Project

HUMAN-WILDLIFE CONFLICT MITIGATION IN THE ROMANIAN CARPATHIANS

Gareth Goldthorpe[1], Radu Popa[2], Mihaela Faur[2], Iain Trewby[2]

[1] *Biodiversity conservation consultant, France*

[2] *Fauna & Flora International, The David Attenborough Building, Pembroke Street, Cambridge, CB2 3QZ, UK*

Contact: iain.trewby@fauna-flora.org

www.connectcarpathians.ro

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

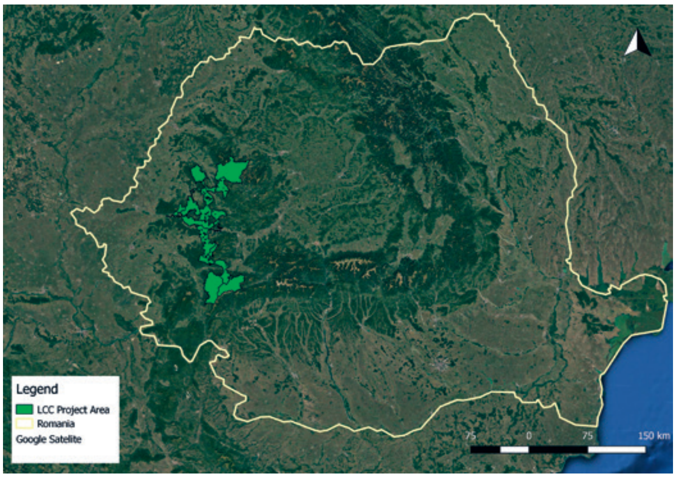

Fig. 1 LIFE Connect Carpathians project area within Romania.

[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.

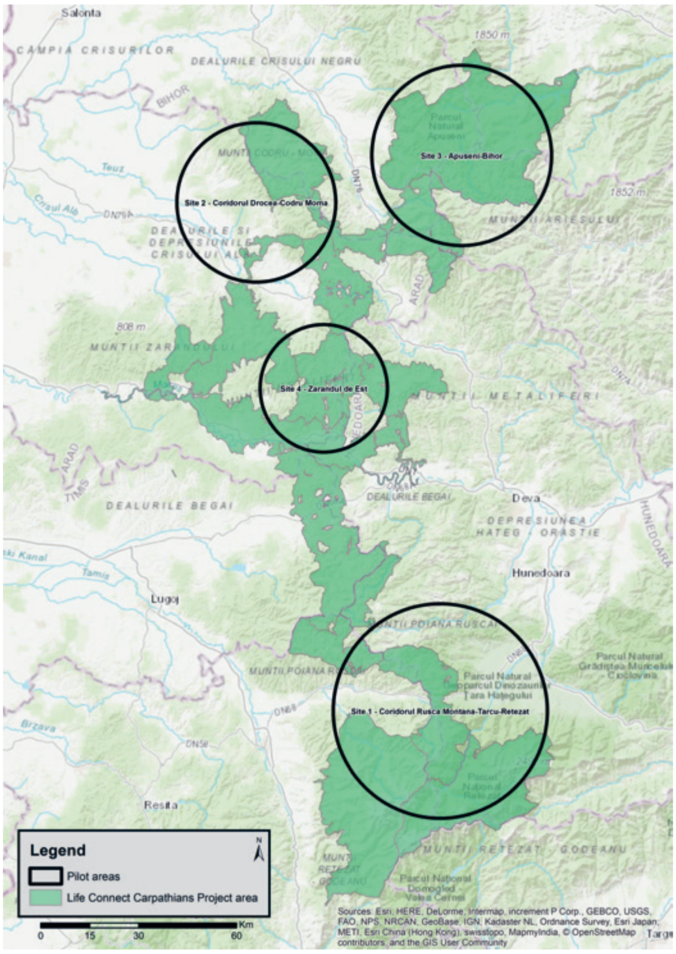

Fig. 2 Key sites within the project area for addressing the issues of human-wildlife conflict.

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 12 V 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.

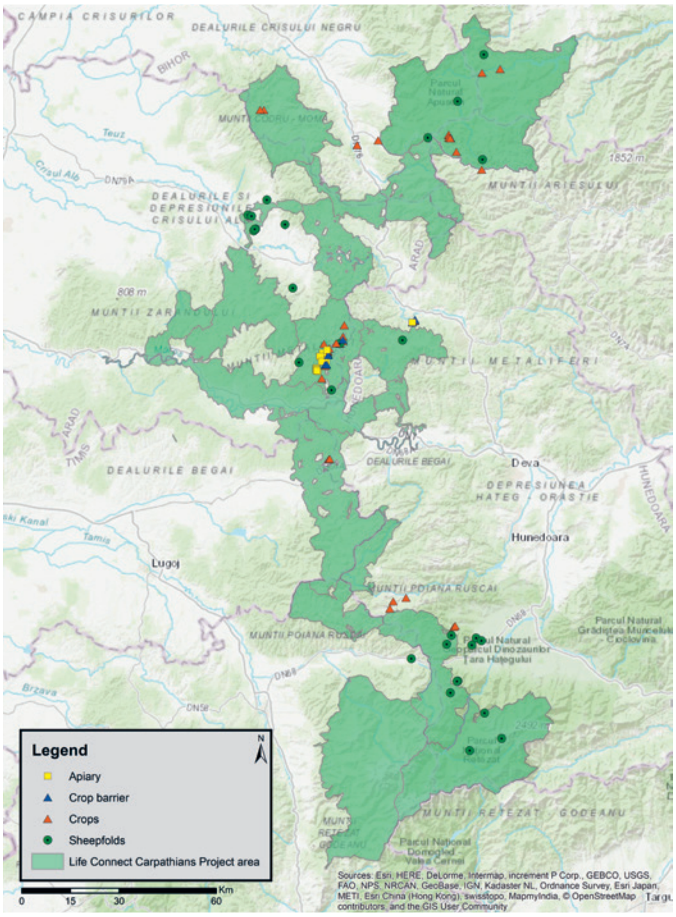

Fig. 4 Location and type of fences deployed by the LIFE Connect Carpathians project.

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 Bistriţa 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

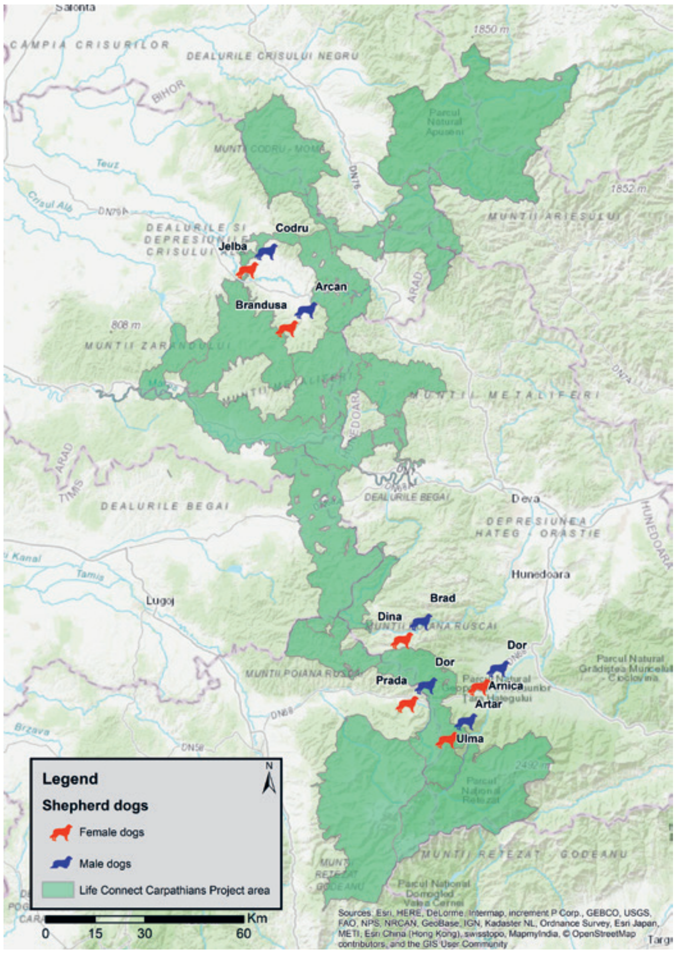

Fig. 5 Locations where LGD pups were distributed between November 2016 and September 2017.

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)*

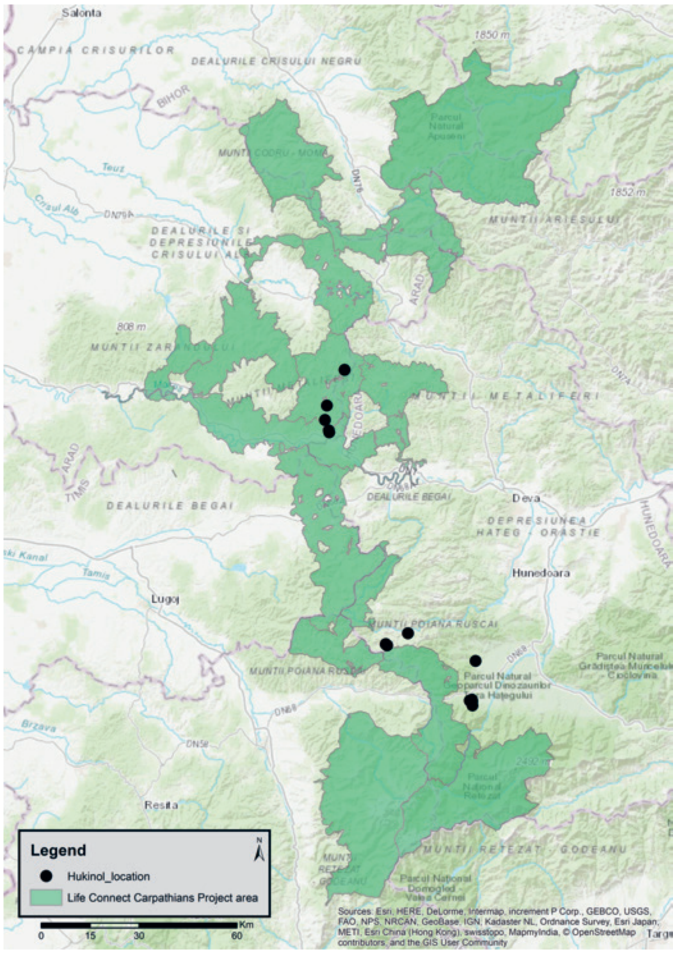

Fig. 8 Locations of croplands where chemical deterrent was applied.

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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