

Economic impacts of livestock depredation by snow leopard *Uncia uncia* in the Kanchenjunga Conservation Area, Nepal Himalaya

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SUMMARY

It is necessary to fully understand the economic conditions of local herders in order to find solutions to the conflicts between wildlife conservation and livestock rearing in remote areas of low-income countries. In the Kanchenjunga Conservation Area (KCA), Nepal, livestock depredation by snow leopards impacts on yak herders' livelihoods. Retaliatory killings of snow leopard by the herders have been reported and the concerned authorities recently initiated snow leopard conservation programmes. In 2001, interviews with the yak herders who used the pastures in the Ghunsa valley in the preceding year collected data on the incidence of livestock death caused by snow leopards. The annual net cash income of the yak herders was estimated by obtaining baseline values of sales and expenditure per livestock head through field measurement of dairy products and interviews with a sample of herders. As yet, the average annual damage does not appear to have adversely affected fundamental livelihoods in households with an average herd size (36.6 head). However, in the worst scenario of livestock depredation, households with medium or small-sized herds (<40 head) might risk their living conditions becoming unsustainable or having to withdraw from yak pastoralism. A supplementary interview showed that the majority of the herders, except those who took completely neutral attitudes towards the regional conservation and development programme, had negative views of the snow leopard conservation policy. For the snow leopard conservation programme in the KCA to be a success, there must be a system to compensate the herders' households for livestock damage.

Keywords: herder, Kanchenjunga Conservation Area, local resident, park-people conflict, wildlife conservation, yak

INTRODUCTION

Snow leopard (*Uncia uncia*), an endangered species listed in the IUCN Red List (Hilton-Taylor 2000), is one of the animal species internationally targeted for conservation. In many

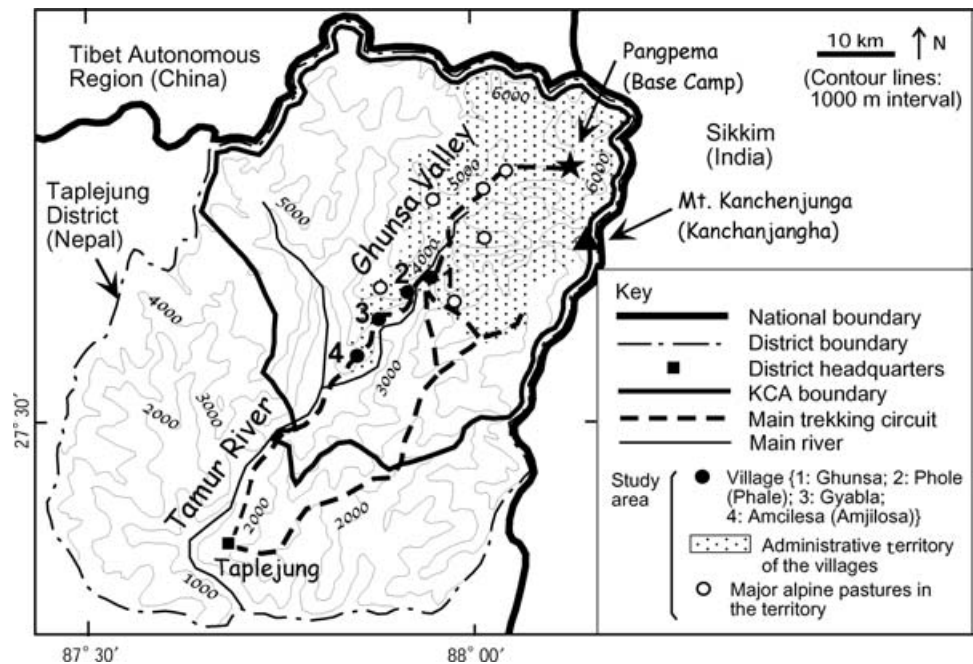
parts of the snow leopard habitat in high mountains in south and central Asia, conflict between snow leopard conservation and livestock rearing has been a common problem ever since the introduction of the conservation policies, and some possible solutions to those conflicts have been discussed (Oli *et al.* 1994; Miller & Jackson 1994; Jackson *et al.* 1996; Mishra 1997; Hussain 2000, 2003; Mishra *et al.* 2003; McCarthy & Chapron 2003; Mishra & Fitzherbert 2004). These previous studies revealed that: local herders were mostly resentful of snow leopards, and introduction of systems, in which conservation performance by individual herders brings economic benefits to themselves, were necessary in most cases. Designing such systems requires detailed socio-economic as well as ecological data (Mishra *et al.* 2003). One of the most important pieces of information required is on economic damage caused by livestock depredation. Excepting Oli *et al.* (1994) and Jackson *et al.* (1996) in the Annapurna Conservation Area, western Nepal, and Mishra (1997) in the Spiti Region of Himachal Pradesh, India, there have been few case studies to derive these data. This paper investigates this issue in the Kanchenjunga Conservation Area (KCA) of eastern Nepal.

In eastern Nepal, the habitat of snow leopard ranges from 3000–5400 m altitude (World Wildlife Fund [WWF] Nepal Program 1999a), and almost coincides with the grazing areas used by the local yak (*Bos grunniens*) herders in the High Himalaya (see Kobayashi 1987; Stevens 1993). Some shepherds from the Middle Mountain also use this altitudinal range during the summer seasons (see Stevens 1993; Watanabe 2000). The predators of these yaks and sheep are not only the snow leopards, but also wolves (*Canis lupus*), as in the Spiti Region of India (Mishra 1997). Although no study has compared the intensities of livestock depredation by the two kinds of wildlife, this study considered the conflicts derived from the snow leopard conservation to be a more serious and deep-rooted problem. The snow leopards tend to provoke herders' antipathy, because: (1) they are treated as 'charismatic flagship species' in the wildlife conservation project in Nepal (WWF Nepal Program 1999b); and (2) there are legal penalties for killing them in the fourth amendment of Nepal's National Parks and Wildlife Conservation Act 2029 BS (1973) (McCarthy & Chapron 2003). In this context, this study focuses on the relationship between snow leopards and the local yak herders in the KCA, whose living space corresponds to the habitat of the snow leopards.

The KCA was established in July 1997. Since then, the WWF Nepal Program has been taking the leading role in the Kanchenjunga Conservation Area Project (KCAP) by

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Figure 1 Map showing locations of the Kanchenjunga Conservation Area (KCA) and the Ghunsa Valley. Base map from 1:500 000 scale map (Survey Department, His Majesty's Government of Nepal 1989). The KCA boundary and main trekking circuit added to the base map are taken from publications of the KCAP. Field observation determined the locations of the major alpine pastures.



providing financial and technical supports to the Department of National Parks and Wildlife Conservation of His Majesty's Government of Nepal (HMGN). The KCAP seeks to protect the region's forests and wildlife as well as promote sustainable livelihoods of the local people, and has already inaugurated various programmes to achieve these objectives (WWF Nepal Program 1998, 1999c, 2000, 2001). The KCAP has appointed one local resident as a Wildlife Monitoring Assistant dedicated to snow leopard conservation, who carries out monitoring trips as well as collecting information on presence of snow leopards in the KCA (WWF Nepal Program 2000, 2001).

KCAP staff are aware of cases of retaliatory killings of snow leopards for the predation of livestock inside the KCA (WWF Nepal Program 2000). Some local herders also mentioned that they killed snow leopards by using poison or by beating the animals, especially in the years before the KCAP's launch, before herders were informed of the legal penalties for such acts. In June 2001, the KCAP staff held workshops at two sites in the KCA (Ghunsa Village and Tseram Kharka) in order to provide information to the local residents on snow leopard conservation, its status as an endangered species, threats to its conservation, and its habits and habitats. In the workshop in the Ghunsa Village, the KCAP staff and the 23 local residents who took part in it also debated the extent of livestock damages caused by snow leopards and measures needed to face the problem (WWF Nepal Program 2001). It seems that these meetings were the first attempt by the KCAP staff to communicate with local herders. However, there are no continuously monitored data on incidents of livestock depredation by snow leopards in the KCA apart from some occasional accidental reports (Yonzon 1996; WWF Nepal Program 2000, 2001). This study aims to cover the deficiency of data, and attempts a detailed economic analysis of the

pastoralism-related elements in the herders' livelihood as the first step to understand the impacts of livestock depredation.

METHODS AND STUDY AREA

This study focuses on the yak/yak-cattle hybrid (hereafter yak hybrid) herders in the Ghunsa Valley, one of the tributary valleys of the Tamur River located within the KCA (Fig. 1). The herders are villagers of Ghunsa, Phole, Gyabla or Amcilesa, with very few exceptions. The majority of the residents in the four villages were Nepali nationals of Tibetan origin, who called themselves *Sherpa* or *Bhote*, but some Tibetan refugees were also residing in Phole. Including both groups of people, there were 73 households (318 inhabitants) residing in the administrative territory of the four villages (Demographical Survey 2001, His Majesty's Government of Nepal Central Bureau of Statistics, unpublished data 2001). The area seems to be substantially important for snow leopard conservation inside the KCA, because it covers approximately two-fifths of the potential snow leopard habitat in the KCA and also includes an important part of the trekking circuit in the KCA (Fig. 1). The Ghunsa office of the KCAP is the base for snow leopard monitoring activities.

The local residents' main sources of income are crop farming, yak/yak-hybrid pastoralism, tourist lodge/campsite management for foreign trekkers, carpet weaving, and trading with Tibet and Taplejung (Fig. 1). Crop farming, which every household practises, is only for subsistence and for exchange for other crops grown at lower altitudes. The most important sources of cash income are presently yak/yak-hybrid pastoralism and tourist lodge/campsite management. Carpet weaving also generates some cash income (Brown 2002), and is generally practised as a sideline in households

where extra women are available for work. Trade is also profitable and is carried out through both bartering and cash-based exchange (Brown 2002). It seems that some households obtain cash income by conducting trading caravans, although the amounts in general remain unclear.

Among the total households in the study area, 25 households engaged in yak/yak-hybrid pastoralism in 2000, including four households that consigned their herds to other herders. Eight of these households also practised tourist lodge/campsite management for some months in the tourist seasons before and after the monsoon, and another four conducted trading trips to Tibet in the summer in the year of survey.

Economic investigations

The production strategies differ slightly between yak herders and yak-hybrid herders. At the time of the survey, yak herders, whose livestock herds were mainly composed of female yaks, were the majority (16 households in 2000) of the total yak/yak-hybrid herders (25 households in 2000), and they were selected as the subjects of the present economic investigations, excluding two households that did not graze their herds inside the Ghunsa Valley. Adding a herder who came to graze his herd in the Ghunsa Valley from a neighbouring area, 15 households of yak herders were included in the economic subject group.

Valuation of damages caused by snow leopard predation on livestock

To obtain information about livestock depredation incidents, I conducted interviews with nine households (60% of the subject group) in June–September 2001. Prior to the interviews, I spent a total of four and a half months in the area in 1998 and 2000, and, at the time of the interviews, the herders recognized that I was neither officially related to the KCAP nor politically related to other concerned authorities. Throughout the field survey, interviews with the herders were conducted mostly in the form of casual conversation, and I avoided taking notes in front of the interviewees as much as possible, as it seemed to be a favourable way to extract accurate accounts. The first question regarding livestock depredation incidents was whether they had experienced any incidents or not. Then they were asked about the time (year and month) and place of each incident, and type, sex and age of individual livestock that had died in each case. I also asked whether they had witnessed snow leopards or perceived signs of the snow leopards' presence at the time and place of the incidents. The last question was planned in order to exclude incidents when respondents were not totally confident that they resulted from snow leopard attacks. The actual causes of livestock deaths in the past could not be confirmed, and the incident reports possibly included unintentionally mistaken cases. Therefore, the incidents included were of livestock losses perceived by the herders as being the result of snow leopard attacks.

The economic value of livestock that had died was estimated using the general market prices for the area, which I obtained from separate interviews. Local perceptions were used to classify different kinds of livestock and define 'adult' stock. I then calculated the economic damage caused by each incident. Economic damages per household per year were estimated by combining the incidents reported to have occurred in a single year of the official Nepali calendar (called *Bikram Sambat*), which starts in mid-April. This calendar was used to establish the time of incidents with the herders.

Estimation of net annual cash income of the yak herders

The main products of yak pastoralism are butter, dried cheese, offspring of livestock, several kinds of hair from different parts of the body, meat and fur. Dried cheese and offspring of livestock were the two major products that the herders could convert into cash. The main livestock offspring for sale were hybrids between female yaks and Tibetan bulls. The hybrids born in spring were usually sold in autumn of the same year. Some of the newborn male yaks were also sold, although the price was lower than that of the hybrids. The rest of the newborn livestock (all of the female yaks and most of the male yaks) generally remained in the herds as the moveable property of the herders. Female yaks became the main component in the herds of the next generation. Male yaks were used as pack livestock or studs. However, some of the male yaks were sold after they had grown up when the herders needed cash. Other products were used for subsistence. Among various kinds of dairy products consumed by the herders themselves, butter was the most important, because the local people are accustomed to drinking a lot of butter tea. Thus, the sales yielded from yak pastoralism were essentially of dried cheese, yak hybrids and other occasional livestock.

To obtain baseline data on net cash income from yak pastoralism, I selected three households in the subject group as representative samples, paying specific attention to herd size. During the summer of 2000, I conducted production measurements, including counting newborn livestock and weighing cheese production. The weights of cheese were measured at each sample household immediately after daily production for three successive days in a month during the main production season (July–September). Because the cheese is always sold in dried form, the weights of fresh cheese were converted into those of dried cheese using measurements I had determined for the local method of production. The amounts of dried cheese produced daily were thus measured for July, August and September. Although a slight adjustment in the production at the beginning and end of the production season (late June and early October) was needed, total seasonal production was calculated as a sum of the daily average production. The annual sales of the three sample households were supplemented by interviews with the same households in 2001. I also examined the pastoralism-related expenditure of these households through interviews conducted in 2001. Herders in the Ghunsa Valley prepare hay during summer for winter fodder, but they also need to purchase fodder

Table 1 Herders' reports on incidents occurring before mid-April 2001. Data collected in June–September 2001. Adult livestock ≥ 3 yrs old.

Household	Year	Month or season of the incident	Place of the incident and its approximate altitude	Number of livestock killed (head)	Dead livestock type (sex – age) and number in the category	Witnessed snow leopard or sign of its presence
7	2001	mid-Mar to mid-Apr	Lumitinga (4280 m)	1	Yak (m-1) 1	no
1	2001	mid-Feb to mid-Mar	Ramtang (4590 m)	1	Yak (f-adult) 1	uncertain
7	2000–2001	mid-Dec to mid-Jan	Teyon (5050 m)	2	Yak (f-1) 1; (m-1) 1	no
1	2000–2001	mid-Dec to mid-Jan	Anidesa-Ramtang (4500–4590 m)	2	Yak (f-0) 2	uncertain
11	2000	mid-Jul to mid-Aug	Sumdoma (?)	1	Yak hybrid (m-adult) 1	snow leopard
3	2000	summer	Zorkyu (5020 m)	1	Yak (m-0) 1	no
3	2000	summer	Ponmarko (4540 m)	1	Yak (f-1) 1	uncertain
2	2000	summer	Doksaho-Tangalimo (4220–4460 m)	2	Yak (f-adult) 2	uncertain
3	1999–2000	winter	Takpakesa (3900 m ?)	1	Yak (m-1) 1	no
14	1999	mid-Aug to mid-Sept	Lhonak (4760 m)	1	Yak (f-1) 1	snow leopard
14	1998	mid-Sept to mid-Oct	Puitinga (4300 m)	1	Yak (m-1) 1	no
11	1998	mid-Aug to mid-Sept	Sumdoma (?)	4	Yak (m-2) 2; (m-adult) 2	snow leopard
4	1997	mid-Jul to mid-Aug	Anidaa-Ramtang (4400?–4590 m)	2	Yak (m-0) 1; yak hybrid (m-0) 1	footprints
3	around 1997–1998	winter	Lunbachemo (4240 m)	6	Yak (f-0) 2; (m-0) 1; (f-adult)2; (m-adult) 1	footprints
10	1997 or 1996	mid-Mar to mid-Apr	Lunbasamba (4080 m)	2	Yak (f-adult) 1; (m-adult) 1	snow leopard
6	1996 or 1995	mid-Feb to mid-Mar	Bokri (3900 m ?)	2	Yak (f-adult) 2	snow leopard
14	around 1995	mid-May to mid-Jun	Lhagyap (4150 m)	1	Yak (m-2) 1	no
Total	–	–	–	31	–	–

(mainly maize) as supplemental feed. Livestock require salt throughout the year. Some herders needed to pay salaries to employees who assisted the households in pasture work. The herders from the sample households provided information on such expenditure, including amounts of fodder purchased and prices.

In order to estimate the annual net cash income of all the households in the subject group, the number of milking yaks and the total number of livestock in each household were employed as indices of the household's production and consumption, respectively, as milking yaks, which also produce infant hybrids, generate most of the profits, while all livestock consume fodder. Using the baseline data collected from the sample households, the average gross annual sales per milking yak (S) and average total annual expenditure per head of livestock (E) were calculated. These two values were adopted as the baseline values for the calculation of the annual net cash income in each household:

Annual net cash income

$$= [(\text{Number of milking yaks}) \times (S)] \\ - [(\text{Total number of livestock}) \times (E)]$$

The calculation was feasible for 13 of the households (87% of the subject group), where interviews on livestock composition were successful. I generally verified the data on livestock composition by direct observation of the pastures.

Survey on attitudes of herders toward KCAP

In order to investigate the herders' perceptions of the KCAP's policies, I conducted interviews in 2000 and 2001 along with other surveys. The interviewees were 17 local herders from 12 households including two yak-hybrid herders from two households. They were asked what kinds of positive and negative impacts on their livelihood the KCAP had produced so far.

RESULTS

Livestock depredation and its economic damage

All of the herders interviewed could recall more than one incident occurring within the preceding seven years. Their memories were largely very clear about the incidents within the previous three years. However, there was uncertainty about the time in most of the reports regarding incidents that had occurred more than four years previously. Incidents reported to have occurred, for example, 'about four years ago' or 'five or six years ago' were accepted as valid, while an incident reported to have occurred 'more than 10 years ago' was excluded from the data, because the reported year of occurrence was not only obscure, but also exceptionally old compared to other incidents (Table 1). There were some other reports without answers to the second (time and place of incidents) and third questions (type, sex and age of dead

Table 2 General market prices of livestock in the Ghunsa Valley as of 2000–2001.

<i>Livestock type</i>	<i>Sex</i>	<i>Age (year)</i>	<i>Price (NR)</i>
Yak	male/female	<1	2000
		1	4000
		2	6000
		3–(adult)	8000
Yak hybrid (products of the Ghunsa Valley)	male/female	<1	6000
Yak hybrid (pack livestock of good quality bred in other areas)	male	3–(adult)	10 000–15 000

livestock), despite the respondents' confidence that they had experienced snow leopard damage in specific years.

The incidence of livestock death among the nine households was 56% in 1998–1999, 44% in 1999–2000, and 56% in 2000–2001, including incomplete incident reports without answers to the second and third questions. Of the 17 incidents listed (Table 1), nine incidents were reported to have occurred in summer (May–October) and eight in winter. However, the actual number of incidents in winter seasons could be much greater, because all of the incomplete incidents reports mentioned above were considered to have occurred during winter seasons. Almost all the incidents were reported to have occurred in alpine pastures (4000–5400 m altitude) or places just below the timberline. The snow leopard, or the sign of its presence, was not always witnessed in each incident. However, the herders were generally confident that the incidents were

caused by snow leopards. They unanimously said 'a vermin is always a snow leopard in alpine areas, although there is another kind of vermin in forest areas'. Among the total livestock that had died (31 head), 42% (13 head) were adults (above three years old), and the rest were infants, mostly below one year old.

The market prices of livestock were relatively stable (Table 2). The only exception was the wide range in the market price of male yak hybrids bred in other areas and used as pack livestock in the Ghunsa Valley (Table 2); consequently the loss of such animals was estimated using the actual purchase price stated by the herder who lost the livestock (Household 11 in Table 1). The estimated annual damage per household was Nepali rupees (NR) 4000–30 000 (US\$ 54–405 in January 2001) or 1–6 head of livestock. The average was NR 12 429 (SD \pm 8346) = US\$ 168, or 2.2 head (SD \pm 1.4) of livestock.

Net annual cash income of yak pastoralism

Based on the annual sales and expenditure of the three sample households, the average gross annual sales per milking yak and average total annual expenditure per head of livestock were estimated to be NR 4343 and NR 360, respectively (Table 3). Among the 13 households surveyed, the numbers of milking yak and of total livestock in the herds were 6–22 and 18–66, respectively. The average number of milking yaks was 13.0 (SD \pm 5.4) head, and the average number of total livestock was 36.6 (SD \pm 13.9) head. The estimated annual net cash

Table 3 Annual sales and expenditure of yak pastoralists in the Ghunsa Valley. Data for three households in 2000–2001 obtained from interviews and field measurement. ¹The selling price of dried cheese was 170–175 NR kg⁻¹ and the selling price of a yak hybrid was 5500–6500 NR head⁻¹. ²*Pina* is a kind of oil cake. One *pathi* corresponds to approximately 4.5 litres, and one *bari* expresses a load by an adult person, which usually weighs around 30 kg. ³There was a large variety in the purchase prices of fodder among the three households mainly because fodder was purchased from different places. ⁴The total numbers of livestock in each household do not include livestock less than one year old.

<i>Items</i>	<i>Household</i>			<i>Mean</i>	<i>SD</i>
	<i>1</i>	<i>4</i>	<i>10</i>		
<i>Main products</i>					
dried cheese (kg)	160	133	104	–	–
yak hybrid (head)	4	7	4	–	–
<i>Sales (NR)</i>					
dried cheese ¹	27 200	22 610	18 200	–	–
yak hybrid ¹	23 000	42 500	24 000	–	–
other livestock	27 000	16 500	6000	–	–
<i>Gross annual sales (NR)</i>	77 200	81 610	48 200	–	–
<i>Number of milking yaks (head)</i>	21	18	10	–	–
<i>Gross annual sales/milking yak (NR)</i>	3676	4534	4820	4343	595
<i>Fodder purchased</i>					
maize (<i>pathi</i>) ²	100	60	50	–	–
salt (<i>pathi</i>) ²	70	30	20	–	–
<i>pina</i> (<i>bari</i>) ²	5	0	0	–	–
hay (<i>bari</i>) ²	0	3	0	–	–
<i>Expenditure (NR)</i>					
maize ³	7000	7800	5000	–	–
salt ³	2800	4500	3000	–	–
<i>pina</i>	2500	0	0	–	–
hay	0	1050	0	–	–
employee salaries	13 000	3500	1800	–	–
<i>Total annual expenditure (NR)</i>	25 300	16 850	9800	–	–
<i>Total number of livestock (head)</i> ⁴	66	47	29	–	–
<i>Total annual expenditure/livestock (NR)</i>	383	359	338	360	23

income of pastoralism to the 13 households was NR 14 538–77 186 (US\$ 196–1043), the average being NR 43 277 (SD \pm 19 645) = US\$ 585.

Attitude of herders toward KCAP

Many herders complained about some of the KCAP's programmes, and there were few positive answers. The major reasons given by the herders for their complaints may be summarized as: (1) increased difficulty in using local wood resources; (2) ban on snow leopard elimination without an effective compensatory measure; and (3) insufficient project management in terms of reliability and transparency (Table 4).

DISCUSSION

Incidence and losses of livestock depredation in eastern Nepal

The population of surveyed households that reported livestock deaths from snow leopard attacks (annually 44–56% in 1998–2001) was not very different from that of Oli *et al.* (1994) in western Nepal (38.2% in 1988–1989 and 34.3% in 1989–1990). The average number of livestock lost per household reporting losses (2.2 head yr^{-1}) was also very close to that reported by Oli *et al.* (1994) (1.5 head yr^{-1} in 1988–1989 and 2.0 head yr^{-1} in 1989–1990). However, average annual damages in the Ghunsa Valley (NR 12 429) were apparently greater than in western Nepal (NR 2070 in 1988–1989 and NR 2175 in 1989–1990; Oli *et al.* 1994). One of the possible reasons for such difference is the date of investigations. However, differences in patterns of livestock possession probably played some role in the spatial difference.

Livestock possession by residents of the High Himalaya differs between western and eastern Nepal. In western Nepal, sheep and goats are of equal importance to yaks and yak hybrids. In contrast, in eastern Nepal, residents specialize in yak/yak-hybrid pastoralism and generally do not possess regular herds of sheep or goats (see for example Takayama 1960; Kano 1978; Brower 1991). As opposed to shepherds, who often possess several hundred head of livestock, yak/yak-hybrid herders in eastern Nepal possess relatively few animals. In addition, the value of each yak/yak hybrid is greater than a sheep or goat. Therefore, in general, the economic impact of losing one of their livestock is greater for the yak/yak hybrid herders in the High Himalaya in eastern Nepal.

Impacts of livestock losses on herders' economy

In previous studies, the monetary value of livestock damage averaged over all households in the community or villages selected for the studies was estimated to constitute a quarter of the per caput average annual income in Nepal (Oli *et al.* 1994) and half of the per caput average annual income in

Himachal Pradesh, India (Mishra 1997). The predators were snow leopards in both areas, but also included wolves in Mishra's (1997) study. Instead of comparing per caput income in the country or the province, this study examines the monetary value of livestock damage in the context of local herders' economy in the Ghunsa Valley.

If the products of yak pastoralism supported half the herders' diet, as far as the production of butter and crops are concerned, cash could be spent not only to supplement diet, clothing and other daily necessities, but also on community life, education, pastoral investment (purchase of livestock to maintain or enlarge their herd size) and travel during winter (off-seasons for pastoralism and crop farming) as necessary.

The first question to be clarified was what economic impact the average level of predation damage had on the livelihood of herders with average herd size. Here the damage was the livestock equivalent of 29% of a household's pastoralism-related cash income (NR 12 429 \div NR 43 277). If the household intended to make good the loss by purchase of new livestock, they would need to reduce other expenses, and the reduction would cause them to lose important opportunities for improving their living conditions in terms of welfare and investment. However, if the household decided not to invest in new livestock, the reduction in herd size would become a potential loss of production capacity, indicated by the number of milking yaks in the herd. The estimated average loss of livestock was 2.2 head yr^{-1} , while the average number of milking yaks was 13.0 head per household. Assuming that half the calves born from these milking yaks were hybrids, which would probably be sold to other areas, and that the latter half were female and male yaks that would remain in the herd, then the lost livestock might be recovered without the extra cost of purchasing replacement livestock. However, the herder would need to wait for three years before the yak calves became productive. If we employ such an analysis, it is possible to be optimistic about predator damage to livestock in the Ghunsa Valley. Although the incidence of livestock deaths caused by snow leopards appears to be quite high, it seems that the average damage will rarely destroy the households' livelihood or cause their withdrawal from pastoralism.

However, if we consider the worst scenario of a household with the smallest income being subject to the largest damage is taken, the largest annual damage would be NR 30 000, which is equivalent to the loss of six head of livestock. This corresponds to more than 100% of the annual net cash income of the three households in the subject group. The decline in livestock numbers might have a serious impact on the livelihoods of these households in the long term, because their herd size would not be large enough to absorb the damage. Their total livestock numbers were 18–39, and they only had 6–9 milking yaks at the time of the research. It seems that the households that possess less than 40 head of livestock in total (69% of households surveyed) or less than 10 milking yaks (46% of households surveyed) risk withdrawal from pastoralism. In fact, there were several recent cases of herders withdrawing from pastoralism in the Ghunsa Valley because of

Table 4 Local herders' statements (the words in parentheses were added by the author) on the impacts of the KCAP upon their livelihoods. The interviews were conducted in 2000–2001 with 17 people from 12 households residing in the Ghunsa Valley and engaged in yak/yak-hybrid pastoralism. Age of the interviewees ranged from 20s to 60s. Male:female = 14:3. Plural answers were accepted. However, the statements listed were made by only 11 of the interviewees. The other six interviewees did not make any concrete comments, and stressed their neutral attitudes toward the KCAP.

<i>Impact</i>	<i>Discussion topic (no. of interviewees who spoke)</i>	<i>Statement</i>	<i>No. of interviewees making statement</i>
Positive impact	Construction of infrastructure (3)	The KCAP has a plan to build hydroelectric power station. (Expectations toward micro-hydro power scheme)	2
		The KCAP provided us with a water supply	1
		The KCAP supported us in trail maintenance	1
Negative impact	Prohibition of green wood collection (7)	The regulation troubles us because we need timber for repairing our houses	5
		Programmes for alternative energy development are not sufficient. Back-boiler water heating systems cannot reduce firewood consumption	2
		If we comply with the regulation, the distance from herders' tents to the sites for firewood collection will be too far, and the herders would not manage to complete their work in the pastures within working hours	2
		It is impossible to conduct dairy production using only dried woods	2
		The regulation increased the labour required for firewood collection	1
		Prohibition of snow leopard killing (7)	3
		The compensation system, which the KCAP staff suggested (at the meeting held at the Ghunsa Village in June 2001) is not efficient, because the procedure of verifying livestock depredation by snow leopard is not realistic	3
		Even if a compensation system is established, herders will not be satisfied if the amount is less than the damage. (The amount of compensation in the system suggested by the KCAP staff at the meeting of June 2001 was too small)	2
		There is a possibility that conserving snow leopards will increase the damage on infant livestock	1
	Prohibition of constructions (1)	The regulation prevents herders from building new huts in the grazing lands	1
	Anxieties about future livelihoods (7)	The plan to impose fees on local resource use will make our livelihood harder	4
		The future plans announced to us in relation to development programmes are untrustworthy	2
		In the explanation of the project content, only convenient facts were conveyed to us and inconvenient facts were concealed initially. The KCAP only gradually revealed to local residents the requirements they would find difficult	1
	Inequalities among households in community (5)	I am anxious about loss of pasture lands caused by future afforestation programmes	1
		Benefits related to village development have not been distributed fairly in Ghunsa Village	5
		The gap between rich people and poor people in the local community has become larger because the benefits related to village development concentrated on the rich people	2

a sudden decrease in livestock number in their herds, although respondents generally attributed these cases to bad weather in winter.

Herders' perceptions of snow leopard conservation

Sixty-four per cent of interviewees who commented on the impacts of the KCAP (41% of all the interviewees) referred to the prohibition of snow leopard killing as an impact of the KCAP. Some of them showed interest in a compensation system for livestock damages, which KCAP staff suggested in the workshop held at Ghunsa Village in June 2001. At the same time, however, they also questioned the fairness of the suggested compensation system, by pointing out that the procedure was not realistic or that the amount of money was too small. Furthermore, one herder pointed to the possibility that the level of damage from livestock depredation may increase in the future as a result of conservation success. Although other herders did not express such anxieties in the interviews, it seems to be a potentially important issue (Jackson *et al.* 1996).

Construction of infrastructure was the only field in which positive impacts were acknowledged by the herders interviewed (Table 4). In reality, the KCAP staff's efforts to improve the communities' socio-economic conditions were not limited to this issue. Their efforts extended to other programmes, including involvement in empowerment of women, education of children, culture conservation and tourism development. They had even initiated income generation programmes, in which some local residents were provided with technical training, such as kitchen gardening, accounting and sewing (WWF Nepal Program 2001). However, it seems that the effectiveness of these programmes was not fully recognized by the households engaged in pastoralism.

CONCLUSIONS

Herders with small or medium-sized herds (below 40 head) risk involuntary withdrawal from pastoralism in cases where they suffer the biggest possible snow leopard damage. In this context, the herders' negative attitudes towards the current snow leopard conservation policy are understandable.

Effective and long-lasting measures to minimize livestock depredation, and economic benefits to offset livestock damage are indispensable in the KCA, as elsewhere, in order to increase the herders' support for the snow leopard conservation policy. As in Mongolia (Mishra *et al.* 2003), the concept of a 'conservation contract' (Ferraro 2001) may be considered when designing systems acceptable to the local herders in the Ghunsa Valley. Further detailed socio-economic surveys of the herders' livelihood, which partly extends to societies and economies outside the valley, would help understanding of the needs of the herders. This study was limited to the pastoralism-related elements in the herders' livelihoods. The next step should be a detailed analysis of their household

livelihood strategies as a whole and their own views of pastoralism, including the issue of successors.

Raising the necessary funds for introducing such a new system to the KCA is another difficult problem. One possibility is to involve herders in ecotourism activities (Schellhom & Simmons 2000); this may work as a compensatory mechanism, as it has in Baltistan, Pakistan (Hussain 2000). However, few tourists visit the KCA; no more than 400–800 foreign trekkers annually during 1989–2000 (Ministry of Culture, Tourism and Civil Aviation 2001). In addition, the political instability in the country could deter future ecotourism projects (Hussain 2000). A desirable option would be for the WWF to ensure clear funding for compensatory programmes with the Nepali Government; the herders in the KCA may then recognize this as suitable and continuous support from international society in return for their conservation-enhancing activities.

The specific measures to solve the conflicts in the KCA should be decided through discussions among the local herders, other local residents and KCAP staff. Two specific points are made in this regard. Firstly, there should be special care of owners of small and medium-sized herds, because they are particularly vulnerable to damage. Secondly, it is desirable to reduce the herders' suspicions that snow leopard may become overabundant in the future, by introducing more flexible conservation policies that allow a better compromise between wildlife protection and livestock rearing for the time being. A legal mechanism to assure the herders' rights to remove individual snow leopards responsible for repeated livestock depredations would be effective (McCarthy & Chapron 2003). The herders might then be more prepared to discuss physical measures recommended by previous studies, such as the introduction of guard dogs or predator-proof livestock corrals, or creation of core areas for snow leopard conservation (see Jackson *et al.* 1996; McCarthy & Chapron 2003).

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