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CHAPTER 16

RED PANDA IN EASTERN NEPAL: HOW DO THEY FIT INTO ECOREGIONAL CONSERVATION OF THE EASTERN HIMALAYA

By

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ABSTRACT

Ecoregion-based conservation (ERBC) is the crux of the World Wildlife Fund's (WWF) global landscape-level biodiversity conservation vision. An ecoregion transcends national borders and, instead, focuses on meaningful biological boundaries that support distinct, major ecological and evolutionary processes which create and maintain biodiversity. Therefore, ERBC ensures long-term protection through representative regional biodiversity. In 1999, WWF and several other international conservation organizations held a workshop to create an ERBC plan for the Eastern Himalaya. One of the critical eco-regions in this plan was the Eastern Himalayan Broadleaf and Conifer Forest, the most under-represented forest type in Nepal's protected area system. In 2002-2003, an interdisciplinary study was conducted focusing on red panda and human ecology to understand the current status and future threats to the endangered red panda and Eastern Himalayan broadleaf ecosystem. To determine red panda distribution and micro-habitat usage over a 12 km^2 study area, an elevational scat survey and sampling of 133 red panda and random plots was conducted from 2,400m – 3,000 m. A land-use survey and non-formal and formal interviews were conducted to understand human usage of Eastern Himalayan Broadleaf and Conifer Forest. The results of this preliminary ecological research indicate that red panda are possible indicators of the status of the Eastern Himalayan Broadleaf and Conifer Ecoregion in eastern Nepal. Human ecological results indicate that the creation of eastern Nepal's first road, through Jamuna and Mabu Village Development Committees, began a trend of intensive, market-driven land-use, which has, in turn, threatened red panda and its habitat, the Eastern Himalayan Broadleaf and Conifer Forest.

Key Words: *Ailurus fulgens fulgens*; ecoregion; Eastern Himalayan Broadleaf and Conifer Forest; Ilam; Nepal; Panchthar; red panda

INTRODUCTION

Eco-regional Conservation

An eco-region transcends national boundaries and, instead, focuses on meaningful biological boundaries that support distinct, major ecological and evolutionary processes, which create and maintain biodiversity. It addresses ecological requirements by meeting spatial needs that maintain viable species populations and manage anthropomorphic threats at multiple scales. Therefore, eco-regional conservation ensures long-term protection through representative regional biodiversity (Dinerstein *et al.* 2000; Wikramanayake *et al.* 2001). To ensure the implementation of eco-regional conservation, a regional biological vision is first created. Then priority areas within the region are selected based on biological importance and landscape integrity.

Eastern Himalaya

The Eastern Himalaya, which spans from central Nepal to northwestern Myanmar, has a high beta diversity, is the world's center for diversity of *Rhododendron*, *Primula*, and *Pedicularis* species, and its little studied terrain could house isolated populations of yet undiscovered species (Yonzon 2000; Wikramanayake *et al.* 2001). Its geographic location makes it a crucial link for global biodiversity conservation efforts in South Asia. It lies between two geologically older biomes -- the paleoarctics to the north and paleotropics to the south. Infiltration of biological species from both, and the mixing with indigenous ones, makes the region rich in all levels of its biodiversity (CBS 1998; Yonzon 1989). However, expanding human population has cleared vast areas of forest to meet its needs (Choudhary 2000; Eckholm 1975, 1976; Hrabravsky and Miyan 1987; Ives and Messerli 1989; Metz 1994;). One of WWF's global 200 eco-regions is the Eastern Himalayan Broadleaf and Conifer Forest (EHBF), which provides an important linkage between the Eastern Himalayan subtropical and Eastern Himalayan subalpine ecoregions. To date, only 11 % of the EHBF is preserved in small protected areas of 275 km^2 or less (Wikramanayake *et al.* 2001). To create conservation priorities for the EHBF region, conservation experts conducted simple spatial analyses using indicator species. The red panda was used as one of the indicator species for the EHBF, because of its habitat specialization, especially its need for mature forest for breeding. However, the understanding of red panda micro-habitat structure and needs are poorly understood (Choudhury 2001; Pradhan, Saha, and Khan 2001a; Yonzon 1991; Yonzon and Hunter 1991). Understanding these needs is important to establishing benchmarks for long-term monitoring of the EHBF throughout the Eastern Himalaya.

The implementation of long-term monitoring is essential to successful eco-regional conservation and depends on participation and empowerment of local people (Stevens 1993). Empowerment begins with the understanding of local people's perceptions of their environment. In the Bolivian Andes, Bastien (1978) identified Aymara indigenous belief systems and demonstrated how these beliefs are important keys to understanding complicated land use patterns (Bastien 1978). Managers can use the understanding of these systems to create effective long-term management plans. Taking into account villagers' beliefs and needs encourages them to take more action in actively conserving their lands (Sherpa, Wangchuk and Mongar 1992). Therefore, in order to establish the importance of red panda to ecoregional conservation, we must simultaneously understand its micro-habitat requirements and elucidate local belief systems and land-use patterns. This preliminary research focuses on understanding red panda micro-habitat stucture and local belief and land-use systems within the cultural mosaic of Mabu and Jamuna villages of Ilam district in eastern Nepal (Wikramanayake *et al.* 2001) (Figure 1). This study is the first of many steps that need to be taken to understand the red panda's role in indicating the health of the EHBF. It also alludes to some of the reasons behind local land-use decisions, which, when more clearly understood, will provide a powerful tool that future managers can use in protection and management of the Eastern Himalayan Broadleaf and Conifer ecoregion.

Study Area

This study was conducted from 2002-2003 in Jamuna and Mabu VDCs of the Ilam district in eastern Nepal (88°59-88°02 East and 27°04-27°01 North) (Figure 1). The study area covers roughly 12 km^2 and contains the largest contiguous pure oak stands in the Ilam district, and possibly all of Eastern Nepal (Yonzon 2000). Its north-and-south facing slopes are the Nepalese extension of the Singhalila range, which forms the eastern border of Nepal with India. Geographically the area is surrounded by the Mahabarat Lekh to the north, Jowbari ridge to the south, the Singhalila range and an international border and motorable road to the east, and the Mai Khola on its western edge. Politically, it is bordered by four VDC's--to the north is Mai Majhuwa, south is Pyang and Jogmai, and Mai Pokhari lies to the west--and Singhalila National Park, Darjeeling district, West Bengal, India to the east (Figure 2)(NCDC 1998a; NCDC 1998b; Bose 1972). Ten villages are found within the study area; those along the border road are called border villages while all other villages are called interior villages. The border villages are (from north to south): Kalpokhari, Kaiyakatta, Gairibas, and Jaubari; and the interior villages are (north to south): Dobato, Piple, Hagetham, Sisne, Nuntala, and Teenkharke (Figure 2). Politically, Jamuna comprises two-thirds of the study area; eight of the ten villages (Gairibas, Jaubari, Teenkharke, Nuntala, Sisne, Hagetham, Piple and Kaiyakatta) are from Jamuna while only two (Dobato and Kalpokhari) are from Mabu (Figure 2) (NCDC 1998a; NCDC 1998b). This *lekh* (highland) area, ranging from 1,600m – 3,000m, contains a mixture of ethnic groups typical of upper elevation villages of mid-hill Nepal. Sherpas, Tibetans, and Bhotia, peoples with origins from the Nepalese Greater Himalaya valleys or Tibet, dominate the study area (Gurung 1999; Stevens 1993). Eastern Kirats, including Rai, Limbu, and Sunwar, and ethnic groups from other regions of Nepal, including Tamang, Gurung, Brahmin, Newar, and Damai, are also present (NCDC 1998a; NCDC 1998b). These peoples depend on two types of forest for sustenance: lower temperate mixed broadleaf (2,200m – 2,800m) and upper temperate mixed broadleaf (2,800m – 3,100m) (Stainton 1972).

METHODOLOGY

Ecological Census

An ecological census, with a total of 67 field days, was conducted from November 2002 until mid-March 2003, with several breaks due to Maoist rebel movement in the study area. Seven elevational line-intercept transects, one every 100 meters from 2,400m – 3,000m, were surveyed using a Garmin Etrex Vista® GPS and a His Majesty's Government of Nepal (HMG) 1:25,000 survey map as elevational guides (Sutherland 1996). The 2,400m mark was used as the starting transect because it was the lowest elevation at which a red panda was observed in neighboring Singhalila National Park , Darjeeling, India (Pradhan, Saha, and Khan 2001a). The 3,000m mark was used as the ending transect because the study area's highest point is 3,080m. Red panda presence was measured by recording the latitude and longitude of indirect (pawprint, scat) and direct red panda sightings with the Garmin Etrex Vista® GPS. These data were then entered into ArcView GIS 3.1 software to create a distribution map.

Micro-habitat Analysis

Two types of plots were measured using the ten-tree sampling method: plots where red panda sign was found and random plots where red panda sign was not found (Mueller-Dumbois and Ellenberg 1974). After approximately ¼ km of hiking, if no red panda sign was observed then a random plot was selected using a random number table (Singh and Singh 1996). If red panda sign was observed then the observed point was used as the plot center and a panda sign plot was measured. The plot center point was determined by pacing the randomly generated number and direction and a random plot was measured.

In panda sign plots habitat variables measured included canopy cover, slope, altitude, aspect, habitat type, topography, ten longitude and latitude points, tree diameter at breast height (DBH) and species, substrate used (if the substrate was a tree its species and DBH), number of pellet groups and pellets per group. At random plots, canopy cover, slope, altitude, aspect, habitat, topography, ten longitude and latitude points, tree DBH and species were recorded.

In every random and panda sign plot bamboo, shrub, and understory species density, cover, and frequency were measured in a 3x3m quadrat (Pradhan *et al.* 2001a; Shrestha 1988). A cardinal direction was chosen using a random table. The 3x3m quadrat was then placed away from the plot center point in the chosen direction (North, East, South, or West). Number, type and percent cover of shrub species, number, height, and percent cover of bamboo and understory species were recorded. In both random and panda sign plots, three degradation variables, livestock (L.S.), human (H.D.), and malingo disturbance (M.D.) (malingo is a small diameter bamboo used for weaving), were measured based on percent cover. For livestock disturbance (L.S.), the percent cover of the plot grazed by livestock as evidenced by hoof marks and vegetation under two meters eaten was measured. Human disturbance (H.D.) was measured by the percentage of plot trees cut for firewood and fodder. Malingo disturbance (M.D.) was measured by the percentage of malingo stems cut. The importance value index (IVI) for the tree species was created by summing the species relative frequency, relative abundance and relative dominance (Curtis 1959). Only species with an IVI of 10 or greater were used in analyses.

Interviewing

For the first month in the field I became acquainted with inhabitants of the study site. Local villagers were curious about the study and asked many questions about red panda and forests. These questions created a natural transition into other subjects like land-use, community forestry regulations, attitudes toward biodiversity conservation, development, and land-ownership and management. After many hours of conversation with different people and families, key informants were chosen for semi-structured interviews that included both group and one-on-one interviews.

Sketch map interviews focused on forest land-use, as well as attitudes toward biodiversity conservation, forest regulations, and community forestry (Fox 1989; Mehta and Kellert 1998). To create the sketch maps, grid cells of an HMG 1996 1:25,000 topographical map were redrawn and enlarged on a blank sheet of newsprint paper. In April and May, four sketch map group interviews were held in Jaubari, Kalpokhari, Dobato, and Hagetham. At each interview, except in the case of Hagetham when Hagetham Community Forest Committee (H.C.F.C.) members attended, five local residents, including one female, labeled and identified physical objects such as rivers, roads, schools, houses, farmland, grazing land, National Forest, and trails on the blank maps. Then interviewees identified and labeled forest land-uses. Each land-use was given a symbol and the symbol was drawn in the area where the activity occurred.

After the completion of each sketch map interview, follow-up one-on-one interviews were held with key informants. These informants included local leaders, teachers, businessmen, women, and farmers. Interviews were taped and some answers recorded during (or five to ten minutes after) the interview was completed. Interviews focused on land-use, ownership and management, the H.C.F.C., the Ilam district forest office, development, the local economy, and settlement history. Questions were left open-ended to create unbiased responses. They were broad at first and then asked about specific topics as the interview proceeded.

Land-use Survey

From May to June 2003, two surveys -- demographic and land-use -- were conducted to obtain complementary quantitative data on Jamnua and Mabu land-use and management, economy, and development. The demographic survey followed Mehta and Kellert (1998), while the land-use questionnaire followed Brown and Shrestha (2000) and Kennedy and Dunlap (1989).

All households from the 10 villages surrounding the study area were surveyed (Figure 2). At each household, the number of household members, ethnicity, age, education level, land owned (*ropani*), number of livestock, monthly expenses, type of roof, monthly firewood usage, monthly bamboo usage, and number of dogs, were recorded. These data were entered into an Excel™ spreadsheet and SPSS version 10.0™ to analyze trends.

In the 10 Jamuna and Mabu villages, villagers were given a 32-question land-use questionnaire to discover the level of intensity of fodder, bamboo, firewood, and timber usage, and to document income sources. First the land-use questionnaire was tested on several villagers after which it was translated into Nepali and administered to every household in the 10 villages. Responses were tallied and entered into SPSS version 10.0™ for analysis. The study area was divided into north (Dobato, Kalpokhari, Piple and Kaiyakatta) and south (Hagetham, Gairibas, Jaubari, Nuntala, Teenkharke, and Sisne) to create a 33/67 split for statistical analysis (Figure 2). Cross-tabulations, and chi-square and t-tests were then performed on the data based on the north and south study area split.

RESULTS

Red Panda Distribution

In the ecological census, indirect and direct red panda observations were recorded between 2,400m - 3,000m (Figure 3). Based on the Pradhan, Saha, and Khan's (2001a) study on the adjacent eastern side of the Singhalila range, the study area was analyzed in 200 meter blocks: 2,400m-2,600m (lower mixed broadleaf forest), 2,600m - 2,800m (oak forest), 2,800m - 3,000m (upper mixed broadleaf forest). From 2,400m - 2,600m, red panda sign was observed at a rate of .56/km. At the 2,600m - 2,800m range, it was observed at close to five times the 2,400m - 2,600m rate at 2.44/km. At the last altitudinal range, 2,800m - 3,000m, red panda sign observance doubled the previous range's rate at 5.1/km (Table 1). This distribution of red panda sign indicates that red panda are relatively more abundant in the 2,600m - 3,000m range and that they are most dense in the 2,800m - 3,000m range.

Based on analysis of video footage and photos taken during direct observations, coat coloration and markings differed between 3 of the 4 individuals observed. Also, the remains of one red panda were found. According to local villagers, an unleashed Tibetan mastiff from Kaiyakatta killed the red panda 4 months earlier. Interestingly, though not statistically significant, the frequency of sightings coincided with the density of scat distribution with one sighting at both the 2,400m - 2,600m and 2,600m - 2,800m range, while 4 sightings occurred from 2,800m - 3,000m.

Micro-habitat Usage

In Pradhan, Saha, and Khan's (2001b) study high red panda use areas were correlated to canopy cover, bamboo height and bamboo cover. During this study, differences between the panda sign (n=56) and random plots (n=77) using the thirteen habitat and disturbance variables--season, canopy cover, altitude, tree density, average DBH, shrub cover, bamboo height, density and cover, and livestock, human, and *malingo* disturbance—indicate similar results. In our regression models, red panda were also more likely to be found in areas with greater canopy cover (SE=.025, P=.02; SE=.036, P=.01; Table 2). However, our models indicate that two other variables - livestock disturbance (SE=.72, P=.05; SE=.04, P=.02) and tree DBH (SE=.01, P=.04) – were important to red panda presence (Tables 2 and 3).

Jamuna-Mabu Settlement History

The creation of Darjeeling and its economy is the most important factor in the development of the Panchthar-Ilam-Singhalila region. In the early 19th century, it attracted Nepalese to its many jobs, such as tea-picking, road and building construction, and portering for exploration. In the late 1940's, to secure the Nepalese-Indian border, the British began building a road. Before its construction it took two or three days walking from Jamuna or Mabu to reach the closest market town, Manebhanjyang, which limited migration into the area. Most of the area was used as spring and summer pastures by Jamuna and Mabu agropastoralists. As one older Kalpokhari resident stated:

> "I came to Darjeeling because I heard the streets were paved with money. It turned out that I had to build the roads with my bare hands for only one rupee a day."

The construction and completion of the road transformed the marginalized uplands into the region's economic center. What used to be a two-to-three day walk turned into a 3-4 hour jeep ride. Villagers who used to trade their wares at weekly fairs now had access to the Darjeeling market. Road workers and businessmen moved in and, where there were only cattle herding shelters or huts before, small trading villages were created. An interesting dichotomy emerged with all of the border villages (Kalpokhari, Kaiyakatta, Gairibas, and Jaubari) becoming trading villages, while the interior villages (Dobato, Piple, Hagetham, Sisne, Nuntala, and Teenkharke) remained marginalized.

Land Ownership and Management

According to 1971 survey maps, all of the land in the study area is government owned land, except for small parcels attached to village homes, two two-*ropani* pieces of land on the ridge between Dobato and Piple, a 10-*ropani* lot on the Piple ridge, another 10-*ropani* parcel on the border directly south of Kalpokhari, and a 40 *ropani* lot to the northeast of Jaubari (HMG: Ilam Land Survey 1960) (one *ropani* = 0.93 ha) (Figure 5).

Legally, the two managed forest types in the study area are 'national' and 'community'. Three fourths of the study area is national forest and one fourth of it is community forest. However, in Jamuna and Mabu, the observed and legal managers differ. Three entities manage the land, two of which are *kipats*, a form of traditional family land tenure, that operate without government consent. A Limbu family from Piple and a Sherpa family from Kalpokhari manage these *kipats*, covering the northern half of the study area, while the Hagetham Community Forest Committee (H.C.F.C.), a local committee working under the auspices of the Ilam District Forest Office (D.F.O.), manages the southern half of the study area.

Land Use

Land-use decisions are driven by land ownership and management but most importantly by the economy. In the study area, livestock and farming are the most important income sources and sketch map interviews and participant observation identified seven land-uses detrimental to Eastern Himalayan Broadleaf Forest (EHBF) that are associated with these income sources. They are grazing, malingo and timber cutting, trail and road building, fodder collection and hunting. These land-uses are found throughout the study area, but have intensive-use areas located around each village. Land use differed between the interior and border villages, with the interior villages using the study area more diversely.

<u>Grazing.</u> The study area has been grazed for at least 156 years. In 1855, Sir Joseph Dalton Hooker's entourage bought meat for their evening meal from a "Guroong" (Gurung) shepherd, whose flock grazed at Tongloo, 1 km to the southeast of Jaubari (Hooker 1855).

Today, livestock is the most important income source to the economy of Jamuna and Mabu. In this study, livestock includes goats, cows and their calves, oxen, *chauri* (yak-cattle hybrids) and their calves, horses, and water buffalo, which are sold for meat and their milk used to make cheese and *churpi*, a form of dried cream. The meat, *churpi* and cheese are produced for the Darjeeling market. Twenty-five years ago, Tibetans introduced *chauri* and *churpi* to the area, and *churpi* subsequently has become one of the main income sources. It is easily produced in dairies, homes, and *goths* from cow and *chauri* milk, and sells for 160 Nrp/kg in Darjeeling.

Stall-fed and free-range cattle and *chauri* supply the two *churpi* production methods, dairy, and household, resulting in differing EHBF degradation. Households produce the majority of study area *churpi* and only in Hagetham, Sisne, and Nuntala are cattle stall-fed (Figure 2). Overall, stall-fed cattle are less degrading to the forest. Fodder is cut selectively, and regeneration is allowed to occur. However, *malingo*, 80% of the red panda diet (Pradhan, Saha, and Khan 2001b), is the most favored fodder cut. Also, children often are sent to cut fodder without learning proper pruning techniques, resulting in a loss of regeneration. Throughout the rest of the study area, milk is provided from free-range cattle or *chauri* that graze the uplands of the northern study area and southern border villages, where red panda reside. According to northern villagers, they need nine-to-ten head of cattle to turn a profit. The actual numbers of livestock head per household and mean number of livestock head per household reflect this statement. In the north, 67.6% of the households have ten or more livestock head per household, while in the south 76.3% of the households have nine livestock head or less (n=110, SE = .04, $P < .001$). Also, the mean number of livestock head per household demonstrates this difference, with the north (13.11) having a significantly greater mean than the south (7.75) (n=110, SE=.03, $P = .045$).

Malingo Cutting. In the Ilam uplands, *malingo* is essential to human and red panda life. A local village woman aptly stated its importance to village life when she said, "No malingo, no work." Without it a household would not function. It is used as fodder, roofing, fencing, walls, and baskets, for bedding, to support crops, as combs, kitchen utensils, and baby cribs. It is also essential to red panda. It is 100% of their diet for seven months of the year and 47% during the other five months (Pradhan, Saha, and Khan 2001b). Two years ago, domesticated bamboo flowered, causing all of its culms to die, and villagers from Maimahjuwha, Jamuna and Mabu, who used to cut it for all their household needs, now have to rely on *malingo*. Kalpokhari and Dobato villagers said the number of *Malinge*, or *malingo* cutters, has doubled during this time period. According to elderly villagers *malingo* last bloomed in 1950.

Firewood Cutting. Besides *malingo*, trees are important to red panda survival. They are used for nesting, sleeping, shelter, and feeding (Pradhan, Saha, and Khan 2001a; Yonzon 1989; Johnson, Schaller and Hu 1988). However, firewood is required for most household energy needs. It is used for cooking, heat, and drying. It is needed to cook human and livestock meals, for making *rakshi*, a homemade rice or wheat liquor, and *chang*, a homemade rice or millet wine, in the preparation of *churpi*, and for keeping clothing and bodies warm and dry during the winter and monsoon.

Average household firewood consumption in the study area was 21 loads a month. Consumption varied depending on elevation and economy. The north, with an average of 24 loads per month, used more firewood than the south, where households consumed an average of 19 loads per month (n=110, SE=.03 P=.001). All the *Lekh* or upper elevation villages, except Jaubari, consumed more firewood than the lower elevation villages. In Jaubari, a *pill*, or stack of firewood, which is 30 loads, costs the same amount of money and lasts the same amount of time as a cylinder of natural gas. Therefore, of the 12 homes with gas in the study area, 10 are in Jaubari, lowering its average household firewood consumption.

Timber. Recent economic and cultural changes have modified timber use. In the past, swidden agricultural practices used old-growth trees as fences. In a five-ropani area, the four largest trees were cut, and their trunks became fence sides and the branches became firewood. In Piple and Dobato, these old fences are still visible as reminders of another time when potatoes were the most important income source. Today, trees are cut for new home, trail, and road construction.

In 2002-2003, 28.2% of households built a new home or go*TH*. The north had a significantly greater percentage (44%) of new homes or *goTHs* built than the south (n=113, SE =.45, P= .001). One of the new homeowners stated that it took seven medium-sized (30-50cm DBH) trees and the overall cost to build a two-story structure, including the tin roof, carpenters, and loggers, was around 100,000 Nrp. The cost of a traditional home is considerably lower because it requires little skilled labor and most materials come from the local forest. The extraction of bamboo and construction of thatch is done by the homeowner. However, the construction of a wood home is a sign of wealth and many villagers strive to build one. In the past two years, eleven wood homes were built. In 2002, four homes, three lodges in Kalpokhari and one home in Hagetham, were constructed. In 2003, seven homes, one each in Kalpokhari, Hagehtam, Teenkharke, and Kaiyakatta and three in Dobato, were constructed. Much of the wood for these homes was cut during the expansion of the area's roads and trails.

Trail and Road Building. Seven years ago, to support and enhance the local economy, a one-meter wide horse trail between Dobato and Kaiyakatta (Dobato-Kaiyakatta) was cleared. Since then, changes in wealth have increased the number of jeeps. Two jeep roads from Dobato to Kalpokhari (Dobato-Kalpokhari) and Jaubari to Teenkharke (Jaubari-Teenkharke) are being constructed (Figure 2). In this construction many large trees (75 cm-125 cm dbh) were felled and either sold to Darjeeling or used locally in home construction. Along the Dobato-Kaiyakatta trail alone, I counted 30 felled large trees (75cm-125cm dbh). Despite the increase in new home construction, the majority of locals (83.9%) believe there has been a decrease in local timber usage and have not planted timber trees on their land (n=113, SE=.53, P= .001).

Fodder. According to locals, fodder usage has increased and availability decreased. Unlike firewood, most fodder is cut from the National Forest (67.8%), and a greater percentage of northern households (89.5%) use the National Forest for their fodder needs than southern households (57.1%)(n=113, SE=.67, P= .001). Most villagers cut two loads of fodder a day, one in the morning and another in the evening. For larger animals, forest grazing does not provide sufficient calories and their diet is supplemented with cornmeal. According to local farmers, green leaves have the most nutrients and provide livestock with minerals not found in the cornmeal. Overall, 46 types of trees and understory plants are used for fodder. During the monsoon, weeds and understory plant species provide the bulk of fodder. In the dry season, *malingo* bamboo is the most abundant and easiest fodder source to cut. However, if *malingo* is not available near the home, tree branches are cut. A preferred tree fodder source is *Balu Chinde (Shefflera impresa),* the second most-used tree by the red panda. In some cases, improper lopping prevents leaf regeneration, decreasing the availability of fodder. This occurred around Kaiyakatta, where 35 *Shefflera impresa* trees were lopped to the trunk.

Hunting. According to Hagetham Community Forest Committee members and Dobato and Kalpokhari villagers, hunting occurs throughout the whole study area. Most hunters are Rai or Limbu men, who are taught hunting techniques when they are 12-14 years old. A 65 year-old Rai man from Dobato stated that Rai men usually hunt in celebration of their tribe's attachment to nature. Twenty years ago, hunting was a lucrative profession and hunters sold anything they could kill. Foreigners bought birds for 5 Nrp and, in India, red panda fetched a price of 1,800 Nrp, which at that time was enough to feed a family of 5 for five months. To catch red panda, a line of 10 hunters would hike the forest on the sides of streams. When they saw a red panda, they would chase it up a tree, throw a bamboo lasso around its neck, yank it down from the tree, shove a piece of wood in its mouth to stop it from biting, and throw it into a sack. A middleman from the village of Rimbik, Darjeeling, would buy the animals and send them through Calcutta to zoos around the world. According to Bahuguna *et al.* (1998), in the 1960s alone, 300 red panda were trapped and traded from the Singhalila range.

Cattle and *chauri* herders, commonly called *goTHwalla*, use red panda fur on the inside of their wool coats. Unleashed local and *gothwalla* dogs pose the greatest immediate threat to the red panda. Forty-six of the 113 households have one or more dogs for a total of 57 dogs in the study area. The majority of these dogs are unleashed. Locals say that *goTHwalla* dogs are the greatest threat because these dogs are trained to hunt.

DISCUSSION

In Jamuna and Mabu VDCs, red panda use a 5.5 km^2 area of montane oak and mixed Eastern Himalayan Broadleaf Forests distributed between 2,600m - 3,000m. Like Pradhan, Saha, and Khan's (2001a) study in adjacent Singhalila National Park, India, direct and indirect observations indicate that red panda are relatively denser in the 2,800m - 3,000m range. However, from 2002-2003, local dogs killed two red panda. Even with a breeding population present, because of low fecundity and predation threats, especially from unleashed local dogs, and also from natural predators, there is a high probability of local extinction. If this case study is any indication of the status of red panda throughout their range, a rapid population viability assessment is urgently required.

Yonzon (1991) states that red panda need mature forest for survival and therefore are indicators of areas with mature Eastern Himalayan Broadleaf Forest. A water source and canopy cover are most important to red panda (Pradhan *et al.* 2001a). The preliminary results of this case study also indicate that red panda prefer forest with greater canopy cover. However, tree DBH and livestock disturbance also influenced red panda usage. Based on these results, further research is needed to accurately understand the factors that influence red panda presence and how they are indicators of the status of Eastern Himalayan Broadleaf Forest.

This study has examined the importance of economics in land-use decisions in the Eastern Himalaya. It gives a glimpse of a larger issue that faces eastern Nepal and many places in the Eastern Himalaya -- economic pressure drives resource usage. Once infrastructure is developed trade routes are created and, if left unmanaged, resources are extracted at an unsustainable rate causing degradation of the last remaining tracts of Eastern Himalayan Broadleaf Forest. In this case, red panda are critically endangered because of unsustainable resource extraction. Unmanaged trail and roadbuilding, grazing, and extraction of *malingo*, fuelwood, and fodder reduce available red panda habitat. This overexploitation of the local forest creates an open forest floor, exposing the red panda to predation, especially from local dogs. If Jamuna and Mabu villages are indicative of similar areas of the Eastern Himalaya, then an aggressive conservation plan that creates local stewardship and includes local management is the only hope for red panda and the maintenance of the integrity of the Eastern Himalayan Broadleaf Forest ecoregion.

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Tables

Table 1. Encounter rate of red panda pellets/km and red panda observed in the three vegetation zones.

	Lower Broadleaf Deciduous Forest (2400-2600)	Oak Forest (2600-2800)	Upper Broad-leaf Deciduous Forest	
Red Panda Pellets	.056 ± .034	2.44±1.21	5.1±2.45	P=.05
Red Panda	1	1	2	

Table 2. Binary Logistic Regression with 2400m Plots Excluded. Binary logistic regression model and significant variables when all 2400m plots are dropped from the analysis. In this model, the variable CANOPY_C represents all canopy cover values and L.S.(1) represents plots with no livestock disturbance.

n=78		**Panda Sign**	**Random**	**% correct**
Plot Type	**Panda Sign**	32	8	80.0
	Random	8	30	78.9
			Total:	**79.5**

	B	**S.E.**	**Wald**	**Df**	**Sig.**	**Exp(B)**
CANOPY_C	.05	.025	.21	1	.022	1.05
L.S.(1)	-3.24	1.72	3.55	3	.05	.03

Table 3. Binary Logisitic Regression with Categorized Variables. Binary logisitical regression model and its significant variables when the variables altitude and aspect are categorized by altitudinal zone and direction. In this model, the variable CANOPY_C represents all canopy cover values, L.S.(1) represents no livestock disturbance, and AVG_DBH represents tree species average DBH.

N=79		**Panda Sign**	**Random**	**% correct**
Plot Type	**Random**	36	5	87.8
	Panda Sign	6	32	84.2
			Total:	86.1

Variable	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
CANOPY_C	.08	.036	.34	2	.011	.08
L.S.(1)	4.73	2.05	5.32	1	.02	.01
AVG._DBH	.02	.013	.86		.04	1.02

Figures

Figure 1. The location of the study area in Ilam District, Koshi Zone, eastern Nepal.

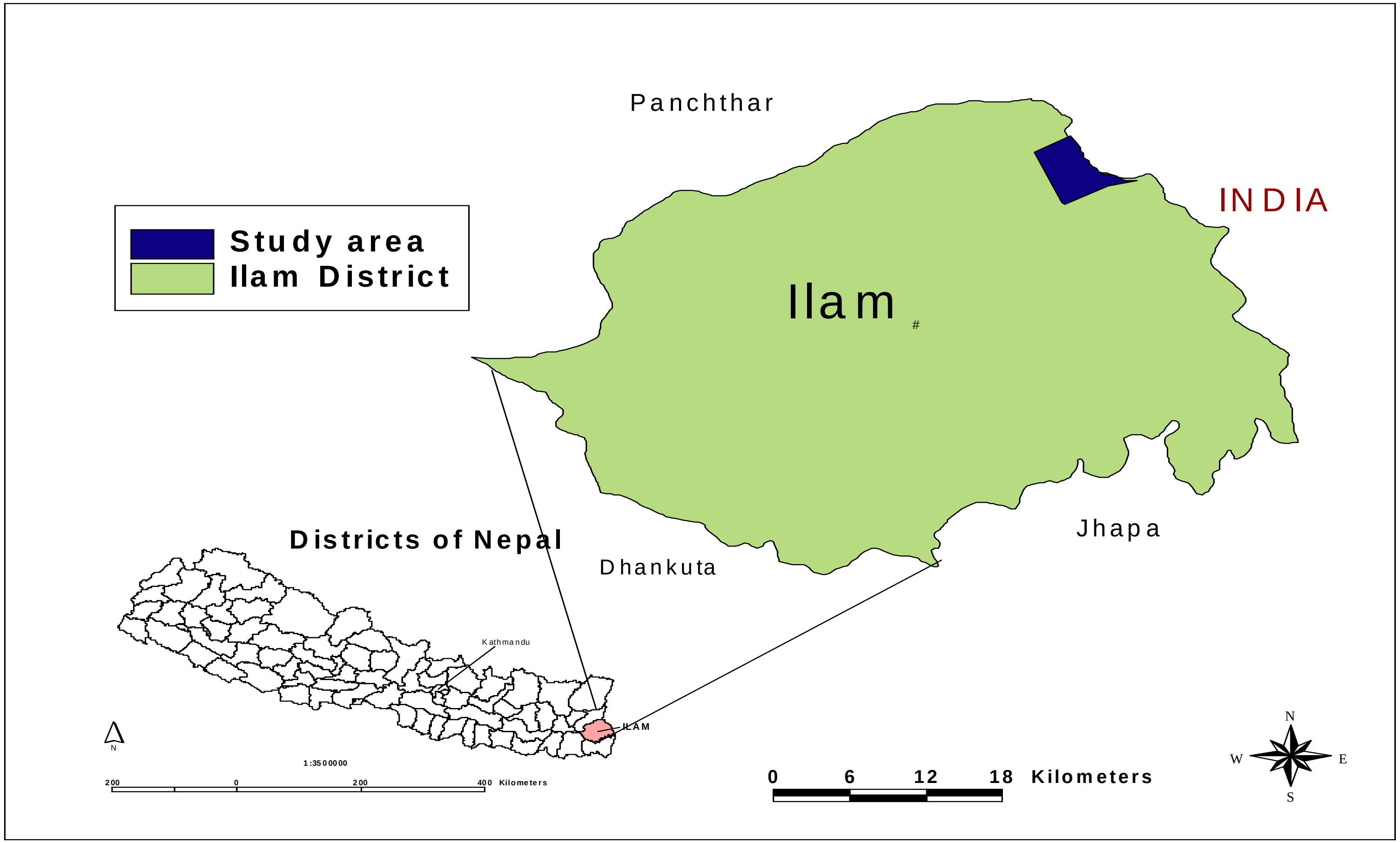

Figure 2. The north and south study areas, which are used in the demographic analysis and land use questionnaire, are distinguished by the shaded area.

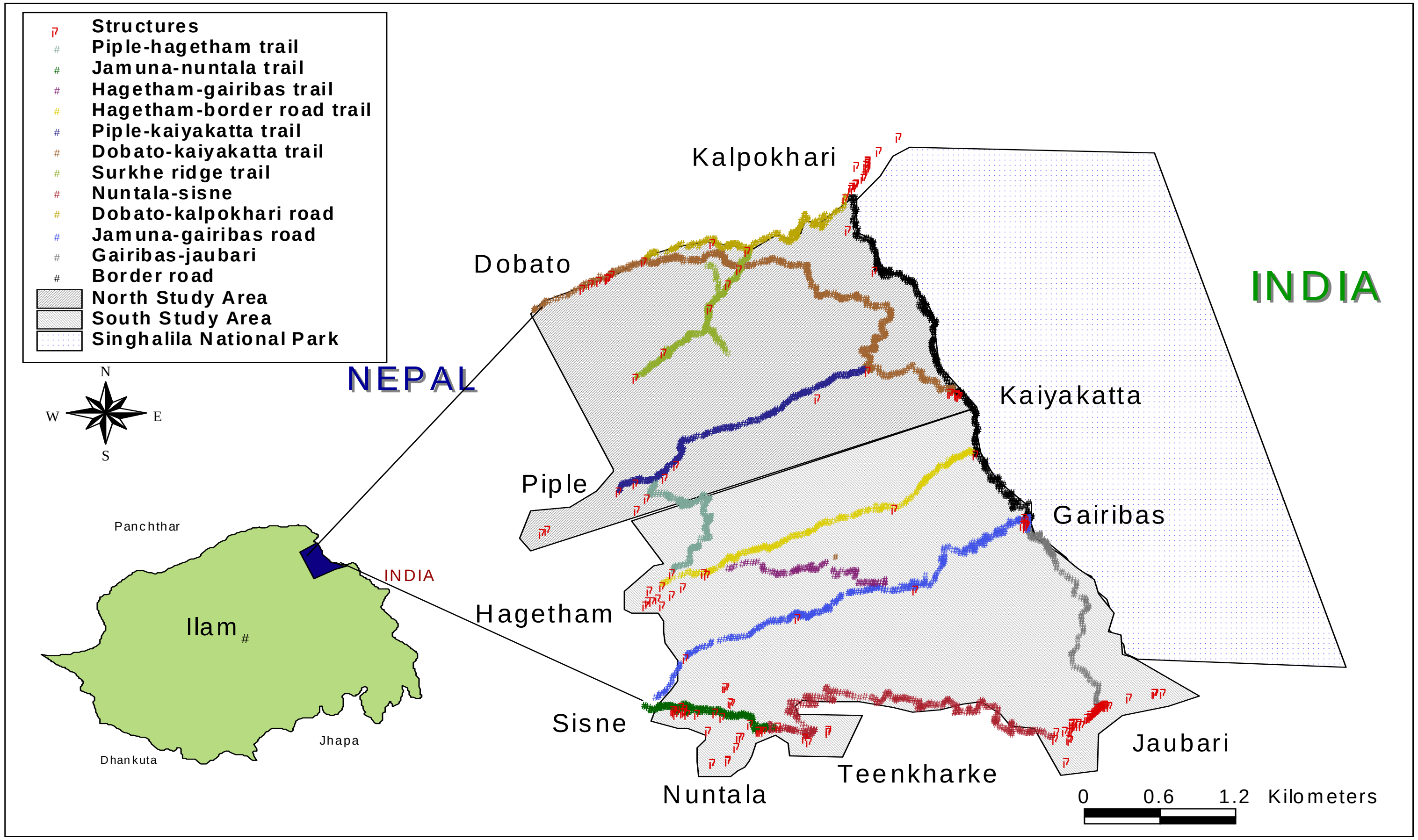

Figure 3. Distribution of red panda. The numbers represent the frequency of red panda sign encountered per kilometer at each elevational zone (i.e., 2400m - 2600m, ect.)