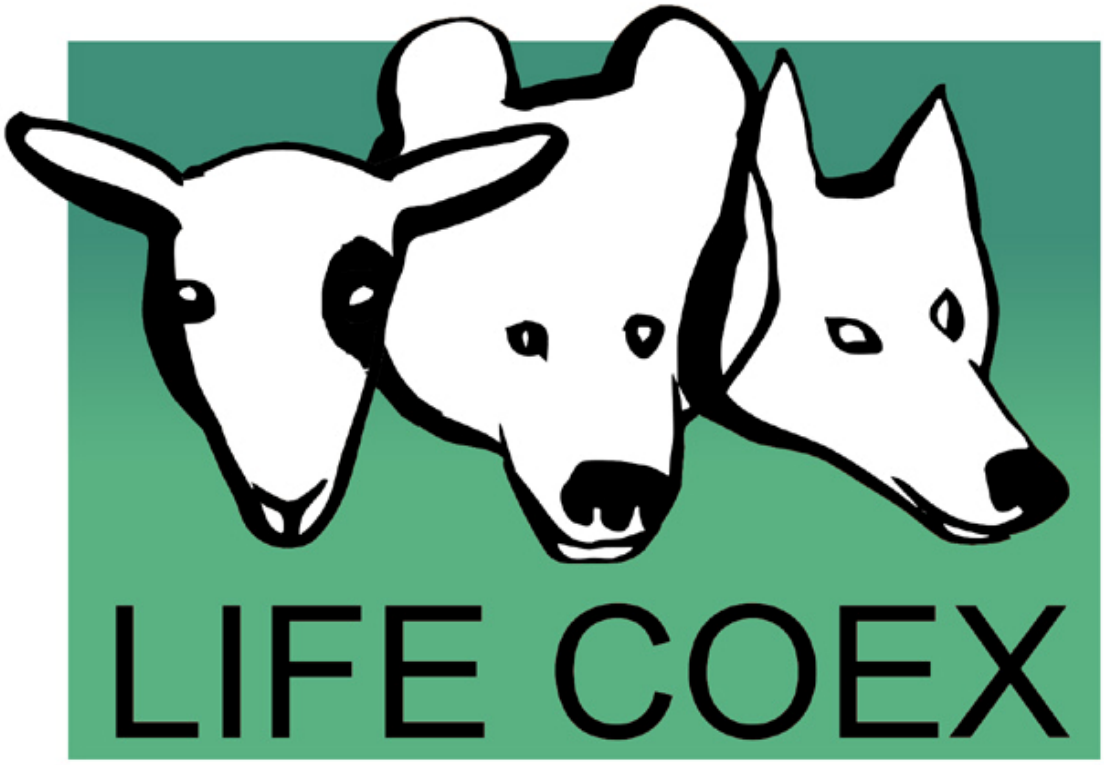
IMPROVING COEXISTENCE OF LARGE CARNIVORES AND AGRICULTURE IN S-EUROPE



ANNEX 11 – ACTION D1

INSTALLATION AND MONITORING OF ELECTRIC FENCES AS A DAMAGE PREVENTION MEASURE

NATURA 2000

Table of contents

List of tables **2**

List of figures **2**

Introduction **3**

Methodology **4**

SELECTION OF THE BENEFICIARY AND INSTALLATION 4

MONITORING OF THE EFFECTIVENESS 4

Results **6**

CHARACTERIZATION OF THE HOLDINGS 6

Description of beneficiary holdings *6*

Description of the donated fences *13*

Effectiveness of the fences *15*

Problems and solutions **20**

Conclusions **20**

References **22**

List of Tables

Table 1. Different types of electric fences installed in Italy in the frame of LIFE COEX from 2005 to 2008 7
Table 2. Annual frequency of attacks and of livestock killed or injured in the holdings with fences before and after the electric fences. 16
Table 3. Average number of attacks and of livestock killed or injured suffered by the holdings per year before and after the donation of the fences 16
Table 4. Decrease of damage in the Italian project areas due to the use of electric fences 17
Table 5. Evaluation of effectiveness of electric fences by beneficiary livestock breeders .. 18

List of Figures

Figure 1. Location of electric fences donated by the Life COEX in Portugal..... 9
Figure 2. Location of electric fences donated by the Life COEX in Spain 10
Figure 3. Location of electric fences donated by the Life COEX in Italy 11
Figure 4. Location of electric fences donated by the Life COEX in Croatia..... 12

Introduction

The activities described in the present report have been carried out in the frame of Action D1 of the LIFE Project “Improving Coexistence of Large Carnivores and Agriculture in SEurope” - COEX (LIFE04NAT/IT/000144). The objective of the project is *to develop the necessary legal and socio-economic conditions for effective conservation of large carnivores in the target areas by reducing conflict situations through a participatory approach.* This includes actions to try to actively prevent the damage caused by carnivores on agricultural goods.

If adopted correctly, the use of electric fences, conventional fences and livestock guarding dogs (LGD) can be highly effective in reducing the damage caused by carnivores to agriculture. Indeed, such devices have been successfully tested and used all over the world in the effort to prevent damages and improve the conditions for coexistence between wildlife and humans (Nass & Theade 1988; Linnell et al. 1996; Huygens & Hayashi 1999; Levin 2002; Mertens et al. 2002).

The implementation and success of this method may also contribute to reduce the costs and efforts associated with livestock management, namely in the traditional system of extensive grazing.

However, the methods involved in the use of fences and guarding animals are not universal. Different types of fencing designs may be used that can adapt to a great diversity of situations and husbandry systems. Therefore the use of such tools requests specific adaptation of the technical details to each socio-economic, geographic and legal situation.

The objective of this action was to test the use of electric fences under specific conditions and to stimulate the use of these devices among the farmers across the project areas. For this, in each project area electric fences were donated to livestock raisers, and their use and effectiveness was monitored. This was accompanied by public information activities that aimed at making the use of this tool known on a wider scale.

The action was carried out in Portugal, Spain, Italy and Croatia, whereas in France it was not done since in this country such tools were not believed to be suitable for the local situation.

In the whole course of the project we donated to livestock breeders 290 electric fences. Overall the donation of the fences has shown to be very successful and it was seen that the damage suffered by holdings that benefited from this effort has decreased.
This suggests that the use of electric fences can be a very useful tool for damage prevention and thus for the reduction of conflicts, as long as some important technical aspects are always kept into consideration.

Methodology

Selection of the beneficiary and installation

The fences were donated in the areas wolf and bear damages were higher attacks during the last years. Beneficiaries were selected mainly according to criteria such as:

- the amount of damages suffered by the farmers (please refer to reports of Actions A3 and F2 of the Project),
- their main dedication to the farming activity,
- the husbandry systems used,
- the flock size,
- their reliability and their willingness to participate in the project.

At the beginning of the project potential beneficiaries were contacted by the project staff, and asked whether they would be interested in receiving an electric fence. In a second phase, when the knowledge of the project activities began to spread in the project areas, the interested farmers generally contacted the project partners to request an electric fence. The potential beneficiaries were previously personally visited in their holdings to assess the usefulness of an electric fence for their work and what type of fence to be installed.
Due to the limited budget of the project not all the requests could be satisfied. In these cases the farmers were recorded for eventual donation in a second step or inclusion in other activities.

First installation of the fences was done either by the personnel of the project partners, or by the beneficiaries themselves, with the assistance of the project personnel. The project partners were in any case always available for whatever requests of assistance by the farmers.

Agreements were signed with all the beneficiaries, specifying important conditions such as: 1) the farmer will follow the instructions of the personnel of the project and will maintain it in an appropriate condition; 2) the farmer will not hand over the fence to anybody else; 3) if the farmer does not use the electric fences appropriately the LIFE COEX Project can confiscate it; and 4) the farmer will allow the project personnel to inspect the use of electric fence, and will inform them about eventual problems.

A database was created in which all data concerning each donated fence was stored, such as: dates of donation, location, beneficiaries, technical components and description of beneficiary holdings (numbers and types of animals or crops).

Monitoring of the effectiveness

To monitor the effectiveness and the correct maintenance of the electric fences, periodical personal visits were made by personnel of the COEX. During these visits we checked the following:

- Equipment integrity;
- Proper handling;
- Flock behaviour;
- Two night check-up in Spring and Summer (in fences installed around corrals);
- Battery charge;
- Inadequate equipment use, taking into consideration the goals of the project;

These visits also allowed to ensure there was a proper handling from the livestock producer, since in most cases they had no previous experience.

In addition, a regular phone contact with the raisers was maintained along the project to check if everything was working properly and to collect data for the analysis of their efficiency. Also, according to the contract each beneficiary was obliged to report any attack or damage to the fence. All the data was stored in a specific database.

For the evaluation of the effectiveness we have analyzed the amount of damage of the holdings in the years before and after using the electric fence, using average yearly data both for the years before and after the installation.
In addition, 78 beneficiaries were interviewed in Italy with the help of a questionnaire with open-ended and close-ended questionnaires. The farmers were asked about their level of satisfaction about the fence and whether they thought that this tool is an effective tool to prevent damage on livestock (for more details please refer to the technical report of Action F3, which can be found on the LIFE COEX website www.life-coex.net)

In Spain we also calculated the amount of damage in the municipalities with fences, in order to assure the presence of predators throughout the period of study.

Results

The COEX has donated 290 electric fences: 30 in Spain, 10 in Portugal, 239 in Italy and 11 in Croatia (Figs. 1-4). In 11 cases an electric fence that had been donated to a farmer was subsequently taken back and donated to another holding (Spain: 6; Portugal: 2; Italy: 3). This happened either because the first farmer was not convinced of the effectiveness of the fence or if they did not respect the terms of the agreement between the Project and the beneficiary. In two cases in Spain the livestock raisers sold their livestock and therefore did not need the fences anymore.

	PT	ES	IT					HR	TOT
			PG	TR	PNGSL	PNM	PNALM		
Number of fences	10	30	110	31	52	18	28	11	290

Characterization of the holdings

Description of beneficiary holdings

Portugal
In Portugal 10 electric fences were donated, of which two (LAD and PIN) were later taken off and transferred to other holdings. Thus, in total electric fences were installed in 12 different locations (Fig. 1).

Dfferent types of fences were used depending on the existing conditions, particularly the type of grazing system: Four fences were installed to protect livestock during night confinement in corrals (mainly for sheep). One permanent fence was installed for an overnight park. Three mobile fences were installed to protect livestock while grazing in different pastures (1.5ha) used for daily grazing/confinement and night confinement during summer. Three more permanent fences were installed on pastures (2.5 to 4ha) for the protection of sheep/cattle.

Of the installed fences 5 are located inside the wolf range, 4 North of the Douro region and 1 south of the river, and the remaining 5 outside the wolf range in the Centre-East region of the country. The 4 electric fences installed in the Northern region of the country aim at preventing wolf attacks while the fences installed in the centre of the country aimed at preventing mainly attacks from stray/feral dogs. This is also the case for one of the fence installed inside the wolf range, since the wolf presence is not stable and stray dogs are common.

In this area the wolf was extinct in the 1980', but the region constitute a potential expansion area for the species since it still has good habitat and the number of wild ungulates (*e.g.* red and fallow deer) is increasing. In fact, a poisoned wolf was recently discovered (October 2004) in the region in the county of Idanha-a-Nova. The appearance of this wolf created a climate of uncertainty regarding the predator responsible for livestock damages since attacks by stray dogs are common. Thus the implementation of electric fences in this area outside the wolf range is important to minimize existing and future conflicts.

The first electric fence installed intended to be an experimental unit. It was used for the night protection in a corral of a flock with 300 sheep (belonging to ESACB), that had been under constant pressure from stray dogs attacks. Its location enabled it to be accessible, easily monitored and allowed to test different fence designs and materials before implementation in the selected holdings.

The electric fences were installed in flocks grazed in a traditional extensive or, in fewer cases, a semi-intensive system (sheep milk producing flocks). In the mountainous areas in the North the traditional grazing system consists of leading the flock to the mountain pastures during the day and

confining the livestock in the stables (inside or close to the villages) during the night. Flocks are usually supervised by a shepherd and protected by dogs. Nevertheless, in the selected flocks the grazing system used was necessarily different to enable the use of e-fences. In these cases flocks (or specific groups, like pregnant females or females with lambs/kids) are lead to graze in specific pastures during limited periods of the year depending on the availability of food. Flocks are confined in stables during the night. In cases when the pastures are well fenced by stone walls or wire fences (preventing animals from straying, shepherds may not be present. In the region of Beira Baixa, during the warmest periods of the year (from Spring to Autumn) flocks are confined (mainly during the night but also during the hottest hours of the day) in corrals (mainly during the night but also during the hottest hours of the day, that do not give an adequate protection to the flock, and most are not accompanied by LGDs.

Spain
Seven fences were donated in Salamanca Province, 5 in Ávila and 18 in Segovia (Fig. 2). As can be seen in Figure 1, the electric fences are located in the core areas of the wolf damages occurred in each province during the last years.

All except one electric fence were used to protect a sheep flock, being the other one (the fixed electric fence) installed to protect bull-fighting calves. Around 21,000 heads of sheep and 200 heads of cattle are potentially benefited from the fences installed, although numbers vary from one year to another. The average total number of sheep owned by the holdings with electric fences is 720, although the average number of sheep locked inside an electric fence is 535.

In the sheep holdings with electric fences, the animals make daily trips normally guarded by a shepherd and a variable number of guiding and, sometimes, guarding dogs. They are driven back to the pen in the evening and spend the night in enclosures that should be secure enough to prevent predator attacks. Respecting cattle holdings, in a high percentage of them the livestock is free-ranging in extended states, so that the animals graze during day and night alone on the pastures. Calves, the most vulnerable section, are born in the field and are not confined in pens to protect them from wolf attacks.

Italy
In Italy 239 electric fences were set up (Fig. 3), mainly for the protection of livestock against the attacks of wolves and bears (Tab. 1). In total round 37.000 animals benefited from the protection of the fences, for an average of 338 sheep and goats, 6,7 cattle and 2 horses. In plus, the fences were used also to protect orchards and beehives against bears and to protect cultures against wild boars.

	PG	**TR**	**PNGSL**	**PNM**	**PNALM**	**TOTAL**
To protect sheep	45	26	52	13	16	152
To protect cattle	10	0	0	5	0	15
To protect bee-hives against bears	0	0	0	0	10	10
To protect orchards against bears	0	0	0	0	2	2
To protect cultures against wild boars	55	5 (11 km)	0	0	0	60
Total	110	31	52	18	28	239

Table 1. Different types of electric fences installed in Italy in the frame of LIFE COEX from 2005 to 2008

In the case of sheep and goats the most common husbandry method is to enclose the animals during night and to let them to roam, either free or under the control of shepherds and/or dogs, during day. This is why in these cases the use o relatively small, mobile fences is sufficient. In the case of the cattle the situation is different: the cattle are mostly kept on large areas both at day and night, which is why the used enclosures are mainly combinations of mobile and permanent systems, covering larger areas than the ones for sheep.

Croatia

In Croatia 10 of the 11 donated fences (Fig. 4) were used for the protection of bee-hives against the depredation by bears. Only one was used to protect a flock of 20 sheep.

Two main bee keeping systems are present – stationary and mobile one. In stationary system bee hives are kept at the same location all year long, usually near the owners' house or on a nearby meadow. Some bee keepers use mobile systems and they move the bee hives according to flowering season.

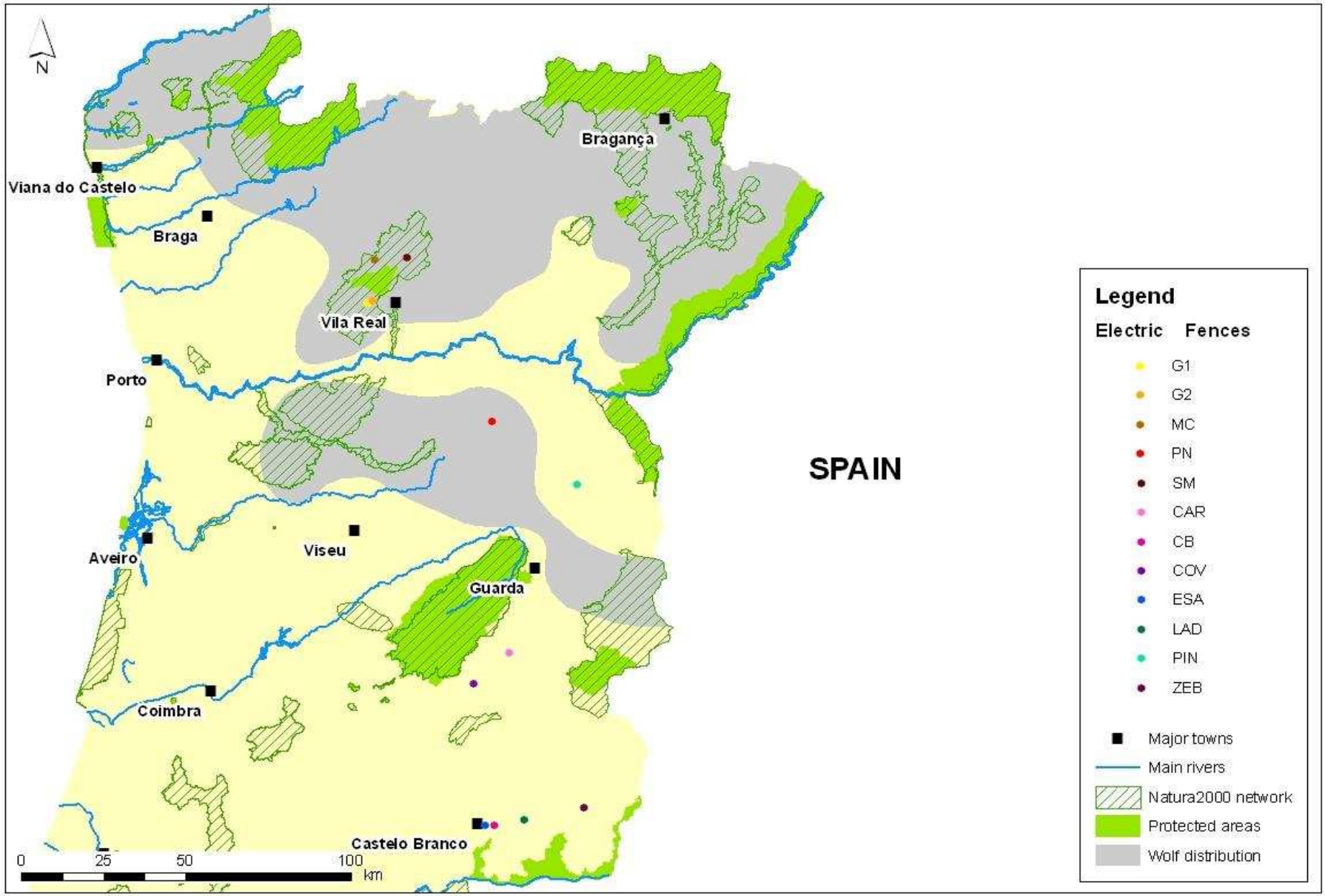


Figure 1. Location of electric fences donated by the Life COEX in Portugal

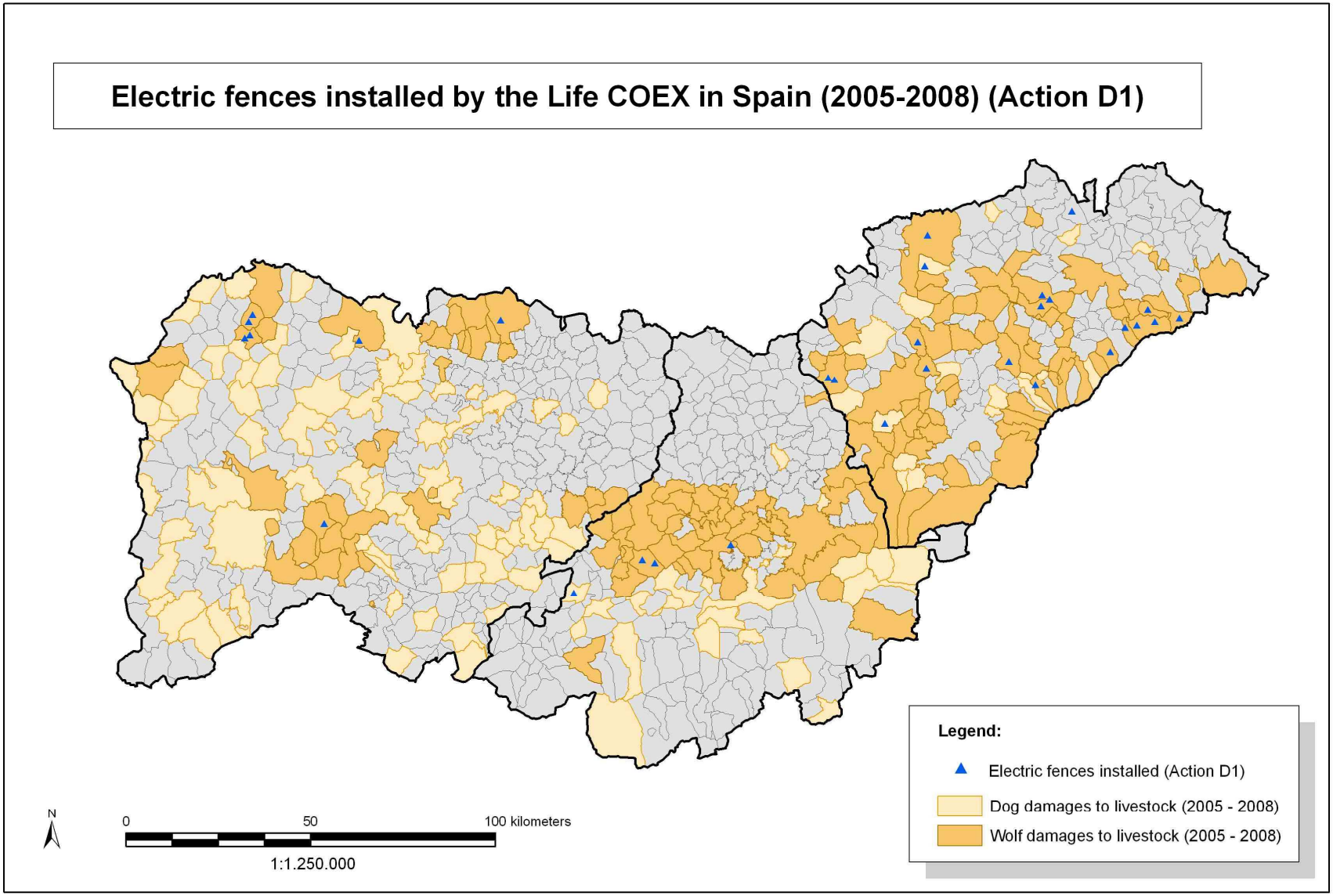


Figure 2. Location of electric fences donated by the Life COEX in Spain

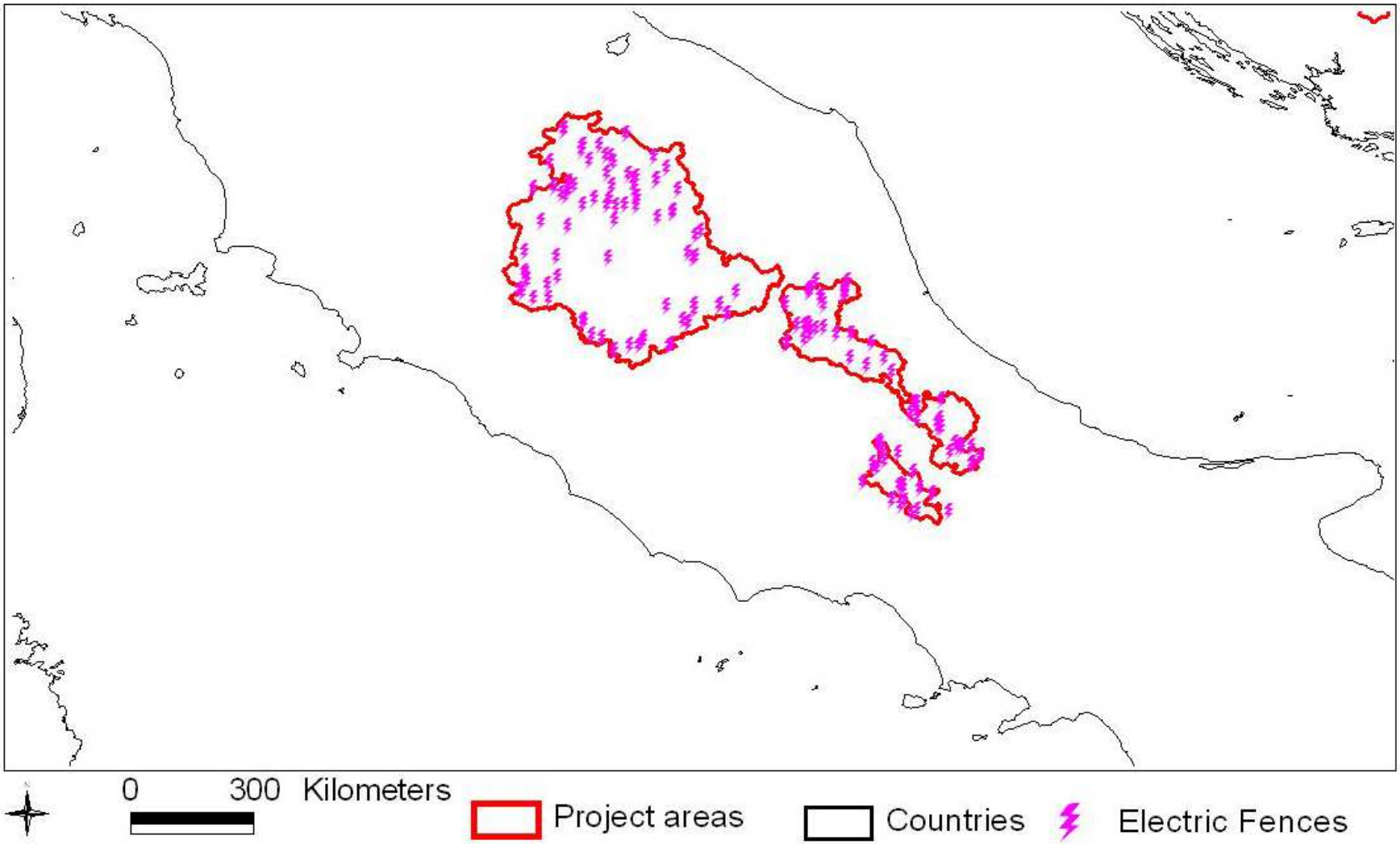


Figure 3. Location of electric fences donated by the Life COEX in Italy

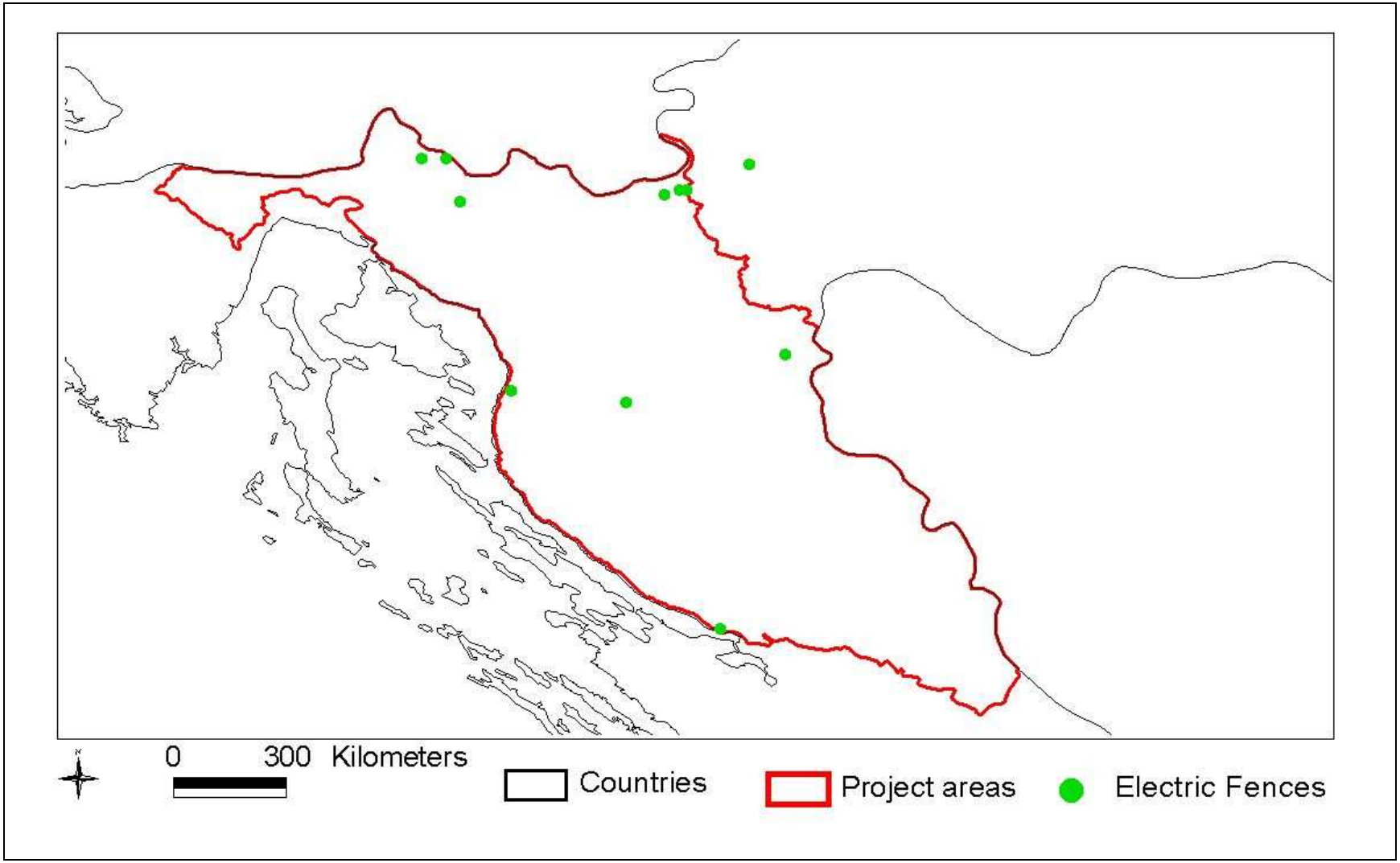


Figure 4. Location of electric fences donated by the Life COEX in Croatia

Description of the donated fences

Portugal
In the case of the fences to protect during night confinement in corrals the mobile fences were made of 4-6 electrified nylon wires (6 stainless steel strands) rolled up on reels and mounted on 1.65 m high. The distance between the wires ranges from 7 to 20 cm whereas the poles were put every 3 meter. The stronger corner poles, initially made of wood are now made of iron and were specifically manufactured based on a design that proved to be successful, created by the technical team of the Spanish partner. The gates were made of metal poles specifically designed to mount the reels and of springs with insulating handles, in the same number of the wires. The fences were set up 3 meters outside the corral, in order to create a buffer area between approaching predators and the animals inside the corral thus avoiding them to panic and take apart the corral (as was usually the case during attacks). Fences had a perimeter 4-6 times bigger than the one of the corral so that the it could be moved several times within the fence without the need to change the fence so often. Generators (1,7J) were connected to batteries of 12V, 65A or 74A powered by 7W solar panels.

For the mobile fences set-up around pastures the same metal poles were used for the corners and rods to sustain the wires every 10 meters. Conductors were electrified nylon wires (6 stainless steel strands) that were used and mounted on reels. For the permanent fences steel wires made of seven intertwined strands (1.5mm diameter) were used. One strainer was used per wire every 500m. Wooden poles (8cm diameter) 1.5m high (of which 20-30cm are buried) were placed at the corners and every 20 meters to increase the stability and resistance of the fence as well as to sustain the gate while iron rods were used between the wood poles.
All fences set-up around pastures were composed of 5 wires placed at a distance from the ground of 15, 30, 50, 75 and 95cm. The wires were usually all positive (live wires) except in cases of dense vegetation close to the wire closest to the ground or when the soil was very dry in which case it could be changed to negative (ground wire), connecting directly with the grounding system. One lightning diverter was fitted to every fence. Gates were made of metal poles specifically designed to mount the reels and of 5 springs with insulating handles. The grounding system was composed of one 1m copper bar deeply buried into the ground. The generators (1.8 J) were connected to car batteries of 12V and 62A recharged with a specific charger directly from an electric source (at an interval ranging from 8-40 days).

Spain
All except one were mobile fences. The fixed electric fence is composed by 5 electrified iron wires mounted over an existing metal fence. The length of the fence is around 800 metres. The holding is dedicated to breed bullfighting cattle, and the fence is used to protect the calves when they are weaned. The mobile fences are composed of five wires that are rolled up on reels and held by poles of 150 cm height. In the corners, metal poles specifically designed and manufactured by the handyman are used. Initially, the intermediate poles were made of plastic, but lately we substitute them by metal ones that were also manufactured by the handyman. In the first fences three of the wires were positives (i.e. with electric current) and two negatives. After some months of usage, we changed this design so that all five wires were positive, modifying the previously delivered fences, in order to improve their effectiveness. We use 12 V rechargeable car batteries to power the fences.

The mobile fences are placed around the traditional enclosures (corrals) commonly used by the sheep breeders in the area to keep the sheep during the night, ideally separated by 2 or 3 metres. This prevents the predator approaching the sheep by creating a buffer area. Every holding is provided with sufficient material to fence 200 metres of perimeter, which makes it possible to move the enclosure several times without dismantling the electric fence.

In all the fences it was installed a plate with the logos of LIFE and the Regional Government of Castilla y León and specifying the financing of the project.

Italy

In Italy the types of fences that were donated differed between the different project areas and according to the items to be protected:

Perugia Province:

Permanent fences for the protection of cattle: Five rows of conductor, placed as follows from bottom to top: 1 steel wire, 1 medium conductivity nylon wire, 1 low conductivity nylon wire (to prevent access of predators from below), two rows of electrified nylon tape (at the top) (to control the movements of the cattle). Total height was 110 cm over the soil. Powered by impulse generator, alimented by a 12 V, 60 Ah rechargeable battery, changed by a solar panel.

Mobile electric fences for the protection of sheep: Net fences, composed of 2-3 50 mt. modules of electrified nylon net, 108 cm high (above the soil). Electrifiers of 1-3 Joule, charged by 12 V/65 Ah rechargeable batteries were supplied.

Wild boars: Two rows of steel wire, placed on wooden posts at 30 and 50 cm height. The fences were powered by 1-2,5 Joule impulse generator, alimented by 12 V rechargeable batteries.

Terni Province:

Mobile electric fences for the protection of sheep: Net fences, composed of 50 mt. modules of electrified nylon net, 108 cm high (above the soil). The fences were powered by 2500 MJoule impulse generators, alimented by 12 Volt rechargeable batteries.

Permanent barriers against wild boar damage: 3 lines of galvanised wire (2,5 mm thickness), mounted on chestnut poles, which were placed at round 5 mt distance from each others. The wires were at 30-50-70 cm above the ground. The fences are powered by 6000 MJoule impulse generators, alimented by direct electricity supply (220 V).

Gran Sasso Monti della Laga National Park:

Mobile electric fences for the protection of sheep: Net fences, composed of 50 mt. modules of electrified net, 108 cm high (above the soil).

Majella National Park:

Mobile electric fences for the protection of sheep: modules of 50 mt. electrified nylon net, of 100 cm height above the soil. Powered by 1 Joule impulse generators, and 12 V rechargeable batteries.

Mobile electric fences for the protection of cattle: 3 wires of electrified nylon wires at 30-60-100 cm height above the ground. Powered by 1 joule impulse generators, and by 12 V/65 Ah rechargeable batteries.

Abruzzo Lazio e Molise National Park:

All fences (for the protection of livestock, be-hives and orchards: 3 lines of electrified nylon tape, 35-65-115 cm height, powered by 1 Joule impulse generators, and by 12 V rechargeable batteries, which are charged by solar panels.

Croatia

The ten donated fences that were used for the protection of bee hives were made of with electric net. Each beneficiary has received a 50 m long and 90 cm high net, 220 V generator (or 12 V batteries), gate components, earth stakes, and insulators. Stroke strength at the exit was 3 to 4 Joules, and the regulator allowed the stroke range from 1 to 9.

Only one fence was used for the protection of sheep on a pasture and it has been equipped with 400 m of wire instead of a net.

After the end of the project 8 more fences have been purchased to be ready in the cases when and where bear troubles might occur. Six of those are electric nets and foreseen to be used for bee hives, and two are foreseen to be used for livestock, and made of electric wire. With the discount for larger order the price per bee hive fence was 485 EUR and per pasture net 1800 EUR.

Effectiveness of the fences

Portugal

Damage evolution

The effectiveness of electric fences was of 100% for all type of fences used since no predator attack occurred to the livestock while inside the fences after they were installed. The fences showed to be effective in protecting flocks during the night in corrals or during the day in pastures. In fact, for the fences that have been installed for longer periods (with rates of use from 47-100%), (mobile fences set-up during night confinement in corrals and an overnight park), in the previous years (2000-2006) the flocks experienced an average of 6,6 dog attacks resulting in an average of 15,7 sheep injured and of 58,1 killed. In these cases the absence of damages during the night may simply signify that there was no attack at all to the flocks. In fact, no attack has occurred to those flocks during the daily grazing period either. Nevertheless, the historical incidence of stray dog's diurnal attacks is much lower than the nocturnal incidence. Another fact that support this view is that in one case, although no attack occurred during the night while the flock was inside the e-fence, one attack occurred during the day while the animals where in the pasture. In the holdings inside the wolf range due to the reduced period of use (10-79 days) of the fences conclusions about efficiency are still preliminary.

Owner satisfaction

After an initial period of doubt concerning the efficiency of electric fences livestock breeders finally seemed to have accepted their use. This was particular evident in the case of meat sheep flocks as proved by a utilization rate of 100%. Initial apprehensiveness was also a result of the problems that occurred before some of the electric fences became operational. Nevertheless, an important aspect is the negligence in the use of the fences that seems to increase with time, resulting in the decreasing rate of use of the fences that could result in damages. The negligence is not linked with the non acceptance and neither with the lack of trust in the method's efficiency but rather with the extra work that its use implies.

One of the positive outcomes that have contributed to reduce the farmers work was that the use of e-fences in grazing pastures made the presence of a shepherd no longer required, since flocks could be left inside the fences during the day and/or night without supervision.

Economics and effort

An electric fence represents a long-term investment and thus the use of adequate material is very important since it reduces fence failures and future maintenance costs.

The average cost of the fences installed around grazing pastures was €850, varying from €700 to almost €1.000. A factor that greatly increased the cost of these fences was the ground irregularities, since they imply the acquisition of a bigger number of poles and rods. In theses fences approximately €0,21/meter was spent in permanent fences and €0,34 in mobile fences. To this amount a total of around €300 should be added to acquire the generator, battery, ground system, lightning diverter and warning sign.

Considering an average cost of the entire equipment/materials of €700 and a maintenance cost of €100 during a period of use of the fence of 7 years, we estimate an annual cost (amortization + maintenance) of €114.3/year. For an average flock size of 550 breeding sheep (estimated from the holdings were the e-fences were installed), and considering the average annual damage by stray dogs we could estimate an annual animal replacement cost as a direct result of predator attacks of €387.2, which is 3.4 times higher than the estimated annual costs related with an e-fence

installation and maintenance. In this scenario we can conclude that for flock sizes larger than 165 sheep the acquisition of an electric fence is cost-effective.

Nevertheless, the values do not include the costs with the extra work for moving the mobile fences, nor the costs associated with the treatment/work associated with the recovery of the injured animals neither the indirect production lost associated with a dog attack (*e.g.* abortions, reduction in milk production).

Spain

These fences have showed to be very effective to prevent wolf and stray dog attacks, as suggested by the sharp decrease of damages since their installation. To calculate the effectiveness of the electric fences, we have analyzed the amount of damage of the holdings one year before and since the donation of the dog to August 30th, 2008. It was not possible to compare the damage suffered by the holdings with a fence in relation with the rest of the holdings in the same municipalities because of the lack of accurate livestock census in the region. However, we have calculated the amount of damage in the municipalities with electric fences throughout the period of study, in order to assure the existence of predation, and this way, the presence of predators during the study.

Damage evolution

Until December 31st 2007, in more than 21,000 days-fence, there were only three attacks since the installation of the electric fences to livestock locked inside of them. Only in one case the wolf injured one sheep that was killed by the shepherd some days later. The annual frequency of attacks and of livestock injured or killed before the arrival of the electric fences was 103 and 719 respectively. After their installation, these numbers were reduced to 1,75 and 0,58 (which means a reduction of 98.35% and 99.9% respectively). In both cases the differences are highly statistically significant ($G_{(1}$= 75.610, p=0.000; $G_{(1}$= 611.970, p=0.000).

	Before fence	**After fence**
Attacks / year	109	1.75
Killed-injured / year	719	0.58

Table 2. Annual frequency of attacks and of livestock killed or injured in the holdings with fences before and after the electric fences.

The average number of attacks suffered by each of the holdings per year was 3,03 before the fence and 0,05 after the fence (a reduction of 98,3%), and the average number of livestock killed or injured was 21,15 and 0,02 respectively (reduction of 99,9%). The reduction in the average number of attacks is not statistical significant, but the average livestock killed or injured has decreased significantly ($G_{(1}$= 1.68, p=0.65; $G_{(1}$= 17.13, p=0.000).

	Before fence	**After fence**
Attacks / holding / year	3.23	0.05
Killed-injured / holding / year	21.15	0.02

Table 3. Average number of attacks and of livestock killed or injured suffered by the holdings per year before and after the donation of the fences

Finally, the number of attacks and the number of sheep killed in the municipalities where the fences are settled have increased since the implementation of the electric fences from 76 to 123, and from 494 to 645 respectively. So, the reduction in the damages in the holdings with electric fences is not due to the disappearance of the predators.

Owner satisfaction

All livestock raisers are quite satisfied with the electric fences donated by the project, as in most of the cases, they have completely avoided the damages in their holdings. All the farmers agree that they are a little more at ease when leaving the livestock alone since they have an electric fence. It is worth mentioning that four of them were spending the night in the field guarding the sheep to prevent wolf attacks the weeks previous to the donation of the fence. They stopped doing this as soon as the electric fence was settled.

This type of method has shown to be the most demanded and preferred by raisers in Segovia, due to the kind of livestock management developed in the habitats present in this province.

Economics and effort

In the initial stage of the project a budget was asked to four different companies in order to choose the best offer in each province. The cost of each mobile electric fence is 780 €, while the only fixed electric fence (800 m long) cost 1200 €. The minimum average total cost of the damages suffered by each holding before the donation of the electric fences was 2581 € (only considering the number of livestock killed, not injured or disappeared). The average cost of the damages per year is 516 €. This is a minimum number as occasionally some of the attacks were not reported and were therefore not included in the calculation.

Italy

Damage evolution

No damage has occurred on any of the orchards and bee-hives where electric fences have been installed.
The same applies for the four barriers that were set up to prevent wild boar damage on crops, where the claimed damage has dropped from 15.000 EUR per year to 0.

Also in the case of the fences installed to protect sheep and cattle from attacks of wolves and bears these tools have demonstrated big effectiveness. Of all the 239 fences installed in 3 years only 5 cases were registered in which damage happened while the livestock was confined in the fence.

However, in the farms the livestock is not always in the fences, and also in several cases the flocks are big and are divided into smaller flocks, of which some are placed in the fences and some are kept free. In these cases some damage continued to occur on the unprotected animals. But still, the overall damage has decreased significantly in each of the project areas:

Project area	**Decrease of damage (%) in the whole farm**
PNGSL	68,9 %
PNALM	51,2 %
PNM	Data not available
Terni	37,8 %
Perugia	72,8 %

Table 4. Decrease of damage in the Italian project areas due to the use of electric fences

Owner satisfaction

In general the opinion of the livestock raisers who benefited from the donation of electric fences was positive about the usefulness and effectiveness of this tool (Tab. 5).
The fences were mostly positively valued because they offer good protection to livestock, but also because of other advantages such as 1) they are easy to use and to manage, 2) they provide more security at night, 3) they allow to leave the livestock outside also at night, and 4) they keep out also other animals such as foxes, which often injure or kill very young lambs.

	Positive	**Neutral**	**Negative**
PNALM	80,0	10,0	10,0
PNM	100,0	0,0	0,0
PNGSL	55,6	0,0	44,4
Perugia	82,4	5,9	11,8
Terni	100,0	0,0	0,0
Total	**85,2**	**3,3**	**11,5**

Table 5. Evaluation of effectiveness of electric fences by beneficiary livestock breeders

Also some negative comments were given, among which:

- the fences are not stable enough,
- the fences are too low,
- they require much work
- animals get tangled up and struck
- they are not effective against wolves

However, in all the project areas except for PNGSL over 80% of the interviewed beneficiaries had a positive perception of the fences, which is because the upmentioned disadvantages occurred only very sporadically.

Economics and effort

In Italy an electric fence for the protection of sheep cost in average 460 EUR, raising to 530 EUR if solar panels were used.
A comparison with the economic damage suffered by livestock raisers is not simple since the price of livestock can vary greatly, ranging only for sheep from 72 EUR for a common breed milk sheep to 155 EUR for a selected breed milk sheep.
However, estimating an average of 100 EUR per animal, and taking into consideration the average number of animals lost per holding in Italy (which ranged from 5,89 heads in 2006 to 8,06 heads in 2007, report of Action F2), each holding is estimated to suffer a damage of at least 600 EUR per month, if considering that these heads are not only sheep but also cattle, horses and pigs, which have a much higher value. This suggests that the costs for one electric fence will be covered by the losses suffered by the holdings in one year.

Croatia

All beneficiaries have suffered at least one brown bear attack before the donation of the fences. The exact data on when and how much damage they had in the past are not available as there was no systematic data collection on bear damage in Croatia prior to the LIFE COEX project.
No attack attempts on bee hives have been recorded after the donated fences have been installed. We can therefore state that the effectiveness has been 100%.
In the only case of fenced livestock one attack was recorded when lynx killed one sheep and a bear came later and consumed the leftovers. However, both the lynx and bear approached the

sheep from the side of the river (only up to 30 cm deep) where the owner had removed the fence. The owner understood the situation and continued to claim that the electric fence is a good solution for the protection against bears. It can be concluded that this fence itself worked perfectly as well.

Problems and solutions

One major problem was that at the beginning of the project it was not easy difficult to find farmers willing to participate in testing the electric fences, which was mainly due to the fact that many of them were reluctant to change their working habits and because they did not know whether they could trust this new tool.
However, after some farmers had used the fences and had positive experiences with them, the news of this effective tool spread quickly and more and more livestock raisers got interested in participating in this initiative.

Sometimes technical problems appeared with fences not working effectively. These problems were mainly related with inadequate materials and some equipment (generator) that broke down or other materials (insulators, wire, solar panels) that had to be replaced. However, the technical problems were solved with the help of technicians who assisted farmers in installing and maintaining the fences optimally, resulting in the increased knowledge of the technical team about a wide variety of different type of equipment/materials and problems/solutions.

In few incidents animals got tangled up in the fences, getting injured. However, these were very sporadic cases which did not affect the overall acceptance of this tool by the farmers.

Conclusions

The main results of this Action were very satisfactory, considering the very high effectiveness of the donated fences in preventing attacks by predators. This has been demonstrated by the fact that in many cases the farmers who had initially benefited from the donation of a fence, have then bought additional fences by themselves. Also, several cases were registered in which farmers in the project area, who had not participated in the LIFE COEX project, observed the usefulness of the electric fences and installed them autonomously.

It was seen that some problems are involved in the implementation of the use of this damage prevention tool on the ground, such as financial issues, technical problems and the need of adapting the used livestock management techniques. However, these problems have been overcome with the help of technical assistance to the farmers and finally the benefits of the use of the fences were higher than the problems.
One issue might however be a major problem, namely the fact that the costs of the equipment/material, which are considerable for many livestock raisers, may reduce the interest towards the use of this method. Besides this is the extra work/time needed to monitor or move/install the fences. This factor may result in a gradual loss of motivation of the livestock breeders to correctly use the method, particularly in areas where predation events are not frequent. These reasons may constitute a real problem since they may condition the future expansion of this prevention measure and ultimately its success in deterring predation due to improper use or maintenance.
It is of fundamental importance that this problem is taken into consideration by the authorities responsible for wildlife management on the ground. In this context the direct participation of local authorities has been particularly important.

In general, the project has enabled the acquisition of knowledge about the use of electric fences as a damage prevention measure in very different situations (*e.g.* husbandry systems, predators, livestock) and the test of different designs and equipment/material. On the one hand, the local authorities outside protected areas often do not have the expertise with damage prevention tools. In this project the local authorities have had the possibility to learn new techniques they can further use for improving conflict management strategies. On the other hand, the fact itself that local authorities have taken the initiative, through the COEX, to start a scheme to assist farmers, has

given this professional category the feeling that their needs are taken account of, and thus this has been a starting point to improve the relationships between these often conflicting stakeholders.

For the further dissemination of this damage prevention tool it is important that farmers in the project countries are informed about the positive results we obtained in the Project, by explaining them to what extent and under which conditions the use of electric fences can significantly reduce the damage caused by wolves and bears on livestock. This is easiest done by concrete demonstration initiative, such as direct involvement of farmers, and by demonstration in public events.

The use of this tool alone will not be sufficient to solve the conflicts between livestock raising and the conservation of large carnivores, but it can give an important contribution for building up coexistence between different interests.

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