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Livestock Depredation and Livestock Guarding Dogs in Slovakia

by
Robin Rigg

Introduction

Slovakia lies not only geographically but in many ways also culturally and politically between western and eastern Europe. Its native large carnivores were never completely eradicated and had already recovered from excessive sport hunting and persecution by the 1980s. Nevertheless the impacts of the recovery are still being felt and debates continue to rage as to whether legal protection for large carnivores should be strengthened or if they are now "over-populated". Being a young and little-known country, whose carnivore populations are not as substantial as those in Romania, not as threatened as some of those in the Iberian peninsula, not as controversial as those in Norway nor in the process of recovery such as those in the Alps, Slovakia has received much less attention in the action plans, case studies, model projects and other international initiatives of recent years. The inward flow of new techniques and results from abroad has been slow due to political, financial and lingual barriers and as a result modern research on large carnivores is still largely missing. However, much can be learned from the situation here, such as how economic development might affect carnivore-livestock conflicts in eastern Europe or how long the process of psychological adjustment to the reality of recovered carnivore populations might take in central Europe.

In 2001–2003 I studied carnivore-livestock conflicts in Slovakia for a Masters degree at the

University of Aberdeen. The study, part of the Protection of Livestock and Conservation of Large Carnivores (PLCLC) project, had the following aims:

1. To study the impact of native predators on domestic animals in Slovakia by
   a) quantifying the diets of wolves and bears in livestock-raising areas with high levels of reported losses;
   b) analysing the extent and patterns of reported damage by carnivores to livestock.
2. To investigate the possibility of using livestock guarding dogs (LGDs) to protect sheep in Slovakia by
   a) conducting a literature survey on the use of LGDs throughout the world (Rigg 2001);
   b) examining the reasons why the LGD tradition had been abandoned in Slovakia;
   c) performing field trials of LGDs with livestock at working farms in order to:
      - observe the development from pups of different guarding dog breeds;
      - test their ability as yearlings to protect a flock of sheep by observing their responses to mock attacks;
      - compare the levels of losses in flocks with and without free-ranging LGDs;
      - identify any barriers to the feasibility of revitalizing the LGD tradition in Slovakia.

Large carnivores and livestock

The main predators on livestock in the Slovak Carpathians are the wolf *Canis lupus* and brown bear *Ursus arctos*. Official estimates of carnivore numbers are compiled by adding together estimates for each species from the 1,747 hunting grounds that together cover c.90% of the country (mean area 25 km^2), without correcting for multiple counts. It is widely acknowledged that these estimates are considerably exaggerated, but there is considerable disagreement about how much. Based on snow tracking in early winter, the density of wolves seems to be c.1 ind./100 km^2. Using the same method or by direct observation above the timberline in spring, bear density in some mountain ranges of central and northern Slovakia has been estimated at 11–13 inds./100 km^2. However, large carnivores are not evenly distributed throughout their ranges, partly because their habitats are becoming increasingly fragmented by highway construction and other development. Using estimated density in a model area of 800 km^2 obtained by snow tracking and extrapolating to the estimated size of occupied wolf range in Slovakia (c.20,000 km^2) suggests a population in early winter of <200 wolves. Dividing the number of wolves found by snow tracking in the model area by the official estimate for the area and multiplying by the official national estimate yields a revised estimate of 212–242 individuals. In reality the lower figure may be more accurate because official estimates are for 31st March whereas the snow tracking was done in early December, i.e. before the majority of mortality in winter and the open hunting season (currently 1st November to 15th January, unlimited bag). The same calculation for bears produces a revised estimate of 810–940 individuals in Slovakia, which is slightly higher than the widely accepted "guestimate" of 600–800.

Wolves and bears are reported to occasionally kill cattle and goats. Bears also kill some poultry, pigs and rabbits, while wolves sometimes prey on dogs and occasionally cats. Sheep, however, are the most frequently predated domestic species. Around 89% of all sheep in Slovakia are in regions with bears and/or wolves. The overall density of sheep across these regions is c.943 inds./100 km^2. Variation among regions in the number of sheep reported lost in 2002 correlated slightly more strongly with number of sheep than with number of predators as estimated by hunters (r_s = 0.733, P = 0.001 versus r_s = 0.697, P = 0.001 for bears, r_s = 0.633, P = 0.003 versus r_s = 0.606, P = 0.005 for wolves). Significant, high correlations were also found between number of sheep and percentage of flocks affected by bear predation (r_s = 0.736, P = 0.001) and percentage of all sheep reported lost to bears (r_s = 0.723, P = 0.001), indicating a marked relationship between sheep available and bear predation. The respective correlations to estimated bear numbers were lower (r_s = 0.684, P = 0.002 and r_s = 0.702, P = 0.001 respectively). In the case of wolves, percentage of flocks affected and percentage of all sheep reported lost were more strongly correlated to numbers of wolves (r_s = 0.642, P = 0.002 and r_s = 0.609, P = 0.004 respectively) than to numbers of sheep (no significant correlation and r_s = 0.552, P = 0.012 respectively). Scat analysis suggests that livestock is not an important component of the diet of either species in Slovakia: remains of domestic mammals were not found in any of 373 bear scats collected in 2001–2003 and in only one of 70 wolf scats collected in the same period. Wild ungulates are present at medium-high densities and constitute >90% (mean percentage of scat volume) of the diet of wolves. Plant

material constituted 90.8% of total bear scat volume and 83.5% of estimated dry matter ingested by bears. A total of 1,455 sheep (or in a few cases goats) were reported lost to predators ("lost" includes killed, missing never found or died/destroyed due to injuries) during the period 2001–2003 at 164 surveyed flocks. Of these, 78.8% were said to have been lost to wolves, 20.0% to bears, 1.0% to domestic dogs and 0.1% to lynx *Lynx lynx*. The mean reported loss to predation was 2.6–4.3 sheep/flock/year. Not all the reported losses were verified. In some cases the accounts of shepherds differed from those of the respective farmers/owners and in some cases the reported figures were known to have been exaggerated, particularly for alleged wolf predation. In each year, ≤14.0 % and ≤29.4% of surveyed flocks were allegedly affected by bear and wolf predation respectively (Figure 1). Based on the predation rates reported at surveyed flocks, the annual loss to bear predation in 2001–2003 was estimated at 0.06-0.15% of all sheep (c.266,400) in regions with bears, i. e.160–400 sheep/year or the equivalent of 0.2–0.7 sheep/bear/year. The annual loss to wolf predation was estimated at 0.5–0.7% of all sheep (c.302,200) in regions with wolves, i.e. 1,511–2,115 sheep/year or the equivalent of 4.5–10.4 sheep/wolf/year. Although wolves were reported to cause considerably higher losses than bears, wolf predation is known to be difficult to distinguish from that of dogs and, because attitudes to wolves were more negative than those to bears (Wechselberger et al. in prep.), aggravated by a lack of compensation for damage caused by wolves prior to 01/01/2003, there may have been a tendency to exaggerate the extent of wolf predation. On the other hand, wolf attacks tended to result in more livestock killed than was usual during bear attacks and instances of surplus killing were more common. Red fox *Vulpes vulpes*, raven *Corvus corax* and golden eagle *Aquila chrysaetos* might cause very minor losses. Feral dogs are not common in Slovakia but damage by domestic dogs and theft are occasional problems for some farms.

Influence of husbandry on level of losses

In addition to lambs sold for meat at Easter, the focus of production at contemporary upland sheep farms in the Slovak Carpathian Mountains is on milk. Sheep are sheared twice per year but wool is of little or no economic importance. Most flocks are based at temporary camps called "salaše" from spring until autumn in order to allow pastures more distant from the home farm or village to be utilized whilst sheep can still be milked daily. It is here that most losses to predation are reported to occur. Pastures are unfenced, typically forming part of a mosaic of agricultural land and forest cover or lying at the edge or in the midst of extensive forest-covered mountains (Figure 2). One shepherd with a herding dog accompanies each flock during the day. The mean number of sheep per flock at 164 flocks surveyed in 2003 was 480 (range 100–2,000). No

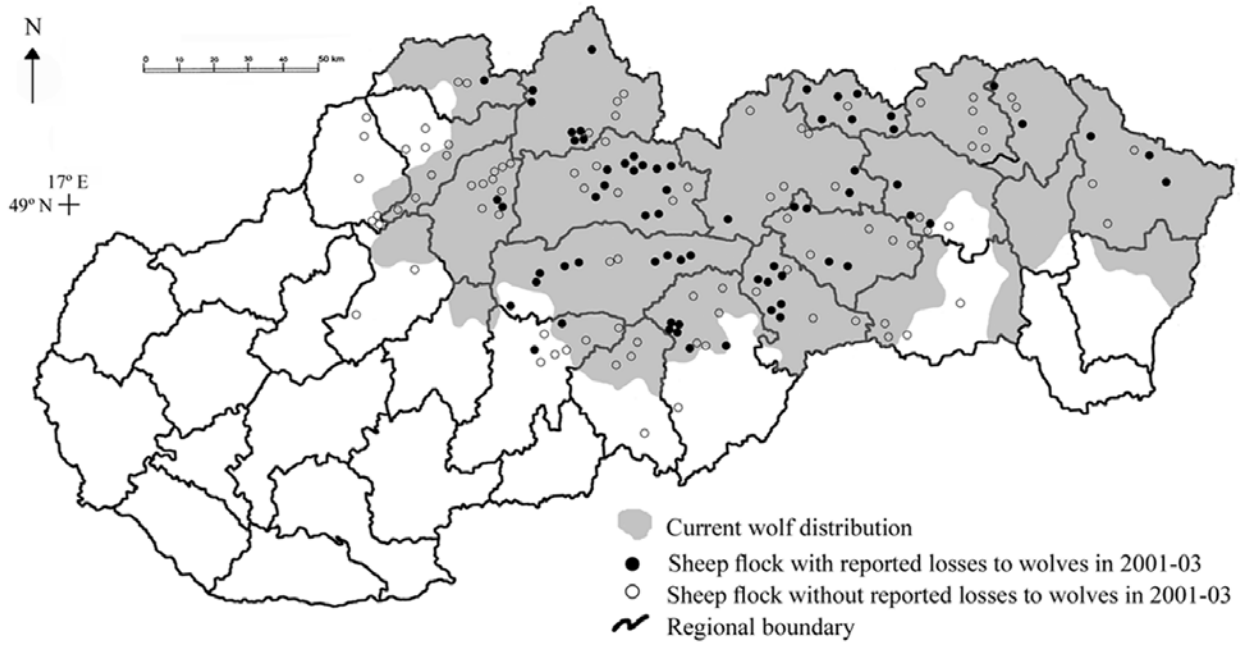

Figure 1. Flocks affected by wolf predation in 2001–2003 as reported by shepherds and farmers.

Figure 2. Typical mosaic of agricultural land and spruce forest patches in northern Slovakia. The mountains in the background are the Western *Tatras* (up to c.2,250 m a.s.l.) in the *Tatras* National Park. Seasonal grazing was common in those mountains until the 1960s, but was gradually excluded by the park authorities. Sheep and cattle are now grazed on pastures among the forest patches on the plains in the foreground and right up to the foot of the mountains, where continuous forest cover starts at about 900 m a.s.l. (Photo: Robin Rigg)

significant correlations were found between size of flock and either total number of sheep reported lost or percentage of flock reported lost to bears and wolves combined in 2003 (respectively n = 139, r_s = -0.009, P = 0.916 and n = 139, r_s = -0.049, P = 0.566).

Reported losses peaked in August-October, with a lesser peak in May (Figure 3). This pattern of losses can be explained as followed: in May flocks are moved to pastures in close proximity to forest cover and so become more vulnerable to predation; the decrease in losses in early summer may be due to the availability of wild ungulate fawns; the increase in predation on livestock in late summer and autumn is perhaps due to the increasing food demands of growing wolf pups and of bears fattening up for winter; the rapid decline in losses in November is caused by the unavailability of livestock confined in barns for the winter.

From spring to autumn flocks that are not returned to barns at night are either assembled into light, mobile sheepfolds or left loose on the pasture. Shepherds sleep nearby in a trailer or small building. 85% of attacks by bears were reported to have occurred at night, whereas wolf attacks were reported to occur equally during the day (51.1%) and at night (48.9%). Wolf attacks at night seemed to cause a higher mean loss of sheep (6.7 ± 4.3, 95% confidence interval) than those during the day (3.1 ± 2.1, 95% confidence interval) and therefore accounted for a greater proportion (67.1%) of the total reported losses, although the difference is not statistically significant (Mann-Whitney U test,

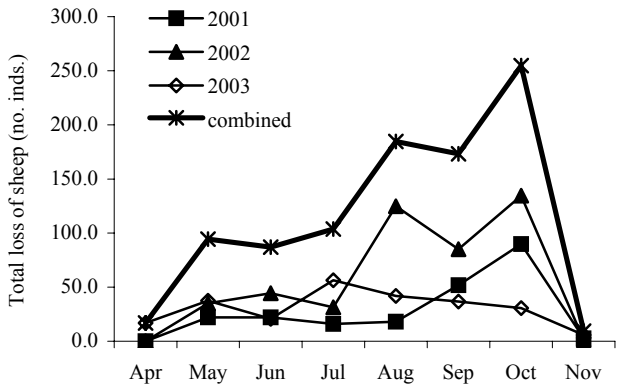

Figure 3. Seasonality of reported sheep losses due to wolf predation in Slovakia, 2000–2003.

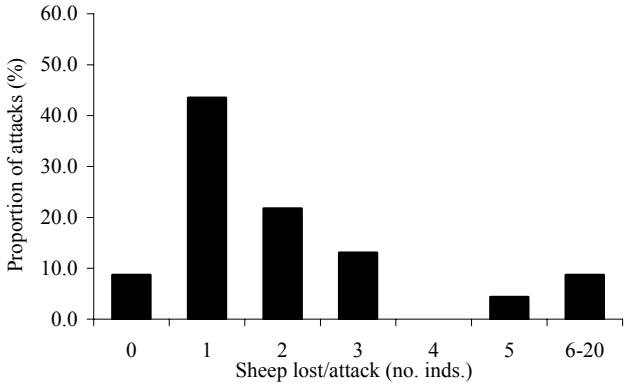

Figure 4. Number of sheep lost per attack by bears as reported by shepherds and farmers.

Table 1. Details of seven cases of surplus killing of sheep/goats in Slovakia in 1999-2003.

Date (time)	Predator	Loss	Circumstances	Preventive measures
26/06/1999	wolf	16 sheep and 7 goats killed.	Fog and rain. Flock wandered into forest.	None – flock left unattended.
May 2000 (night)	wolf	7 sheep killed	Sheep panicked and ran out through fencing.	Poorly constructed and incomplete electric fence.
July 2000 (night, before 02.00h)	wolf	11 sheep killed and 11 injured later died	Storm. Flock of yearling sheep kept overnight on remote pasture surrounded by forest cover.	1 shepherd and 1 herding dog sleeping in nearby trailer.
19/07/2001 (02.00–05.30h)	wolf	c.18 sheep missing, 2 found alive but died, 19 seriously injured	"Bad weather". Flock from same farm and in same location as July 2000 attack.	1 shepherd and 1 herding dog sleeping in nearby trailer.
08/05/2002 (c.01.30h)	wolf	17 adult sheep and ≥16 lambs/kids killed	Small flock of lambing sheep and goats fenced within lines of bushes. Flock of ewes in nearby open area with several chained dogs not attacked.	Several shepherds attempted to chase wolves away with firecrackers and lights.
c.30/08/2003 (c.04.00h)	wolf	8 sheep killed (2 thoroughly eaten), ≥14 injured	Flock of yearling sheep in sheepfold <100 m from forest edge with some trees/bushes nearer.	3 chained dogs.
9-10/12/2003 (night)	bear	5 sheep killed, 15 missing	Flock still on remote pastures several days after substantial snowfall.	Had been left inside insecure barn.

$P > 0.05$) if length of day is not taken into account. According to the reports of shepherds and farmers, 87% of attacks by bears and 70.1% of attacks by wolves resulted in 0–3 sheep being lost (Figure 4). However, in each year from 2001–2003 surplus killing events or multiple attacks at between four and nine flocks accounted for >50% of all reported losses at 141–149 surveyed flocks. Surplus killing was associated with a lack or failure of preventive measures (Table 1).

Flocks that reportedly suffered some losses to bears or wolves in 2002 were significantly more likely than expected by chance to also allegedly suffer losses in 2003 (n = 131, χ^2 = 27.01, d.f. = 1, $P < 0.001$). Flocks that reportedly suffered some losses to wolves during the period 2001–2003 were significantly more likely than expected by chance to also allegedly suffer losses to bears (χ^2 = 10.23, d.f. = 1, $P < 0.001$). These results suggest that some aspect(s) of individual flocks or their location rendered them more vulnerable to predation. In order to investigate factors which could account for differences in reported losses among flocks, two extreme categories were formed: "no losses" included all flocks at which no losses to predation were reported during the period 2001–2003 (n = 61) while "high losses" were those which suffered predation by bears or wolves in ≥2 of the three years and/or allegedly lost ≥10 sheep in any one year (n = 51). Flocks in the "high losses" group accounted for 83.2–96% of all reported losses each year. The most significant difference detected (chi-square test of association using actual frequencies of occurrence, χ^2 = 21.41, d.f. = 1, $P < 0.001$) between the two groups was in the method of night-time confinement. In the "no losses" group, 26/61 flocks (43%) were kept in a temporary sheepfold or left loose on the pasture and 35/61 (57%) were always or sometimes confined in a barn or farmyard at night, whereas in the "high losses" group the respective figures were 43/51 (86%) and 8/51 (16%). Considering all flocks with complete data on night confinement and reported losses for 2003, flocks kept in a sheepfold or left free on the pasture at night (n = 93) had mean reported losses to wolves and bears of 3.6 sheep/flock whereas flocks always or sometimes returned to a barn (n = 47) lost a mean of 0.4 sheep/flock, a highly significant difference (Mann-Whitney U test, $P < 0.001$).

In October-November and March-April flocks or

small groups of sheep are grazed near villages or farms, usually accompanied by a shepherd. During the period of snow cover (approximately late November until March-April) most sheep are kept permanently in barns, either within fenced farmyards or in villages. Most lambing occurs in barns in January-February. Successful attacks by predators are rare during this period. In the last decade or so there has been a trend towards flocks being grazed on pastures nearer villages and returned to the farmyard or barn at night throughout the year. A significant negative correlation (r_s = -0.546, P = 0.013) was found between the percentage of flocks in a region kept in a barn at night and the percentage of flocks in the region affected by predation in 2003.

Livestock guarding dogs

The situation in Slovakia is quite unusual in that, although many aspects of the traditional herding system are still used, knowledge about how to raise livestock guarding dogs has been lost. When the PLCLC project began in 2000 there were LGDs at almost all upland sheep farms but very few were free-ranging and attentive to sheep. Instead, most were used in one of three ways:

1. permanently chained near the sheepfold or farm buildings, which may have provided some protection, mainly by barking to alert shepherds at night;
2. chained during the day but released at night;
3. left free to wander.

There are various possible explanations for why shepherds began to chain up LGDs. Perhaps socio-economic change, especially a decline in agriculture, led to the loss of traditional knowledge. Large carnivores were almost eradicated in the first half of the 20th century. Predation being less of a concern than theft by humans, chaining them up might then have become simply the easiest way to keep dogs near what they were supposed to guard, and this became the habit. Many farmers and shepherds have not yet adjusted to the recovery of large carnivore populations. In 2003 dogs were found to be permanently chained at 125 out of 155 (80.6%) flocks surveyed, with a mean of 2.9 chained dogs/flock. Dogs were reported to be released at night at 26/155 (16.8%) flocks, with a mean of 1.8 dogs/flock released at night. There were no significant differences in reported losses to wolves, bears or wolves and bears combined in 2003 for flocks where some dogs were said to be free-ranging or released at night (n = 66) versus those where only chained dogs were mentioned (n = 76)

Figure 5. Two *Slovensky Cuvac* within a flock of sheep. (Photo: Robin Rigg)

Figure 6. A *Caucasian Shepherd Dog* within a flock of sheep. (Photo: Robin Rigg)

(Mann-Whitney *U* test, $P > 0.05$), suggesting that inappropriately raised dogs are ineffective against predators even when released.

As part of the PLCLC project in 2000–2002 a total of 50 pups were placed at farms in central, northern and eastern Slovakia and raised with sheep. We mostly included the native breed, the *Slovensky Cuvac* (Figure 5), as well as *Caucasian Shepherd Dogs* (Figure 6), but a few crossbreeds (*Slovensky Cuvac* x Tat*r*a *Mountains Shepherd Dog)* and dogs without pedigree papers were also used. Pups were bought from dog breeders (in a few cases from shepherds) and placed with sheep mainly when between 5 and 8 weeks of age, in rare cases up to 13 weeks of age. No significant correlations were found between age when pups were first put with sheep and various outcome measures and behavioural scores. Initially one or two dogs were placed with each flock in order not to overburden shepherds, with the intention to subsequently increase the number of dogs through breeding on site. There was some evidence that two dogs put together before six months of age expressed more playful and obnoxious behaviour towards livestock than dogs raised singly. As the project progressed and the dogs matured and began to breed, pups born to sheep-attentive dogs were seen to quickly become socialised to sheep and remained sheep-attentive when relocated to other flocks.

Shepherds have reported many instances of encounters between project LGDs and predators. Some young dogs (<1 year old) apparently fled from bears or wolves or only barked at them without approaching, but more self-confident and older LGDs were said to have chased both wolves and bears away from flocks and sometimes also chased wild boar *Sus scrofa*. The chi-square test of association indicated that at flocks with well-raised, free-ranging LGDs placed as part of the PLCLC project ($n = 13$) there were significantly fewer reported losses to bears and wolves combined in 2002 than expected ($\chi^2 = 20.58$, d.f. = 1, $P < 0.001$) in comparison to other flocks in the same regions without such dogs ($n = 42$). The mean and maximum losses of sheep (or goats) reported for flocks with and without well-raised, free-ranging PLCLC project LGDs were respectively 1.1 versus 3.6 sheep/flock and 5 versus 35 sheep, suggesting that LGDs might reduce the likelihood of surplus killing as well as total losses. The protectiveness of four PLCLC project LGDs at three different flocks was tested during mock attacks by a substitute predator (an unfamiliar *German Shepherd Dog*). A dog handler endeavoured to remain hidden behind vegetation while approaching to <100 m of the nearest sheep. He then released the "predator" and, if necessary, encouraged her to run towards the flock. After the first such trial, the "predator" was led away, sheep and dogs were given time to settle and the procedure repeated from a different direction. The following were recorded: 1) the distance of the "predator" from the nearest sheep and the LGD when it was detected by the LGD; 2) the LGD's immediate response on detecting the "predator"; 3) the LGD's behaviour when confronting the "predator". Two dogs in the same flock appeared to be more confident, protective and effective at confronting the threat than one. Other anecdotal evidence supports this conclusion. For example, a single young (c.6 months old) LGD bitch with sheep early in her first grazing season was attacked and badly scared by a dog accompanying a horse, whereas two 4-month old C*a*ucasian *Shepherd Dogs* together chased away an unfamiliar and aggressive 5–6 year old *German Shepherd Dog*.

The greatest difficulties we encountered were in cooperation with shepherds. Typically, shepherds in Slovakia are not the owners of most of the sheep they look after, are not held responsible for losses to predators and in many cases are employed only seasonally. They therefore have little incentive to develop good preventive measures and are extremely difficult to work with. Some were unwilling to exert extra effort to raise dogs properly, others interpreted normal problems as signs of failure or did not follow standard guidelines (see Dawydiak and Sims 2004) for raising LGDs because they did not consider details such as isolating pups from other dogs important. In the worst cases, shepherds did not take proper care of dogs (give sufficient food, treat illness/infection, vaccinate). Sometimes they removed dogs from sheep and tethered them because they were fearful that they might attack people or kill sheep. Some shepherds had unrealistic expectations of LGDs or were too quick to judge them as failures, e.g. when a young dog on its own failed to repel a bear during its first encounter with one.

A quantitative focal observation protocol was devised involving four continuous hours of observations every two months for each pup >6 months old. Using this protocol a total of 128h of observations were conducted in 2002 by the researcher during the morning grazing period for sheep on pastures or, for pups with sheep in barns, during and after morning feeding. Dogs were scored at one-minute intervals for variables including identity of nearest neighbour, distance from sheep and instantaneous behaviour. In the assessment of developmental environments, the

method of raising pups was rated by marking a cross on a scale drawn between the minimum expression (not at all following recommended guidelines) and maximum expression (perfectly following guidelines) of the item being assessed (Martin and Bateson 1993). The rating was then converted into a score as follows: lower third of the range = 1 ("poor"); middle third = 2 ("intermediate"); upper third = 3 ("good"). This method was also used to generate observer-rated scores for overall attentiveness, trustworthiness and protectiveness, allowing comparison among dogs in different circumstances. These subjective scores corresponded very well to quantitative measures obtained using the focal observation protocol. Twelve of the 14 pups (86%) studied in detail showed intermediate-good patterns of behaviour according to observer-rated scores of attentiveness to sheep, degree of trustworthiness and protectiveness. However, as yearlings only half of these were allowed to accompany flocks regularly. The rest were generally excluded from flocks due to problems that could probably have been solved with further training, had shepherds been patient enough. An analysis of outcome measures used to assess the degree to which LGDs became integrated into flocks was consistent with the conclusion that success or failure was determined more by the attitudes and knowledge of shepherds, their willingness (and ability) to accept free-ranging LGDs and do the extra work required to provide them with appropriate developmental environments, than by genetically determined differences in behaviour among the dogs tested. The likelihood of dogs becoming successful guardians can probably be increased by careful consideration of the time of year and location in which they are raised, over winter in barns or farmyards being preferable to temporary summer camps. In addition, strengthening the link between compensation payments and the implementation of effective preventive measures might be helpful in motivating shepherds and farmers. Compensation is paid at market value of the lost animal(s) by the state or, if the damage was done by a bear and a licence for bear hunting was in effect, by the local hunting club.

The majority of pups showed some obnoxious behaviour during the socialisation period, typically chasing, biting and mounting sheep. Skittish sheep that fled from LGDs were likely to be chased and some dogs learned to provoke sheep into running. This problem was worse with lambs or yearling sheep than with ewes or rams. Sheep seemed more likely to run from the larger, dark-coloured *Caucasian Shepherd Dog* (males can be >90 kg) than the smaller, more sheep-like *Slovensky Cuvac*. Chasing often also occurred when adolescent dogs began to accompany flocks to pasture. The attitudes of shepherds were very important in this regard. Tolerant shepherds recognised that dogs exhibiting obnoxious behaviours were being attentive to sheep and so tried to correct undesirable behaviour without removing LGDs permanently from the flock. In general, the frequency of obnoxious behaviour decreased as dogs grew older. Less tolerant shepherds concerned about possible loss of lambs or reduced milk production tended to solve problems of trustworthiness by removing LGDs from livestock, particularly milking ewes.

Six out of 30 dogs (20%) placed in 2000–2001 had been lost (killed or missing) by the end of 2002. Three were known or believed to have been shot by hunters, two were hit by vehicles and one was poisoned. Less sheep-attentive or temporarily inattentive dogs (typically males) were more vulnerable to being shot or hit by vehicles. All dogs had been left intact to allow later breeding; neutering might have helped reduce wandering. Some dogs aggravated local residents by scaring them when wandering through villages or because they chased and killed chickens. Dogs were chased away following such incidents so it is not known if they would have eaten the chickens. Playful behaviour sometimes became very rough and resulted in the injury or even death of sheep, particularly young or sickly lambs. According to shepherds, one or more lambs died as a result of chasing or rough play by 4 out of 14 pups (29%). None was consumed. It is possible that some of them died due to previous ill health, as shepherds often put very weak animals in training enclosures with LGDs. On the other hand, several dogs >6 months old were left either alone or in pairs with lambing ewes without causing any problems.

Environment, experience and learning as well as inherited traits seemed to influence the degree of obnoxious behaviour. For example, a female *Slovensky Cuvac* who had had minimal contact with sheep during the critical period for forming social attachments, persistently ignored sheep completely or harassed them relentlessly. This behaviour was clear at four months of age and was still apparent when she was three years old. A similar bipolar pattern of either ignoring or harassing sheep was shown by two other dogs following an extended period of being chained up outside the barn. Some dogs chased cats and small birds, while others ignored them or reacted to them cautiously and playfully. One or two dogs showed some signs of stalking-type predatory behav-

iour at the age of 6–10 months, but this soon disappeared. Some dogs chased wild animals (one was thought to have killed a young wild boar), others apparently did not. A male *Caucasian Shepherd Dog* showed typical protective behaviour when roe deer *Capreolus capreolus* passed his flock. That free-ranging LGDs might chase after and kill game animals has been a source of grievance among some local hunters.

Aggressiveness towards people

A major concern among shepherds that is often given in explanation for why they cannot have free-ranging LGDs is that dogs might bite people. Livestock grazing areas are frequented by many people in summer and autumn, mainly berry/mushroom pickers, walkers/tourists in the general area and people visiting farms to buy cheese. Farmers and shepherds were advised to put up signs warning of the presence of LGDs and to put coloured collars on dogs to identify them, but they did not often do so. In general LGDs within the PLCLC project rarely or never showed unprovoked aggression towards people. Sometimes LGDs playfully chased after people who ran away from them. The *Slovensky Cuvac* seems to be less likely to be aggressive towards people than the *Caucasian Shepherd Dog*. Three out of 8 of the dogs raised with sheep in the first year of the PLCLC project bit people once or twice during their first season on pastures: a *Slovensky Cuvac* x *Tatra Mountains Shepherd Dog* female bit a woman passing through the flock on pasture; a male *Caucasian Shepherd Dog* twice seriously injured drunk people; a male *Slovensky Cuvac* attacked a farm visitor after she screamed hysterically. There have been a few additional incidents involving other dogs. A male *Slovensky Cuvac* chased and very lightly injured a motorbike rider after dark. Typically dogs in the PLCLC project >6 months old were more attentive, vigilant and protective during twilight and darkness and were then more likely to show aggression to people. A male *Caucasian Shepherd Dog* also chased vehicles and exhibited dominant behaviour if a bitch was in heat. Such incidents caused local problems with the people involved, led to the respective dogs being chained up and may have been the reason for one LGD being poisoned. In a different kind of incident, a male *Slovensky Cuvac* bit a shepherd who tried to tether him shortly after he had been relocated to a new farm, apparently out of fright. There was a similar problem with a male *Caucasian Shepherd Dog*; several other dogs were relocated without such problems.

Another set of difficulties was presented by socio-economic change. The continuing decline of the sheep industry plus uncertainty and reform leading up to and following Slovakia's entry to the EU in May 2004 made it difficult to implement a longer-term strategy such as LGDs. Several sheep farms involved in the PLCLC sold their flocks during the course of the project. However, cost cannot be said to be a limiting factor to the use of LGDs in Slovakia, as most farms have many dogs - up to 15. When bought from breeders, *Slovensky Cuvac* pups with pedigree papers typically cost € 150 for a male and € 100 for a female. *Caucasian Shepherd Dogs* cost € 200–400 for a pup with papers. Pups without papers cost around € 30–50.

Other preventive measures currently used

Twenty-eight out of 152 flocks (18.4%) surveyed in 2003 were found to have an electric fence. At some flocks where fences had been installed shepherds left them switched off. In other cases the fences were inadequate (did not conform to recommended parameters for predator-exclusion fencing), did not

Table 2. Preventive measures reported by Slovak shepherds and farmers to have been very effective in preventing or reducing losses of sheep to wolves and bears.

Preventive measure	No. mentions
close the flock in a barn or farmyard at night or when it rains	8
have good livestock guarding dogs	5
change location, e.g. graze the flock nearer the village	3
chase predators away	3
use an electric fence	2
increase vigilance (sleep nearer flock, keep watch, chain dogs nearer)	2
provide alternative food for bears nearby	2
(nothing helped)	(2)

encircle the whole sheepfold and/or had been badly set up. Predators apparently sometimes succeeded in passing between, over or under electrified wires and killed sheep, or livestock frightened by predators stampeded out of the fence and were subsequently attacked and killed. The ineffectiveness of electric fences currently used to protect flocks in Slovakia is shown by the finding that there was no significant difference (Mann-Whitney *U* test, $P > 0.5$) in numbers of sheep reported lost to bears, to wolves or to bears and wolves combined at flocks with electric fences ($n = 27$, mean loss = 2.4 sheep/flock, range 0–18) compared to those without ($n = 104$, mean loss = 2.4 sheep/flock, range 0–21).

Of 136 shepherds and farmers who answered a questionnaire on preventive measures, 34 (25%) said that they used methods besides livestock guarding dogs and electric fences to protect sheep from carnivores. Shepherds regarded fireworks and firecrackers, lamps and other aversive devices as helpful but some said that predators quickly habituate to them. In a few cases attacking predators were chased away without losses, in others wolves and bears were said to be "not afraid of anything" and succeeded in killing sheep despite attempts by shepherds to repel them. Actively repelling predators obviously depends on an attack being detected. In this regard chained dogs might be of some help, but cases were reported in which chained dogs remained silent during attacks. Measures that shepherds said had been very effective in preventing or reducing losses to predators are listed in Table 2.

Summary of main findings and recommendations

1. Predation on livestock

- Remains of livestock were not found in any of 373 bear scats and in only one of 70 wolf scats collected in the *Tatra* and *Fatra* Mountains from March to November 2001–2003. As some of the highest levels of losses to carnivores are reported from farms within or near these regions, it can be concluded that livestock does not form a significant component of bear or wolf diet in Slovakia.
- Overall, 48.0% of flocks surveyed ($n = 127$) were not affected by wolf or bear predation at all during the period 2001–2003. In each year, ≤14.0% and ≤ 29.4% of surveyed flocks were allegedly affected by bear and wolf predation respectively.
- According to the reports of shepherds and farmers, 87.0% of attacks by bears and 70.1% of attacks by wolves resulted in 0–3 sheep being lost.
- Losses to wolves seemed to be considerably higher than those to bears. Wolves were often reported to attack during the day as well as at night. The main peak of losses to both bears and wolves was in August-September (October) but attacks in May were also reported to result in substantial losses. Shepherds should be prepared for attacks during these seasons.
- The distribution of reported losses was not adequately explained by estimates of the numbers of carnivores, particularly of bears. Various factors appeared to increase the vulnerability of flocks and predispose them to attack. Very high losses were generally associated with poor husbandry and/or inadequate preventive measures.

Particularly in the case of wolves, one farm suffering substantial losses to its various flocks (in single surplus killing events or as a result of multiple attacks) could account for up to a third of total losses in a particular year at all surveyed farms combined. Future efforts to improve livestock protection methods should be focussed on these farms. Where only bears are present, installing adequate electric fencing around flocks at night should reduce or eliminate losses. Where wolves are causing losses, free-ranging and sheep-socialised livestock guarding dogs are a better choice as they can provide protection on the pasture during the day.

2. Livestock guarding dogs

- *Slovensky Cuvac* and *Caucasian Shepherd Dogs* in Slovakia retain traits desirable for livestock guarding dogs. Almost all the dogs tested seemed capable of becoming effective guardians.
- The presence of LGDs alone did not necessarily deter predators or stop all losses, but the mean and maximum reported losses at flocks with one or more free-ranging LGDs were significantly lower than those at other flocks in the same regions.
- There was some anecdotal evidence for differences between breeds. *Caucasian Shepherd Dogs* were perhaps more likely than *Slovensky Cuvac* to exhibit aggressive protective behaviour which may make them more effective at repelling determined predators. However, they suffered more from heat and caused more initial disturbance to flocks. The *Slovensky Cuvac* might be a better choice where there are concerns about dog-human encounters.
- The environments in which dogs were raised had an important influence on the development of attentive and trustworthy behaviour patterns and in

some cases were the limiting factor in the outcome of integrating LGDs into flocks. The likelihood of dogs becoming successful guardians can probably be increased by careful consideration of the time of year and location in which they are raised. Beginning in late summer or autumn with a few lambs in the farmyard followed by over-wintering in a barn with more sheep produced the best outcomes.

- A successful outcome was not guaranteed by bonding pups to livestock. Shepherds' concerns about sub-adult dogs disrupting flocks with over-attentive behaviour often led to dogs being removed from contact with sheep. This tended to discourage attentiveness and aggravated problems of untrustworthy behaviour, in some cases leading to dogs that would probably have become good guardians being permanently excluded from flocks. The attitudes of shepherds were therefore of key importance in the success or failure of established free-ranging, sheep socialised LGDs.
- Many farmers and shepherds were reluctant to undertake extra work in order to implement more effective preventive measures against predators, even where high losses had been reported. Strengthening the link between compensation payments and the implementation of effective preventive measures might be helpful in this regard.
- Several external factors hindered revitalizing the proper use of LGDs, including dogs being shot by hunters, encounters with walkers and farm visitors and socio-economic changes both within the livestock industry and on a broader scale. An outreach programme could help to alleviate some of these problems by explaining the role and behaviour of livestock guarding dogs.

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