ECONOMIC ASPECTS OF LARGE CARNIVORE–LIVESTOCK CONFLICTS IN ROMANIA

ANNETTE MERTENS, Carpathian Large Carnivore Project, Str. Ec. Teodoroiu 67, 2239 Harman (Bv), Romania, email: nuschka@usa.net; annette@clcp.ro
CHRISTOPH PROMBERGER, Carpathian Large Carnivore Project, Strada Mare 887, 2241, Prejmer (Bv), Romania, email: christoph@clcp.ro

Abstract: In Romania, more large carnivores live near livestock than in any other European country, but little is known about conflicts between the two. Designing a management strategy to preserve livestock protection methods while limiting the economic burden on livestock raisers requires data on (1) organization of livestock raising, (2) cost–income relations of livestock camps, and (3) financial damage caused by large carnivores. To understand these systems, we submitted questionnaires to shepherds and interviewed key personnel in local town halls. Species killing livestock during summer were primarily wolves (*Canis lupus,* 63%) and bears (*Ursus arctos*, 36%). Ninety-one percent of livestock killed were sheep. Excluding one outlier from the analysis, number of kills/camp was positively correlated with ratios of sheep:shepherd and sheep:livestock guarding dog. Mean damage was US$465/ livestock camp and US$35/km^2 (1999 year basis) Considering all cost and income factors, livestock camps incurred a mean loss equivalent to 10% of their total expenses and 74% of the total income of the livestock camp organizer. We hypothesize that an important step for minimizing conflicts between large carnivores and livestock is the implementation of an economic strategy as support for small-scale livestock raisers.

Ursus 12:173–180

Key words: brown bear, *Canis lupus*, conflicts, damage, economics, large carnivores, livestock, management, Romania, shepherds, *Ursus arctos*, wolves

Conflicts between livestock and large carnivores have historically occurred wherever wild predators have coexisted with humans (Davenport 1953, Schaefer et al. 1981, Bibikov 1982, Boitani 1982, Promberger and Schröder 1993, Kaczensky 1996). Damage caused to livestock is one reason persecution of large carnivores has persisted for centuries (Zimen 1990, Boitani 1995), extirpating them in parts of their range, or in the best case, reducing them to small, remnant populations (Servheen 1990, Promberger and Schröder 1993). In many of these latter areas, traditional livestock protection methods, such as intensive guarding by shepherds with livestock guarding dogs, have disappeared (Kaczensky 1996). In some regions, bears, wolves, and lynx (*Lynx lynx*) are now coming back naturally or are being reintroduced (Promberger and Schröder 1993, Elmauer 1997). Unprotected livestock in these regions are vulnerable to attacks from wild predators. The consequence is a high incidence of damage for livestock producers (Swenson et al. 1995, Kaczensky 1996, Ciucci and Boitani 1998; B. Lequette, Parc National du Mercantour, France, personal communication, 1998).

Agriculture is the most important economic activity in Romania, involving 37% of the labor force. Despite reductions of 40% of sheep and 54% of cattle production since the revolution in 1989, there are still 9 million sheep and 3 million cattle in Romania. Over half these animals are kept in the mountains during summer. The Carpathian Mountains in Romania are home to approximately 5,400 brown bears, 2,800 wolves, and 1,800 lynx (Micu 1998, Schröder and Promberger 1998; O. Ionescu, Institute for Forest Research and Management, Bucharest, Romania, personal communication, 2000). This range is the only place in Europe outside Russia where healthy populations of all 3 large carnivore species live. These predators range over approximately 70,000 km^2 (Schröder and Promberger 1998). Thus, the Carpathians hold high densities of both large carnivores and livestock during summer. Traditional livestock protection methods are still well preserved. No direct, public compensation is paid for damage caused to livestock by large carnivores, thus formal data quantifying natural losses to livestock are unreliable. Our objective was to gain insight into the extent of damage caused to livestock and its importance to the economy of livestock camps. Such information is a prerequisite to developing an effective management strategy to reduce conflicts that, ultimately, threaten large carnivore populations. We conducted surveys during summer 1998 and 1999 to determine (1) the organization of the livestock camps in the study area, (2) income and expenditures in camps, and (3) economic damage caused by large carnivores. We identify possible causes of losses in the camps and recommend management measures.

STUDY AREA

The study area was located in the elbow of the Carpathians surrounding the city of Bras¸ov (Fig. 1). The area consists of several extended mountain ranges (Postavaru, Piatra Mare, and Piatra Craiului) and their foothills; elevations are between 600 and 2,500 m. Climatic conditions are moderate continental, with warm summers and cold winters. Eighty percent of the mountains are covered with forest. The vegetation of the forests consists principally of beech (*Fagus* sp., 30%), conifers (spruce [*Picea abies*] and fir [*Abies alba*], 30%), oak (*Quercus* sp., 18%), and mountain maple (*Acer pseudoplatanus*). The lower hills are covered by beech or mixed beech–conifer forests, whereas the vegetation of

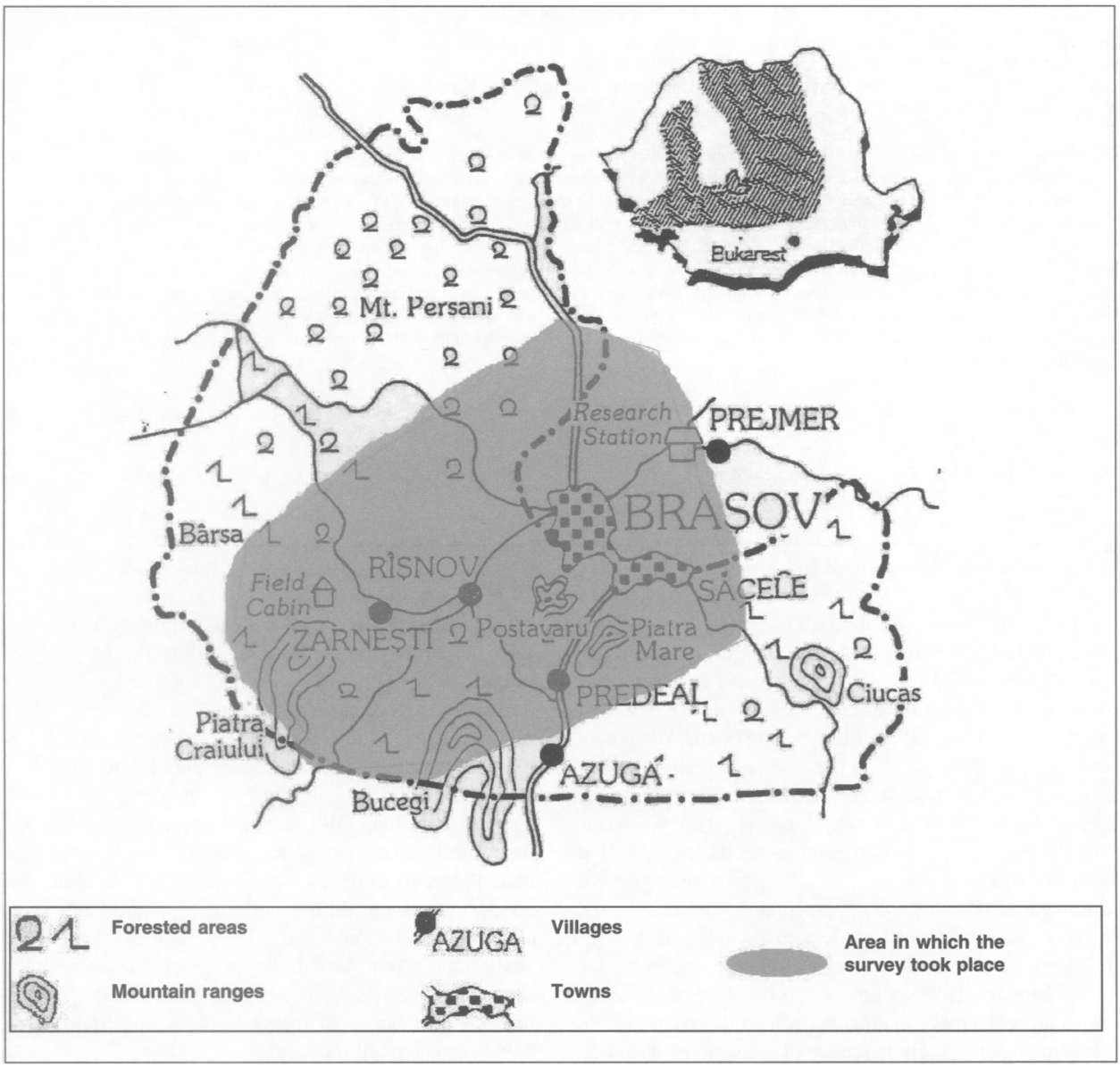

Fig. 1. Livestock camps included in the 1998–99 survey covered 917 km² in the county of Brasov in Romania.

the higher areas is made up mainly by spruce forests. The timberline is as low as 1,600 m. Almost the complete original large mammal fauna still lives within the study area. Only the European bison (*Bison bonasus*) has been extirpated. Human density in Braşov County averages 119.9 people/km². The lowlands northwest of the city of Braêov are intensively used for the production of potatoes, sugar beets, and corn. All the meadows above, as well as the valley bottoms, are used for livestock grazing and hay production.

Livestock Practices

Braşov County has a sheep density of 47.4/km² and a cattle density of 14.4/km². Although pigs and horses are present, they do not contribute significantly to the income and expenses of the livestock camps. Eighty-five percent of sheep and 94% of cattle are privately owned (Romanian Statistic Yearbook 1998); the remainder is owned by state associations. Flock owners can be a single individual or a group of people from within a settlement. Over half the sheep and most of the cattle are kept in camps in the mountains during summer. In early May, livestock owners combine their individual animals to create a flock. Some herds stay in the lower base camps and walk every day to meadows in or around the forest, and others spend the entire summer in the mountains. During winter only a few livestock camps remain in the mountains; most animals are either brought to the warmer south or are dis-

persed to the owners.

Summer flocks are managed by individuals we termed "organizers". Livestock owners enter into contracts with organizers, agreeing to specific per animal remuneration (which we termed the "management fee") in return for summer grazing management. Organizers, in turn, hire the staff (including "shepherds") that take care of the animals during the grazing period. Organizers must cover all expenses with income from the camp. As of the beginning of the year 2001, there were no taxes on livestock or on agricultural land. At the beginning and end of the summer, livestock undergo mandatory sanitary–veterinary treatment as a protection against diseases (e.g., anthrax, fasciolasis, echinococcosis, tuberculosis).

Pasture land rented by organizers is most often owned by nearby villages. Pasture sizes vary from as small as 3 to as large as 333 ha, with a mean of 86.2 ha. For each pasture, a maximum density of animals is determined. Livestock must be grazed exclusively on the pastures rented by the organizer (National Law no. 18/1991). Forest management legislation forbids grazing in the forested areas (as opposed to open meadows) (National Law no. 103/1996). Enclosures for nightly bedding of livestock must be moved at 3–5 day intervals, according to climatic conditions, to avoid overgrazing and soil erosion.

Sheep and cows are raised mainly for the production of cheese. Cheese is produced directly in the livestock camps because transport to towns and markets occurs too sporadically for fresh milk to be transported. Cheese is sold (or used) both by camp organizers and livestock owners; contracts specify fixed allocations of production between the 2 parties. The production of wool and meat is of lesser importance.

Livestock Protection

Livestock guarding dogs accompany every livestock camp. They are fed boiled corn flour and whey. Vaccination is optional. Guard dogs are currently tax-free, but as of this writing, a law is being proposed that would institute a tax on dogs.

During the day, flocks are grazed on pastures rented by the organizer. Every flock is accompanied by shepherds and guard dogs. At dusk, sheep flocks are brought back to the camp and penned in a wooden enclosure. Shepherds responsible for the sheep spend the night near the enclosure. When predators kill an animal, shepherds must recover the skin of the animal, which is specially marked, to demonstrate the reason for its death. Organizers are responsible for such losses unless the shepherd was clearly negligent, in which case the shepherd must reimburse the organizer.

Feral dogs are uncommon in Romania. However, stray dogs, which are partially bonded to specific settlements but go off for hunting in the forest, are commonly encountered. The number of these dogs is unknown. They may adversely affect wild ungulates (O. Ionescu, Institute for Forest Research and Management, Bucharest, Romania, personal communication, 2000), but shepherds do not report attacks by such dogs on domestic flocks.

Legal Background, Economic Support, and Damage Compensation

Agricultural subsidies are uncommon in Romania. Currently, the main kind of support is the system of so-called "coupons": bills representing a fixed sum of money. Each farmer receives from the state 1 coupon/ha of land he owns or manages. He can use it to cover expenses to increase production. In 1998 one coupon was valued at US$10. Beginning in 2000, livestock owners also received one coupon/head of cattle (but none for sheep).

In Romania wolves and bears are strictly protected species (National Law 103/1996). However, according to Article 9 of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979), special permission can be obtained to hunt wolves or bears for management reasons. Lynx can be hunted during a fixed hunting season. The law also includes provisions to reimburse livestock owners for losses caused by protected game species in cases where the livestock was properly guarded and managers of the hunting ground were responsible for the damage (Article 15, Law 103/1996). However, procedures for requesting reimbursement for damage from the Ministry of Waters, Forests and Environmental Protection are extremely complicated, and very little public compensation is paid for livestock losses caused by wolves or bears. During the communist regime, public insurance constituted a kind of compensation system for the damage caused to agriculture. After the revolution, public insurance was replaced by private insurance offered by several companies. These companies offer insurance policies for damage caused to agricultural activities by wild animals, diseases, and natural catastrophes. In reality, these insurance policies are too expensive for private small-scale animal raisers and entail considerable bureaucratic complexity, and thus very few small-scale livestock raisers insure their animals.

METHODS

From early June through mid September 1998 and 1999, we collected data from randomly selected livestock camps and all community town halls within the study area (Fig. 1). Initially, lists of all livestock camps potentially in the survey were obtained from community town hall staffs. We then arbitrarily chose a 25-km radius around Braşov city, within which we randomly selected livestock camps

for inclusion in the survey. Selected livestock camps were spread over an area of 917 km^2. Of the 70 livestock camps present in the area, 19 were selected in 1998 and 17 in 1999. Data on livestock killed by large carnivores were collected from interviews with shepherds. Shepherds, in turn, based their knowledge on direct observations of the predation event, the place where the animal was attacked, the kind of damage caused, and the behavior of the dogs.

Four separate questionnaires were submitted to the shepherds in the camps, focusing on (1) general data on the camp staff, animals present, camp location, and dates of arrival and departure; (2) methods used to guard and protect the animals; (3) income and expenses; and (4) damage caused by large carnivores. Questionnaires 1, 2, and 3 were submitted to selected shepherds once at the beginning of the study season of each year. After that, each livestock camp was visited weekly and questionnaire 4 was submitted.

Data on income (e.g., market value of animals and products) and expenses (e.g., salaries, rent of the pastures) were obtained from staff of each community town hall as well as from shepherds and directly from the local markets. In addition, the staff of the town halls provided data on hiring practices, legal background of livestock raising, pasture sizes rented by each camp, and livestock numbers in each camp.

To estimate income and expenses of livestock camps, we considered sheep and cows. However, the number of animals killed reported here only includes sheep, because very few cows were killed. In testing for significance, we used nonparametric tests (Spearman correlation, χ^2 tests of independence) throughout, and took significance as $P < 0.05$. We limited our investigations and conclusions to the summer. U.S. dollar equivalents are expressed on a 1999 basis.

RESULTS

Incomes and Expenses

Sheep produce an average of 300–350 ml milk/day, and cows produce an average of 7 l/day. Thus, during the entire summer, milk production averages 43 l/sheep (4.5 months grazing) and 735 l/cow (3 months grazing). An average of 4.5 liters of sheep milk, or 8 liters of cow milk, is required to produce 1 kg of cheese. Most cheese is produced by a mixture of cow and sheep milk. The cheese is sold on the local markets for an average of US$2.21/kg.

Income and expenses vary considerably between villages (Table 1). Among livestock camps surveyed, there were a total of 8,137 sheep in 1998 and 9,012 sheep in 1999. Sheep were the most common livestock at surveyed camps (90%), followed by cows (7%), pigs (3%), and horses (1%) (Table 2). The number of both shepherds and guard dogs per camp were positively correlated with the number of sheep (shepherds and sheep $r_s = 0.85, P < 0.01$; dogs and sheep: $r_s = 0.60, P < 0.01$).

Damage

In 1998, 192 sheep were reported killed (2.4% loss rate weighted by herd size, 3.2% unweighted loss rate). Comparable figures in 1999 were 166 sheep (1.8% weighted and 2.5% unweighted loss rates). A mean of 9.9 sheep/

Table 1. Average prices of all cost and income components in an average shepherd camp in the county of Brasov, Romania, 1998, 1999.

Component	Price (US$)	SD
Average market value of animals per head		
Sheep	40[a]	
Cattle	260[a]	
Income for the organizer		
Management fee sheep	2	0.8
Management fee cow	12	5
Income from cheese/summer		
Sheep	21	4.8
Cattle	203	117
Expenses for the organizer		
Value of cheese from organizer to owner/cow	139	24
Value of cheese from organizer to owner/sheep	15	2.6
Salaries shepherds/month	52	21.5
Food for shepherds/month	56[a]	
Food for dogs/month	5.6[a]	
Guarantee	203	204.9
Sanitary treatment, sheep	1.8[a]	
Sanitary treatment, cows	5.6[a]	
Expenses for animal owners (soil rent)		
Per hectare	4.2	3.9
Per sheep	0.6	0.3
Per cow	4.3	1.7

[a] Data provided from the department for zootechny of the town hall Brasov and the national sanitary-veterinary agency.

Table 2. Number of animals, shepherds, sheep/dog, sheep/shepherd and kills in an average shepherd camp in the county of Brasov, Romania, 1998 and 1999.

Items	Mean	Range
Sheep	476.4	22–1200
Cows	35.5	6–70
Pigs	15.8	0–40
Horses	4.2	0–15
Dogs	8.3	3–17
Sheep/dog	56.7	3.6–150
Shepherds	5.3	2–15
Sheep/shepherd	79.4	7.3–200
Kills 1998	10.1	1–39
Kills 1999	9.7	0–49
Total kills	9.9	0–49

livestock camp were lost. Three livestock camps (8%) suffered no damage, and 20 camps suffered damage of less than 2%. Three camps suffered damage of over 10%. The largest numerical loss at any camp during a single summer was 49 kills (5.4% of the flock), and the largest percent of a flock killed was 14% (21 sheep). Three camps had over 30 sheep killed each (5.4%, 5.6%, and 10.7% losses). Sheep constituted 90.8% of all livestock reported lost, although dogs, cattle, horses, and pigs were also lost (Fig. 2). The proportion of sheep lost to predators did not differ from the proportion of sheep among all live animals ($\chi^2 = 0.01$, 1 df, $P = 0.91$). Number of sheep killed was positively correlated with flock size ($r_s = 0.36$, $P = 0.03$), but proportion of flock killed was not ($r_s = -0.18$, $P = 0.29$).

When considering the entire data set, we were unable to find a correlation between proportion killed and either the sheep-to-guard dog ratio ($r_s = -0.15$, $P = 0.36$) or the sheep-to-shepherd ratio ($r_s = 0.012$, $P = 0.79$), although there was a positive correlation between the number of sheep killed and sheep/shepherd ($r_s = 0.45$, $P = 0.006$). However, one livestock camp with a relatively high guard dog/sheep ratio (1 dog/27.3sheep) experienced a substantial die-off of dogs during the summer (from an unknown infectious agent), so the dog/sheep ratio recorded early in the season may not have reflected actual protective capability. In addition, the sheep at this particular camp were most often bedded in forested areas during both day and night and lacked a protective enclosure. This camp lost 32 sheep during the summer, the third highest recorded. Excluding this camp from the analysis, we found positive correlations between the number of kills and both sheep/shepherd ($r_s = 0.418$, $P = 0.013$) and sheep/dog ($r_s = 0.39$, $P = 0.017$). All 3 camps that suffered a damage rate of over 10% had small ratios of sheep/dog (25, 27, and 3.7) but relatively small number of sheep (150, 300, and 22 respectively). For camps that suffered only 1 to 5 kills, 63% had sheep/shepherd ratios smaller than the overall mean, and 84% had sheep/dog ratios smaller than the overall mean. In contrast, 75% of camps that exceeded 10 sheep killed had sheep/shepherd and sheep/dog ratios exceeding the overall mean. All camps that suffered between 10 and 20 kills had sheep/shepherd and sheep/dog ratios exceeding the mean.

Species implicated in livestock depredation were primarily wolf (59.9% of kills) and brown bear (39.7%). Lynx were reported to have killed only one sheep. Fourteen camps (39%) lost sheep only to wolves, 6 camps (17%) lost sheep only to bears, and 13 camps (36%) suffered attacks from both wolves and bears. We found no significant differences among sheep numbers killed in camps that were exposed to attacks by wolves only, bears only, and both species ($\chi^2 = 1.64$, 2 df, $P = 0.54$).

We found no differences in sheep/dog ratios among camps suffering damage from wolves only, bears only, both, or neither species($\chi^2 = 2.88$, 3 df, $P = 0.4$). Similarly, we found no significant associations between sheep/shepherd and predator species involved ($\chi^2 = 0.75$, 3 df, $P = 0.80$).

For 264 sheep kills, shepherds recorded whether the kill occurred during "day" or "night". Of these, 147 (56%) were categorized by shepherds as night-time kills. Assuming an average value for nighttime during summer as 10.5 hours, this suggests that predation occurred more often during night than would be expected had kills occurred irrespective of time-of-day ($\chi^2 = 3.88$, 1 df, $P < 0.05$).

The majority of attacks (88%) involved 1 to 3 sheep killed; the mean number of sheep killed/incident was of 2.00. Only 1 case was reported in which as many as 10 sheep were killed. No complaints were documented of decreases in milk production or abortion due to stress caused by predatory attacks, lost animals, or of animals harming themselves or another animal during an attack of a predator.

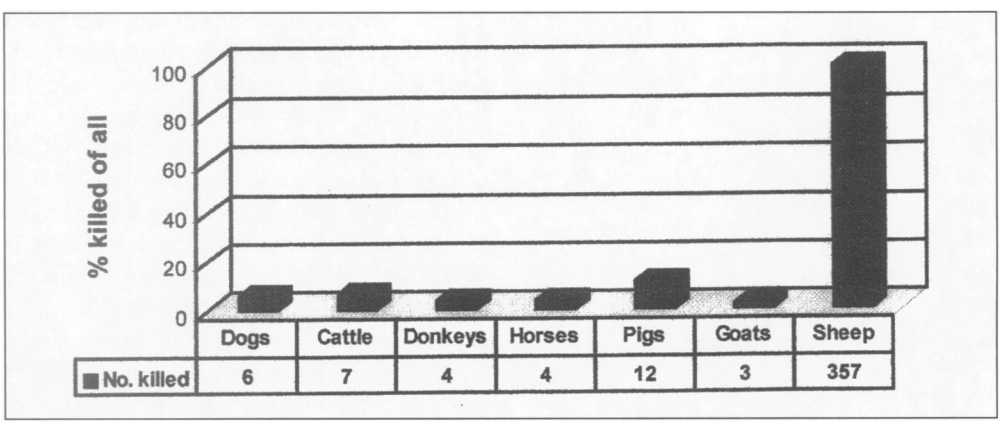

Fig. 2. Percent and numbers of livestock killed by large carnivores in Brasov County, Romania, 1998–99, by species.

Economic Evaluation

Assuming a market value of US$40/sheep (Table 1), a loss of 9.9 sheep/camp meant a market value loss of US$387/camp. In addition, the loss of milk production caused by predation reduces yearly revenues. Assuming constant loss (and thus that sheep are lost to production, on average, mid-way through the summer), revenue was reduced by US$78/camp. Combining lost value and revenue, a mean loss of US$465/camp was attributable to predation. For the entire study area, market value loss was thus US$29/km^2, and loss of value and yearly milk production combined was US$35/km^2.

For the summer 4.5-month period and assuming mean values for income and expenses, a simple economic model indicated a mean income of US$139/organizer/month ($627/4.5) (Table 3). Salaries and consumables constituted 56% of all expenses incurred by shepherds, and the maintenance of dogs added an additional 4.5%. Revenue from cheese production lost to predation equated to 1.6% of the mean total cost of the livestock camp, and 12% of the mean organizer net income. For organizers unable to demonstrate that missing sheep were killed by large carnivores, losses amounted to 62% of mean salaries and over 8% of mean, total camp expenses. Considering reductions in cheese production as well, losses reduced mean organizer income by 74% and added 10% to total livestock camp expenses. The mean expense of keeping guard dogs was 46% of the mean combined loss of market value and production (Fig. 3).

Table 3. Income and expenses for the organizer of an average shepherd camp (county of Brasov, Romania, 1998 and 1999).

Component	Cost (US$)
Income	
Management fee	1,378
Cheese production[a,b]	3,844
Total income	5,222
Expenses	
Salaries shepherds	1,240
Food shepherds	1,335
Food dogs	210
Sanitary treatment	1,212
Subtotal	3,996
15% unforeseen	599
Total expenses	4,594
Profit for organizer	627
Damages	
Animal value	387
Milk loss	71

[a] The value of the produced cheese minus the cheese given back to the animal owners.
b Calculated for 266 sheep, 60% of the average sheep number, the average ratio of milk sheep over an average grazing period of 4.5 months.

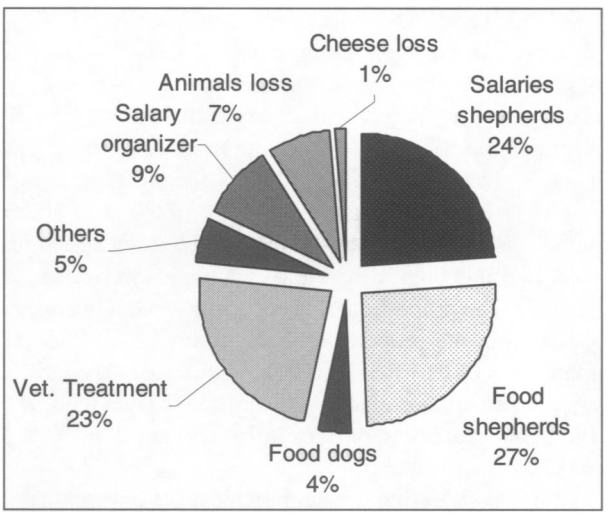

Fig. 3. Mean cost components of livestock camps (Brasov County, Romania, 1998–99). The economic loss of cheese production refers to half of the amount of cheese that would have been produced throughout all the grazing season.

DISCUSSION

Our data quantifying damage caused to livestock by large carnivores were based solely on weekly interviews with shepherds. We visited the camps weekly, reasoning that frequent visits would engender trust among shepherds and thus yield reliable information and that shepherds would remember accurately events occurring within the previous week. Still, we do not know how accurate the data actually are. Thus, these data should be viewed as providing the correct order of magnitude of damage, but not necessarily exact figures.

The similarity of the proportions of sheep among all livestock and among all those killed by predators suggests that wolves and bears do not have a preference for killing sheep over other animals. The high proportion of sheep among all livestock killed probably stems simply from the their numerical dominance among livestock types.

Projections from existing density estimates within their Romanian range to the study area suggest that it may contain about 78 bears (12/km^2), 32 wolves (29/km^2) and 28 lynx (32/km^2). This results in an average annual damage of 1.5 sheep kills/individual bear or wolf. Calculating the density of sheep in the study area according to the average density of sheep in our selected livestock camps yields 36 sheep/km^2. Norway, with a surface of 386,975 km^2 (Rand McNally/Westermann 1994), has a national flock of 2.5 million sheep. Sheep densities are lowest in northern and eastern Norway, where bears occur (J. Linnell, Norwegian Institute for Nature Research, Trondheim, Norway, personal communication, 2000). Bears were reported to have killed an average of 100 sheep/bear each

summer in Norway (Linnell 2000). In Tuscany, Italy, Ciucci and Boitani (1998) reported a damage of US$15/km^2. This is less than in the present study, but in Tuscany the only predators responsible for kills were from a recovering population of wolves, whereas our study area contained a very high density of large carnivores (1 bear or wolf/8.3 km^2). In Mercantour, France, 25 wolves caused livestock damage of about US$200,000 in 1997 (B. Lequette, Parc National du Mercantour, France, personal communication, 1998), a per wolf damage of US$6,000, far more than the per capita damage in our study. In these 3 examples, predators have just recently made comebacks, so livestock protection methodology had been unused for a long time. This suggests that maintaining traditional livestock protection can be important in decreasing conflicts with livestock. Although livestock losses in our study were lower than in several others, the economic damage is still considerable when compared with the average salaries of camp staff.

Our inability to find correlations between kill rate and flock size, sheep/guard dog ratio, or sheep/shepherd ratio would appear to downplay the importance of these factors for effective protection of livestock. The fact that camps with >10% damage had low sheep/dog ratios similarly casts doubt on the effectiveness of guard dogs. However, positive correlations between the absolute number of kills and sheep/shepherd and sheep/dog ratios when the anomalous camp is excluded suggest that the number of dogs and shepherds in camp do affect sheep vulnerability. Also supporting this interpretation are the facts that sheep/shepherd and the sheep/dog ratios exceeded their average in every livestock camp losing 10–20 sheep/year, and 75% of camps losing >10 sheep/year. Similarly, in camps that lost <5 sheep/year, the sheep/shepherd and sheep/dog ratio were lower than the average in 63% and 84% of cases, respectively.

The use of livestock guarding dogs has been recommended by many authors (Boitani and Fabbri 1983, Green and Woodruff 1983, Andelt 1992, Boitani 1992, Kaczensky 1996, Linnell et al. 1996). In Romania, the use of livestock guarding dogs has been preserved for centuries, supporting the idea of dogs as important for livestock protection. The presence of shepherds has also been demonstrated to help in the protection of livestock. Ciucci and Boitani (1998) found that in Tuscany, 63% of attacks occurred on free ranging and unguarded sheep, 22% on sheep alone in enclosures, 13% on sheep guarded only by dogs, and only 2% on sheep guarded by shepherds with or without dogs.

The phenomenon of surplus killing (killing of many animals that are not eaten) has been reported to occur among many predator species (Boitani and Fabbri 1983, Hell 1993, Linnell et al. 1996, Ciucci and Boitani 1998). According to Linnell et al. (1996), although it is a natural phenomenon occurring also in natural conditions, surplus killing may be prevalent in circumstances in which unnaturally high densities of prey (such as a flock) are confined but still accessible to predators. Although sheep were often kept in enclosures during night, we did not document surplus killing. The presence of livestock guarding dogs might partially explain this. Although wolves and bears manage to kill livestock, shepherds report that they usually just have time to grab an animal and eat a part of it before they are chased by the dogs, or that they take an animal and run off with it.

We hypothesize that sheep would be better protected if they were kept fenced during night and not bedded in the nearby forest. However, to increase milk (and thus cheese) production and income, many shepherds allow sheep to graze at night. Also, the rented pasture often does not provide sufficient forage, given flock size and length of the grazing period. Consequently, many shepherds allow sheep to graze in forested and shrubby areas where they are more vulnerable to predators. Evidently, these shepherds calculate that the increased milk production compensates the loss of some animals.

Our survey suggests that a sufficient number of well-trained, well-fed, healthy dogs may reduce losses. However, in Romania not all shepherds can afford to maintain a sufficient number of dogs. The dogs are often not well fed, and some look for additional food in the forest, leaving the flock unattended. A sufficient number of shepherds can probably help decrease damage caused by large carnivores. However, salaries and the food for shepherds are a large portion of organizer income.

Would it be worth the additional expense of having more dogs or hiring more shepherds? We cannot quantify this possibility directly, but can offer some suggestions. Doubling the current number of dogs/camp (to 16.6), would cost the organizer an additional US$210, which is less than the mean value of lost sheep and cheese production. We do not know how many fewer sheep would be lost with this increase in dogs, but speculate it would be substantially fewer than currently. If camps were to spend US$71 (the mean lost value of cheese only), 2.8 dogs could be fed during a 4.5 month-long season. An average of 2.8 dogs more for each camp could make a difference in the amount of damage caused to the camps. On the other hand, the hiring of one additional shepherd would cost the organizer US$486, which is greater than the mean, total damage/camp at present. These rough calculations suggest that increasing dogs could be helpful in reducing economic losses for the organizer, but the hiring of additional shepherds probably would not.

ACKNOWLEDGMENTS

This project was possible due to the support of: WWF Switzerland and WWF UK, JACK WOLFSKIN Ltd., Vier Pfoten e. V., the Bernd Thies-Foundation, P. Lister, H. Wyss, and the travel agencies GAEA Tours, ARCATOUR, Natur-Studienreisen, ECOVOLUNTEER, OneWorld, AnimalWatch, Romanian Travel Centre, and Colibri Umweltreisen. We want to thank the mayors and the staff of the community administrations and all the shepherds in our study area for the information they provided us.

LITERATURE

ANDELT, W.F. 1992. Effectiveness of livestock guarding dogs for reducing predation on domestic sheep. Wildlife Society Bulletin 20:55–62.

BIBIKOV, D.I. 1982. Wolf ecology and management in the USSR. Pages 120–133 *in* F.H. Harrington and P.C. Paquet, editors. Wolves of the world. Perspectives of behavior, ecology and conservation. Noyes Publications, New York, New York, USA.

BOITANI, L. 1982. Wolf management in intensively used areas of Italy. Pages 158–172 *in* F.H. Harrington and P.C. Paquet, editors. Wolves of the world. Perspectives of behavior, ecology and conservation. Noyes Publications, New York, New York, USA.

———. 1992. Wolf research and conservation in Italy. Biological Conservation 61:125–132

———. 1995. Ecological and cultural diversities in the evolution of wolf–human relationships. Pages 158–172 *in* L.N. Carbyn, S.H. Fritts, and D.R. Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional publication N. 35.

———, AND M.L. FABBRI. 1983. Strategia nazionale di conservazione del lupo. Ricerche di biologia della selvaggina 72. Bologna, Italy. (In Italian.)

CIUCCI P., AND L. BOITANI. 1998. Wolf and dog depredation on livestock in central Italy. Wildlife Society Bulletin 26:504–514.

DAVENPORT, L.B. 1953. Agricultural depredation by the black bear in Virginia. Journal of Wildlife Management 17:331–340.

ELMAUER, K. 1997. Management plan für Braunbären in Österreich. Munich Wildlife Society. Oberammergau, Germany. (In German.)

GREEN, J.S., AND R.A. WOODRUFF. 1983. The use of three breeds of dog to protect rangeland sheep from predators. Applied Animal Ecology 11:141–161.

HELL, P. 1993. Current situation and perspectives of the wolf in Czechoslovakia. Pages 37–42 *in* C. Promberger and W. Schröder, editors. Wolves in Europe, status and perspectives. Munich Wildlife Society, Oberammergau, Germany.

KACZENSKY, P. 1996. Large carnivore–livestock conflicts in Europe. Munich Wildlife Society, Oberammergau, Germany

LINNELL, J.D.C. 2000. Norwegian brown bears: Holders of an unwanted world record. Carnivore Damage Prevention News 1(March):4–5

———, M.E. SMITH, J. ODDEN, P. KACZENSKY, AND J.E. SWENSON. 1996. Strategies for the reduction of carnivore–livestock conflicts: a review. Norsk Institutt for Naturforskning (NINA). Oppdragsmelding 443, Trondheim, Norway.

MICU, I. 1998. Ursul Brun. Aspecte eco-etologice. Ceres Editor, Bucharest, Romania. (In Romanian.)

PROMBERGER C., AND W. SCHRÖDER. 1993. Wolves in Europe, status and perspectives. Munich Wildlife Society, Oberammergau, Germany

RAND MCNALLY/WESTERMANN. 1994. The International Atlas. Publisher Georg Westermann. Braunschweig, Germany.

ROMANIAN STATISTICAL YEARBOOK. 1998. National Commission for Statistics. Bucharest, Romania. (In Romanian.)

SCHAEFER, J.M., R.D. ANDREWS, AND J.J. DINSMORE. 1981. An assessment of coyote and dog predation on sheep in Southern Iowa. Journal of Wildlife Management 45:883–893.

SCHRÖDER, W., AND C. PROMBERGER. 1998. GEF Biodiversity Project Romania. Large carnivore component. Final Report. Munich Wildlife Society, Oberammergau, Germany.

SERVHEEN, C. 1990. The status and conservation of the bears of the world. International Conference on Bear Research and Management, Monograph Series 2.

SWENSON, J.E., P. WABAKKEN, F. SANDEGREN, A. BJÄRVALL, R. FRANZEN, AND A. SÖDERBERG. 1995. The near extinction and recovery of brown bears in Scandinavia in relation to the bear management policies of Norway and Sweden. Wildlife Biology 1(1):11–25.

ZIMEN, E. 1990. Der Wolf. Verhalten, Ökologie und Mythos. Knesebeck und Schuler, München, Germany. (In German.)