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Livestock Damage by Carnivores and Use of Livestock Guardian Dogs for its Prevention in Europe - A review

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Abstract

In the last century livestock animals in Europe were decreased after industry revolution because of mechanization and industrialization. Ungulates were ignored as transport or pack animals. Small ruminants were decreased because lesser importance of wool and hair additional grazing areas were decreased because of using those areas as field, industrial or human buildings. In ancient times majority of people were farmers but nowadays farmers are minority almost in all developed countries. Because of those reasons while pastoral areas were decreasing, urban areas were increased which caused smaller living areas for wild animals. Besides that developed gun industry facilitated killing wild animals for hunting or other reasons. In most of European countries, large carnivores have been decreased because of those reasons. Farmers tend to raise animals from extensive systems to intensive systems in order to get more yields by giving less feed or spend less money. All these reasons push farmers for intensive farming systems.

Keywords: Bear; wolf; lynx; wolverine; livestock guardian dog.

Introduction

A livestock guardian dog (LGD) is a domesticated canine which stays with its herd, does not harm the herd and defends livestock against predators (Yilmaz 2006). Unlike herding dogs, an LGD does not control the movement of the flock with predatory actions causing bunching (Anonymous, 2012). LGDs have some common characteristics that they are about the same size and colour as the livestock they were bred to guard (Cruz, 2011). LGDs should have at least four characteristics that are intelligence, trustworthiness, attentiveness, and protectiveness. First they have at least moderate intelligence, preferably high level of intelligence. Secondly they must always stay with livestock but must not interfere with feed, reproduction, and puppy care of the herd beside that must not harm any member of the flock/herd and must not show aggression to them. Thirdly they must always be careful and alert. Fourthly they must exhibit instant deterrent response to intruders by barking or attacking because of being independent self-thinking breed when they are on their own (Yilmaz 2006, Yilmaz 2007[a,b]).

LGDs are commonly used for guarding livestock animals which graze or browse. For sheltered animals large carnivores are not much problematic but for open grazing, free range grazing, open hold animals, large carnivores find chance to prey them and this situation is a real problem. The aim of this paper is to present a short review about large carnivore damage on extensively grazing animals in 28 European countries.

1. Albania

Albania has large carnivores like bears, lynxes, and wolves except wolverines. There are about 180-200 bears, 5-10 lynxes, 200-250 wolves (but official estimate is 2,370 in 2009). In the country population of bears is increasing, lynxes are decreasing, but wolves are stable. In the country there are neither compensation system nor prevention and mitigation measures (Kaczensky et al. 2012[a,b]).

2. Austria

In Austria there might be about 5 bears, 3-5 lynxes, and 2-8 wolves but they are generally seen sporadically. In the country the populations of bear and lynx are stable, but wolves are decreasing. The bears annually cause damage on 10-100 sheep, 0-2 other livestock such as cattle and rabbits, 10-30 beehives, 0-25 canisters with rape-seed oil. The wolves also cause damage on 15-70 livestock annually (Kaczenky et al. 2012[a,b]). In Austria bears are problem for livestock especially in forest areas. The bears caused damages in four ways including damaging beehives and chain saws lubricated by vegetable oil, killing deer (both red and row) and sheep. For prevention damages on beehives, electric fences were used. The vegetable oil is highly attractive energy source for bears but bears caused more damage on the equipment than the loss of vegetable oil. Even though a lot of chemical admixtures were used to prevent this problem, the result was unsuccessful. Another problem was killing of red and row deer by bears. There was not an effective solution about this problem. The last problem was being killed sheep by bears. For instance about 50 sheep were killed by about 10 bears in southern Austria. In order to reimburse the sheep loss, a compensation program was started in 1970s. Authorities pay the same price for such a sheep the farmer could get on the market within about 8 weeks. On the long term authorities could offer money to farmers that want to invest in prevention measures or change the way they keep their livestock. As a second step they could slowly decrease the percentage of compensation for those who did not set any prevention measures. By this means authorities might be able to reach a gentle pressure for the farmers to adapt to coexistence with bears and in general with big predators again (Gutleb 2001).

3. Bosnia-Herzegovina

Bosnia-Herzegovina possesses large carnivores like bears, lynxes, and wolves but not wolverines. There are about 550 bears, 70 lynxes, 650 wolves. The population of bear is increasing but lynx and wolf are stable. Between 2007-2011 42 sheep, 20 cattle/horse/pigs, 23 beehives, crop and fruit tree were damaged by bears; 400 livestock by wolves; sheep and goat by lynxes but there were no available data (Kaczensky et al. 2012[a,b]).

4. Bulgaria

In Bulgaria there are about 530-590 bears, 11 lynxes, and 1.000 (according to official estimate 2.200-2.500) wolves but no wolverines. The population of bear, lynx and wolf is stable. Between 2007-2011 about

81,850 € were paid for compensation caused by bears for 249 sheep, 18 goats, 27 cattle, 6 ungulates, 12 pigs, 3 dogs, 533 beehives, 58 fruit trees, and 325 kg of chokeberry (Kaczensky et al. 2012[a,b]). Bulgaria has a very good shepherd dog named as Karakachan Shepherd and plenty of predators like brown bears, wolves, lynxes, foxes and jackals (Sedefchev 2005, Stoynov 2005) and predation on livestock is a serious problem in Bulgaria. This problem is not only just because of the number of animals killed but also livestock losses motivate the livestock breeders to kill large carnivores in revenge, even using poison baits which are illegal in Bulgaria. Carnivores that kill livestock in Bulgaria include the brown bear (*Ursus arctos*), wolf (*Canis lupus*), jackal (*C. Aureus*) and exceptionally, the red fox (*Vulpes vulpes*). The spread of poison baits has unfavourable impact on the populations of carrion eating species as black vulture (*Aegypius monachus*), bearded vulture (*Gypaetus barbatus*), griffon vulture (*Gyps fulvus*), egyptian vulture (*Neophron percnopterus*), imperial eagle (*Aquila heliaca*) and golden eagle (*Aquila chrysaetos*). Most of those species are threatened and some of them have even been exterminated from Bulgaria because of the use of poison baits in the past (Stoynov 2005).

In a region which is about 20-25,000 km2 there are about 1,200 wolves and 600 bears. This population is the highest in Europe. In 1997 a project was initiated by cooperation with Bulgarian Biodiversity Preservation Society, Wolf Protection Society and Wolf Conservation Trust. In this project some Karakachan dogs were supplied for herdsmen in order to reduce conflict between local people and large carnivores. The second aim was to increase nationwide population of Karakachan dogs. There was no report of livestock loss since Karakachan dogs were provided to specific flocks. There was a major problem that some Karakachan dogs were killed by hunters and this problem was getting worse in the country. This was because of the hunter's hatred of livestock guarding dogs and the fact that these dogs sometimes kill hunting dogs, which try to penetrate into a flock (Sedefchev 2005).

Another project with support of Wild Flora and Fauna's (WFF) was initiated in southwest edge of Bulgaria. In this region wolves cause the most numerous killing of livestock, but bears causes the highest economic losses by killing larger livestock like cattle and horses. Jackals and red foxes are rarely responsible for livestock losses. Feral dogs are a very serious problem in the settlements and the areas where wolves and bears are absent. The mortality ratio due to predation is up to 10 % in the herds where no LGDs are used and less than 1% in herds where good LGDs are used with. The mortality due to feral dogs is about 1.1%, and due to other reasons like thunderstorms, diseases etc., is about 1.2 %. A compensation program was applied in 2000 under this project by the WFF. In order to get compensation if predators kill livestock, the farmers must implement three criteria containing a) good guarding dogs should be used with the herd, b) the herd should always be herded by a shepherd and c) the herd should never be left outside the corrals during night. The WFF provided 20 Karakachan dogs under the project and the results were highly satisfied. It was proved that predators did not attack the herds with well-trained mature Karakachan dogs (Stoynov 2005).

5. Croatia

Croatia has large carnivores like bears, lynxes, and wolves except wolverines. There are about 1,000 bears, 50 lynxes, 168-219 wolves containing 50 packs. The population of bear is increasing but that of lynx and wolf is stable. Between 2007-2010, 6,000 € was paid as compensation for 2-20 sheep/goats, 0-33 beehives, crop and fruit tree that were damaged by bears, and 194,000 € for 1,500 livestock. There were no cases of confirmed damaged by lynxes (Kaczensky et al. 2012[a,b]).

6. Czech Republic

In the Czech Republic there are 43-58 lynxes, and 1 wolf but no bears and wolverines and their population is stable. There were no report of damage by lynxes but 1,800 € was paid for 10 livestock because of wolf damages (Kaczensky et al. 2012[a,b]).

7. Estonia

Estonia has large carnivores like bears, lynxes, and wolves but not wolverines. There are about 700 bears, 790 lynxes, 230 wolves. The population of bears, lynxes and wolves is increasing. In the country there was almost no livestock depredation. The most damages happened on beehives which was 12,500 € for 105 hives by bears and 95,000 € for 209 cases by wolves (Kaczensky et al. 2012[a,b]).

8. Finland

Finland possesses large carnivores like bears, lynxes, wolves, and wolverines. There are about 1,600-

1,800 bears, 2,430-2,610 lynxes, 150-165 wolves and 165-175 wolverines. In the country population of bears, lynxes and wolverines is strongly increasing, on the contrary wolves are decreasing. There was almost no livestock depredation. Compensation costs were 750,000 € for 681 reindeers and 172,700 € for 30-100 sheep, 0-5 other cattle/ horses, 0-4 dogs, 150-250 beehives, hundred packages of silage and some damage in outfields caused by bears, 15,600 € for 25 livestock and 827,122 € for 554 reindeer caused by lynxes, 0.5-1.35 million € for 650-1001 reindeer, 32,68-154,302 € for 30-120 sheep, 2-6 cattle and horses, 25-35 dogs (Kaczensky et al. 2012[a,b]).

9. France

Bears, lynxes and wolves are present in France but not wolverine. There are about 22 bears, 13 lynxes, and about 68 wolves consist of 13 packs and 7 trans boundary packs. In France the populations of bear, lynx and wolf is increasing. Between 2006 and 2011 the amount of 103,000 € was paid for 200 sheep/goats and 31 beehives because of bears, 18,360 € was paid for 92 sheep because of lynxes, and 1 million € was paid for 4,618 livestock because of wolves (Kaczensky et al. 2012[a,b]). It is possible for a Great Pyrenees, a large breed of dog used as LGD to wander the village during the winter when its flock of sheep were stabled in barn. When spring came the dog would follow her sheep to the mountains. The tendency to travel great distances that was originally a positive trait is now liability in a country crossed with highways and heavy traffic (Cruz, 2011).

In French Jura there are about 36,000 ewes together with 347,000 cows and 4,000 goats. In grazing system of the region sheep and lambs are kept in pastures from early spring to late autumn. In these pastures sheep are always unguarded and wander freely by day and night. Livestock guard-dogs are not used in the Jura which may cause damage to livestock. A long term surveillance showed that there was no general lynx-livestock problem in spite of the absence of measures to livestock guardian dogs. At the regional scale, sheep losses to lynx were less than 0.5 % of the available stock (Stahl and Vandel 2001).

A study was carried out to investigate the recolonization of lynx in French Jura between 1984 and 1998. The number of attacks increased from three to 188 between 1984 and 1989. During following years, 66-131 attacks were recorded annually which caused 92-194 sheep killed per year. These observed data demonstrated that lynx were not killing sheep due to shortages of alternative prey or in response to an increased need for food when rearing young. As a result it could be said that the cost-effectiveness of guard-dogs or the selective removal of some individual lynx should be evaluated (Stahl et al. 2001a). The research team conducted another research about effect of removing lynx for reducing attacks on sheep between 1989 and 1999. In the research a total of eight lynx and two large carnivores thought to be lynx was legally removed from high conflict areas by trapping (n=7), shooting (n=1) or poisoning with toxic collars on sheep (n=2). The sex-ratio of captured lynx was seven males and one female. The researchers realized after a long term observation that selective removals could only temporarly reduce the problem of concentrated lynx damage. The only way to obtain a durable effect was to improve shepherding techniques (Stahl et al. 2001b).

10. Germany

In Germany there are lynxes and wolves, but there are no bears and wolverines. In Germany there are estimated about 12 lynxes, and 14 wolf packs besides single residents of 43 adult wolves. The population of lynx is stable but wolf is stable. Although livestock depredation is rare, the wolves caused damage on 225 small livestock in 2011 and 26,584 € was paid for this damage (Kaczensky et al. 2012[a,b]). In some regions, some shepherds do not have enough experiences how to integrate an adult and trained guard dogs. An experiment in cooperation with the College and Research Institute for Animal Breeding and Husbandry had been conducted to gain practical information about how to integrate two adult guarding dogs into a sheep herd. In addition to it the possible use of guarding dog was analysed in the Netherlands by holding one interview with a Dutch shepherd combined with analysing the Dutch farming system. Shepherds indicated that they had no experiences with integrating an adult guard dog and they recommended using a similar strategy for integrating an adult dog as they had used for guard dog pups. A Switzerland study reported that mostly a leash was used to guide the dog through the herd and let the sheep accustomed to the dog. In some other reports, the dog was located in a separated fenced in place, so there was only smell and sight contact with the sheep. In most cases it took up to 5 days before the sheep accepted the presence of the guard dogs inside the herd. In order to overcome this difficulty a project was applied by signing a protocol between the Guard Dogs Inc. and State Agency for Environment, Health and Consumer Protection in state of Branderburg (Van der Geest 2013).

In the protocol, it was important to consider what kind of guard dog, kind of sheep and kind of environment was present during the process, due to influence of those factors on the result of the integration process. On the

second stage some actions which should be taken are explained. The most used material in the beginning of the process was a strong leash. Buying two adult guard dogs and the price for a LGD expert for the supervision of the project were the major costs of an integration process. Two main issues were recommended by shepherds. They are financial support for food expenses and public awareness for the use of livestock guarding dogs. Shepherds kept sheep on a similar way in the Netherlands as in Brandenburg. However, the Netherlands was more populated then most regions in Brandenburg. According to observed results, it could be concluded that guarding dogs were an effective protection method for sheep against wolves. A good integration of inexperienced guard dogs in a sheep herd was possible, when there was a good understanding about sheep and guard dogs from shepherds. Moreover it was necessary to think about prevention methods to protect sheep against predation by wolves (Van der Geest 2013).

11. Greece

Greece possesses bears, and wolves, but do not possess lynxes, and wolverines. There are about 400-450 bears, and 700 wolves. Year by year population of bears is increasing, but wolves is stable. In the country there was almost no livestock depredation. Compensation costs were 19,000 € for 200 sheep/goat, 98,000 € for 215 cattle/horse, 24,000 € for 530 beehives/swarms caused by bears, 0.8-1.5 million € for 20.000 sheep, 12.000 goat, 2.000 cattle, 2.000 ungulates (Kaczensky et al. 2012[a,b]).

12. Hungary

Hungary owns lynxes but do not own other large carnivores like bears, wolves, and wolverines. There are about 1-3 lynxes in the whole country and this population is stable. In the country there was hardly livestock depredation cases (Kaczensky et al. 2012[a,b]).

13. Italy

Italy has bears and wolves as large carnivores. Lynxes are not present in the Apennine but there are no available data about presence of lynxes in the Alps. The number of large carnivore population is estimated about 45-48 bears, and minimum 67 wolves consists of 12 packs and 7 trans boundary packs. In the country the populations of bear is stable but wolf is increasing. Between 2007-2011 about 81,850 € were paid for compensation caused by bears for 249 sheep, 18 goats, 27 cattle, 6 ungulates, 12 pigs, 3 dogs, 533 beehives, 58 fruit trees, and 325 kg of chokeberry (Kaczensky et al. 2012[a,b]). In northwest Italian Alps, sheep breeding is a traditional activity which is still important for the economy of the region. On the other hand it is an important area for the conservation of the alpine environment too. Because of the absence of large carnivores and the lack of labour, shepherds used to drive their flocks to mountain pastures and leave them alone for the whole summer until 2000s. The free ranging flocks used to exploit even the remote areas of summer pastures, spending the night outdoors without protection. After some increased carnivores attack including wolf, fox and stray dogs, the risk of losses due to depredation has affected alpine grazing management. This situation discouraged the exploitation of more remote and inaccessible pastures, and forced shepherds to guard flocks during the day and fenced them in protected enclosures during the night. This new condition has altered the distribution of sheep dung on pastures (Coppinger et al. 1983, Cugno, 2004).

Hence a study was conducted to search dung distribution of sheep on summer pasture in Demonte, province of Cuneoy. Large carnivores in the Alps have caused great changes in sheep pastoral systems. The traditional grazing management has been replaced by a non-traditional system, with constant shepherd surveillance and the use of night-time enclosures. Consequently it was seen that the distribution of sheep dung had been affected, with possible effects on vegetation and pastoral quality. As a possible solution the corrals could be surrounded by permanent electric fences to prevent livestock depredation. Nevertheless dung was excessively concentrated in the areas where flocks were sheltered. As a result, being of large carnivores in the area might be indirectly detrimental not only to the ecosystem, but also to the economic system, if management changes to integrate them will not be put into practice (Cugno, 2004).

14. Kosovo

In Kosovo there is no information about bears, lynxes and wolves and do not have any wolverines (Kaczensky et al. 2012[a,b]).

15. Latvia

Latvia possesses bears, lynxes and wolves, but do not possess wolverines. There are about 10-15 bears, 600 lynxes, and 200-400 wolves. In the country population of bears and wolves are increasing, but lynxes are stable. In the country there was no damages caused by bears and no damage compensation system. There were only few cases of livestock depredation reported annually caused by lynxes. Although there were 50-329 livestock damages, there was no compensation policy caused by wolves (Kaczensky et al. 2012[a,b]).

16. Lithuania

In Lithuania there are lynxes and wolves, but there are no bears and wolverines. There are about 40-60 lynxes, and roughly 300 wolves. In the country populations of lynx and wolf are stable. In the country there were no damages and no damage compensation system caused by lynxes and wolves. Although livestock depredation is rare, the wolves caused damage on 225 small livestock in 2011 and 26.584 € was paid for this damage (Kaczensky et al. 2012[a,b]).

17. Macedonia

Macedonia owns bears, lynxes and wolves, but do not own wolverines. There are about 160-200 bears, 23 lynxes, and 267 wolves. In the country population of bears is increasing, wolves are stable, but lynxes are decreasing. There were only few cases reported for 53 sheep/goat, 167 cattle/horse/donkey/pig, and 152 beehives caused by bears. In the country there is no central information on livestock depredation existed, although interviews and other surveys indicated that conflict levels are low caused by lynxes and is no information about damages caused by bears (Kaczensky et al. 2012[a,b]).

18. Montenegro

In Montenegro there is no information about bears, lynxes and wolves and do not own any wolverines. (Kaczensky et al. 2012[a,b]).

19. Norway

Norway has large carnivores like bears, lynxes, wolves and wolverines. There are about 46 bears, 384-408 lynxes including 65-69 family groups, 23-24 wolves containing 3 packs and 2 scent marking pairs, and about 385 wolverines. Except lynxes the other large carnivores are increasing in the country. Compensation costs were 2,000,000 € for 3,800-7,000 sheep, 35,000 € for 4-75 semi-domestic reindeer because of bear damage, 2.1-2.9 million € for 7,000-10,000 sheep and 1.1-3.4 million € for 3,000-8,000 semi-domestic reindeer because of lynx damage, 120,000-430,000 € for 400-2,300 sheep and 70,000 € for 239 reindeer because of wolf damage (Kaczensky et al. 2012[a,b]). Norway spent considerable resources attempting to eradicate carnivores during the last 100 years. After Law on the Extermination of Predators was constituted in 1846 wolves, bears, lynx, wolverines and golden eagles were started to be terminated. By the early 20th century, they were nearly extinct. When the large predators were mitigated, the pattern of sheep farming changed, and flocks grew in size and were no longer guarded by shepherds. From 1996 to 1999, an average of 2.1 million sheep was released each summer into the wild lands for grazing (Linnell and Broseth 2002). For example in Norway lynx are always crucial problem for livestock. About 9,000 lambs were killed by lynx in 1999. Therefore Linnell performed an analysis to define age and sex specific depredation rates of Eurasian lynx on sheep. Some radio-collared lynx were monitored to investigate their behaviours. Yearling lynx and males killed more than others (Linnell et al. 2000).
Even though Norway has several sledges and hound dog breeds containing Norwegian Buhund, Norwegian Elkhound Black, Norwegian Elkhound Grey, Norwegian Lundehund, Halden Hound, Hygen and Dunker (Anonymous, 2014), there is no livestock guardian dog breed. To overcome this handicap, a project was initiated and 13 Great Pyrenees were tried to use for livestock guarding. They were analysed for behaviours against people, livestock, dogs, horses, reindeer, and bear to determine if they will be suitable for protecting livestock in Norway. All of 13 dogs did not show any aggressive behaviour against unfamiliar people, and aggressiveness towards dogs and livestock was also low. However, 91% of the dogs chased reindeer and 3 dogs intended to chase bears. Their nonaggressive behaviour against people, dogs and livestock, and their active reaction towards bears suggested that this breed could be suitable for using as livestock guardians in Norway. However, the tendency of dogs to chase reindeer was a trait that could cause conflicts in reindeer-herding areas (Hansen and Bakken 1999).

Hansen and Smith did another study to search different working regime of Great Pyrenees. A total of

3,500 ha unfenced forest/mountain range pasture in bear habitat comprised the research area in which 624 sheep from 2 herds grazed. The field trial lasted 3 months, and a total of 10 Great Pyrenees participated for various time intervals. In this study three various working systems were evaluated including loose dogs without the command of a dog handler as Method A, loose dogs under the command of a dog handler as Method B, and loose dogs guarding sheep inside a fenced, 1 km2 forest pasture as Method C. Behavioural activity patterns on night and data on predation were recorded. The Method A was proved unusable because it was too uncontrolled for Norwegian conditions. Sheep dispersed too widely and dogs ranged too far, causing conflicts in nearby settlements with wildlife, and with livestock. In the Method C the dogs were 3 times less active and were engaged in guarding activities. They barked 15 times more frequently, and no sheep carcasses were found inside the fence. Hence the Method C probably had the best preventive effect (Hansen and Smith 1999).

Between 1996 and 2002 three different projects were initiated using 25 LGD dogs of Great Pyrenees, Maremma-Abruzzese, and Tatra Mountain breeds. In these projects four different LGD using methods were employed- LGDs used in combination with herding and use of night corrals as Method 1, LGDs on fenced pastures as Method 2, LGDs alone with sheep on open range as Method 3, and LGDs loose on patrol together with a range inspector as Method 4. The Method 1 was significantly most successful loss-reducing method, but also the most expensive due to the need for continuous herding, moreover the limitation placed on grazing pattern resulted in reduced lamb growth. The Method 2 was the least expensive method and proved the second best preventive effect. Losses were reduced by close to 100%, dependent upon pasture size. This way of using dogs was not very time consuming because the dogs could guard during both day and night without people being present. The Method 3 required dogs that were strongly socialized to sheep. This method was not to be recommended under Norwegian condition because this way of dog keeping could be too uncontrolled, and widely scattered free-ranging sheep made the guarding difficult. The Method 3 of patrolling method showed that a range inspector patrolled the grazing area together with a loose LGD in a systematic way. In that way the range was covered during a certain time. LGD breeds were preferred to other dog breeds because they have good combination of behaviours suited for this job. They are calm with respect to livestock, would chase carnivores away, and had a low hunting instinct against to other wildlife. This method also has a lower loss-reducing effect than the Method 2, however, total losses of depredation, accidents and illness reduced from 15% to as little as 2–3% in that area where the best results were achieved. However, after the two year LGD study was finished and the dogs were taken away, losses increased again. Other studies had shown that patrolling without a dog had minor loss reducing effect (Hansen 2005).

20. Poland

In Poland there are all large carnivores except wolverine. The number of large carnivore population is estimated about 80 bears (but official estimate is 119-164), 200 lynxes, and 576-723 wolves containing 136-150 packs and 2 scent marking pairs. In the country populations of bears and wolves are increasing, but lynxes is stable. In 2010 about 61,555 € were paid for 556 beehives because of bears and 95,000 € for 1,000 livestock because of wolves (Kaczensky et al. 2012[a,b]). Livestock damage caused by large carnivores is not a severe problem in Poland. The amount of compensation paid is also quite small. It is paid by the authorities of every province and reaches on average €uro 50,000 per year for the whole country. Nevertheless, predation on livestock affects negative attitudes among farmers and makes this issue interesting for the media. As a consequence sensational press and TV reports increase influence on social attitudes towards large carnivores. Moreover hunters generally use this situation as an argument for including wolves on the game list again despite being protected in Poland. In Poland two projects were applied in 2000s which were attempting to resolve large carnivore/farmer conflicts by the introduction of Tatra Mountain Shepherd Dogs which were the only LGD breed of Poland into livestock flocks (Nowak and Myslajek, 2005; Smietana, 2005).

The first project was conducted in the Bieszczady Mountains which was eastern range of the Polish Carpathians by the Institute of Nature Conservation, Polish Academy of Sciences between 1995 and 2001. In Bieszczady Mountains there were about 40-80 wolves, 40-60 lynxes and 30-50 brown bears which are all protected in Poland. In the project the aim was to decrease losses from wolf predation using LGDs among breeders who never used such dogs. 13 Tatra puppies were delivered to 11 sheep or sheep/goat farms. At the end of the project all dogs were successfully used by farmers except one. This dog was not accepted by the flock of sheep except two lambs (Smietana 2005).

The second project had been started by the Association for Nature Wolf in the Western Beskidy Mountains. In Western Beskidy Mountains there were about five wolf packs containing about 22 individuals, 19 lynxes and 4 brown bear which are all protected in 2000s. Based on the project 12 Tatra Mountain Shepherd

dogs were distributed into 10 farms. The dogs protected sheep flocks in eight farms and cows and horses in two farms. After several years it was proved that the Tatra Mountains Shepherd Dog could be successfully used as a method of livestock protection against wolf attacks, both for sheep and cattle. The most common mistakes made by farmers were inadequate care and training process such as poor care leading to diseases and allowing the dog to play with children (Nowak and Myslajek 2005).

21. Portugal

There were about 220-435 wolves in 2005 but recent data is not available. In Portugal population of lynxes is decreasing. In 2010 the amount of 763,858 € was paid for 2,497 wolf attacks (Kaczensky et al. 2012[a,b]). In Portugal the carnivore damage is commonly made by Iberian Wolf (*Canis lupus signatus*). Due to the low numbers of natural prey such as roe and red deer, the main Iberian wolf diet is based almost exclusively on domestic animals mainly sheep and goat. On the other hand in some areas of Portugal mortality of goat kids due to the lack of disease prevention can reach more than 50% of the yearly production per flock, whereas maximum wolf predation registered was around 5%. In Portugal, human persecution caused to Iberian wolf extinction in 80% of the country, particularly since the 1970s (Ribeiro 2004, Ribeiro and Petrucci-Fonseca 2004, 2005).

The best solution for this problem is use of Livestock Guarding Dogs among livestock flocks and herds. Grupo Lobo applied a project overcome this problem in 1997. On the first step the alternate use of native breeds of LGDs was searched. Three breeds of LGDs containing the breeds of Cão de Castro Laboreiro, Rafeiro do Alentejo and Cão da Serra da Estrela were chosen to protect livestock from predators. From those breeds a total of 75 pups (38 males and 37 females) was selected and distributed to flocks. Criteria for flock selection were based on the amount of damages, the existence of conditions to receive a dog and the shepherd's motivation to cooperate in the project. After pups grew up, they were evaluated by caring criteria of attentiveness, trustworthiness and protectiveness which were suggested by Coppinger and Coppinger (2005) (Fonseca 2000).

The adult dogs were evaluated as excellent or good in attentive, trustworthy, and protective behavior as 92%, 98% 90% respectively. The projects gave some outcomes that there had been the increased tolerance towards the wolf. The support given by the project in what concerns LGDs and the payment of damages were referred by some livestock producers as the main causes that prevent the use of illegal lethal methods to reduce predation. Secondly there was overall increase in concern by livestock producers regarding the welfare of the dogs integrated in the project. There was also a higher regard for these dogs in comparison to others, due to their performance and contribution to flock protection. One factor that contributed to the acceptance of the project and the acknowledgment of the importance of using good LGDs had been the reputation achieved by some of the dogs integrated in the project. Lastly one of the most important means of diffusion of the use of LGDs had been the transfer of information between livestock producers. This was evident in the more than 40 requests for dogs by new livestock producers, in the last few years (Ribeiro 2004, Ribeiro and Petrucci-Fonseca 2004, 2005).

22. Romania

Bears, lynxes and wolves are present in Romania but not wolverine. There are about 6,000 bears which is the highest population in Europe, 1,200-1,500 lynxes, and 2,300-2,700 wolves. The population of bears, lynxes, and wolves is stable. There was no recent information about damages and compensation costs (Kaczensky et al. 2012[a,b]). The Carpathian Large Carnivore Project (CLCP) was applied in 1990s and it made a survey of the damage caused by large carnivores to livestock in summers 1998, 1999 and 2000. Shepherd camps included in the survey were 17 in 1998, 19 in 1999 and 26 in 2000. In 1998 and 1999 it revealed that wolves and bears killed 2.08 % of all the sheep, for an average of 9.94 sheep per camp in each grazing season of 4.5 months (Mertens and Prombeger 2000, Mertens et al. 2001). In Romania there are three LGD breeds, the Ciobănesc Român Carpatin, the Ciobănesc Român Mioritic (Mioritic Shepherd Dog) and the Ciobanesc Român de Bucovina (Bucovinian Shepherd Dog). These are ancient breeds and it is likely that these dogs have been commonly used by shepherds until not too long ago (Mertens and Schneider 2005).

Livestock protection methods in Romania are still quite well preserved, with dogs and shepherds always guarding the flock and the sheep being penned at night. On the other hand several kinds of problems made so that guarding was not always done optimally. First the livestock guarding dogs were not actively trained. As soon as they were big enough, the pups were put in the flock together with the adult dogs and they were supposed to learn from the other dogs how to guard the sheep. Secondly the salaries and the food for the shepherds and the rent of the pasture were expensive compared with the incomes from livestock rearing. That was why often not enough shepherds were present to guard the sheep and, as the rented pasture was often not enough, the sheep were kept in the forest, being more exposed to attacks of predators. Another problem in

Romania is that dogs are killed by wolves. Between January 2001 and October 2002 the wolves were reported to have attacked livestock in 149 households on an area of 69.9 km^2, killing 62 sheep, 7 cattle, 1 kid, 2 foals and 186 dogs including 157 adult LGDs, 2 pups and 27 small herding dogs. Dogs were killed in 137 households, other livestock in 24. The amount of attacks per household ranged between 1 (74%) to 2 (17%), exceptionally up to ten. Only four attacks (2%) were unsuccessful in which the animals were neither injured nor killed. The amount of animals attacked per household ranged between 1 to 14 animals. In most of them one animal was attacked (65%) and in only 5% between 5 and 14 animals (Mertens and Schneider 2005).

23. Serbia

In Serbia there are bears, lynxes and wolves but no wolverines. There are about 68-78 bears, 65-75 lynxes, and 750-850 wolves. The population of bears and wolves is stable, but lynxes is decreasing. There were no damages and no damage compensation system caused by lynxes and wolves. There is no central information on livestock depredation, although interviews and other surveys indicated that conflict levels are low caused by lynxes and is no information about damages caused by bears. There is no governmental compensation for livestock but only in the Province of Vojvodina wolf is strictly protected to be killed (Kaczensky et al. 2012[a,b]).

24. Slovakia

Slovakia has large carnivores like bears, lynxes, and wolves but not wolverines. There are about minimum 800-1,100 bears (but official estimate is 1,940), 300-400 lynxes (but official estimate is much higher), 200-400 wolves (but official estimate is 1,823). All large carnivores are stable and not increasing. Compensation costs were 5,500 € for 160 sheep/goat, 1200-.1900 € for 15 cattle, 12,000 € for 200 beehives because of bear damage, and 16,000 € for 500 livestock because of wolf damage (Kaczensky et al. 2012[a,b]). The main predators on livestock in the Slovak Carpathians are the wolf and brown bear (Rigg et al. 2011). The species of wolves and bears are reported to generally 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. Slovensky Cuvac and Caucasian Shepherd Dogs in Slovakia retain traits desirable for livestock guarding dogs (Rigg 2001). PLCLC started a project in 2000 there were LGDs at almost all upland sheep farms but very few were free-ranging and attentive to sheep (Rigg 2001). LGDs were used in one of three ways. First permanently they should be chained near the sheepfold or farm buildings, which could have provided some protection, mainly by barking to alert shepherds at night. Secondly they were chained during the day but released at night. In third way they were left free to wander (Rigg 2005). The project revealed that 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. Caucasian Shepherd Dogs were perhaps more likely than Slovensky Cuvac to exhibit aggressive protective behaviour which could make them more effective at repelling determined predators. A successful outcome was not guaranteed by bonding pups to livestock. 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. 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 (Rigg 2004, 2005).

25. Slovenia

Slovenia has bears, lynxes and wolves but no wolverines. There are about 401-490 bears, 10-15 lynxes, and 32-43 wolves. The population of bears is increasing but lynxes and wolves are stable. Compensation was 252,497 € containing number of attacks by bears to 650 sheep/goat, 15 cattle/horses/pigs, 425 other like bee hives, agriculture, orchards, animal feed, car accidents, and feeders by increasing the trend since 2007. In 2011 about 975 € were paid for 9 sheep because of lynxes and 269,000 € were paid for 453 animals because of wolves (Kaczensky et al. 2012[a,b]).

26. Spain

In Spain there are bears and wolves but not lynxes and wolverines. The number of large carnivore population is estimated about 22-27 bears. There was no recent estimate of total population size of wolves but it

was about 2,000 wolves in 2005. In the country population of bears is increasing, but wolves are decreasing. In 2010 about 20,500 € were paid for 70 sheep and 29 beehives because of bears and 2 million € because of wolves (Kaczensky et al. 2012[a,b]). In order to strengthen the dwindling population (only 6 bears at that time) in the Pyrenees, extra 3 adult bears arrived from Slovenia in 1996. As a result attacks on sheep have increased from that time significantly. Those 3 bears were brought from a Slovenia where there were relatively few sheep, and where sheep usually grazed in the vicinity of little villages in the countryside. Whilst local bears were responsible for only 3-4 sheep kills per year, newly arrived bears killed between 20 and 25 sheep annually. Moreover cubs born from those bears appeared to have acquired similar feeding habits. In reaction to these conflicts, the Spanish Great Pyrenean Club (GPC) offered to share their knowledge on Great Pyrenean Mountain Dogs (GPMDs) with the Department of the Environment in Catalonia (Icardo 2005). GPC convinced Spanish authorities that this breed was used effectively to prevent predation in North America, Canada, France, and Israel and could benefit both shepherds and wildlife. Efforts were made to put such plans into action and during the years 1998 and 1999, twenty-nine Great Pyrenean puppies which were born in flocks, mainly issued from the French Pyrenees were purchased by the administration from the Spanish Great Pyrenean Club, to be given to stockowners to protect their flocks. Unfortunately the speed at which these changes took place was detrimental to the efficiency of dogs, which were handed over to shepherds with few instructions and no funding for technical surveillance or veterinary care. The Department of Environment eventually examined the outcome of these reintroductions. Results showed that there was an alarming mortality rate of 21% of LGDs. Moreover, 23 % of the owners showed unsatisfactory procedures, while only 3 % were qualified as excellent. However, 80 % of the LGDs showed attentive behaviours towards the flock. As a result the project reached the optimum target and was almost successful (Icardo 2005).

27. Sweden

Sweden has large carnivores like Norway containing bears, lynxes, wolves and wolverines. There are about minimum 3,300 bears, 1,400-1,900 lynxes including 277 lynx family groups, 29 packs and 25 scent marking pairs, and about 680 wolverines. Except lynxes the other large carnivores are increasing in the country like Norway. Compensation costs were 37,000 € for 50-100 sheep and few other animals, 187,000 € for reindeers because of bear damage, 17,500 € for 90 sheep and 3.5 million € for reindeer herders because of lynx damage, 100,000 € for 200-500 livestock and 20 hunting dogs and 82,000 € for 239 reindeer herders because of wolf damage (Kaczensky et al. 2012[a,b]). In Sweden there is no modern knowledge of working with guarding dogs to protect livestock from large predators and there are no special breeds of livestock guarding dogs from Scandinavia. According to data from people living in the 19th and the beginning of the 20th centuries revealed that some kind of dogs in those days were used as all-round dogs, some of them accompanying livestock and people during the days in the forest. On some occasions some of them actually got into fights with both wolves *Canis lupus* and bears *Ursus arctos*. Still, the interest in guarding dogs was aroused again and both farmers and the authorities wanted to learn more about how they work and how to raise and keep them. Recently most livestock in Sweden is fenced, either within electrical fences, traditional sheep wire-netting fences, or with sheep wire-netting fences supplemented with two electrical wires. The 210,000 (adult) Swedish sheep are found in 7,600 flocks and some of them are situated in areas with large carnivores, mainly wolves and lynxes. The Wildlife Damage Centre has worked intensively with electrical fences to protect against large predator depredation since 1997 (Levin 2005).

A minority of farmers which were less than a hundred let their animals range freely during the summer. These farms were situated in boreal areas in the central to north central parts of Sweden. Majority of them were located in the same area as dense, or growing, populations of bears and wolves. Between 1995 and 2005 problems had been reported from a few farms with free ranging sheep or dairy cattle. The confirmed number of free ranging animals being killed or injured by large predators was not high, but there was a widespread anxiety that something will happen and some farmers were also convinced that the actual presence of predators in the neighbourhood stressed the livestock and caused indirect damage, like failed ovulation, abortions, decreasing milk production, etc. In those situations a livestock guarding dog could be of help, as long as it could work by itself. Unfortunately there were no shepherds in Sweden and it would probably be very difficult to get people to work as shepherds. Less than 2% of the economically active population was engaged in farming (Levin 2005).

The Wildlife Damage Centre encouraged farmers with certain needs to get puppies of good quality guarding dogs and also recommended that the county councils subsidise the purchase of the dogs. The intention of Swedish livestock breeders was to follow the development of those dogs under Swedish conditions in the long term. They did this with yearly survey for each dog, as well as annual meetings with the dog owners to discuss

and share experience. In 2000s there were nine dogs working actively to protect livestock in Sweden. Eight of the dogs were Maremma-Abruzzese, and work within fenced areas. The dogs were born in a Swedish kennel, but had Italian working dogs as parents. The breeders had lived in Italy and spent a lot of time learning about the dogs from shepherds in the Abruzzi Mountains. All working dogs were raised with livestock at the same farms where they now live. Two of these dogs protect alpacas in a flock that was attacked by wolf two years ago, the rest protect sheep in areas with lynx, wolves and occasionally bears. The ninth dog was an Anatolian Shepherd Dog. This dog was first raised in a town, but was taken to a farm as a two-year-old. The introduction seemed to have gone well so far, and last summer the dog was protecting free ranging goats in an area with bears, lynx and occasionally wolves (Levin 2005).

28. Switzerland

Bears, lynxes and wolves are present in Switzerland but not wolverine. There are about 2 bears, 124-143 lynxes, and about 8 wolves which had first reproduction in 2012. In the country populations of bears and lynxes are stable, but wolves are increasing. Between 2006 and 2011 the amount of 103,000 € was paid for 200 sheep/goats and 31 beehives because of bears, 18,360 € was paid for 92 sheep because of lynxes, and 1 million € was paid for 4,618 livestock because of wolves (Kaczensky et al. 2012[a,b]). Wolves *Canis lupus* were extinct in Switzerland about 150 years ago (Landry et al. 2005). However, wolves spread from Italy and France to Switzerland in 1995 and started regularly to attack livestock (Landry et al. 2005, Mettler 2005). In February 1999, the Federal Office for Environment, Forests and Landscape initiated the Swiss Wolf Project (SWP) in order to overcome the conflicts generated by the wolf and make possible the cohabitation with man. The project was carried out by KORA which was a coordinated research projects for the conservation and management of carnivores in Switzerland (Mettler 2005). KORA had three main targets including prevention, information and monitoring the wolves. 25 guard dogs which were mainly Great Pyrenees had been brought to different sheep flocks, some of them already before the start of the SWP. Moreover 8 shepherds and aid shepherds had been involved in the project in order to advice the farmers or to protect sheep flocks located in hot spots. At last, donkeys and electric fences had been used to protect smaller sheep flocks (Weber 2000).

In Switzerland shepherding was left to reduce the expenses since 1940s. At present sheep were free-ranging on alpine pastures and checked only once a week. In 2000s the wolf had returned only in the south of Switzerland in cantons of Valais, Tessin and Grisons. Between 1998 and 2003, 456 sheep and goats had been compensated as wolf kills. The carcasses are checked by a local gamekeeper. Officially, there were still about 3 to 6 wolves in the southern part of Switzerland in 2000s (Weber 2000).

The first LGDs were provided by two sheep owners who faced the first wolf attacks in 1995. They bought two Great Pyrenees pups in the Alps Maritime, Mercantour, and South of France in 1996. Between 1998 and 2003, 64 more LGDs were brought in flocks in Switzerland. KORA authorities acquired a total of 20 Great Pyrenees (10 females and 10 males, from three distinct regions) directly from France and four Maremma-Abruzzese dogs (Landry et al. 2005). The Maremma-Abruzzese originated from the Abruzze province, Italy, where its use as a LGD had been known for at least 2000 years (Lüthi and Mettler 2005). Every LGD was bred from working parents. KORA also provided 3 St-Bernard pups at the St- Bernard Hospice. They have received two Spanish Mastiffs and one Mioritic from a Romanian worker from Brasov as well. 42 pups were directly born in KORA project from 9 litters and 36 (19 females and 17 males) were introduced in flocks, the others in families. The wolves were quite rare in Switzerland, so it was impossible to estimate the effectiveness of the LGDs. However, sheep owners noticed that their dogs were very effective against foxes and ravens predation on lambs and against stray dogs (Landry et al. 2005).

On the other hand Maremmanos showed some deficiencies. Playfulness that leads to injuries and losses had been a common problem especially in young dogs and it must to be taken seriously. Mobbing and unbalanced social structure within a team of Maremmanos could be successfully controlled by removing or exchanging individual members of a team. Two Maremmanos had shown more attachment to people than to livestock and thus were insufficiently loyal and attentive to their flock. Some dogs roamed too far from the flock for possible reasons of being females in heat, hunting for wildlife, searching for food leftovers near huts or houses. Harassment of sick individuals that stayed behind or showed abnormal behavior had been observed in some cases mainly with dogs younger than 2 years. Some dogs showed too aggressive guarding behavior towards other dogs or people. Imported adult dogs coming from a different context should have been treated carefully, especially if it was unclear how the puppies have been raised (Lüthi and Mettler 2005).

Conclusion

In Europe livestock animals decreased after industrial revolution because of mechanization and industrialization year by year. Because of some reasons while pastoral areas were decreasing, urban areas were increased which caused smaller living areas for wild animals. On the other hand developed gun industry facilitated killing wild animals for hunting or other reasons. In most of European countries, large carnivores have decreased because of these reasons. Farmers tend to raise animals from extensive systems to intensive systems in order to get more yields by giving less feed or spend less money. At conclusion large carnivores have strong pressure on livestock animals in Europe.

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