Hedmark University College

Faculty of Applied Ecology and Agricultural Sciences

Slavomír Janda

Master Thesis

Gone to the dogs

Comparison of approaches to livestock protection against large carnivores in Slovakia and Norway

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Abstract

The use of livestock guardian dogs (LGDs) to prevent depredation is considered to be a powerful conservation strategy for the mitigation of conflicts between farmers and wildlife, and is currently on the rise worldwide. Despite all the potential of this management strategy, there are problems reported from several European countries where large carnivores reoccurred after their previous eradication. To elucidate possible obstacles for effective use of LGDs I have taken a holistic approach and analyzed different parts of carnivore-related conflicts of interest and their mitigation tools across several scientific fields. I focused on two countries: Norway, where carnivores were extirpated previously, husbandry changed, livestock losses are among the highest in Europe, and carnivore conflicts appear to be one of the top political problems; and Slovakia, where carnivores have always been part of everyday life, traditional husbandry techniques were never abandoned and livestock losses are negligible. Questionnaire surveys were undertaken in both countries with farmers known to employ LGDs in their operation, to compare differences and similarities in their husbandry practices, use of dogs and some of the factors known to play a role in the formation of attitudes towards large carnivores.

Since most losses on Norwegian sheep farms are caused by wolverine (*Gulo gulo*), a species that does not occur in Slovakia, and since Eurasian lynx (*Lynx lynx*) causes many losses in Norway but is rarely considered a threat by Slovak farmers, direct comparison between countries was challenging. However, despite much higher carnivore densities and a longer grazing season, the Slovak respondents suffered 10 times lower losses than their Norwegian colleagues. This is most likely a result of a combination of several factors, e.g. continuous coexistence with large carnivores, maintaining traditional husbandry, and a more effective use of LGDs in Slovakia. Differences in the attitudes of the farmers themselves and compensation systems for lost sheep may also have contributed to the country-specific losses. While Slovak farmers saw little profit in sheep farming and emphasized the importance of non-financial values as a reason for their profession, farmers in Norway considered profit as the most important reason for keeping sheep. Neither the number of carnivores, nor the extent of depredation appeared to be the key driving factor in forming farmers' attitudes towards large carnivores. With the exception of lynx, respondents in both countries shared the desire for reduced carnivore populations.

I suggest the promotion of the full potential that LGDs in combination with traditional husbandry methods requires active involvement of government in cooperation

with stakeholder groups in both countries. This may involve revisiting legislation and compensation process in Slovakia. In Norway, it may also require reconsideration of compensation system along with carnivore policy. Modifications of the Norwegian sheep farming system - at least in carnivore areas - seem inevitable to secure the national dual goal of having viable carnivore populations and maintaining livestock production and the cultural landscape.

Contents

1. Introduction

The domestication of livestock may be traced back some 12,000 years ago. No longer purely hunters of early wild cows, goats and sheep, livestock farmers became owners and masters of herds of tamed animals. These originally wild ruminants moved from being solely the prey of the wild carnivores that killed to live off their flesh to becoming prized possessions of farmers who used them for milk, meat, skin, hairs/wool, draught power, dung producers, tools (bones), musical instruments (horns) etc. A new competition arose between livestock farmers and carnivores. We have lived with this competition ever since, and farmers and societies have developed management tools to protect their domesticated livestock interests. These management techniques have partly relied on reducing wildlife populations to levels which livestock farmers could tolerate, and partly to develop conflict control methods whereby livestock and carnivores occupy different parts of the landscape (the agricultural landscape against the wilderness) or where carnivores are discouraged from approaching livestock (fences, shepherds, guard dogs).

Nevertheless, carnivores have had important roles in the spiritual lives of people, rural as well as urban dwellers. Some of these attitudes remain in our societies albeit sometimes in different forms from earlier: reverence, fear, desires for trophies, class manifestations. More recently animal ethics and the increasing importance of "back-to-the-land"-attitudes in the growing urban populations have combined with new ecological understanding of the role of carnivores in ecosystems to open up for revisiting many of the original assumptions of livestock-carnivore relations.

The central idea of this thesis is the comparison of approaches of European sheep farmers to livestock protection against large predators in areas of their permanent occurrence (Slovakia) and areas in which the predators were nearly extinct but recently re-established (Norway). Focus will primarily be on one protection method: the use of livestock guardian dogs. Their roles in livestock production systems will be elucidated both with reference to international literature, mainly from Europe and North America, and my collection of information from both countries through personal interviews and a questionnaire survey, mainly of Slovak and Norwegian sheep farmers.

2. Large carnivores, people, sheep and dogs – a historical review

The relationship between humans and large carnivores is as long as the history of humankind itself. Although it took different paths throughout the ages, from being our hunting teachers, spiritual guides and totem animals to competitors, enemies or even symbols of evil, it was always full of emotions. The problem of coexistence of humans and carnivores, with special emphasis on the wolf, in addition to damages, evokes various emotions in modern people just as it used to in our predecessors (Fascione, Delach & Smith 2004). Therefore, the solution of conflict situations are often affected by what may seem to be irrational elements. Transformation from hunter – gatherer lifestyle to pastoralism and agricultural lifestyle some 12 thousand years ago (Gignoux, Henn & Mountain 2011) brought a significant paradigm shift in human perception of nature (Find'o & Skuban 2011a). Wildlife animals became competitors and pests.

Once widespread, large carnivores were driven to extinction or very near to it in most of Europe as well as in North America (VerCauteren *et al.* 2013). Bounties, trapping and poisoning were common practices in the eradication campaign of nearly all European and American agricultural societies (Breitenmoser 1998; Lopez 2004). The parallel spread of human population along with expansion of cultivated land, forest destruction and overexploitation of natural prey, forced remaining predators to increasingly prey on growing numbers of domestic livestock, further exacerbating the conflict with humans (Breitenmoser 1998). By the early 20th century bear, wolf, lynx and wolverine were eradicated or down to low numbers in most developed countries. Elsewhere carnivores survived to the present, mainly due to early conservation efforts during the late 19th century. However, it was not before the second half of 20th century when some people started to realize the importance of top predators in ecosystems. Our knowledge about the importance of the top predators for health of ecosystems is now greater than ever. Through trophic interactions, top predators influence the entire landscape, preserve overall biodiversity (Fascione, Delach & Smith 2004) by restoring balance in their prey population, changing their behavior (Mao *et al.* 2005) and keeping it healthy. The extensive ongoing research conducted in Yellowstone National Park in the USA since the reintroduction of wolves in 1995 gives many examples of the importance of top predators. Ripple and Beschta (2006) documented over years improved floodplain functioning, stabilization of riverbanks, increased shading of streams

benefiting fish population and overall improve in food web and biodiversity. Baker *et al.* (2005) documented increased beaver population as a result of the wolves and Westbrook, Cooper and Baker (2011) explained how beavers influence the formation of alluvial valleys and riverine landscapes. Monbiot (2013), in his talk at TEDglobal 2013, explains "How wolves can alter the course of rivers". Under the accumulated scientific evidence, it would be hard to argue that return of the wolves to Yellowstone was not beneficial (Fascione, Delach & Smith 2004). The total financial benefit was estimated between $6 and $8.9 million annually (Chambers & Whitehead 2003), however, the spread of wolves out from Yellowstone National Park has been of concern of nearby livestock farmers. Increasing the number of wolves in YNP beyond the original agreements with neighboring farmers and ranchers has created new tensions: see Lopez (2004). More complex studies about the benefits of wolves was done for example by Weiss *et al.* (2007), for importance of large carnivores see also Miller *et al.* (2001). Carnivore predation has been associated for example with reduction of browsing damage in forest (Voskár 1976; 1993), more viable red deer (*Cervus elaphus*) (Mrkva 2001) and roe deer (*Capreolus capreolus*) (Červený 2006) populations and prevention of spread of diseases (Voskár 1993; Strnádová 2000; Finďo 2002; 2003).

2.1 The Human-Carnivore conflict

As a result of growing environmental awareness and implementation of conservation tools into national and international policies and treaties, carnivore populations began to re-occupy the areas of their original distribution in Europe and North America. Although it was only a gap of a few decades, the country sides into which they have returned had changed (Broggi 2009). New agricultural and forestry practices as well as game management resulted in lands full of food resources easily and quickly accessible to the predators thanks to extensive infrastructure of forest roads and highly predictable occurrence of prey due to omnipresent fragmentation. Strange as it is, there is only negligible evidence of anyone foreseeing the consequences or taking preventive measures to mitigate inevitable conflicts between human and carnivores (Breitenmoser 1998; Zimmermann, Wabakken & Dötterer 2001). We prepared legislation, unintentionally even habitats but we forgot to prepare ourselves. The return of large carnivores into the modern world brought new situations and challenges to people who have partially or completely lost contact with these top predators. Wildlife managers found themselves in a completely new situation where the protection of

carnivores depends not only on biological conditions but more and more on a sociopolitical situation (Treves & Karanth 2003). Human behavior, always changing in space and time according to changes in values and society (Bisi *et al.* 2007) is a decisive factor for large carnivore numbers and distribution in most parts of the world (Herfindal *et al.* 2005; Andrén *et al.* 2006). Carnivore-free land caused significant changes of livestock husbandry practices, especially sheep, goat and cattle farming in many western countries (Kaczensky 1999; Garde 2011). Without predation risk, even anti-predatory behavior of both wild and domestic animals has changed. Periods without carnivores led to less labor-intensive ranching since it was no longer necessary to protect herds from predation. Only a few decades were enough to change centuries old ways and practices of pastoral life where part of the shepherd obligations was not only to care about the health of livestock and grazing, but protect them from thieves and predators as well. Protection was ensured by the presence of shepherds, whose duty was to guard the flock continuously with the help of their accomplices - livestock guardian dogs.

There appears to be significant difference in the current approach of farmers to the protection of their livestock. It is necessary to distinguish between regions (countries), where the carnivores were eradicated and only recently returned, and the areas where they have never been extinct (Oli, Taylor & Rogers 1994; Kaczensky 1996). In the first case the return to protection of farm animals against carnivores is a daunting task (Naughton-Treves, Grossberg & Treves 2003; Chapron *et al.* 2014). Sheep farming has changed dramatically. In the spring, animals are taken on their summer grazing areas, where they are left alone, unsupervised by shepherd and without any additional protection. Sheep are not aggregated into a cohesive herd, but are scattered over large, often forested area where they are very easy prey. We meet with situations that farmers are reluctant to reopen the protection of their herds and insist on eradication of predators in order to avoid changing their established and simplified system of farming.

However, this approach runs counter to current trends in biodiversity conservation and nature protection as such. International conventions and national laws on the protection of fauna along with large public support for carnivores already barred the eradication alternative (Gehring, VerCauteren & Landry 2010). The only available tool is regulation along the lines of selected rules, which is most commonly implemented as system of established hunting quotas. Partial hunting is permitted only if it does not threaten the viability of carnivore populations or is aimed at removal of certain troublemaking individuals. In the lands where free grazing husbandry systems are practiced, domestic

animals are easily accessible and carnivores do not need to develop special skills to hunt them down. Under such management, all of the carnivores are potentially troublemakers (Linnell *et al.* 1999).

Free grazing system is seen by some as offending the principles of animal welfare. Sheep as domestic animal are not adapted to survival in the wild without care by the farmer. This leads to losses not only due to predation, but also to diseases and other adverse circumstances. The extent, composition and real impact of different causes of death is largely unknown. In areas where carnivores were never extinct, the relationship of the farmer to his livestock is fundamentally different. In this case, there were no such radical changes in people's attitudes. Shepherds are responsible for the safety of the flock 24 hours a day, usually assisted by livestock guardian dogs and herding dogs.

Modern methods such electric fencing may contribute additional help, however their effect is often controversial and short term (Shivik 2006). Wam, Dokk and Hjeljord (2004) showed that wolf attacks on sheep herds in traditional fencing were 5 – 6 times higher compared to fences improved with electric wires, but the lasting effect is unknown. The experiment also revealed that electric fences were not properly installed on 99% of the farms, due to time-consuming maintenance. Authors argued that weak points in fences might be quickly discovered and used by wolves, compromising the effectiveness of the electrical fences in the whole area, as such fence is more a psychological than a physiological barrier. Similarly, Poole, Western and McKillop (2004) argued that animals which learned to cross electrical fences while inoperative are likely to keep this habit despite electric shock in the future. In another study, Musiani *et al.* (2003) found that week points in fladry installations were indeed used by wolves. The research team also confirmed only short-term efficiency of the boundary conditioned by presence of alternative prey and novelty of the barrier. Effectiveness might also be caused partly due to increased human activity (Harper *et al.* 2008). First years after several "predator-proof" fence installations in Norway, none was well functioning and losses were even higher than they would be without the fence (Skogen 2015). In addition to their high cost, labor intensiveness and often limited temporal function, fences have ecological and ethical cost and should be considered only a short-term solution while more sustainable methods are identified (Hayward & Kerley 2009). Despite the fact that in the recent past several modern methods of protective equipment were developed, in terms of practical use on a larger scale they are still not suitable for the protection of livestock on pasture against large carnivores (Treves & Karanth 2003). They are either

unavailable to the ordinary farmer (on market or financially) or cannot be applied in a particular farming system (Rigg *et al.* 2011).

Systems of compensation payments for losses associated with protection of large carnivores are used worldwide as a part of management to mitigate the negative aspects of living alongside carnivores (Dickman, Macdonald & Macdonald 2011). Schemes and conditions for subsidies may differ considerably between individual countries, but usually consists of ex-post payments for direct losses to depredation or damage to property and financial contributions for preventive measures. Although substantial amounts of money are often invested in these programs, only rarely are they evaluated in terms of their impact on human attitudes towards carnivores (Vynne 2009; Karlsson & Sjöström 2011). Evidence from evaluation studies often range across the whole spectrum, from being beneficial to even detrimental. While Karlsson and Sjöström (2011) directly associated subsidies to preventive measures with increased tolerance for local wolf presence and considered them to be an effective tool for human dimensions of conservation biology, Naughton-Treves, Grossberg and Treves (2003) reported no effect of compensations on farmer attitudes towards wolves. Dickman, Macdonald and Macdonald (2011) concluded that it is unlikely for such schemes to create long-term benefits for conservation. When poorly designed, subsidies might even create perverse incentives and motivate people to overestimate their actual losses or decrease motivation for livestock protection in order to obtain financial compensation for depredation (Naughton-Treves, Grossberg & Treves 2003; Nyhus *et al.* 2003; Dickman, Macdonald & Macdonald 2011). Dickman (2009) found that initially reported depredation events were nearly five times overestimated and that similar scenarios were reported in studies across the globe. Farmers often consider compensations to be inadequate compared to the value of their animals (Naughton-Treves, Grossberg & Treves 2003). Compensations might also send an unwanted message to the public supporting the perception of predators as widespread livestock killers and thus hinder conservation efforts (Berger 2006). Therefore development of effective compensation schemes must be planned carefully and take into account community impacts and perspectives (Hill 2004; Vynne 2009), but see Dickman, Macdonald and Macdonald (2011) for a detailed review of financial instruments used to tackle human-carnivore conflicts and recommendations for best practice. A promising alternative to common ex-post payments was introduced in Sweden in 1996. A performance payment scheme where monetary compensation is paid for expected damage the carnivore offspring might cause throughout their life, not for actual losses. It is then up to farmers to find ways

to coexist with large carnivores and maintain their numbers. For more detailed description see Zabel and Holm-Müller (2008).

2.2 A major tool employed by sheep farmers has been the use of livestock guarding dogs

The origin of livestock guarding dogs (LGDs) is most likely somewhere in wide steppes and hills of the Middle East. From here, they continuously spread with nomadic tribes to new areas. The oldest archeological evidence of dogs from these areas dates back some 12 – 13 thousand of years (Finďo & Skuban 2011a) and the shepherding tradition has remained intact until today. The fact that they have been used successfully for thousands of years to protect wandering flocks of sheep and goats in Asia and Europe from thieves and depredation is undeniable evidence of effectiveness of this method. There is also a mounting scientific evidence that LGDs can dramatically reduce or completely eliminate livestock depredation (Green & Woodruff 1980; Blanco, Reig & de la Cuesta 1992; Rigg 2001; 2004) and has potential to be the ultimate tool for better coexistence of human with wildlife (Shivik 2006; Gehring, VerCauteren & Landry 2010). Published literature reports reduction of losses between 11 – 100% (Coppinger *et al.* 1988; Smith *et al.* 2000; Ribeiro & Petrucci-Fonseca 2004; Van Bommel 2013). An important aspect regarding mitigation of losses is that free ranging LGDs protecting their flock has a likely potential to prevent incidents of surplus killing (Mertens & Promberger 2001; Rigg 2004; Rigg *et al.* 2011). Instances of this behavior has been showed for many carnivore species (Linnell *et al.* 1999) and usually are picked by mainstream media as a sensation as many animals might be killed during a single attack. Such incidents might then have substantial impact on the development of negative public attitudes towards large carnivore species, since the critic is rarely focused on inadequate herd protection, but rather on bloodthirsty carnivore (Finďo & Skuban 2011a). Application of LGDs has not only the potential of dampening depredation but also reduction of stress levels in domestic animals, which contributes not only to increased animal welfare, but likely also to increase in productivity of livestock (Landry *et al.* 2005; Van Bommel 2013). Low losses give fewer reasons for human-carnivore conflict. This directly limits the need for lethal management and most likely the levels of poaching (Potgieter 2011), allowing more space for successful conservation efforts. Application of LGDs with various breeds of livestock has potential for preventing the spread of disease between livestock and wildlife (Vercauteren, Lavelle & Phillips 2008; Gehring *et al.* 2011; VerCauteren *et al.*

2012), offer farmers relative independence from carnivore policy and provide them with a tool for integration into carnivore management and thus becoming an active stakeholder group (Gehring & Potter 2005). This might strengthen farmers' internal focus of control, which is considered to be important in forming attitudes towards large carnivores (Bjerke, Vitterso & Kaltenborn 2000). The tolerance of humans to the subject of conservation is very important part of its success. Some of the most needed tools for predator conservation are the social ones (Shivik 2006).

Because LGDs function as a dynamic fence, the need to set up physical fences is also reduced. This bring us to the economic efficiency of LGDs. Apart from directly quantifiable components of this management strategy, it is necessary to take into account also the indirect components that are often very difficult to quantify. What is the financial value of peace of mind, unfenced land or animal welfare? In general the use of LGDs is considered to be relatively low cost (Gehring, VerCauteren & Landry 2010). Economical cost-benefit evaluations of LGD efficiency from many countries in the world are mostly positive. Not only from countries with low wages like Namibia (Marker, Dickman & Schumann 2005; Potgieter 2011) or countries in West Africa (Rust, Whitehouse-Tedd & MacMillan 2013), but also in USA (Andelt & Hopper 2000; Vercauteren, Lavelle & Phillips 2008) and partly in Switzerland (Landry *et al.* 2005). On the other hand, the traditional use of LGDs in Norway is considered too expensive (Hansen 2005).

Dogs accompany their herds day and night, attentive to any potential threat, which they will announce with loud barking and display of threatening behavior. Physical confrontation occurs only rarely. Carnivores instinctively avoid the risk of injury in confrontation with LGDs and do not attempt to take livestock when costs might be higher than the gain (Find'o & Skuban 2011a). In most situations this is enough to discourage carnivores from attacking livestock (Coppinger *et al.* 1988). In addition, dogs display territorial behavior, which often further excludes the predators away from the flock. In this manner the dogs guarding livestock are not only ultimate disruptive stimuli, but have a potential to become a very effective aversion stimulus and provide both biological and psychological benefits (Shivik 2006). Farmers in this study provided many anecdotal stories how well they can rest knowing that dogs keep watch. Similar observations are also reported by Gehring, VerCauteren and Landry (2010).

The change of animal husbandry in lands free of large carnivores simplified farming practices and made for more comfortable lives for farmers who had one big problem less to worry about. These changes over the years caused not only changes in farmers' behavior but

also to changes in behavior of both livestock and wild animals. In population ecology it is often referred as "naive prey" when wildlife is facing predation after long gap. The loss of proper anti-predatory behavior is not caused only by carnivores not present in the land, but probably also by selective management done by human hunters (Allendorf *et al.* 2008). The way of hunting moose (*Alces alces*) in Norway might be a good example of this. Norwegians hunt moose with help of moose dogs. The dog is loose, tracking down the moose attempting to make him stand the ground and face the dog(s). Under the wolf attack, this would be the proper behavior leading to higher chances of surviving the wolf attack (MacNulty 2002). Under the human management, however, this moose is shot. Hunting selectively may therefore remove the animals with proper anti-predatory behavior. Once wolves returned to Norway, their hunting success is remarkable compared to regions where wolves never disappeared. Sand *et al.* (2006) found 4 – 5 times higher rate of success of Scandinavian wolves compared to those in North America. Similarly Berger, Swenson and Persson (2001) found that bears recolonizing Norway fed on moose carcasses more than twice as much as their counterparts from the source population and same pattern in North America. Prey usually re-adapt swiftly to predation and the anti-predatory behavior might reoccur already after one generation (Berger, Swenson & Persson 2001), but this did not happen in Norway. The reason is most likely besides a long period without wolf predation, strong human management of moose population (Sand *et al.* 2006). It seems like human actions have far wider impact on our environment than we ever realized. We do not change only wildlife numbers, demography and distribution but also their behavior. In the land of naive prey it is even likely for wolves to make rather new kills instead of fully utilizing the old one (Zimmermann *et al.* 2007; Sand *et al.* 2008).

In this light, the concept of "naive prey" is probably applicable to the predators as well. We might see them as "naive" to the land they returned to, being unaware of the fact that some of the resources (livestock) are considered to be property of the competitor (man). A land full of livestock grazing without any protection gives us no means how to communicate our claim over this resource to carnivores. Proper herding of animals by man accompanied with livestock protection dogs on the other hand is a clear message to the carnivores communicating the ownership and "the rules of the game". The livestock losses in countries where herd protection practices were never abandoned are much lower compared to countries where carnivores were eradicated even if the protection is not done properly. A good example of this comes from Slovakia where a man is always present by the sheep flock, however the LGDs are often used only around night penning being chained. Such

LGD with restricted movement has very limited ability to protect the flock and there are many stories how wolf or bear sneaked in between chained dogs. These practices may also lead to aggressive and frightful dogs further reinforcing believes that LGDs are aggressive and dangerous to people. There is a saying among farmers from carnivore areas that "the best carnivore is the educated one". Indeed, considering the learning ability of animals, especially carnivores and the theory of optimal foraging, it is easy to see the local wisdom of this saying also from the broader ecological perspective. The evidence of learned predation behavior is not only reported by shepherds and farmers (this study), but also in further scientific research. Harper, Paul and Mech (2005) showed that wolves in Minnesota might specialize on livestock. Similar observations are reported by Linnell *et al.* (1999). Just like carnivores influence and change behavior of their prey, LGDs if used properly to guard livestock over the land might influence and change predatory behavior of carnivores. Evidence that conditioned behavioral changes might remain in the population even after the individuals with direct negative experience were removed from the test group provides for example Stephenson (1967). The constant presence of shepherd and/or LGD with the flock might in this sense induce a "landscape of fear" associated with livestock, see Støen *et al.* (2015) for details. In addition, the foraging habits are learned by parents, hence individuals not thought to attack livestock are less likely to do it in the future (Skuban 2005). Several studies around the world confirmed that carnivores responsible for livestock depredation represent only a small part of their population: see for example Jedrzejewski *et al.* (2003), Treves *et al.* (2003), or Stahl *et al.* (2001). Successful attack on domestic animals means increased risk of predation in that area or inflicted farm in the future (Karlsson & Johansson 2010; Finďo & Skuban 2011a). Carnivore habituation for livestock meat is possibly created also by inappropriate disposal of carcasses near the farms. Such food resources are allurement for carnivore species, which again leads to increased risk of predation (Kalaš 2011).

Lethal control of wolves was even associated with increased levels of depredation in the following year (Musiani *et al.* 2005; Harper *et al.* 2008; Wielgus & Peebles 2014). Wielgus and Peebles (2014) found that for each additional wolf removed by lethal control management the expected mean depredation increased by 4 – 6%, and they explained this effect with social disruption of the wolf pack, compensatory effects, smaller pack size and reduced effective prey use. The same explanation for increased livestock depredation by wolf after intense persecutions is also observed by Voskár (1976); (1993). Similarly Zimmermann (2014) found that small packs (2 – 4 wolves) killed more than 3 times than

they would require to sustain their daily energy needs, while large packs appear to be food limited in Scandinavia. Also others consider lethal management of large carnivores only a short term solution because the abandoned territories will be quickly filled by new individuals (Gehring *et al.* 2003; Herfindal *et al.* 2005; Odden *et al.* 2010) and if preventive measures won't be implemented into husbandry, the predation will resume (Rigg 2004). Considering that a wide array of the public is in support of non-lethal management and recent research has pointed out its inefficiency and often high costs, lack of alternative modern methods to protect livestock and need to preserve sustainable populations of large carnivores, the use of LGDs seems to be an option offering the win-win scenario.

The use of livestock guardian dogs is currently undergoing its renaissance in many countries around the world. This thousands-of-years-old method once widely used by all pastoralist cultures, almost ceased to exist in the modern, fast developing world (Gehring, VerCauteren & Landry 2010; VerCauteren *et al.* 2013). LGD in the system of modern farming have had and will most likely have its justification, especially in the areas where large carnivores are present, but their role, compared to their traditional use in the distant past has been partially changed. These dogs are indispensable in protecting the flock against the attacks of large carnivores on grazing animals where other (new) technical methods are not applicable. A fundamental requirement for LGD is now non-aggressive behavior towards human strangers near the herd. Compared with the past, there are now many more visitors to nature and summer pastures. Not all these visitors know how to properly treat the guard dog, so they can provoke an attack with serious consequences. Raising LGD is not an easy task and requires devotion, time and financial investments which are not always affordable for farmers in many countries where the current state of agriculture presses them towards intensification and lowering of investments. The problems with LGDs like for example roaming, harassing of livestock, wildlife and people are well acknowledged and solutions for correction of unwanted behavior are accessible in form of professional advice and technical solutions (electric collars, invisible fences…) in most of western countries and Africa. The instances of undesirable behavior are rather rare and mostly linked to inappropriate handling. See for example Landry *et al.* (2005), Finďo and Skuban (2011a) or Rigg (2004) for problems encountered during LGDs projects and remedy recommendations.

2.3 Human dimension point of view

The process of environmental awakening, by some called New Environmental Paradigm started to gain importance slowly throughout the world. As part of this process environmental policies started to change and through employment of conservation laws, international treaties and reintroduction projects, numbers of large carnivore populations begun to rise once again (Chapron *et al.* 2014). Many countries, however, underestimated the inevitable clash of interest groups and rise of conflicts (Breitenmoser 1998; Zimmermann, Wabakken & Dötterer 2001). We cannot simply call it a human – carnivore conflict. More often, it appears to be a human – human conflict over large carnivore policies and socio-political struggle. Carnivores, especially wolves, became a symbol of urban dominance over the countryside (Ericsson & Heberlein 2003; Treves & Karanth 2003; Bisi *et al.* 2007; Skogen & Thrane 2007) or symbol of human persecution and exploitation of wildlife (Bjerke, Reitan & Kellert 1998) and their real impact on our environment does not play significant role in attitude shaping. Karlsson and Sjöström (2011), for example, found no association between number of wolf attacks on sheep and dogs and human attitudes towards the wolves in Sweden. Similarly Naughton-Treves, Grossberg and Treves (2003) argued that social group rather than individual experience with wolves, their numbers or depredation frequency, played an important role for attitudes. The fact that livestock losses to predation are in most countries almost negligible in comparison with loses to parasites, diseases or accidents (Robel *et al.* 1981; Dickman 2009) also supports this theory. Despite this, livestock losses are one of the most used arguments against carnivores and were determined as one of the key driver for negative attitudes (Kaczensky 1999; Linnell *et al.* 1999; Ribeiro & Petrucci-Fonseca 2004; Dickman 2009). Our failure to predict upcoming troubles, our underestimation or negligence in taking preventive measures, gave rise to strong antagonism towards large carnivores among some interest groups. This is often a direct obstacle to implementing measures for sustainable coexistence between humans and wildlife. The most active groups in the human-carnivore conflicts are nature conservation, hunting, agricultural and landowner organizations (Skogen & Krange 2003; Blekesaune & Rønningen 2010). Major groups opposing the carnivores are hunters and farmers (Breitenmoser 1998). Depending on the social and political structure, historical development and economy, different interest groups in different countries do have not only different impact on policymaking and public opinion but also different perception of natural landscape (Skogen & Thrane 2007). Media often report only sensational tragedies regarding predation

incidents which stir the emotions and further strengthen opposition towards carnivores (Breitenmoser 1998; Røskaft *et al.* 2003) but do not help with solving the situation (Finďo & Skuban 2011a). As humans relate to wildlife at an emotional level, Manfredo (2008) advises the managers to consider it seriously. Emotions are not only linking human together with our world, but also to the social groups. They are important for making decisions, changing attitudes, shaping our memory, function as a barometer of things that are important to people, operate as sanctions to ensure normative behavior and are tied with our values and value orientations (Manfredo 2008).

Another theory suggests that continuous historical presence of large carnivores in the country plays significant role on people's attitudes towards large carnivores and conservation efforts might meet higher acceptance than in countries where large carnivores were extinct for several decades (Broggi 2009). Simply, the broken bond is much more difficult to repair. Humans have often tendencies to be afraid of the unknown, so people who lost contact with large carnivores are expected to be more reluctant in their acceptance. Direct experience with large carnivores may reduce the fear (Zimmermann, Wabakken & Dötterer 2001; Røskaft *et al.* 2003; Bisi *et al.* 2007), however, this may not necessarily influence other aspects of antagonism (Røskaft *et al.* 2003). For example, people living in rural areas with presence of large carnivores tend to be generally more negative towards them than people from urban areas (Røskaft 2007; Broggi 2009; Blekesaune & Rønningen 2010). However, even in these communities the population varies greatly in their views on predators (Bjerke, Reitan & Kellert 1998; Skogen, Krange & Figari 2013).

Public surveys about the attitudes towards large carnivores might often be misleading in these countries as attitudes of people with no or little experience with the topic have usually weak horizontal structure and are relatively easily swayed (Manfredo 2008). A good example of this comes from Sweden, where hunters were strongly in favor of protection of wolves in the 1970s, however their attitudes have changed after living with wolves to being less supportive than the general public (Ericsson & Heberlein 2003). Similar change in attitudes of local residents, mostly hunters after 5 – 8 years of living with wolves, was shown in Wisconsin, USA (Treves, Naughton-Treves & Shelley 2013). Also other studies defined hunters from wolf areas as those with predominantly negative attitudes towards large carnivores (Bjerke, Vitterso & Kaltenborn 2000; Skogen & Krange 2003; Bisi *et al.* 2007) but this is not always so (Bjerke, Reitan & Kellert 1998; Williams, Ericsson & Heberlein 2002). In many countries, hunters might represent a strong political lobby and influence the legislation to counteract the conservation efforts. In addition, they are the ones most likely to

take part in illegal hunting. Poaching represents a serious threat for species with large territories and relative rare occurrence like large carnivores. In Norway represents poaching probably as much as half of wolf (Liberg *et al.* 2011), lynx (Andrén *et al.* 2006) and wolverine (Persson, Ericsson & Segerström 2009) total mortality.

While the potential threat of wolf aggression towards man is negligible when comparing with the bear (McNay 2002), other large carnivores or wildlife in general, it is still the fear of the wolf often reported from the people living within the wolf areas (Linnell *et al.* 2002; Blekesaune & Rønningen 2010). It might be sensible to assume that fear expressed towards the wolf actually represent different levels of the conflict.

Indeed emerging evidence from social science research points out that so called human-carnivore conflict is often conflict between urban people and people living in the countryside (Skogen & Thrane 2007). While people living in cities view carnivores in more "romantic" ways and the rural areas as wilderness, rural people have often different views and consider their surroundings as manageable resources and cultural landscape (Breitenmoser 1998; Skogen & Thrane 2007). As these people often live off the land and livestock losses have direct influence on their livelihood, it is understandable that they are often the ones with most negative attitudes towards conservation of large carnivores. Shifting power over the land use to central political authorities, economic and social differences may then support the feeling of being marginalized (Bjerke, Vitterso & Kaltenborn 2000; Skogen & Haaland 2001) and conflict take on new, often hidden features (Barua, Bhagwat & Jadhav 2013). The antagonism of rural people against perceived or real centralism where all the "bad" comes from the capital, whether it be Brussels or Oslo, is likely to play an important role in the conflict and rejection of large carnivores might be based on deeply rooted idea of the "enemy outside" (Broggi 2009). In addition, the place where people grew up, social background, socioeconomic status and other demographic features are considered to play role in attitudes towards large carnivores (Blekesaune & Rønningen 2010). Other studies on human-carnivore attitudes considers as important factors perceived risk (Naughton-Treves, Grossberg & Treves 2003; Hill 2004), occupation (Kaltenborn *et al.* 1999), external locus of control (Bjerke, Vitterso & Kaltenborn 2000), cultural and religious believes, vicinity to protected areas (Dickman 2009), wealth (Naughton-Treves & Treves 2005) and many others.

The controversy, strength and complexity of human-carnivore conflicts have attracted many researches and there is a clear need for cooperation across several scientific fields. Knowledge about population dynamics and estimates or economic impact of large

carnivores is necessary but alone cannot find solutions for mitigation of the conflict. Human dimension research may shed light on the complexity of underlying aspects of conflict but in order to develop sustainable, long-terms solutions, it is necessary to bridge this knowledge gap and apply it to the management (Breitenmoser 1998; Treves & Karanth 2003; Barua, Bhagwat & Jadhav 2013).

3. Situation in Norway

Since around 1970, the functionally extinct Scandinavian wolf population started to slowly recover through in-migration of wolves of Finnish/Russian origin but remained in the single-digit range until around 1991 (Wabakken *et al.* 2001; Ericsson & Heberlein 2003). Return of the wolves, along with increasing population of other large carnivore species, sparked intensive debates and a greatly polarized society. Carnivore-livestock conflict increased dramatically over last decades and large carnivores appear to be one of the major political issues (Kaltenborn *et al.* 1999).

Out of roughly 2 million sheep released to summer pastures, around 125 - 130 thousand sheep are lost yearly (Statens landbruksforvaltning 2008; Hansen & Rødven 2013). About 45% of these losses are claimed to be consequence of depredation, about 30% are compensated (Holien, Stornes & Ystad 2014) by sums between 61 – 77.5 million Norwegian kroner every year (Hansen & Rødven 2013). Although the total amount of sheep grazing in outlying fields is quite stable over the last thirty years, the losses were steadily raising roughly until year 2000. While total losses represented 4.1% in period 1985-1989, it was 4.4% in 1990-94, 5.7% in 1995-99 and 6% in 2000-2003 (Asheim & Eik 2005). After 2000, losses have stabilized at around 6% (Statens landbruksforvaltning 2009), more precisely 3.1% ewes and 7.7% lambs (Mabille *et al.* 2015a).

Unlike most European countries, Norway does not have its national LGD breed nor a tradition of this use of dogs. Livestock was traditionally herded and protected by children and youth (Skurdal 1997), but this tradition disappeared after the end of 2nd World War (Krogstad *et al.* 2000). Extremely low carnivore density allowed for change in livestock husbandry to a free grazing system. Sheep in the spring, after short period on fenced outer fields, are released to outdoor pastures comprised mainly of forest and alpine tundra, where they are left with no guard and limited supervision until autumn collection. This system allowed for best utilization of open range resources and good growth rates among lambs. Norwegian sheep breeds were developed to avoid flocking and to scatter widely to use good, but scattered grazing resources. On the other hand, farmers have limited possibilities to control and protect their animals. The legal minimum is a weekly visit to the sheep, which, however, are widely scattered and inspection of all animals is impossible. This extensive husbandry system, although very likely incompatible with the return of the carnivores, did not change in Norway. As a result, the losses of livestock in Norway are among the highest

in Europe. Government spend on compensation for bear depredation 1.5M € (which is more than all European countries together), between 2.7 – 3.8M € for sheep and 1.8 – 2.2M € for reindeer losses to wolverine, up to 5M € for lynx and 120.000 – 430.000 € for wolf yearly (Kaczensky *et al.* 2013a). Current estimates are 136 brown bears, 343 adult wolverines, 350 lynx and 80 wolves, out of which 50 are part of a shared population with Sweden (Source: Rovdata). Still, the attempts to adopt other than lethal mitigating measures have been rather rare (Bjøru, Mogstad & Jetne 2002).

The implementation of LGDs into Norway began with the series of experiments led by Bioforsk Nord in the middle of 90s. The same process in USA took some 10 – 15 years before farmers started to accept LGDs as a mean for protection of their herds, however it has been around 20 years in Norway and not much has happened since initial trials despite all the effort invested. Three main research projects testing several possible ways of implementation of LGDs into Norwegian husbandry system showed that most of them have potential to reduce livestock losses (Sandmo 2010) and none of the methods is cost effective (Hansen 2005).

Although the traditional method of use of LGDs along with herding and night penning was proved as most effective with statistically significant loss reduction (Krogstad *et al.* 2000; Nilsen, Hansen & Christansen 2003; Hansen 2005), it is currently not recommended due to its time and labor requirements and incompatibility with the Norwegian husbandry system. Also the use of independent free ranging LGDs without shepherd was excluded from recommended methods (Hansen 2006). The methods evaluated as appropriate for Norwegian conditions are use of free ranging dogs within fenced areas and patrolling grazing areas with LGD under field inspector supervision. Both methods and their combination are being used and are financially subsidized in Norway (Hansen 2010b). All methods evaluated are described in detail in Nilsen, Hansen and Christansen (2003) and Hansen (2005). While the first method requires less time/labor investment and is more loss-reduction effective, it is limited by the need of fences and most suitable for short periods in spring and autumn, while sheep are kept in valleys. Fencing off large areas of open range pastures in Norway is rare, very expensive and hardly accepted by the public, creating further polarization of society (Skogen, Krange & Figari 2013). It also requires areas with suitable size and forage quality (Andersen *et al.* 2003). Such areas, if available, are however preferably used for production of crops or winter fodder for livestock.

The second method was developed to be compatible with the current husbandry system. The pioneering studies soon showed the importance of LGDs quality, its proper rearing and area size limitation (Hansen, Staaland & Ringsø 2002). With new expertise, follow-up projects showed better results. After locating the depredation hot spots in grazing area, losses were reduced by 44% in final third year of guard dog trial in Ringebu (Smestad 2015, pers. communication), although in most grazing areas the total losses were reduced by 10 – 15% (Hansen, Christansen & Linnell 2010). During a three years trial in county Lierne, the losses had been brought down from an average of 37% to 31% in first, 11% in second and 9% in third year of patrolling (Sandmo 2010). As described in Hansen (2010b), the loss reduction is achieved by a range inspector systematically patrolling grazing areas with free ranging LGDs during hours when probability of predation is highest. LGDs track not only carnivores, but also sheep, which helps to find sick, injured and killed individuals. This method is recommended in Norway for areas with predation losses lower than 15% with a size of 10 – 12 km^2 for one man-dog unit. The true effectiveness is difficult to quantify since it is usually used in combination with other preventive measures, like late release of sheep in spring and early collection in autumn. Also, there is large spatio-temporal variation in losses (Kaltenborn *et al.* 1999; Hansen & Rødven 2013). The reasons may be relatively low carnivore density and intensive carnivore management in parts of land prioritized for sheep industry. This leaves the land full of potentially vacant territories for migrating individuals.

Detailed guides for use of LGDs in Norway were published by Hansen, Christansen and Linnell (2010) and Hansen (2010a).

Most opposition to the use of LGDs in Norway seems to come from inside the farming community itself (Hansen 2005). Among the most highlighted arguments against the implementation of this method in Norway are high costs and sheep breeds with poor flocking instincts. Further arguments against flocking of sheep are poor grazing conditions in Norway, necessitating a spread-out grazing pattern and higher risk of parasite related diseases among sheep concentrated into cohesive herds (Asheim & Eik 2005). Indirect effects of LGDs (and other alternative loss mitigation tools) in the form of damage displacement where lowering losses at one farm might then lead to increased losses in neighboring farm were also suggested as an argument against (Flaten & Kleppa 1999; Asheim & Eik 2005; Asheim & Mysterud 2005). Direct experience gained through various LGD projects in Norway however often contradicts these claims. Although such management techniques have been showed to lead to lower body-mass growth among the lambs, the important part of this negative trend might been caused by the novelty of

husbandry change (Krogstad *et al.* 2000). Krogstad further found that use of portable night penning limits the negative effects and argues that after some time sheep will likely adjust to different grazing regime under herding and that body-mass growth could be even increased with good knowledge of pastures. To similar conclusions came for example Lombardi (2005). Employment of rotational grazing systems and portable night penning may also limit possible negative influences of high concentration of animals in area, like uneven transfer of organic and nutrient matter over the pastures (Cugno & Lombardi 2004). The losses related to diseases and injuries in flock herded during the day and kept in fences during night were 3.9% in the first year with downward trend of 2.2% in second and only 1.2% in final third year (Krogstad *et al.* 2000). In comparison, normal lamb loss to diseases in free grazing flocks is between 4 – 7% (Kvam *et al.* 1999). Several sheep breeds tested throughout LGD projects got used to herding after relatively short period (Krogstad *et al.* 2000). It is difficult to assess how much is the flocking behavior influenced by instincts or by learned behavior. Despite many generations of herding traditions, Slovak farmers in this study reported that lambs and young sheep must be trained to walk with the flock.

Despite quite good results achieved through projects, LGDs were not accepted widely by the sheep farming community in Norway. As a result, more recent projects focused on testing other alternative methods. With goal for mitigation of human carnivore conflict and raising animal welfare, trials with increased supervision on open-range fields (*forsterket tilsyn på utmarksbeite*) in 2007 – 2008 and a project with focus on radio bells and electronic tag readers (*Nasjonalt beiteprosjekt*) in 2009 – 2012 were carried out. Both projects showed some positive results but not enough to become a nation-wide solution. The main goal of the first project was to gain more knowledge about livestock losses on open range pastures, what kind of losses and what are the typical causes (Statens landbruksforvaltning 2008). Since it proved difficult to find carcasses and document causes of death despite the increased effort in patrolling grazing areas, the second project could be seen as its extension. The main idea behind both methods was to gain more information about movement of sheep and to find killed animals. In this way, the farmer gets a better overview of the situation, which allows him or her to react more swiftly. In addition, in order to be eligible for compensation of losses to protected large carnivores, farmers must document at least 10% of losses claimed as killed by these species. Professional field inspectors, appointed by the authorities, are called to found carcasses to assess cause of death. Many farmers are not able to find carcasses, especially in areas where wolverine is the main predator. Often carcasses found are too old to confirm cause of death. Mabille *et al.*

(2015b) using 11 years of data reported that carcasses found and confirmed as killed by predators represented only 2.8% of lambs and 6.4% of ewes of all losses claimed to be killed in Norway. As a result, it is not only very difficult to estimate the real extent of depredation, but many farmers do not get compensation and suffer huge financial losses. Since confirmation of at least 10% of losses claimed as carnivore kill is the only condition for compensation, projects aimed to find carcasses appear to be more popular among farmers than LGDs. Despite their limited effectiveness regarding losses prevention and animal welfare in comparison with traditional techniques, such projects are important for establishment of working relationships with local communities, which may help to overcome intolerance issues (Ribeiro & Petrucci-Fonseca 2004).

Unlike traditional methods, these approaches do not install the condition to prevent losses by disturbing and/or changing the predatory behavior. Information about movement of sheep provides means to more precise and time effective supervision over animals with positive influence on animal welfare, but loss-reducing effect is only indirect. Management tools available are still only exclusion of sheep from inflicted or dangerous areas and/or lethal management of carnivores. Still, the electronic tracking devices have a great potential for monitoring and proactive risk management. In the long run, if Norway should hold their international agreements on keeping viable populations of large carnivores, such approaches are not likely to lead to change in farmers' attitudes towards these species. In addition, it is hardly an elegant or ecological solution to have electronic gadgets on "2 million sheep". Strictly economically speaking the national grazing project was supported 5-6 million NOK a year. Flaten and Kleppa (1999) calculated yearly cost increase of 170.000 NOK for a farmer employing LGD, shepherd and night penning on summer fields. That might cover costs for 35 farms.

The challenge in livestock industry in Norway is not only high losses but in addition fewer farmers with bigger farms and increased demand on product quality (Statens landbruksforvaltning 2009).

Aase (2015) expresses the raising concern of increasing import of food and livestock fodder to Norway, reaching a new record in 2014 representing 53.2 milliard NOK, which is 7% more than in 2013. He further argues that this development has very negative impact on agriculture and its values with implications on security of national food production. Raising import if not met with proper political regulations has impact on the development of food prices and competitiveness of Norwegian farmers. The small farmers association (*Norsk bonde og småbrukarlag*) represented by M. Furuberg expressed similar worries adding that

Norway uses almost the same area in foreign countries than is the whole production area of Norway to produce fodder for livestock. The amount of raw material for fodder imported varies as a function of what has been produced in the country depending on the annual weather conditions (Stai & Lie 2012). The market price of food products along with other forms of subsidies for agriculture play important role in deciding whether farming is economically interesting and influence what is being produced and how. The system of subsidies has impact on farmers management decisions and thus influence the cultural landscape (Blumentrath *et al.* 2014). Although one of the key aims of national support for agriculture administered by the Norwegian Agricultural Authority (*Statens landbruksforvaltning*) is to ensure continued farming within the country the small and middle-sized farms are disappearing over past years and larger farms acquire, the land. The number of farms receiving subsidies declined from 47 289 in 2008 to 42 168 in 2014 (Landbruksdirektoratet 2015b). In 2013 there were 14 329 sheep farms registered, which represents 28% decline within last 10 years (Holien, Stornes & Ystad 2014). More or less parallel declining trend can be seen also in use of summer farms (*Seter*), which are important symbol of national heritage and cultural landscape (Daugstad, Mier & Peña-Chocarro 2014). Statistics on the number of adult sheep between 2004 and 2014 do not display any particular pattern relating to the occurrence of predators (Landbruksdirektoratet 2015a). In the light of above problems and raising living standards, the return of large carnivores and associated livestock losses along with need for extra labor and change in husbandry practices to mitigate losses due to depredation and ensure animal welfare, might be the "last drop in farmers' patience". Also to officially justify the reason for quitting the farming as "a carnivore political problem" might be, considering the symbolism, that large carnivore present a more tempting argument than for example low income and high labor load that farming represent. Berger (2006) analyzing 60 years data found that severe decline in sheep farming in USA primarily blamed on high predation pressure were correlated with market conditions and independent from depredation or control efforts.

When comparing findings and recommendations of Breitenmoser (1998) with the ongoing debates in Norway, there are many similarities between the situation in the Swiss Alps 17 years ago and the current situation in Norway. Heavily subsidized sheep husbandry, most of flocks kept unattended on mountain pastures in summertime, hunters and farmers being the most negative groups opposing carnivores, 25 years after its reintroduction lynx is still illegally hunted and controversy far beyond the damages lynx caused to sheep husbandry with locals asking whether they still live in democracy. Breitenmoser argues that

this question is expressing the deep concern of rural people over the loss of control of their traditional lifestyle and carnivores seen as a negative symbol of these processes, but see also Landry *et al.* (2005).

4. Situation in Slovakia

Unlike in Norway, large carnivores were never eradicated in Slovakia. Although there have been some tendencies for their eradication, Slovakia did not accomplish this and has been one of few refugees of wild carnivore populations in Europe. Large carnivore populations of bear, lynx and wolf are present in approximately 40% of the country (Finďo & Skuban 2011b) and despite one of the highest carnivore densities in Europe along with relatively high concentration of people and popularity of outdoor activities, no proven incident of fatal carnivore attack on humans was documented within the last 100 years (Hell, Slamečka & Gašparík 2001). Also livestock losses to depredation appear to be low in comparison with other European countries (Kaczensky 1996; Kaczensky 1999) and the majority of them (80%) occur on 12% of the farms (Rigg & Finďo 2000; Rigg 2004). This is most likely a result of continuous coexistence of farmers with large carnivores. Most of the land was grazed in the past and by the end of 19th century there was about 3 million sheep in Slovakia (Martincová 2015), but see Margetínová and Apolen (2013) for the historical review of sheep keeping in Slovakia. Meadows and pastures suitable for livestock grazing represents around 800 000 hectares in Slovakia. A large majority of all sheep during past centuries until today were in areas with presence of large carnivores and depredation attacks are common (Wechselberger *et al.* 2005). As a result, the traditional husbandry system based on transhumance and herding with constant human supervision and use of night penning during dark hours remained. This is likely also one of the reasons why sheep operations are still mainly based on milk production rather than production of meat, like it is in Norway and some other European countries.

Most conflicts over large carnivores appear to be caused by different perceptions of their numbers by individual stakeholders, mainly hunters and conservationists. The official population estimates of large carnivore species in Slovakia are derived from hunting ground users reports and largely differ from professional estimates (Kaczensky *et al.* 2013a). According to official hunting statistics, since 2012 the population of wolf exceeds 2,000 individuals, while most recent estimate resulting from agreement of all stakeholders participating at currently ongoing conservation plan for wolf is 300 – 600 (Antal *et al.* 2015). For the controversy regarding estimation of wolf population in Slovakia see Rigg (2007). The recent estimates of bear and lynx populations are between 800 and 1100 individuals for bear (officially almost 2,000) and around 400 for lynx (Kaczensky *et al.* 2013a). The

hunters' estimate of the lynx population in 2004 was for instance up to 1,052 individuals (Finďo, Skuban & Koreň 2007). Since the official statistics are more easily available to the public, these high estimates are partly responsible for a general notion that large carnivores are overpopulated in Slovakia. Especially bears are recently subject of public debates despite the fact that since 2002 the damage they cause to livestock is decreasing (Finďo & Skuban 2011b) and the total economic damage remained more or less unchanged (Rigg *et al.* 2011).

On average there were 389.629 sheep during the period 2008 – 2014 in Slovakia and losses to wolf, which is responsible for majority of sheep depredation (Finďo & Hood 2001), in the same period represented 325 (0.08%) sheep/goats (Antal *et al.* 2015). The mean annual depredation costs calculated from losses reported by farmers represented 16 000 € for wolf (500 individuals of livestock), 1766 € for lynx (14 sheep/goats, 1 cattle) and 20 000 € for bear (160 sheep/goats, 0 – 15 cattle) in 2010 (Kaczensky *et al.* 2013b). However, the losses reported to authorities do not represent the full amount of damage that farmers experience and might be largely underestimated (Finďo & Skuban 2011b). This is in contrast to many other countries where claims for compensation are mostly overestimated (Dickman 2009). One of the reasons is most likely the current compensation system based on conditional use of preventive measures such as employment of shepherds, LGD, night penning or electric fence and payment only for losses documented by an inspection commission. While this system creates important incentives for farmers to use preventive measures, the bureaucratic procedures are so sluggish and most farmers consider the compensation too low so they do not report the losses if they are not substantial (See also this study). Another reason might be the lack of awareness about compensation possibilities among farmers (Antal *et al.* 2015).

Very high losses are often associated with poor husbandry and/or inadequate preventive measures (Rigg 2004; Finďo & Skuban 2011a). In 2001 – 2003, farms with very high/repeated losses accounted for ca. 90% of all reported losses annually and rather local conditions along with husbandry system than number of carnivores are determinants for the extent of losses (Rigg *et al.* 2011).

Increasing sheep losses to wolf during the last decade, despite its more or less constant population and abundant natural prey (Antal *et al.* 2015) might be a result of the wolf's reaction to inadequate protection of herds. At the end of 20th century and especially after 2nd World War, the traditional use of LGDs in Slovakia almost ceased to exist. From unclear reasons, the shepherds began to tie their LGDs around the flock instead of using free ranging dogs. Such practice was shown inferior to the traditional method (Finďo & Hood

2001), but see also Finďo and Skuban (2011a) for details about the historical and present use of LGDs in Slovakia.

Large populations of ungulates (red deer, roe deer) and wild boar (*Sus scrofa*) are responsible for the majority of damage caused by wildlife in Slovakia. Their numbers likely doubled over the last 10 years (Antal *et al.* 2015). Losses to agricultural crops reported in 2009 amounted to almost half a million Euro and most likely did not represent the full amount of the damage that farmers suffered (Slamečka, Gašparík & Slamka 2011). The damage to agricultural crops is, according to current legislation, the responsibility of the owners of corresponding hunting grounds. The stakeholders should reach an agreement on the compensation or go to the court. This creates a tension and divides hunters and farmers who are then less likely to cooperate on common interests, like for example hunters and farmers in Norway do regarding the large carnivore issue. Conflicts are also supported by discrepancies in the legislative decrees issued by the two ministries, Ministry of Environment (*Ministerstvo životného prostredia*) and Ministry of Agriculture and rural development (*Ministerstvo pôdohospodárstva a rozvoja vidieka*). Especially the change in the Hunting act in 2009 (*Zákon o poľovníctve č. 274/2009 Z. z*. § 24/3, d) released the exception for working LGDs. As a result, hunters shot several LGDs in some regions. Despite critique and later changes in the law, this fatal mistake was still not corrected. However, the ongoing consultation procedure for a new conservation plan for the wolf in Slovakia should remedy the situation. See Antal *et al.* (2015) for details.

In a recent study, Lescureux and Linnell (2013) explored the development in former communistic countries during the transition after regime change. Many of their observations and conclusions apply also for Slovakia and can be used for better understanding of the situation in the country. Challenges in livestock industry in Slovakia must be seen within the wider timeframe and compare the period during and after socialism. The radical changes and considerable decline in agriculture after 1989 is threatening the country's goal of food sovereignty. The topic exceeds the scope of this paper, but see Kanianska *et al.* (2014). The current international EU policy seems to further exacerbate the decline and is likely the most pressing challenge for the agricultural sector in the country. For example, the support package for the dairy sector worth 500 mil. € recently approved in an extraordinary meeting of the EU Agriculture Council (Council of the European Union 2015) is hardly adequate to help Slovak farmers who as a result of the Russian embargo lost its main export market worth annually 5.5 mld. € (Slovenská poľnohospodárska a potravinárska komora 2015).

5. Methods

In this chapter, I will outline the methods used to collect first-hand data in Slovakia and Norway on sheep farmers' experiences and attitudes in respect to carnivores, sheep and dogs. The internet and telephone interviews in Norway were carried out during the period November 2014 – January 2015. The fieldwork in Slovakia took place in February 2015.

5.1 Selection of respondents

The target population for this study were farmers from Norway known to use LGD(s) as a measure to protect their livestock from carnivore depredation and farmers from Slovakia employing LGDs in a traditional way, i.e. dogs ranging free with the sheep flock. I chose this group since keeping LGD on sheep farms is common in Slovakia, but only few use them actively to protect their flocks. I argue that such interest groups are comparable despite different methods of employing LGDs as both groups are doing more than is common in their country to protect their livestock. The contacts were obtained from the previous LGD research studies and pilot projects in both countries. Farmers were asked for permission to share their contact information electronically in Norway and personally in Slovakia. For further collection of potential respondents to build up and actualize the interest group network, informants were asked if they could think of someone who in their opinion should be invited to take part in the survey. This approach is referred to as snowball sampling technique (Rastogi *et al.* 2013). I consider this technique appropriate for this study as its aim is mostly to explore and analyze (Biernacki & Waldorf 1981).

For analyzing various elements of human-carnivore conflict, I used mostly examples of grey wolf (*Canis lupus*) as the large carnivore representative. The reason for this is that the wolf as a symbol of the wilderness is a highly controversial species and likely stirs human emotions accordingly. As such it may serve as a magnifying glass for social aspects of the conflict (Skogen & Thrane 2007).

5.2 Questionnaire

Since very little knowledge is accessible through the literature about the focus groups of this study, I developed a broader questionnaire to elicit the local knowledge, perceptions

and practices of respondents concerning not only their use of LGD, but also other factors known from previous research to play an important role in carnivore related conflicts of interest. I divided the questionnaire into six parts.

Part 1: I classified pastures into eight categories based on altitude and vegetation cover. Open/Overgrown pastures above tree line, Forest, Meadows surrounded by forest, Open/Overgrown pastures in agricultural land, Fenced pastures and Others. These characteristics provide information about carnivore species presence and the potential for sheep, dogs and shepherd to detect attacks early. I asked respondents about types of pastures used for sheep grazing, the time sheep spent utilizing individual pastures and losses associated with the different pasture types. Additional question asked about the pasture ownership and sheep management during nighttime when carnivores are most active.

Part 2: focused on sheep and contained questions about sheep breed(s) used by the respondents, size of herd, the flocking characteristics, reasons why farmers keep sheep and for how many years they have been keeping sheep.

Part 3: was dedicated to sheep losses. To account for yearly variation, respondents were asked for the average loss across the last three grazing seasons. Questions aimed to find out which types of losses respondents experience. In case of predation, I asked about the carnivores species involved, the proportion of sheep injured and the time of year and day when losses mostly occur.

Part 4: asked questions about the LGDs used by the respondent: breed, age, number of dogs and how they have been reared and are being used. I also asked about respondent's motivations, attitudes and beliefs regarding use of LGDs and obstacles for their implementation.

Part 5: explored carnivore species occurrence within the grazing areas of the respondents and the attitudes of the respondent towards these species. The attitude was measured by desired management of carnivore species on county and country level.

Part 6: contained questions about demographical variables (age, gender, education), as well as questions regarding the source of respondents knowledge about livestock operations, percentage of income generated by sheep farming and labor load associated with sheep farming operations. Several questions aimed to elucidate respondent's perceptions of current compensation scheme, governmental policies, information sources regarding wildlife and position in society.

To simplify the survey for both, respondents and further data manipulation, I used mostly partially closed-ended questions with ordered response choices. This method offers

the advantages of close-ended questions yet allow respondents freedom for their own answer (Needham & Vaske 2008). Ordered response choices were on a 5 point Likert scale, which is an instrument frequently used to measure respondents attitudes, opinions or feelings about particular issue (Nemoto & Beglar 2014). Due to the exploratory character and complexity of the survey, I used also questions with unordered response choices and open-ended questions (Needham & Vaske 2008). The questionnaire draft was consulted with and reviewed by my supervisors. A corrected version was subsequently reviewed by four experienced sheep farmers and LGD breeders. The original English version was then translated into both Norwegian and Slovak language, consulted with my supervisors from both countries and again pre-tested by one experienced LGD keeper in each country. See: http://goo.gl/forms/lqe42PVSeq for the questionnaire.

I sent first notification emails to the focus group of Norwegian farmers known to use or having used LGDs in the middle of November 2014. The email briefly explained the project and its goals, announced the questionnaire survey and asked farmers for their cooperation. In case of errors in delivery, I sent a text message. Online questionnaires were sent a week later to 40 farmers. One month later, a reminder was sent including the link to the questionnaire. Finally, I obtained answers from 13 Norwegian farmers, corresponding to a response rate of 33%.

Because of the differences in the farming systems and in communication channels between government and farmers, the approach in Slovakia was different. While in Norway, it is mostly the farmer who runs the operation and the communication with authorities is secured via internet, Slovak farmers often employ shepherds who are responsible for the sheep. The shepherds own the LGDs to help them do their job efficiently. The communication with authorities does not depend on internet, hence the online survey was replaced by personal semi-structured in-depth interviews with representatives of farmers, shepherds and local hunters. In total, twenty personal interviews were carried out during February 2015. In addition, I used phone interviews when personal meeting could not be arranged. With 16 farmers and shepherds the questionnaires were filled during the interviews. The respondents had their farming operations within three regions (Horehronie, Orava and Liptov) representing the core area for large carnivores in Slovakia which allowed to correct for possible regional differences. I asked Slovak respondents the same questions as their Norwegian counterparts with some exceptions where questions were adapted to special local conditions. This approach, although time and resource demanding, proved very efficient as the vast majority of addressed people agreed to meet. The qualitative data-

gathering techniques such semi-structured interview and open-ended questions provided additional information to increase the precision of questionnaire (Nemoto & Beglar 2014). During the interviews the emphasis was put on avoiding social desirability bias (Needham & Vaske 2008). On average, the interview took about one hour.

5.3 Analysis

For analysis, I converted the ordinal answers on the Likert scale into numbers from 1 – 5 and/or 1 – 4 where one is the least and four/five the most agreeable with the question asked. I compared answers to different questions or between the two groups of farmers by estimating the mean and confidence limits (standard error) of the ordinal Likert scale. Where relevant I used the Mann–Whitney U test to check for statistical significance. In the questionnaire, the loss were categorized into seven classes (1-3%, 3-5%, 5-10%, 10-15%, 15-25%, >25%). For analysis purposes, I converted the classes into numbers by extracting the median. For the class >25% I assumed a 30% loss. I treated the number of sheep with five classes (<50, 50-100, 100-300, 300-500, >500) in similar way but I fixed the lowest class to 50 and the highest to 500. The respondents had also the possibility to answer questions with “I do not know”.

The number of Norwegian farmers included in the results is small but it constitutes a relatively large sample of relevant Norwegian farmers. The same applies to the Slovak farmers included. The statistical basis for more elaborate model building of farmer behavior and attitudes is therefore relatively small. In view of this, I have chosen to present the results more directly in the form of numbers, percentages and histograms.

6. Results and discussion

6.1 Pastures and ownership

The ownership of pastures differed between Norway and Slovakia. The majority of the Norwegian respondents (5 of 11 answers, 45%) owned the grazing grounds used for sheep during summer, 3 (27%) owned parts of the grounds and rented some more, and 3 (27%) did solely rent summer grounds. In Slovakia however, only 2 of the 16 respondents (13%) owned all the grounds used for their sheep. The majority of the Slovakian farmers partly owned and partly rented grounds (50%) or rented all grounds (31%). The two countries also differed in the way farmers were organized: While two third of the Norwegian respondents (8 of 12 answers, 66%) cooperated with other sheep farmers and kept sheep on common grazing grounds during summer, only 6 of 16 Slovakian farmers (38%) cooperated with other farmers for the same purpose (collective farm).

The main pasture types used by Norwegian farmers were open pastures above tree line (34%) and pastures in forest (40%, N = 12). Sheep spent respectively ca. 33% and 43% of the total length of summer grazing season on these pastures. Other pasture types represented ≤ 5% of the summer grazing area and were utilized to a small extent accordingly. In Slovakia, only 2 of the 16 farmers (8%) used pastures above tree line, but they used them to a great extent: sheep utilized the mountain pastures for 50 – 75% of the summer grazing period. Most represented pasture types in Slovakia were meadows in forests (38%), used for approximately 43% of the total grazing time, open meadows in agricultural land (22%), used for approximately 23% of time, and 17% share formed overgrown meadows in agricultural land, used for approximately 13% of time.

The different use of the pasture types between the countries is not only a result of different environmental conditions, but also of historical development and legislation. The cultural landscape in Slovak mountain regions was largely shaped through the Wallachian and Goral colonization (14th and 17th century respectively), when people turned large forest areas into pastures for their livestock (Kanianska *et al.* 2014). The use of portable pennings (*košiar*) used to gather sheep for resting hours and milking was employed also for fertilizing even the most remote pastures (*košarovanie*): see Martincová (2013) for details. In addition, sheep grazing in forest is not allowed in Slovakia since 18th century to prevent forest browsing damage. This might be one of the reasons why Slovaks maintained these meadows

throughout the centuries. The use of pastures above tree line is restricted in Slovakia to protect unique ecosystems rich in biodiversity (called *hole* in Slovakia). Paradoxically these ecosystems are largely a result of extensive grazing in the past. As a result of protection, encroachment of non-pastoral herbaceous species followed by shrubs cause loss of biodiversity and heterogeneity (Lombardi 2005). Use of forests as pastures along with a sharp decline in farming and transhumance practices in Norway during 20th century might be a reason why meadows in forests were not present among Norwegian respondents, but see Daugstad, Mier and Peña-Chocarro (2014) and references therein.

More than half of Norwegian farmers (5 of 9, 55%) that used open pastures above tree line reported that they frequently suffered losses there, mostly due to wolverine, while 2 farmers (22%) reported seldom losses (Tab. 1). In comparison, 30% of farmers using pastures in forest lost their sheep usually here, mostly to bears, while 30% reported seldom losses, mostly to lynx and wolverine, and 30% of the farmers with forest pastures reported that losses never happened. The majority of Slovak farmers (8 of 12, 66%) using meadows in forest experienced carnivore attacks about half the time on these pastures, and one fourth of the farmers reported more frequent attacks (25%) . On open agricultural pastures, 6 out of 14 farmers (43%) reported attacks to happen seldom, while three farmers (21%) about half the time and three (21%) never. On shrubby, overgrown pastures however, 8 of 10 farmers (80%) reported attacks to happen about half of time and 20% more frequently than that (see Tab.1. for details).

Despite the higher proportion of forest pastures than pastures above the tree line among the Norwegian respondents, most reported highest frequency of losses on pastures above the tree line. This seems to coincide with the current distribution of the wolverine, whose preferred habitat has been associated with higher elevations (May *et al.* 2008). Farmers appointed the wolverine on the mountain pastures and the brown bear on forest pastures as the main predators. One of the reasons for this pattern might be easier discovery of carcasses in open terrain in comparison with forested areas.

All respondents from Norway kept their sheep usually spread over grazing areas during the night. About half of the Norwegian farmers (54%) patrolled areas with LGD(s) to ensure security for their sheep, while 23% used free ranging dogs and 23% left their animals unattended during the night.

In Slovakia, all respondents kept their sheep during night inside a pen guarded by free ranging LGDs. Since most Slovak farmers kept several dogs (see 6.3.), they had some dogs inside the night pen, some patrolling outside, and 13 of the 16 farmers (81%) kept a

few additional dogs chained around the night pen. The number of free ranging dogs during night hours varied between days. Shepherds judge individually the probability of attack for example according to weather conditions and decide how many dogs put on guard. They associated storm, bad visibility or very hot temperatures with higher probability of attack.

This difference between husbandry practices is likely one of the most important reasons for the much higher losses in Norway. Night confinement practices, even without the use of LGDs is considered as a very effective mitigation measure (Robel *et al.* 1981). The spreading pattern during the night implies that sheep were very likely scattered also during the day. Coppinger *et al.* (1988) reported that the implementation of LGDs was only unsuccessful for farms where sheep were not confined during night hours.

Tab. 1. Frequency of depredation incidents on individual pasture types reported by farmers in both countries.

Likert scale	**NO**						**SK**					
	open above tree line	shrubby above tree line	forest	meadows in forest	open agricult. land	shrubby agricult. land	open above tree line	shrubby above tree line	forest	meadows in forest	open agricult. land	shrubby agricult. land
Never	1	1	3	2	2	2	-	-	-	-	3	-
Seldom	2	2	3	2	1	2	-	-	-	-	6	-
About half the time	1	-	2	-	1	-	1	1	-	8	3	8
Frequently	5	1	3	-	-	-	1	-	-	3	1	2
Always	-	-	1	-	-	-	-	-	-	1	1	-
Total	***9***	***4***	***12***	***4***	***4***	***4***	***2***	***1***	***0***	***12***	***14***	***10***

6.2 Sheep numbers, breeds, behavior and reasons of sheep farming

Farmers in Slovakia had on average bigger sheep flocks than Norwegian farmers. They kept on average more than 400 adult sheep (range 200 to > 500), while Norwegian farmers in this study had on average 140 adult sheep on summer pastures (range <50 to > 500.

All Slovak respondents described the flocking behavior of their sheep as “Somewhat spread but in vicinity of each other”. All of them used sheep for production of milk, meat and wool. Breeds mostly used were Zošľachtená valaška and its hybrids with Lacaune, Pôvodná valaška and Cigaja. Half of Norwegian respondents (6 of 12, 50%) characterized their flocks as “Spread over large area”, while the other half reported their sheep being flocked. Better flocking behavior was associated with old Norwegian sheep breeds, mostly Gammelnorsk spælsau, Villsau and Dala sau. More than half of the Norwegian farmers (58%) kept Norwegian White Sheep (*Norsk kvit sau*, NKS), but most of these farmers (71%) had in addition to NKS also some of the old breeds in their flocks. None of respondents in Norway used their sheep for milk production. Most (7 of 12, 58%) produced meat and wool, while the rest (42%) produced only meat.

The motivation of farmers for keeping sheep differed between the two countries. While income was the most important reason for Norwegians, hobby, preservation of traditions and maintenance of pastures were most important for Slovak farmers (Fig. 1). The most significant difference between the two countries (Mann–Whitney U test, $p < 0.001$) was in importance of keeping sheep as a hobby. Norwegian farmers considered hobby as unimportant (8 of 12, 61%) or of little importance (17%), while for the majority of Slovaks hobby was very important (11 of 16, 69%) or important (25%). Most Slovak farmers were also more unified in importance of preservation of traditions (62.5% very important, 25% important) while there was a large variation in Norwegian group (23% very important, 23% moderately important and 23% unimportant). Overall, Slovak farmers considered preservation of traditions as more important than Norwegian farmers did ($p = 0.01$, Fig. 1). This may imply the difference in attitudes towards sheep farming between the two countries. Slovak farmers often emphasized the importance of sheep keeping as a hobby also during interviews. They largely saw little financial profit in it and often claimed that “a man is born as a sheep farmer, or he is not”, suggesting other, non-financial values to play a key role in choice of their profession.

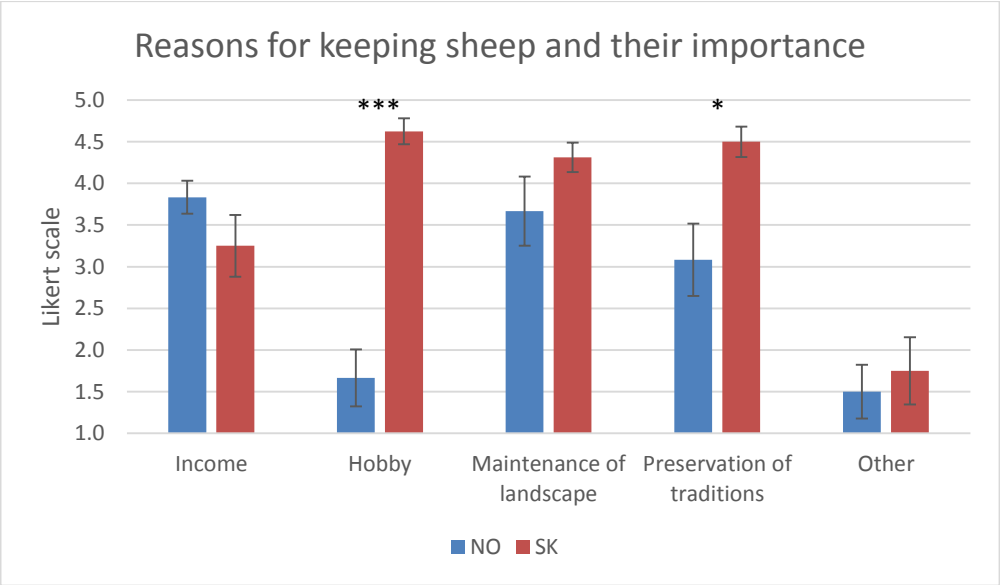

Fig. 1. Perceived importance of individual reasons of Norwegian and Slovak farmers for keeping sheep. Bars represent average response values on the Likert scale 1 – 5 where 1 is Unimportant and 5 Very important. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

6.3 Sheep losses and predator attacks

Causes of sheep losses during the past three grazing seasons as reported by respondents differed considerably in several aspects between countries (Fig. 2). While disease was the most important cause of sheep losses reported by Slovak farmers, depredation was the by far most important cause reported by Norwegian farmers. Slovakian farmers reported significantly higher losses to diseases (2.6%) as compared to farmers in Norway (1.6%, $p < 0.05$). The seeming difference between countries regarding losses to accidents (0.8% in Slovakia versus 1.9% in Norway) was not significant. Losses to other causes included poisoning from plants/mushrooms and snakebite are not displayed in the figure since these represented < 0.1% in both countries. Losses assigned to depredation in Norway (16%) were >10 times higher than those reported by Slovakian farmers (1.5%, $p < 0.001$). There was also large amount of uncertainty regarding causes of losses in Norway (7.5%) compared to Slovakia (0.6%). If I take into account the average percentage of documented losses in Norway (25%, N = 8 farmers) the unknown causes represented likely a much higher value. Three out of five Norwegian farmers (60%) who reported losses to depredation to exceed 25% reported at the same time >25% unknown causes of loss. In addition, there was a large variation in farmers' ability to find carcasses whose cause of

death could be confirmed. Half of respondents (4 of 8, 50%) reported that < 2.4% of the losses were documented. With one exception, the higher values of documented losses (>10%) were associated with lower losses to depredation (<7.5%). In Slovakia, farmers reported to find on average 72% of sheep lost.

The large uncertainty regarding causes of losses in Norway makes it difficult to compare the two groups and results should be taken with caution. Up to three fourths of all sheep losses in Norway are due to other causes than predation (Jakobsen 2001), likely diseases, accidents, illegal slaughter etc. however there is a large variation between individual districts (Statens landbruksforvaltning 2008). Tjomsland (2013) reported that in some herds, ticks were responsible for 30% of mortality, but see Grøva (2011). In areas with carnivore populations, depredation may likely mask losses which would occur as a result of diseases. Constant herding has not only the potential to prevent majority of such losses, but also gives means for precise determination of causes of death. In case of either parasites or disease, early knowledge of symptoms will allow for application of preventive measures soon before it can spread (Cox *et al.* 1999). Since use of LGDs has been confirmed to have a potential to prevent the spread of diseases also between wild and domestic animals (Vercauteren, Lavelle & Phillips 2008; Gehring *et al.* 2011; VerCauteren *et al.* 2012), the resulting effect on the health of the flock might well exceed the danger of increased parasite load due to flocking.

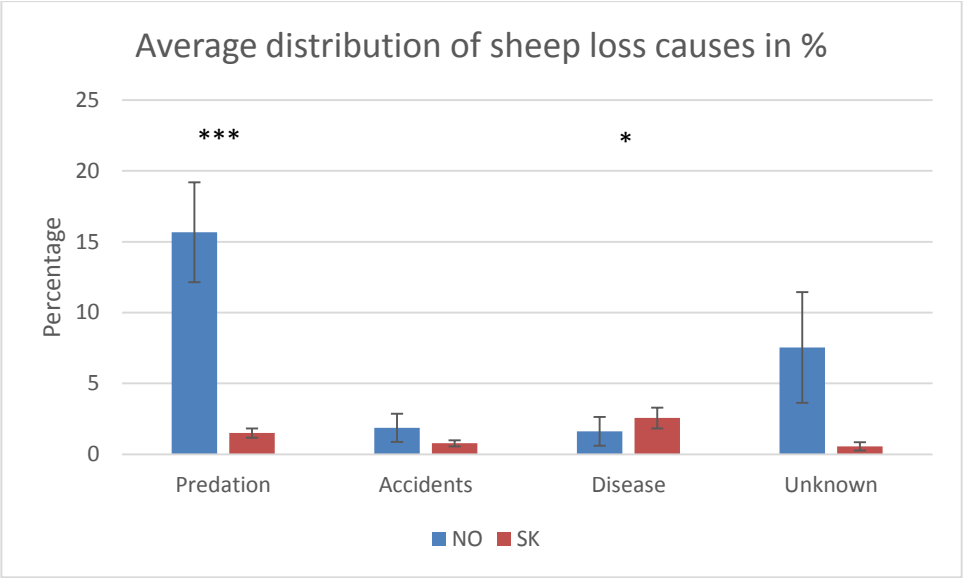

Fig. 2. Average distribution of sheep losses during the past three grazing seasons to individual factors as reported by Norwegian and Slovakian sheep farmers. Median value of loss groups (1-3%, 3-5%, 5-10%, 10-15%, 15-25%, 25%<) was taken for calculation. Since the last group >25% had no upper limit, the value was fixed to 30%. Bars represent average response values. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

Despite use of LGDs, almost half of Norwegian farmers (5 of 12, 42%) reported more than 25% losses to depredation. There appeared to be considerable variation in these losses. One farmer (8.3%) suffered 10-15% losses, three (25%) reported losses 5-10% and three (25%) suffered < 5% depredation. I could not find any pattern on how this variation related to the presence of different carnivore species, the way LGDs were used, or the flocking behavior of sheep. Interestingly, the only farmer in Norway reporting zero losses to depredation had most LGDs (4 individuals) among all Norwegian respondents. One farmer with three LGDs reported losses of 4%. Such low losses to depredation among respondents with two dogs was reported only by one farmer. The limited effectiveness of patrolling in areas with losses to depredation >15% (Hansen 2005) may also be a reason of the unsuccessful use of LGDs among some respondents. In addition, the size of grazing area and quality of LGDs have been associated with the lack of loss reduction in Norway (Hansen, Staaland & Ringsø 2002).

The main carnivore species identified by the farmers as being responsible for the losses was the wolverine in Norway and the wolf in Slovakia (on average 50% of all attacks, Fig. 3). Wolf is the only species causing significant difference between the two countries

($p = 0.003$, wolverine not tested). In addition to the four mammalian carnivore species, one fourth of the farmers in Norway (23%) experienced various degree of losses to golden eagle (*Aquila chrysaetos*). Sheep found injured but still alive by carnivores represented on average 4.8% in Norway (range 0 to 12%, N=7) and 0.7% in Slovakia (range 0 to 3%, N=12).
The significant difference in losses to wolves in Norway and Slovakia is very likely explained by simple comparison of the wolf population size. Slovak estimates are between 300 – 600 wolves (Antal *et al.* 2015), which is roughly the same like the whole Scandinavian population (Sweden and Norway together) estimated at approximately 400 wolves in winter 2013-2014 (Wabakken *et al.* 2014). The difference is breathtaking in relation to effectiveness of LGDs and traditional husbandry to prevent losses.

Farmers in Norway experienced steadily increasing predation attacks and losses from June (time of release to summer pastures) until September (end of summer pasture period) with a peak in August when the predation pressure was significantly higher than in Slovakia ($p < 0.001$). The decrease of losses in September is likely due early movement of sheep out of mountains in the end of the summer (tidlig sanking). In Slovakia, attacks began in May, increased in June and continued with the same frequency until October, with a more relaxed period in August (Fig. 4.) Likely due to the longer grazing season, Slovaks experienced significantly more attacks/losses in May and October ($p = 0.022$, $p < 0.001$ respectively). The relaxed period in August is a peculiarity since the peak of both, bear and wolf depredation in Slovakia were reported in this month (Rigg 2004). Smietana (2002) explained a similar low by the availability of red deer fawns, however this rather covered the period June – July. Another possible explanation might be that bears change food habits in August when cornfields mature.

The time of day when different carnivore species usually attack was mostly unknown in Norway. In Slovakia, bear attacks occurred mostly at night according to 63% of respondents and twilight (19%), wolf attacks evenly throughout the day (56%) or in dark hours (31%, night and twilight pooled). Time of lynx attacks was at night according to 25% of farmers, but was largely unknown (69%). Unknown time of attack in Norway can be explained by little supervision of sheep flocks in general. Lynx was reported by some of respondents in Slovakia as a very stealthy carnivore able to steal sheep from the flock even without disturbance of LGDs. Time of attacks of bear and wolf in Slovakia showed a similar pattern also in previous studies: see for example Finďo and Hood (2001). Although Rigg (2004) found wolf attacks evenly divided between night and day, the prevalence of day

attacks in this study might be explained by a reported change in predatory behavior of wolves after implementation of LGDs. (see part 6.7).

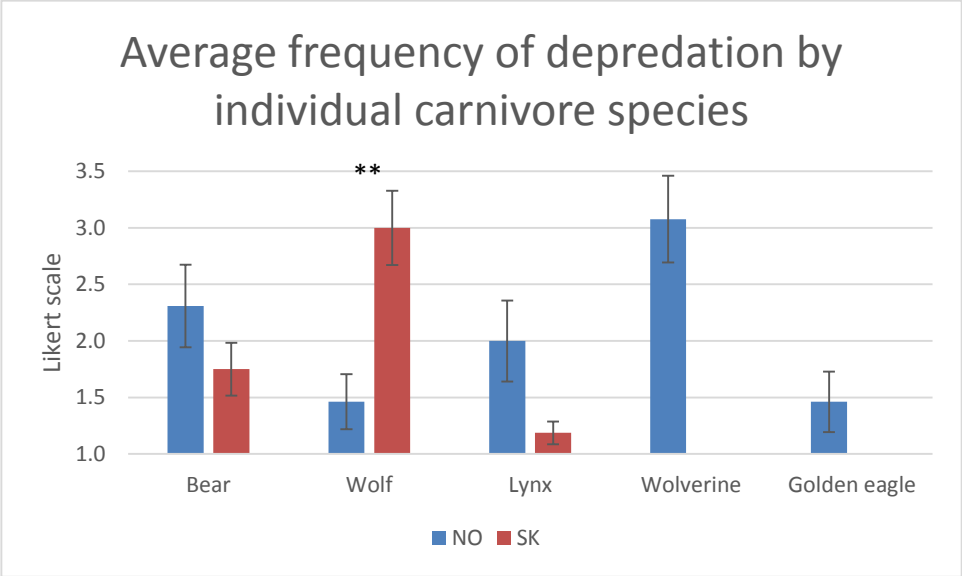

Fig. 3. An average frequency of carnivore species responsible for sheep losses during the past three grazing seasons. Bars represent average response values on the Likert scale 1 – 5 where 1 is Never and 5 Always. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

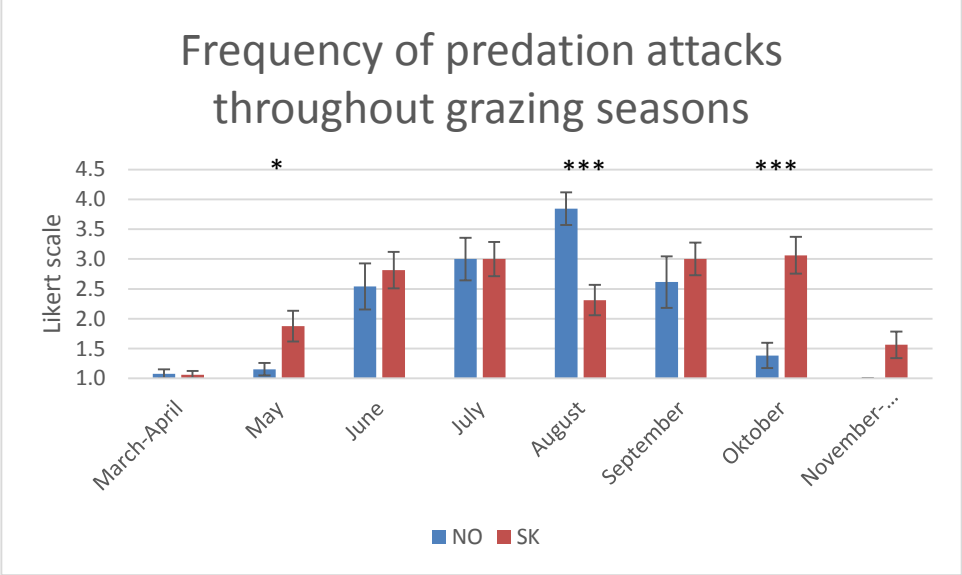

Fig. 4. Time of the year when farmers experience predation attacks/losses. Bars represent average response values on the Likert scale 1 – 5 where 1 is Never and 5 Always. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

6.4 Livestock guardian dogs: motivations, numbers, breeds, practices and experiences

In general, farmers of both countries kept LGDs primarily with the motivation to reduce livestock losses (Fig. 5). They claimed the responsibility to protect livestock as an important reason to implement LGDs. Interestingly, the motivation to prevent livestock losses had a 1.7 higher importance in Slovakia (mean score 4.7) than in Norway (mean score 2.8, $p = 0.003$, Fig. 5). In both countries, law requirements and other reasons were considered to be of little importance to implement LGDs (Fig. 5). Norwegian farmers indicated the use of LDGs to find sheep carcasses as another good reason to implement LDGs. Slovak farmers on the other hand pointed out economic reasons and peace of mind.

The different perception of LGDs as a measure to prevent losses at a first place might be explained by different husbandry techniques and use of LGDs in both countries. The use of patrolling LGDs in Norway is expected rather to reduce the losses than to prevent them totally (Hansen, Christansen & Linnell 2010). In general, high losses to predation in Norway may render the perception of LGDs as a primarily preventive method since it is likely that most of farmers implementing LGDs into their operations suffered considerable losses already before and consequently have been forced to introduce some mitigating measures. In Slovakia however, the traditional husbandry practices are generally associated with low losses, and the improvement by adding LGDs has the potential to completely eliminate losses to depredation (Green & Woodruff 1980), although such efficiency might be difficult to achieve (Rigg 2001).

In Norway, the by far most used LGD breed was Great Pyrenees (9 of 11 farmers, 81%). Other breeds used in Norway were Maremma Sheepdog, Polish Owczarek Podhalansky, Slovak Čuvač and Volpino Italiano. Together 24 LGDs were placed on 12 farms (mean = 2 dogs): 3 farms with 1 dog, 7 farms with 2 dogs, 1 farm with 3 dogs, 1 farm with 4 dogs and 1 farm did not report.

Most used LGD breed in Slovakia was Slovak Čuvač (48% of all LGDs), followed by Caucasian Ovcharka (26%). Polish Owczarek Podhalansky, Central Asian Ovcharka and Great Pyrenees made up < 10% of all dogs. Various hybrids of LGD breeds were common (12%). Together respondents (N = 16) owned 129 LGDs. Farmers had on average 8.1 LGD (range 1 to 25): 2 farms with 1 dog, 3 farms with 3-4 dogs, 3 farms with 5-6 dogs, 3 farms with 7-9 dogs and 4 farms with >10 dogs.

For effective use of LGDs, their numbers should be adjusted to the size of the flock. A minimum of 2 LGDs for ≤100 sheep is recommended in Slovakia and one extra LGD for each additional 200 sheep (Antal *et al.* 2015). This should provide adequate protection, but the local environment along with carnivore species and their numbers must be considered as well. Wild carnivores are formidable opponents and there is an increasing number of incidents where especially wolves killed LGDs (Rigg 2001; Andelt 2004; Urbigkit & Urbigkit 2010). To prevent such situations, emphasis must be placed on the quality and sufficient number of LGDs (Bangs *et al.* 2005). More dogs however does not mean automatically better protection. Well cooperating LGDs forming a functional pack have much higher success against an attacking pack of wolves, than a high number of overly aggressive, individually operating LGDs, but see (Dorgelo n.d.)

Factors affecting the selection of specific LGD breeds did not differ substantially between countries (Fig.6). The farmers mostly emphasized the working behavior of the dog, followed by non-aggressive behavior towards humans and good working parents.

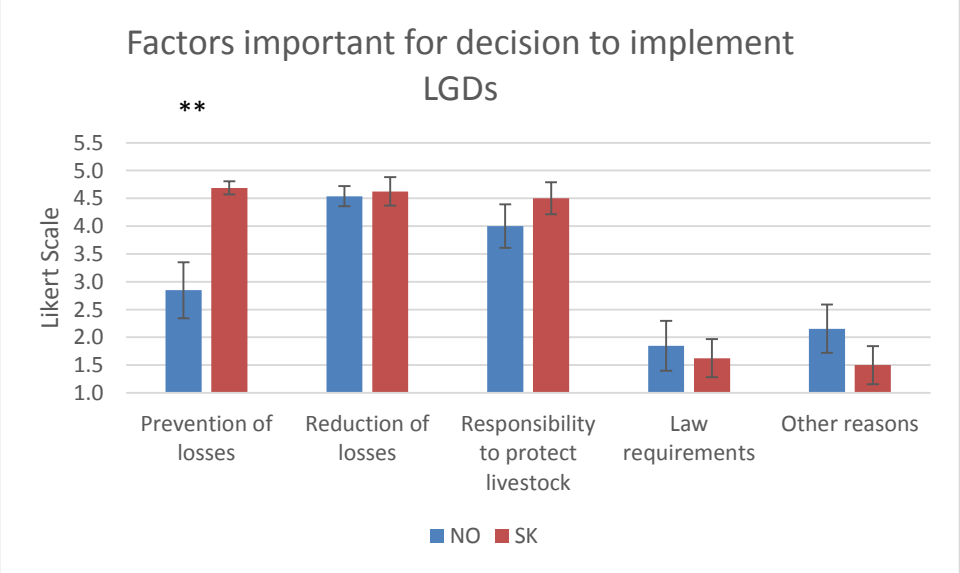

Fig. 5. Factors most important for decision to implement LGDs into husbandry system as reported by farmers in Norway and Slovakia. Bars represent average response values on the Likert scale 1 – 5 where 1 is Unimportant and 5 is Very important. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

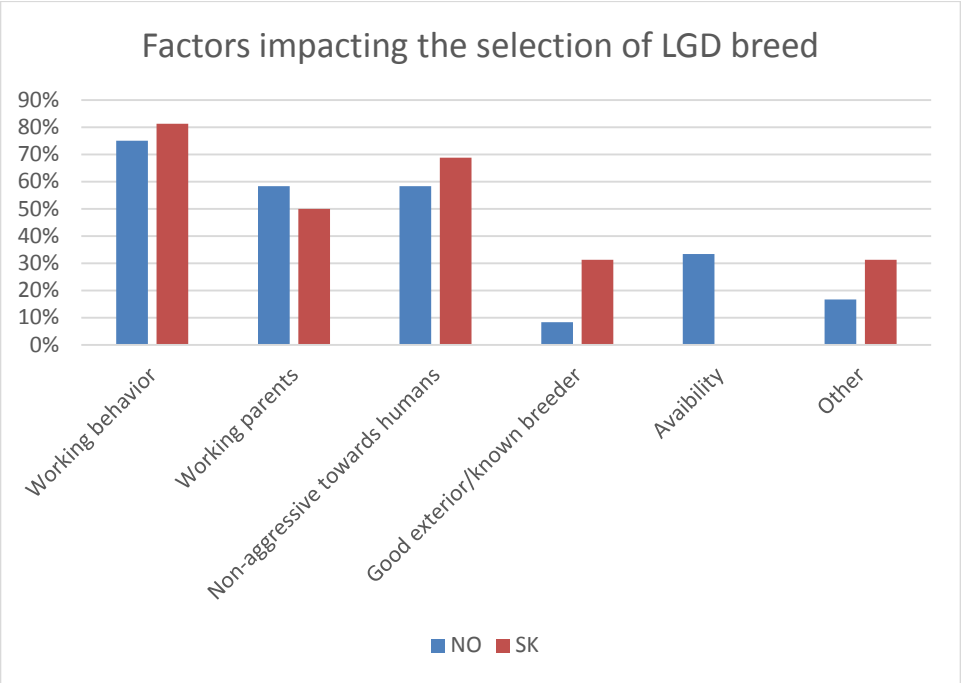

Fig. 6. Importance of individual factors playing role when selecting for LGD breed. Bars represent % proportion of respondents who reported individual factors played role in their decision making when selecting for LGD breed.

The most common way of introducing LGD to the sheep in Slovakia (81% of respondents) was to place the puppy with sheep during the imprinting period (from 5-16 weeks of age). This way of rearing puppies was also used by more than half of Norwegian farmers (54%). One third of the Norwegian farmers (31%) introduced already socialized dogs to the herd.

Use of free ranging LGDs to protect the flock, which at all time was attended by a shepherd, was the method utilized by 15 of 16 (94%) respondents in Slovakia. Only one farmer did not take his LGDs to the pastures. In addition to free ranging dogs, some farmers (19%) tied several LGDs around the flock. In Norway, dogs patrolling grazing areas with shepherd or dog handler several times a week was the most used method (8 of 12 farmers, 67%). Free ranging dogs were used by four farmers (31%). Another four farmers used free ranging dogs inside fenced areas. Four farmers were combining several methods, i.e. dogs within fenced areas at the beginning and the end of the grazing season with patrolling during main season when sheep were outside fences.

In Norway, almost half of the respondents (6 of 13, 46%) characterized the behavior of their LGD as accepting sheep well but prefer human company, while another half (46%) considered their dogs well bonded with flock but listen to commands well. One farmer

reported that his LGD was well socialized but difficult to handle. In Slovakia, 5 of 16 respondents (31%) described their LGDs to prefer human company. The other farmers (69%) considered their dogs well bonded but under control. As most farmers had many dogs with different degree of socialization, these results need to be interpreted with caution.

The key behavioral characteristics of LGD, i.e. trustworthiness, attentiveness and protectiveness (Coppinger *et al.* 1983), as well as overall efficiency of LGD as carnivore deterrent were judged relatively high by farmers in both countries (Fig.7). Norwegians seemed to trust their dogs considerably more than their counterparts in Slovakia did ($p = 0.036$), but they scored lower, although not significantly, on both, attentiveness and overall efficiency. Despite relatively high scores for trustworthiness, Slovaks reported a lower degree of trust regarding their LGDs than their Norwegian counterparts. This might be due to higher human densities in Slovakia, hence likely a higher frequency of tourists encountering the flock and reportedly high fear of Slovakian respondents that their LGDs might injure humans (see Fig. 8).

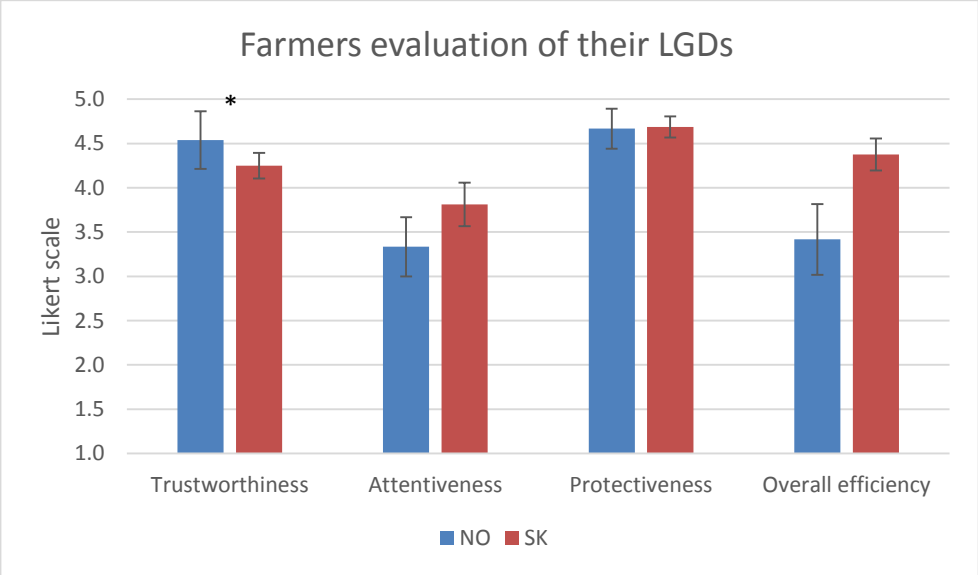

Fig. 7. Behavioral characteristics of LGDs as perceived by their owners. Bars represent average response values on the Likert scale 1 – 5 where 1 is Poor and 5 Excellent. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

As most important obstacle to implement LGD, farmers of both countries emphasized the lack of governmental support (Fig. 8). In Slovakia, farmers also feared LGD attacks of strangers. In Norway, both LGD attacks, availability of LGD puppies and costs

were considered as moderately important obstacles. Among "Other" obstacles, farmers in Norway reported incompatibility of traditional method of using LGD with free grazing system, overall difficulty to raise a good dog and fear or incomprehension of people visiting grazing areas. In Slovakia, other obstacles were uneducated public, inappropriate behavior of tourists, use of bicycles and motorized vehicles in grazing areas and conflicts with hunters. When comparing the two groups, Norwegian farmers considered availability of puppies, sheep behavior and quality of grazing as significantly more important obstacles than Slovakians did (p = 0.035, 0.039, 0.019 respectively), however these obstacles were all of moderate to little importance. The low importance of sheep behavior was also supported by the fact that the majority of Norwegian farmers (9 of 13, 70%) did not experience problems with sheep accepting LGDs. The other four farmers reported that either sheep were afraid of dogs, sheep disliked the dogs, sheep got used to dogs but it took several months or sheep preferred to stay in the vicinity of LGD. Similarly, most Slovaks (9 of 16, 56%) reported that sheep accepted dogs relatively easily, however seven respondents (44%) thought their sheep even preferred to stay in the vicinity of LGD.

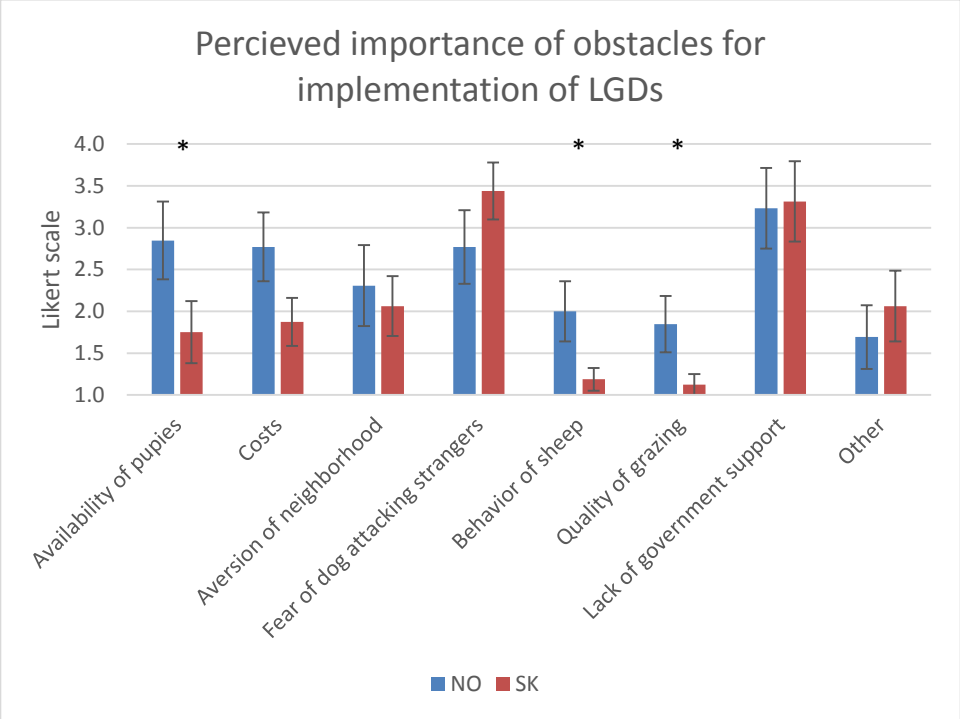

Fig. 8. Importance of individual obstacles for implementation of LGD into husbandry system as reported by respondents in Norway and Slovakia. Bars represent average response values on the Likert scale 1 – 5 where 1 is Unimportant and 5 Very important. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

Almost all Slovak respondents (15 of 16, 94%) strongly agreed with the statement "Implementation of LGD to husbandry leads to significant reduction of losses to predation". In Norway, almost half of the respondents (5 of 13, 42%) agreed strongly and six respondents (50%) agreed somewhat ($p < 0.01$). All Slovaks strongly disagreed with the statement "Use of LGD is causing reduced growth of lambs" and the majority of Norwegians (64%) thought so as well, while 15% disagreed somewhat and 31% were neutral ($p < 0.01$). Further, the majority of Slovak (88%) and almost two thirds of Norwegian farmers (62%) strongly agreed that the imprinting period is crucial for rearing good LGDs. One Slovak (6%) disagreed strongly and one was neutral, while in Norway two farmers (15%) agreed somewhat and three (23%) were neutral or had no opinion on the matter.

Only two farmers in Slovakia (13%) received support for use of LGDs, both from a non-governmental organization (NGO), while ten farmers in Norway (77%) received support from government, one farmer from an NGO and one from both ($p < 0.001$). Farming organizations in both countries did not seem to support the use of LGDs.
Fourteen of the interviewed Slovak farmers were part of a pilot project promoting LGDs in Slovakia in 2001-2003 where they received LGDs from an NGO. Hence, it is likely that they no longer consider the initial support as valid in the context of my question.

Roughly half of the respondents in Norway (54%) used other preventive measures in combination with LGD. In all cases it was "Moving animals out of areas with increased risk of predation" which in Norway is an approved preventive measure used in a form of late release of livestock to and/or early collection from the unfenced grazing range, or moving sheep to a less exposed grazing range. In combination with this measure, one farmer used electric fences, one increased supervision in August and one used taste and odor deterrents. In Slovakia, ten respondents (63%) used other preventive measures in addition to LGDs. These were mostly sound and/or light deterrent devices (44%) and electric fences (31%). One quarter (25%) used a combination of these two measures. In addition to LGDs, almost all Slovaks (94%) and the majority of Norwegians (69%) used herding dogs around the flock.

More than half of respondents in Norway (7 of 12, 58%) would recommend, or highly recommend the use of LGDs to other Norwegian sheep farmers in carnivore-exposed areas. The other five farmers (42%) would possibly recommend the use of LGDs. In Slovakia, almost all respondents (15 of 16, 94%) recommended the use of LGDs highly and one respondent possibly ($p = 0.004$).

6.5 Large carnivores, their presence and attitudes towards them

Most respondents (93%, N = 29) participating in this study reported to operate in areas with presence of at least three large carnivore species, although there were differences regarding species, sex and age of carnivores (Tab. 2). In Norway, farmers reported that their summer ranges were mostly visited by dispersing individuals of bears and wolves, and both breeding and dispersing individuals of lynx and wolverine. In Slovakia, farmers operated mostly in areas with stable breeding populations of bears, wolves and partly lynx.

Tab. 2. The population status of carnivore species reported to occur in the grazing areas used by the respondents in Norway and Slovakia.

Population status	**Norway**				**Slovakia**		
	Bear	*Wolf*	*Lynx*	*Wolverine*	*Bear*	*Wolf*	*Lynx*
Does not occur	2	2	1	1	-	-	-
Only dispersing individuals	10	11	5	2	-	1	4
Breeding population	1	-	6	10	16	15	10
I do not know	-	-	1	-	-	-	2

With the exception of lynx in Slovakia, the farmers in both countries thought that the management of large carnivore's species should aim for reduction of population size (Fig.9). There was no significant difference between desired management on country and county level. The attitudes towards bear and wolf seemed to be slightly more positive in Norway and except for lynx were quite constant among the species. Attitudes towards the wolf as the most controversial carnivore species did not seem to be extremely negative. Although more Slovaks (19%) than Norwegians (8%) called for complete removal of the wolf on both country and county level, Slovaks agreed more (3.6, SE = 0.42) than Norwegians (2.5, SE = 0.42) with the statement "I would consider seeing wolf in the wild as very positive experience". Two thirds of the Norwegian farmers (8 of 12, 67%) wanted to see lynx completely removed from their county, and four farmers (33%) even wanted to have lynx removed from all of Norway. This was somewhat surprising since more than half of Norwegian respondents (54%) reported that lynx was not responsible for any of the losses they suffered. Only two respondents reported more frequent lynx depredation, and one of

these two wanted to have lynx completed eradicated in Norway. For most farmers, bear and/or wolverine were responsible for the majority of the losses. There was no desire however to eradicate these two carnivore species in neither country.

The results regarding desirable population size of large carnivores should be considered in light of what farmers believe to be the population size in their country/area (Bjerke, Reitan & Kellert 1998). They found that in Norway only 19% of population trusted the scientific estimate of wolf population size in 1998 (5-10 individuals), while almost half (42%) believed there were >10 times more wolves in the country. The official population size of carnivores in Slovakia is 3 – 5 times higher than scientific estimation (Finďo & Chovancová 2004; Antal *et al.* 2015) which might imply that also respondents in Slovakia perceive population size to be considerably larger than it likely is. Under such scenario, people might be more willing to reduce the population if they do not perceive it to be endangered.

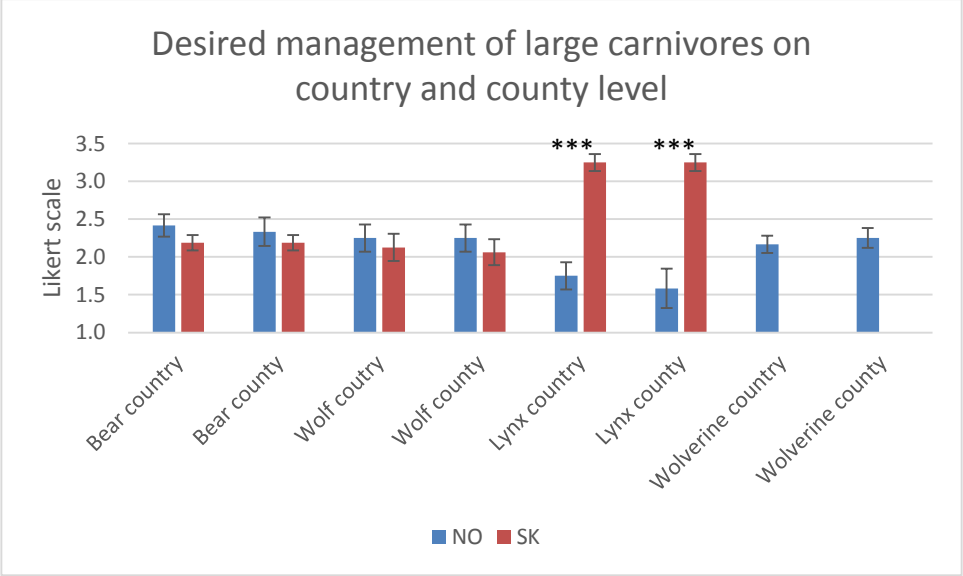

Fig. 9. Desired management of large carnivore species on a national and regional level in Norway and Slovakia. Bars represent average response values on the Likert scale 1 – 5 where 1 is Complete removal and 5 No limits to population size. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

6.6 Demography, education and opinions of respondents

All respondents in Slovakia and most in Norway (77%) were males. Slovak farmers were slightly younger with longer experience in farming (Fig.10). On average, the working

time the sheep operation required from farmer's total working time seemed almost the same, but there was a significant difference ($p = 0.041$). However, the mean percentage of total income from sheep operations was almost double in Slovakia (Fig.11). This implies that the livelihood of the Slovak respondents depended to a larger degree on their sheep operation.

Although this appears to be in contrast to the main motivation to keep sheep (hobby for Slovak and income for Norwegian farmers, (see section 6.2), the high labor associated with traditional sheep husbandry and diary production simply do not allow Slovak farmers and especially shepherds to have other sources of income. Additional production of sheep milk products (*bryndza, oštiepky, žinčica*, etc.), which in some cases form a substantial amount of farmers' income, is traditionally a part of the sheep farming culture in Slovakia, and respondents would not consider it as other income. The sheep farming is for many an important part of cultural heritage and folklore, and although in decline, it is still a part of rural communities that sees a pride in its maintenance. Slovak folklore preserved many rituals and believes of indigenous Slavic spiritual culture deeply interconnected with its natural environment (Švický 2014). This is likely one of the reasons for the different motivation of the Slovak group regarding sheep keeping. In addition, the shepherds' lifestyle is usually very simple and does not require the luxury of the rich man's world.

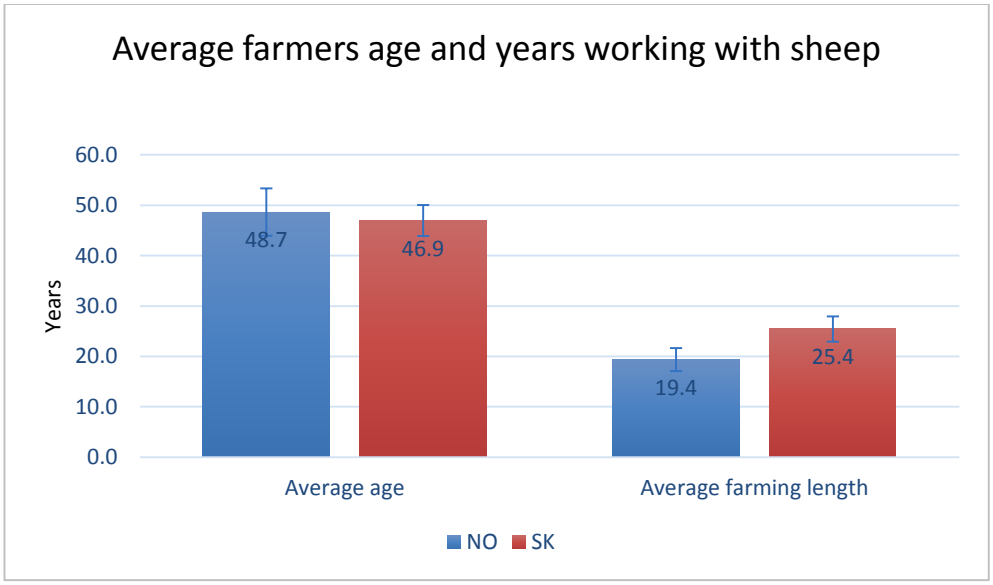

Fig. 10. Age of Norwegian and Slovak respondents and time famers have used to work with sheep. Bars represent average response values in years. Error bars represent standard errors.

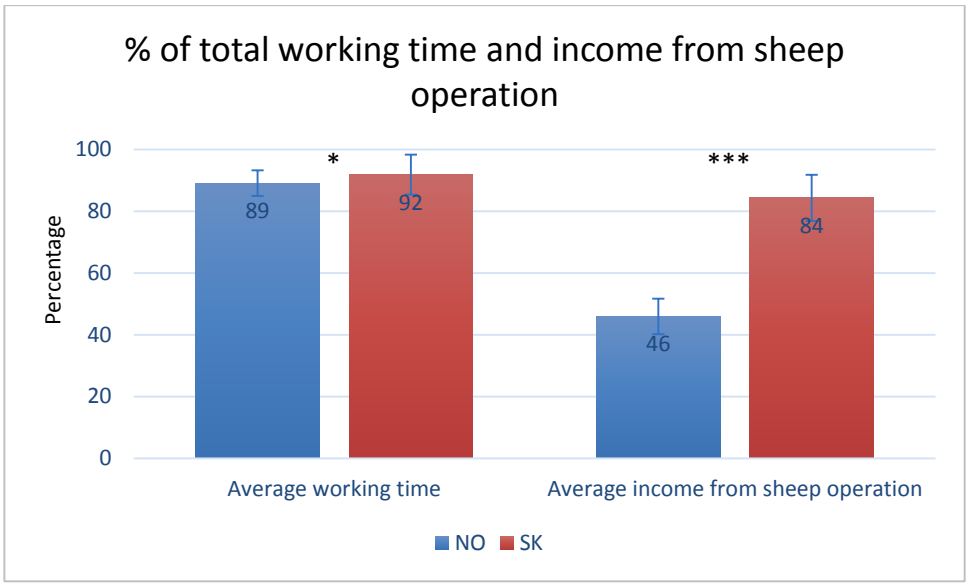

Fig. 11. Percentage of the farmer's total working time concerning sheep operation, and income from sheep operation as percentage of the total income, including governmental support. Bars represent average response values on % scale. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

Farmers in Norway had on average significantly higher level of education compared to the Slovak counterparts ($p = 0.004$). More than half of Norwegians (7 of 13, 54%) had absolved higher education at the college or university level. Secondary education was most common in Slovakia (14 of 16, 88%). However, the proportion of farmers with agricultural education did not differ substantially. More than one third of respondents in Slovakia (6 of 16, 38%) had an agricultural education on secondary level and one (6%) on tertiary level, similarly to 39% and 8% of respondents in Norway. The majority of respondents in both countries came from farming families (100% in Norway, 75% in Slovakia).

Almost all Slovak respondents (15 of 16, 94%) believed that it is possible to teach flocking behavior to sheep which naturally do not flock, by regularly using herding dogs (not LGD) and one farmer believed that it is possible to some extent. Norwegian farmers however were more skeptical. Only 4 of 13 (31%) believed so, three (23%) believed to some extent and six (46%) did not consider it possible ($p < 0.001$). This might be caused by the lack of experience with herding in Norway, although the early trials with herding during Sørli-project did not report it very difficult to flock Norwegian sheep (Krogstad *et al.* 1998; 2000). Slovaks reported that they have to train young sheep to go with the flock every year.

Respondents of the Norwegian group tended to be neutral or somewhat agreed with the statement that farmers have some of the lowest income in the country (average score 3.5,

SE = 0.33), while the Slovakian group agreed more strongly (4.4, SE = 0.30, p = 0.020). Most farmers agreed that it is the government who is responsible for livestock losses to large carnivores (average score 4.0 in Norway, SE = 0.28; 4.6 in Slovakia, SE = 0.15) and that governmental policies regarding agriculture often contradicts their interests (average score 3.6 in Norway, SE = 0.33; 4.7 in Slovakia, SE = 0.12). Slovak farmers however were more negative in their attitudes towards the policies (p = 0.004). The majority of the respondents thought that the government in their country does not listen (94% Slovakia, 46% Norway) or listens somewhat (6% Slovakia, 39% Norway) to the needs of farmers. It seems like farmers in both countries had relatively negative attitudes towards the actions of their government and felt of being marginalized. These negative attitudes and feelings were stronger in Slovakia.

Both groups considered the availability of professional advice regarding proper use of LGD to be very important (4.5 Norway, SE = 0.14; 4.8 Slovakia, SE = 0.10). The Norwegian respondents tended to be neutral (3.2, SE = 0.44) when asked whether the current compensation scheme for losses caused by depredation is fair, while Slovaks were more negative (2.1, SE = 0.33).

Respondents in both countries seemed to trust strongly the local information sources and farmer colleagues when it comes to the management of nature and wildlife (Fig.12). Mostly trust in science, nature management authorities and conservation organizations was substantially higher in Slovakia than Norway (p = 0.014, 0.014, 0.009 respectively, Fig. 12). It is possible that differences were influenced by different data collection methods (anonymous questionnaire in Norway and personal semi-structured interviews in Slovakia) as the interviewer might have been perceived as a representative of science (in both countries), nature management authorities in Norway (Bioforsk Nord was involved in pilot projects) and conservation organization in Slovakia (Carpathian Wildlife Society was involved in pilot project), despite the effort to avoid social desirability bias (Needham & Vaske 2008). Skogen and Thrane (2007) argued that trust in local vs. institutional information sources might capture the social dimension of negative attitudes towards large carnivores because the institutional authorities are largely perceived as representatives of urban expansion by the (imagined) rural community. Their study confirmed that trust in local information sources strongly indicated negative attitudes towards wolf population. This appear to be in accordance with the results of this study considering the desired large carnivore population management.

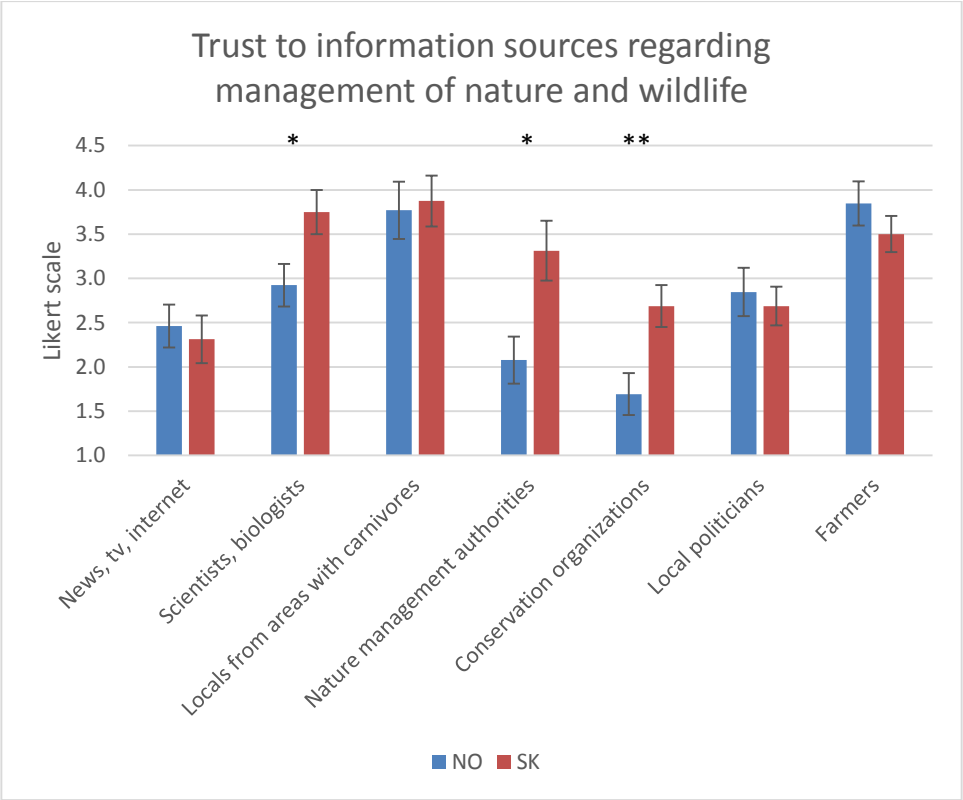

Fig. 12. The degree of trust farmers held to individual sources of information in relation with nature and wildlife management. Bars represent average response values on the Likert scale 1 – 5 where 1 is Not at all and 5 Totally. Error bars represent standard errors and stars indicate significance levels from Mann-Whitney U-tests (* < 0.05, ** < 0.01, *** < 0.001).

6.7 Personal interviews of Slovak farmers

Personal approach and semi-structured method of interviews allowed for a lot of additional information and deeper insight into experiences and attitudes of the Slovak respondents. Many stories about carnivores, sheep and human behavior elucidated the complexity of farming in Slovakia, requirements for effective keeping and protecting livestock and dogs as well as obstacles and conflicts on the way to achieve the goals. Most of the farmers had a very good overview about past and current situation in agriculture and its development in time as well as legislation. These insights were invaluable for understanding some of the reasons for their opinions and situation and revealed the importance of management adjusted for local environment and need for good cooperation with authorities, hunters and public. Attitudes towards the authorities were different not so much among farmers as among the counties pointing at the importance of local government representative. While farmers in county of Banská Bystrica held positive attitudes towards

nature conservation authorities, those falling under the jurisdiction of county Brezno exhibited largely negative attitudes.

Eight of twenty respondents (40%) expressed nostalgic feelings for the past socialistic regime in Slovakia with regard to agriculture. Among the most mentioned reasons were better financial and legislative government support for traditional shepherds and their dogs and support for small family farms in remote areas allowing good maintenance of mountain pastures. The current deplorable state of these pastures with many of them overgrown was mentioned as problem by 20% of interviewees who seemed to deeply care about the landscape.

Farmers perceived problems regarding insufficient legislation (80%), lack of human resources (45%) and the disappearance of traditions (25%) as the largest threats. They considered the human factor as the most important factor of successful animal husbandry and protection. Seventy percent of farmers mentioned the importance of proper care towards both dogs and sheep. Twenty percent mentioned the importance of strong selection towards appropriate behavior of LGDs, and 15% the importance of dogs working in a functional pack. One quarter (25%) confirmed that they do not claim for compensation if the losses were small (1-2 sheep). This problem was also mentioned by the representative of Slovak Sheep and Goat farmers association. One fourth (25%) of farmers also reported no losses to carnivore attacks while neighboring farms not employing traditional protection by LGDs suffered losses. Twenty percent of farmers mentioned the change in the predation behavior after they started to use LGDs. While losses before LGD implementation mostly incurred during night hours in night penning, the attacks occurred during day hours on pastures after implementation. Fifteen percent had problems with local hunters shooting their dogs and 15% thought the public needs to be informed about the use of guard dogs and how to behave around them. In addition, one quarter of farmers (25%) mentioned the importance of top predators in the nature. Only one farmer, who was also a hunter exhibited strong negative attitudes towards large carnivores. Similarly, an interview with a representative of a local hunting community revealed in general negative attitudes among hunters and poaching incidents. Interestingly, a large majority of respondents, when talking about various carnivore attacks on their herds and losses they suffered, analyzed the incident as the failure of the shepherd. Most wolf attacks were reported to happen during instances when the shepherd had left the flock. The wolf was called by some as the “Professor of the forest”, the ultimate test of farmers/shepherds quality and efficiency of flock protection.

Only three farms from our contact list did not use free ranging LGDs to protect their herd. One operation changed their management strategy from extensive grazing to indoor production and two farmers stopped releasing their dogs to accompany sheep because of conflicts with neighboring gypsy communities. Sadly, none of these farmers had time for a personal meeting, as information about such conflicts leading to cessation of management practice would be invaluable for development of possible mitigation measures.

7. Conclusions

The competition between farmers and large carnivores is inherently part of a complicated relationship between man and wildlife since the evolution of agriculture. Farmers tried many tactics over the centuries to find ways how to coexist within the frame of their environment. As one of these tactics, the system of husbandry techniques based on herding were developed and livestock guardian dogs were employed to protect domestic animals from human thieves, carnivore attacks, stress related to these incidents and energy required for the anti-predatory behavior. Unique nature of LGDs prevented also spread of diseases within the herd and between livestock and wildlife. The system was so successful that soon millions of sheep, goats and cattle were grazing the lands, fertilizing pastures and creating what nowadays we call cultural landscape. For the relatively short period connected to technical revolution, humankind got carried away by its own success in dominion over nature, only to realize that our existence depends on our environment. During this period, a lot of knowledge was lost and the effort to restore the balance in ecosystems brought farmers back in time when their ancestors had to live with carnivores. More and more researchers, conservationists and farmers around the world are once again reinventing the use of LGDs and finding it as the best solution for coexistence with large carnivores, however their re-installment is often hampered by changes in husbandry systems and attitudes of farmers. The use of LGDs is still largely refused by farming communities in countries where large carnivores were eradicated and employment of preventive methods seems to be perceived by farmers as the symbol of giving up and acceptance of these species in the land.

The differences between Norway and Slovakia regarding sheep husbandry and use of LGDs are a good example of the ongoing situation. The problems for farmers should be inherently the same, but losses to depredation in Slovakia are 10 times lower than those in Norway.

Some of it might be explained by differences in grazing environment, some by differences in sheep breeds and the contrast between the two husbandry systems and some by the attitudes of farmers themselves. People in Slovakia have lived with large carnivores for many generations and consider the protection of their herds as a natural part of farming while Norwegians are essentially new to the problem of predators. In addition, while Slovak farmers saw little profit in sheep farming and emphasized the importance of non-financial

values as a reason for their profession, farmers in Norway considered profit as the most important reason for keeping sheep.

A number of factors most likely condition the transformation of LGDs from being a disruptive to become an aversive stimulus. Most important is likely a stable local population of carnivores and introduction of dogs accompanied by shepherd to protect the flocks within the whole grazing range. Consistent, territory wide use of LGDs to guard livestock will likely act as an effective condition for change in predatory behavior of local carnivores. Stable populations of breeding carnivores with well-established individual territories allow for learned behavior to be passed on to next generations.

Low losses of sheep for Slovak farmers who employ several LGDs contrast sharply with the high losses and limited use of such dogs by Norwegians. Farmers who suffer high losses despite the use of LGDs imply that these farmers belong to those most affected by the return of carnivores and that the husbandry system used in Norway today is not compatible neither with return of carnivores, nor with LGDs. A major change in Norwegian husbandry system might be the most effective solution for development of sustainable farming model alongside viable carnivore population (Mabille *et al.* 2015a). Considering the level of sheep losses and the intensity of public debate even after 30 years of recovering carnivore populations, the return to more traditional husbandry might be the only effective solution. While there will be vacant territories and large amount of free and easily accessible food, Norwegian mountains will likely serve as a "pantry" for young inexperienced individuals of carnivores dispersing from neighboring Sweden: see Wabakken and Maartmann (1994); Wabakken (2014).

Since the majority of sheep in Norway are lost to other reasons than predation, even taking aside the positive effects on animal welfare, the economic effect of adopting husbandry techniques based on traditional use of LGDs might be considerably positive. Most farmers within this study strongly called for professional help. This would create new job possibilities within agriculture and education, secure the use of mountain pastures and allow their increased usage in the future, restoring and maintaining the cultural landscape while viable population of endangered carnivore species could be maintained. In regard to little agricultural land in Norway, need for increased food production with raising population and market demand for healthy, locally produced food and deep conflict over large carnivores, it does not seem to be a financial drawback. The economic situation for Slovak farmers is different to those in Norway but simplistic economic calculations regarding effectiveness of

LGDs in modern farming systems should be replaced by holistic calculations including also indirect positive effects that a “man's best friend” could bring.

8. Management implications

The Slovak respondent group was reasonably unified in their opinions, perceived obstacles and successful implementation of LGDs into their husbandry system. The low losses with no reported instances of surplus killing incidents confirm traditional methods to be very efficient for flock protection. Management could focus on further promotion of LGDs in Slovakia, correction of negative aspects of legislation, and involvement of livestock farmer's organizations into the process. Professional guidance should advise on quality and performance of LGDs and building a functional LGD-pack based on local knowledge of environment and carnivore species population in the area. Education of the public and hunters regarding the importance of large carnivores in ecosystem, their real population size and the role of LGDs in protection of livestock along with their potential to secure the coexistence with carnivores in the multi-use landscape is important for conflict prevention. Not to discourage the public, they require information on proper behavior when encountering LGDs with sheep flocks.

The low sample size and large variation regarding the effectiveness of LGDs in prevention of losses makes it difficult to generalize. About half of the farmers in the Norwegian group suffered substantially lower losses, and local knowledge and evaluation of the situation in order to make the LGDs effective seems to be the best option. The creation of national or local LGD-centers in areas with high losses could assist with the transformation of the husbandry system to be compatible with carnivores and LGDs. A long-term project to judge the effectiveness of herding sheep in Norway and their performance under such husbandry should be encouraged. Considering the little trust farmers in Norway have of nature management authorities and conservation groups, there is a strong need for better communication and work at the local level. Building an effective system on several farms should be the most effective way to show the farmers that alternative methods could work also in Norwegian conditions. Education and training centers for shepherds would be a good option for future farmers. Organizations from both sides of the opinion spectrum (conservation/farming) could cooperate as LGDs protect both sheep and carnivores. Students (and maybe refugees as many come from countries where herding is traditional) might after a training course get opportunities for summer jobs, but professional guidance would be necessary with young dogs still being trained. The use of electric collars by professional shepherds may prevent most incidences with tourists in mountains. The information about

the potential of LGDs in the holistic perspective should be presented also to public to gain their support. With strong farmer motivation as a precondition for future effective use of LGDs, would they be employed regularly, rather stable, local population of large carnivore species might be part of the solution for mitigating the livestock-carnivore conflict. With the potential LGDs could provide and long-term perspective in mind, Norwegian carnivore and husbandry management should be revised.

If new sheep management methods could mean the revival of old management methods, then sheep farming may rely on going to the dogs as an efficient and environmentally friendly way of securing good conditions for farmers, good conditions for the sheep, a good life for the dogs and a better life for the carnivores.

Acknowledgement

This dissertation is dedicated to my mother. Her unflagging energy ignited my admiration for nature and deep longing for understanding its complex, ever-changing processes.

Firstly, I would like to thank Stein W. Bie, for allowing me to share his life and intrude upon his family. He bravely took the challenge of opening my eyes to the world of sustainable farming and its challenges in Norway, which led me to reconnection with cultural heritage of my home country, Slovakia. Where I saw the way, he knew how to walk it. I could never have done this without his friendship, humor, wisdom and support. The same goes for my supervisors Barbara Zimmermann and Slavomír Finďo. Barbara was the light leading me through the dark, winding paths of the process of education while Slavomír's dedication in helping sheep farmers to coexist with large carnivores in Slovakia was the motivation to continue.

I would also like to thank Barborka Malá; her love, care and desire to grow as a human being showed me how deep the "rabbits hole goes".

Last, but certainly not least, I would like to thank to all the people who contributed to data collection. Their time, knowledge, experience and opinions were the essential for my work. Their endeavor for searching for sustainable solutions in their quest to achieve security and animal welfare for their protégés is praiseworthy.

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