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Carnivore Damage Prevention

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STANDARDS FOR SCIENTIFIC EVALUATION
CONFLICT MITIGATION IN ROMANIA
LIVESTOCK FARMING AND THE WOLF IN GERMANY

LIFE EURO LARGE CARNIVORES

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EDITORIAL

In recent years, 'fake news' has become an all-too-familiar term. The presentation of fabricated statements as if they were factual is nothing new, and indeed has been a tactic of political leaders for millennia to achieve partisan goals. However, labelling contrary arguments as 'fake news', sometimes muddying the waters with 'alternative facts', is now a common strategy to dismiss legitimate criticism, rival points of view and inconvenient truths. In this 'post-truth' world in which we now live, facts often seem to be of lesser importance than emotional appeal.

The internet has facilitated this through fake news websites and social media. Although professional journalists and others have sought to counteract false narratives with 'fact checking', the sheer volume of material makes this a demanding task. The International Federation of Library Associations and Institutions has suggested several approaches to help separate fact from fiction (www.ifla.org) and technological tools are being developed to provide assistance (e.g. www.fullfact.org, www.factcheck.org). Nevertheless, many people continue to believe patently false narratives even when they are flagged as disputed (https://psycnet.apa.org). Cognitive biases play a role, such as the 'illusory truth effect' that arises through repeated exposure to false statements.

Carnivores tend to be controversial species due their potential impacts on people's lives and livelihoods on the one hand and their conservation significance on the other, frequently leading to strong statements from both sides of the debate. Science should be able to help: after all, it entails unbiased observation and systematic experimentation in order to understand the complexity of how we can approach the interdisciplinary challenges around the coexistence of large carnivores and human activities.

CDPnews seeks to contribute in the sense of providing access to 'popular science'. The article on standards for experimental evaluation of depredation prevention methods by Naomi Louchouarn, Tara Meyer and Kelly Stoner (page 11) is an excellent illustration of how rigorous approaches are needed to minimise bias and thereby maximise confidence in the accuracy and reliability of research findings. As Nathalie Soethe notes in her article on volunteer initiatives to help farmers install protection measures (page 31), common beliefs are not always upheld by a careful approach to examining evidence and gathering experience. Other articles from Romania (page 1) and Switzerland (page 19) show how 'evidence-based' approaches try to create reliable knowledge.

This is not to say that there is no place for well-documented case studies and reports of how individual livestock producers solve practical problems: the Kuvasz Guard Programme in Hungary is a nice example (page 39). These bottom-up stories are an essential starting point to design effective studies or to modify the details of everyday practices. However, it is only the formal process of well-designed scientific evaluations and experiments that can create the broader platform of robust and generalisable knowledge. *CDPnews* aims to contribute to the application of evidence-based knowledge which can be used for the benefit of livestock farmers and to inform wildlife management policy.

The Editors

Project

HUMAN-WILDLIFE CONFLICT MITIGATION IN THE ROMANIAN CARPATHIANS

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1. Introduction

The Carpathian Mountains are an important biodiversity reservoir, providing habitat for Europe's largest populations of brown bears (*Ursus arctos*), wolves (*Canis lupus*) and Eurasian lynx (*Lynx lynx*) and supporting their dispersal across Central and Western Europe (Andel et al., 2010; Salvatori et al., 2002). In terms of carnivore ecology, the range can be categorised into three key areas: *core zones* where large carnivores persist; *recolonisation zones* where conditions favour the return of large carnivores; and *corridors*, where the movement of large carnivores can be facilitated. Currently, the region is undergoing rapid economic transition with dominant land-use changing from traditional practices to more intensive agricultural and forestry ones, whilst infrastructure developments are increasingly fragmenting the landscape, reducing connectivity and biodiversity value. Fragmentation of the Carpathian landscape is already occurring, with the Western part of the range at risk of becoming isolated from the rest.

LIFE Connect Carpathians, a recently completed EU LIFE+ NATURE project that was jointly implemented by Fauna & Flora International and the Zarand Association, sought to address these threats. Focusing its efforts on a key route for bears and wolves moving between the Western and Southern Carpathians, the Zarand Landscape Corridor (Fig. 1), the project incorporated a network of 17 Natura 2000 sites. In doing so, it was able to build on the Natura 2000[1] concept to ensure functionality of the corridor, i.e. securing habitats critical to the maintenance of

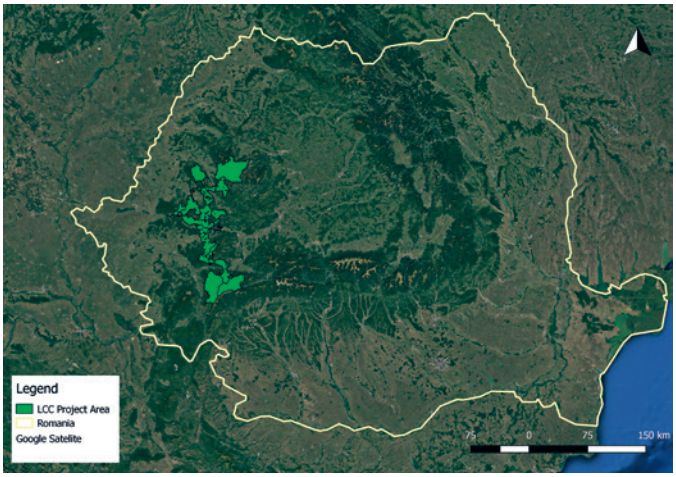

Fig. 1 LIFE Connect Carpathians project area within Romania.

[1] An initiative of the European Commission, Natura 2000 is a coordinated network of protected areas that collectively provides protection for Europe's most valuable and threatened species and habitats; incorporating more than 18% of the European Union's land area and almost 6% of its marine territory, it is the largest of its kind in the world.

connectivity. An important part of the project was to address the issue of human-wildlife conflict (HWC) and the negative attitudes towards large carnivores that this can engender.

1.1 Agriculture and HWC in the project area

The first task facing the project team was to gauge the nature and scope of the issue. This was done through a survey of the various rural communities in order to build a picture of the types of agriculture typically practiced in the area, as well as the types of wildlife conflicts normally experienced. In 2015, semi-structured interviews were used to survey 87 households in three key sites, focusing on specific interest groups such as livestock owners, shepherds, crop farmers and beekeepers. The key objectives were to: gain an overall understanding of HWC in the area; gather baseline data from which project and mitigation impact could be measured; and begin forming positive relations with farmers.

Summary of agriculture

The primary source of income in the project area was agriculture and almost everyone raised livestock (mostly sheep) and cultivated crops (primarily hay, potatoes and corn). Sheep were moved between summer and winter pastures each year (transhumance) and pastures tended to be fairly small, around 55ha. Areas under cultivation were typically even smaller, averaging around 3ha. Most households (a general term that includes a working farm and the family home) sold produce from their farms, but prices and demand were generally low. The main problem experienced was damage caused by wild animals, which seemed to be becoming more common.

Summary of HWC

On average, farms experienced around 15 HWC events annually, typically involving two wolves attacking sheep in summer pastures (causing an average annual loss of around 1.8%), or wild boar in sounders averaging c.14 animals feeding on crops (hay, potato and corn) at night. Livestock depredation happened either at night while the sheep slept in a corral, or during the day whilst they grazed in pastures. Attacks typically occurred less than 500m from the nearest forest edge.

Nearly all households had dogs for livestock protection, and most used at least four methods to protect their stock/crop: dogs, humans guarding the flock at night, avoidance of risky areas and non-electric fencing. Most farmers did not report HWC events to relevant authorities, primarily because they did not know who to report it to or because they did not consider the damage to be serious enough.

Location of interventions

The completion of the survey laid the foundations for the subsequent implementation of the project's key HWC action: to implement and demonstrate new methods of bear and wolf damage prevention. Based on the findings of the survey, as well as discussions with the project team, four key areas (Fig. 2) were identified for further engagement with rural communities and, most crucially, provision of HWC mitigation support:

Site 1 – Rusca Montană-Țarcu-Retezat corridor
A core area with an important corridor between northern and southern populations of large carnivores, which are present in high densities. Local knowledge of living with large animals is intact, whilst the seasonal movement of livestock meant that conflict was likely to be high in summer pastures, as well as at higher-altitude apiaries and orchards in lowlands.

Site 2 – Drocea-Codru Moma corridor
An important and clearly defined corridor that connects a re-colonisation area but that has high densities of livestock, some crops and apiaries as well as abandoned orchards.

Site 3 – Apuseni-Bihor
Has relatively high densities of large carnivores and intact local knowledge on co-existence. Seasonal movements of livestock result in some conflicts in both winter and summer pastures. Beehives and orchards are also present.

Site 4 – Zarandul de Est
Large carnivores are relatively rare and local knowledge pertaining to coexistence with them is consequently low. However, densities of wild boar are high, resulting in frequent conflicts.

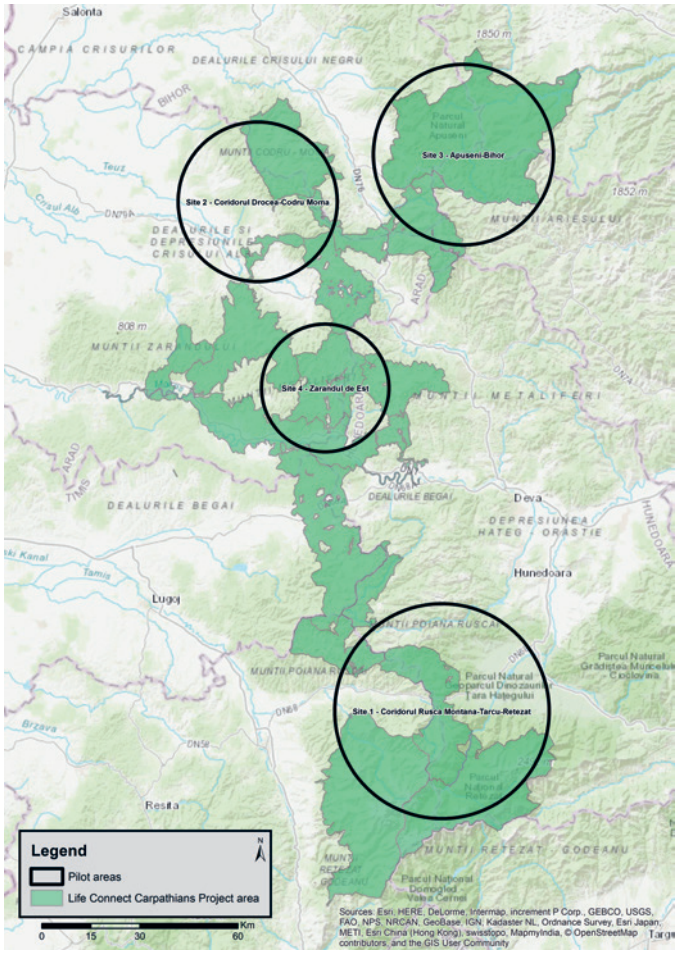

Fig. 2 Key sites within the project area for addressing the issues of human-wildlife conflict.

Engagement with households in these sites continued with a smaller version of the survey repeated each year, allowing the project team to offer support and advice on conflict-related issues as well as continuing to build an understanding of human-wildlife conflict in the area. The project also became directly involved with HWC mitigation support, providing resources and training in a variety of measures.

In addition to those included in the survey, there were several project stakeholders that received mitigation support from the project, either within other project activities, including engagement with Game Management Units (GMUs) or in response to specific and extreme HWC events made known to the project team (Emergency Interventions).

At the end of the project, in 2018, the full survey was repeated in order to allow for a comparison with the baseline and to discuss the potential impacts of HWC mitigations provided to households by the project.

The mitigation measures applied were broadly categorised as: electric fencing (to protect livestock and crops); livestock guarding dogs (for the protection of sheep in pastures); and chemical deterrents (for use with crops). Households were selected for provision of mitigation measures based on the findings of the baseline HWC survey, in response to damage reports made to local authorities or the project directly or through the recommendations of third parties.

1.3 Damage mitigation measures used

Electric fencing

Physical barriers are one of the simplest, most effective ways to reduce livestock depredation or damage to crops by wild animals (Stone, et al. 2016). Although fencing is not always convenient for large, open-range operations, it can be particularly successful around the fold at night and often represents a cost-effective mitigation tool for protecting livestock from predators at local scales (Fig. 3). As the design of such fences is relatively simple, they can be used anywhere and their installation and maintenance can be learned by anyone.

The main components of fences provided within the LIFE Connect Carpathians project were: a pulse generator, a 12V car battery, steel cables (to add tension at posts), insulators, 1m galvanised steel grounding rods, 1.2 mm galvanised steel conducting wires, a voltmeter and battery charger. Wooden posts for the fences were sourced in the local area by recipients. An average of 1000 m of fencing was used for each site with crops covering an average of 1.3 ha and sheep corrals needing to contain, on average, 315 sheep.

Installation of fences was initially carried out by a contractor in order for the team to become famil-

Fig. 3 Electric fence constructed around sheep fold as protection form wolves. *(Photo: LIFE Connect Carpathians)*

iar with the process. Subsequent installations were carried out by the project team and recipients were given on-the-job training in installation and maintenance. This is one of the benefits of this type of mitigation: installation is straightforward and can be carried out by farm personnel with minimal supervision. Wooden posts were placed four to five metres apart with three insulators[2], around 30 cm apart, fixed to each. The electric wire was threaded through these and the enclosure completed with a simple gate consisting of electric wiring with plastic grips to facilitate opening and closing. Finally, a pulse generator (2000–10 000 V) was connected, with a grounding rod pushed at least 50 cm into the soil.

The deployment of fencing occurred in three stages. Between May and September 2016, a total of 43 fences were distributed to 19 livestock owners (summer/winter sheepfolds) and 24 farmers with vulnerable crops (potatoes or maize). In addition, one fence was provided to a livestock farmer as an emergency measure. Then, between May and September 2017, three livestock owners and 13 crop farmers received fencing under a combination of HWC survey reports or engagements with GMUs. In addition, Emergency Interventions saw fences deployed at 13 apiaries in the Zarandul de Est area.

Finally, in 2018, and as a result of either Emergency Interventions or GMU engagements, six livestock owners and nine crop farmers each received fencing between June and December. The most recent Emergency Intervention, carried out near Muntil Bihor, was in response to repeated visits by a bear to an orchard which resulted in the destruction of nine (18%) fruit trees. This made a total of 88 fences distributed by the project in and around the project area (Table 1; Fig. 4).

In addition to the 'classic' enclosures described above, the project also installed fences, to the same specifications, as linear barriers, mostly at GMU sites. The aim here was to optimise the use of electric fencing by incorporating existing features or structures (such as rivers, roads or housing) to expand the area protected. Fencing was placed between crops and the forest edge from which wild boars might emerge, whilst existing structures prevented boar from approaching from elsewhere.

This approach was avoided in areas where permeability for wildlife might be negatively impacted; in such areas, the more classic enclosure approach was used. However, these linear barriers had the additional benefit of encouraging community cohesion: the project maintained all the fencing for the first year on the pre-condition that the village agreed to collectively maintain them thereafter. Seven such barriers were installed, four in Zarandul de Est and three in the Metaliferi Mountains (Fig. 4).

Table 1. Number of electric fences distributed in Romania between May 2016 and December 2018 by the LIFE Connect Carpathians project according to stock/crop to be protected and deployment type. GMU = Game Management Unit.

Deployment Type / Target	Livestock Protection	Crop / Fruit Protection	Apiary Protection	Total Deployed
Survey site 1	9	5	0	**14**
Survey site 2	8	0	0	**8**
Survey site 3	1	9	0	**10**
Survey site 4	2	19	0	**21**
Emergency	7	1	13	**21**
GMU	2	12	0	**14**
Totals	**29**	**46**	**13**	**88**

[2] As the electric fences installed by the project surrounded existing standard fencing, it was decided that three strands of conducting wire would be sufficient. In situations where no existing fencing is present, a minimum of five strands is usually recommended.

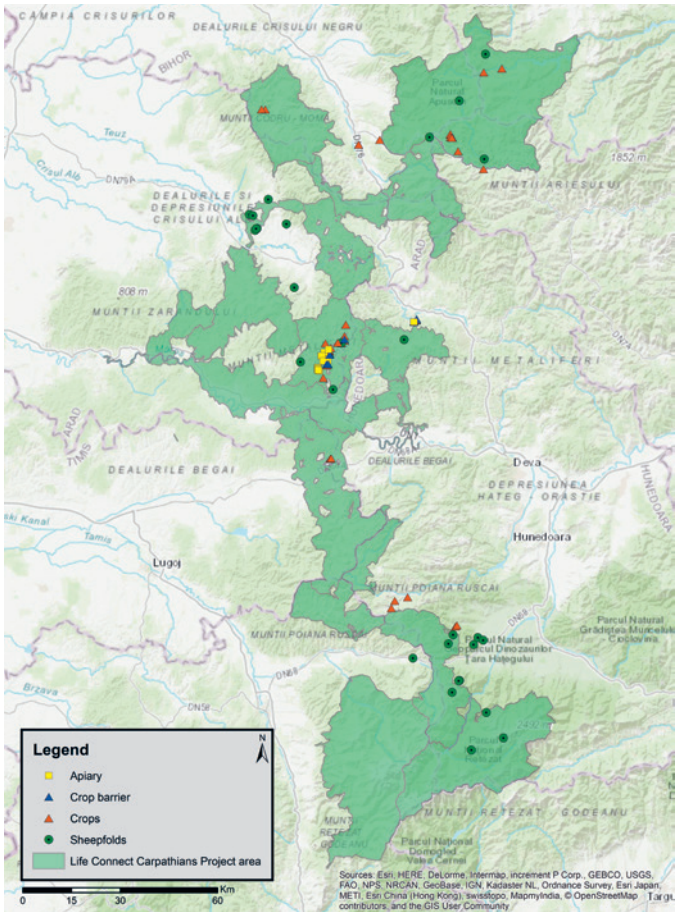

Fig. 4 Location and type of fences deployed by the LIFE Connect Carpathians project.

Monitoring of all fences, at least once every month, was carried out by the team throughout the project, primarily through telephone interviews but also with some irregular site visits. Recipients were also asked to contact the project team whenever carnivores or wild boar attempted to gain access. However, this rarely happened. At crop sites, the project also monitored HWC at neighbouring fields for changes in the rate and/or severity of attacks on crops by wild boar. This not only provided an additional measure of the impact of mitigation but also acted as an early warning of conflict transfer. In addition, the use of camera traps was trialled at four sites (two at crop fields and two at sheepfolds) but was abandoned as a monitoring tool due to a combination of equipment failure and low success rate (i.e. very few images of carnivores were obtained).

The cost of installing 280 m of electric fence was €500. This included all materials and equipment (other than posts, which were locally sourced) but excluded the cost of a contractor for installation and the time needed for two people to carry out the work, which varied depending on the scenario: around six man-hours for fencing sheep corrals; eight man-hours for crop protection; 12 man-hours for linear barriers for community cropland.

Livestock guarding dogs

The use of livestock guarding dogs (LGDs) has proven, worldwide, to be one of the most effective methods to limit losses of livestock to a variety of predators (Gehring et al., 2010; Linnell and Lescureux, 2015). Livestock guarding dogs require both instinctive and learned behaviour, so achieving good LGDs is a combination of choosing the right pups (i.e. from a lineage of working dogs) and raising them in the correct way. Pups which do not have the right genetic predispositions will not succeed, regardless of how they are raised; while dogs not reared properly cannot be retrained later, no matter how well-defined their instincts (Coppinger et al., 1983). To make a good livestock guardian, a dog must be trustworthy, attentive and protective (Coppinger and Coppinger, 2005).

As seems typical of the region, LGDs are ubiquitous in the project area and are a key resource in protecting livestock from predators. Whilst the households that were interviewed recognised the need to socialise their dogs with livestock from an early age, the continued loss of livestock to wolves in the project area might suggest that this initial period of 'training' was not being carried out as effectively as it could be although, of course, other factors could also be at play.

To address the use of ineffective LGDs that were of mixed breeds and not correctly trained, the project implemented a LGD puppy distribution programme. Shepherds were presented with two pedigree LGD pups, a male and a female (always unrelated), and the shepherds were trained in how to raise them.

The programme used pedigree Romanian Carpathian Shepherd Dogs: a traditional breed used by livestock owners for centuries and known for its speed, agility and strength (Fédération Cynologique Internationale, 2015). Pups were sourced through a well-established organisation, the Carpatin Club Romania (CCR)[3], and selected from their breed-

[3] www.carpatinclub.ro

ing centre, using their own established protocols. The CCR breeds dogs both for show and for distribution amongst working sheep farms in the Bistrița area, a few hundred kilometres north-east from the project site.

Between November 2016 and September 2017, a total of 12 pups were distributed to six households (Fig. 5). Of these, three died (two due to an acute skin disease[4] and the other by accidental poisoning, as confirmed by the project veterinarian), one of which was replaced by the supplier (at no cost to the project) but given to a different livestock owner because of concerns of mistreatment by the original owner. Other, non-fatal incidents included a dog injured by wild boar and another case of accidental poisoning. In addition, one contract was cancelled due to a breach of the agreed terms, with the dogs being relocated to a different livestock owner.

Recipients were required to sign a contract with the project, under which they agreed to several conditions. These included: adherence to training in correct pup-handling protocols as designed by the project; close monitoring of pup behaviour; and the control of breeding. The contract stipulated that the dogs were being leased, free of charge, to the beneficiary for a year, after which ownership of the dogs would be signed over to them. Any deviation from the conditions of the contract would result in its termination and the return of the pups to the project. Whilst the farmer was under contract, the project provided dog food and veterinary care.

In order to facilitate the contract, three training sessions were organised by the project in collaboration with CCR. All recipients took part in at least one of these sessions. Workshops were also held, open to all livestock owners in the project area, enabling the project to disseminate information on the general benefits of, and legislative issues relating to the use of good LGDs, as well as best practices for raising them.

Additional monitoring was carried out by the project team with monthly visits to each participating farm to interview the livestock owner and carry out a series of behavioural tests designed specifically for measuring the development of LGD behaviour (Rigg, 2012). In this way, the project was able to identify and

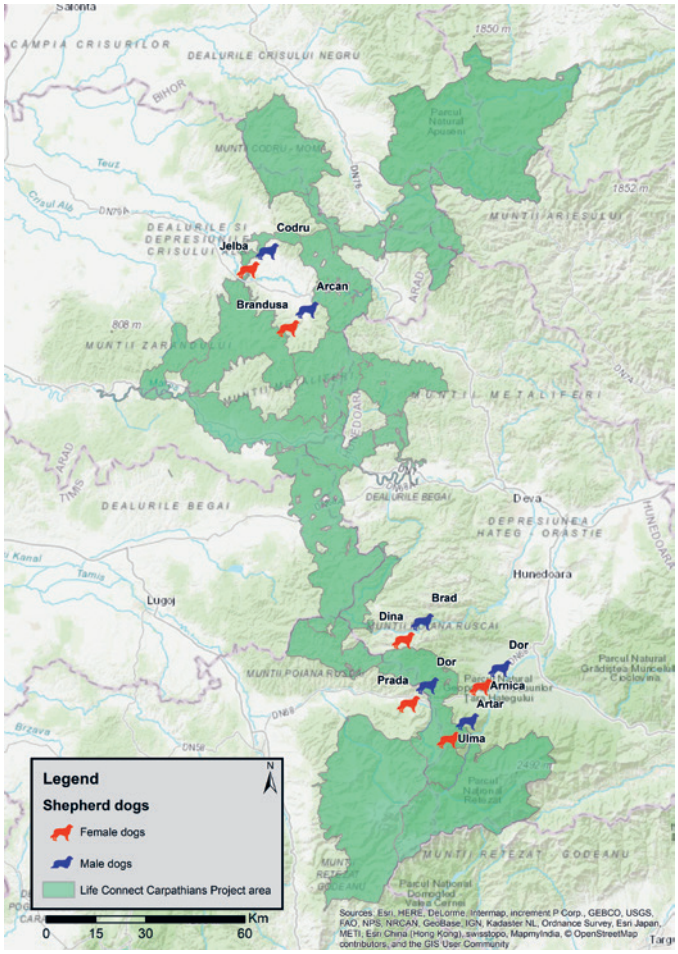

Fig. 5 Locations where LGD pups were distributed between November 2016 and September 2017.

address any inappropriate behaviours that emerged as well as to assess the degree to which guidelines for raising LGDs were followed (Fig. 6).

In terms of costs, pups were bought for € 300 each. Food was around € 265 per dog per year whilst veterinary care (vaccines, de-worming and other services as required) averaged € 340 per dog per year, making a total of € 905 for one dog over the one-year contracted period.

Chemical deterrent

Wild boars tend to be mostly nocturnal in areas where they are hunted and, therefore, damage to agricultural land is usually caused at night (Ohashi, 2013). Deterrents designed to work on their senses, such as sight, smell and taste, have been developed. Such commercially available deterrents claim to be effective in protecting crops from wild boar damage

[4] *Demodex canis* is a species of non-zoonotic mite which is usually non-fatal; however, in cases where infested dogs have an immunosuppressive condition, infestation can escalate to fatal levels

Fig. 6 Mature LGD, provided by the LIFE Connect Carpathians project, protecting sheep in summer pastures in Romania. *(Photo: LIFE Connect Carpathians)*

(Schlageter and Haag-Wackernagel, 2012).

Although the few independent studies that have been carried out on such chemical-based deterrents have been less than conclusive about their efficacy (Schlageter, 2015), the project used one commercially available substance, Hukinol©. Wooden posts 130cm in height were placed at three- to five-metre intervals around the crop perimeter. Each had a 250ml plastic cup nailed to the top into which was placed a piece of fabric soaked in Hukinol©. Depending on the prevailing weather conditions, the Hukinol© was refreshed every week (or the day after heavy rain).

The first deployments of Hukinol© were made in June 2015. A total of seven hectares of cultivated land belonging to around 50 households was incorporated between two Natura 2000 sites, Zarandul de Est and Defileul Mureșului, following reports of damage to potato crops by wild boar. In 2016, several requests from crop owners in Sites 1 and 4 were made and Hukinol© was distributed to several other farms. However, no follow-up was carried out on these households. In 2017, a further six treatments were implemented, mostly in Site 1, with those concerned receiving training in the application and maintenance of the deterrent (Table 2; Figs. 7, 8).

Hukinol© and the other materials needed (excluding posts) cost €45 per ha of fencing whilst the time needed to deploy the system (with posts) was around one hour per ha. Maintenance involved checking Hukinol© levels once per week, which took around 10 minutes per hectare.

Table 2 Number of treatments with chemical deterrent and size of area treated during the LIFE Connect Carpathians project.

Site	2016		2017		2018		Totals	
	Treatment	Area (ha)	Treatment	Area (ha)	Treatment	Area (ha)	Treatment	Area (ha)
1	1	0.3	7	3.7	2	0.7	10	**4.7**
2	0	0	0	0	0	0	0	**0**
3	0	0	0	0	0	0	0	**0**
4	2⋆	14	1	0.1	0	0	3	**14.1**
Totals	**3**	**14.3**	**8**	**3.8**	**2**	**0.7**	**13**	**18.8**

⋆ Carried out in 2015.

Fig. 7 Participating farmer maintaining chemical deterrent at crop. *(Photo: LIFE Connect Carpathians)*

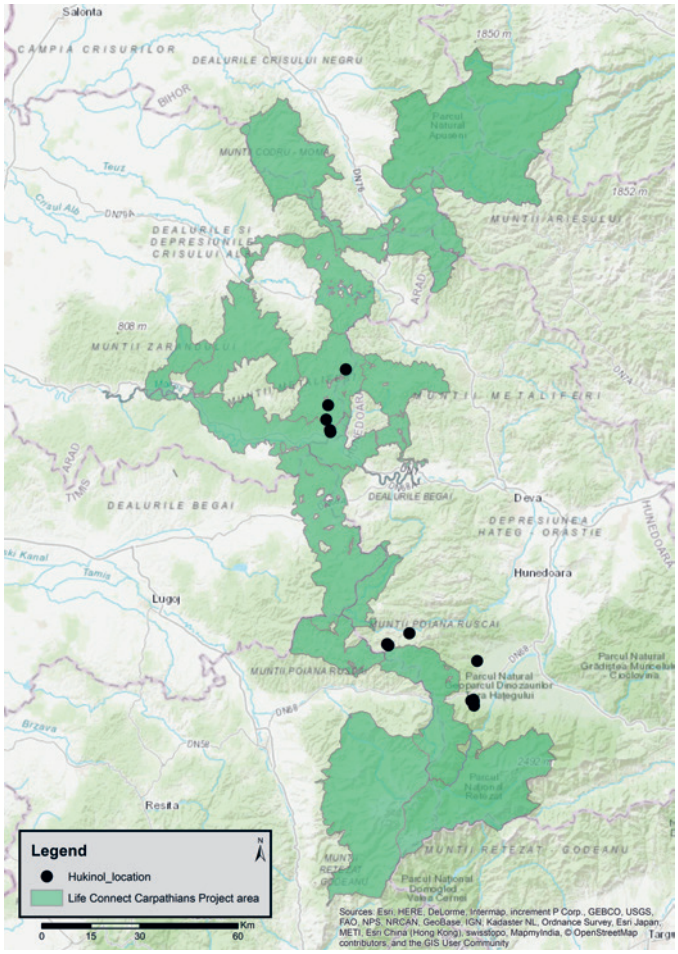

Fig. 8 Locations of croplands where chemical deterrent was applied.

2. Results and Discussion

2.1 Survey respondents and HWC mitigation

Throughout the duration of the project, and based on several types of engagement, the project team provided active support to farms in mitigating the impacts of human-wildlife conflict. This included 36 of the 87 (41 %) HWC survey respondents who received support[5] in the form of: electric fencing for protecting sheep in the fold (n = 18, 50 %); electric fencing to protect crops from damage caused by wild boar (n = 16, 44 %); LGD pups for protecting sheep in pastures (n = 4, 11 %); and chemical treatment for crop protection (n = 2, 6 %).

In 18 cases (50 %), no further HWC was suffered at sites with mitigation intervention. This includes four of the farms that received fencing for sheepfolds (22 % of all those that received fencing), 13 (81 %) that received fencing for their crops and two (100 %) that used Hukinol© to protect their crops. In most cases (72 %), the mitigation interventions had been installed between 2 and 2.5 years prior to the last survey (the remaining 28 % had their mitigation in place for a year). Whether these cessations in HWC can be attributed solely, or at all, to the mitigation support provided by the project is difficult to say, but anecdotal evidence collected by the authors suggests that, in most cases, there is a strong correlation. It should be pointed out that, of 43 livestock farms involved in the survey that did not receive any mitigation support from the project, 18 (42 %) experienced no HWC in 2018.

[5] Eight of the original HWC survey respondents sold all livestock during the project and were removed from further analysis, giving an effective total of 79 survey respondents. Some farms received multiple interventions.

Of the remaining 18 (50%) HWC survey respondents that received mitigation support, all reported subsequent HWC events. A total of 32 attacks were reported, with the number per farm ranging from one to three (mean = 1.78). Of these, 31 involved livestock owners and only one involved a crop farm. However, 25 (78%) of these attacks were reported by 16 farms and occurred at sites other than those where the mitigation support had been installed. Most (72%) of these 16 farms had been provided with livestock fences and 18 (67%) of the HWC events involved wolves attacking sheep flocks in pastures. One of the farms had also received LGD pups from the project and they gave details of three attacks by wolves on the flock in pastures, none of which resulted in the loss or injury of sheep.

The other three attacks occurred at sheepfolds that had received electric fencing and, in all cases, no sheep were lost. Taken together, these cases lend support to other results demonstrating the efficacy of electric fencing in protecting corralled sheep from wolf attacks.

2.2 Non-survey respondents and HWC mitigation

Of the 54 non-survey farms receiving mitigation support, 32 gave details of HWC events experienced before the project's intervention, with a total of 44 attacks reported: 18 on crops, seven on livestock and seven on apiaries. Usually, it was a matter of weeks, or even days (in the case of emergency responses), before the intervention and so these data span several years (early 2016 to late 2018). More than half the reports (54%) were of wild boar damage to crops, followed by bears attacking sheep and apiaries (33%) and, finally, wolves attacking sheep flocks (13%).

As a result of the attacks on sheep, a total of 23 sheep were killed (mean = 2.09); three of the attacks were unsuccessful. Other livestock affected included an attack on goats (two killed) and one attack on cattle (two killed). A shepherd was also injured by a bear attacking his flock. All seven of the bear attacks on apiaries occurred over a one-week period in early November 2017 and resulted in the loss of 18 hives. All crop damage was caused by wild boar with a total of 30 ha being damaged. The most affected crop was corn (26.4 ha; 89%), followed by pastures (1.5 ha), wheat (1.1 ha) and potatoes (0.83 ha).

Each farm was asked to assign a rank of *mild*, *serious* or *severe* to the level of HWC typically experienced; most (63%) households chose *serious.* However, almost a third (31%) described their usual HWC experiences as *severe* whilst only 6% assigned a rank of *mild*.

Households were visited, or contacted by phone, towards the end of the project (mostly in October 2018) and asked if they had experienced any further attacks on their livestock or crop since receiving mitigation support. A total of 51 households provided this information; 31 (59%) had received fencing for their crops whilst 13 (25%) had fences installed at their apiaries and three (6%) at their sheep corral. Of these, 36 (71%) had not experienced HWC since fencing had been installed and all felt this was directly a result of the project's intervention. Of the 15 (29%) that reported continuation of HWC, all reported that they had suffered no damage to their crops or stock as a result of the event. When asked to rate the severity of their HWC experiences since mitigation was provided, all said it was *mild*.

3. Conclusions and Recommendations

The early indications of success in the mitigation interventions provided to project participants, particularly with regards to electric fencing, are promising and momentum should be maintained, including the demonstrably strong relations that the project team established with rural communities throughout the project area. To these ends, continuation of the HWC monitoring team is a priority.

Disseminating success stories, anecdotal or otherwise, would maximise their impact and could be achieved by distributing the project's findings and communicating the generally positive experiences of project participants to the wider communities in the project area and beyond. The efficacy of the LGD pup programme initiated by the project is harder to demonstrate, primarily because more time is needed for the pups to fully mature but also as the pool of pedigree Carpathian LGDs is still diluted by the presence of existing dogs, mostly of mixed breeds, at the recipient farms. The extension and continued monitoring of this particular programme is, then, especially important.

The assessment of all the mitigation methods implemented by the project would greatly benefit from

a more formalised distribution and monitoring approach. This could be achieved through the establishment of more well-designed trials, using model farms as well as control sites, something that could have been done under this project had the resources been available. Model farms, where certain aspects of management (in this case, animal husbandry) are designed and implemented using specific practices, can provide an excellent pool of evidence for the uptake of methodologies within the wider community. However, this is an involved process and can be fairly demanding on resources, particularly manpower. As such, this would be a long-term commitment to be considered as a collaboration with regional or national institutions that can provide their own resources.

It has become a well-established trope that biodiversity conservation today has much to do with garnering positive public opinion and this is particularly relevant to rural communities expected to live alongside wildlife that directly impacts their livelihoods. Some of the lessons learned within the HWC component of this project, along with some of the other broader project components, should be used to develop and implement a regional, or even national, awareness-raising programme as well as feeding into effective implementation of wildlife management policies at a regional and national level.

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Perspective

QUALITY STANDARDS FOR SCIENTIFIC EVALUATION

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1. Introduction

Managing large carnivores is a priority for wildlife agencies and conservation organizations around the globe. Reducing livestock damages caused by carnivores and fostering coexistence are key objectives for successful management and conservation (Treves, 2009; USFWS, 2017). In 2016–2017, four independently published scientific reviews examined the efficacy of intervention methods used to prevent carnivore attacks on livestock (Miller et al., 2016; Treves et al., 2016; Eklund et al., 2017; van Eeden et al., 2017). Synthesizing these efforts, van Eeden et al. (2018) found that only 114 out of the 27,000 studies examined across these four reviews used rigorous, objective and quantitative experimentation standards. These were articles that initially came up using the search terms used by each team of authors. The initial number was then narrowed down using specific pre-determined qualities (i.e. the methods were quantitative and/or the species were large carnivores). This filtering process narrowed down the results significantly. Even commonly used intervention methods lacked rigorous scientific evidence of their effectiveness (van Eeden et al., 2018).

All four reviews reported feasibility and perception of intervention efficacy as key management decision factors for livestock producers and wildlife managers, but most evaluations of depredation intervention methods were opportunistic (van Eeden et al., 2018). The review by van Eeden et al. (2018) revealed that many currently employed methods are not effective or may even be counter-productive, meaning they either increased the number of depredations or reduced tolerance for carnivores when an intervention was ineffective. These results expose a significant need for greater rigor in experimentation. Wildlife managers and producers should use quantitative evidence of effectiveness whenever possible when making decisions about carnivore management and preventing livestock damages (van Eeden et al., 2018).

Treves et al. (2016) described standards of evidence for examining the effectiveness of depredation intervention methods and initially outlined two levels of rigor: gold and silver. Here, we summarize a new report (Treves, 2019) which clearly defines these standards of evidence and an additional bronze standard. Additionally, we will share examples of recently

A lioness feeds on and defends her prey in Botswana. *(Photo: Kelly Stoner)*

published studies employing these three standards and how they relate to the findings of van Eeden et al. (2018), identify common challenges to implementing these standards in the field and make recommendations for future research.

2. Establishing standards for experimental evaluation

The strength of a scientific experiment depends on whether the study successfully reduces biases in selection (how the test groups are chosen), treatment (how the interventions are applied), measurement (how data are collected) and reporting (including statistical analyses) (Treves et al. 2016; Treves, 2019; Treves et al., 2019). The three standards of evidence are therefore categorized according to their ability to reduce these four biases (Treves, 2019; Table 1). While the best scientific practice requires interventions to be assessed using a 'gold standard', designing and carrying out gold standard experiments may not be feasible in all real-world situations. We review the aspects of each standard described in van Eeden et al. (2018) and Treves (2019) and describe examples that illustrate the feasibility of each in practice below. The standards explored here should be applied when managers and researchers define method success or effectiveness as reducing livestock depredations by carnivores (Rigg et al., 2019).

2.1 Gold standard

The strongest standard of evidence, the gold standard, aims to eliminate biases by comparing randomly assigned intervention methods (treatments) with randomly assigned controls (i.e. no treatment) and employing a statistically appropriate number of replicates (Treves, 2019; Treves et al., 2019). For example, a number of independent livestock herds (replicates) can be randomly assigned to receive either an intervention or a control. Random assignment for each herd reduces selection bias (Treves et al., 2019), which is common in conflict-prevention studies since livestock owners may volunteer for treatments, researchers or wildlife managers may choose areas where they believe treatments would be most effective (e.g. Santiago-Avila et al., 2018) or effectiveness of methods may be self-reported rather than measured (e.g. Boast et al., 2016).

Treatment bias must also be eliminated or reduced by standardizing intervention implementation on the

ground (Treves, 2019; Treves et al., 2019). This improves comparability between replicates, increasing the probability that results are based on carnivore responses to the intervention and not on differences in implementation (Treves, 2019). Ideally, gold standard experiments should also aim to reduce measurement bias by ensuring the measurements on replicates are made without knowledge of whether they are controls or treatments (Treves et al., 2019). In other words, if a herd is receiving an intervention, it is best for data to be collected by a researcher who is unaware whether the herd is or is not receiving an intervention. This is especially challenging because many depredation intervention methods are too conspicuous to be invisible to the researcher taking measurements. One way to attempt to reduce measurement bias is to have a researcher other than the field researcher take measurements (Treves, 2019).

Further biases can also be eliminated through the design of the experiment itself (Table 1). For example, a cross-over design is a method that allows replicates to be compared to themselves by having a randomly selected portion of replicates begin as controls and then switch to treatments and *vice versa* for the remaining replicates (Treves et al., 2019). This method allows researchers to account for potentially confounding variables that may make herds incomparable, such as the location of pastures. Confounding variables can make it difficult to design a field study with independent herds, such that researchers can correctly identify changes in predation risk as being due to treatments and not to other factors (Treves et al., 2016; Ohrens et al., 2019; Treves, 2019; Treves et al., 2019). The cross-over design also ensures that all herds receive a treatment at one point in time, which may make the experiment more palatable to participating livestock producers (Ohrens et al., 2019; Treves, 2019).

An exemplary peer-reviewed, gold standard study comes from Ohrens et al. (2019). This study in Chile used an experimental test on 11 herds of domestic alpacas *(Vicugna pacos)* and llamas *(Lama glama)* randomly assigned to control or treatment conditions, with a cross-over design to test a light deterrent against pumas (*Puma concolor*) and Andean foxes *(Lycalopex culpaeus)*. In this study, the researchers were able to isolate the effects of light devices in deterring pumas and Andean foxes by comparing each replicate to itself, thereby avoiding the difficulty of comparing herds that may have differences (e.g. predisposition to predation, individual differences in animals, etc.). Therefore, researchers in this study could make a strong inference that light deterrent devices could successfully deter pumas, but not Andean foxes. This result is not surprising given van Eeden et al. (2018)'s finding that deterrent devices were effective in 67–75% of 11 experimental or quasi-experimental studies. Interestingly, van Eeden et al. (2018) found that deterrent devices were effective in 95–100% of correlative studies examined (n = 29). The differences in results clearly illustrate the importance of standards of evidence that lead to strong inference when determining effectiveness of predator deterrence methods.

Gold standard experimentation can be challenging to implement in practice, particularly when a control is necessary for comparison. In order to achieve the highest level of scientific rigor, the experimental control ought to be the absence of any treatment. However, creating a true control may not be practical in these experiments because absence of any treatment would require leaving a herd (and therefore a producer's livelihood) entirely unprotected. For example, if the treatment is predator-proof fencing, then one might assume that the absence of the treatment (control) would be no predator-proof fencing, and thus in order to assess the real effectiveness of this method, no other type of prevention intervention should be allowed to be implemented by the producer. A more ethical solution would instead be to maintain the same base conditions between treatment and control groups (Treves, 2019; Treves et al., 2019). For example, if a producer habitually checks on his or her herd every few days, then the producer may continue to do so for both treatment and control while the erected fence acts as the treatment. Herds receive *more* protection under a treatment scenario than when they are a control group, instead of receiving *no* protection. This method is likely to be more acceptable to producers if scientists are testing an *added* prevention method while producers maintain 'business-as-usual' practices. Treves (2019) suggests that this is a particularly important distinction as it shows that gold standards of experimentation are more challenging, but not impossible, to implement.

Gold standard experiments, while resulting in the most consistent and rigorous scientific inference, require studies to be developed with very specific conditions (Treves, 2019). Unfortunately, this means that gold standard studies will rarely use previously col-

Table 1 Three common biases, how to avoid them and the strength of inference that can be achieved when using gold, silver and bronze standards of experimentation. Adapted and expanded from Treves (2019).

Standard of evidence	**Gold**
Definition	Randomly selected control and treatment groups which are statistically comparable.
Types of biases[1]	
Selection bias	**None.**
Treatment bias	**None.**
Measurement bias	**Sometimes.** Avoided if the researcher collecting data is unaware of whether the replicate is a treatment or control.
Potential conclusions	Can isolate treatment effects from potential impacts of confounding factors such as time, spatial characteristics and other differences between replicates.
Standard of evidence	**Silver**
Definition	Depredations are measured multiple times over the study period before and after a treatment is implemented (in which case controls come before treatments), and/or treatments are compared to controls but one or both are not randomly selected.
Types of biases[1]	
Selection bias	**Yes.** Treatments and/or controls are not randomly selected.
Treatment bias	**Sometimes.** Avoided by using a cross-over design and standardized implementation between treatment replicates.
Measurement bias	**Often.** Same as with gold standard but more likely to occur when no controls are used. May be avoided if the researcher collecting data does not know what the intervention is, but this is rare.
Potential conclusions	Can isolate treatment effects from many confounding factors such as treatment implementation, but not necessarily from spatial or time variables.
Standard of evidence	**Bronze**
Definition	Depredations are measured on replicates where treatments are already being used or have just been implemented in response to a depredation. Rarely a control. Correlative studies.
Types of biases[1]	
Selection bias	**Yes.** Non-random selection of treatment replicates and treatments are often implemented as a result of depredations.
Treatment bias	**Yes.** Treatments are harder to standardize, usually because they have been implemented before the study begins.
Measurement bias	**Often.** As for silver.
Potential conclusions	Can identify potential patterns and correlations between treatments and outcomes but cannot isolate effect from time, spatial patterns, implementation (unless this is controlled for) or other potential confounding factors.

[1] Note that there is always potential for reporting bias, but we have not included it here since this is a bias that should be eliminated based on ethical scientific reporting standards. For more on this bias, see table in Treves (2019).

Livestock held in an effective *kraal* in Botswana. This is an example of very effective fencing using purchased or found materials.

An example of an ineffective fence that is permeable to predators in Botswana.

(Photos: Kelly Stoner).

lected data. Due to this, we observed that silver or bronze standards of experimentation are more commonly found in the recent literature for evaluating depredation prevention tools and methods.

2.2 Silver standard

Silver standard experimental designs lack the random assignment of treatments and/or controls, and are often longitudinal over time, i.e. the effectiveness of the treatment is measured at multiple points along a timeline (van Eeden et al., 2018; Treves, 2019). In most longitudinal studies, either controls are not used at all or there is no specific record of control conditions occurring prior to implementation of the treatment (Smokorowski and Randall, 2017). This means that changes observed during a study could be the result of treatments or other factors such as time or seasonal conditions (Treves, 2019). Furthermore, the lack of random assignments may inadvertently introduce selection bias. Researchers could unintentionally select replicates predisposed to depredations (or *vice versa*) for replicates receiving treatments. However, silver standard studies still allow researchers to reduce other biases such as treatment and measurement biases as they allow a great deal of control over intervention implementation and measurement of predator responses (Treves, 2019).

A recent study by Weise et al. (2018) examined the efficacy of fortified *kraals* (predator-proof night enclosures) in reducing carnivore attacks on livestock in the Kavango Zambezi Transfrontier Conservation Area, in Botswana. This study randomly assigned some herds as control groups (e.g. controls used unfortified *kraals*, therefore they were fenced but not predator-proof), but it did not randomly assign treatments; instead, researchers found and included producers who already used fortified kraals. The authors examined the number of livestock attacks in both treatment and control herds over 18 months. Because treatment herds were not randomly assigned, control groups were spatially separate from treatment groups and the environmental conditions for these control groups (e.g. geographic features, dominant landcover types, predator density, wild prey density, etc.) were not recorded for treatment groups. Thus it is difficult to conclude whether attack occurrences or absences were due to the fortified *kraals* or another external variable. However, comparing randomly assigned controls and treatment *kraals* over time enabled the researchers to minimize some treatment biases (e.g. differences in *kraal* type, style and maintenance) and allowed them to isolate the effect of *kraal* implementation.

The experiment found fortified *kraals* to be more effective at reducing predator attacks but that *kraals* required a great deal of maintenance to stay effective. This result is consistent with the findings of Eklund et al. (2017) and Treves et al. (2016) (as referenced in van Eeden et al., 2018): 66 % of high inference studies on enclosures found them to be effective. However, about 22 % of the studies showed enclosures to be ineffective, perhaps because their effectiveness was highly reliant on frequent maintenance (Weise et al., 2018). Despite having a weaker strength of inference than gold standard, silver standard experiments are easier to implement and accommodate situations

where researchers and managers have less control. As with the Weise et al. (2018) study, silver standard experimentation allows for greater use of existing intervention efforts.

Another example of the silver standard of inference was published by Santiago-Ávila et al. (2018). In this study, the authors used pre-existing data collected by the Government of Michigan to examine the effectiveness of lethal methods versus non-lethal methods for wolf-livestock conflict prevention. These authors retroactively compared the data from lethal efforts to a variety of non-lethal methods employed by state wildlife managers. The authors considered the herds protected by non-lethal intervention methods to be pseudo-controls, because wildlife managers would sometimes choose to forgo lethal control and instead provide livestock producers with non-lethal deterrents (Santiago-Ávila et al., 2018). Because the field agents made non-random decisions about where to implement lethal control, the method in which herds were assigned either lethal or non-lethal control introduced selection bias. The authors accounted for spatial variation and the potential for treatment bias by comparing an intervention site to itself over time (cross-over design). However, they could not account for the selection bias imposed by field agents (Santiago-Ávila et al., 2018). In this study the researchers were able to eliminate sufficient confounding variables (e.g. spatial variation) in order to isolate the effect of certain depredation prevention methods. Therefore, while not all biases are removed, statistical analyses from silver standard studies may be used to draw conclusions about the relationship between variables and outcomes (Treves, 2019).

2.3 Bronze standard

The third standard of evidence is the bronze standard, which relates primarily to correlation studies (van Eeden et al., 2018; Treves, 2019). Correlative studies have a lower power of inference because they examine the effects of interventions non-systematically (resulting in treatment bias), they usually do not use control replicates and they are frequently implemented in response to livestock losses (thereby they do not reduce selection bias; Treves et al., 2016; van Eeden et al., 2018; Treves 2019). A recent example of a bronze standard study comes from Boast et al. (2016). This paper examined the effects of cheetah (*Acinonyx jubatus*) translocations on livestock losses. Data for this study were collected after a livestock kill occurred and no controls were used (e.g. no comparisons were made for depredation events in areas where translocations had and had not occurred) (Boast et al., 2016). Therefore, it is possible that other factors may have confounded the results. Van Eeden et al. (2018) described only five peer-reviewed studies on translocations as a predator deterrence method, all of which were correlative and one of which found translocations to be counterproductive in preventing conflicts.

Bronze standard experiments are quite common in scientific literature about depredation prevention, likely because they usually cost far less than gold or silver standard experiments and they can be conducted opportunistically. For example, it is simpler and less expensive to do a bronze level analysis of cheetah translocations that are already occurring in response to livestock losses than it is to design and implement a new cross-over gold standard experiment. While correlation studies cannot isolate causal links, they can identify potential patterns of depredation as a result of intervention methods. Van Eeden et al. (2018) suggest that, due to the lower strength of statistical inference in correlation studies, it would be best to use these as preliminary studies that identify methods for more rigorous testing.

3. Recommendations and future research

When implementing intervention methods to prevent livestock depredations by carnivores, either for experimental or functional purposes (or both), it is important not only to select the appropriate method(s) but also to implement them consistently and effectively. Intervention methods are applied across a diversity of ecosystems and species, and their effectiveness in various contexts should be carefully and rigorously examined (Rigg et al., 2019).

We encourage further research to be focused on:

1. designing high quality experiments to rigorously test the functional effectiveness of intervention methods, as suggested by van Eeden et al. (2018);
2. examining the relationship between functional effectiveness of intervention methods and likelihood of method use by producers (i.e. whether quantitative evidence of intervention effectiveness influences which method(s) a producer chooses to implement); and

A foxlight placed on a woodpole next to a llama or alpaca sleeping site in the altiplano of Chile. *(Photo: Omar Ohrens)*

3. using rigorous social science methodologies to qualitatively evaluate the links between livestock depredation reductions and any resulting cultural shifts in how carnivores are perceived or accepted on the landscape.

Conservation practitioners, whether they be wildlife managers, non-profit organizations or researchers, will be invaluable in achieving these research goals, as they are likely to best identify which methods are used locally, how to implement an experiment cost-effectively and how to communicate with participating producers in order to examine its effectiveness.

When choosing to study or implement conflict mitigation methods we recognize that managers, researchers and conservationists have varying definitions of effectiveness. In general, intervention effectiveness is commonly understood as either reducing the frequency of depredations, improving producer tolerance for depredation events, reducing the killing of carnivores in retaliation to depredations, or a combination of these. Thus it will be important for researchers to have clear goals and a clear definition of the desired method effectiveness from the outset of each study.

Finally, we recognize that a key goal of evaluating depredation prevention methods is to understand their relative efficacy, enabling wildlife managers, conservationists and producers to select the most effective method(s) for their situation. However, we should note that the effectiveness of a method that is tested using high standards is not absolute, because the effectiveness will vary given there are infinitely diverse environmental and human factors and conditions (species dynamics, weather patterns, geography, socio-political dynamics, etc.; Treves, 2019). In order to assume that a method will match the effectiveness in multiple contexts, these dynamic factors would all

have to be exactly the same. Therefore, these evaluations should be used as guides to help producers, managers and conservationists understand which tool or suite of tools are *more likely* to be effective in a particular scenario with regard to the specific carnivore species, habitats and livestock involved. Decisions about which techniques to use are likely to be influenced by a number of other factors besides their efficacy, including cost and availability. Understanding the relative effectiveness of key conflict intervention methods will save wasted resources spent on ineffective methods and lend credibility to decisions as managers and researchers update management plans and respond to livestock damages caused by carnivores.

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Research Paper

EFFECTIVENESS OF FENCES AT PROTECTING LIVESTOCK FROM WOLVES

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1. Introduction

After an absence of 150 years, wolves *(Canis lupus)* are slowly repopulating Switzerland. The first individuals were noted in the Swiss Alps in the mid-1990s and the first pack became established in 2012 (Breitenmoser et al., 2016). With their return, the old conflict with farmers worried about their livestock has re-emerged. However, tools are available to modern-day farmers to help them protect their flocks. One such tool is electric fencing.

For several reasons, it is difficult to measure the effectiveness of fences (see Rigg et al., 2019 in *CDPnews* issue 18). The pressure that fences have to withstand depends on a number of variables including wolf density; prey populations diversity, density and vulnerability; whether wolves are present in reproductive groups or as single individuals; and if they have any previous experience with fences. In addition, other factors such as time of day and proximity to forest cover and human settlements may affect wolf predation pressure (see Dondina et al., 2013).

In a series of experiments in a zoo, it was found that wolves hardly ever crossed electric fences if certain criteria were fulfilled (see Lüthi et al., 2017 in *CDPnews* issue 13). In particular, none of the wolves jumped over fencing, even if it was as low as 65 cm. It therefore seems possible that high fences, above a standard height of 90 cm, may not provide greater protection, while on the other hand being inconvenient for farmers and posing a greater risk to wildlife.

However, wolves might behave differently in captivity than in the wild. We therefore investigated the effectivity of fences to protect livestock from free-ranging wolves on farms in Switzerland.

The aims of our study[1] were to:

- identify which types of fences are currently used on Swiss pastures;
- assess how effective they are at preventing attacks by wolves;
- identify the most common flaws in fence design and installation;
- identify the main challenges for farmers in using fences to protect their livestock.

[1] The full study can be downloaded from www.protectiondestroupeaux.ch

2. Study area

Even excluding mountain pastures, over 70% of Switzerland's agricultural area is grassland and pastures. Sheep husbandry declined from 417,000 sheep in 2012 to 351,000 in 2017 and, with an average of 40 sheep per farm, is fairly small-scale. In summer, around half of them go to alpine pastures where they graze freely, in mobile fences, or with a shepherd (Federal Office of Statistics, 2018). Most farms in Switzerland use either electric wire or net fences or unelectrified mesh wire to keep their sheep in pastures. The grazing period usually starts in late March and ends in November, with sheep generally kept in barns during winter. Transhumant flocks have become quite rare in Switzerland: there are about 30 shepherds who take their sheep to winter pastures.

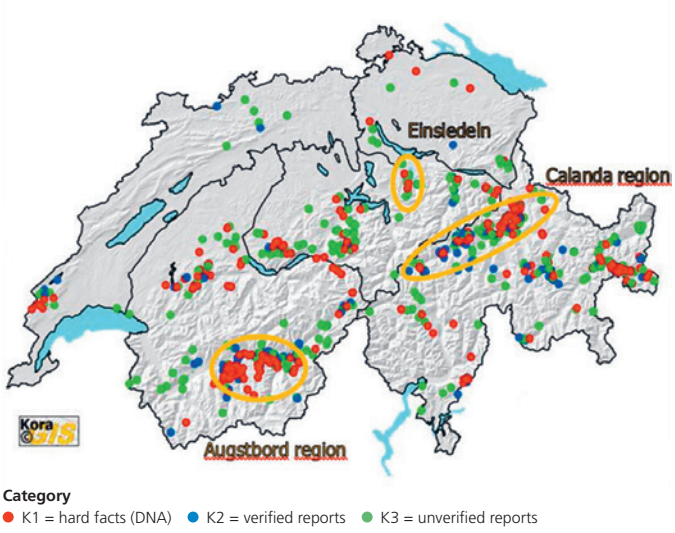

Fig. 1 Locations of study areas and records of wolf occurrence in Switzerland in 2017. *(Source: KORA, AGRIDEA[2]).*

In 2017, 42 wolf individuals were identified in Switzerland: four packs of which three reproduced in 2017, three possible pairs and several single animals, of which six were resident within a territory. Eighteen individuals were known to have left Switzerland (KORA, 2017). Even though wolf numbers are increasing and their distribution is expanding, livestock damages declined from 397 animals killed in 2016 to 235 in 2017. Losses are almost exclusively of small stock (Hahn et al., 2018).

3. Methods

Our study was based on three different approaches to assess the effectiveness of fences in livestock protection. Firstly, gamekeepers[3] in Switzerland who had reported attacks by wolves between January 2017 and June 2018 (n = 40) were contacted and asked to provide details of these cases. Wolf damages were assessed regarding the characteristics of fence systems and their condition at the time of attacks. Attacks on alpine pastures and/or pastures with the presence of livestock guarding dogs were excluded from the analysis, since the situation in these environments is usually rather complex and fence systems may not play a major role.

Since there are many unconfirmed rumours about wolf behaviour, the second approach was to ask experts who have been dealing with wolf attacks for several years to share their experience and opinions. A total of eight experts were interviewed: four gamekeepers and cantonal livestock protection advisers from Calanda region; one gamekeeper from Augstbord in Canton Wallis; a technician from KORA[4], which is responsible for monitoring large carnivores in Switzerland; an adviser on wolf issues in Saxony; and another wolf expert in Germany. Most questions related to livestock-protection fences. We wanted to know if experts considered them to be effective, what they regarded as the most important aspects when setting up fences and where mistakes and misinformation occurred. Other questions included, for example, whether individual wolves posed a bigger threat to livestock than packs, or to what extent wildlife populations have changed since wolves returned to Switzerland.

Thirdly, in the spring of 2018 we visited farms in three regions with wolves in order to find out which fence types were used on Swiss pastures, how well they worked, how farmers checked and maintained them and what the challenges were when setting them up. Three regions were chosen: Calanda Valley, the territory of the oldest wolf pack in Switzerland and where attacks on livestock are relatively rare; Augstbord region in Canton Wallis, which also has a

[2] www.kora.ch

[3] Gamekeepers are responsible for local wildlife management, planning and control of hunting and the monitoring and conflict management of all wildlife species.

[4] KORA: Koordinierte Forschungsprojekte zur Erhaltung und zum Management der Raubtiere in der Schweiz (Coordinated Scientific Research Projects on the Protection and Management of Predators in Switzerland) www.kora.ch

resident pack but a high number of attacks; and the region around Einsiedeln in Canton Schwyz, where there is a single resident wolf and quite frequent evidence of other individuals passing through (Fig. 1). Altogether, 29 farms were chosen as typical for the regions: 13 in Canton Wallis, eight in Calanda Valley and eight in Canton Schwyz. For the selection it was important that either the farm itself or a neighbouring farm had suffered wolf predation. Eleven of the farms visited had had attacks, eight of them in Augstbord region. Farms with livestock guarding dogs were mostly excluded, since the confounding effects of the dogs might obscure any effect of the fences.

We also visited pastures and assessed the characteristics of the terrain and the fence systems. We wanted to know how difficult it was to protect the pastures. This assessment was done using a coding system. Both fence quality and pasture protectability were assessed using five categories with four possible points each, adding up to a maximum of 20 points. Data were collected on steepness, scrub encroachment, complexity of shape, proximity to forest edge and ground characteristics. In order to evaluate the protection status of the fence systems, we assessed the type of fence system, its condition, electric current, visibility and distance from the ground of the bottom wire.

4. Results and Discussion

4.1 Analysis of fence systems and damage

All interviewees remembered quite well situations where damage occurred. The proportions of different fence systems in use when attacks occurred are shown in Figure 2. It is clear that, apart from those by a particular problem individual M75, most attacks happened within non-electrified fences or electric fences with obvious flaws (e.g. electricity discharge due to heavy snowfall).

Attacks by wolf M75 are collated separately, since this individual evidently jumped over fences. M75 began attacking livestock in southern Switzerland, where non-electrified fences are common, so it is assumed that it learned to jump over them. When it moved further north, it also jumped over electric fences, as proven by tracks in the snow.

Broken fences were considered in detail, because they are difficult to assess. One pasture, for example, was rather small. The interviewed gamekeeper believed that the presence of a wolf outside the fence caused panic in the flock, which must have broken through the fence. Even though the churned-up ground provided a good substrate for footprints, he did not find any tracks of wolves inside the fenced area, while all dead sheep lay outside the fence. It is theoretically possible that a wolf could overcome a well set-up fence system, but this is very difficult to determine after the fact if parts of the fence are found torn down. Only one attack happened in a fence system without obvious flaws. In this context, 'obvious' is a relative term, as gamekeepers generally do not check fence systems or the electric current in them when assessing damage. Still, the general pattern is clear: most attacks happened in the absence of fully functional electric fences.

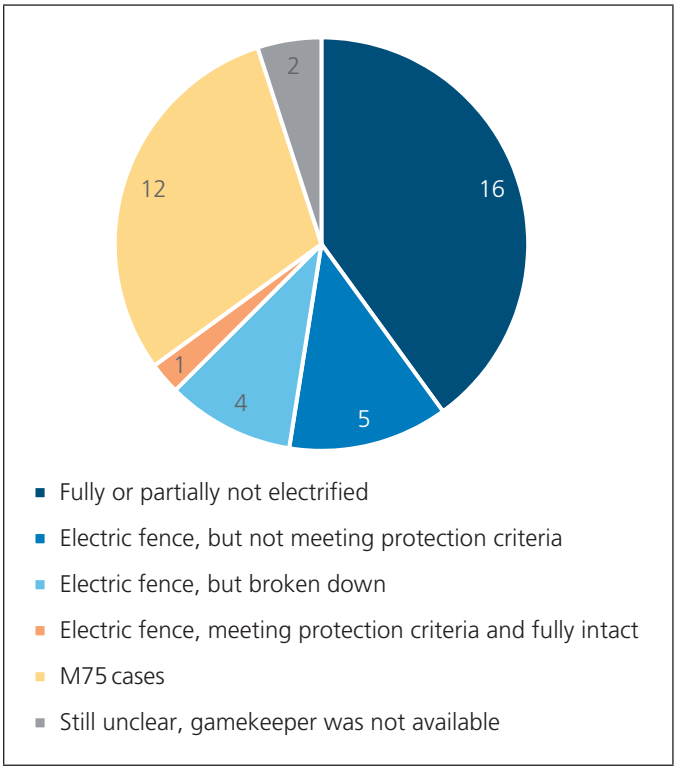

Fig. 2 Condition of fences at the time of attacks by wolves on livestock as reported by gamekeepers in Switzerland between January 2017 and June 2018 (alpine pastures and situations with livestock guarding dogs excluded) (n = 40). *(Source: AGRIDEA).*

4.2 Interviews with experts

Although the interviewed experts did not agree on all questions, trends in their responses were apparent. All of them were very confident about the effectiveness of fences in protecting livestock from wolves. Apart from correct setup, the avoidance of weak points and maintaining a sufficient electric current (min. 3000 V) were thought to be of utmost im-

portance. Basic protection standards were considered satisfactory. According to the experts, common flaws were insufficient electrification (i.e. grounding problems, high grass or old fence components), but also non-electrified parts (e.g. gates, water courses, etc.) (Figs. 3, 4). All experts saw major constraints in the additional workload and, to some extent, the expense of energizers, which are not supported by the state.

Fig. 3 Non-electrified gate in an otherwise well set-up electric fence. *(Photo: AGRIDEA)*

The experts differed in their opinions concerning whether individual wolves or wolf packs varied in their behaviour when attacking livestock. Due to the lack of consensus, no clear answer to this question can be provided.

Fences pose a risk of entanglement to wildlife. Apart from welfare concerns, this also causes problems for livestock protection, as fences become dysfunctional when damaged by wildlife. To avoid this, experts agreed on the necessity for removal of fencing after the grazing period and to enhance its visibility while in use (e.g. with fladry or fence tape) as an effective means of preventing wildlife damage.

Regarding changes in wildlife populations and behaviour following the return of wolves, opinions diverged slightly. Gamekeepers reported that wildlife became more careful and less predictable. It seemed that populations of roe deer *(Capreolus capreolus)* had been decreasing in areas with wolves. For red deer *(Cervus elaphus)* and wild boar *(Sus scrofa)*, the correlation has been less distinct. In Calanda Valley, for example, red deer populations had decreased, while in surrounding regions numbers had increased. It was

Fig. 4 A well set-up electric fence with one substantial weak point at a stream crossing. *(Photo: AGRIDEA)*

therefore assumed that some red deer had migrated. However, interpretation is very complex since wildlife populations also show fluctuations without the presence of wolves.

There was an interesting insight from Saxony, a region with a relatively high density of wolf packs. Standard electric fences such as 90 cm nets or 4-wire fences were recommended in the region and mostly worked quite effectively. However, it seemed that some individual wolves had learned to jump over them. Initially it was recommended to add an additional tape above the fence at around 120 cm. However, after providing protection for some weeks, these extra high fences were also jumped over.

4.3 Farm visits

The three regions differed significantly in terms of the types of fencing used to protect livestock (Fig. 5). In Calanda Valley, all the interviewed famers used electric net fences, mostly with a standard height of 90 cm. Only one farmer had had an attack on his livestock, when lambs broke out of the fence. It was interesting to hear that farmers in Calanda had also been using electric fences before wolves returned to the area. Some farmers mentioned that farms in Calanda are able to put more effort into fencing, since there is a higher proportion of full-time farmers, but this could not be verified with the data collected.

In the Augstbord region, there are more hobby and part-time farmers than in Calanda. Their fences, however, are in no way inferior to those of their full-time colleagues. Many farmers in Augstbord still use 'classic', 100 cm high non-electrified mesh-wire-

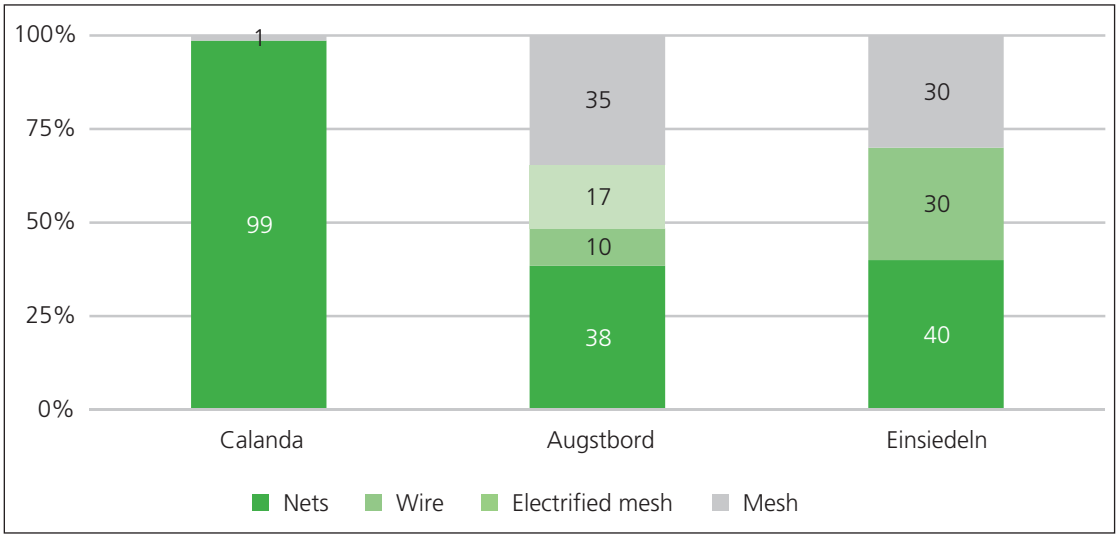

Fig. 5 Type and proportion of fences used in three regions of Switzerland. *(Source: AGRIDEA)*

fences. We visited several farmers who had already retired from their main jobs. They said it was easier for them to use night pens or barns as livestock protection than to clear steep pastures for electric fencing and maintain it regularly. In the Einsiedeln region, with low and irregular wolf presence, farmers did not make substantial adjustments. Many farmers stated that upgrading fences would not just mean additional costs, but also an ongoing increased workload due to maintenance. This was not considered worthwhile until the predation risk increased.

Six farmers consistently used extra high electric nets or wire fences of 105 or 120 cm and four others only partially. Two farmers also used nets with alternate charged wires. With this type of fencing it is possible to avoid grounding problems which can occur, for example, in dry or shallow ground.

Concerning the maintenance of electric fences, most farmers stated that they only cut the grass once before setup, not at all, or only if necessary. Only one farmer cut it regularly, every two weeks.

The types of adaptions that farmers had made since the return of wolves are shown in Figure 6. Livestock protection llamas were quite popular in Einsiedeln: five of the eight farms visited kept llamas for this purpose. Llamas work especially well for smaller flocks and are believed to be mainly effective against single wolves. One reason that llamas were so popular in Einsiedeln could be that there was a llama breeder in the area.

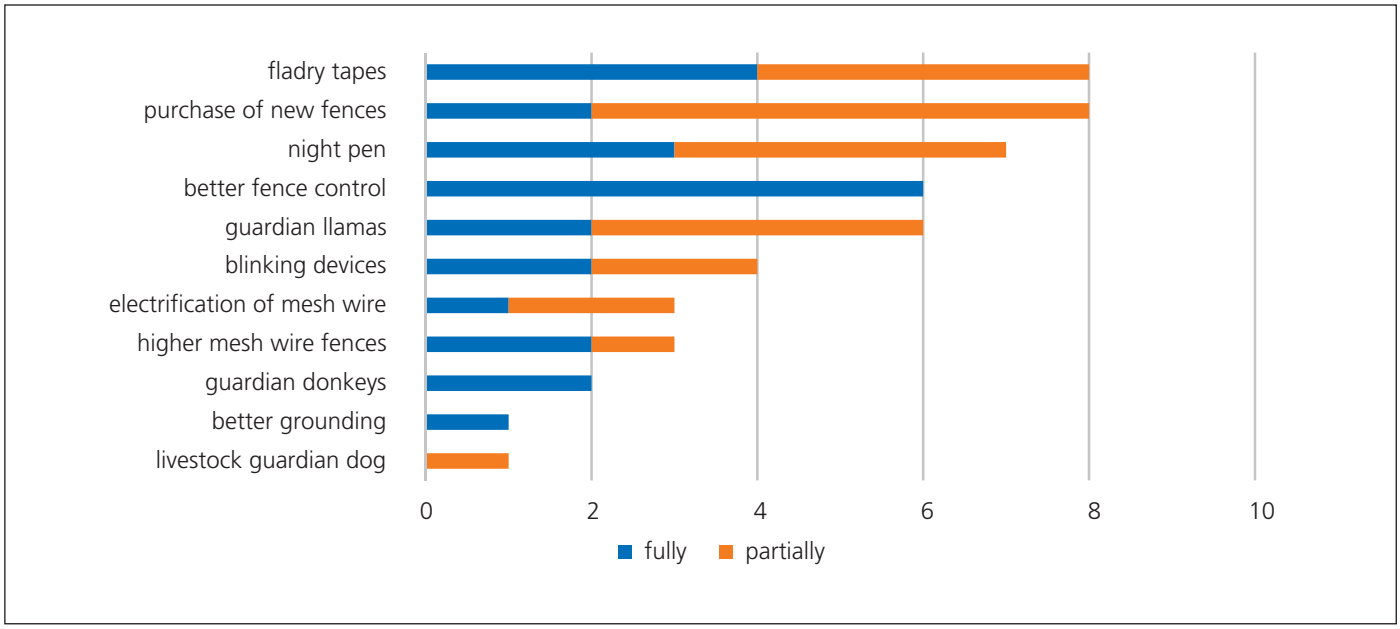

Fig. 6 Type and frequency of adaptions to protective measures implemented by farmers in Switzerland in response to the return of wolves. Multiple answers were possible. *(Source: AGRIDEA).*

More difficult pastures tended to be assessed as having lower protection status. It should be mentioned, though, that the two fences with the best protection status were in extremely difficult terrain. It obviously took a lot of effort to set them up and farmers emphasized that the physical effort and time required were huge.

Considering the quality of protection fences, the main issues resulting in an assessment of low protection status were missing electrification, low electric current and inappropriate setup, while distance between the bottom wire and the ground was rarely a problem, since only a few farmers worked with wire fences and electric netting provided good closure to the ground. The thorough and appropriate setup of electric fences is more difficult and labour intensive in demanding terrain.

4. Conclusions

Although our findings do not provide a generalised answer to the question of fence effectiveness, some clear tendencies can be identified. The case of individual M75 showed that a livestock-protection fence that is both practicable in a mountainous environment and 100% risk free does not exist. Still, experience shows that wolves hardly ever jump over correctly installed electric fences, even though they are physically more than capable of doing so. The height of the electric fence does not seem to play a major role.

Higher fences translate into additional work for farmers and shepherds and their setup can be especially challenging in steep and remote areas, such as alpine pastures. On many farms, 90 cm standard-height fences are already in use as they are comparatively easy to handle and offer a level of protection similar to higher fences. For this reason, this solution for livestock protection is widely accepted and implemented by farmers. However, experience from Germany suggests that the protection level provided by using standard-height fences can only be maintained if problematic individuals that learn to jump over them are quickly removed from the population.

It is important to point out that fences must be properly installed and well maintained. If a wolf is persistent and has time to thoroughly examine a fence, it will find any flaws. Fences must be electrified all the way around the pasture and under tension. Typical weak points are: water crossings, uneven ground and non-electrified components (e.g. gates). It is important to use good quality materials and to check and maintain fences and their electrification regularly.

Acknowledgements

Thanks go to Claudio Spadin, Jan Boner, Sven Baumgartner, Rolf Wildhaber, Martin Brantschen, Ralph Manz, André Klingenberger and the late Ulrich Wotschikowsky for sharing their experience and expertise as well as to all the visited farmers. Despite making all efforts not to give them a feeling of being inspected, it still was an assessment of the situation, which could be aggravating. Nevertheless, everybody was very kind, frank and honest when taking the time to show their work. Thank you also to the AGRIDEA team for their support and discussions during the study as well as to the editors of *CDPnews* for improving this article.

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Position paper

LIVESTOCK FARMING AND THE WOLF IN GERMANY

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World Wide Fund for Nature Germany (WWF) — *Contact: Moritz.Klose@wwf.de*

1. Recommendations for nationwide standards for livestock protection against wolves

There is currently a patchwork of standards and recommendations in Germany for livestock protection. Neither technical implementation nor funding are regulated within a national framework. Also, there are no clear rules for the killing of a wolf that overcomes herd protection measures and attacks livestock, although the removal of such problematic wolves under current nature conservation law is possible. Some federal states therefore criticize inadequate legal clarity concerning wolves and livestock protection. A framework regulation from the federal government could create more security and contribute to sustainable coexistence. Its consistent implementation would be up to the federal states. In the following, the signatory associations recommend standards for livestock protection as well as for the removal of individual wolves showing problematic behaviour and call upon the federal government to create the legal and regulatory basis for their practical implementation.

According to the current state of knowledge, the measures described in the appendix guarantee sufficient protection of livestock against attacks by wolves. The recommended standards should therefore be adopted throughout the country in areas with wolf occurrence. They should be implemented according to best professional practice and practicability. In this context, it is important to begin the development of livestock protection in potential wolf areas before the first wolf settles and to define areas with proven wolf presence rapidly in accordance with the relevant funding guidelines. There is an urgent need for improvement in both aspects in the federal states.

First German Network Meeting and press conference.
(Photo: NABU/V. Gehrmann)

2. Support for livestock protection

The additional expenditure resulting from the presence of wolves for material and personnel costs for the recommended livestock protection measures should be financed 100% by State aid, especially since the obstacles in European State aid law have now been removed[1]. This aid should be paid to all farmers concerned, irrespective of their employment status or herd size.

3. Compensation for killed livestock

Cost-covering compensation for the consequences of attacks on livestock in regions with proven wolf presence should be paid by the federal states if the farm had implemented the recommended standard of protection and the wolf was not excluded as the cause of damage. In other areas, compensation should be paid if the wolf was likely to be the cause.

4. Removal of wolves

The removal of wolves is always a case-by-case decision and does not replace the need for comprehensive livestock protection measures. If a wolf repeatedly overcomes properly implemented livestock protection measures according to the standards recommended by the signatory associations and repeatedly attacks farm animals, it may be necessary for the respective competent state authority to grant an exemption permit for its killing after the legally necessary examination of the individual case in order to prevent further damage. The wolf to be removed must be sufficiently clearly identified or caught during an attack on protected livestock. Removals should be carried out by specialists commissioned by the authorities.

A removal is appropriate in individual cases after at least one of the following:

- one overcoming of a measure of standard protection followed by a further overcoming of a measure of increased protection, *or*
- one overcoming of a measure of increased protection, *or*
- one attack during active herding of a flock, for example by shepherding.

[1] Editor's note: see Katrina Marsden's article on *Changes to State aid: European guidelines for financing compensation measures* in *CDPnews* issue 18.

Interview with Moritz Klose

Wolves and livestock protection can go hand in hand in Germany

In July 2019, 11 non-governmental associations from the fields of agriculture, livestock husbandry, nature conservation, animal welfare and hunting published a position paper calling for common standards for livestock protection across all federal states in Germany. *CDPnews* talked to WWF Germany's Moritz Klose, one of the authors of the paper.

How long did it take to reach consensus among such a varied group of partners?
Our alliance has been discussing the need for a joint position paper since we first got together in 2017. It took several months to finalize the document and agree on key recommendations for nationwide livestock protection standards and criteria for the management of wolves showing problematic behaviour. As you can imagine, the removal of wolves is quite a touchy subject, but we managed to agree on recommendations for how to deal with individual wolves that repeatedly cause damage to properly protected livestock. In essence, this means that if a wolf gets into a flock of sheep more than once, even though proper protection measures were in place, the wolf should be removed.

What are the main criticisms of livestock protection and wolf management in Germany?
Our associations are critical of the practical and legal uncertainty that often prevails in Germany when it comes to managing wolf-livestock conflicts. There is a confusing patchwork of different recommendations and standards for the adaptation and promotion of livestock protection measures. In addition, although it is possible to legally kill individual wolves that overcome recommended livestock protection measures and attack livestock, there is a lack of clear criteria and procedures for how this should be done. This 'federal confusion' is at the expense of both conservationists and livestock owners.

What is your alliance demanding?
We don't want politicians and society to offset ecologically valuable livestock grazing against the ecologically valuable return of the wolf. Mitigating the impacts of the return of the wolf should be considered a societal responsibility and livestock owners must not be left alone with the challenges they face.
Our alliance is calling for a framework of regulations from the federal government to foster sustainable coexistence between wolves and livestock farming. In contrast to the planned amendment to the Federal Nature Conservation Act, our position paper focuses on substantive and practicable approaches and provides concrete recommendations for the nationwide implementation of suitable livestock protection in current and potential wolf areas.
We demand a cost-covering state subsidy, which also includes ongoing maintenance costs of, for example, livestock guarding dogs. Our associations regard the killing of wolves that show problematic behaviour as a last resort. We agree that the need for good livestock protection is unavoidable. The Ministry of the Environment and above all the Ministry of Agriculture must work together to achieve this.

Is support available to livestock owners to implement protection measures?
The European Commission has created legal frameworks and funding schemes for member states to promote and support livestock protection measures. In Germany, most federal states already offer funding for protection measures. The federal government and states must now act urgently. Our associations agreed that not only the initial investment costs for fences and dogs should be paid by the states but also the cost for keeping dogs and maintaining the fences. For example, currently existing agri-environmental schemes could be expanded to offset maintenance costs.

Appendix: Recommendations for protection standards

1. Standard protection

Relevance: animal welfare protection law, damage compensation for livestock killing by wolves

1.1 Grazing of sheep and goats

- Fences with at least four electrified wires or electric netting, in each case with a minimum construction-related height of 90 cm, a maximum height above the ground of the lowest current-carrying wire of 20 cm and a minimum voltage of 2500 volts; *or*
- Fixed fences made of mesh wire, hinge-joint fencing or similar material, with a construction-related minimum height of 120 cm and protection to prevent wolves from digging under the fence; *or*
- Active herding, for example by shepherding.

1.2 Grazing of farmed deer

- Fixed fences made of mesh wire, hinge-joint fencing or similar material, with a construction-related minimum height of 180 cm and protection to prevent wolves from getting under the fence.

1.3 Grazing of cattle, horses, donkeys and ponies

Cattle and horses are much less affected by wolf attacks than sheep, goats or farmed deer. Comprehensive protection is not absolutely necessary. For this reason, damage compensation should be paid in the event of wolf attacks if herding containment (escape proof) is guaranteed.

- Fences with at least two current-carrying wires, a construction-related minimum height of 90 cm and a minimum voltage of 2500 volts.

2. Increased protection

Relevance: Decision to remove a wolf

2.1 Grazing of sheep and goats

- Fences with at least five electrified wires or electric netting, in each case with a minimum construction-related height of 90 cm, a maximum height above the ground of the lowest current-carrying wire of 20 cm and a minimum voltage of 2500 volts; *or*
- Electric netting with a minimum construction-related height of 90 cm reaching an overall construction-related height of at least 120 cm using electric fence tape or other wide tape as well as a minimum voltage of 2500 volts; *or*
- Fixed fences made of mesh wire, hinge-joint fencing or similar material, with a construction-related minimum height of 120 cm and protection to prevent wolves from getting under the fence and reaching an overall construction-related height of at least 160 cm using additional current-carrying wire and wide tape if appropriate; *or*
- Fences with at least four current-carrying wires or electric netting, in each case with a minimum construction-related height of 90 cm, maximum height above the ground of the lowest current-carrying wire of 20 cm and a minimum voltage of 2500 volts and, depending on the size of area and flock, two or more adult, tested[2] livestock guarding dogs per flock; *or*
- Active herding, for example by shepherding.

2.2 Grazing of farmed deer

- Fixed fences made of mesh wire, hinge-joint fencing or similar material, with a construction-related minimum height of 180 cm and protection to prevent wolves from getting under the fence and a current-carrying wire on top of the fence with a minimum voltage of 2500 volts.

2.3 Grazing of cattle, horses and donkeys with calves or foals and ponies

In regions where wolves repeatedly attack cattle, horses or donkeys, protective measures should be applied throughout the area to be defined.

According to the current state of knowledge, the signatory associations recommend:

- Fences with at least five current-carrying wires with a minimum construction-related height of 120 cm, a maximum height above the ground of the lowest current-carrying wire of 20 cm and a minimum voltage of 2500 volts.

[2] Editor's note: 'tested dogs' are experienced in protecting livestock, preferably having been certified by one of the German associations for livestock guarding dogs. Within the certification process, dogs are tested for different behaviours, e.g. if they can be integrated into a new herd or if they show any unwanted behaviour such as aggression towards livestock.

Interview

PETER HATALA
INTERVIEW WITH A SHEPHERD IN SLOVAKIA

Interview: Michaela Skuban, Daniel Mettler

How and when did you become a shepherd?
Sometimes I have the impression that I was born a shepherd! *(laughs)* From the age of eight I started to herd sheep during my free time. I spent my holidays and weekends just with the sheep outside, alone in some abandoned pastures. Of course, I got some money for my work but, beside this, I was simply happy with this job. After I finished school aged 18, I fully dedicated my life to this work.

Could you describe your passion? What do you love most about your job?
That is a difficult question, what do I love most? Actually, two things: I love the sheep for how they are and that I make a living from them. And I love the dogs as my companions and that they protect me and my animals. Let's make a long story short: I simply have a great passion for sheep and dogs.

Can you remember the most difficult moment during your shepherding life?
Yes, as if it was yesterday. One night I was walking back from the pasture to the sheep-camp (*salaš* in Slovak) after dark. I had to pass a very dense forest and suddenly it was there: a bear, behind me. It was roaring at me and I could smell its body. Maybe it was afraid of me, I don't know, but it simply didn't stop roaring right in my ears. I started to run, but somehow slipped on the wet forest floor, fell and hit my mouth on my shepherd stick. I broke some teeth and started to bleed. It was painful and I felt helpless. Suddenly, I spotted two white creatures in the pitch darkness: my livestock guarding dogs (Slovak Čuvač). They chased away the bear and I managed to get away. Till today, I am extremely thankful to these two dogs who possibly saved my life. So, I lost some teeth *(laughs)*, but managed to run away otherwise unscathed.

Did you ever think about doing something else? If yes, why?
No, I never thought about changing my profession. However, I remember some very painful moments when I realized how difficult and time-consuming my shepherd life is in reality. I get up at 3 o'clock or 3:30 in the morning and often return around 10 or 11 o'clock in the evening. When my first child was born, I only saw her sleeping, never active. One day, though, I returned a bit earlier from the pasture and went straight home to see my 6-month old daughter playing in the garden. When she spotted me for the first time, she was afraid of me and started to scream. Actually, she didn't know me at all; I was for her an unknown person, a strange man, frightening for her. In that moment, my heart was full of pain. Nowadays, I can sometimes return home a bit earlier. Now, we have a grandchild and I can enjoy this little baby even more than my own children. I am very thankful to my wife, who always supported me. She managed everything alone at home and never blamed me for that. I can say that I truly love her till today. And I am also thankful to my two daughters who help me a lot with the dogs.

Can you remember when you met a wolf for the first time?
Oh, yes, you never forget such a meeting. It was in 1989 and I was with my sheep quite far away from the farm. At that time, wolves were very rare here in the

Low Tatra mountains due to hunting, but suddenly I spotted one 100 metres away. It was just observing me and followed me a bit when I tried to walk back, but always slightly hidden in the dense vegetation. I just had a small herding dog with me that I called Diabol (which means Fiend or Devil in Slovak), because he was so sharp with bears. However, Diabol stayed back; he had great respect for the wolf. The wolf did not attack, but from that moment it was clear that life would become more difficult.

When did you start breeding livestock guarding dogs?
During my childhood I trained and bred various dogs at the sheep camp. Sometimes I took them home, but my parents didn't like it. During my military service, I worked with German shepherd dogs and can now compare various breeds of dogs and their working abilities. When I returned to work, I continued to select puppies and trained them, but sometimes it happened that my boss stole my well-trained dogs. Since 1984 I've had my own herding and livestock guarding dogs and also breed them.

Have you ever seen your dogs chase away wolves or bears?
Yes, of course, I've seen both: how my dogs actively chased away attacking wolves and bears. Sometimes I also saw that very strong dogs just stood at the forest edge and barked without joining an active chase, which was enough, too. But you should never forget: attacks by wolves are more serious. I always say that

(Photos: Peter Hatala)

bears are wise, but wolves are professors *(laughs)*. Thus, you really need very good, brave dogs against them. That's why I always have between two and seven dogs with me. The number of dogs depends on various factors including the place where I go with the sheep, the weather conditions, the situation with wolves, the numbers of tourists and the dogs themselves.

Do you get some support for preventive measures, either from the State or some agricultural or sheep breeding organizations?
This is easy to answer: almost nothing. Sometimes it even happens that people are annoyed with me because I have so many dogs. Nowadays, my boss contributes a bit towards dog pellets, but it is not a reliable cash flow.

How serious is the influence of bears and wolves on sheep breeding in your region?

Actually, bears and wolves are not directly responsible for many sheep farms closing. This is rather due to people. During recent years, there are more and more people in the forest, mainly for recreational purposes like mountain biking, hiking, mushrooming etc. Such people are not willing to take care about either sheep or dogs. They walk through my flock and start to beat the livestock guarding dogs if they bark at them. Mountain bikers and motorcyclists even kill your sheep if they get in their way. Arrogant people are much more destructive than predators. Since 2006, I have nearly no losses due to predators except one ewe and one lamb. On average, I herd around 300–400 sheep, exceptionally up to 600 sheep.

How do you judge the future of shepherding in your region?

Simply: bad. No one wants to do this job. It is difficult and responsible work and also very time-consuming. It is definitely not all about money: if you pay an unreliable and alcoholic person a sum of 200 or 300 euros more, what will change? Nothing. Before, such a person spent 600 euros in the pub, afterwards 800 euros. It is our society which is lazy and wants to make a lot of money in a short time without much effort. A shepherd's life is the complete opposite.

How long do you plan to work as a shepherd?

(laughs) Until I jump into the coffin … Or maybe I would stop if something dramatic happened in my family. Or if I had a boss who was just making money from me. I don't want to contribute to the dirty lifestyle of corrupt people. Otherwise, I love my job with all my heart.

Perspective

HERD PROTECTION AID BY WIKIWOLVES

THE POTENTIAL AND LIMITS OF A NETWORK OF VOLUNTEERS

Nathalie Soethe[1]

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1. Introduction

Volunteer work has long been an important part of environmental protection efforts and plays a major role in the management and protection of wolves in Europe. Volunteer initiatives for herd protection aid have been established in several European countries, e.g. the PastoraLoup initiative of French organisation FERUS (www.ferus.fr), the Pasturs project of the Eliante cooperative in Italy (www.eliante.it), the recently founded Dutch group Wolf-Fencing Nederland (www.wolf-fencing.nl) and, until the beginning of 2019, the HirtenHilfe Schweiz (Swiss Shepherd Aid) of VösA (Union for Ecological and Safe Alp Management).

In Germany, the WikiWolves initiative has supported livestock owners in the implementation of herd protection measures since the spring of 2015 (www.wikiwolves.org). WikiWolves is an open and informal network of volunteers led by a team of regional organizers that act as liaison between volunteers and livestock owners. The network is open for anyone willing to donate their labour in order to assist livestock owners in setting up herd protection fences or similar measures.

WikiWolves aims to:

- assist livestock owners with herd protection measures against wolf attacks;
- promote dialog between people who are interested in or affected by wolves;
- provide information on wolves and livestock farming;
- encourage a wider appreciation of the work of livestock owners.

In the long term, the goal of WikiWolves is to contribute to a more peaceful co-existence of people and wolves. The network is independent of other organisations but thrives on and functions through close collaboration with sheep farming unions, other livestock owner associations, official wolf management representatives, nature and wolf conservation organisations and many other stakeholders concerned with the return of wolves to Germany.

2. Successful livestock protection

The experience of the WikiWolves initiative refutes both the generalization made by many livestock owners that livestock protection measures do not work and also the claim of some wolf proponents that such measures are always successful. Here, I would like to offer my personal perspective of what 'successful livestock protection' means and where I see the potential but also the limits of WikiWolves' contribution.

(Photo: Daniel Mettler)

One of the important roles I see for WikiWolves is to pose questions: '*How* can wolves and humans co-exist with little conflict?' and, '*How* can livestock protection measures be successful?' A follow-up to the second question is: 'What does successful livestock protection mean?' In the best-case scenario, it would mean that no livestock are hurt or killed by wolves. Reality shows, however, that even with the greatest efforts by livestock owners to protect their herds, wolf attacks cannot be avoided entirely.

A milder but more realistic definition of 'successful livestock protection' is that livestock owners are not overwhelmed by the requirements of the protection measures and are able to cope well with a low and calculable risk of wolf attack on their animals. For many regions in Germany this scenario is still far off in the future, requiring many political and societal changes before the goal can be reached, some small and some larger.

3. Activities of WikiWolves

The core activities of WikiWolves are 1–2 day weekend events during which small groups (about four to seven volunteers) help to build permanent fences that meet herd protection requirements (Fig. 1). The livestock owners generally provide meals and, if necessary, basic accommodation (e.g. a place for a sleeping mat or tent). Volunteers almost always cover their own travel costs. Every group event is organized by a WikiWolves campaign leader who either participates or designates an on-site leader.

Sheep farmers in Germany usually use mobile electric fences rather than permanent structures. Set-up and maintenance of such fences require daily attention. The typical 1–2 day events are therefore unsuitable for this situation. Nonetheless, WikiWolves has been able to support sheep farmers through individual volunteers who assist the farm in the long term, e.g. taking care of the day-to-day checks of electrical systems and repairs of damaged fencing material.

Fig. 1 Volunteers constructing protection to prevent predators getting under fencing. (*Photo: S. Dittgen*)

Fig. 2 Break on the meadow during a work assignment. (*Photo: N. Soethe*)

Volunteers generally require no prior skills. The only important prerequisite is simply the will to actively help as well as a certain openness towards people with different opinions. Occasionally, volunteers have the opportunity to participate in seminars organized by WikiWolves (Fig. 2). In northeast Germany, several 3-day seminars specifically for leaders have taken place. Participants learn about wolf management and ecology, various livestock protection measures and sheep farming. They also gain practical experience in sheep handling, interaction with livestock guardian dogs and the set-up of different fencing systems. One of the seminars' most successful elements has proven to be a barbecue together with interested livestock owners, giving volunteers and farmers the opportunity to get to know each other.

In our experience, participation in a seminar is not essential to provide effective assistance for livestock owners. This is one difference between the WikiWolves approach to herd protection assistance and that of the Swiss HirtenHilfe, in which a multi-day training session was a pre-requisite for a volunteer event on alpine meadows. However, campaigns in the mountains require a different level of commitment and much higher physical robustness than in the easily accessible lowlands. The multi-day on-site training sessions of the HirtenHilfe thus provided each volunteer with the opportunity to discover their own capabilities and limits.

4. Development of the network

The idea for WikiWolves was inspired by WikiWoods (www.wikiwoods.org): an online platform connecting volunteers who want to plant trees as a reforestation measure. Since herd protection from wolf attacks is a much more sensitive and conflict-prone topic than planting trees, it quickly became apparent that WikiWolves could not replicate the framework of WikiWoods directly. Thus, despite its name, WikiWolves could not be shaped by anyone who was simply interested in the subject, as is typical for Wiki platforms[1]. The challenge became to combine the wish for a decentralized network that allows participation by people from various regions and with different interests and opinions with the necessity to present shared values in order to allow us to work constructively within a societal conflict situation without foundering.

The result is an initiative shaped primarily by a team of organizers, consisting of a webmaster and liaisons for various federal states of Germany. The liaisons coordinate the network in their federal states in collaboration with regional supporters and under consideration of local possibilities and requirements, giving WikiWolves their own personal touch in their federal state. New liaisons are supported and mentored by established ones from other regions, if necessary. The team of organizers are unified by a WikiWolves codex that is based on past experience and which has been internalized by each team member. This codex presents rules and guidelines for conducting campaigns and representing WikiWolves in public. Its contents evolve and are adjusted as needed and as the organizers gain new experience.

The team of organizers supports each other and regularly shares experience and discusses important issues together. Overall, the network currently consists of around 300 volunteers across Germany. Some volunteers are one-time participants, others regularly take part in events and may even develop a fence-building-routine. The spirit of the network is dynamic: it changes and progresses depending on who participates and contributes. It is fascinating to have watched these developments over the past four years.

5. Key factors for a successful volunteer network

Two crucial factors are the participants' and liaisons' high level of personal commitment and, secondly, cooperation with other NGOs for wolf and nature protection. Finding sufficient volunteers for the individual work assignments is difficult and takes time; thus, every chance to address a new pool of volunteers should be taken. Interestingly, media presence helps in reaching new volunteers but is insignificant for establishing contact with new livestock holders, who are better addressed on the basis of their colleagues' recommendations or from farmers' associations. Since every new volunteer is of high value, we do not recommend a selection procedure. Everybody is welcome as long as some rules of good cooperation are respected. The selection of new liaisons for a new region is a more individual decision process that requires a period of getting to know each other. The interested person should agree with the codex and needs to understand the mediating role of WikiWolves. There is no need to build the network rapidly. Volunteer work is fed by enthusiasm and we acknowledge everyone's capacities and limitations.

6. What effect does WikiWolves have?

6.1 Fences

Between April 2015 and November 2019, WikiWolves assisted over 50 livestock owners through about 130 events nationwide. These events represent about 630 days of unpaid work by volunteers. Obviously, WikiWolves does not have the capacity to perform the additional tasks required for effective livestock protection measures for all of the nearly 20,000 sheep farmers in Germany (minimum herd size: 1 animal, data for 2016; BMEL 2019) as well as owners of other livestock. Our contribution is rather of a symbolic nature: we can support an individual farmer during a specific campaign, showing them that others care about their work and encouraging them to continue despite the additional efforts necessary due to the return of the wolf to Germany. The helping hands of several volunteers allow a project to be completed in a relatively short time, while the farmer would be

[1] 'Wiki' is Hawaiian for 'fast'. A 'wiki' website allows anyone to add, delete or revise content by using a web browser (https://en.wikipedia.org/wiki/Wiki)

hard-pressed to find enough time on top of her or his daily duties to complete the task alone.

6.2 Personal dialogue

Some livestock owners appreciate dialogue with volunteers even more than their practical help. Often during events, the central topic of conversation is not the wolf. Participants feel it is more important to work together on a project (building a fence), exchange views and tips on livestock protection measures, and talk about 'anything under the sun' while sharing a beer in the evening. Some sheep farmers particularly enjoy dialogue with wolf proponents and people who think differently from themselves. Such discussions can last until late into the night.

6.3 Awareness of livestock owners

One motivation for many volunteers is to increase acceptance of the wolf among livestock owners. This is neither one of the aims of WikiWolves (which takes the approach that everyone has the right to their own views about the wolf) nor have I personally had the

Box 1

Sheep farmers' concerns in Germany

Sheep farmers, in particular, are confronted by a plethora of everyday problems and concerns unrelated to the return of the wolf to Germany, as I have found out in conversations with them during fence building campaigns. Many concerns are related to the low profitability of sheep farming in general, such as prices for sheep products, dependence on subsidies, availability of pastures, feed quality in nature conservation areas, high risk of penalties and sanctions, farming requirements on pastures, and fragmentation of the landscape.

Based on data from 30 relatively large sheep farms in Baden Wuerttemberg (a federal state in south Germany), the average hourly income of sheep farmers was 6.15 euros (LEL, 2015). Similar average income was reported for other German regions, with even lower values for some surveyed farms. The global market exerts downward pressure on meat and milk prices (with meat being economically more relevant in Germany, based on quantity). Wool has mostly lost its commercial value and in most cases the shearing process necessary for most sheep breeds leads to financial losses rather than additional income. Overall, the monetary gain per area is very low in sheep farming, resulting in two important consequences for German sheep farms:

1. Sheep farms are rarely able to compete with other agricultural businesses when it comes to paying the currently very high land prices (due largely to federal subsidies for renewable resources and speculation with agricultural land). Sheep farmers therefore commonly lack access to sufficiently high-quality pasturing areas;
2. Many sheep farms are economically dependent on subsidies (for example, in the form of contractual conservation management agreements and agri-environmental schemes). This dependence affects the flexibility and planning ability of farmers, since funding measures frequently change and are tied to an allocation plan of areas. Such subsidised areas are generally of low productivity and the pasture has a low nutritional value. Sheep breeds that were optimized for milk output or meat yield, however, require high-quality feed. The animals' weight gain is usually insufficient in extensive pastures.

These interconnections clearly show that sheep farming can only be economically viable in the long term if labour input is very high. Full-time sheep farmers are used to such intensive workloads, but more than a few of them reach their physical limits sooner or later, even without additional, wolf-related problems. Understandably, these sheep farmers do not have much time or motivation left to deal with the details of livestock protection measures, whether in theory or in practice.

impression that our volunteer campaigns have any direct effect on the attitude of farmers regarding the return of the wolf to Germany. One aspect that noticeably changes through a campaign, however, is the opinion of participating farmers about wolf proponents: the image becomes more differentiated and more positive as they realize that strangers come to their farms to provide hands-on help without wanting anything in return (Fig. 3). Some sheep farmers are surprised to realize that not only students donate their time to help them but also regular working people from the full range of employment sectors. I see this as an enormous success, since the societal wolf conflict to a large part also reflects a conflict in human relations.

Fig. 3 Let's tackle it – together! (*Photo: N Soethe*)

6.4 Awareness of volunteers

Many volunteers have little or no contact with the agricultural sector prior to participating in a WikiWolves campaign. They gain many new impressions while helping a livestock owner protect her or his herd, not least an understanding of how much effort is required not just to build protective fences but also to keep livestock in general (Box 1). WikiWolves volunteers learn a lot about the excessive demands that sheep farmers face due to the need to implement livestock protection measures. Anyone who has participated in a fence building campaign gains a much more realistic view of what this work entails in reality (as opposed to in theory) and will see statements such as 'But the sheep farmer could simply...' or 'If it was me, I would immediately...' in a different light.

7. What are the limits of volunteer work?

WikiWolves would like to play a part in making livestock protection a societal matter, but this is limited to providing an impetus in that direction. For some volunteers, their new perspectives on pasturing animals and livestock protection may continue to affect them in their private, non-WikiWolves lives, for example by experimenting with regionally sourced lamb in their cooking. However, the ultimate goal of reaching the general public is something that a volunteer initiative such as WikiWolves cannot do on its own. It can only provide volunteers with experiences at a local level that can be communicated to representatives of government and nature conservation associations with greater societal influence.

A comprehensively conceived livestock protection plan has the best chance of success if nature conservation organizations and livestock owner unions join forces and support not only the unbureaucratic implementation of specific protection measures (with appropriate subsidisation) but also focus more on the societal and political framework of livestock farming.

We can only create good conditions for a realistic coexistence between livestock farming and wolves if we as a society are willing to pay more for the maintenance of a cultural landscape that includes livestock grazing in pastures, for the preservation of species-rich grasslands, for the production of meat, milk and wool and of course also for livestock protection measures.

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Project

LIFE EURO LARGE CARNIVORES

IMPROVING COEXISTENCE THROUGH CROSS-BORDER COOPERATION

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1. Introduction

In many European countries, the grey wolf *(Canis lupus),* brown bear *(Ursus arctos)* and, to a lesser extent, the Eurasian lynx *(Lynx lynx)* are recovering after centuries of intense persecution. As their ranges expand, they inevitably come into contact with people and their activities, potentially resulting in conflicts that call for strategies and tools to enable coexistence. Over the past 30 years, more than 135 projects in 19 countries under the LIFE programme of the European Union have dealt with large carnivores (Oliveira and Krofel, in press), for example by focusing on species recovery or developing tools and approaches to prevent or mitigate human-wildlife conflicts.

In 2017, 16 partners across Europe under the coordination of WWF Germany initiated the LIFE EuroLargeCarnivores project which seeks to improve coexistence with large carnivores in Europe through effective stakeholder communication, cross-border cooperation and the exchange of knowledge. The partners share the belief that coexistence is possible and that powerful tools have been developed within past and current projects and initiatives of which many deserve better dissemination. The project, which has a budget of € 6.2 million euros and will run until 2022, aims to provide a platform to gather and share knowledge on human-large carnivore coexistence among various stakeholders across Europe. Topics such as large carnivore monitoring, human-wildlife conflict mitigation and prevention measures, the discussion of fears and concerns for safety, herding and livestock protection practices, but also poaching, economic opportunities and investment requirements are topics included in the project.

2. Sharing experience and good practice across borders

With most European large carnivore populations being transboundary in nature (Linnell and Cretois, 2018), the need for better transboundary cooperation in their management has long been highlighted (Boitani et al., 2015). The LIFE EuroLargeCarnivores project seeks to improve experience sharing across national borders by making diverse approaches to managing social, economic and ecological challenges available through workshops on the ground, online platforms, transboundary exchange visits and international conferences such as the 2018 Pathways

Europe Conference (www.nna.niedersachsen.de) in Goslar, Germany that was co-hosted by the project and brought together 300 participants from around the world in a transdisciplinary exchange around human-wildlife conflict.

Project activities are implemented in five distinct regions and populations: Scandinavia (focussing on the wolverine, *Gulo gulo*), the Iberian Peninsula (wolf), the Carpathians (wolf, Eurasian lynx and brown bear), as well as north central Europe and the Alps (wolf and Eurasian lynx) (Fig. 1).

Fig. 1 LIFE EuroLargeCarnivores project focus areas.

3. Communication as the key to success

Listening to and engaging with people who interact with large carnivores on a daily basis is critical to the LIFE EuroLargeCarnivores project. Thus, to capture the perspectives of different stakeholders and the relationships among them, an extensive stakeholder engagement process was designed using surveys and facilitated workshops across 14 countries to identify concerns, challenges and solutions raised by people living with large carnivores (EuroLargeCarnivores, 2019). Looking at the conflicts from a European perspective and comparing them offers the chance to find similarities and differences among countries, populations and areas and develop recommendations and tools that fit different regional contexts and explore the potential for transferring good practice approaches to new regions.

One of the major challenges raised by stakeholders across the project regions within surveys and at workshops was a lack of up-to-date, reliable and trustworthy information about large carnivores as well as missing access to scientifically proven facts about their distribution, conflicts and possible prevention methods (Grossman et al., 2019). To improve understanding of the social and economic impacts of large carnivores, a study was initiated by the project that looked on the one hand into management costs and livestock damage of large carnivores and on the other examined tourism income and regional marketing (Rode et al., in press). The project website (www.eurolargecarnivore.eu) facilitates dissemination of these and other findings and of tools to prevent or mitigate conflicts and to share stories of people living with large carnivores. Everyone is invited to add their experiences and stories concerning large carnivores. Stories are collected by project partners across Europe to share first-hand experience and help to identify possibilities for transferring tools and approaches that have worked elsewhere. For example, readers can learn from farmer Swen Keller how he lost some calves to wolves, how he started to test different fencing systems and now uses dogs to protect his livestock from future attacks. Project partners are also running a series of targeted press trips to build relations with journalists, offering fact-based information and sensitising journalists about their role in how large carnivores are perceived among the general public.

The findings from the surveys and workshops are collated in a report, *European Perspectives on Coexistence with Large Carnivores* (EuroLargeCarnivores, 2019), that describes the main challenges and expectations of farmers, foresters, hunters, conservationists, researchers, representatives from public authorities, politicians and citizens in the 16 countries and beyond. Building on the findings of these workshops and identified needs, a unique set of training events was designed to enhance the capacity of conservation actors (NGOs, authorities and independents) to communicate with stakeholders. By the end of 2019, 200 participants throughout the project regions had undergone training with the goal of enabling them to support local stakeholders and help establish and maintain networks to exchange experience in dealing with human-wildlife conflicts. During these training

workshops, participants are trained in mediation and communication techniques but are also asked to map their ideas for activities and projects to foster coexistence in their neighbourhood. The project also strives to support implementation of the proposed activities.

4. Livestock versus large carnivores?

Farmers, especially livestock owners, in all project focus areas raised concerns about the economic impacts of livestock losses and the expense of obtaining and managing the tools needed to prevent such losses (Grossman et al., 2019). During the surveys and workshops, they clearly stated a need for economic support to cover the costs of adopting prevention tools and a compensation system for livestock losses or improved efficiency of systems already in place. Within the LIFE EuroLargeCarnivores project, farmers and wildlife managers from different regions of Europe are brought together to exchange experience of conflict management. The aim of these 'peer-to-peer' workshops, carried out in the Alps, Central Europe and the Carpathians, is to initiate and sustain transboundary exchange among practitioners (Fig. 2).

Fig. 2 Livestock exchange trip to Graubünden, Switzerland within the LIFE EuroLargeCarnivores project with a delegation from Austria and Germany. *(Photo: Moritz Klose)*

To enable exchange around livestock protection among a broader audience, the project hosted an international conference on *Livestock Protection in the Alpine Region* on 21–23 January 2020 in Salzburg, Austria, together with the EU Platform on Coexistence Between People and Large Carnivores, the European Landowners Organization, the German Association of Professional Shepherds and AGRIDEA.

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Project

KUVASZ GUARD PROGRAMME IN HUNGARY

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1. Introduction

Until 100 years ago, the Kingdom of Hungary encompassed the entire Carpathian Basin, including the Carpathian Mountains now in Slovakia and Romania as well as the territory of present-day Hungary. The most densely human-populated regions were in the Great Hungarian Plain. In response to frequent human-carnivore conflicts, large carnivores were gradually eradicated from these lowing lying-areas and driven back to the less densely populated Carpathian Mountains (Márkus and Szemethy, 2003a). The Kuvasz, a traditional dog breed known as '*kuvas*' in Hungarian, continued to be used as a livestock guarding dog (LGD) where there was still a risk of predation. In the Great Hungarian Plain, however, people began to use the Kuvasz as a watch dog or for personal protection.

Organized Kuvasz breeding in Hungary started in 1905 and in 1938 a national standard was agreed. In 1954, the Federation Cynologique Internationale (FCI) accepted the definitive basis for the breed (www.fci.be). The territory of Hungary was reduced by more than two thirds after the First World War, leaving the mid mountain and lowland areas with the highest density of human presence. The population of Kuvasz used for livestock protection was left outside the new borders and effectively 'lost' to Hungarian breeders. Only a few were 'rescued' and brought back from, for example, Transylvania. The Great Hungarian Plain's Kuvasz population also suffered. Here, the Kuvasz was regarded as a dangerous enemy and many of them were killed by German and Russian soldiers who plundered the area.

After the Second Wold War, Kuvasz breeding resumed with the remaining population and individuals imported from Germany. It flourished until the late 1980s, reaching a peak of 2,000 pups per year. (Hudák et al., 1996). However, due to the eradication of large carnivores, shepherds in the Carpathian Basin, even in the mid mountains, used only herding dogs at this time. During the 1990s, after the end of the communist regime, many new fashionable dog breeds such as the Caucasian Shepherd or Central Asian Shepherd were introduced into the country, further distracting attention from the Kuvasz. This resulted in a decline in Kuvasz breeding to 150–200 pups per year. Due to this, the risk of genetic erosion arose within the breed.

In this article, we present the results of recent efforts to revive the traditional use of the Kuvasz as a livestock guarding dog in order to help preserve the breed and mitigate conflicts arising as a result of the return of large carnivores to Hungary.

2. Recovery of large carnivores

For most of the 20th century large carnivores were extremely rare in Hungary (Márkus and Szemethy, 2003a). Thanks to the joint efforts of nature conservationists, wildlife managers and foresters, by the end of the 1990s the grey wolf *(Canis lupus),* brown bear *(Ursus arctos)* and Eurasian lynx *(Lynx lynx)* became re-established in Slovak-Hungarian border regions (Szabó and Gadó, 2015). All three large carnivore species are now strictly protected in Hungary. So far, there have been only a few observations of bears and lynx per year, but wolves are already present in larger numbers: around 5–6 packs, though probably less than 50 individuals in total. The North Hungarian Mountains are contiguous with the Western Carpathian Mountains of Slovakia and the genetic diversity of wolves, bears and lynx in northern Hungary is highly dependent on source populations in Slovakia (Márkus and Szemethy, 2003b).

During the period of their absence, Hungarian shepherds lost their knowledge of how to defend flocks from predators. The return of large carnivores has therefore brought a need to renew livestock protection measures. In 2007, nature conservationist Ferenc Puskás began the 7-year Kuvaszok and Large Carnivores Programme which placed Kuvaszok (the plural for Kuvasz) from Hungary at shepherd camps in Transylvania, Romania. This programme showed that even Kuvaszok from lines of watch dogs and personal protection dogs could be suitable for protecting livestock against predators if given proper training (Puskás, 2010, 2013 a, b).

In 2016, stakeholders were surprised by the first press report in Hungary about depredation on livestock by large carnivores. This was the moment when it became clear that carnivore populations had increased and good practices for coexistence with them needed to be widely disseminated. Thus, the Kuvasz Guard (Kuvasz Őr) Programme was born (Box 1).

3. The Kuvasz Guard Programme

The Programme started on 14th February 2016 with the placing of two Kuvasz pups from the Programme leader's kennel on a farm in Karancskeszi, Hungary. A good working relationship was established with the Bükk National Park Directorate (NPD) and a cooperation agreement was drafted with the Hungarian Kuvasz Breeding Association (MKFE) to reintroduce, after a century of absence, the Kuvasz breed into its original livestock guarding role.

The main aims of the Programme are:

1. *Carnivore conservation*: to help achieve relatively problem-free coexistence between humans and large carnivores in rural regions of northern Hungary;
2. *Dog breeding*: to re-establish the Kuvasz in its original role and function as a livestock guarding dog as a way to save the breed from the risk of extinction;
3. *Research*: to provide researchers with opportunities to study interactions among wolves, dogs and livestock in Hungary.

Box 1

Abraham Szep with one of his puppies (Photo: Lili Szép)

The face behind the Programme

Kuvasz Guard was established in 2016 by dog breeder and wildlife conservationist Ábrahám Szép. Ábrahám was born in Transylvania, Romania, where he learned the 'rules' of coexisting with carnivores during his childhood. He expanded his knowledge and experience of the hunting world as a gamekeeper after settling in Hungary. In 2009, Ábrahám graduated from Szent István University, Gödöllő, as a wildlife and game manager. His motto is: *"Large carnivores are not to be toyed with; they can easily become dangerous for humans. Nevertheless, it is my strong conviction that we do not have the right to exterminate them. Predators are essential, key species in the wild."*

Many Kuvasz breeders have voluntarily given pups to farmers, the process being coordinated by the Kuvasz Guard Programme. Breeders usually join the Programme because they want to show that the Kuvasz is still a good working dog and therefore a viable option to protect flocks. This is helping to maintain Hungary's Kuvasz population as well as aiding in mitigating conflicts between farmers and conservationists.

The Kuvasz Guard Programme also supports the introduction of other non-lethal conflict management methods such as light and sound deterrents, fladry, electric fences and continual human presence. We also seek to participate in and promote the elaboration of a prevention and compensation system in Hungary. For example, in 2018, a meeting was organized at the headquarters of the Hungarian Sheep and Goat Breeders' Association (MJKSZ) in Budapest with the participation of Bükk NPD, WWF Hungary and the Kuvasz Club in order to issue a joint call for the Ministry of Agriculture to elaborate damage prevention and compensation systems. Unfortunately, there is still no compensation system in Hungary, but the Ministry supports the use of prevention methods by giving electric fences to Bükk and Aggtelek NPDs for distribution among affected farmers.

4. Methods

Bükk NPD investigates all suspected cases of large carnivore depredation and suggests the Kuvasz Guard Programme to farmers as a good prevention method. The Hungarian Kuvasz Breeding Association (MKFE) assists in finding breeders with available pups. Livestock farmers are provided with Kuvasz pups on a one-year contract etween the farmer and dog breeder, which commits them to take care of the pups and train them properly. Usually two pups of the same age

Fig. 1. Locations in Hungary where the Kuvasz Guard Programme operates.

Fig. 2 Younger Kuvaszok are allowed to sleep in the barn with the flock. *(Photo: Kuvasz Guard Programme)*

are provided: either an unrelated male and female or two pups of the same sex from the same litter (so they are tolerant of each other). Farmers who are inexperienced with LGDs receive one pup initially and the second is added after a few months. The Programme leader regularly visits in order to assist farmers with training, documenting each visit in a log. After one

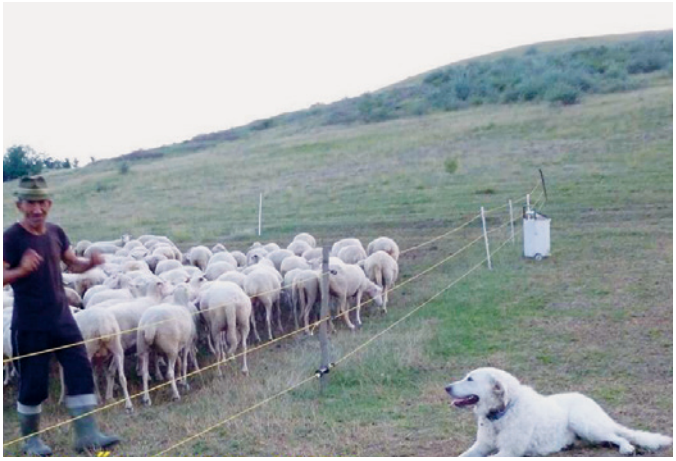

Fig. 3 When the flock is in the night enclosure outside, Kuvaszok lie nearby to guard.
(Photo: Kuvasz Guard Programme)

year, if there have been no serious difficulties and the dogs are in good health and working well, the farmer takes over their ownership.

Currently, the Kuvasz Guard Programme operates in 13 locations where large carnivores occur (Fig. 1–5). Eight of them have sheep, two have cattle, one has horses and two have sheep, cattle, buffalo, horses and poultry Most of them are in the mountains of northern Hungary, but one is in the Great Hungarian Plain, where golden jackals (*Canis aureus*) are common.

Fig. 4 A well-trained Kuvasz stays with the flock all day long, even when the shepherd changes.

(Photo: Kuvasz Guard Programme)

5. Results & experience

So far, 17 farmers have joined the Programme and received a total of 26 Kuvasz pups (Table 1). Only four farmers have had to return their dogs. Difficulties occurred when two farmers did not spend enough time getting their dogs used to livestock. In these cases, the dogs were given back to the breeders. Thanks to collaboration with MKFE and the help of the Kuvasz Rescue Team, they were placed with new owners. In one case, dogs left a farm where the farmer switched off the electric fence. In another case, dogs had to be taken back due to prolonged illness of the farmer.

After dogs reach maturity (at around two years old) they can be used for breeding, but only with the guidance and agreement of the Kuvasz Guard Programme, the breeder, the farmer and the MKFE. A prerequisite for breeding is a test conducted free of charge at farms by the MKFE. This test includes many elements that inform the breeding judge about the psychical healthiness of the examined individual, such as how it reacts to strange or weird noises, lights, objects and unfamiliar people and whether it is able to defend its owner.

Based on our experience, the key to success is the 'human factor'. The relationship between Kuvasz and livestock depends on human attention, care, patience and education. A really important factor is early placement in the flock and bonding with livestock. For dogs to bond fully with livestock, this has to happen before they reach the age of three months.

After many discussions with shepherds participating in the Programme, we feel that their perceptions of carnivores have changed positively due to the presence of LGDs, since the Kuvasz functions like a barrier between carnivores and the flock. An example is the case of Komlóska village. During the winter of 2018, footprints in the snow showed that the Kuvaszok of a farmer participating in the Programme encountered a lone wolf. Two Kuvaszok in conjunction with a four-wire electric fence were sufficient to prevent the wolf from causing harm to the sheep flock.

The success of our bottom-up initiative has attracted the attention of the media. Newspaper articles, TV slots and radio interviews are conducted regularly to present the Programme and show the life of a working Kuvasz.

The most important milestones and activities of the Kuvasz Guard Programme so far include:

- A workshop organized in 2017 together with Bükk NPD in Romania's Selkerland region, where local wildlife experts, hunters and farmers shared their experiences about carnivores with participating Hungarian colleagues in October 2017;
- The Programme was a highlight of the 1st Hungarian Large Carnivore Summit at Felsőtárkány, Hungary;
- The Programme has worked closely with WWF since 2017 and together we have given numerous lectures during nature conservation related events as well as participating in carnivore-related field work and filming;

Table 1 Outcomes of 26 Kuvasz pups placed with livestock farmers in Hungary by Kuvasz Guard.

Sex	Number of pups placed	Outcomes			
		Well-suited	Returned	Lost	Other
Male	17	8	6	2	1
Female	9	9	0	0	0
Total	26	17	6	2	1

- On 4th October 2017 the State Secretary for the Environment visited two Kuvasz Guard Programme localities. As a result, the Ministry asked for closer cooperation between Bükk NPD, the MKFE and the Kuvasz Guard Programme;
- We were invited to showcase good practices and results for livestock breeders at the 2nd Hungarian Large Carnivore Summit, organized by WWF Hungary;
- In 2018/19 Bükk NPD invited us on a road show to four localities in the Northern Hungarian Mountains in order to show the lay public and livestock breeders how to coexist with large carnivores;
- In 2019, the Programme won a tender announced by the Ministry of Agriculture to buy Kuvasz pups from breeders and distribute them to farmers.

6. Future plans and perspectives

The Ministry of Agriculture supports the work of the Programme with several important steps, which will help it develop to another level. This support covers the costs of buying pure breed Kuvasz pups; screening for hip dysplasia; a road show to schools and universities; the Programme's travel costs; and advertising.

In December 2019 the Programme was transformed into the Kuvasz Őr (Guard) Foundation. With the support of the MKFE, Bükk NPD, WWF Hungary and hopefully also the Ministry of Agriculture, the Foundation will explore additional locations to provide assistance to livestock farmers. The Foundation's website (www.kuvaszor.hu) is currently under construction.

Fig. 5 The Programme leader accompanied by dog breeders, nature conservation students and National Park rangers while checking Kuvaszok with a sheep flock in Hungary.
(Photo: Kuvasz Guard Programme)

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ABSTRACTS OF SCIENTIFIC ARTICLES

LIVESTOCK GUARDING BEHAVIOUR OF KANGAL DOGS IN THEIR NATIVE HABITAT

Ibrahim Akyazi, Yusuf Ziya Ograk, Evren Eraslan, Murat Arslan, Erdal Matur

Applied Animal Behaviour Science: April 2018

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Kangal Shepherd Dog is one of the endemic large dog breeds in Anatolia, Turkey. It is bred in different regions of Turkey as well as in different countries as a livestock guarding dog (LGD). Being one of the most popular and common LGD breeds, basic behavioural traits and the effectiveness of Kangals have been subjected to several studies. However, most of the behavioural data originate from surveys conducted with LGD users and there is a lack in the literature of studies which focus on direct observation and recording of guarding behaviours of Kangals.

The present study investigated 10 sheep flocks guarded by Kangal dogs in their natural habitat, in Sivas, Turkey, by recording the movements of dogs, sheep and shepherd using GPS-receivers in the pasture. We collected instantaneous geographical position and speed data to assess to what extent the movement data overlaps with the behavioural data present in the literature about the livestock guarding behaviour of Kangals.

The mean speeds of the sheep, the shepherd and dogs were lower in the night, compared to that in the daytime. The shepherd stayed, on average, closer to the herd in the night compared to the dogs. Both the shepherd and the dogs preferred to be closer to the herd at night, compared to the daytime. Dogs moved farther away from the herd than did the shepherd in the night. Our results indicating that Kangal dogs generally established a closer relationship with shepherd rather than the sheep may imply an anthropogenic disruption in one of the three behavioural components of LGDs, namely in the attentiveness of Kangals.

To the best of our knowledge, the present study is the first one to collect geographical data regarding the livestock guarding behaviour of Kangal dogs in their native habitat. Hence, our results and any future studies on this matter will contribute to a better understanding of livestock guarding behaviour of Kangal dogs and lead to more efficient breeding practices and training programs in this respect.

CHARACTERIZING CONFLICT BETWEEN HUMANS AND BIG CATS *PANTHERA* SPP: A SYSTEMATIC REVIEW OF RESEARCH TRENDS AND MANAGEMENT OPPORTUNITIES

Kathleen Krafte Holland, Lincoln R. Larson, Robert B. Powell

PLoS ONE: September 2018

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203877

Conservation of big cats (*Panthera spp.*), a taxonomic group including tigers, lions, jaguars, leopards and snow leopards, is a daunting challenge. As expanding human populations across Panthera range countries exacerbate competition for land and prey, conflicts between humans and big cats are inevitable. Through a systematic review of the peer-reviewed literature published from 1991 to 2014 and indexed in Web of Science and Google Scholar (186 articles), our study explored the current state of knowledge regarding human-Panthera conflict and potential solutions, examining variables such as spatial and temporal distribution of research, methods used to study conflict, evaluation of interventions, and management recommendations. Our synthesis revealed several key data gaps and research needs. More studies could utilize diverse data collection approaches to focus on both the ecological and socio-cultural context for conflict. Additionally, only 21 % of articles included in the review evaluated conflict mitigation interventions, and few of these yielded conclusive results. Success ratios suggest that compensation schemes and livestock management strategies were more effective tools for addressing conflict than either direct interventions (lethal removal or translocation of animals) or community interventions (e.g. education, ecotourism, local management). More studies should systematically evaluate the efficacy of conflict mitigation strategies, many of which are consistently recommended without empirical support. Results highlight trends and opportunities that can be used to inform future research and management efforts focused on human-Panthera conflict, ultimately enhancing the potential for coexistence between humans and carnivore species worldwide.

EVALUATING THE EFFICACY OF PREDATOR REMOVAL IN A CONFLICT-PRONE WORLD

Robert J. Lennox, Austin J. Gallagher, Euan G. Ritchie, Steven J. Cooke

Biological Conservation: June 2018

https://doi.org/10.1016/j.biocon.2018.05.003

Predators shape ecosystem structure and function through their direct and indirect effects on prey, which permeate through ecological communities. Predators are often perceived as competitors or threats to human values orwell-being. This conflict haspersisted for centuries, often resulting inpredator removal (i.e. killing) via targeted culling, trapping, poisoning, and/or public hunts. Predator removal persists as a management strategy but requires scientific evaluation to assess the impacts of these actions, and to develop a way forward in a world where human-predator conflict may intensify due to predator reintroduction and rewilding, alongside an expanding human population. We reviewed literature investigating predator removal and focused on identifying instances of successes and failures. We found that predator removal was generally intended to protect domestic animals from depredation, to preserve prey species, or to mitigate risks of direct human conflict, corresponding to being conducted in farmland, wild land, or urban areas. Because of the different motivations for predator removal, there was no consistent definition of what success entailed so we developed one with which to assess studies we reviewed. Research tended to be retrospective and correlative and there were few controlled experimental approaches that evaluated whether predator removal met our definition of success, making formal meta-analysis impossible. Predator removal appeared to only be effective for the short-term, failing in the absence of sustained predator suppression. This means predator removal was typically an ineffective and costly approach to conflicts between humans and predators. Management must consider the role of the predator within the ecosystem andthe potential consequences ofremoval on competitors and prey. Simulations or models canbe generated to predict responses prior to removing predators. We also suggest that alternatives to predator removal be further developed and researched. Ultimately, humans must coexist with predators and learning how best to do so may resolve many conflicts.

NON-LETHAL DEFENSE OF LIVESTOCK AGAINST PREDATORS: FLASHING LIGHTS DETER PUMA ATTACKS IN CHILE

Omar Ohrens, Cristian Bonacic, Adrian Treves

Frontiers in Ecology and the Environment: February 2019

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Anthropogenic mortality among populations of large terrestrial carnivores undermines the health of ecosystems globally, and generally increases when people respond lethally to real or perceived threats to property, including livestock. Reducing such threats through the use of non-lethal methods could therefore protect both large predators and human interests. However, the scarcity of information on the effectiveness of methods to prevent livestock predation hinders the formulation of science-based policy. We present the results of a randomized crossover experimental test of a method to prevent predation on livestock, which to our knowledge is the first such test in Latin America. By relying on a so-called 'gold-standard' design, we evaluated the effectiveness of using flashing lights to deter predators. We found that light deterrents discouraged pumas (*Puma concolor*) but not Andean foxes (*Lycalopex culpaeus*) from preying on alpacas (*Vicugna pacos*) and llamas (*Lama glama*), and demonstrated that gold-standard experiments are feasible in large natural ecosystems, contradicting assumptions that people will reject placebo controls and that such systems contain too many confounding variables. Functionally effective non-lethal methods can protect wildlife, livestock, and people. Strong inference is needed for the development of sound policy concerning wildlife management, livestock husbandry, environmental conservation, and biodiversity.

ATTITUDES TOWARDS RETURNING WOLVES (*CANIS LUPUS*) IN GERMANY: EXPOSURE, INFORMATION SOURCES AND TRUST MATTER

U go Arbieu, Marion Mehring, Nils Bunnefeld, Petra Kaczensky, Ilka Reinhardt, Hermann Ansorge, Katrin Böhning-Gaese, Jenny A. Glikman, Gesa Kluth, Carsten Nowak, Thomas Müller

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Understanding how exposure and information affect public attitudes towards returning large carnivores in Europe is critical for human-carnivore coexistence, especially for developing effcient and de-escalating communication strategies. The ongoing recolonization of wolves (*Canis lupus*) in Germany provides a unique opportunity to test the role of different information sources and trust on people's attitudes towards wolves. We conducted a phone survey (n = 1250) and compared country-wide attitudes towards wolves with attitudes in a specific region where wolves initially recolonized and have been present since 2000. In particular, we investigate the relationship between information sources, trust and people's attitudes while accounting for factors like knowledge, exposure and socio-cultural determinants of respondents. We found significant differences in attitudes and knowledge about wolves as well as in the use and frequency of information sources between the two population samples. Higher knowledge, information from books and films, science-based information, and higher trust in information sources related positively with positive attitudes towards wolves. Comparatively, information from press or TV news was associated with more negative attitudes. Providing science-based information to the public and building trust in information is likely to be one measure, among others, to dampen extreme attitudes and improve people's appreciation of costs and benefits of human-carnivore coexistence. Management of conflictual situations emerging from large carnivore recolonization in Europe and beyond should consider incorporating assessments of people's use of and trust in information in addition to existing tools to pave new ways for constructive human-carnivore coexistence.

ANIMAL WELFARE CONSIDERATIONS FOR USING LARGE CARNIVORES AND GUARDIAN DOGS AS VERTEBRATE BIOCONTROL TOOLS AGAINST OTHER ANIMALS

Benjamin L. Allen, Lee R. Allen, Guy Ballard, Marine Drouilly, Peter J. S. Fleming, Jordan O. Hampton, Matthew W. Hayward, Graham I. H. Kerley, Paul D. Meek, Liaan Minnie, M Justin O'Rian, Daniel M. Parker, Michael J. Somers

Biological Conservation: April 2019

https://doi.org/10.1016/j.biocon.2019.02.019

Introducing consumptive and non-consumptive effects into food webs can have profound effects on individuals, populations and communities. This knowledge has led to the deliberate use of predation and/or fear of predation as an emerging technique for controlling wildlife. Many now advocate for the intentional use of large carnivores and livestock guardian dogs as more desirable alternatives to traditional wildlife control approaches like fencing, shooting, trapping, or poisoning. However, there has been very little consideration of the animal welfare implications of deliberately using predation as a wildlife management tool. We assess the animal welfare impacts of using dingoes, leopards and guardian dogs as biocontrol tools against wildlife in Australia and South Africa following the 'Five Domains' model commonly used to assess other wildlife management tools. Application of this model indicates that large carnivores and guardian dogs cause considerable lethal and non-lethal animal welfare impacts to the individual animals they are intended to control. These impacts are likely similar across different predator-prey systems, but are dependent on specific predator-prey combinations; combinations that result in short chases and quick kills will be rated as less harmful than those that result in long chases and protracted kills. Moreover, these impacts are typically rated greater than those caused by traditional wildlife control techniques. The intentional lethal and non-lethal harms caused by large carnivores and guardian dogs should not be ignored or dismissively assumed to be negligible. A greater understanding of the impacts they impose would benefit from empirical studies of the animal welfare outcomes arising from their use in different contexts.

A FRAMEWORK OF MOST EFFECTIVE PRACTICES IN PROTECTING HUMAN ASSETS FROM PREDATORS

Igor Khorozyan, Matthias Waltert

Human Dimensions of Wildlife: May 2019

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Widespread damage by large mammalian predators to human assets (e.g., livestock, crops, neighborhood safety) requires the application of non-invasive (i.e., without direct contact with predators) and targeted interventions to promote predator conservation and local livelihoods. We compiled 117 cases from 23 countries describing the effectiveness of 12 interventions designed to protect human assets from 21 predators. We found: (a) the most effective interventions were electric fences, guarding animals, calving control, and physical deterrents (protective collars and shocking devices); (b) the most effectively protected asset was livestock; and (c) the most effective interventions being used were to protect assets from cheetahs (*Acinonyx jubatus*), Eurasian lynx (*Lynx lynx*), gray wolves (*Canis lupus*), and lions (*Panthera leo*). In all of these cases, the relative risk of damage was reduced by 50–100%. We combined these outcomes into a novel framework of most effective practices and discussed its structure, practicality, and future applications.

FORAGING THEORY PROVIDES A USEFUL FRAMEWORK FOR LIVESTOCK PREDATION MANAGEMENT

Haswell PM, Shepherd EA, Stone SA, Purcell B, Hayward MW

Journal for Nature Conservation: June 2019

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A societal shift toward plant dominant diets and a reduction in livestock rearing could have broad social, environmental and conservation benefits. Livestock husbandry, however, has a wealthy cultural history, strong support and high consumer demand. It is therefore likely to continue as a major land use and conservation issue for predators. From a producer's perspective, the primary goals of livestock protection are maximising, or at least maintaining, production by minimising losses and mitigating detriment to stock welfare. Lethal removal of predators remains a commonplace solution. Such management measures are questionable as they raise animal welfare and conservation concerns, risk inhibiting ecological processes, are often expensive, and in some circumstances, exacerbate livestock predation problems. Non-lethal alternatives can facilitate co-existence between livestock farmers and predators, ideally reducing the ecological impact of pastoralism and achieving conservation goals. The need for rigorous study of non-lethal approaches has however been recently highlighted. Tools and methods involved in livestock protection, as well as the theoretical basis of how we perceive and manage the problem, require deeper consideration. Non-lethal approaches require knowledgeable implementation and an effective decision making system is a pre-requisite for successful practice. Livestock predation and its prevention are fundamentally influenced by the underlying principles of foraging ecology and risk theory. We propose that manipulating elements of Brown's (1988) quitting harvest rate model provides a useful conceptual framework for reducing livestock predation and encouraging coexistence.

TOOLS FOR CO-EXISTENCE: FLADRY CORRALS EFFICIENTLY REPEL WILD WOLVES (*CANIS LUPUS*) FROM EXPERIMENTAL BAITING SITES

Yorgos Iliopoulos, Christos Astaras, Yorgos Lazarou, Maria Petridou, Savas Kazantzidis, Matthias Waltert

Wildlife Research: August 2019

DOI: 10.1071/WR18146

Context: Mitigating wolf–livestock conflict is crucial for both wolf (*Canis lupus*) conservation and livestock farming. Wolf attacks at livestock gathering areas often result in surplus killing, severe economic losses and emotional distress for the farmers, and financial claims from compensation funds. They may also trigger retaliatory killing of wolves. One method for reducing attacks on gathered livestock is the fladry fence, a primary repellent based on wolf neophobia. Fladry, used mainly in North America, remains largely untested in southern Europe. Aims: To test the effectiveness of fladry corrals at excluding wild wolves from experimental feeding sites and discuss their potential for protecting livestock in human-dominated landscapes. Methods: We tested the repelling efficiency of fladry corrals at six stations baited with livestock remains close to the homesites of three wild-wolf packs in central-northern Greece. Using infrared cameras, we recorded approaching and feeding rates of wolves, brown bears and wild boars attracted to the baits, before and during fladry use. Key results: The feeding rate of all wolf packs reduced to zero during fladry use. Effective repelling lasted from 23 to 157 days and ended with the removal of fladry. Wolf approaches also reduced by 75%. Modelling of wolf-approach levels showed fladry effect to be stronger when using a less attractive bait and weaker as pre-baiting duration or wolves' pre-exposure time to fladry increased. Fladry also significantly reduced the overall feeding rates of wild boars, whereas repellence of brown bears was poor. Key conclusions: Fladry can be a cost-effective tool to exclude wolves from small-sized corrals, for weeks or months. It may also be useful for repelling wild boar. We recommend further testing with live-prey at the regional scale with standardised protocols. Implications: Fladry installation at farms should take into account livestock attractiveness and wolf habituation. Fladry efficiency and deterrence duration can be improved when it is combined with other livestock protection methods. Wolf habituation to fladry can be reduced by deploying it primarily in high-risk depredation areas. Moreover, deployment soon after an attack could prevent wolves from associating specific farms with being sources of prey.

HOW LONG DO ANTI-PREDATOR INTERVENTIONS REMAIN EFFECTIVE? PATTERNS, THRESHOLDS AND UNCERTAINTY

Igor Khorozyan, Matthias Waltert

Royal Society Open Science: September 2019

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Human–predator conflicts are globally widespread, and effective interventions are essential to protect human assets from predator attacks. As effectiveness also has a temporal dimension, it is of importance to know how long interventions remain most effective and to determine time thresholds at which effectiveness begins to decrease. To address this, we conducted a systematic review of the temporal changes in the effectiveness of non-invasive interventions against terrestrial mammalian predators, defining a temporal trend line of effectiveness for each published case. We found only 26 cases from 14 publications, mainly referring to electric fences (n = 7 cases) and deterrents (n = 7 cases). We found electric fences and calving control to remain highly effective for the longest time, reducing damage by 100% for periods between three months and 3 years. The effectiveness of acoustical and light deterrents as well as guarding animals eroded quite fast after one to five months. Supplemental feeding was found to be counter-productive by increasing damage over time instead of reducing it. We stress that it is vital to make monitoring a routine requirement for all intervention applications and suggest to standardize periods of time over which monitoring can produce meaningful and affordable information.

THE TAIL WAGGING THE DOG: POSITIVE ATTITUDE TOWARDS LIVESTOCK GUARDING DOGS DO NOT MITIGATE PASTORALISTS' OPINIONS OF WOLVES OR GRIZZLY BEARS

Daniel Kinka, Julie K. Young

Palgrave Communications: October 2019

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While the re-establishment of grizzly bears (*Ursus arctos*) and wolves (*Canis lupus*) in the American West marks a success for conservation, it has been contentious among pastoralists. Coincidentally, livestock guarding dogs (LGDs; Canis familiaris) have been widely adopted by producers of domestic sheep (*Ovis aries*) in the United States to mitigate livestock depredation by wild carnivores. We surveyed pastoralists to measure how experience with and attitudes towards LGDs related to attitudes towards livestock predators, and found positive responses regarding LGDs and negative responses regarding wolves and grizzly bears. The more respondents agreed that LGDs reduce the need for lethal management ($p < 0.01$) and prevent the spread of disease ($p < 0.05$), the more positive their opinion of wolves in the wild. Regarding wolves and livestock, respondents who disagreed with the statements that 'LGDs do more harm than good' ($p < 0.05$) or 'reduce the need for lethal management" ($p < 0.001$), were more likely to express more negative opinions of wolves. While results pertaining to a reduced need for lethal management may suggest LGDs have some ability to increase tolerance for wolves, the causal order of these effects is difficult to discern. A more positive attitude for wolves to begin with may predict more optimistic attitudes about the capacity of LGDs to reduce human–wildlife conflict. We found almost no support for the opinion that LGDs do more harm than good, even though attitudes towards wolves were generally negative. Respondents with up to 10 years' experience using LGDs had more negative attitudes towards grizzly bears ($p < 0.01$) and respondents with more than 10 years' experience using LGDs had the most negative attitudes towards grizzly bears ($p < 0.001$). Thus, while experience was the greatest predictor of attitudes towards grizzly bears, attitudes towards wolves were most correlated with the belief that LGDs offset the need for lethal management of carnivores. These results suggest that LGD use in the United States does not seem to have resulted in more positive attitudes about livestock predators amongst pastoralists.

EVALUATING DOMESTIC SHEEP SURVIVAL WITH DIFFERENT BREEDS OF LIVESTOCK GUARDIAN DOGS

Daniel Kinka, Julie K. Young

Rangeland Ecology & Management: November 2019

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Livestock guard dogs (LGDs; *Canis familiaris*) have been widely adopted by domestic sheep (*Ovis aries*) producers because they reduce predation by wild carnivores. LGDs were originally used in the United States to reduce coyote (*Canis latrans*) depredations, but their efficacy against a suite of large carnivores, including wolves (*Canis lupus*), brown bears (*Ursus arctos*), black bears (*Ursus americanus*), and cougars (*Puma concolor*), and whether specific breeds perform better than others remains unclear. To assess breed-specific effectiveness at reducing depredations from a suite of livestock predators, we compared survival rates of sheep protected by different breeds of LGDs, including three breeds from Europe (Turkish kangal, Bulgarian karakachan, and Portuguese cão de gado transmontano) and mixed-breed LGDs, 'whitedog,' common in the United States. With the help of participating sheep producers, we collected cause-specific mortality data from domestic sheep in Idaho, Montana, Oregon, and Wyoming between 2013 and 2016. All three of the novel breeds of LGD tested were associated with overall reductions in sheep depredation relative to whitedogs, ranging from 61% to 95% ($P < 0.05$). In terms of predator-specific effectiveness, the Turkish kangal was associated with decreases in depredation from cougars ($e^{\beta} = 0.31$, 95% CI = 0.10–0.94, $P = 0.04$), black bears ($e^{\beta} = 0.33$, 95% CI = 0.28–0.37, $P < 0.01$), and coyotes ($e^{\beta} = 0.56$, 95% CI = 0.35–0.90, $P = 0.02$). The Bulgarian karakachan was associated with a decrease in coyote depredations ($e^{\beta} = 0.07$, 95% CI = 0.01–0.49, $P < 0.01$). The Portuguese transmontano was not associated with significant reductions in depredation hazard for any specific predator. Although variations in breed-specific effectiveness were subtle and nuanced, these findings will help livestock producers and wildlife managers make tailored decisions about how best to incorporate different breeds of LGD into sheep grazing regimes.

THE EFFECTIVENESS OF LIVESTOCK PROTECTION MEASURES AGAINST WOLVES (*CANIS LUPUS*) AND IMPLICATIONS FOR THEIR CO-EXISTENCE WITH HUMANS

Antonia Bruns, Matthias Waltert, Igor Khorozyan

Global Ecology and Conservation, March 2020

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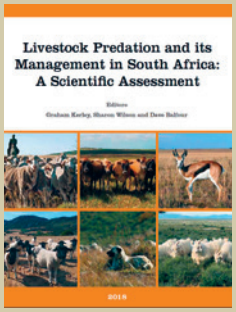
Wolves (*Canis lupus*) can kill domestic livestock resulting in intense conflicts with humans. Damage to livestock should be reduced to facilitate human-wolf coexistence and ensure positive outcomes of conservation efforts. Current knowledge on the effectiveness of livestock protection measures from wolves is limited and scattered in the literature. In this study, we compiled a dataset of 30 cases describing the application of 11 measures of protecting cattle and smaller livestock against wolves, estimated their effectiveness as a relative risk of damage, and identified the best measures for damage reduction. We found that: (1) lethal control and translocation were less effective than other measures, (2) deterrents, especially fladry which is a fence with ropes marked by hanging colored flags that sway in the wind and provide a visual warning signal, were more effective than guarding dogs; (3) deterrents, fencing, calving control and herding were very effective, but the last two measures included only one case each; and (4) protection of cattle was more effective than that of small stock (sheep and goats, or sheep only) and mixed cattle and small stock. In all of these cases, the relative risk of damage was reduced by 50–100%. Considering Germany as an example of a country with a recovering wolf population and escalating human-wolf conflicts, we suggest electric fences and electrified fladry as the most promising measures, which under suitable conditions can be accompanied by well-trained livestock guarding dogs, and the temporary use of deterrents during critical periods suchas calving and lambing seasons. Further research in thisfield is of paramount importance to efficiently mitigate human-wolf conflicts.

BOOKS



Livestock Predation and its Management in South Africa: A Scientific Assessment

Editors: Graham I. H. Kerley, Sharon L. Wilson, Dave Balfour
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ISBN: 978-0-620-78763-5

Preface

Formal scientific assessments are increasingly used by society to develop approaches and seek solutions to complex problems. Predation on livestock represents such a problem, in that it includes a range of social, economic, legal, ethical and management challenges to a broad range of role players (including inter alia livestock farmers, policy makers, conservationists) and plays out in poorly-understood natural ecosystems. The scientific assessment of livestock predation and its management in South Africa (PredSA) presented here is therefore an attempt to provide role players with a critically assessed compilation of the state of agreed-upon information in the various disciplines (from ethics to ecology) relevant to livestock predation in South Africa.

This initiative is supported by the key role players (affected government departments and livestock industry) and undertaken by a body of recognised experts in the various disciplines. Importantly, in this process, emerging best practice in undertaking scientific assessments has been followed, including careful governance of the process by an independent group, and measures taken to promote the saliency, legitimacy and credibility of the assessment. In general, assessments are based on currently known (published) information.

An unusual and ground-breaking step undertaken here has been the attempt to address information shortcomings that were identified early in the process, specifically the recognition that there is a paucity of published information on the issues around livestock predation in communal farming areas in South Africa. Accordingly, an independent research group was commissioned to undertake a survey of this issue, and these findings incorporated into the assessment.

This assessment represents a synthesis of the current state of understanding around the challenges in managing livestock predation in South Africa. Given the global nature of this problem, the assessment also draws on international experiences and lessons. The time-frame of the material included ranges from pre historic to publications still in press at the time of this assessment itself going to press. The latter highlights a key aspect relevant to scientific assessments, this being that scientific knowledge is growing rapidly and society is constantly changing. As a consequence our understanding of, and hence approaches to, issues such as the management of livestock predation need to be changing as well. While this Scientific Assessment on livestock predation and its management in South Africa represents a global first in terms of the novel approach of commissioning of the acquisition of material to fill identified gaps in information, and is also the first assessment globally to address this topic at a national scale, it is also clear that this is not the end of the assessment process for this topic. Scientific assessments are ongoing undertakings, being revised and updated at appropriate intervals as information and the understanding of the focal topic develop. Thus, while it is intended that the information compiled here should be of immediate and relevant value to policy-makers, managers and scientists, it is also clear that the next step in the process is the assimilation of lessons learnt and emerging science to contribute to assisting South African society in dealing with the challenges around the predation of livestock.

https://predsa.mandela.ac.za/predsa/media/Store/documents/PREDSA-eBook-2018.pdf

A Fieldguide for Investigating Damages Caused by Carnivores

Brown Bear, Grey Wolf, Golden Jackal, Red Fox, Eurasian Lynx

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Publisher's description

The purpose of the Fieldguide is to provide detailed information for field investigators to identify the cause of death of livestock, when suspected to be attacked by carnivores. Its aim is to assist damage inspectors, agricultural advisors, and others in determining the species of wildlife that caused the damage.

The guidebook was initially prepared within the LIFE+ SloWolf project, and has now been updated within DinAlp Bear project. New chapters were added and it was also translated into several languages.

https://dinalpbear.eu/a-fieldguide-for-investigating-damages-caused-by-carnivores/

UPCOMING EVENTS

29th Vertebrate Pest Conference
2nd – 5th March 2020 in Santa Barbara, California, USA
For details see: www.vpconference.org

Human-Wildlife Conflict and Coexistence
1st – 3rd April 2020 in Oxford, UK
For details see: www.hwcconference.org

Pathways Europe 2020: Human Dimensions of Wildlife Conference and Training
20th – 23rd September 2020 in Wageningen, The Netherlands
The programme is designed to address the myriad issues that arise as people and wildlife struggle to coexist in a sustainable and healthy manner. Hosted by Colorado State University and the Wageningen University.
For details see: https://sites.warnercnr.colostate.edu/pathways-europe/

27th International Bear Association Conference
21st – 25th September 2020 in Kalispell, Montana, USA
For details see: www.iba2020mt.com

NEXT ISSUE

We welcome your feedback and suggestions as well as news, articles and information from around the world.

To contact us, or be added to our mailing list, please write to: info@cdpnews.net

Past issues of *CDPnews* and our Guidelines for Authors can be downloaded from: www.cdpnews.net

The next issue of *CDPnews* is due out in summer 2020

MEET THE EDITORS

Robin Rigg is a zoologist focused on large carnivore management, ecology and coexistence with people. He has over 20 years' experience of implementing and evaluating damage prevention measures. He is a member of the IUCN Bear Specialist Group's Human-Bear Conflict expert team, the Large Carnivore Initiative for Europe and the Slovak Wildlife Society. He has studied at the universities of Cambridge, Aberdeen and Ljubljana and wrote his Masters thesis on livestock guarding dogs.

Daniel Mettler studied philosophy and economics. He worked for several years as a shepherd and created the Centre for Livestock Damage Prevention for Switzerland at AGRIDEA. He has published several articles, technical papers and guidelines on protection measures. He is currently responsible for a variety of topics including regional development in mountain areas and the management of alpine pastures.

Silvia Ribeiro is a biologist at Grupo Lobo, Portugal, with extensive experience in conflict mitigation, particularly the use of livestock guarding dogs to prevent damage by wolves. She has trained in animal welfare and her Masters in ethology focused on the ontogeny of social preferences in livestock guarding dogs. She is currently concluding her PhD on physiological aspects of canine social attachment.

Micha Herdtfelder is a trained mediator and specialist in human dimensions of wildlife. He is head of the large carnivore working group at the Forest Research Institute in Baden-Wuerttemberg, Germany. He promotes fact-based, trust-building communication between stakeholders in order to find viable solutions for coexistence with carnivores, including damage prevention. He studied geoecology in Karlsruhe, focusing on wildlife ecology and hunting techniques, and wrote his PhD thesis on Eurasian lynx.

Valeria Salvatori is a conservation biologist who has focused her work on carnivore ecology and management for the last 20 years. She is a member of the Large Carnivore Initiative for Europe and has led LIFE projects aimed at mitigating the impacts of large carnivores on agricultural production. She gained her Masters degree at Sapienza University, Rome, on the ecology of South American foxes and her PhD at Southampton University on habitat suitability assessment for wolves, bears and lynx in the Carpathian mountains.

CDPnews Carnivore Damage Prevention

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