

Research

# Best practices to reduce wolf predation on free-ranging cattle in Iberia

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## Introduction

Since the last decades of the 20<sup>th</sup> century, legal protection together with socioeconomic changes that improved habitat quality and reduced human presence in remote areas have enabled ongoing recovery of wolves (*Canis lupus*) in much of Europe (Fig. 1) [1]. The return of the wolf, combined with a decline of traditional husbandry practices during its absence, has resulted in increased depredation on livestock [2]. If this is not adequately mitigated, for example through damage prevention measures and compensation systems, various social conflicts arise [3].

The management and conservation implications of these issues are particularly relevant where livestock has a high social and economic value [4]. In many European countries livestock breeding is changing, with declining numbers of sheep and goats being replaced by larger herds of extensively grazed cattle, mostly for meat production, while full-time attendance of livestock is becom-



*Fig. 1. Iberian wolves have been recovering their range in recent decades (Photo: JC Blanco).*

ing less common [2]. As numbers of both wolves and cattle increase, there is growing concern about the impact of predation, exacerbated by a lack of knowledge and experience among farmers about how to cope with wolf presence [2,5,6]. Increasing our understanding of cattle breeders' historical and contemporary coexistence with wolves

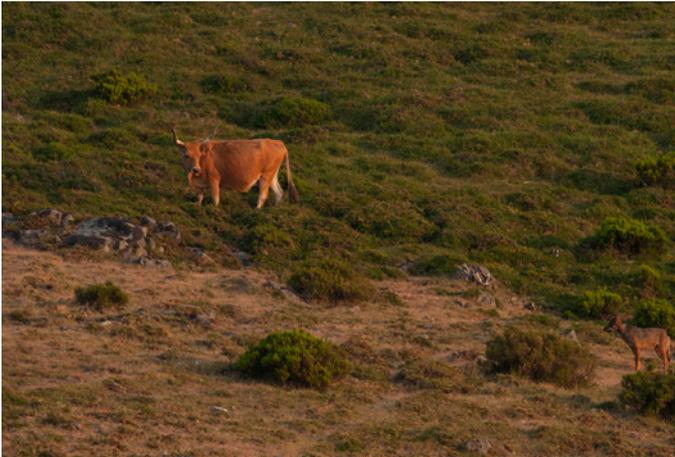


Fig. 2. Free-ranging cattle and wolves share the mountains in Peneda-Gerês National Park (Photo: J Cosme).

is therefore of great relevance for wolf management and cattle herding in highly humanised regions.

Insights can be gained in NW Iberia, where wolves occur at high densities (up to 6 individuals/100 km<sup>2</sup>) and frequently prey on free-ranging cattle (Figs. 2 and 3). Since the average value of cattle is more than seven times that of sheep or goats [7], the impacts on owners are severe. Although damage is compensated, there are frequent complaints about delayed or inadequate payments and missing animals not being compensated. Together with the difficulty of applying nonlethal prevention measures in extensive grazing systems, this results in breeders resorting to poaching or lobbying for wolf control<sup>1</sup> [8–10], which in turn leads to social conflicts with other interest groups.



Fig. 3. Young calf predated by wolves in Peneda-Gerês, Portugal (Photo: F Álvares).

A Pilot Action was implemented in 2013–2014 by Istituto di Ecologia Applicata, with the guidance of the Large Carnivore Initiative for Europe, and in collaboration with a research centre from Porto University (CIBIO), the Institute of Nature Conservation and Forests (ICNF), Grupo Lobo and the LIFE MedWolf project [11,12]. The goal was to bring together stakeholders to address the conflicts and explore practices that could help facilitate sustainable coexistence of wolves and cattle. Here, we present the results of a study examining relationships between damage levels and cattle husbandry practices in northern Spain and Portugal. Based on this analysis and information shared among stakeholders during workshops, we make recommendations for best practice to reduce wolf predation on extensively grazed cattle in NW Iberia.

## Study areas

The study was carried out in two mountainous regions: Peneda-Gerês National Park, NW Portugal, and the eastern Cantabrian Mountains, Spain<sup>2</sup> (Figs. 4 and 5). These areas have some of the highest reported losses of cattle to wolves in Iberia, accounting for 21–33% of all livestock killed and 43–65% of all compensation paid [11,12]. In Spain, compensation was paid for damage regardless of the use of prevention measures. According to the law in Portugal, compensation was conditional on the presence of shepherds and livestock guarding dogs (1 dog/50 head of livestock), or confinement of livestock, but this was not strictly enforced prior to 2017.

The human population of both areas is sparse and largely concentrated in small villages. Livestock breeding, especially cattle, is an important economic activity. In Portugal, numbers of cattle holdings have declined in recent years but the mean number of animals per holding has more than doubled and cattle density in Peneda-Gerês is the same as that of goats and sheep (3–22 compared to 1–28 head/km<sup>2</sup>, respectively) [7]. There is a similar trend in Spain, with cattle replacing sheep, a declining number of breeders but increasing number of animals per holding. Cattle and horse densities in summer pastures in the northern Cantabria Mountains averaged 23 head/km<sup>2</sup> in 2007 [14,15]. Cattle require less supervision than sheep

<sup>1</sup> Wolf hunting has not been permitted in Portugal since the end of 1988 or in Spain since September 2021.

<sup>2</sup> The Spanish study area included parts of three contiguous protected areas spanning the juncture of two autonomous regions: Riaño in Picos de Europa Regional Park (Castilla y León); Redes Natural Park (Asturias); and Covadonga in Picos de Europa National Park (Asturias).

and provide higher profits. The changes have also been supported by European Union (EU) subsidies and an exodus from rural areas which gives remaining farmers access to larger grazing areas, allowing them to feed more cattle during winter.

Wild ungulate species diversity and abundance differ between the two study areas. Wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*) and Spanish ibex (*Capra pyrenaica*) have lower abundances in the Portuguese area. These species, together with chamois (*Rupicapra pyrenaica*), occur at moderate to very high abundances in the Spanish area, with Riaño having higher availability of wild ungulates and Covadonga the lowest [8]. Cattle comprise 10–33% of wolf diet.



Fig. 4. Location of the study areas in Portugal and Spain, relative to the Iberian wolf range (Source: adapted from Blanco & Cortés [13]).



Fig. 5. Landscape dominated by communal grazing areas in (left) Peneda-Gerês and the Cantabrian Mountains (Photos: F Álvares, JC Blanco).

## Methods

### Interviews with farmers

Cattle breeders were interviewed using a structured questionnaire (Fig. 6) which was adapted from similar questionnaires developed within the LIFE MedWolf project and a doctoral thesis [4]. Information was gathered on: i) breeder demographics; ii) herd composition; iii) traditional and contemporary husbandry practices; iv) prevention measures currently in place; and v) losses to wolves in the previous year.

In Portugal, selection of interviewees was based on official wolf damage records provided by the ICNF. We aimed to visit all holdings chronically affected (defined as >10 attacks/year) as well as holdings with lower levels of

damage (0–10 attacks/year) in the same or neighbouring parishes. This helped minimise spatial confounding effects, as farms in the same area were expected to be exposed to similar conditions (e.g. densities of wolves and wild prey) and therefore variation in damages would most likely be due to differences in husbandry [4].

In Spain, since wolf damage statistics were not readily available, cattle breeders were initially identified with the help of local experts and administration managers, after which additional breeders were added by ‘snowballing’ [16]. An effort was made to interview more breeders in Riaño, where the use of livestock guarding dogs (LGDs) to protect extensively grazed cattle in summer pastures was more common than in the rest of the project area, offering the chance to gain a deeper understanding of this practice.



Fig. 6. Interviewing cattle breeders in Peneda-Gerês, Portugal (Photo: I Barroso).

### Analysis of predation and prevention

To gain further insight into factors that influence predation levels, the interviewed owners' husbandry and damage prevention practices were compared with their reported losses to wolves. Data on losses were obtained from official damage statistics (Portugal) or gathered during interviews with breeders (Spain).

In Portugal, the average number of cattle killed per holding per year during the period 2009–2013 was compared to herd size, distance from shelter, pasture type (private versus communal<sup>3</sup>) and other factors including age of calves in mountain pastures. For the latter, calves were classified as either older or younger than three



Fig. 7. Cattle grazing in communal mountain pastures is common in both study areas in summer (left) and year-round for some herds in Peneda-Gerês, Portugal (Photos: JC Blanco, M Nakamura).

months. This age was chosen from examination of raw data as it showed a strong connection with damage levels and allowed a representative and balanced number of holdings for further analysis. We used Spearman's correlation coefficient ( $\rho$ ) to measure the strength of linear relationships between variables and Wilcoxon rank sum tests (significance level = 0.05) to look for significant differences in damage levels between holdings grouped by husbandry practices and protection measures.

## Results

### Cattle breeders and holdings

A total of 61 breeders were interviewed: 31 in Peneda-Gerês (from 17 villages throughout the region) and 30 in the Cantabrian Mountains (20 in Riaño, five in Redes and five in Covadonga from a total of 19 villages). In general, they were born in the area and inherited the business from their parents. Most ran small holdings, with less than 100 animals, and their main source of income was from livestock production. Beef cattle prevailed, with a few dairy cows kept for cheese-making in Covadonga. In Portugal, each breeder had an average of 76 (range 6–300) head of Barrosã or Cachena<sup>4</sup> while in Spain the average was 98 (16–210) head of Casina<sup>5</sup> or various crosses. Most

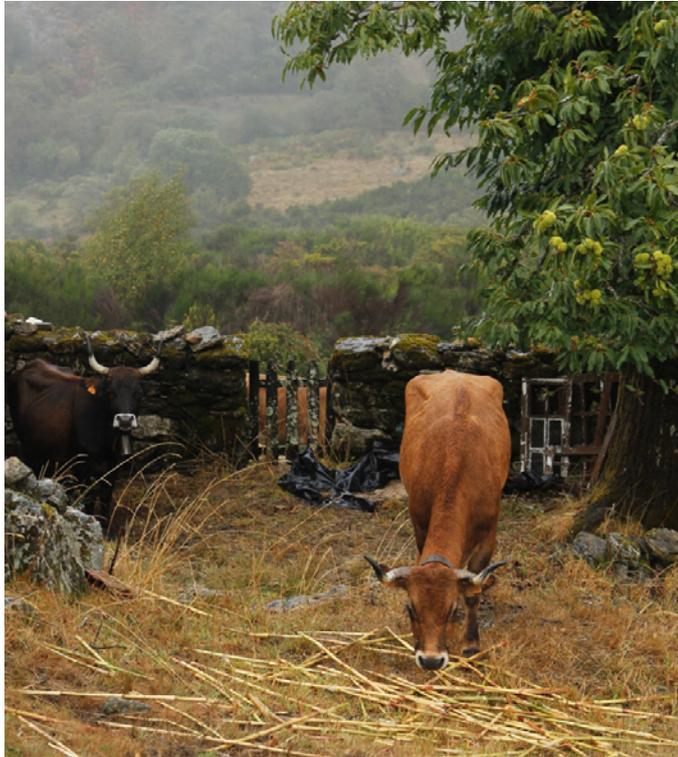


<sup>3</sup> Communal pastures are usually located further from villages, at higher elevations and closer to shrubland and forested areas than private meadows. Previous studies elsewhere have found a higher risk of predation on livestock associated with proximity to forest cover, shrublands and natural pastures and with longer distances from human settlements and disturbance [17–19].

<sup>4</sup> Both are ancient mountain breeds. Barrosã average 420 kg and 120 cm at the shoulder for females, 700 kg and 135 cm for males, while Cachena cows are <115 cm at the shoulder (www.amiba.pt; cachena.pt).

<sup>5</sup> An old mountain breed. Females average 450 kg and 128 cm at the shoulder, males 700 kg and 143 cm (www.mapa.gob.es/es/ganaderia/temas/zootecnia/razas-ganaderas/).

cattle were grazed extensively in communal pastures (owned and managed by local communities) in summer and, in Peneda-Gerês, year-round (Fig. 7).



### Traditional husbandry and damage prevention

According to the interviewees, most families owned far fewer cattle in the mid-20<sup>th</sup> century than today's breeders: up to a dozen head. During snow-free periods, calves and adult draught cows with calves less than six months old grazed in fenced pastures near villages and were protected in barns at night. Cows without calves and heifers grazed in the mountains from late spring to early autumn. As people owned fewer animals than today and families were larger, it was easier for them to tend their cattle. More effort was invested in maintenance and protection, as every cow was important to family survival.



Fig. 8. Traditional husbandry of cattle in northern Portugal: adult cows grazing in an enclosed pasture near a village (left); stone corral used by shepherds for night confinement of extensively grazed communal herds (Photos: M Nakamura, F Álvares).

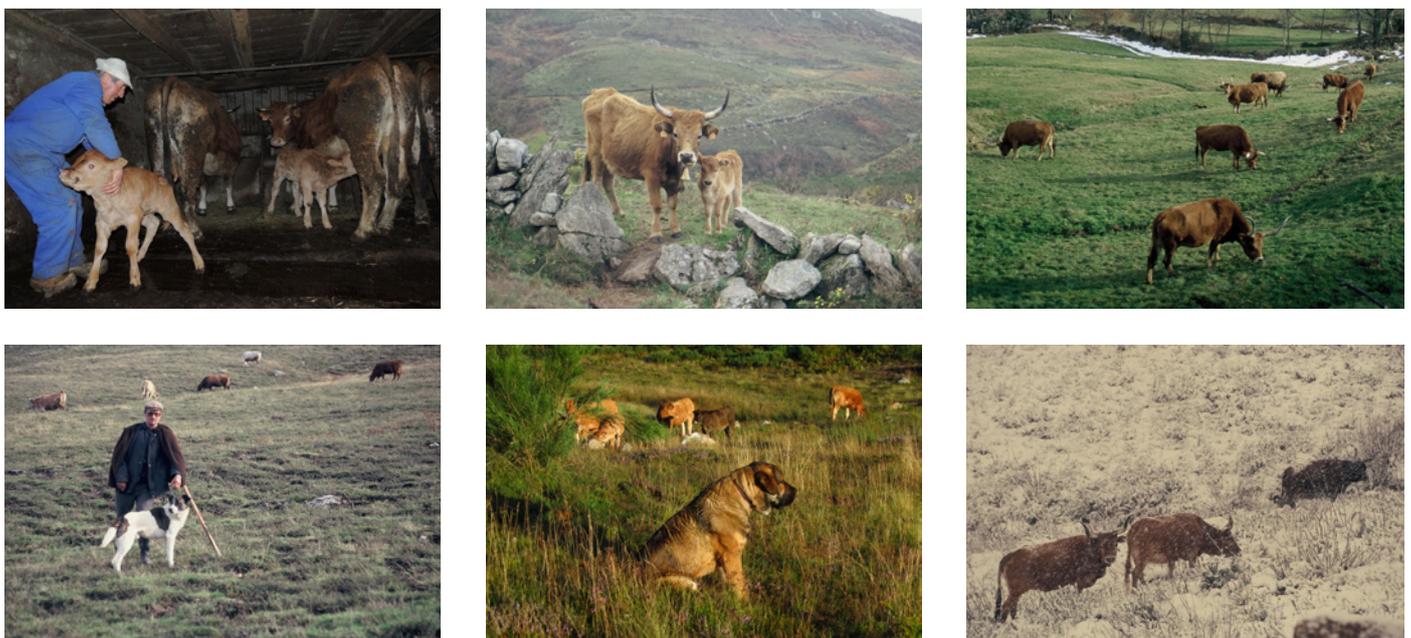


Fig. 9. Current husbandry practices associated with extensive cattle grazing in northern Iberia: (from upper left to lower right) cows with young calves in a barn, Spain; unattended calving in mountain pasture, Portugal; unattended daytime grazing within stone walls, Portugal; extensive grazing with shepherd and LGD, Portugal; extensive grazing with LGDs, Spain; year-round free-grazing, Portugal (Photos: JC Blanco, F Álvares).

The small herds of individual owners were usually gathered into larger herds for the summer and taken to communal mountain pastures where they were gathered into stone corrals at night (Fig. 8). One or two shepherds usually guarded the herd at night, sleeping close by in stone huts in order to deter wolves and, if needed, chase them away. The number of days that each owner shep-

herded the communal herd was proportionate to the number of cattle they owned. LGDs were not common with cattle, being mainly used to protect the stock most frequently attacked by wolves: sheep and goats. Wolf killing was allowed and even encouraged as a way to prevent damage [8,9].

Table 1. Characteristics of holdings, husbandry practices and damage prevention measures of cattle breeders interviewed in northern Portugal (n=31) and Spain (n=30).

	Peneda-Gerês, Portugal		Cantabrian Mountains, Spain	
	n	%	n	%
<b>Type of production</b>				
- meat only	31	100	25	83
- milk only	0	0	1	3
- meat and milk	0	0	4	13
<b>Type of grazing</b>				
Confined	0	0	1	3
Attended	1	3	2	7
Free-ranging	30	97	27	90
<b>Seasonality of extensive grazing</b>				
- summer only	0	0	30	100
- year-round	31	100	0	0
<b>Ownership of pastures for extensive grazing</b>				
- communal only	22	71	0	0
- communal and private	9	29	30	100
<b>Damage prevention measures</b>				
- livestock guarding dogs	2	7	8	30
- night attendance or confinement	5	16	4	13
- confinement of calves <3 months old	15	48	5	17

### Current husbandry and damage prevention

The husbandry practices described by interviewed breeders can be grouped into three main types (Table 1). In confined grazing, cattle are left unattended during the day in richer pastures (near villages and along river valleys), enclosed with stone walls or rudimentary fencing (<1m high metal mesh or 1–2 electric or barbed wire fences), and usually kept in village barns at night (Fig. 9). This practice is more frequent in lowland areas and during

winter. In attended grazing, cattle are shepherded, which is most common in high-productive pastures close to villages or in mountain pastures during summer. Free-ranging cattle graze unattended in unfenced mountain pastures during summer (sometimes year-round), mostly in communal land. They are not confined at night and their owners check them irregularly. This is now common practice in northern Iberia where, as a result of EU subsidies, owners invest less effort to protect their cattle from pred-



Fig. 10. Mastiffs protecting free-ranging cattle in the Cantabrian Mountains, Spain (Photo: JC Blanco).

ators and other hazards.

Although husbandry practices were similar in both study areas, some differences were found regarding attendance and confinement (especially in winter) and damage prevention measures (Table 1). In the Cantabrian Mountains, cattle were usually confined to barns in winter, whereas in Peneda-Gerês most owners left their cattle unattended to free-range during the day, all year round, and also during the night in summer. During late autumn and early spring in the Cantabrian Mountains, as well as in winter in Peneda-Gerês, (depending on weather and grass availability), cattle spent several hours grazing in meadows close to villages, being usually confined at night.

Some breeders in the Cantabrian Mountains tried to time births within this period, so calves were older and less vulnerable to wolf predation when taken to summer pastures in the mountains. In Peneda-Gerês, half the interviewed breeders kept calves confined until they were at least three months old before releasing them to mountain pastures.

Most cattle in both study areas were taken to mountain pastures up to 15 km from villages where they grazed from May to October without shepherds. LGDs were rarely used with cattle in Peneda-Gerês but 30% of interviewed breeders in Spain had them, either with free-ranging cattle or confined grazing (Fig. 10).

Some dairy cattle owners in Covadonga spent the summer in mountain huts in order to be able to milk their cows (as well as sheep and goats) and make cheese. In a single case in Peneda-Gerês, cattle were still grouped into a communal herd for the summer, which was attended by a shepherd during the day and, until 2010, shepherds spent the night in huts nearby.

A few calves are born in summer and left unattended in mountain pastures with their mothers (Fig. 11). Owners generally visit herds once or twice a week, although some do so daily. Some breeders in Riaño try to increase



Fig. 11. Calf born in summer pasture in the Cantabrian Mountains, Spain (Photo: JC Blanco).

herd cohesion by putting rock salt in pastures to bring cows together when the risk of predation is high, since they consider compact herds to be more capable of defending calves against wolves.

### Factors influencing damage levels

#### *Peneda-Gerês, Portugal*

Comparison of damage records with husbandry practices revealed a strong correlation ( $\rho=0.79$ ,  $p<0.001$ ) between herd size and the risk of predation (Fig. 12A). Breeders with >100 head (22% of interviewees) suffered 65% of reported wolf attacks in 2009–2013, those with 50–100 head (36%) reported 30% of attacks and those

with <50 head (42%) accounted for just 5% of attacks. Furthermore, we found a positive correlation ( $\rho=0.40$ ,  $p<0.05$ ) between number of wolf attacks and distance from usual pasture to nearest shelter – a barn or fenced pasture (Fig. 12B). Significantly less damage was reported by breeders who used private meadows and grazing areas <5 km from shelter compared to those who used only communal pastures located further from villages (Table 2). Other practices may also be linked to higher rates of predation, such as the presence of calves <3 months of age in mountain pastures. On the other hand, losses were significantly lower among cattle that were confined in barns or fenced pastures at night in winter.

Table 2. Variations in husbandry practices and protection measures at 31 cattle holdings in Peneda-Gerês, Portugal, and the corresponding mean number of reported wolf attacks (with significant p-values from Wilcoxon rank sum tests marked in bold) and mean compensation payments per holding per year in 2009–2013.

Husbandry practice / protection measure	Variant (n holdings)	Wolf attacks		Compensation payments (€)
		mean no.	p	
Night protection (summer)	None (26)	7.7	0.63	3,594
	Barn/fence (5)	3.8		1,670
Night protection (winter)	None (8)	17.3	<b>&lt;0.01</b>	8,332
	Barn/fence (23)	3.5		1,528
Day protection (summer)	None (30)	7.3	0.15	3,394
	Shepherd (1)	0		0
Day protection (winter)	None (26)	8.3	<b>&lt;0.01</b>	3,843
	Shepherd/fence (5)	0.8		377
Age of calves in summer mountain pastures	<3 months old (15)	11.0	0.057	5,316
	>3 months old (16)	3.3		1,379
Distance to shelter from summer grazing areas	<5 km (18)	3.0	0.059	1,106
	>5 km (13)	12.7		6,300
Distance to shelter from winter grazing areas	<1 km (12)	2.1	0.056	758
	1–5 km (15)	8.4		4,006
	>5 km (4)	16.9		8,155
Ownership of pastures	Communal/private (9)	2.1	<b>&lt;0.01</b>	1,103
	Communal only (22)	9.1		4,176
Overall	All holdings (31)	7.1	-	3,284

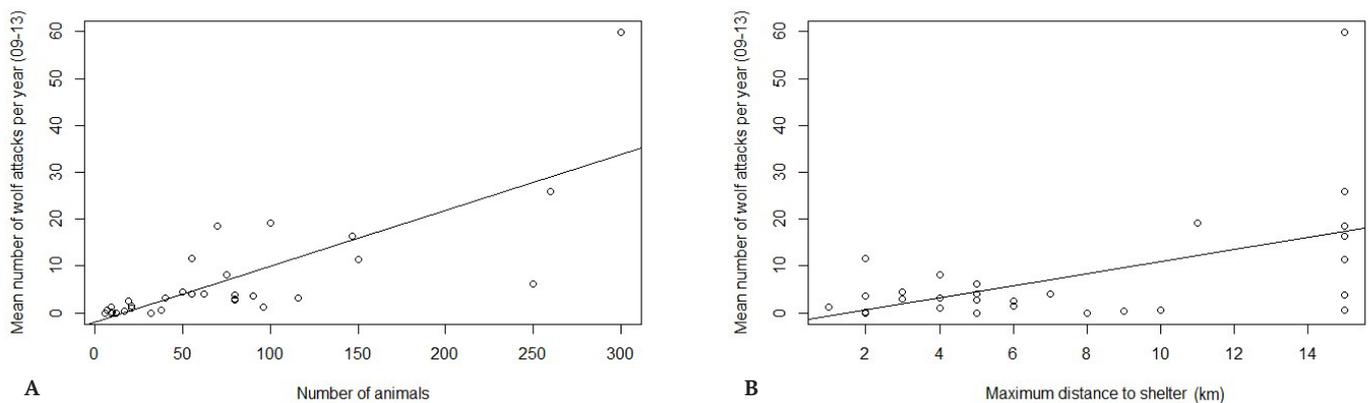


Fig. 12. Relationship between mean annual number of wolf attacks reported in 2009–2013 and (A) number of cattle at holding and (B) maximum distance in kilometres from usual pastures to a barn or fenced pasture for 31 holdings in Peneda-Gerês, Portugal.

### Cantabrian Mountains, Spain

All predation events occurred in mountain summer pastures, since during winter cattle is kept in barns, inaccessible to wolves, and during early spring and late autumn cattle graze in meadows near villages and are kept in barns at night. According to the responses of interviewed breeders, cattle mortality rates due to wolf depredation varied across the study area. Wolves killed 0.68% of cattle summering in mountain pastures in Riaño and Redes but 3.34% of those in Covadonga, i.e. five times more. Since wolf densities were similar in all three areas and breeders in Covadonga used appropriate preventive measures (shepherds spend the summer with dairy cattle and avoid taking small calves to mountain pastures), the higher predation rate in Covadonga may relate to lower availability of wild prey.

LGDs were only reported in Riaño, where eight interviewees (30%) used mastiffs to protect unattended beef cattle (Fig. 10). Six of them (75%) reported no losses to wolves whereas only four of 11 breeders without LGDs (36%) had no losses. LGDs therefore seem to be effective at preventing wolf predation on cattle in mountain summer pastures. However, breeders mentioned several constraints on their use: i) the remoteness of summer pastures makes it difficult to regularly feed, monitor and take care of dogs; ii) a perception that dogs only bond weakly with cattle so are prone to wander away; iii) they chase game animals; iv) the effort and cost required to raise and maintain them means they are only worthwhile if predation risk is high; v) some dogs prefer to go with hikers who feed them rather than stay with cattle. One breeder also claimed (incorrectly) that animal health regulations ban the presence of LGDs in barns to prevent transmission of brucellosis to cattle.

A positive relationship between level of damage and distance to shelter was evident across the study area, since all losses occurred in mountain summer pastures, which were around 5 km from villages. The presence of calves in mountain pastures was another determinant factor, since most cattle killed by wolves were young calves.

## Recommendations

Based on the above analyses and other knowledge acquired since the start of the Pilot Action, we make the following recommendations for best practice to reduce wolf predation on extensively grazed cattle. The choice of measures to apply at a particular holding should include consideration of which are best suited to local conditions and husbandry practices.

### Damage prevention tools

- Livestock guarding dogs, well-trained and in sufficient numbers, together with shepherds and night-time confinement within wolf-deterrent fencing or barns, is the best combination for extensively grazed cattle. LGDs should always be used if wolf access is not adequately prevented by fencing or other barriers. In some circumstances, LGDs can provide protection even without the presence of shepherds, but it is important to select good-quality pups and properly raise and socialise them with calves from a young age [20]. Automatic feeders are suggested for remote pastures without daily human presence. Care must be taken to ensure that water is always available. GPS collars to monitor movements can be useful to check dogs' be-



Fig. 13. Wire mesh fencing for night confinement of a communal cattle herd in Peneda-Gerês, Portugal (Photos: ACHLI).

havioural development and prevent roaming [21].

- Wolf-deterrent fencing can be constructed from wire mesh, electrified netting or wires or a combination of materials (Figs. 13 and 14). Good results were obtained in Portugal with permanent metal fences [22]. Permanent or mobile fences can be used in mountain pastures to confine vulnerable stock (e.g. debilitated animals, pregnant cows, new-borns and calves), particularly when predation risk is high. Cattle should be grazed within fenced pastures whenever shepherds and LGDs are not present, particularly during winter since rain, fog or snow may favour wolves. Shared fencing can be a solution for communal lands, but all local breeders should be involved from the outset to ensure it meets their needs. Confinement at night, when wolves are most active, is strongly recommended.
- Other deterrents can be helpful, at least in the short-term, such as turbo-fladry and disruptive devices with lights, sounds or even pyrotechnics. Additionally, new tools may become available in the near future, such as sound/light-activated collars to scare predators away from vulnerable animals.

### Herd management

- Pastures within 5 km of villages/shelters are recommended for grazing, particularly during winter.
- Calving in winter or early spring, when cattle are usually kept in barns, is highly recommended. Young

calves in pastures should be protected in wolf-proof structures for at least the first three months of life, when they are most vulnerable.

- Herd size of 10–100 head is recommended since smaller numbers of animals are more vulnerable and larger herds are difficult to manage and protect.
- Integration of new animals (replacement heifers) should be done gradually and with care to avoid them straying away from the main herd. It is advised to replace cows >10 years of age as predation risk increases with age [23].
- Local breeds (already common within the Iberian wolf range due to EU subsidies) are preferable as they are better adapted to extensive grazing in mountainous areas and may retain anti-predator behavioural traits [24].

### Other measures

- *Compensation payments* should be linked to adequate husbandry practices and damage prevention measures, for which financial aid, technical support and training should be readily available to breeders [25].
- *Recovery of wild ungulate populations* as an alternative food resource<sup>6</sup> is crucial in the medium-term. This is particularly relevant in areas where wild ungulates are scarce and wolves feed mostly on livestock. Prey recovery should be achieved through habitat improvement, appropriate hunting management and anti-poaching measures.

<sup>6</sup> Although the availability of wild prey does not automatically lead to a decrease in livestock predation rates, as a more direct relationship appears to exist with the availability of accessible livestock [26], their increased presence is expected to contribute to the maintenance of healthy wolf populations with limited access to well-protected livestock.



Fig. 14. Permanent metal fencing installed at a cattle farm in central Portugal as part of the LIFE MedWolf project (Photos: D Petrucci, Grupo Lobo).

## Conclusions

Our results show that there is high regional and local variability in losses of cattle to wolves, with predation risk being dependent on ecological conditions as well as husbandry practices. Protecting free-ranging cattle raises many challenges, since usually they are not attended by shepherds and often scatter over large areas, making it more difficult to deploy LGDs or fences. Moreover, many breeders lack information on how best to implement damage prevention measures and have misconceptions about their effectiveness. Others are unwilling to invest the necessary money and time without technical or financial support.

In Spain, where wolf hunting was permitted until 2021, many farmers preferred killing wolves rather than imple-

menting nonlethal alternatives. In areas recently recolonised by wolves, some farmers think that using such measures implies acceptance of wolf presence, which they strongly oppose. The fact that compensation was not made conditional on the use of prevention measures contributed to delayed uptake.

The Pilot Action confirmed the value of taking an integrative approach, considering social, economic, and ecological aspects, as well as the importance of dialogue between stakeholders to identify best practices. While it might appear that little can be learned from traditional husbandry as socio-economic conditions are so different now compared to 50–60 years ago, some practices are still applicable today, such as corralling livestock within secure structures at night. Economic costs are a limitation

to implementing damage prevention measures nowadays, so the most cost-effective approaches should be chosen and subsidised.

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