

CHAPTER III

ANIMAL-RANGELAND LINKAGES AND VEGETATION CHARACTERISTICS

3.1 INTRODUCTION

High altitude areas in the Khangchendzonga Biosphere Reserve are considered among the most important protected areas with high biological and landscape diversity in the region. The biosphere covers three main ecological zones; temperate, subalpine and alpine including permanent snow cover with elevation ranging from 1600 to 8598 m asl. (Lepcha 1997). It is estimated that Sikkim harbours nearly 4500 species of flowering plants with many endemic species, which represent a high diversity for this tiny state (Singh & Chauhan 1998). The vegetation of the region is used for diverse purposes, i.e. fuelwood, timber, fodder and non-timber forest products (Balaraman 1981; Sundriyal *et al.* 1994; Sundriyal & Sharma 1996)

Agriculture and animal husbandry are the primary occupation of the different ethnic communities of the Sikkim Himalaya and each household keeps on an average of about 4 animals i.e. 1 cow for milk, ox for ploughing, goat for cash need and pig for meat (Sundriyal 1994). Cattle rearing have been an integral part of farming system in the Sikkim State. The state housed about four hundred thousand livestock during 1992, which showed an increment of over 66% from 1987. Over the years these animals were reared as stall-fed (Balaraman 1981). A large number of plant species are used in feeding the domestic animals. Fodder from forest had the largest share in livestock feeding (Balaraman & Golay 1991; Sundriyal & Sharma 1996). Agricultural residues and agroforestry species maintained at the farms also contribute as fodder resources (Sundriyal 1995). Various fodder species maintained at the farms are highly nutritious and used during lean period. During recent years grazing has been replacing stall-feeding as a popular

means because of easy access to forest areas. Family fragmentation is another cause for increase in livestock number.

In Sikkim, local communities have been practising the agro-pastoral system of livelihood in which livestock are the backbones of the system. With increasing elevation the dependence on animals becomes more substantial. The Yuksam-Dzongri trail supports a large number of grazing livestock that move to alpine areas in summer months for free grazing and come down to temperate zone during winter months. The vegetation of different elevations forms the main source of fodder to these animals. The livestock are the source of economy for some people which mainly comes from animal products and pack animals engaged in tourism or mountaineering. These pack animals either free graze along the trek or at the campsites, or sometimes fed from lopped fodder. Since large number of animals are dependent along this trekking corridor within the biosphere reserve, animal and rangeland linkages and vegetation composition have to be properly understood. The vegetation utilization pattern is equally important. This information would help in drawing guidelines for management of the rangeland. The present chapter describes the information on vegetation pattern, phenology, growth and life forms of plants, assessment of economic plant wealth and documentation of their uses, parts and mode of uses, livestock rearing pattern and revenue generation from livestock grazing animals.

3.2 LIVESTOCK GRAZING AND LINKAGE

3.2.1 Livestock Number and Rearing Pattern

During 1992, livestock number of 200035 cattle, 114707 goats, 16268 sheep, 44477 pigs, 5349 yaks/dzos, 2932 buffaloes and 1789 horses totalling

to 385557 were recorded in Sikkim state (Paljor 1998) (Table 3.1). The average number of 54 animals per km² has been recorded for the state. Livestock population in Sikkim has increased by about 66% from 1987 to 1992 (Table 3.1). The livestock types and population of Yuksam-Dzongri trekking corridor is presented in Table 3.2. At Yuksam 274 families reared a total number of 1448 livestock which is 5.28 animals household⁻¹ while in Tshoka village 75 livestock was recorded showing 7.5 animals household⁻¹. The total livestock of Yuksam block was 1324 in 1996, 1365 in 1997 and 1523 in 1998 showing a growth of 15% from 1996 to 1998 (Table 3.2).

Sikkim has four major grazing routes out of which two falls in the Khangchendzonga Biosphere Reserve (Fig. 3.2). All the routes lead to alpine pastures during summer months. The animals graze on lush-green vegetation in these areas. The major portions of the grazing land is under alpine pasture followed by 'khasmal' land and 'gaucharan'. The graziers take their animals to alpine and sub-alpine pastures during the warm period generally from April to October and bring them back to the lower valley during winter months. In the lower altitudes free grazing inside the forest is not a common practice and stall-feeding has been practised. Although, some households are continuing free grazing. Generally, villagers practised free grazing and stall-fed for cow and goat, free grazing for dzo, horse, yak and sheep (Table 3.3). Only a few milking animals and calves are kept at home and stall fed. At Tshoka village all the animals were free grazed. Around 40 cows, 160 yaks, 120 dzos, 13 horses and 508 sheep (total livestock 841) extensively graze in Dzongri and its surrounding alpine pastures during summer months. Yaks graze throughout the year at high altitudes because of their inability to adapt at lower elevations.

3.2.2 Agricultural Practices and Animal Husbandry

Cultivation of cash crops like large cardamom, ginger, mandarin orange and potato along with animal husbandry have become the major economic activity in farms. Animal husbandry has good scope for further development because the region has a high potential for fodder production. The main vegetable crops are cabbage, beans, mustard, peas, potato, etc. All these vegetables are grown in their private lands and are mainly for their own consumption. Small quantities of surplus are sold to the market. The crop residues are fed to animals and supplement a good proportion of forage demand. The villagers maintain a good number of fodder trees in the agricultural lands that provides fodder during the lean period. Details on fodder trees are covered in Chapter IV. Oxen are generally used to plough the land. Livestock dung forms a major traditional manure and many villagers maintain animal numbers especially to get the manure for their agricultural land. Large cardamom based agroforestry is a traditional practice whose area of cultivation has increased by 2.3 times from 1980 to 1995 (Sharma *et al.* 1998). This agroforestry has strong component of dense shade trees. These trees provide fodder for livestock in cardamom growing areas.

3.2.3 Tourism and Livestock

The 26-km Yuksam-Dzongri corridor inside the Khangchendzonga Biosphere Reserve is one of the most important trekking routes in Sikkim. Every year about 2000 domestic and foreign tourists trek in this popular destination. A tourist group of more than 3 persons generally hired pack animals. If the group is small than 3 persons then the local porters manage. Local porters are available at trail head i.e. Yuksam village whose rate is Rs. 80/- per day. Trekking cooks are hired @ Rs 100/- per day. The cost of one pack animal range between Rs 110-120/- per day, and the animal can carry

about 40 kg load. Himalayan Mountaineering Institute (HMI), Darjeeling, West Bengal, conducts training programs every year (5 basic and 3 advance courses) at the base camp. These groups have trek along the same route. Around 100-120 trainees in each basic course and around 80-100 trainees in each advance course participate in HMI training. In every course they used around 40 pack animals for fairly long time. The area also provides pasturage for local and transhumance herders along with entrepreneurs owning pack animals for trekking groups and mountaineers.

The Forest Department started collection of fees for pack animals entering the reserve since September 1998 (Notification No.124/KNP/WL/F/01). The entry fee has been fixed as Rs 5/- per animal per day. However, it was observed that generally more number of pack animals freely graze in the area than the number of animals for which fees has been collected for entry.

Revenue generated from the grazing livestock in the Yuksam-Dzongri trekking corridor in 1997 and 1998 is presented in Table 3.4. There are three main items of revenue source from livestock viz. pack animals, dairy products and wool products. Some livestock products are shown in Photoplate 3. During 1997 a total revenue of Rs 11,37,600/- was generated; out of which 64.9% was from pack animals, 28.7% from dairy products, 6.04% from wool products and remaining 0.46% from skin products. The revenue during 1998 was Rs 10,29,300/-, out of which 57.09% was contributed from pack animals, 34.63% from dairy products, 7.91% from wool products and remaining 0.37% from skin products. Besides this, the Forest Department also collected a sum of Rs 19,800/- as state revenue during 1998 as entry fees for pack animals operating in the Yuksam-Dzongri trail. About 68% of the fees came from Himalayan Mountaineering

Institute's training program and remaining 32% came from pack animals hired by trekkers. Unit rates for different sources of income from livestock were: (a) pack animal Rs 110-120/- per animal per day, (b) raw wool Rs 70-80/- per kg, (c) yak and sheep milk Rs 10/- and Rs 15/- per litre, respectively, (d) butter (cheese) Rs 160/- per kg, and (e) dried cheese (chhurpi) Rs 120/- per kg. Reduction of about 10% in income from livestock in 1998 compared to 1997 was mainly because of less tourist arrivals resulting from road disruption due to landslides.

Livestock accounts for as much as 10 per cent of our Gross National Product (GNP), the cash equivalent being approximately Rs 15,000 crores or more (Anonymous 1986). The energy components of the livestock in the form of dung as a source of fuel and draught power derived from cattle and buffaloes are a very significant contribution to various agricultural operations in the rural areas. It has been worked out that 193 million of cattle population in the country produces as much as 37,000 mega watts of power for agricultural products (Bhat 1987). The cattle were considered chief sign of wealth and a person with 20 herds of cattle was considered a rich man in Lepcha community (Gorger 1984). In north Sikkim around 72% households receive income from livestock rearing (Paljor 1997). They also provide a good percentage of organic manure to the soil. But animal grazing in high mountains is considered as one of the major factors responsible for environmental degradation.

3.3 VEGETATION CHARACTERISTICS

3.3.1 Vegetation Pattern

Three distinct vegetation zones have been identified, viz. temperate (warm and cool), subalpine and alpine based on the elevation along the Yuksam-Dzongri trail (Table 3.5). The warm temperate starts from Yuksam

(1600 m elevation) upwards to 2000 m and this zone supports to fulfil the local resident's demands for fuel, fodder and timber. The area also receives heavy grazing pressure. The forest cover is very sparse mainly due to timber and fuelwood extraction. The area received medium to high level of grazing pressure. The dominant trees are *Castanopsis* spp. *Cedrela toona*, *Evodia fraxinifolia*, *Macaranga pustulata*, while *Rubus ellipticus*, *Edgeworthia gardneri*, *Melastoma normale* formed the middle layer. *Eupatorium cannabinum*, *Cyanotis vaga*, *Hydrocotyle javanica*, *Pilea umbrosa*, *Pilea scripta*, *Persicaria capitata*, *Brachiaria* sp. are prominent ground vegetation (Table 3.5).

At the cool temperate (2000-3000m) the tree layer is formed by *Magnolia campbellii*, *Rhododendron arboreum*, *Quercus lamellosa*, *Acer campbellii*, etc., while *Aconogonum molle*, *Arundinaria maling*, *Zanthoxylum acanthopodium* formed the secondary layer. The dominant ground vegetations are *Tupistra nutans*, *Viola* sp., *Silaginella* sp., *Elatostema sessile*, *Urtica dioica*, *Girardinia palmata* and *Laportea terminalis*.

The maximum canopy coverage in the sub-alpine zone has been formed by *Abies densa* and secondary middle layer by *Rhododendron barbatum*, *Rhododendron hodgsonii*, *Viburnum cordifolium*, *Arundinaria maling* and *Rosa serecia*. Primulas, *Selinum tenuifolium*, *Fragaria* sp., *Prunella vulgaris*, with high density of *Abies densa* seedlings and saplings formed the ground vegetation.

Alpine areas were devoid of trees, shrubs of rhododendrons, Junipers and *Rosa serecia* formed the major species. High density of *Juniperus recurva* in the form of depressed circular patches were common in gentle slope side whereas bushes of rhododendrons in steep side. The ground vegetation was dominated by *Poa* spp. *Potentilla peduncularis*, *Potentilla*

microphylla, *Potentilla coriandrifolia*, *Aletris pauciflora*, *Bistorta affinis*, *Pedicularis* spp. and *Primulas*. As the elevation goes higher to 4000 m and above, botanically curious plants like woolly *Swertia multicaulis*, *Eroiphyton wallichii* and pyramid-shaped *Rheum nobile* are seen and these plants are adapted to harsh climate.

3.3.2 Floristic Composition

Lists of plants encountered along with their flowering period, life forms and growth forms have been prepared according to the Bentham and Hooker's sequence of classification for temperate (Appendix 1), subalpine (Appendix 2) and alpine (Appendix 3). In the temperate zone, a total of 182 species were recorded whose 148 were dicots (81.3%), 32 monocots (17.6%) and only 2 species of gymnosperms (1.1%). These species belonged to 66 families (57 dicots, 7 monocots and 2 gymnosperms) and under 133 genera (109 dicot, 22 monocot and 2 gymnosperm) (Table 3.6).

At subalpine zone, a total of 73 species were recorded whose 60 species belonged to dicots (82.2%), 11 species monocots (15.1%) and remaining 2 species were gymnosperms (2.7%). These species belonged to 32 families (27 dicots, 4 monocots and 1 gymnosperms) and under 48 genera (38 dicots, 8 monocots and 2 gymnosperms).

No tree stratum was found in alpine zone, only the species of *Rhododendron* shrubs formed the major cover. A total of 120 species were recorded in alpine zone, out of which 105 were dicots (87.5%), 13 monocots (10.8%) and only 2 species of gymnosperms (1.7%). These plants belonged to 34 families (26 dicots, 7 monocots and only one gymnosperm). The families like Ericaceae (12 spp.), Primulaceae (10 spp.), Polygonaceae (8 spp.), Ranunculaceae and Scrophulariaceae (7 spp. each) were represented

most. Rawal and Pangtey (1987) have reported similar observation from the central Himalaya. Some alpine flowering plants are shown in Photoplate 1.

3.3.3 Phenology

Flowering periods of species were recorded for temperate (Appendix 1), subalpine (Appendix 2) and alpine zones (Appendix 3). Temporal flowering pattern of the three ecological zones have been drawn (Fig. 3.2). In temperate zone, flowering of species occurred throughout the calendar year from January to December. A maximum of 81 species bloomed during June, followed by 79 species in July and 75 species in August. During June 44% of the total species were flowering (Fig. 3.2).

At subalpine, there was no flowering during December to January. Maximum flowering occurred during July when 43 species (59%) bloomed, followed by 38 species (52%) during June and 29 species (40%) during August (Fig.3.2).

Flowering in the alpine pasture started just after the snow-melted in March and ended in November when winter began. Most of the plant species flowered during the months of June, July and August, with a peak in August when 104 species were in bloom, where as 72 and 86 species bloomed in June and August, respectively. This is the period of highest rainfall and maximum temperature. Individuals of *Bergenia ciliata* (Saxifragaceae) started flowering just after snow melt in March and continued flowering until July; *Hemiphragma heterophyllum* of the Scrophulariaceae family also started flowering then, but blooming ended in August. *Primula glomerata* (Primulaceae) started flowering only in August and continued until very late into November. About 48% of the species flowered for three months, 41% flowered for two months, 10% for four months and only one species (*Bergenia ciliata*) flowered for five months (Fig. 3.2).

3.3.4 Life and Growth Forms

The life forms study of the species at temperate zone showed 69.2% phanerophyte, 17.6% chaemephyte, 4.1% therophyte, 2.2% geophyte and only 1.1% hemigeophyte. At subalpine, phanerophyte was highest (38.4%), followed by chaemephyte (30.1%), therophyte (15.1%), hemigeophyte (9.6%) and the least geophyte (6.8%), whereas at alpine zone chaemephyte (57%) was dominant, followed by hemigeophyte (15%), phanerophyte (12%), therophyte (9%) and geophyte (7%) (Table 3.7).

The growth forms study revealed that at temperate zone 36.3% was tree, 20.9% shrub/undershrub, 15.4% tall forb, 6.7% cushion and spreading forb, 6% each for climber and epiphyte, 5.5% short forb, 2.7% graminoid and least being the creepers (0.5%). At the subalpine zone, climber, creeper and epiphytes were absent. Some of the epiphytes could be grown on ground also, hence regarded as other suitable growth forms. Tall forb (27.4%) dominated at the subalpine zone which was followed by shrub/undershrub (20.5%), cushion and spreading forbs (16.4%), short forb (15.1%) and the graminoid (6.9%) was the least. At the alpine zone, tree stratum were absent and was dominated by short forb (31%) followed by cushion and spreading forb (28%), tall forb (25%), shrubs (10%) and the graminoid (6%) the least.

Woody plants dominate in the temperate and subalpine zones. Lower per cent of herbaceous vegetation might be due to certain pressure especially by livestock grazing and collection of non-timber forest products. As the elevation increased woody components decreased and in contrary forbs increased, and change further higher elevation comprised of cushion and spreading forbs. This change is an adaptive mechanism to severe climate in the higher elevation. Phanerophyte (69.2%) in temperate zone is fairly higher than that of Raunkier's normal spectrum (46%). This is an indication of

more arboreal structure. But 1.1% hemigeophyte, 2.2% geophyte and 4.1% therophyte in the present study is much lower than Raunkier's normal spectrum (26% hemigeophyte, 6% geophyte and 13% therophyte).

Higher percentage of chaemephyte (57%) compared to 31% in Rudranath flora, 46.7% in snowline vegetation of Central Himalaya, 46.4% in Yusmarg Kashmir alpine and 4.7% in Kumaun Himalaya indicates that the plants were surviving under stresses such as physical, climatic or biotic (Ram *et al.* 1988). Members of Rosaceae and Ericaceae appeared to have the widest adaptability to the alpine environment. Most of the species of these families are least palatable to livestock grazing.

Compared to the Central and Western Himalaya the present study area has more woody plants. Per cent geophyte is closely comparable with that of Raunkier's normal spectrum but 4 times fold less than the report from Rudranath flora (28.9%) (Ram *et al.* 1988), this indicates that rhizomatous plants are less in number in the present study areas and forbs are dominating. Maximum plants were forbs (56%), which is an indicator of favourable climate for annual plants, while graminoid represented by 6% only and no tree stratum was found, instead 10% shrubs and undershrubs were recorded which is comparable with other reports from the western and central Himalaya. Higher percentage of cushion and spreading forbs of plants (28%) indicates a hard physical and climatic surroundings. Continuous and heavy grazing might change the growth forms of the plants to a large extent. A lack of trees and big shrubs and the low stature of vegetation in the alpine region was ascribed both to winter desiccation and ice abrasion and to a low annual carbon gain which is inadequate to build and maintain large woody support structures (Billings & Mooney 1968; Savile 1972; Tranquillini 1979). From the growth and life forms study, it revealed that the alpine area faces harsh

climatic conditions. This makes the growth of the plants slower. As we ascend from timberline to snowline, the severity of the environment increased, which leads to a progressive decline in the abundance and diversity of plant species. In the severe climate the morphology of plants changed to woolly or cotton rosettes, striking dwarfness, perennial root stocks and surface level spreading probably due to the need of thermal heat liberated by the rock or soil surface for survival and need physiological process.

3.3.5 Ethnobotanical Plant Wealth

The ethnobotanical plant wealth of temperate and subalpine zone is presented in Table 3.8. At temperate zone 13 species (under 12 families and 13 genera) were found to have medicinal use (Table 3.8). Nearly 23 species (belonging to 16 families and 23 genera) were frequently collected by the villagers from the surrounding forests as wild edibles. Besides, fibre and paper (4 species under 2 families and 4 genera), dye (1 species), and incense (2 species under 2 families and 2 genera) yielding plants were also collected by local people from the surrounding forests. Local communities commonly used 17 species for timber and other construction purposes. Forty-one species are used as fodder and either collected from wild or animals graze on them. Details of fodder and forage resources are presented separately in chapter IV. The local residents commonly used 26 different plant species as fuelwood.

The ethnobotanical plant wealth of alpine meadows is presented in Table 3.9 and 28 species have been reported for different usage. Only 11 species (8 families) were recorded to have medicinal value, their uses are given in Table 3.9. Species of *Rhododendron*, *Juniperus* and *Crementhodium* (6 species under 3 families) were used as traditional incense especially by

Buddhists and at the Monasteries. *Rheum emodi* (syn. *R. australe*) is used as tea-substitute by grazers and porters at high altitudes. Six species of *Rhododendron* are used as fuelwood by the yak herders. *Rheum nobile*, locally called as “Kenjoh” or “Sikkim cabbage”, is edible as pickle and also used as medicine. Species of *Primula* are frequently collected as decorative and garden plants (Table 3.9). A few medicinal plants are presented in Photoplate 2.

Collection of various plant materials by local porters and villagers is a common practice. The collection of plants for medicine (e.g. *Aconitum hookeri*, *Allium wallichii*, *Picrorhiza kurrooa*, *Orchis latifolia*, *Rheum nobile*, *R. australe*, *Nardostachys jatamansi*, *Bergenia ciliata*, *Swertia multicaulis*, etc.), fuelwood (*Rhododendron anthopogon*, *R. lepidotum*, *R. setosum*, *R. fulgens*, *Juniperus recurva*, *J. indica*, etc.), tea substitute (*Rheum emodi*), decorative pieces (*Primula* spp. *Bergenia ciliata*) and edible species (*Rheum nobile*) have exerted continued pressure on these species at the alpine pasture affecting the vegetation composition and structure. A code of conduct for visitors have been made by a local NGO (Khangchendzonga Conservation Committee) which stresses on stopping illegal collections of plant species especially from alpine areas. ■

Table 3.1 Livestock types and their numbers during 1987 and 1992 in the Sikkim State.

| Livestock | 1987 | | 1992 | | Per cent change/ from 1987 to 1992 |
|-----------|---------|-------|--------|-------|---------------------------------------|
| | Number | (%) | Number | (%) | |
| Cattle | 15,7546 | 53.98 | 200035 | 51.88 | 26.97 (+) |
| Buffaloes | 5438 | 1.86 | 2932 | 0.76 | 46.08 (-) |
| Sheep | 16104 | 5.52 | 16268 | 4.22 | 1.02 (+) |
| Pig | 18596 | 6.37 | 44477 | 11.54 | 139.18 (+) |
| Goat | 88986 | 30.49 | 114707 | 29.75 | 28.90 (+) |
| Horse | 1186 | 0.41 | 1789 | 0.46 | 50.84 (+) |
| Yak/dzo | 3995 | 1.37 | 5349 | 1.39 | 33.89 (+) |
| Total | 291851 | 100 | 385557 | 100 | 66.02 (+) |

Source: Forest Department, Government of Sikkim 1995.

Table 3.2 Grazing livestock types and numbers for the study period in Yuksam Block

| Village/livestock type | Livestock number | | | Per cent change from 1996 to 1998 |
|------------------------|------------------|------|------|--------------------------------------|
| | 1996 | 1997 | 1998 | |
| Yuksam village | | | | |
| Cattle | 361 | 399 | 454 | 25.76 (+) |
| Goat | 245 | 267 | 311 | 26.94 (+) |
| Sheep | 441 | 435 | 461 | 4.54 (+) |
| Horse | 31 | 31 | 22 | 29.03 (-) |
| Dzo | 96 | 101 | 122 | 27.08 (+) |
| Yak | 83 | 70 | 78 | 6.02 (-) |
| Total | 1257 | 1303 | 1448 | 15.19 (+) |
| Tshoka village | | | | |
| Cattle | 35 | 30 | 45 | 28.57 (+) |
| Dzo | 24 | 24 | 23 | 4.17 (-) |
| Horse | 8 | 8 | 7 | 12.5 (-) |
| Total | 67 | 62 | 75 | 11.94 (+) |
| Total for block | 1324 | 1365 | 1523 | 15.03 (+) |

Source: Primary data

Table 3.3 Rearing pattern and seasonal mobility of different grazing animals along the Yuksam-Dzongri trail in Khangchendzonga Biosphere Reserve

| Animal types | Season | Grazing mobility and characteristic pattern |
|--------------|--------|---|
| Cattle | Summer | Only a few cattle grazed in alpine pastures at Dzongri while rest grazed in lower forest around Yuksam except milking cows and calves. In Tshoka village all the cattle are free-grazed except milking cows and calves, for them fodder are lopped from the nearby forest and fed with other agricultural byproducts like 'pina' (oil cake) which they purchase from market @ Rs 8-10/- per kg. |
| | Rainy | Only a few cattle graze in alpine pastures while rest graze in forest pastures except milking cows and calves. |
| | Winter | Both stall-fed and free-grazing inside forest. |
| Yak | Summer | Yaks grazed in alpine pastures and near timberline. Never come down to temperate areas due to its adaptation in cold climate. |
| | Rainy | Graze in alpine pastures close to snow line. |
| | Winter | Graze near timberline and lower alpine pastures. |
| Dzo | Summer | Dzos are used as pack animals by tourist trekkers and mountaineers. At resting stations like Yuksam, Sachen, Tshoka, Phedang, Deorali, Dzongri, Thangsing, Basecamp free grazing is observed. At Yuksam, Tshoka and Dzongri these pack animals are provided some common salt and mustard oil. Salt and mustard oil are believed to strengthen the knee of the animals for trekking. |
| | Rainy | Graze in both alpine pastures as well as inside the temperate forests. |
| | Winter | Graze freely inside temperate forest. |
| Horse | Summer | Free grazing inside lower elevation forest grounds and used for carrying loads. |
| | Rainy | Most graze in alpine pastures. |
| | Winter | Free grazing inside temperate forest. |
| Sheep | Summer | Graze in alpine pastures. |
| | Rainy | Graze in alpine pastures |
| | Winter | Free grazing inside temperate forest. |
| Goat | Summer | 70% stall-fed while remaining freely graze inside the forest. |
| | Rainy | Both stall-fed and free grazing in temperate forest was recorded. |
| | Winter | Both free grazing and stall-feeding (around 70% stall-fed). |

Table 3.4 Income generated from grazing livestock along the Yuksam-Dzongri trail

| Income source | Animal types (items) | Price rate (Rs)* | Quantity | | Revenue (Rs) | | Per cent change from 1997 to 1998 |
|---------------|----------------------|------------------|----------|------|--------------|---------|-----------------------------------|
| | | | 1997 | 1998 | 1997 | 1998 | |
| Pack animals | Dzo | 120 | 6084 | 4834 | 730080 | 580080 | 20.55 (-) |
| | Horse | 110 | 77 | 69 | 8470 | 7590 | 10.39 (-) |
| | Total | - | - | - | 738550 | 587670 | 20.43 (-) |
| Milk | Cattle (milk) | 10 | 8170 | 9500 | 81700 | 95000 | 16.28 (+) |
| | Yak (milk) | 10 | 7000 | 7000 | 70000 | 70000 | No change |
| | (chhurpi) | 120 | 1000 | 1000 | 120000 | 120000 | No change |
| | Sheep (milk) | 15 | 667 | 1094 | 10005 | 16410 | 64.07 (+) |
| | (butter) | 160 | 282 | 344 | 45120 | 55040 | 21.99% (+) |
| | Total | - | - | - | 326825 | 356450 | 9.09 (+) |
| Wool | Yak (raw) | 80 | 119 | 125 | 9520 | 10000 | 5.04 (+) |
| | (rope) | 35 | 50 | 70 | 1750 | 2450 | 40.00 (+) |
| | (sofa cover) | 120 | 40 | 50 | 4800 | 6000 | 25.00 (+) |
| | Sheep (raw) | 120 | 333 | 444 | 39600 | 48000 | 21.21 (+) |
| | (blanket) | 650 | 20 | 23 | 13000 | 14950 | 15.00 (+) |
| | Total | - | - | - | 68670 | 81400 | 18.54 (+) |
| Skin | Yak (shoe) | 45 | 25 | 30 | 1125 | 1350 | 20.00 (+) |
| | (sofa cover) | 250 | 10 | 10 | 2500 | 2500 | No change |
| | Total | - | - | - | 3625 | 3850 | 6.21 (+) |
| Grand total | - | - | - | - | 1137670 | 1029370 | 9.52 (-) |

* Price rate (hiring charge for pack animals on per day basis, milk on per litre basis, chhurpi, butter and wool on per kg basis, sofa cover on per piece basis, shoe on per pair basis. Rates during 1997 and 1998 were same.

Table 3.5 Vegetation characteristics at different ecological zones along the Yuksam-Dzongri trail in Khangchendzonga Biosphere Reserve

| Ecological zones | Dominant vegetations | | |
|---------------------------------|---|--|---|
| | Tree | Shrub | Herb |
| Temperate-warm (1600-2000 m) | <i>Castanopsis</i> spp., <i>Cedrela toona</i> , <i>Cinnamomum</i> spp., <i>Symplocos</i> spp., <i>Michelia lanuginosa</i> , <i>Macaranga</i> sp., etc. | <i>Rubus ellipticus</i> , <i>Edgeworthia gardneri</i> , <i>Oxyspora paniculata</i> <i>Pentapanax</i> sp., <i>Girardinia dicursifolia</i> , <i>Melastoma normale</i> , <i>Casearia</i> sp., etc. | <i>Eupatorium cannabinum</i> , <i>Cyanotis vaga</i> , <i>Hydrocotyle javanica</i> , <i>Pilea umbrosa</i> , <i>Impatiens</i> sp., <i>Brachiaria</i> sp., <i>Persicaria capitata</i> , <i>Plantago erosa</i> , etc. |
| Temperate-cool (2000-3000 m) | <i>Rhododendron arboreum</i> , <i>Quercus lamellosa</i> , <i>Acer campbellii</i> , <i>A. oblongum</i> , <i>Castanopsis tribuloides</i> , <i>Magnolia campbellii</i> , <i>Eurya acuminata</i> , etc. | <i>Maesa</i> sp., <i>Rubus paniculatus</i> , <i>Zanthoxylum acanthopodium</i> , <i>Daphne retusa</i> , <i>Aconogonum molle</i> , <i>Arundinaria maling</i> , <i>Viburnum</i> spp., <i>Caesaria</i> sp., etc. | <i>Tupistra nutans</i> , <i>Viola</i> sp., <i>Silaginella</i> sp., <i>Elatostema sessile</i> , <i>Urtica dioica</i> , <i>Rumex nepalensis</i> , <i>Drymaria cordata</i> , <i>Diplazium umbrosum</i> , <i>Impatiens</i> sp., <i>Laportia terminalis</i> , Ferns, etc. |
| Subalpine (3000-3800 m) | <i>Rhododendron barbatum</i> , <i>R. hodgsonii</i> , <i>Abies densa</i> , <i>Betula alnoides</i> , <i>Acer</i> sp., <i>Tsuga dumosa</i> , etc. | <i>Rhododendron cinnabarinum</i> , <i>R. wightii</i> , <i>Viburnum</i> sp., <i>Arundinaria maling</i> , <i>Rosa sericea</i> , <i>Daphne</i> spp., etc. | <i>Potentilla</i> spp., <i>Selinum tenuifolium</i> , <i>Fragaria</i> sp., <i>Platystemma violoides</i> , <i>Prunella vulgaris</i> , <i>Gaultheria</i> spp., <i>Thalictrum</i> sp., <i>Primula</i> spp., etc. |
| Alpine (>3800 m) | | <i>Rhododendron anthopogon</i> , <i>R. lowndesii</i> , <i>R. setosum</i> , <i>R. lepidotum</i> , <i>R. fulgens</i> , <i>Spiraea arcuata</i> , <i>Juniperus recurva</i> , <i>Rosa sericea</i> , etc. | <i>Aletris pauciflora</i> , <i>Primula</i> spp., <i>Potentilla</i> spp., <i>Rheum emodi</i> , <i>R. nobile</i> , <i>Pedicularis</i> spp., <i>Gentiana</i> spp., <i>Saxifraga</i> spp., <i>Hemiphragma heterophyllum</i> , <i>Cassiope fastigiata</i> , <i>Poa</i> spp., <i>Anaphalis</i> sp. |

Table 3.6 Number and per cent contribution of species, genera and families of different plant groups in three ecological zones along the Yuksam-Dzongri trail

| Ecological zones/ Plant groups | Families | | Genera | | Species | |
|-----------------------------------|----------|------|--------|------|---------|------|
| | Number | (%) | Number | (%) | Number | (%) |
| Temperate | | | | | | |
| Dicotyledon | 57 | 86.4 | 109 | 82.0 | 148 | 81.3 |
| Monocotyledon | 7 | 10.6 | 22 | 16.5 | 32 | 17.6 |
| Gymnosperm | 2 | 3.0 | 2 | 1.5 | 2 | 1.1 |
| Total | 66 | 100 | 133 | 100 | 182 | 100 |
| Subalpine | | | | | | |
| Dicotyledon | 27 | 84.4 | 38 | 79.2 | 60 | 82.2 |
| Monocotyledon | 4 | 12.5 | 8 | 16.7 | 11 | 15.1 |
| Gymnosperm | 1 | 3.1 | 2 | 4.1 | 2 | 2.7 |
| Total | 32 | 100 | 48 | 100 | 73 | 100 |
| Alpine | | | | | | |
| Dicotyledon | 26 | 76.5 | 59 | 84.3 | 105 | 87.5 |
| Monocotyledon | 7 | 20.6 | 10 | 14.3 | 13 | 10.8 |
| Gymnosperm | 1 | 2.9 | 1 | 1.4 | 2 | 1.7 |
| Total | 34 | 100 | 70 | 100 | 120 | 100 |

Table 3.7 Per cent representation of life and growth forms of plants at different ecological zones along the Yuksam-Dzongri trail

| Plant forms | Per cent | | |
|---------------------------|-----------|-----------|--------|
| | Temperate | Subalpine | Alpine |
| Life forms | | | |
| Phanerophyte | 69.2 | 38.4 | 12.0 |
| Chaemephyte | 17.6 | 30.1 | 57.0 |
| Hemigeophyte | 1.1 | 9.6 | 15.0 |
| Geophyte | 2.2 | 6.8 | 7.0 |
| Therophyte | 4.1 | 15.1 | 9.0 |
| Growth forms | | | |
| Tree | 36.3 | 13.7 | - |
| Shrub/undershrub | 20.9 | 20.5 | 10.0 |
| Climber | 6.0 | - | - |
| Creeper | 0.5 | - | - |
| Tall forb | 15.4 | 27.4 | 25.0 |
| Short forb | 5.5 | 15.1 | 31.0 |
| Cushion & spreading forbs | 6.7 | 16.4 | 28.0 |
| Graminoid | 2.7 | 6.9 | 6.0 |
| Epiphyte | 6.0 | - | - |

Table 3.8 Ethnobotanical plant wealth of temperate and subalpine zones along the Yuksam-Dzongri trail in Khangchendzonga Biosphere Reserve of Sikkim Himalaya

| Uses/Species | Vernacular name | Plant parts, used and mode of uses |
|------------------------------------|-----------------|--|
| Medicinal | | |
| <i>Artemisia vulgaris</i> Linn. | ‘Titepatey’ | Shoot and leaves are given in nervous and spasmodic affections connected with debility in asthma and diseases of brain. Hot fomentation of stem is used for treatment of eye cataract. |
| <i>Astilbe revularis</i> Ham. | ‘Buro-okhati’ | Dried root boiled with milk is taken to get relief from body pain. |
| <i>Drymaria cordata</i> Willd. | ‘Abhijalo’ | Hot fomentation of shoot is used to cure sinusitis and nasal blockade. |
| <i>Eupatorium cannabinum</i> Linn. | ‘Banmara’ | Fresh leaf decoction juice is applied as blood coagulant. |
| <i>Heracleum nepalense</i> D. Don | ‘Chimphing’ | Fruit is used as anti-typhoid treatment, nausea and vomiting. |
| <i>Kaempferia rotunda</i> Linn. | ‘Bhui-champa’ | Tubers are used as poultice in fracture, swelling and healing. |
| <i>Oroxylum indicum</i> Linn. | ‘Totala’ | Root bark is aphrodisiac tonic, as appetizer, in fever, dysentery. Seeds are used to cure pneumonia. |
| <i>Piper longum</i> Linn. | ‘Pipla’ | Root is used in healing, stomachae, and laxative, improve appetite, bronchitis, abdominal pain. Roots are anti-diarrhoetic, anti-dysenteric, fever, tumour, piles, leprosy, jaundice, etc. |
| <i>Plantago erosa</i> Linn. | ‘Nasey jhar’ | Root and leaves are astringent and used in fever. Seeds are used in dysentery. |
| <i>Rhododendron arboreum</i> Sm. | ‘Lali-gurans’ | Flower is sour and used to cure dysentery and preserve the flower |

| | | |
|---|-----------------|---|
| <i>Rubia cordifolia</i> Linn. | 'Majheto' | petals as de-obstruction of fish spines in the throat. Root is used as antidyreutric, antipyretic. It cures diseases of uterus, vagina, eyes, ulcer, urinary disorder, jaundice, piles, etc. Fruit is used in spleen disorder. |
| <i>Rumex nepalensis</i> Spreng | 'Halhaley' | Root extracts are used for hepatitis and for hair loss. |
| <i>Swertia chirata</i> Ham. | 'Chirowto' | The plant decoction is having coolen effect, anthelmintic, antipyretic, laxative, biliousness, leucoderma, inflammation, body-ache, urinary disorder, ulcer, asthma bronchitis, piles, etc. |
| Wild edibles | | |
| <i>Agaricus</i> sp. | 'Kalungey chew' | Fruiting body is one of the most delicious vegetables. Sun dried is also preserved for off-season. |
| <i>Arundinaria hookeriana</i> Munro. | 'Pareng' | Tender shoots eaten as vegetables. |
| <i>Bassia butyracea</i> Roxb. | 'Chewri' | Fruit are eaten. Seeds yield edible oil. |
| <i>Bauhinia variegata</i> Linn. | 'Koiralo' | Flowers are making curry. |
| <i>Castanopsis tribuloides</i> A. DC. | 'Patley katus' | Seeds are taken after fried. |
| <i>Cinnamomum impressinervium</i> Meissn. | 'Sisi' | Seeds are fried and eaten. |
| <i>Citrullus colocynthis</i> Schrad. | 'Indreni' | Fried seeds are eaten. |
| <i>Dendrocalamus hamiltonii</i> Nees. & Arnolt. | 'Choya bans' | Tender shoot eaten as vegetables and made into pickles. Fermented shoot can be preserved and used in off-season to add flavour and taste to curry. |
| <i>Dioscorea hamiltonii</i> Hook. | 'Ban tarul' | Tuber boiled eaten. |
| <i>Diplazium umbrosum</i> Willd. | 'Ningro' | Tender shoot is one of the best delicious vegetables. |
| <i>Evodia fraxinifolia</i> Hook. f. | 'Khanakpa' | Fruit into pickles. |

| | | |
|---|----------------------|--|
| <i>Ficus infectoria</i> Roxb. | 'Kabra' | Shoots into pickles |
| <i>Girardinia dicusifolia</i> (Link) Friss | 'Bhangrey sisnoo' | Leaves and tender shoot cooked with dal (<i>Phaseolus</i> sp.) is regarded as most delicious curry. |
| <i>Juglans regia</i> Linn. | 'Okhar' | Seed kernels eaten. |
| <i>Litsaea citrata</i> Blume | 'Siltimur' | Fresh fruit made into pickles. |
| <i>Machilus edulis</i> King. | 'Kaulo' | Mature fruit are cured for some days in earthen pits and the pulp eaten. |
| <i>Pleurotus sajor</i> Caju. | 'Kanney chew' | One of the best mushroom. Dried fruiting body is preserved for off- season use. |
| <i>Prunus nepalensis</i> Hook. f. | 'Arupatey' | Ripe-fruit pulp eaten. |
| <i>Pyrus pashia</i> Ham | 'Mehel' | Fruit eaten raw, also made into pickles. |
| <i>Rhus semialata</i> Murray | 'Bakhimlo' | Ripe fruit eaten. |
| <i>Rubus ellipticus</i> Smith. | 'Aiselu' | Ripe fruit eaten. |
| <i>Tupistra nutans</i> Wall. | 'Nakima' | Inflorescence is eaten as vegetable and fetch high prices. |
| <i>Urtica dioica</i> Linn. | 'Patley sisnoo' | Leaves and tender shoot cooked with dal (<i>Phaseolus</i> sp.) is regarded as most delicious curry. |

Fibre/ paper yielding plants

| | | |
|-------------------------------------|-----------------|--|
| <i>Daphne cannabina</i> Wall. | 'Syanu argeley' | Bark is used for making paper and rope. |
| <i>Edgeworthia gardneri</i> Meissn. | 'Thulo argeley' | Bark is used for making paper and rope. |
| <i>Urtica dioica</i> Linn. | 'Patley sisnoo' | Stem fibre is used for making fine threads. |

Dye yielding plants

| | | |
|-------------------------------|-----------|---------------------------------|
| <i>Rubia cordifolia</i> Linn. | 'Majheto' | Fruit yield reddish-orange dye. |
|-------------------------------|-----------|---------------------------------|

Incense

| | | |
|------------------------------------|----------|---|
| <i>Cryptomeria japonica</i> D. Don | 'Dhupee' | Branchlets used as incense in Buddhist monasteries. |
| <i>Juniperus</i> sp. | 'Dhupee' | Branchlets used as incense in Buddhist monasteries. |

Timber

| | | |
|--|-----------------|--|
| <i>Abies densa</i> Griffith ex Parker | 'Salla' | Trailing, roofing, walling and other heavy construction. |
| <i>Alnus nepalensis</i> D. Don | 'Uttis' | House and other construction. |
| <i>Beilschmiedia sikkimensis</i> King. | 'Tarshing' | House and bridge construction. |
| <i>Castanopsis</i> spp. | 'Katus' | House and other heavy constructions. |
| <i>Elaeocarpus sikkimensis</i> Mast. | 'Bhadrasey' | Heavy construction. |
| <i>Cedrela toona</i> Roxb. | 'Tooni' | Furniture and household constructions. |
| <i>Juglans regia</i> Linn. | 'Okhar' | Furniture and house construction. |
| <i>Machilus edulis</i> King. | 'Phunsey' | House, cow shed and furniture. |
| <i>Magnolia campbelli</i> Hook. f. | 'Ghogey chanp' | House and heavy construction |
| <i>Michelia champaca</i> Linn. | 'Rani chanp' | Best wood for furniture. |
| <i>Michelia lanuginosa</i> Wall. | 'Phusrey chanp' | Best wood for furniture |
| <i>Quercus lamellosa</i> Smith | 'Bajrant' | Heavy construction. |
| <i>Symingtonia populnea</i> R. Br. | 'Pipli' | Cowshed construction and firewood. |

Fuelwood species

| | | |
|--|---------------|-----|
| <i>Abies densa</i> Griffith ex R. Parker | 'Salla' | ††† |
| <i>Acer campbellii</i> Hook. f. & Thoms. | 'Kapasey' | †† |
| <i>A. cappadocicum</i> Gled. | 'Kapasey' | †† |
| <i>A. laevigatum</i> Wall. | 'Kapasey' | †† |
| <i>A. oblongum</i> Wallich. ex DC. | 'Kapasey' | †† |
| <i>Albizia procera</i> Benth. | 'Siris' | †† |
| <i>Alnus nepalensis</i> D. Don | 'Uttis' | †† |
| <i>Amoora wallichii</i> King. | 'Badar' | ††† |
| <i>Beilschmiedia roxburghiana</i> Nees. | 'Tarshing' | ††† |
| <i>Bucklandia populnea</i> R. Br. | 'Pipli' | ††† |
| <i>Casearia glomerata</i> Roxb. | 'Barkaunle' | †† |
| <i>Castanopsis hystrix</i> Miq. | 'Katus' | ††† |
| <i>Castanopsis tribuloides</i> A. DC. | 'Katus' | ††† |
| <i>Cedrela toona</i> Roxb. | 'Tooni' | †† |
| <i>Cinnamomum cecidodaphne</i> Meissn | 'Sinkauli' | †† |
| <i>C. impressinervium</i> Meissn | 'Sinkauli' | †† |
| <i>C. obtusifolium</i> Nees. | 'Sinkauli' | †† |
| <i>Elaeocarpus sikkimensis</i> Mast | 'Bhadrasey' | ††† |
| <i>Engelhardtia spicata</i> Blume' | 'Mahuwa' | †† |
| <i>Eurya acuminata</i> DC. | 'Jhinguni' | ††† |
| <i>Gambelia ciliata</i> C.B. Clarke | - | † |
| <i>Garuga pinnata</i> Roxb. | - | †† |
| <i>Glochidion acuminatum</i> Muell. | 'Latikat' | †† |
| <i>Macaranga pustulata</i> King. | 'Mallata' | ††† |
| <i>Maesa chisia</i> Buch.-Ham. ex D. Don | 'Bilaune' | †† |
| <i>Magnolia campbellii</i> Hk. f & Thoms | 'Chanp' | ††† |
| <i>Quercus lamellosa</i> Smith. | 'Bajrant' | ††† |
| <i>Rhododendron arboreum</i> Linn. | 'Lali gurans' | ††† |
| <i>R. barbatum</i> Wallich ex G. Don | 'Gurans' | ††† |
| <i>Symplocos theifolia</i> Don. | 'Kharane' | ††† |
| <i>Viburnum colebrookianum</i> Wall. | 'Asare' | ††† |
| <i>V. erubescens</i> Wallich ex DC. | 'Asare' | ††† |

††† = highly preferred, †† = medium preferred and † = least preferred

Table 3.9 Ethnobotanical plant wealth of Dzungri alpine pasture along the Yuksam-Dzungri trail.

| Uses/Species | Vernacular name | Parts, uses and mode of uses |
|--|-----------------------|---|
| Medicinal | | |
| <i>Aconitum ferox</i> Wall. | 'Bikhma' | Fresh root decoction juice is taken in fever. Higher concentration can be given in food poisoning. Dried root is used in jaundice and diabetes. |
| <i>Aconitum heterophyllum</i> Wall. | 'Bikhma' | Fresh root decoction juice is taken in fever. Higher concentration can be given in food poisoning. Dried root is used in jaundice and diabetes. |
| <i>Bergenia ciliata</i> (Haw.) Sternb. | 'Pakhanbed' | Soup of fried root in boiling water is taken in fever and diarrhoea. Higher concentration can be recommended in fever. |
| <i>Heracleum wallichii</i> DC. | 'Chim-phing' | Tender shoot and leaf is cooked and eaten in gastric problems. Dry fruit powder is also used in influenza. |
| <i>Nardostachys jatamansi</i> DC. | 'Jatamansi' | Soup of dried root in boiling water is taken in malaria fever. Dried root powder can be applied in hair loss. It has also been reported used in epilepsy. |
| <i>Orchis chusua</i> Linn. | 'Syanu panch-aungley' | Fresh root paste is used applied in cut, wound, bruise and injuries. |
| <i>Orchis latifolia</i> Linn. | 'Panch-aungley' | Fresh root paste with root of <i>Rheum nobile</i> , <i>Rheum australe</i> and <i>Swertia multicaulis</i> is used in bone fracture. It is also applied in cut, wound, bruise and injuries and in bodyache. |
| <i>Picrorhiza kurrooa</i> Royle ex Benth | 'Kutki' | Fresh/dry root boiled in water is taken in cold, cough and fever. For |

| | | |
|---------------------------------------|--------------|--|
| <i>Rheum australe</i> D. Don | 'Khokim' | fever higher dose can be used. Root paste is used as bandage in minor fracture. The root paste is also administered externally in chest-pain. The soup prepared from the root is taken in bodyache. |
| <i>Rheum nobile</i> Hook. f. & Thoms. | 'Kenjoh' | Fresh root paste is administered externally in chest pain. Root soup boiled with water can also be taken. |
| <i>Swertia multicaulis</i> D. Don | 'Sarma-guru' | Fresh root paste is used in cut, wound and injuries. It is also very effectively used in bone-fracture. |

Incense

| | | |
|---------------------------------------|-----------|--|
| <i>Cremanthodium reniforme</i> Benth. | 'Dhup' | Branchlet along with leaves |
| <i>Juniperus indica</i> Bertol. | 'Dhupee' | Branchlet along with leaves, used extensively in Buddhist Monasteries. |
| <i>Juniperus recurva</i> D. Don | 'Dhupee' | Branchlet along with leaves, used extensively in Buddhist Monasteries. |
| <i>Rhododendron anthopogon</i> D. Don | 'Sunpate' | Branchlet along with leaves |
| <i>R. lepidotum</i> Wallich ex G. Don | 'Sunpate' | Branchlet along with leaves |
| <i>Rhododendron setosum</i> D. Don | 'Sunpate' | Branchlet along with leaves |

Tea substitute

| | | |
|--|----------|--|
| <i>Rheum emodi</i> Wallich ex Meissner (syn. <i>R. australe</i> D. Don) | 'Khokim' | Root used both fresh and dried. One cube of 1 x 1 cm is sufficient for one cup of tea. |
|--|----------|--|

Fuel wood

| | | |
|---------------------------------------|-----------|--------------|
| <i>Rhododendron anthopogon</i> D. Don | 'Sunpate' | Whole plant. |
| <i>R. fulgens</i> Hook. f. | 'Chimal' | Whole plant. |
| <i>R. setosum</i> D. Don | 'Sunpate' | Whole plant. |
| <i>R. thomsonii</i> Hook. f. | 'Chimal' | Whole plant. |
| <i>Juniperus indica</i> Bertol. | 'Dhupee' | Whole plant. |
| <i>J. recurva</i> D. Don | 'Dhupee' | Whole plant. |

Edible

Rheum nobile Hook. f. & Thom. 'Khokim' Tender shoot prepared as ickles.

Miscellaneous uses

Bergenia ciliata Hook. f. 'Pakhanbet' Growing in home garden.

Primula spp. 'Primula' Growing in home garden.

Rhododendron fulgens Hook. f. 'Chimal' Made field implement handle from wood.

Table 3.10 Plant species number belonging to different utilization groups from three ecological zones along the Yuksam-Dzongri trail.

| Utility type | Temperate | Subalpine | Alpine |
|---|-----------|-----------|--------|
| Number of species recorded | 182 | 73 | 120 |
| Number of species of different utility* | | | |
| Fodder | 41 | 4 | - |
| Fuelwood | 26 | 6 | 6 |
| Timber | 17 | 2 | - |
| Medicinal plants | 12 | 1 | 11 |
| Wild edibles | 23 | - | 1 |
| Aesthetic plant | 6 | 4 | 4 |
| Dye yielding plants | 1 | - | - |
| Paper | 2 | - | - |
| Fibre | 4 | - | - |
| Thatch | 2 | 2 | - |
| Agricultural implements | - | - | 1 |
| Incense | 2 | - | 6 |
| Tea-substitute | - | - | 1 |

*Some species have multiple uses

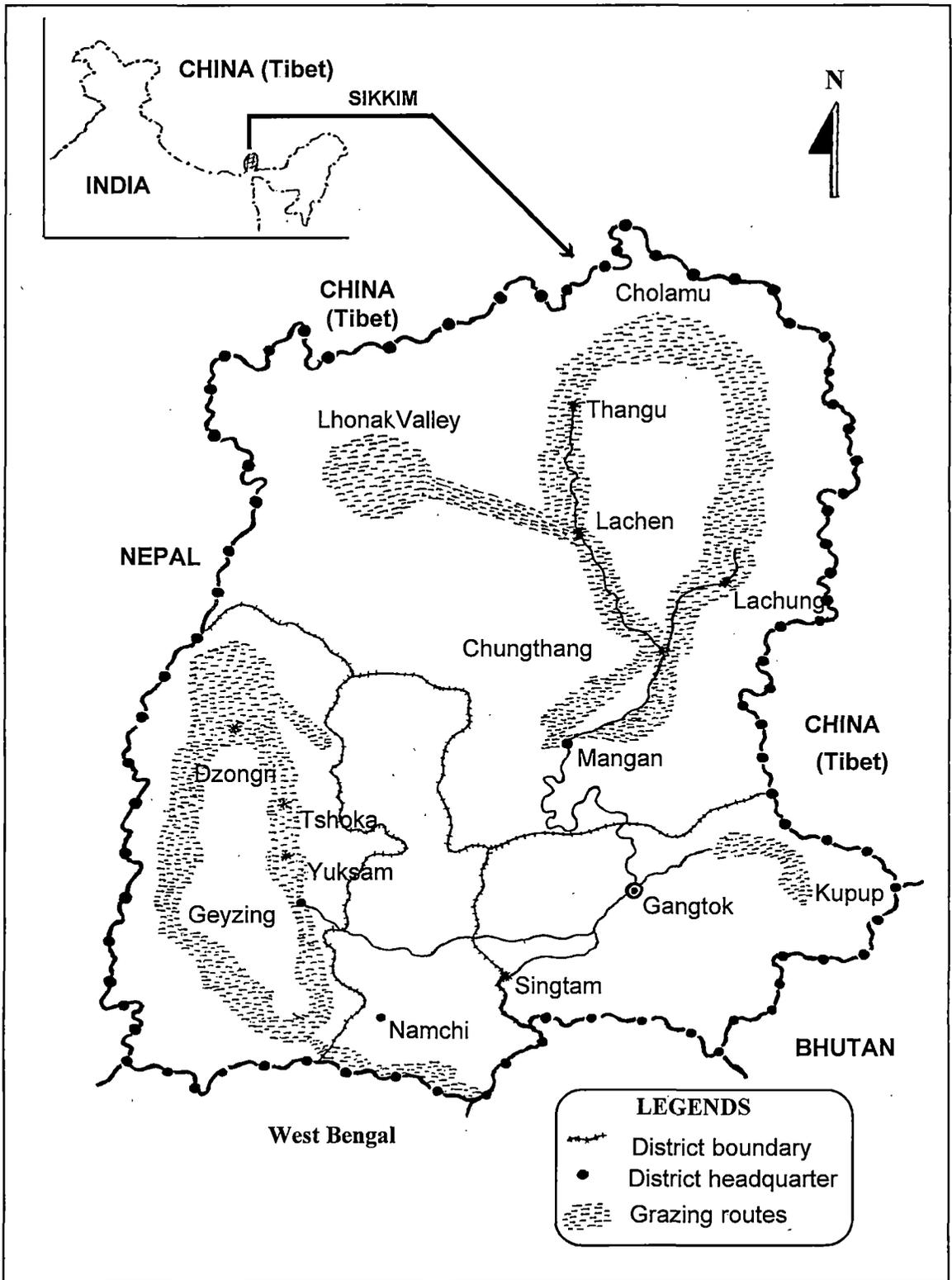


Fig. 3.1 Map showing major livestock grazing routes in the Sikkim Himalaya

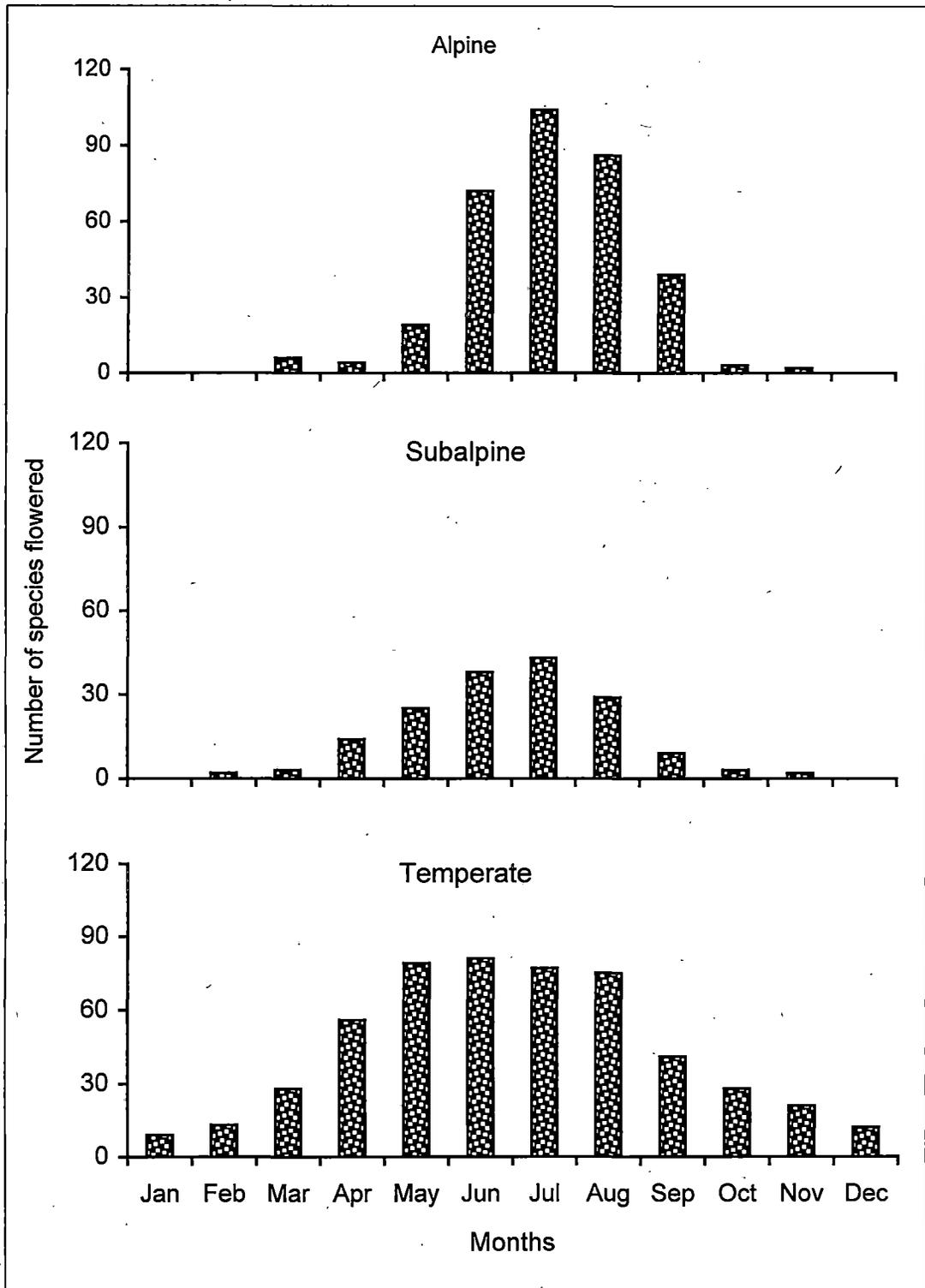


Fig. 3.2 Temporal distribution of flowering at three ecological zones along the Yuksam-Dzongri trail in Khangchendzonga Biosphere Reserve