already used the fences told the others about their positive experience with the fences - they had no losses since they have installed the fence. As a result of these meetings, many livestock breeders became quite interested in using this device. In summer 2001, we managed to install all the fences at livestock camps. Through our media activities, people from other areas in Romania were informed of our activities, and we even received a request for an electric fence from a shepherd located far from our study area. At present, we can't meet the huge demand for electric fences. Thus, our next step will be to find a manufacturer to produce fences within Romania that can be sold at prices affordable to Romanian livestock raisers.

Does the reduction of damage pay for the costs of electric fences?

Our experiments have shown that the use of electric fences can help to reduce the damage to livestock caused by large carnivores . However, an electric fence is not a cheap measure. On the western European market, a good quality fence of 400 m length with five wires can cost US$ 500.- to 800.-. This is much too expensive to be affordable for Romanian livestock breeders. However, we are interested in knowing how much an electric fence could cost in order to be profitable, if it were produced more cheaply in Romania.

This year we calculated an average damage at livestock camps of US$ 260.- per camp. This includes animals killed and the loss of milk production. The damage caused at camps with electric fences was US$ 6.70, only 2.59 % of the damage caused at the other camps. According to these calculations, an electric fence that cost approximately US $ 250.- would be paid for by the reduced loss of livestock in one year.

However, there is one factor influencing these calculations: the person in charge of the livestock camp never has to pay for all the damage caused by large carnivores. He has to pay only a part of the damage. The animal owners bear the rest of the loss. Thus, nobody suffers such a high loss that it would be profitable to pay a high price for an electric fence. On the other hand a fence like the one we tested can work for many years if it is properly maintained. Thus, the investment for an electric fence would probably be profitable for a person who owns many animals or who is in charge of a flock for a longer period.

See also the *Carpathian Large Carnivore Project* on: www.clcp.ro

How to Prevent Damage from Large Predators with Electric Fences

by
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Swedish experiences with electric fences

The Wildlife Damage Center / Viltskade center (WDC) in Sweden continually tries to develop and evaluate preventative methods against large predators and other protected species. Since the majority of livestock in Sweden are grazed in fenced areas, WDC has put some effort in finding the most efficient fence design to exclude large predators. In 1997 we learnt that electric fences successfully prevented bears from raiding beehives, which is among the most attractive food they can get. At that time we tested fences with both three and six wire strands. Both turned out to be "bear safe". Building on this knowledge, this kind of fence (but with four or five wires) has been erected all over the country. There have been few, if any, livestock attacked by large predators within well constructed and maintained "predator-proof fences" in Sweden.

Fence tested with captive lynx

These fences seem to effectively exclude bears and wolves in Sweden, but when it comes to lynx people have been more doubtful. Some reports of lynx that had jumped between the wires led us to set up a study in cooperation with Swedish zoological parks in the fall of 2001. So far we have only results from experiments with lynx but we plan to perform tests with wolves in spring and summer 2002.

Four types of fences were tested:

- a standard non-electric sheep net (woven wires, height 90 cm)
- a sheep net supplied with two electric wires – one on top of the net and one at the bottom (see figure 1)
- an electric fence with three wires (wires on heights of 20, 40 and 70 cm)
- an electric fence with five wires (wires on heights of 20, 40, 60, 85 and 110 cm (see figure 2)

The lynx (one at a time) were kept in an enclosure in which the test fences (two at the time) cut off a corner. Food (roe deer meat) was only supplied on the other side of the test fences. Monitoring cameras that registered and recorded every movement the animals made were installed close to the fences. The results from this study are not yet published, but we

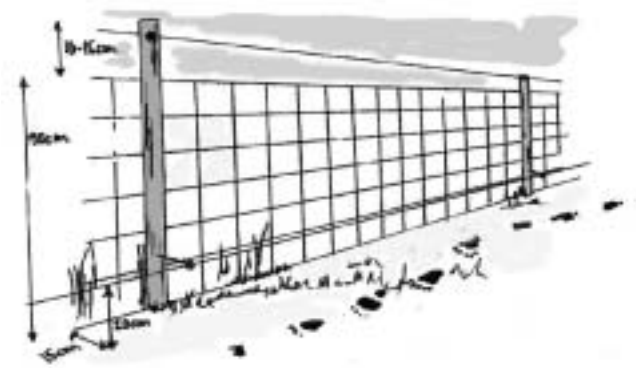

Fig. 1: Sheep net supplied with two electric wires – one on top of the net and one at the bottom.

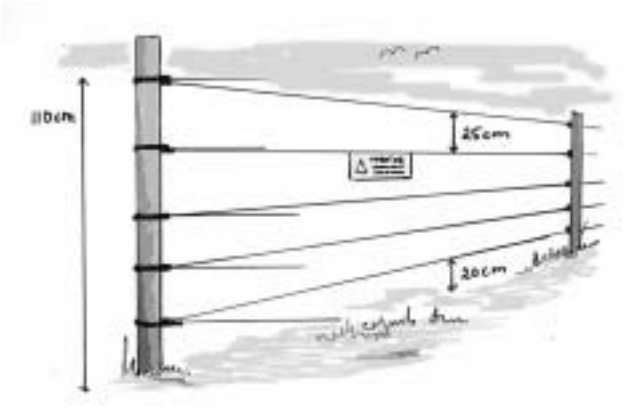

Fig. 2: Electric fence with five wires (wires on heights of 20, 40, 60, 85 and 110 cm above ground).

learnt that the most efficient fences were the sheep net with two electric wires and the electric fence with five wires. The lynx were capable of slipping under the lowest wire if the distance by accident exceeded 20 cm (25 – 30 cm). In some cases they also jumped between two wires if the distance between them was 25 cm or more. The lynx never jumped over any of the fences. So far the results from this study make us believe that lynx might be the most difficult predator to exclude with fencing. Swedish experiences so far reveal that bears and wolves are much more suspicious about electric fences than lynx. The critical point is that the lowest wires are mounted as close as 20 cm to the ground.

Recommended construction of electric fences

Today WDC recommends the two types of fences mentioned above against large predators. We think that they provide a good protection against mainly wolves and bears but in most cases also against lynx. Construction and maintenance of electric fences are the very base condition for success. It pays to invest in good quality from the start – it lengthens the lifetime of the fence and results in less costs and time of maintenance. We calculate a lifetime of 15 - 25 years for well-kept fences of good quality.

Poles

The refraction poles should be of impregnated wood, with a diameter of 10 - 15 cm. Impregnated wood is lasting much longer in the soil. The poles should be knocked down to a dept below freezing (in Sweden at least 1 m). It is important to stabilize the foundation properly. The distance between the refraction poles depends only on the terrain.

The in between poles can consist of glass fibre, plastic or hard wood like eucalyptus with a diameter of 4-6 cm. The distance between these poles should be about 4 to 8 m, depending also on the terrain. Try hard to get as straight lines as possible that will make the fence much stronger.

Wires

The wires should be smooth and of high-tensile quality and have a good galvanization. A wire of stainless steel is also acceptable but has to be supplemented with a spring so that is does not stretch too much. The diameter of the wire should be 1.4 - 2.5 mm (a coarse wire is more visible but also more expensive and harder to work with). The wires (or net) have to be properly stretched. If they loosen, the risk that animals will jump between them increases. For this reason special wire stretchers should be mounted on the wires. Splicing should be carefully done. Make sure that the wires get attached close to each other to make the resistance as little as possible and to achieve a good conductivity. The distance between the wires should not exceed 20 cm to make sure that lynx don't jump between them. It is also important that the distance between the lowest wire and the ground is not larger than 20 cm. Use five wires for a predator safe fence. Avoid electric cords or ropes as well as twisted wires in permanent fences. They provide less conductivity, are more expensive, and have a shorter lifespan than those recommended above.

WDC recommend against electric nettings if it is not the only practical solution at a place. Experience tells that animals, both domestic from the inside and wild from the outside, have died while struggling to get loose from entangling. The fences can however provide an emergency short-term solution before a permanent fence is mounted, for example in an area newly exposed to predation. In areas where there is a

need to move the farmed animals between different smaller pastures during the season electric nets can also be a solution.

Insulators

The insulators (that hold the wires) must be strong and durable. It pays to choose a good quality from the start. A good insulator should have a distance of at least 20 mm between the wire and the closest part that is not insulated (counted as the surface of the insulator). At corner poles the stress on an insulator is severe. A good (and cheap) solution is to mount pieces of insulation tube around the wire around the pole. The tube should be resistant to UV-light and harsh weather. If a standard sheep net is supplied with wires the wires should be mounted on distance insulators. The distance should be at least 15 cm between the net and the wire.

Earth

It is very important to earth the fence properly. The iron bars that earth the fence must be at least 1 m long. They should be knocked down at a distance of 1-2 m or more from each other. Use three iron bars as a minimum. Adjust the earth connection to the soil conditions. The voltage to the iron bars should be less than 300V.

Energizers

Generally one should choose an energizer with over-capacity to make sure that the voltage is large enough even after rain and when grass might have grown up and bent over the lowest wires. It also makes it possible to extend the fence without changing the energizer. The energizer should supply the wires with at least 4’500V. Feeder cables can overcome long distances between energizer and mains electricity. In Sweden there are some examples of such cables being more than 2 km long. If the energizer cannot be mains operated there are powerful battery-operated energizers available on the market. These batteries can be supplied with solar panels that reduce the work with charging the batteries.

Voltage

Keeping a good control of the voltage is of main importance! This must be done with a voltmeter. Special applications can supply the unit with an alarm system that warns if the voltage gets below a certain level. Lightning conductors that protect the energizer during thunderstorms can also be a good investment.

Maintenance

Maintenance is an absolute condition for an effective predator-proof electric fence. Growing vegetation that lays against the wires must be cleared up at least once a year. The wires must be kept stretched.

Ground frost, dry earth and snow

To prevent the effect of snow or very dry earth or leaves from functioning as insulators, wires number 2 and 4 (counted from the ground) can be earthed. Disconnect them from the other wires and connect them with the earth cable of the unit. This gives the animal that tries to cross the wires an electric shock when it touches an earth and a hot wire in the same time. This is also effective if snow builds up and covers the lowest wires.

Large objects near the fence

Try to get large objects such as rocks, walls or other objects that can be used to climb into the enclosure as far from the fence as possible.

Time consumption and cost

The time needed to install a predator safe fence depends on the terrain and what facilities one can use. The use of a tractor equipped with a certain implement to knock down the poles reduces personal time consumption but increases the total cost. For a calculation of time consumption see table 1.

Tab. 1: Time consumption for two people to install an electrical fence with five wires. Time consumption is calculated for some kind of rather smooth terrain. It is also calculated for people who have previous experience on fence mounting. Time for preparatory work such as clearing away bushes and grass if necessary is not included.

Fixed time consumption		**hours**
Mounting of unit		0.5
Grounding	3 iron-bars	0.5
Gates	2 gates	1
Sum		2

Flexible time consumption (100 m)		**hours**
Mounting of refraction poles	2 poles	0.5
Mounting of wires		1
Mounting of in-between poles (16 poles, 1 minute per pole)		0.25
Mounting of insulators/ wire-holders (16 poles, 2 minutes per pole)		0.5
Sum		**2.25**

Tab. 2. Cost for two different kind of 4 km long fences.

	Electric fence with five wires	**Sheep net supplied with two electric wires**	**Two extra electric wires (for already mounted sheep nets)**
Total cost excluding energizer	3'400.- US$	7'090.- US$	1'940.- US$
Cost per meter	ca. 1 US$	ca. 1.8 US$	ca. 0.5 US$
Energizer and lightning conductor	640.- US$	640.- US$	640.- US$

Note that the prices are very approximal (table 2). The sheep nets used in Sweden are actually more expensive than the electric fences. The sheep net of woven wires is more expensive and also a little harder to set up. It is, however, the standard sheep fence in Sweden. Most farmers already use them and therefore just have to supplement them with two electric wires to get a predator safe fence.

Common mistakes

1. Inadequate grounding
2. Weak poles
3. The poles are not knocked down properly
4. The insulators are of a poor quality
5. The lowest wire is too high off the ground
6. Insufficient voltage because of leakage or resistance

- If the fence is too long for the unit's capacity the voltage becomes too low.
- High resistance because of the material of the wires or bad splicing implies lower voltage.
- Vegetation that leans over the wires or wires that get into contact with the sheep net cause voltage losses.

Conclusions

The fences are very efficient in keeping the domestic animals inside. They also provide effective protection against dogs and foxes. At least there have been no recordings of foxes crossing the fence.
Since the fences have an elastic function they bend instead of breaking if i.e. a deer jumps into it. Deer and other wildlife quickly learn to avoid the fences. To maintain this effect the fences should be electrified all year round. The cost is small and the benefit greater.

The fences described in this article are mounted in different kind of terrains in Sweden. In some areas a drill must be used in order to get the poles as deep as recommended. The most difficult part is to get the lowest wires as close to the ground as 20 cm all the way along the fence.

The main problem with electric fences far from human settlement is theft since the equipment is quite valuable.

For technical details and special solutions contact an authorized retailer for electric fences. Some retailers (for example Lundex below) also provide demo video tapes that show how the fences should be erected.

Links (most of them in Swedish)

AGRA Elephant fences
Telephone: + 46 19 31 41 65
E-mail: agra@oreline.net
The retailer speaks good English and has severe knowledge of electric fences.

Bole products
Telephone: + 46 652-747474
E-mail: bole@bole-produkter.se
http://www.bole-produkter.se/

L-G products
Telephone: + 46 456 303 31
E-mail: order@lgprodukter.se
www.lgprodukter.se

Lundex
Postadress: Box 142, 234 23 Lomma.
Besöksadress: Järngatan 35 Lomma.
Tel 040-41 88 80 Fax 040-41 88 88
E-mail: lundex@lundex.se
http://www.lundex.se/

Gallagher (English)
www.gallaghereurope.com
www.gallagher.co.nz/dynamic/index.cfm
Www.gallagherusa.com

other links
http://sureguard.com.au/fencedesign.html#high