasing)
7. What do you think is the reason behind it?

8. What is the role of the community in red panda conservation?

9. Who are actively involved in red panda conservation? (Person/group/agency)

10. How active is the community based red panda conservation initiative in this region at present?

11. What are the efforts made/activities done by community based red panda conservation initiative?

12. How effective is it?

13. How aware are you/people about the need of the conservation? (High/Medium/low)

14. What do you think are the conservation challenges of red panda?

15. How can it be overcome?

16. What changes do you see in the commitment among people after the project ceased?

17. How is the support like from concerned agencies?

18. What are the existing laws/regulations to conserve red panda?

19. What is the status of capacity development of local people?

20. Do you think the project impact was sustainable? Yes/No. Was it effective?

21. What changes did it bring?

22. What weakness did it have?

Annex III: Checklist for KII - 2 (with warden, Buffer Zone Committee Chairman)

Date:

Name: ……. Age: ……. Gender: …….....
Literacy Status: …… Address: …… Occupation: ……..
Involved organization/group: …… Post: ……..

1. What's your view on conservation of wildlife? Why should they be conserved?
2. What are the efforts made to conserve wildlife? (Personal/organizational)
3. Why do you think red panda is important?
4. What are the efforts made in monitoring of red panda?
5. How do you rate your success of work? Good/Fair/Poor
6. What is the status of red panda conservation initiative?
7. How is it now? What's the difference? Why?
8. What problem you faced during the conservation program? If any.
9. What is the trend of it during five years? Increasing/decreasing/stable
10. What are the major challenges on conservation of red panda?
11. What is the support like from concerned agency?
12. What is the people's perception towards your work?
13. How often the monitoring work is done? (Always/Often/Sometimes/Rarely/Never)
14. How often patrolling is done? (Always/Often/Sometimes/Rarely/Never)
15. What is the status of red panda crime within five years? (High/Moderate/Low) (also in number)
16. What is the status of red panda population within five years? (High/Moderate/Low)
17. Has there been any effort from Govt./NGO/INGO for your capacity build- up or motivation?
18. What other agencies/group/unit are involved in red panda monitoring?

19. Are you satisfied with the present activities of community based red panda conservation program? (Very satisfied/Satisfied/Neither/Dissatisfied/Very dissatisfied)

20. How do you think can community based red panda conservation be promoted in coming days?