WILDLIFE PERMEABILITY OF WOLF-DETERRENT PERMANENT ELECTRIC FENCES

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Short communication

Wildlife permeability of wolf-deterrent permanent electric fences

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Introduction

The wolf *(Canis lupus)* was considered extinct in Germany for about 150 years but began recolonising the country at the turn of the millennium [1]. Since then, the species has continued to increase in numbers and spread to more regions [2,3] (Fig. 1). Expansion of the wolf population is accompanied by an increasing number of attacks on livestock [4]. These mostly occur where wolves establish new territories and livestock keepers have not yet adapted their farm management to the new situation, for example by upgrading livestock protection measures [5].

Non-lethal approaches such as wolf-deterrent fencing are reported to be significantly more effective than lethal removal of wolves at preventing attacks on grazing animals [6]. When choosing a suitable fence system, each grazing area must be considered individually depending on the prevailing local conditions such as topography or soil properties, as well as the species kept; a fence system best suited to these conditions should then be selected [7]. Many years of practical experience in the German federal state of Lower Saxony show that five- or six-wire permanent electric fences are an effective long-term solution for many livestock farms to protect their grazing animals from wolf attacks [6,8]. The recommended spacing of electrical conductors for wolf-deterrent fences made of steel wire (Fig. 2) or plastic-coated steel wire (for horses) are 20, 40, 60, 80–90 and 110–120 (plus 140 for horses) centimetres from the ground [9–11]. The purchase of this type of fence is subsidised in Lower Saxony.

Fig. 1. Young wolf in heathland in Lower Saxony (Photo: Theo Grüntjens).

Fig. 2. Wolf-deterrent five-wire permanent electric fence (Photo: Peter Schütte).

Concerns about the installation of permanent wolf-deterrent electric fences creating impassable barriers for non-target wildlife are often raised at meetings, events and on agriculture-themed social media platforms. Discussions with stakeholders and interested parties reveal inaccurate perceptions of the exact nature of the fencing, with many assuming it to be an impenetrable barrier up to four metres high. Landowners and hunters, in particular, express concerns that permanently installed wolf-deterrent fences could hinder wildlife movements by barricading the landscape or that wildlife may become entangled in such fences. Their assessments of the exact consequences of wolf-deterrent rangeland fencing are mostly hypothetical and are based on speculation rather than experience, observation or research.

A recent global review of the impacts of exclusion fencing on target and non-target fauna highlighted a need for more careful consideration of possible negative effects and their mitigation [12]. There has been little research on the consequential effects of newly constructed or upgraded fences in Germany. Emmerich (2021) [13] stated that the use of electric fences with livestock guarding dogs did not lead to displacement of wildlife from the immediate environs of fenced pastures where cattle or sheep and goat flocks were grazing but did not find evidence of wildlife crossing the fences. Occasional hints of the permeability to other wildlife of wolf-deterrent permanent electric fences have been documented by farmers using their own private wildlife cameras. Anecdotal reports and information from livestock owners who installed permanent five- or six-wire wolf-deterrent electric fences also indicate permeability to wildlife, with the exceptions of wolf and wild boar *(Sus scrofa)*. However, there has been a lack of systematically collected data on the specific effects of wolf-deterrent fences on the behaviour of non-target wildlife.

In order to gain further insights into the interactions of wildlife with wolf-deterrent permanent electric fences, it was decided in 2021 to launch a field study in Lower Saxony within the Herdenschutz Niedersachsen project [14]. This article presents a summary of the findings.

Study area and methods

The study was carried out in Lower Saxony, northwest Germany, where the landscape is largely dominated by agriculture and forestry. In 2021/22 the total number of occupied wolf territories in the state was 49 [3], comprised of 34 reproducing wolf packs (which produced a total of 145 documented pups), ten pairs and five individuals (Fig. 3). The population densities of the main prey of

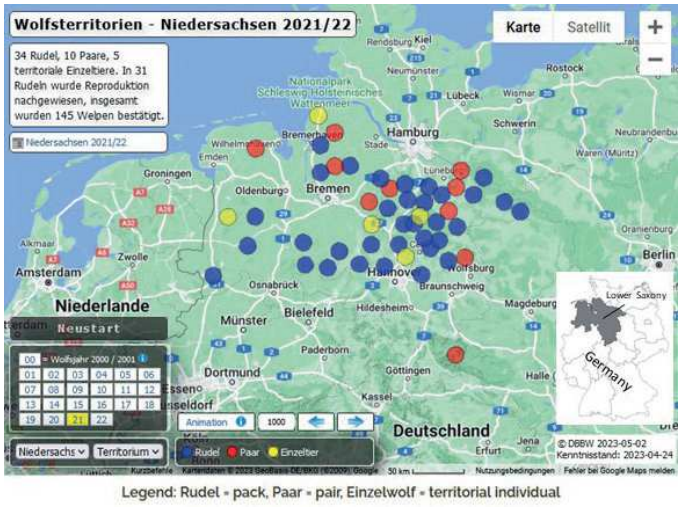

Fig. 3. Occupied wolf territories in Lower Saxony in 2021/22. Circles correspond to the approximate size (diameter 16 km, area 200 km²) of a typical wolf territory (Source: DBBW 2023).

wolves – roe deer *(Capreolus capreolus)*, red deer *(Cervus elaphus)* and wild boar – tend to be high due to active feeding for hunting purposes [15]. However, red deer only occur in large, forested areas in the east and south of the state due to active management to prevent substantial damage to forest stands. Roe deer are the most widespread and adaptable wild ungulate species and occur almost everywhere. Agricultural landscapes and even urban spaces within the state are increasingly populated by wild boar, especially in the east and south [16].

Fig. 4. Locations of cattle (blue) and horse (red) pastures included in the study.

Eight owners who had previously received assistance from the Herdenschutz Niedersachsen project to instal permanent wolf-deterrent electric fences were asked, and agreed, to participate in the study (Fig. 4). All of them had reported signs of wolf presence in the vicinity of their farms and there had been a proven wolf attack on one of the cattle farms prior to setting up an appropriate fence. All the farmers also reported signs and sightings of wildlife in their pastures prior to the installation of livestock protection fences. A total of ten pastures were studied: six with cattle and four with horses.

For wolf-deterrent electric fences to be effective, there must be at least 4,000 volts in the wires [9–11]. The voltage of fences at farms in the study was continuously checked with the help of fence monitors (ZaunMonitor II), which collect and save data that can be retrieved via software (Fig. 5).

Wildlife occurrence in the ten pastures was observed and recorded by means of automatic trail cameras (various models). Depending on the local conditions (pasture size, topography, observed wildlife paths/crossings, livestock owners' reports of wildlife movements), between two and six camera 'traps' were set up in each pasture at a distance of 2–5 metres inside the fence line (Fig. 6). Cameras were set to continuous (24-hour) operation in hybrid mode, recording a single still image and a 20-second video at each trigger, followed by a pause of one minute before the camera could be triggered again.

Cameras operated for a total of 693 'trap nights', between 11 and 130 per pasture (Table 1). The length of observation period varied among pastures mainly due to changes in husbandry, for example when livestock was moved to another pasture better suited to hot weather or to allow the pasture to be used for making hay. In three cases (pastures #4, #9 and #10), wolf-deterrent fences were installed during the study and cameras were installed immediately after the fences were completed. Cameras were checked by an employee of Herdenschutz Niedersachsen

Fig. 5. Fence monitor saving voltage data (Photo: Timo Nolte).

and data retrieved every four weeks. During data analysis, in order to eliminate multiple counting, only recordings without a spatial or temporal connection to other recordings were taken into account (i.e. two or more recordings of the same animal on different cameras, or on the same camera within a few hours, were treated as a single detection).

To assess possible changes associated with wolf-deterrent fencing, information was gathered on wildlife behaviour around pastures before and after its installation. This was done by means of interviews with 22 livestock owners (including all those participating in the camera trap study) using a standardised survey questionnaire. Interviewees were selected from among livestock owners who had previously received assistance from the Herdenschutz Niedersachsen project and had installed five- or six-wire wolf-deterrent permanent electric fences since the beginning of 2018.

Fig. 6. Typical set-up of a camera trap to monitor wildlife in the vicinity of a wolf-deterrent permanent electric fence (Photo: Timo Nolte).

Results and discussion

Camera trap data

The presence of wildlife was documented in nine of the ten pastures included in the study (Table 1). The permanent presence of cattle in front of cameras in pasture #6, the only pasture in which no recordings of wildlife were obtained, resulted in rapid exhaustion of the cameras' data storage capacity. This pasture was therefore excluded from further analyses. Considering the other nine pastures, the longer the observation period lasted, the more species of wildlife were detected (Fig. 7).

Cameras detected seven different wildlife species on a total of 275 separate occasions (detections) during 188 of the 620 trap nights of observation (excluding pasture #6). The most-detected species were brown hare *(Lepus europaeus)* and roe deer (Fig. 8), which were recorded in all or almost all pastures, followed by fox *(Vulpes vulpes)*, which was detected in half the pastures. There were infrequent

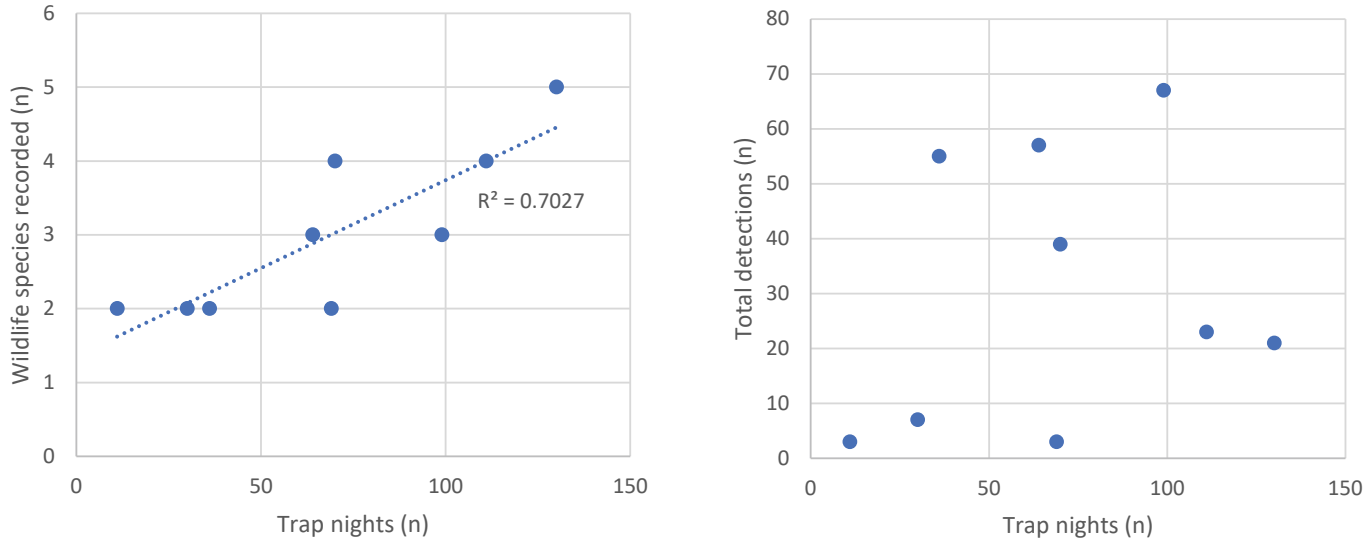

Fig. 7. Relationships between length of observation period and number of wildlife species (left) versus total detections (right) recorded by cameras in nine pastures with wolf-deterrent fences.

Fig. 8. Young roe deer in a horse pasture enclosed with six-wire permanent electric fencing (Photo: Herdenschutz Niedersachsen).

detections of marten (*Martes* sp.), badger *(Meles meles)*, raccoon dog *(Nyctereutes procyonoides)* and hedgehog *(Erinaceus europaeus)* in 1–2 pastures each.

Most detections were of single animals but 2–3 roe deer were documented together in a total of ten cases in two different pastures. The simultaneous presence of 2–3 hares in pastures was also documented in ten cases. No wolves or wild boar were detected in any of the observed pastures. Red deer and fallow deer *(Dama dama)* were also not detected but the presence of these species was not expected in the study area.

Detections of wildlife largely occurred between 5 pm and 9 am. At the three sites where cameras were installed immediately after new fences were built, hare and roe deer were detected in pastures after seven and eight days, respectively. The manageable size and intensive use of pastures by farmers make it unlikely that these animals were already present and unintentionally 'trapped' during fence construction.

Fig. 9. Roe deer jumping through wolf-deterrent electric fencing filmed opportunistically by project staff.

Fig. 10. A brown hare jumping through a wolf-deterrent electric fence (Photos: Herdenschutz Niedersachsen).

The actual crossing of a fence by roe deer was recorded three times. In all cases they jumped through wires spaced 20 cm apart, twice between the second and third wires and once between the third and fourth wires from the ground (Fig. 9). On many other occasions cameras recorded roe deer walking along the inside or outside of fence lines without immediately crossing. Cameras also recorded ten instances of hares passing through fences: seven times by jumping between the first and second wires (Fig. 10) and three times by crawling under the lowest wire. Hares sometimes ran up to fencing then stopped without crossing but in other cases they passed through with little or no hesitation.

Table 1. Wildlife detected by trail cameras inside ten fenced pastures with cattle (#1–6C) or horses (#7–10H) in Lower Saxony.

Pasture ID (n trap nights observed)	Detections by species (n)							
	hare	roe deer	fox	marten	badger	raccoon dog	hedge-hog	Total
#1C (70)	20	7	10	2				39
#2C (130)	15	2	1	1		2		21
#3C (11)	2	1						3
#4C (36) [a]	42	13						55
#5C (64)	4	51	2					57
#6C (73) [b]	-	-	-	-	-	-	-	-
#7H (99)	47	18					2	67
#8H (111)	18	1	2		2			23
#9H (69) [a]		1	2					3
#10H (30) [a]	6	1						7
Total (693)	154	95	17	3	2	2	2	275

[a] *In pastures #4C, #9H and #10H wolf-deterrent fences were installed during the study and cameras installed immediately after the fences were completed.*

[b] *No wildlife was recorded in pasture #6C due to the permanent presence of cattle in front of the cameras quickly depleting their data storage capacity.*

Interviews with livestock owners

According to the statements of livestock owners, in most cases the presence of cattle or horses had no effect on the frequency of wildlife occurrence in pastures. Twenty of the 22 interviewees reported seeing roe deer or their tracks in pastures prior to fence construction, 17 of whom also reported the presence of this species in pastures after fence construction. While three of the interviewees said they saw fewer roe deer or their tracks in pastures after fence construction, the rest noticed no change. Three interviewees stated that they had observed roe deer passing through fences, in each case by jumping between the second and third wires from the ground.

Red and fallow deer were not permanently present in the study area and were not reported by interviewed livestock owners, either before or after fence construction. Elsewhere, however, red and fallow deer are reported to jump over wolf-deterrent electric fences. An investigation of this by the authors is currently underway.

Wild boar and wolves apparently did not cross wolf-deterrent permanent electric fences. Evidence of wolf presence in the direct vicinity was reported by 20 interviewees before and 15 after fence construction, but no wolves were sighted in any of the pastures after the construction of the fences. Similarly, 18 respondents reported having damage caused by wild boar prior to the installation of fences but not subsequently.

Smaller mammals such as hare, fox, badger, hedgehog, raccoon dog, squirrel and marten were sighted by 20 out of 22 livestock owners both before and after construction of wolf-deterrent fencing. In only one case was a decrease in the number of individuals reported.

In relation to other possible detrimental impacts of fences on non-target wildlife, one owner reported finding two dead toads in a pasture where the distance between the lowest electric fence wire and the ground was only 12 cm. This underlines the importance of correct wire placement as well as regular fence inspection and maintenance to protect small animals. No other interviewees reported any wildlife killed or entangled in fences.

Conclusion

The results of this study show that wolf-deterrent permanent electric fencing of the type used in Lower Saxony can provide good protection of livestock from wolves (and of pastures from wild boar) without excluding other wildlife. All surveyed pastures had some occurrence of wild mammals, with most of them being regularly visited by several different species. As the number of species detected by camera traps correlated with the length of observation period, the full range of wildlife accessing fenced pastures was almost certainly greater than that recorded during the study. Furthermore, the majority of interviewed livestock owners stated that they had not perceived any significant changes in wildlife presence in pastures following the installation of wolf-deterrent fencing.

Acknowledgements

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