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.

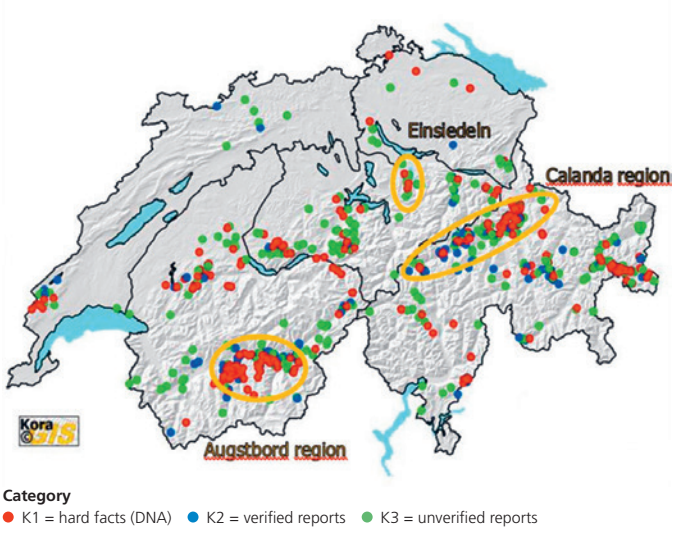

Fig. 1 Locations of study areas and records of wolf occurrence in Switzerland in 2017. *(Source: KORA, AGRIDEA[2]).*

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.

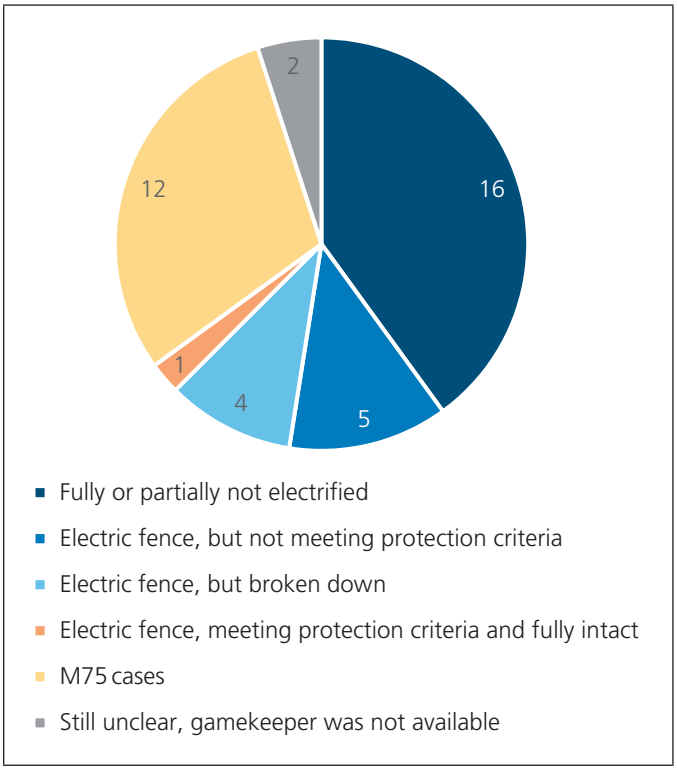

Fig. 2 Condition of fences at the time of attacks by wolves on livestock as reported by gamekeepers in Switzerland between January 2017 and June 2018 (alpine pastures and situations with livestock guarding dogs excluded) (n = 40). *(Source: AGRIDEA).*

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-

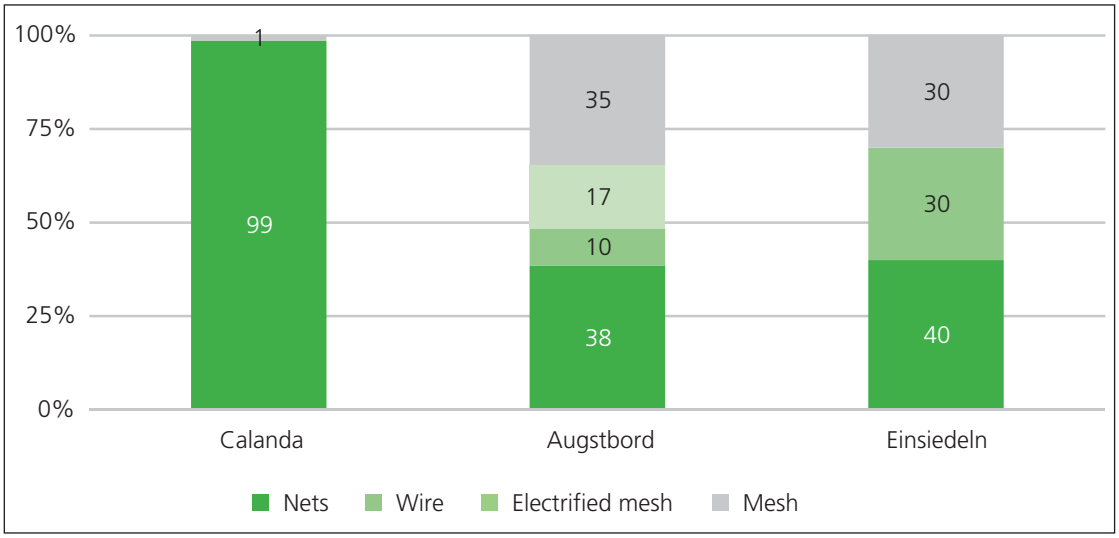

Fig. 5 Type and proportion of fences used in three regions of Switzerland. *(Source: AGRIDEA)*

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.

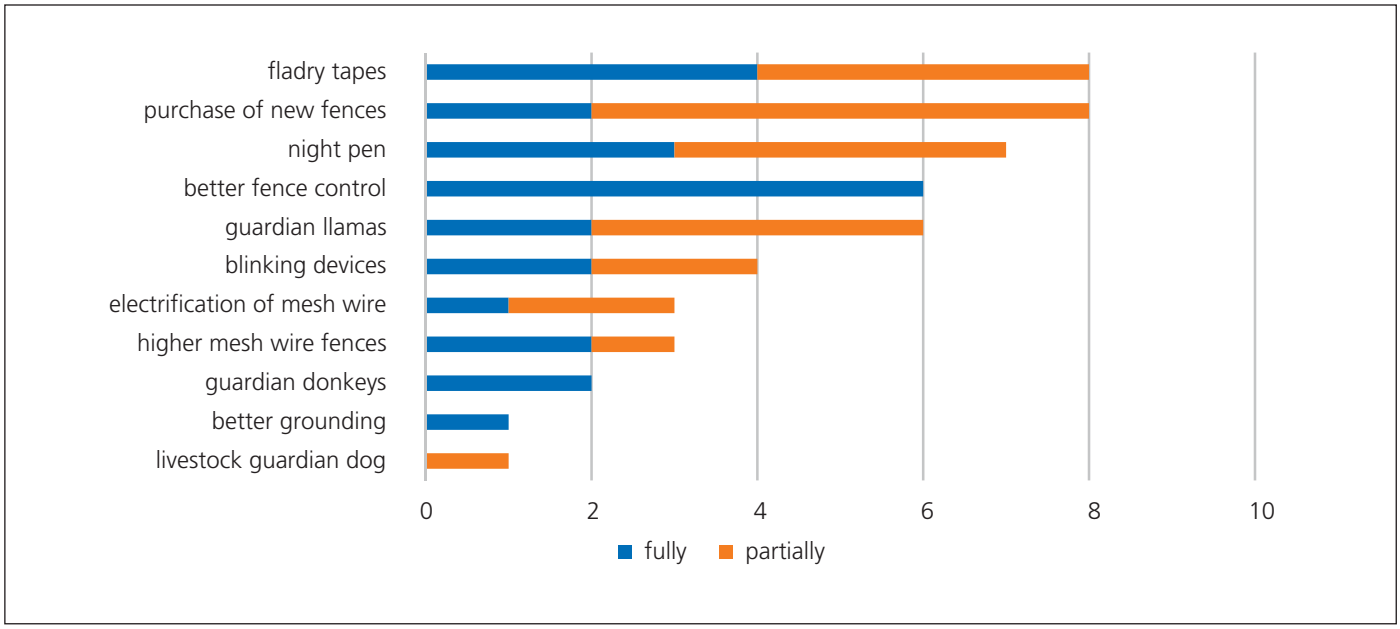

Fig. 6 Type and frequency of adaptions to protective measures implemented by farmers in Switzerland in response to the return of wolves. Multiple answers were possible. *(Source: AGRIDEA).*

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.

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