

# Snow leopards and local human population in a protected area: a case study from the Nepalese Himalaya

The high altitude grasslands of upper Manang, western Nepal, are home of one of the last remaining populations of the endangered snow leopard (*Uncia uncia*). These grasslands, however, have also been used for centuries by the local inhabitants for livestock grazing. Close encounters between snow leopards and the livestock make occasional killing of livestock almost inevitable, bringing snow leopards into direct conflict with the human population.

Snow leopards kill livestock over most of their range and the impact on local economies can be substantial (Annenkov 1990, Fox et al. 1988, 1991, Jackson 1991, Schaller et al. 1987, 1988, Sherpa and Oli 1988). This results in a negative public attitude toward snow leopards, can lead to the death of many leopards killed in revenge (Mallon 1984, Fox et al. 1991, Osborne et al. 1983), and consequently poses a serious threat to the leopards. While conflict between snow leopards and local inhabitants continues to grow, local people's perspective of the problem has not yet been understood and little is being done to resolve the situation.

This paper analyses aspects of snow leopard - human conflict and other constraints on snow leopard conservation within the ecological and socio-economic background of Manang, and examines the issues relevant to snow leopard conservation.

## STUDY AREA

This study was conducted in northwestern Manang district, within the Annapurna Conservation Area, Nepal (28°30'-28°50'N, 83°50'-84°05'E). Snow leopards and blue sheep were studied in the upper Marsyangdi Valley, north-northwest of Manang Bhot village. This area consists of moderate to very steep ridgelines and valleys between 3600 m to 6000 m elevation. It lies in the rain shadow of the Annapurna Mountain range and precipitation is low. Spring and autumn are generally dry, but some precipitation is brought by summer monsoon and westerly storms in winter. Because of the low temperature, most precipitation between October and April is snow. The mean minimum temperature falls below -20°C in winter, and both diurnal and annual variations in temperature are great. Rainfall data for Manang are not available, but the average annual precipitation recorded at the nearest weather station (Jomsom) is less than 500 mm (Dobremez and Jest 1976).

Vegetation in the area falls under the steppe vegetation type of Dobremez and Jest (1976) and consists of grasslands and interspersed scrub. Scrub is dominated by *Juniperus squamata* on gentle slopes, whereas steeper slopes are dominated by *Caragana gerardiana*, *C. brevispina*, *Rosa sericea*, *Ephedra* spp. and *Lonicera* spp. Vegetation above 5600 m consists mainly of *Rhododendron anthopogon*, *Potentilla biflora*, and *Saxifraga* spp., and little or no vegetation is found above 5800 m.

The mammalian fauna of the area includes snow leopard, red fox (*Vulpes vulpes*), blue sheep (*Pseudois nayaur*), Himalayan marmot (*Marmota himalayana*), Royle's pika (*Ochotona roylei*), least weasel (*Mustela nivalis*), stone marten (*Martes fiona*), and Sikkim vole (*Alticola sikkimensis*). The avifauna is relatively diverse, and some of the common birds include lammergeier (*Gypatus barbatus*), Himalayan griffon (*Gyps himalayensis*), Tibetan snowcock (*Tetraogallus tibetanus*), and Himalayan snowcock (*Tetraogallus himalayensis*).

Although there are nine villages around the potential snow leopard habitat in Manang district, only four (Bhraka, Khangsar, Manang, and Tanki Manang) are located in the immediate vicinity of the study area. Livestock from all these villages are grazed in the alpine pasture, which also provides habitat for snow leopards and blue sheep. Crop and livestock farming are the major economic activities in the area, but some people are also involved in trekking and tourism-related, or other trades.

## METHODS

A method that combined radio-tracking of three snow leopards and measurements of hind paw-marks of unknown cats was used to estimate the snow leopard population (Oli, unpubl. data). Diet of snow leopards was investigated by analyzing 213 scats collected between April 1990 and February 1991 (Oli et al. 1993). The blue sheep population was censused between 13 April and 9 May 1990, using a direct observation method (Oli 1991).

A questionnaire was developed and addressed to a total of 102 randomly selected households of Bhraka, Khangsar, Manang, and Tanki Manang villages, which represented 18.5% of all households. The

questionnaire requested information concerning livestock holding patterns, types and numbers of livestock lost to snow leopards and their economic value, and villagers' suggestions for reducing predation losses (Oli 1991).

## RESULTS AND DISCUSSION

**The Snow Leopard** -- Five to seven adult snow leopards used the study area, giving a density of about 5 to 7 leopards/100 km<sup>2</sup>. This compares closely with the leopard density reported from Langu valley, western Nepal (Jackson and Ahlborn 1989) and Nar-Phu valley, Nepal (Sherpa and Oli 1988), but is considerably higher than those reported from elsewhere in the range (e.g., Shey, Nepal: Schaller 1977; Taxkorgan Reserve, China: Schaller et al. 1987; Ladakh, India: Mallon 1984, 1988; Dzungarsky Alatau, USSR: Annenkov 1990).

The diet of snow leopards in Manang consisted of 12 species (7 wild and 5 domestic) of mammals, birds, and an unidentified mammal (Oli et al. 1993). Blue sheep was the staple prey throughout the year and marmots were also important except in winter. In winter, marmots hibernated and their unavailability was compensated for by eating more Himalayan pika and livestock. Livestock remains were found in 11.5, 15.9, 10.4, and 39.0% of scats collected in spring, summer, autumn, and winter, respectively (Oli et al. 1993).

Although livestock are known to form a part of snow leopard's diet, it is unclear whether remains in the scats represent livestock killed by snow leopards or a portion eaten from animals that had died of other causes (Schaller 1977, Zhirjakov 1990). However, frequent predation incidents were reported from Manang, most often in winter, coinciding with the highest frequency of occurrence of livestock remains in scats (Oli et al. 1993), and it is likely that most, and perhaps all, livestock remains identified in scats came from the animals killed by snow leopards.

**The Prey Population** -- The population of blue sheep in Manang was estimated at 697 to 1071. The sheep density of 6.6-10.2/km<sup>2</sup> is similar to those reported from Nar and Phu valleys, Manang, (Sherpa and Oli 1988), but is higher than those reported from elsewhere (Schaller 1977, Wegge 1976, Wilson 1981). This density also compares closely with the density of 10 sheep/km<sup>2</sup> in a part of the study area surveyed in late autumn of 1987 (Wegge and Oli 1988), suggesting that the sheep population has remained relatively stable over this period. An analysis of predator - prey relationship in Manang suggested that the blue sheep population is abundant enough to support the estimated snow leopard population (Oli 1991).

**The Human Population** -- The majority of the inhabitants of Manang are subsistence farmers whose main economic activities are crop and livestock farming. Barley, wheat, potatoes, buckwheat and some vegetables are grown on farmlands located around villages. Most crops are sown in late spring or early summer and harvested in autumn. Farming is unprofitable because most slopes are steep and difficult to irrigate, land holdings are small, soil fertility and rainfall are low, and the growing season is short. A few farms (e.g., around Gunsang) have been abandoned because lack of irrigation resulted in substantial reduction in land productivity.

Animal husbandry is also an important economic activity, but livestock holdings are very small (Tables 1, 2). The average number of livestock per household was 26.6, **TABLE 1. Livestock holding pattern in the surveyed villages (% of households).**

Village	Size of holding (number of animals)						
	<=10	11-20	21-30	31-40	41-50	>50	
Bhraka	14.28	33.33	14.28	19.04	4.76	14.28	
Khangsar		6.89	48.27	17.24	17.24	0.00	10.34
Manang/Tanki	5.76	19.23	38.46	21.15	9.61	5.76	

**TABLE 2. Average number of livestock per household in Manang, based on a survey of 102 households.**

Village	Yak	Cow/ox	Horse	Goat	Sheep	Total	SD	Range
Bhraka	0.0	2.66	1.19	21.47	0.57	25.90	17.21	0-61
Khangsar		5.82	5.00	1.13	12.44	0.93	25.34	15.38 6-68
Manang/Tanki	5.13	0.94	1.67	19.52	0.22	27.51	13.08	2-64
All combined		4.28	2.43	1.42	17.93	0.49	26.57	15.29 0-68

of which about 67% were goats. Yaks and horses were the most valuable livestock types, but the average holding of these animals were only 4.3 and 2.4, respectively. Only local, unproductive breeds of animals are tough enough to survive the harsh climatic conditions and frequent forage shortages. For example, a female yak gives milk only for about five months (May-September) and the average daily milk production is about two liters, which probably does not cover the cost of tending such a large animal. Although animal farming is not profitable, it is still the primary source of milk and meat for the area.

After the opening of the area for trekking in the 1970s, some local people became involved in trekking lodge management and other tourism-related businesses. However, only a few benefit from it. High local inflation caused by an increased cash-flow to the bartering-based subsistence economy has made the lives of most of the population even more difficult. In addition, demand for timber for the construction of new trekking lodges, and firewood for cooking and heating needs of an ever-increasing number of tourists has increased pressure on the already scarce forest resources.

The annual per capita income of Manang and other villages in the mountainous region of the country is probably smaller than the national average of US \$160 (CBS 1987), and most people live a life below the poverty line. Many emigrate to Pokhara or Kathmandu in search of new economic opportunities or a better quality of life. As a result, the indigenous population of the area is decreasing (Table 3) despite a high fertility rate.

**TABLE 3. Population of Manang district in 1971 and 1981 censuses.**

	1971	1981	Change
Total population	7436	7021	-415
Male	3904	3543	-361
Female	3532	3478	-54
Density/km <sup>2</sup>	3.31	3.10	-0.21

Source: (CBS 1987).

### Threats to Snow Leopard Conservation

In Manang, the primary threats to snow leopard survival were the strongly negative public attitudes towards the leopards, and the local pastoralist's killing of the leopards in defence of their livestock. However, other human activities such as grazing and firewood collection also affected the leopard habitat.

**Predation of Livestock** -- A total of 38% and 34% (n=102) of households reported to have lost animals to snow leopards during 1988-89 and 1989-90, respectively. A total of 60 and 72 animals were lost to leopards in 1988-89 and 1989-90, with an average per household loss of 0.6 and 0.7, respectively. The number of animals lost in 1989-90 represented 2.6% of total stock holdings, but it was 5.1% for Khangsar village. All animals were killed in pastures and there were no reports of leopards killing livestock within villages, as has been reported from Ladakh (Mallon 1984). Forty-two percent of the predation incidents were reported to have taken place in winter, which corresponds with the high frequency of occurrence of livestock remains in scats collected in the same season (Oli 1991, Oli et al. 1993). It is possible that harsh winter conditions, particularly deep snow, might encourage leopards to kill livestock which represent easy-to-kill prey.

The economic value of livestock reported to have been lost to snow leopards by the surveyed villages was estimated at NRs 212,300 and NRs 174,100 (NRs = Nepal Rupees, US \$1 = NRs 50). Most losses, however, were less than NRs 5000, (68.6% in 1989-90, and 64.1% in 1988-89), but 20% and 12.8% of surveyed households reported a loss of more than NRs 10,000 for the years 1989-90 and 1988-89, respectively (Oli 1991, Table 5). The average per household loss was NRs 2175 and 2070 for the year 1989-90, and 1988-89, respectively, which is about a quarter of the per capita income of an average Nepali. One household lost 2 adult horses in one attack, worth NRs 30000 (\$600), an economic value almost equal to 5 times the per capita income; and another lost 11 goats in one attack which represented about 20% of its holdings. These losses were serious enough to upset the household economy for several years.

This study was based on the villager's reports on predation losses and their judgement of the cause of death. It is often difficult to separate predation from other causes of mortality such as disease. Also the possibility that the respondents inflated the number of livestock reported lost to leopards or inaccurately attributed the death of animals to snow leopard predation cannot be ruled out. However, even if the reported loss was inflated somewhat, the impact of loss was still substantial relative to the subsistence economy.

**TABLE 4. Frequency distribution of economic loss due to livestock depredation in Manang (% of households, n=102).**

Loss category (NRs)	1989-90	1988-89
<1,000	20.0	17.9
1,001-5,000	48.6	11.2
5,001-10,000	11.4	23.1
10,001-15,000	20.0	7.7
>15,000	0.0	5.1

**Snow Leopard Poaching** -- Five adult leopards were reported to have been killed in different incidents over the past decade, however, the number may be higher than this as most of the respondents refused to provide any information on this subject. Unlike the Langu Valley of western Nepal, where snow leopards are hunted for fur using poisoned spears (Jackson 1979), leopard poaching in Manang seemed to be all in defence of livestock.

**Public Attitude** -- As a result of the history of snow leopard's predation on domestic animals and its economic impact, 95% of the respondents had a negative attitude toward snow leopards (63% strongly and 32% slightly disliked them, n=100). In contrast, public attitude towards blue sheep was positive (81% strongly and 15% slightly liked them, n=100), because blue sheep were considered harmless and beautiful. No complaints of crop raiding by blue sheep were reported (Oli 1991).

### **Human Activities in Snow Leopard Habitat**

**Grazing** -- Virtually all accessible areas of snow leopard habitat were grazed by livestock. Ownership of pastures was communal, and different parts of pasture were grazed in different seasons. Domestic animals were not allowed to stay in the villages or near any farm between the sowing (May-June) and harvesting (September-October) seasons. The pattern of herd movement greatly depended upon the decision of individual herders. Predator-proof permanent enclosures were not available in most of the grazing areas; thus domestic animals were corralled in temporary enclosures which were not good enough to keep the leopards out.

Livestock compete with the blue sheep for forage throughout the year, and may also transmit communicable diseases. Presence of livestock in the snow leopard habitat throughout the year increases the predation risk by bringing snow leopards and their potential prey (livestock) into close proximity.

**Firewood Collection** -- Because upper Manang lies above the tree line, *Juniperus* scrub formed the most important source of firewood, but a few remaining stands of *Betula utilis* were also cut for firewood. In the southern part of the study area, villagers from Khangsar, Manang and Tanki Manang came to collect wood, whereas in the northern part, trekking lodge owners of Yak Kharka, Leddar, and Thorung Phedi collected wood. In addition, some of the organized trekking groups and their support staff used juniper for cooking meals. Severe damage was done to scrub when wood collectors set fire to the juniper to dry the wood and to make the collection easier. Some wood collectors cleared large patches of juniper, thus reducing regeneration potential. Uncontrolled burning of grasslands, a rare practice in the area, also occasionally destroyed scarce vegetation. The destruction of juniper scrub has affected the habitat by reducing hunting cover for the leopards.

**Trekking** -- As a part of the popular Annapurna circuit trek, Manang receives over 5000 trekkers annually. The main trekking trail passes through the middle of the study area along Jargeng Khola. Trekking tourism seemed to have affected the habitat in two ways, first by using scarce juniper for firewood, and second by littering the environment with non-biodegradable trash. A continuous flow of people during the trekking season through the middle of their habitat might also affect the leopard's and blue sheep's natural behavior.

**Hunting** -- Hunting of blue sheep has been non-existent in upper Manang since it was banned by the local monastery about 15 years ago. However, they are hunted in Nar Valley (Sherpa and Oli 1988).

**What Do the Local People Say?** -- Local people considered snow leopard to be vermin because of the leopard's livestock killing behavior. All questionnaire respondents considered the economic impact of predation very serious and thought it necessary to reduce the loss. Most of them (52%, n=102) suggested extermination of snow leopard as the only way of reducing loss, whereas only 3% considered financial compensation as the best option. An additional 35% preferred compensation but considered extermination as the only alternative, and the rest (10%) were prepared to consider compensation as an option only if extermination proved impossible. Other possible management options, such as removal of problem leopards or improving husbandry practices, were not considered to be suitable/acceptable ways of reducing loss (Oli 1991).

During interviews and casual conversations, the people of Manang demanded that they either be left alone to deal with the problem of livestock predation or the loss be properly compensated. Obviously, the Manang people's way of dealing with the predation problem would be to kill the leopards whenever possible. The tradition of financially rewarding successful leopard hunters testifies to the local people's determination to eradicate snow leopards.

### **Conserving the Snow Leopard**

Given the high dependence of the local people on their animals, their small holdings, substantial predation losses and strong negative public attitude toward snow leopards, it seems unlikely that the remaining snow leopard populations can be protected without local people's cooperation or their participation in conservation programs. The objective of snow leopard conservation/restoration might not be achieved unless there is something for locals such that the rewards of maintaining snow leopard populations exceed perceived gains from killing or hating them. Some important aspects of snow leopard conservation, particularly relevant in the context of Manang, are presented below.

**Reducing Predation Losses** -- Predation on livestock by wild predators is a complex phenomenon, and it is often difficult to pin-point the ultimate cause. However, most predation in Manang can be attributed to the ease of close encounters between leopards and livestock, making them easy-to-stalk prey. The following points are noteworthy: (1) the population of the main ungulate prey, blue sheep, in Manang was adequate to support the estimated leopard population, (2) all instances of reported predation occurred in the pasture, none within villages, and (3) livestock were not always closely guarded when grazing in the day, and were not corralled in predator-proof enclosures at night.

Therefore, it may be possible to reduce predation losses if close contact between leopards and livestock and could be avoided by: (1) closely guarding the animals during the day, (2) corraling animals in predator-proof enclosures at night, and (3) if practicable, avoiding the grazing areas with higher predation risk.

However, most pastures in Manang are potential snow leopard habitats, and local people do not consider it cost effective to construct a series of predator-proof enclosures throughout the pastures or to hire people to closely guard animals during the day. None of the respondents considered options other than eradication of leopards and compensation as suitable ways of reducing the loss.

While eradication of the snow leopard is unacceptable from the conservation point of view, compensation may be initially expensive, and prone to the problems of false claims, nepotism and favoritism. Preliminary analysis of a possible compensation scheme suggested that an endowment fund of US \$135,000 at an interest rate of 12% could compensate the predation losses in and around potential snow leopard habitat in Manang district at the loss rate recorded for 1989-90 (i.e., 2.6% of holding; Oli 1991). Financial compensation has been found to be successful and well worth its cost elsewhere (Fritts et al. 1992, Gurba 1982). Since it involves instant financial incentive, it may help change local people's negative attitude towards snow leopards. If sufficient money to create an endowment fund is made available and an efficient management system can be designed and administered jointly by dedicated protected area managers and a committee of respected villagers and religious leaders, the above noted problems could be minimized and sustainability of the scheme ensured (Oli 1991).

Improvement in husbandry practices, in combination with financial compensation for specific losses might, in the long run, be a sustainable and satisfactory solution. Assisting local herdsmen in the construction of predator-proof enclosures in pastures and the hiring of people for guarding animals closely could substantially reduce predation losses. These programs should be given special consideration.

**Conservation of Prey Population** -- Currently, the population of blue sheep is adequate to support the estimated snow leopard population, and they are under not threat (Oli 1991). Depletion of the prey population may result in increased predation on domestic animals, which consequently encourages killing of leopards in revenge. Therefore, prohibition of trophy or any other kind of hunting of blue sheep in Manang should be retained. This would not be difficult to implement because blue sheep hunting is already locally prohibited in most parts of Manang, and the local community is against such hunting operations (Oli 1991). However, in Nar valley and other areas in the leopard's range where blue sheep are hunted by local hunters, such restriction should be immediately enforced.

**Habitat Conservation** -- During this study, several blue sheep carcasses freshly killed by snow leopards were examined, and most of them were located close to juniper scrub. This suggested that juniper scrub is used by snow leopards as hunting cover. Therefore, using juniper for firewood should be discouraged. It would be difficult to impose such a restriction on the general public because juniper sometimes is the only source of wood. However, trekking lodges and organized trekking groups should be encouraged to use kerosene or other alternative source of energy. This can be achieved by setting up a kerosene depot and making kerosene available at a subsidized rate. Similar arrangements in the Annapurna Sanctuary area by Annapurna Conservation Area Project (ACAP) have proven successful. Clearing of large patches and setting fire to juniper should be discouraged. Plantation of locally adapted and fast-growing species of trees around the villages would reduce pressure on the scarce vegetation of the snow leopard habitat.

**Education and Public Participation** -- Only about 1% of people in Manang were aware of the legally protected status of the snow leopard (Oli 1991). The local people find it difficult to understand why they should not kill snow leopards that damage their property. Education programs aimed at providing information and changing local people's attitude could play a major role.

Bringing about attitude changes and increasing public participation in conservation can often be difficult, and may only be achieved by carefully designed conservation education programs. A direct message to protect snow leopards considered vermin by the local people may not be acceptable and should, therefore, only be a part of the overall package of an education program. A message acceptable to the local target group should be properly identified and slide shows and education materials such as posters and post cards of snow leopard should be considered. Trekkers should also be made aware of the fact that they are trekking in fragile snow leopard habitat and that their activity may affect the survival of the species. This could be achieved by adding a few lines to the protected area brochures, which should be made available to the tourists visiting those areas.

Involving local people in the planning and implementation of snow leopard conservation and development projects would help ensure sustainability and public acceptance of such programs. Therefore, such programs should be designed and implemented in collaboration with the local communities.

**Capturing Religious Sentiment** -- A vast majority of the population in Manang is Buddhist, and believe that no animal should be killed. This religious sentiment dictates the prohibition of blue sheep hunting in Manang. But snow leopards are an exception because they are generally considered vermin. However, this religious sentiment can be captured and promoted with the help of local Gompas and Lamas to give snow leopard a similar protection. Lamas might be persuaded to use their influence to stop the killing of snow leopards if compensation or other suitable methods of reducing predation loss were offered.

Honoring the people who contribute significantly to the snow leopard conservation program (e.g., lamas, members of local committees, or local village leaders) would encourage others to follow their example. A reward scheme would also encourage the people to participate actively in other conservation and local development programs. Such a scheme is being practiced by ACAP in Ghandruk area and has worked well to date.

**Complementary Development Scheme: a Trade-Off** -- Poverty and subsistence activities are often a threat to conservation, so a package involving programs aimed at improving living conditions for local people is more likely to be accepted than a conservation program in isolation. In addition, experience has shown that the people of impoverished areas are more responsive to a conservation program offered in conjunction with development projects that are aimed at improving local services. Supporting the local community in the establishment and upgrading of basic services such as drinking water, health care, and construction of bridges and schools would establish protected area management and conservation organizations as partners in the process of local development, strengthening their standing in the community.

**Improve Law Enforcement** -- Numerous reports on illegal trade of snow leopard fur in Kathmandu and elsewhere in its range are available (Barnes 1989, Chopra 1988, Osborne et al. 1983). Snow leopards are legally protected in most parts of their range, and strict legal measures should be taken to stop the illegal fur trade.

Improved law enforcement in the area may further discourage killing of snow leopards in revenge or for fur. Although law enforcement can be difficult in Manang and elsewhere in the leopard's habitat, it

may be possible to improve the situation after some measures for protection of livestock or compensation for losses are provided and local people's support is secured. Training and employing selected local people, who have good knowledge of the area, could help increase the efficiency in detecting any poaching, or cross-checking claimed livestock losses if a compensation scheme is implemented.

## CONCLUSIONS

This study has shown that although snow leopards still occur in Manang, they are constantly in conflict with the local human population. The objective of snow leopard conservation cannot be achieved without the cooperation of the local communities, and it is unlikely to be secured unless some ways of reducing predation losses acceptable to the affected community are offered. Snow leopard conservation can work only if it is acceptable to, participated in, and intelligible to the local people who are directly affected by the nature of such programs.

Protected areas and conservation organizations in the snow leopard range can play an important role by working towards resolving the conflict and implementing conservation education and other programs aimed at protecting or restoring leopard populations. However, most protected areas and governments in the leopard's range lack the resources, both financial and technical, necessary for implementing such programs. Therefore, the objective of bringing snow leopards back from the brink of extinction seems possible only through a collaboration among governments, protected area managers in the snow leopard range, and international organizations dedicated to the conservation of endangered species.

The modern concept of conservation goes well beyond the limit of the blanket protection of a species and emphasizes the conservation of the ecosystem as a whole, of which humans have been an important part, and conservation objectives cannot be achieved by excluding the humans. There are enough reasons; scientific, aesthetic, and ethical, to conserve snow leopards. But it would be unfortunate if it were achieved at the expense of the well-being and livelihoods of indigenous human populations.

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**FIGURE 1. Frequency of occurrence of major prey items identified in snow leopard scats collected in Manang between April 1989-February 1990.**

**FIGURE 2. Number and type of livestock killed by snow leopard in different years.**

TABLE 0. Number of snow leopards in Manang, local people's estimation (% respondents).

Village	n	Estimated number								
		2-3	3-4	4-5	5-6	6-7	7-8	8-9	10-11	
Bhraka		21	28.57	23.81	28.57	4.76	9.52	4.76	0.0	
Khangsar			29	3.45	34.48	41.38	13.79	6.90	0.00	0.0
Manang/Tanki	52	0.00	34.00	42.00	8.00	10.00	4.00	2.0		

TABLE 1. Livestock holding pattern in the surveyed villages (% of households).

Village	Size of holding (number of animals)						
	<=10	11-20	21-30	31-40	41-50	>50	
Bhraka	14.28	33.33	14.28	19.04	4.76	14.28	
Khangsar		6.89	48.27	17.24	17.24	0.00	10.34
Manang/Tanki	5.76	19.23	38.46	21.15	9.61	5.76	

TABLE 2. Average number of livestock per household in Manang, based on a survey of 102 households.

Village	Yak	Cow/ox	Horse	Goat	Sheep	Total	SD	Range	
Bhraka	0.0	2.66	1.19	21.47	0.57	25.90	17.21	0-61	
Khangsar		5.82	5.00	1.13	12.44	0.93	25.34	15.38	6-68
Manang/Tanki	5.13	0.94	1.67	19.52	0.22	27.51	13.08	2-64	
All combined		4.28	2.43	1.42	17.93	0.49	26.57	15.29	0-68

TABLE 3. Population of Manang district in 1971 and 1981 censuses.

	1971	1981	Change
Total population	7436	7021	-415
Male	3904	3543	-361
Female	3532	3478	-54
Density/km <sup>2</sup>	3.31	3.10	-0.21

Source: (CBS 1987).

TABLE 4. Frequency distribution of economic loss due to livestock depredation in Manang (% of households, n=102).

Loss category (NRs)	1989-90	1988-89
<1,000	20.0	17.9
1,001-5,000	48.6	11.2
5,001-10,000	11.4	23.1
10,001-15,000	20.0	7.7
>15,000	0.0	5.1

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