Review

WOLVES AND CATTLE: OVERVIEW OF DAMAGE AND MANAGEMENT IN GERMANY

Ronja Schütz*, Micha Herdtfelder

Forest Research Institute Baden-Wuerttemberg, FVA-Wildtierinstitut, Freiburg, Germany

**Contact: ronja.schuetz@forst.bwl.de*

www.fva-bw.de

1. Wolf population development

Following the return of wolves to Germany after an absence of more than 150 years, their numbers and range have rapidly increased (DBBW, 2021a). The first reproduction was recorded in Saxony in 2000. The current population, based on the 2020/21 monitoring year, consists of 157 packs, 27 pairs and 19 territorial individuals[1]. The majority are in Brandenburg (57 territories), Lower Saxony (44 territories), Saxony (34 territories), Saxony-Anhalt (26 territories) and Mecklenburg-Western Pomerania (24 territories) (Fig. 2; DBBW, 2021a,c). In 2020/21, territorial or transient wolves were documented in all federal states, except for the state of Saarland (DBBW, 2021a). Despite this increase, the conservation status of the wolf in Germany has so far been assessed as "unfavourable-poor" due to low numbers and limited distribution (BfN, 2019).

The wolf is strictly protected or protected in almost all European countries. In Germany, the species is listed in Appendix II of the Bern Convention and Annex IV of the Habitats Directive, i.e. strictly protected. The intentional disturbance, capture or killing of wolves is prohibited. Since the reunification of Germany in 1990, wolves have enjoyed the highest possible protection under the Federal Nature Conservation Act. However, as of September 2012 the wolf is listed in the hunting law of Saxony and, from May 2022, also in that of Lower Saxony, but without a hunting season. The inclusion of the wolf in the hunting laws of individual federal states has no relevance regarding permits for the lethal removal of individual wolves. As before, the taking of a strictly protected species requires an exception in accordance with the Federal Nature Conservation Act.

[1] According to official monitoring standards (Reinhardt et al., 2015), a pack is defined as a group of more than two wolves living in one territory/at least one sexually mature wolf with confirmed reproduction; a pair consists of a male and female marking their territory together but no reproduction (yet); and a territorial individual is a single animal that is detected in a definable area over a period of at least six months.

Fig. 1 The wolf returned to Germany at the turn of the century. *(Photo: Benny Trapp)*

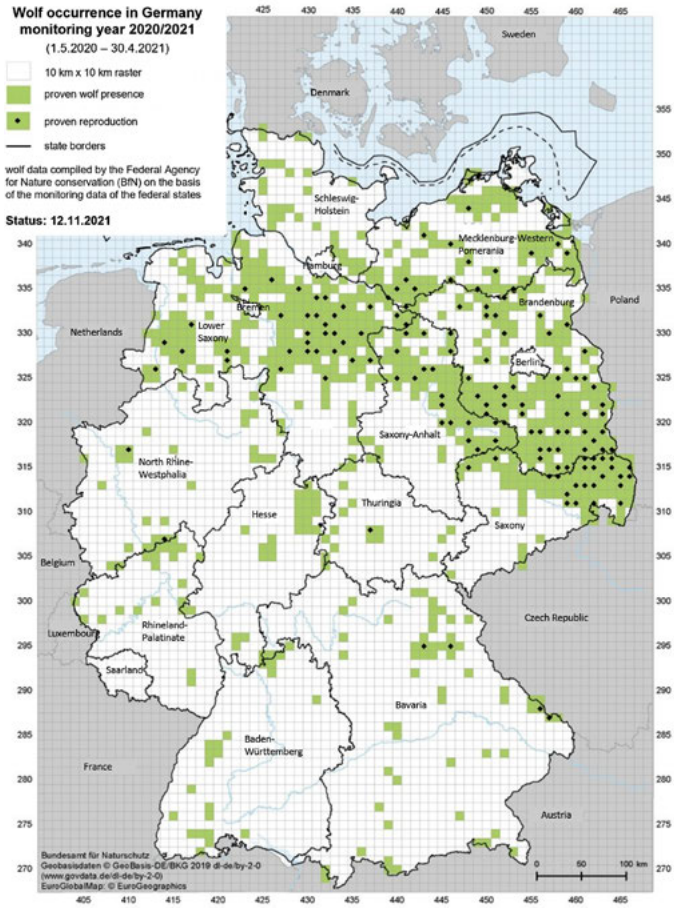

Fig. 2 Wolf occurrence in Germany in 2020/21. Compiled by the Federal Agency for Nature Conservation based on federal states monitoring data (Source: DBBW, 2021d).

Since the return of the species to Germany, the presence of wolves and wolf depredation on livestock have been recorded in all federal states. In order to obtain a nationwide overview of wolf damage statistics, the Federal Bureau of Documentation and Consultation Regarding the Wolf (DBBW) on behalf of the Federal Agency for Nature Conservation, conducts an annual survey in all federal provinces. Data are summarised in national statistics and published by the DBBW in yearly reports which form the basis of the following review.

2. Wolf attacks on cattle

Compared to sheep and goats, cattle are considered to be more defensive and their herd behaviour can provide some protection against wolf attacks (e.g. NLWKN, 2020). However, despite their large size and the defensive nature of some breeds, it should not be generally assumed that cattle can protect themselves from attack. Even single wolves have learned to kill adult cattle (DBBW, 2022).

In general, the number of attacks on cattle throughout Europe is significantly below the level of smaller livestock (Kaczensky et al., 2013). An analysis based of wolf compensation payments from 21 European

Fig. 3 Cattle pasture fenced with a single electric wire. *(Photo: FVA, Olga v. Plate)*

Table 1 Numbers and type of cattle in Germany in 2019 (Source: Statistisches Bundesamt, 2020, 2021).

Category	Total head
Total cattle stock	11,700,000
• non-dairy grazing cattle	2,341,000
• grazing dairy cows	1,221,900
Type of use	**Most represented breed (head)**
Dairy cattle	Holstein Schwarz-Bunt (4,307,700)
Beef cattle	Cross breeds (577,000)
Dual-purpose cattle	Fleckvieh (3,115,200)

Table 2 Damage to cattle by wolves in 2016–2020 in terms of the total number of cattle harmed (killed, wounded or missing); as a proportion of all livestock harmed; and the proportion of wolf attacks on livestock that involved cattle. NA = missing data. (Source: DBBW, 2015–2020).

Year	Number harmed (head)	Proportion (%)	
		of livestock harmed	of attacks on livestock
2016	67	6.2	(NA)
2017	140	8.3	(NA)
2018	136	6.5	(NA)
2019	127	4.3	13
2020	153	3.8	14

countries found that sheep, and to a lesser extent goats, are the species most preyed upon, with cattle damages being much lower, ranging from 0 to 19% of all damages (Linnell and Cretois, 2018).

Attacks by wolves on cattle have also been documented in Germany. There were 131,000 registered cattle farms in Germany in 2021 (BMEL, 2021). In 2019, 30% of cattle in Germany were held in systems with pasture grazing. The most represented breeds in pasture grazing were Holstein Schwarz-Bunt, crossbreeds and Fleckvieh (Table 1). In most cases, cattle pastures are semi-permanent and fenced with simple metal stakes and electric wires (Fig. 3). Often, these do not follow recommendations for secure fencing according to the AID brochure (Kamp, 2021; Wehrsporn et al., 2014). This is the reference source for the construction and operation of fencing systems for livestock in Germany, regardless of wolves. This

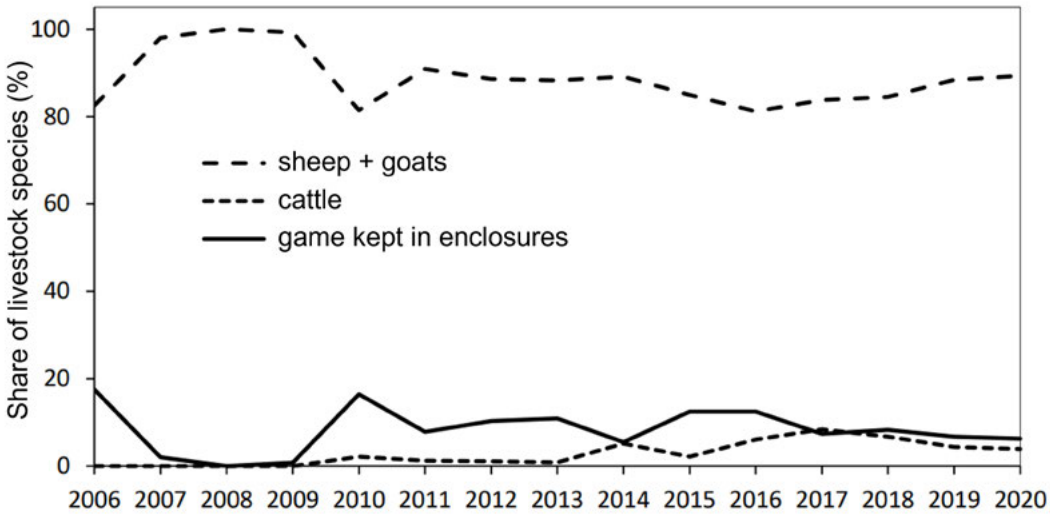

Fig. 4 Composition by species of animals killed / injured / missing due to wolf predation in 2006–2020 (Source: DBBW, 2021b).

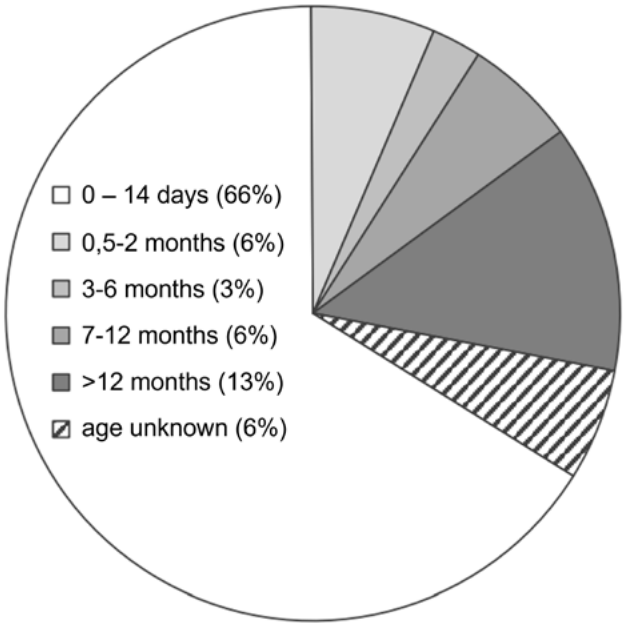

Fig. 5 Proportions of cattle killed / wounded / missing due to wolf predation in 2020 (n = 153) by age class (DBBW, 2021b).

continues to form the basis for assessing fence system safety. For cattle herds with calves in risk area 3, which refer to pastures located up to 500 m from sources of danger such as busy roads and railway lines, the AID brochure calls for a permanent fence with at least three galvanised steel wires and a fence height of 110 cm, primarily intended to prevent breakouts (AID, 2021).

Beginning in 2006, DBBW statistics on livestock damages due to wolves show a low overall proportion of cattle, with an upward trend until a maximum of 8.3% in 2017 (Fig. 4) followed by a slight decline to 2020 (Table 2). A more detailed look at the data for 2019–2020 shows a marked difference in the proportion of cattle in verified attacks versus that among animals killed, injured or missing (Table 2; DBBW, 2015–2020). This is due to the fact that the number of cattle killed in each attack is normally lower than that of sheep. In some attacks there are no cattle killed, only wounded. Young calves, especially those aged 0–14 days, represent a substantial share of losses (Fig. 5; DBBW, 2021b). Other criteria besides age, such as information on the herd composition, breed or weight of animals harmed in wolf attacks, are not recorded or compiled on a nationwide basis. Robust statements on these factors therefore cannot be made at this point.

According to official figures (DBBW, 2015–2020), the states most affected are Brandenburg (290 animals), Lower Saxony (135 animals) and Saxony-Anhalt (119 animals) followed by Mecklenburg-Western Pomerania (22 animals) and Schleswig-Holstein (16 animals). In recent years there have also been attacks in federal states with fewer resident wolves. In 2021 in Baden-Wuerttemberg, where there were three territorial individuals, a wolf killed a young cow (UM, 2022) and in North Rhine-Westphalia, where there were two packs in 2020/21, a calf was killed (DBBW, 2021a; LANUV, 2021).

Cattle damage is often concentrated in some areas, with hardly any damage recorded in other areas (Fig. 6; Kamp, 2021; LfU, 2021; NLWKN, 2021; NMUEBK, 2021). Among other factors, the level of damage seems to be linked to the degree of learning of local wolves (Sime et al., 2008).

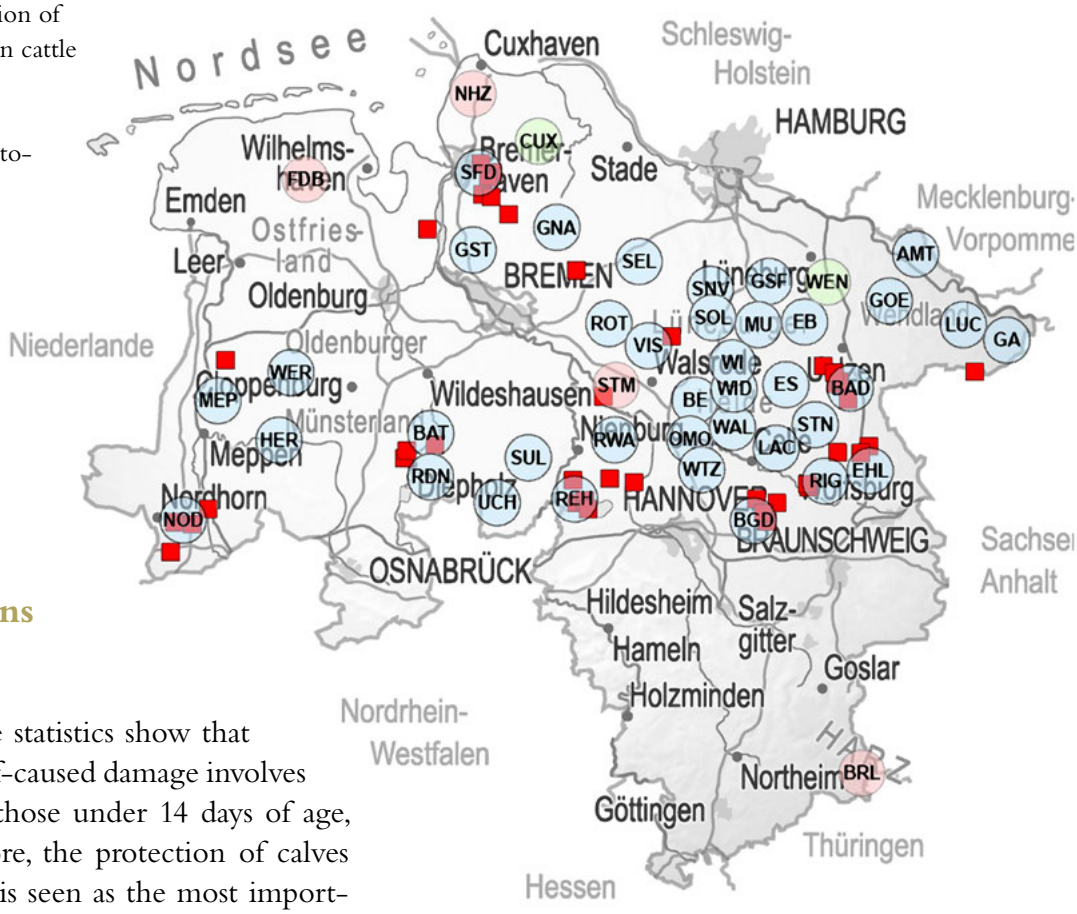

Fig. 6 Geographical distribution of confirmed attacks by wolves on cattle (red squares) that resulted in animals killed, injured or missing in 2021 and wolf territories confirmed by monitoring in 2020/21 (circles) in Lower Saxony (NMUEBK, 2021). Blue circles = packs, green circles = pairs, red circles = territorial individuals as defined in the official monitoring standards (Reinhardt et al., 2015).

3. Recommendations for risk mitigation

The reviewed damage statistics show that only about 4–8 % of wolf-caused damage involves cattle. Calves, especially those under 14 days of age, are most at risk. Therefore, the protection of calves in the first weeks of life is seen as the most important measure for cattle. Where individual wolves learn to kill adult cattle, the latter should also be protected from attack. The implementation of high-quality herd protection measures has an impact on livestock mortality and can be used effectively for cattle holdings (Hartleb et al., 2017; LAU, 2018). Herd protection measures recommended mainly for sheep and goats in many federal states in Germany, such as wolf-proof fencing, night pens and livestock guarding dogs (LGDs), can also be used for cattle protection, for example in calving areas and pastures (Figs. 7 and 8).

In addition, there are further options specifically for counteracting the risk of attacks on cattle. Recommended measures include seasonal calving, to simplify the establishment of designated and fenced calving pastures, as well as night-time stabling (Reinhardt and Kluth, 2007; VOSS, 2020). Altering the grazing sequence, especially for herds with calves and groups of young cattle, based on pasture area characteristics such as open terrain and distance to the farm, can reduce the cost for farmers of regular checking on their animals. Furthermore, targeting a herd composition that allows the formation of a defensive position and supports leadership and tranquillity by sufficiently experienced adult animals, can also reduce risks (Reinhardt and Kluth, 2007). Nevertheless, the level of reactivity towards wolves and protective qualities may depend on the traits of each specific breed as well as the characteristics of individual animals.

If fencing is done using only a single strand of electrified wire, calves can leave their herd's area of influence. In some grazing systems such as creep-grazing[2] this is intentional, in others it may be unintentional (e.g. calves look for shelter in higher grass outside the pasture). In both cases, the risk of wolf attacks on unprotected animals can be reduced by adding additional wires to deter calves from leaving pastures (Mettler and Schiess, 2021; Reinhardt and Kluth, 2007). Thorough pasture hygiene, with rapid and professional disposal of stillbirths and afterbirths, which does not allow wolves to establish a positive association with grazing animals, may help to reduce attacks on cattle herds in the long-term by potentially influencing wolf learning behaviour (VOSS, 2020).

[2] Placing an electric wire at c. 90–105 cm allows calves to pass under while deterring cows from jumping over or going under. In a rotational grazing system, calves can thereby advance to an adjacent paddock where forages are higher quality before rotating the cows to that paddock.

Under certain circumstances, the wolf's substantial capacity to learn can spread undesirable behaviours, resulting in concentration of damage in specific regions. Recording noticeable behavioural changes in cattle herds, such as sudden and excessive aggression towards dogs, as well as attacks on herds and individuals, allows early identification of damage clusters and patterns (BUL, 2018). With adequate monitoring, states and regions can react to such developments, for example through the designation of certain aid arrangements for protective measures explicitly for cattle in the affected areas.

In case of attack, measures such as 'Foxlights', (electrified) fladry fences and the reinforcement of existing fences with additional electrified wires or nets are currently used for short-term immediate protection in Germany. Keeping herds locked up at night to minimise the risk of further attacks is also an option at some farms.

The approaches described above do not represent a comprehensive list of all livestock protection measures available for cattle but show a selection of methods applied in Germany. Projects on various cattle protection measures are currently underway or planned in individual states to test their practicality, ability to be integrated into existing work processes and effectiveness. One such project focuses on the implementation of protection measures for cattle (such as electrified fences or technical upgrades of stables to prevent the intrusion of wolves) with continuing support during the steps from planning customised measures to applications for funding and maintenance for participating farms. This project, a cooperative venture between cattle associations, a nature park and a research institute, is planned to start in 2023 in Baden-Württemberg.

Fig. 7 Young cattle in the Rhön Mountains, Bavaria, within an electrified 5-wire fence, built according to Bavarian recommendations for protecting livestock from wolves. *(Photo: FVA /Ann-Kathrin Klotz)*

Fig. 8 Cattle in Saxony-Anhalt protected by livestock guarding dogs and a 5-wire electric fence.

4. Compensation payments and financial support for protection measures

Most federal states have set requirements for "basic protection", the correct application of which can be a prerequisite for compensation to be paid for some livestock species in the event of damage in designated areas (such as confirmed territories). In addition, some states have defined "recommended protection" measures which, according to experience in Europe, offer more reliable protection. These protection standards can differ from state to state and, therefore, we cannot give a consistent overview at this point.

In most federal states with wolf territories, no basic protection is required in order to be eligible to claim compensation for damage to cattle. This is due to the comparatively lower risk of attacks on cattle compared to sheep and goats, the large size of some cattle farms and the associated difficulty and expense in implementing comprehensive protection measures. An exception is the state of Bavaria, which requires basic protection according to Bavarian standards for example for the protection of cattle under 24 months of age where "necessary and possible" (LfL, n.d. a), corresponding to that for sheep and goats, as a prerequisite for compensation in the event of damage in areas with confirmed territories. For example, technical measures accepted as "basic protection" in Bavaria are electrified nets and wire fences at least 90 cm high with four (or five) wires at 20 cm, 40 cm, 65 cm, 90 cm (and 120 cm) above the ground (Fig. 8), or 90 cm high wire mesh fences with additional electrification 20 cm from the ground and 20 cm above the top of the fence to prevent passing under or over (STMELF, 2021). Shepherding or protection with at least two LGDs per herd of 50 or more mother animals, as well as night-time confinement in closed stationary or mobile stables protected by, for example, electrified or physical barriers according to Bavarian recommendations (STMELF, 2021; LfL, n.d.b) also meet the requirements. In Thuringia, the

(Photo: FVA / Laura Huber-Eustachi)

implementation of basic protection is required for cattle species with a height at the withers of up to 112 cm for adult animals (TMUEN, 2020).

In Germany, state subsidies for protection of small stock (sheep and goats) and enclosed game are provided in almost all federal states in areas with confirmed wolf territories. In most federal states, however, protection measures for cattle are only supported where cattle have been killed (DBBW, 2021b; decrees of the federal states). Some states designate specific funding areas in case of increased attacks within definable regions and in a temporal context, such as in Lower Saxony. Here, the funded protection of horses or cattle can be considered if wolf attacks on the respective species have occurred in at least three cases within a radius of 30 km during a period of twelve months (NI-VORIS, 2021). In addition, measures are funded in some federal states on a case-by-case basis after assessment by experts from the advising or funding institutions, for cattle up to a specific age in designated funding areas or dwarf cattle (e.g. STMELF, 2021; TMUEN, 2020). The funded measures and the amount of funding are determined by the federal states themselves and can include, for example, LGDs, electric fences or fencing accessories to upgrade existing fences.

In principle, compensation is paid in all federal states after attacks on cattle. Some states only pay if several conditions are met. For example, Saxony-Anhalt and Brandenburg require the use of fences in accordance with AID good professional practice. Furthermore, in areas of Bavaria with documented resident wolves, compensation is only paid if appropriate preventive measures meeting basic protection requirements were taken within a transitional period of one year (MLUE, 2019; LfL, n.d. a; MLUL, 2019).

5. Discussion & Conclusions

The occurrence of attacks on livestock is influenced by a wide range of factors, such as the availability of wild animals as a food source, the preferences and experience of individual wolves, the husbandry systems in place as well as the degree and quality of implementation of livestock protection measures as well as many others (Pimenta et al. 2017; Janeiro-Otero et al. 2020; Sidorovich et al., 2003; Sime et al., 2008). A general statement on the level of loss based solely on the number of wolves present is therefore not possible. Experience to date does not allow any precise conclusions to be drawn as to why, when and by which wolves cattle are attacked.

The protection of cattle is a challenging task that must be considered in the long term. Implementation of instant measures such as fladry fences and Foxlights can help to protect livestock in an acutely threatening situation, while interventions such as electrified fences or system measures target long-term protection. For cattle, experience has also shown the effectiveness of operational adjustments and livestock protection measures (e.g. Bruns et al. 2020). However, these measures are often challenging to implement and have an impact on farm operations and workload. Therefore, in order to make their use more possible, the involvement of practitioners such as farmers and fence-builders is needed in addition to funding programmes in order to review, develop and integrate practicable solutions.

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