Research

Wolf territoriality and livestock depredation in Saxony-Anhalt, Germany

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Introduction

Heavy persecution and overharvesting during the 19th century led to the extinction of the wolf (*Canis lupus*) in Germany, although some larger populations survived in the Carpathians and Balkans [1,2]. With the opening of borders within Europe in the 1990s and the enhancement of nature and species protections, wolves were able to start recolonising parts of their former range [3 – 6]. The first wolf territory was re-settled in eastern Germany, in Saxony, during the late 1990s and the first reproduction was reported in 2000 [5,7]. Wolf populations continued to expand across the country and elsewhere in Europe [8].

After an absence of around 150 years, in the federal state of Saxony-Anhalt the first territorial wolf pair was documented in 2008 and the first reproduction was reported in the following year [9]. In 2023/24 there were 44 occupied territories [10] (Fig. 1). Conflicts have arisen, especially with animal husbandry. Although the main prey species in the state are roe deer (*Caproelus capreolus*), fallow deer (*Cervus dama*), wild boar (*Sus scrofa*) and red deer (*Cervus elaphus*), livestock predation (accounting for only 1.7 % of biomass in wolf diet) became one of the biggest public concerns [11]. An analysis of 472 livestock predation events in Saxony-Anhalt in 2008 – 2022 revealed that minimum-standard protection measures were present in only 18 % of all predation events [12], i.e. most affected livestock was inadequately protected.

Whereas a multitude of techniques to prevent livestock predation have been tested worldwide [e.g. 13 – 15], the long-term effectiveness of lethal control remains controversial and the subject of considerable debate in the scientific literature [e.g. 16 – 19]. In Saxony-Anhalt, as of September 2025 lethal removal of wolves responsible for livestock predation could be permitted if minimum-standard protection measures had been installed but were repeatedly overcome. However, this option can only prevent further losses if the specific wolf responsible is removed. Since wolves are phenotypically nearly indistinguishable and it is not possible to link genetic information to the phenotype of the respective wolf, shooting the 'right' wolf is a major challenge. In Germany, after recurring attacks on livestock, managers are advised to immediately remove any wolf in close proximity to the most recent attack site. It is assumed that the perpetrator is probably still in the area and thus the likelihood of shooting the 'right' wolf is high.

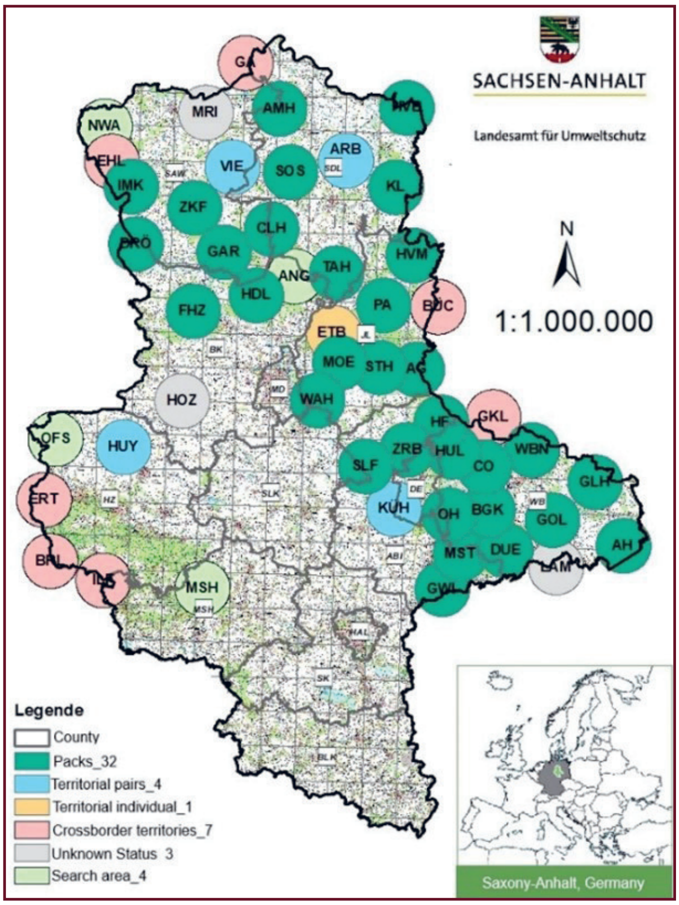

Fig. 1. Wolf territories in Saxony-Anhalt, Germany, in 2023/24 (Source: Weber et al. [10]).

In this study, we aimed to determine whether wolves attacking livestock are resident in the area and thus more likely to remain in close proximity to kill sites, or originate from neighbouring packs or are non-resident dispersers or floaters. This will enable us to make more specific, evidence-based recommendations for management actions, thereby improving the protection of livestock and the coexistence of humans and wolves.

Methods

We collated all livestock depredation events reported throughout the period from 2017/18 until 2023/24[1] in which the involvement of wolves was either confirmed or supposed. During field inspections of carcasses, samples for genetic analysis are routinely taken from the killing bite. In rare cases, when no killing bite is externally visible, samples are taken from areas of the carcass where feeding occurred. Usually, one sample per livestock predation event is sent for genetic analysis (to confirm the predator species and, when possible, individual identification). According to practicability and limitations imposed by veterinarian infection control in the field and following monitoring standards for the Central European wolf population [20], predation events are categorised as C1 (wolf genetically identified), C3 (no genetic evidence but wolf cannot be ruled out[2]) or false. Animal owners can claim financial compensation for categories C1 and C3.

The total number of all C1 and C3 incidents in each monitoring year was compared to the corresponding number of wolf territories in Saxony-Anhalt (including cross-border territories). We did this to assess whether there is any relation between the number of wolf territories and the number of depredation events per monitoring year. This analysis was done by testing for correlation and conducting a loglinear regression.

We used C1 incidents for which individual information was available to check the territoriality status of depredating wolves. Status as well as territory size and centre point were assigned according to established monitoring standards [20]. A 'standard' territory[3] with diameter 16 km and area 200 km² [21] was placed such that everything within it was part of the respective wolf territory. If there was an attack on livestock within the circle and one of the resident breeding pair was implicated, then the perpetrator was assigned to the 'territorial' category; if one of their resident pair's offspring was responsible, it was categorised as 'within parental territory'; and if a wolf from a different territory was detected it was considered 'territorial outside'. A depredating wolf that did not fall within any of the three territory-related categories was designated a 'natal disperser/floater'.

We also checked for relations /differences between wolf sex, territoriality status and adherence to minimum standards of livestock protection against wolf attacks. During field inspections of depredation events, the condition and functionality of fencing[4] is documented. Since it is a requirement to be eligible for compensation, adherence to minimum standards of protection against wolf

1 In Germany, wolf monitoring years run from 1st May to 30th April.
2 For example, carcasses show signs of wolf involvement such as a throat bite, the abdominal cavity opened below the ribs and the rumen set aside.
3 This standard size is used in Germany to create visualisations of wolf territories for the public; see Fig. 1.
4 We did not include livestock guardian dogs in our analysis because in Saxony-Anhalt they are only used as an addition/backup to wolf-deterrent fencing, not as an alternative.

attacks is assessed. These are defined differently in each federal state in Germany. In Saxony-Anhalt, the current definition depends on the livestock species and region [22]. The categories for adhering to minimum protection standards within the state are as follows:

Yes – minimum protection standards were applied;

No – minimum protection standards were not applied;

Unknown – due to changes by the owner after the incident, such as repairing the fence to protect the rest of the herd before official assessment of the kill, it is not possible to determine if minimum protection standards were applied;

Irrelevant – no minimum protection standards are defined for the affected livestock species or region.

Results

Wolves were genetically implicated in 181 livestock depredation incidents (C1) between 2017/18 and 2023/24. We found no clear visual relation between wolf population growth and the number of livestock attacks (C1 and C3) during the period covered by our study. While the number of occupied wolf territories continued to increase, from 2016/17 onwards the number of attacks on livestock fluctuated within the range of 50 – 75 per monitoring year with only 2019/20 being an outliner with 95 attacks (Fig. 2). Although there was a correlation ($r^2 = 0.88$), the number of attacks was independent of the number of wolf territories (ANOVA loglinear regression, $p < 0.01$).

The individual wolf responsible was determined in 110 depredation events. Most events (55.5 %) involved dispersers/floaters, followed by wolves that were hunting outside their own territory (20.0 %). Territorial animals and those hunting within their parental territory together accounted for 24.6 % of wolves genetically implicated in depredation (Fig. 3). Males were detected twice as often as females at livestock depredation events (65.5 % versus 33.6 %, respectively). Moreover, males predominated in three of the four territoriality status categories, with wolves present within their parental territory being the only exception (Fig. 4). Of a total of 73 different individuals detected (genotyped) among samples collected at depredation sites, 44 were males, 28 females and 1 of unknown sex.

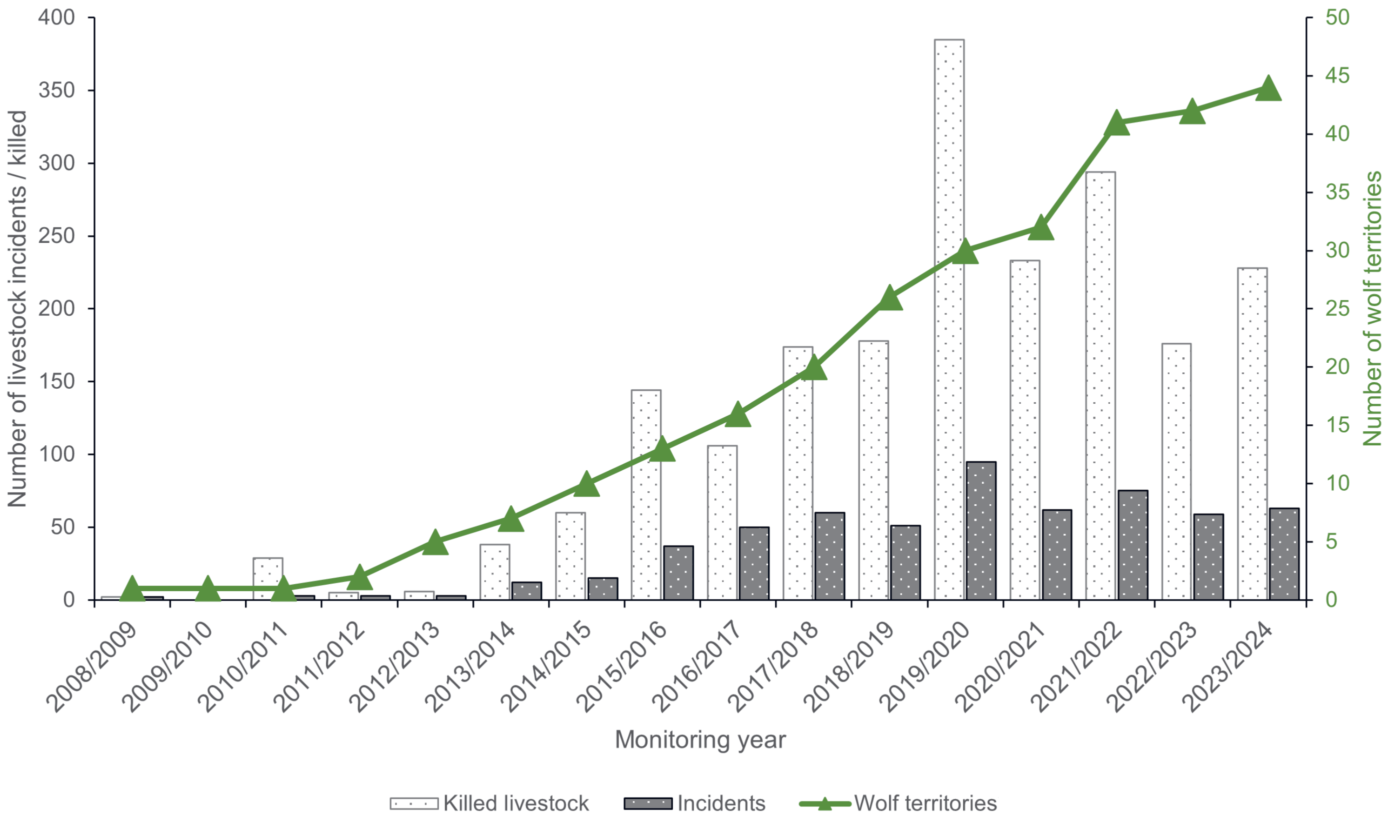

Fig. 2. Wolf population development (including cross-border territories) and attacks on livestock (C1 and C3) in Saxony-Anhalt since wolves began recolonising the state.

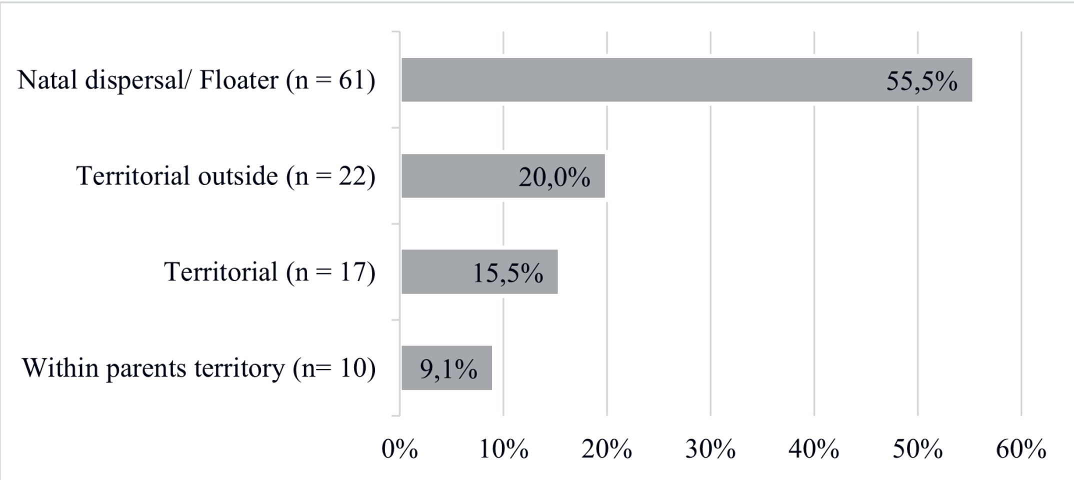

Fig. 3. Territoriality status of wolves implicated in livestock depredation.

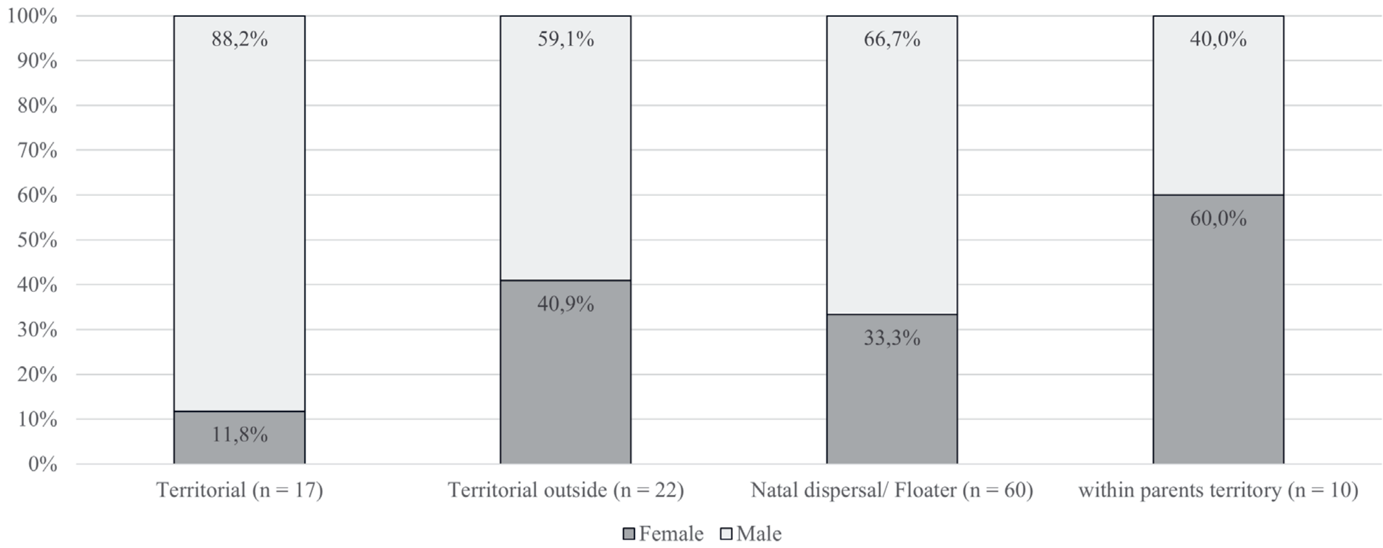

Fig. 4. Sex and status of individual wolves implicated in livestock depredation.

Sheep and goats (83.6 %) were the livestock species most subject to wolf attacks, followed by farmed game (9.1 %), cattle (6.4 %) and alpaca (0.9 %). Regarding damage prevention measures, fencing did not meet the minimum standard of protection during 49.1 % of attacks compared to 26.4 % in which it did. Adherence to protection standards was irrelevant in 10.9 % of cases and unknown in the remaining 13.6 %. We did not obtain any relevant outcomes when comparing territoriality status with adherence to standards or affected livestock species or the sex of the attacking wolf. We did not detect significant differences in territoriality status, adherence to minimum protection or sex between monitoring years.

Discussion

When determining the territorial status of wolves in relation to livestock depredation sites, a standardised territory size was used [21]. In reality, wolf territories are clearly not perfect circles, so it is possible that territoriality status was wrongly assessed for some wolves in our study. The placing of the 200 km² circle was based on monitoring data, hence it is unlikely that depredators would be incorrectly assigned to the ‘territorial’ category. However, while a wolf might be assessed as ‘territorial outside’ for a particular incident if the depredation site lay beyond the periphery of the standard circle, its actual territory could have included the site, i.e. the wolf was in fact ‘territorial’. Unfortunately, we were unable to demarcate territory boundaries more precisely with the resources available to us.

During the period of our study, there was no proportional relation or a causation between the number of predation events and the increasing number of occupied wolf territories. It is likely that the chances of livestock predation increase with an increasing number of wolves. However, as we have seen in earlier analyses [12] and as we explain below, there are more important factors that influence the number of livestock attacks than the number of wolves.

A comparison with trends in sheep and cattle numbers in the state would have been valuable. Overall, livestock numbers slowly decreased in recent years. However, as these numbers are collected once a year in November, it was not possible to assign them to a respective wolf monitoring year (which runs from May to April), thus precluding a proper comparison.

Other factors besides numbers of wolves and livestock surely affect the extent of livestock depredation. One of the most important is probably the condition and functionality of protective fencing. We found that fencing adhered to minimum standards for protection against wolf attacks in only a quarter of the assessed incidents while the minimum standard was not met in half of them. We therefore suppose that many predation events would be preventable if more livestock owners applied adequate protection measures, which coincides with many published findings [e.g. 23 – 27].

Consistent with the findings of a recent study in northern Germany and Denmark [15], we found that most wolves implicated in attacks on livestock were either dispersers or floaters, i.e. non-territorial. This might be because such individuals are less familiar with their surroundings than territorial wolves that live in a fixed area within which they know how and where to locate wild prey. Furthermore, territorial wolves more often live in packs, for whom hunting large wild ungulates is easier and more successful than for single, non-resident wolves [28 – 30]. Therefore, we assume that dispersing wolves and floaters are more likely to assess livestock pastures as possible hunting grounds. Even a lone wolf, if it finds a weak spot in fencing and enters a pasture, can easily prey on livestock, which mostly cannot escape.

In our study, two thirds of wolves predating on livestock were males. The only category in which males did not predominate was that of wolves within their parental territory. However, the sample size in this category was rather small (n=10). While the scientific literature addresses sex-specific predator responses in prey species [31,32], we could not find any studies focusing on sex-specific differences in wolf depredation on livestock. First reproduction tends to occur at a later age in females than males [33], so we assume that females stay longer within their natal territory before dispersing. If this is correct, females would have more time than males to learn how to hunt effectively from their parents and so may be less inclined to search for vulnerable prey in proximity to humans once they leave their natal territory. If females indeed remain in the parental territory longer, this could also mean that they help with pup-raising [34 – 36]. Furthermore, if females leave their parental territory later than males, they have a higher probability of being detected at livestock attacks while still within their natal territory, which would explain our findings. A 15-year study in the Rocky Mountains, USA, found no difference between sexes in mean age at dispersal, but the sex ratio of dispersers was male-biased [37]. The latter, combined with our finding that mostly dispersers or floaters attack livestock, is congruent with detecting mostly males at livestock depredation sites.

Conclusions

Our findings have important implications for future management actions to reduce livestock predation by wolves. Non-territorial wolves were responsible for most attacks on livestock in Saxony-Anhalt. As such dispersers and floaters tend to roam rather unpredictably through the landscape, the management approach of shooting a wolf in the immediate vicinity of a recent attack in the hope that it is the culprit probably has a low success rate. There is instead a high chance that the responsible wolf leaves the area before the measure is initiated, while the local territorial pack remains. Therefore, it cannot be ruled out that the ‘wrong’ wolf is killed, which should be avoided to the greatest possible extent. Properly installed and maintained protection measures, including fencing, have proven to be more effective at preventing further attacks on livestock. The continuation of government funding programmes to support livestock owners with their implementation is essential.

Acknowledgements

Data on wolf distribution and livestock depredation in Saxony-Anhalt were gathered and processed by staff of Wolfskompetenzzentrum Iden, department of the Environmental Protection Agency of Saxony-Anhalt. We thank our many diligent volunteers for their assistance in wolf monitoring. Genetic analyses were conducted by the Senckenberg Society for Nature Research. We also acknowledge the contribution of the Documentation and Consultation Centre on Wolves (DBBW) as an important professional contact for the federal states regarding all wolf-related matters in Germany.

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