CDP news

Carnivore Damage Prevention

Issue 26 Spring–Summer 2023

Project
Protecting cattle from wolves in the Alps

Focus
Electric fencing, predators and other wildlife

Perspective
The power and limits of different forms of knowledge

Editorial

The pressing need for global action on human–wildlife conflict was recognised last December by the 196 Parties to the UN Convention on Biological Diversity (see p. 14 for details), placing it on the highest level of intergovernmental policy. And yet a recent online panel discussion[1] described human–wildlife conflicts as "wicked socio-ecological problems that can rarely be solved". Here, "wicked" is not slang or a reference to evil witches, but a label for complex problems that seem to defy resolution[2]. In contrast to 'tame' problems of a technical-scientific nature (engineering projects or Sudoku puzzles, for example), 'wicked' problems are said to be so entangled in multiple factors, disputed by stakeholders, that it is difficult not only to reach consensus on a solution but even to agree what the problem actually is!

Does this mean we should give up trying to find solutions? Absolutely not! Becoming aware that human–wildlife interactions are complex, and accepting that there may be no quick fixes, calls for adaptation with new ways of working. More collaboration is needed between social sciences and natural sciences, both of which have advanced considerably during the 50 years since wicked problems were first defined[3]. Instead of attempting to tame wicked problems through authoritative or competitive approaches, collaborative strategies recognise the existence of a plurality of views and seek to engage all interest groups in participatory processes in order to reach the best possible outcome[4].

At *CDPnews* we aim to contribute to the search for viable solutions. In this, the first issue of a new series, you can read about the design and testing of damage prevention tools such as fencing to exclude predators (p. 18). In addition, we feature the results of efforts to improve understanding of socio-economic and cultural contexts (p. 52); to facilitate dialogue among stakeholders (p. 39); and, even more broadly, to elucidate psychological aspects of how and why conflicts arise and escalate (p. 43). The challenge – and necessity – of building bridges between science and practice is also illustrated in our interview (p. 23) and perspective piece (p. 28).

Thanks to renewed support from WWF Switzerland and WWF Germany, in the coming months we will be introducing some exciting innovations, including a dedicated website with an online version of *CDPnews*, which many of you requested in our reader survey last year. The Agridea design team have helped to freshen things up with a stylish new look – we hope you like it! As always, we welcome your feedback, suggestions and proposals for new articles.

[1] https://onlinelibrary.wiley.com/page/journal/27709329/homepage/integrative-conservation-webinar-series
[2] https://link.springer.com/article/10.1007/BF01405730
[3] https://link.springer.com/article/10.1007/s42532-022-00106-w
[4] https://ipmr.net/index.php/ipmr/article/view/175

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Project

Protecting cattle from wolves in the Alps

Arianna Menzano[a]*, Rok Černe[b], Tine Gotar[b], Vesna Mihelič Oražem[b], Tomaž Berce[b]

[a] Large Carnivore Centre, Maritime Alps Natural Park, Valdieri (CN), Italy

[b] Slovenia Forest Service, Ljubljana, Slovenia

* Contact: arianna.menzano@centrograndicarnivori.it

Introduction

The Alps are the highest, most extensive mountain range in central Europe, reaching a height above sea level of 4,808 m and a length of 1,200 km. They are shared by eight countries: France, Switzerland, Monaco, Italy, Liechtenstein, Austria, Germany and Slovenia (Fig. 1).

The grey wolf *(Canis lupus)* was eradicated from the Alps in the 1920s [1]. Wolves from the Italian Apennine population began recolonising the south-western Alps of Italy and France from 1992 (Fig. 2) and the Swiss Alps from 1995 [2]. In 2012, the first signs were documented of wolves naturally dispersing from the Apennine and Dinaric populations to the eastern Alps of Italy and Slovenia [3,4]. Today, wolves are regularly present in all Alpine countries except Monaco [5].

The return of the wolf to the Alps has repercussions for livestock farming, in particular the traditional activity of summer pasturing in the mountains (Fig. 3) [6,7]. This is especially the case where husbandry systems no longer include measures to protect livestock from wolves due to their long absence. The resulting impacts, in terms of both economic losses and psychological and social effects on breeders, who thus have attitudes of aversion and intolerance towards wolves, represents one of the concrete threats to wolf conservation in the Alps [8]. Reducing the impact of wolf depredation to economically acceptable and socially tolerable levels, through appropriate adaptation of breeding systems and correct adoption of prevention measures, is therefore a strategic priority in order to maintain and develop traditional economic activities in tandem with long-term wolf conservation in the region.

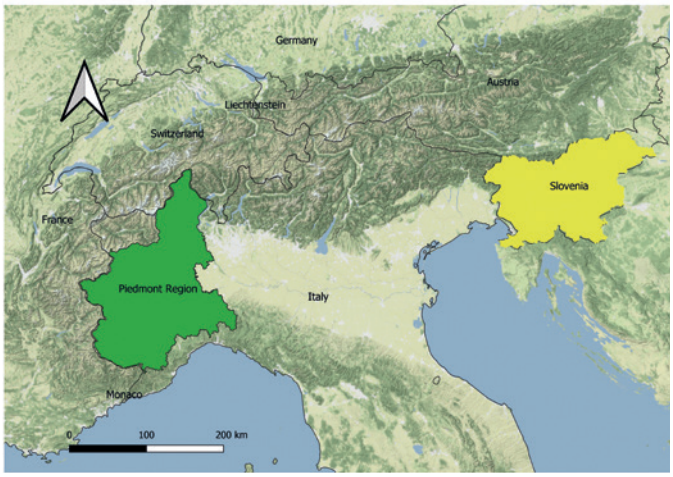

Fig. 1. The Alps showing project areas in Italy and Slovenia.

Fig. 2. A wolf in the SW Italian Alps in early spring (Photo: Andrea Avagnina).

Fig. 3. Sheep flock grazing in a typical high-altitude Alpine pasture (Photo: Arianna Menzano).

Although losses of livestock to wolves have mainly been of sheep and goats, depredation on cattle has become a growing issue in most of the Alps in recent years. During the period 2010–2019, annual cattle losses increased in France from 34 to 199, in Italy from 23 to 245 and in Slovenia from 25 to 60 [9]. This is problematic since the economic impact and compensation costs of damage to cattle are higher than those to sheep.

The LIFE WolfAlps (LWA) project implemented conservation actions in key areas of the Italian and Slovenian Alps in 2013–2018. A second project, LIFE WolfAlps EU[1] (LWA EU), is currently running with the goal of improving wolf–human coexistence across the Alpine region. One of this project's actions aims to decrease negative impacts on livestock farming by implementing effective preventive measures in response to wolf attacks.

The work presented in this article was implemented within the LWA and LWA EU projects in Slovenia and the Piedmont region of Italy (Fig. 1). We describe methods of protecting cattle; guidelines for removal of individual 'problem wolves'; possible sources of finance for subsidising damage prevention measures and paying compensation; and the establishment of rapid response teams as a useful tool to support farmers in areas of wolf presence. Finally, we make recommendations for improvement of protection measures.

Project areas

Slovenia

Activities were implemented throughout Slovenia. The Dinaric and Alpine mountain regions, each with approximately 70 % forest cover, have regular presence of wolves as well as brown bears *(Ursus arctos)* and Eurasian lynx *(Lynx lynx)* whereas the eastern part consists mainly of lowlands with sporadic occurrence of large carnivores in recent years. The main prey of wolves in the mountains are red deer *(Cervus elaphus)*, roe deer *(Capreolus capreolus)* and wild boar *(Sus scrofa)*. The spatial distribution of wolves expanded in 2018–2020 and packs were detected in the Slovenian Alps for the first time since the 19th century [10]. In 2020/21 the country was estimated to have a total of 106–147 individuals in 12 packs [4].

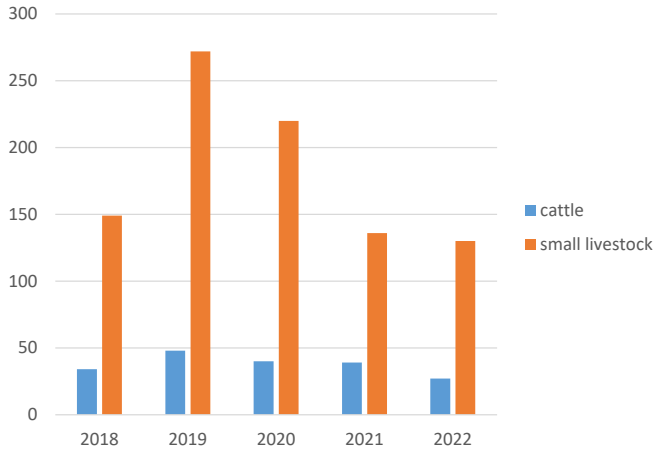

Fig. 4. Livestock damage events by wolves in Slovenia from 2018 to October 2022.

Slovenia has large areas of grassland and many family (hobby) farms with a tradition of livestock breeding. Cattle predominate (482,000 head in 2021) followed by poul-

[1] https://www.lifewolfalps.eu/en/

try, pigs, small stock (145,000 head in 2021, 82 % of them sheep), horses and bees [11]. Dairy cattle (Fleckvieh, Holstein Friesian, Braunvieh) are more numerous than meat breeds (Limousin, Charolais, Belgian Blue) [12].

Wolf attacks on livestock most often target sheep and goats. Approximately 11 % of damage cases involve cattle, around 65–75 % of them calves less than one year old. According to field evaluations by Slovenia Forest Service (SFS) damage inspectors, calves up to three months of age are the most vulnerable. Wolf attacks on cattle increased until 2019, since when the number of cases per year has fallen (Fig. 4) [13].

Piedmont, Italy

The Piedmont region in northwest Italy has a highly varied landscape, from rugged peaks, high mountain meadows and forests of the Alps to plains dotted with farms and industrial companies. The main economic activities are agriculture, viticulture, rice-growing, animal husbandry, automotive, textile and food industries as well as financial services and tourism.

Cattle dominate the livestock sector, with 808,500 head at c.11,500 farms in 2022 taking advantage of the large availability of fodder and Alpine pastures. Around 165,000 cows are managed through extensive Alpine grazing from June to September, with only occasional surveillance and little use of protective measures. The most common breed in Alpine pastures is the Piedmontese, which is mainly kept for meat according to the 'cow-calf' system. Sheep and goats occupy a relatively marginal role associated with more fragile areas (hills and mountains) and less intensive farming.

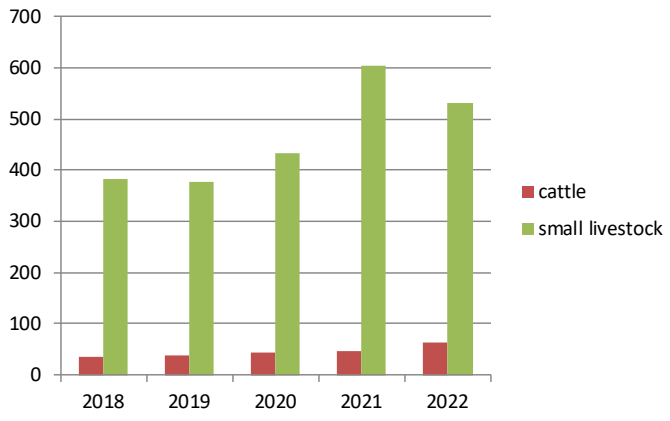

Fig. 5. Wolf damage to livestock reported in Piedmont in 2018–2022.

The wolf has been present in Piedmont for almost 20 years and can now be found in around 63 % of the region. In 2020/21 there were estimated to be a minimum of 195 individuals in 33 packs and two pairs in an occupied range of c. 20,000 km² [3]. The main prey are wild ungulates, which are abundant throughout the region: roe deer and wild boar in lowland areas as well as red deer, chamois *(Rupicapra rupicapra)* and ibex *(Capra ibex)* in mountain areas.

Livestock damage caused by wolves, mostly to small stock, has increased in recent years. Attacks on cattle, although much less frequent than those on sheep, almost doubled from 2018 to 2022 (Fig. 5). According to data from the public veterinary system, depredations of cattle in the last two years were mainly of calves less than one month old (34 %), 1–4 months old (27 %) or 4–12 months old (21 %), with animals more than one year old accounting for 18 % of cases (Fig. 6).

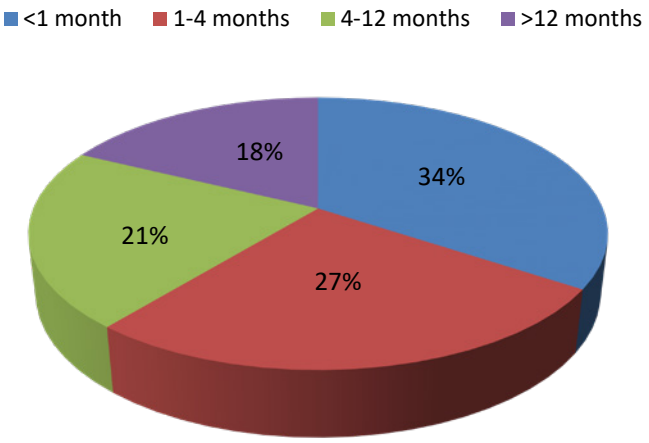

Fig. 6. Age classes of cattle depredated by wolves in 2021–2022.

Damage prevention measures

Protecting livestock from attack is widely regarded as one of the main strategies to enable coexistence of wolves with human communities. Most cattle breeders use single current-carrying wires to delimit grazing areas. However, such simple fences clearly cannot prevent wolves from entering and in many cases they allow calves to exit by passing underneath, thereby becoming more vulnerable to predation. Animals are most at risk when isolated, as they cannot benefit from herd protection. Scenarios with a heightened level of risk include:

a) females leaving the herd for parturition (both mother and new-born may be at risk);

b) young calves left alone lying/hiding in the grass while their mothers feeding (calves up to 3–4 months of age or until they are able to follow their mothers – primiparous cows in particular may leave their calves unattended for long periods of time);
c) injured or sick animals of any age have difficulty following the herd or defending themselves if attacked.

Damage prevention strategies developed for small stock are not always suitable for cattle, particularly where farmers do not attend their animals on a daily basis. Nevertheless, good examples of solutions adapted to fit specific characteristics of cattle management are available:

- Livestock guarding dogs (LGDs) in Portugal, Spain, Turkey and North America [14–17];
- Fixed or mobile physical barriers in Italy, Portugal and Spain [16,18,19];
- Fladry and electrified fladry ('turbo fladry') in North America [20,21];
- Other possible tools include acoustic devices to scare off predators [22–25].

There are no universal solutions and each case should be carefully evaluated in order to define ad hoc prevention strategies designed to fit the local circumstances taking into account husbandry, environmental context, age of livestock and farm finances.

Slovenia

Interested livestock farmers in 'hot-spots' of persistent wolf damage were invited to participate in testing possible solutions within the LWA EU[2] project and other projects (such as Carnivora Dinarica[3]). So far, five cattle breeders have improved their fencing, opting for high electric netting or fixed multi-wire electric fences.

For efficient implementation of prevention measures it is crucial to ensure strong collaboration among experts and farmers. This means that farmers have to be able to receive expert advice any time they need it. In addition, electric fencing should be checked regularly (more often than once per year) and, in case of improper use, instructions provided on how to improve the system.

Electrified nets: In Slovenia, high electric netting with at least 5 kV is recommended for protection of livestock from large carnivores. It can be 170 cm high or, alternatively, 145 cm netting is used with an electric tape above it at a height of 160–170 cm (Fig. 7). Such fences have

Fig. 7. Suckler cows with calves protected by 145 cm high electric netting topped with an electric tape at a height of 160 cm (Photo: Tomaž Berce).

proven effective at protecting sheep and other grazing animals. The main downside is the extra workload for farmers associated with gathering their animals into night pens, releasing them in the morning and frequent relocations of the mobile fencing.

Multi-wire electric fences: To protect larger pastures, some breeders agreed to try fixed electric fences with six wires and a total height of approximately 150 cm (Fig. 8).

Fig. 8. Horses and cattle protected with a 150 cm high, 6-wire electric fence (Photo: Tine Gotar).

A crucial element of this approach is the farmers' commitment to take down the fencing at the end of the sum-

[2] https://www.lifewolfalps.eu/en/axes-of-intervention/prevenzione/
[3] https://www.dinapivka.si/en/project/project-carnivora-dinarica/

mer grazing season. This is to enable free passage of wild animals and, most importantly, to avoid predators getting used to the fences when electricity is not switched on. There are two alternative approaches: either to remove the wires from the fence and place them on the ground or, if removable posts are used, to lay the entire fence on the ground (Fig. 9).

Fig. 9. Electric fence with removable posts lain flat on the ground at the end of the grazing season (Photo: Tine Gotar).

Removal of problem wolves: Based on the need for an efficient response to repeated attacks on cattle, guidelines for removal of 'problem wolves' were agreed in 2020 between decision-makers and stakeholders including the Chamber of Agriculture and Forestry of Slovenia. The threshold for intervention was set at three attacks on cattle, horses or donkeys (or at least nine on small stock) by the same wolf/wolves during a three-month period. In this context, the type of preventive measures used is not relevant. Following approval of a permit by the Ministry of Environment and Spatial Planning (MESP), the SFS defines the rules of engagement, which typically specify that removal has to be carried out where the problems occurred. Up to 2022 a total of six permits for removal of 11 problem wolves (1–2 individuals per permit) were issued after damage to cattle, horses or donkeys. As the rules of engagement are very strict in order to achieve the best possible results in the field, only four of the 11 targeted individuals were actually removed. Another downside of this measure is that it usually takes approximately 2–3 months from initial proposal to formal confirmation of permission.

Piedmont, Italy

To minimise the risk of depredation, we suggest a combination of changes to livestock management together with other measures such as electric fencing, LGDs, acoustic and visual deterrents. We selected cattle farmers to test various options within the LWA project on the basis of their availability, established relationship with project staff and high risk of wolf attack. In addition, general recommendations for adaptations of management strategies to reduce damage risk were given to farmers both within the LWA project and on other occasions.

Management strategies:

- synchronisation of births and avoiding calving during summer grazing;
- avoid taking calves younger than 3–4 months to pasture, otherwise protect them with electric fencing or in steel cages (Fig. 10);
- prevent cows, especially those at the end of pregnancy, from using areas most at risk of depredation and keep them under observation;
- provide more water points so cattle do not disperse over long distances;
- avoid removing horns, which breeders have reported to be an effective defence tool [26].

Active herding: The presence of a shepherd acts to deter wolves from approaching livestock and also permits the implementation of other damage prevention measures such as livestock guarding dogs and night pens [27].

Electric fences: Most cattle farmers use mobile electric fences rather than permanent structures. To deter large carnivores, the voltage must be at least 5 kV with an energiser providing 2–3 J. Farmers should check their fences regularly (at least once a week) to maintain functionality. It is best to avoid fencing large areas in which livestock can disperse and so become more vulnerable to predators. Within the LWA project, 14 livestock breeders in the Maritime Alps Natural Park tested 3-wire electric fences (wires at 30, 60 and 90 cm from the ground) to contain livestock at night and during bad weather (Fig. 11). Although wolves can easily pass under the lowest wire, we expect such fences to have a beneficial effect by preventing calves from leaving their mother's protection.

Fig. 10. A steel cage (1.9 × 1.9 m) to protect young calves in pasture (Photo: Arianna Menzano).

Fig. 11. A 3-wire electric fence to protect cattle (Photo: Davide Sigaudo).

Electrified nets: Although rarely used for adult cattle, 100–145 cm high netting is sometimes used to enclose new-born calves and protect them during the first weeks of life while their mothers are grazing. We suggested this option to all breeders with livestock grazing in the LWA project area but only 15 (4.8%) of them agreed because most of them prefer to keep the whole herd together. None of the calves protected with electrified nets was predated during the project.

Livestock guarding dogs: The use of LGDs is increasing in Piedmont in part due to aid available to maintain them. Experience of socialising LGDs with sheep is widespread but many farmers still have difficulties achieving this with cattle. As part of the LWA project, eight 4–7 months old Pastore Maremmano Abruzzese pups from working lines, already socialised with cattle, were given to five breeders. To create a bond between dog and cattle at the new farm, pups were initially kept with young calves in a stable (Fig. 12). Later, LGDs were put with cattle in a fenced pasture [28]. A second activity within the LWA project was to evaluate the efficiency of LGDs protecting cattle (Fig. 13). Nineteen dogs bought and raised by farmers themselves were included in the study. Preliminary results suggested that the dogs were attentive to cattle, tending to stay with them even at night and despite not being contained within fences [29]. However, complaints from tourists frightened by the dogs led to farmers preferring to keep them tied up near the pasture or mountain hut during the daytime and release them in the evening, thereby compromising the ability of dogs to protect livestock from wolves. More in-depth studies are underway within the LWA EU project.

Fig. 12. An Abruzzese LGD pup with calves in a stable (Photo: Arianna Menzano).

Visual deterrents: Twenty breeders whose cattle grazed in areas of wolf presence tested the use of fladry (mostly turbo fladry) to deter wolves [20,28]. Fladry lines consisted of 50 × 10 cm red flags suspended at 50-cm intervals from a fence wire 90 cm above the ground (Fig. 14). In eight cases this was the highest of a 3-wire electric fence (described above); in two cases the top of a 2-wire electric fence was used; in nine cases there was only one electrified wire and in one case fladry flags were suspended from a single non-electrified wire. In 15 cases, the main goal was to evaluate the compatibility of fladry with cattle management and assess the workload needed to instal and maintain it. In the remaining five cases, fladry was used as an emergency measure following depredation. No cattle were attacked while fladry was in place.

Acoustic deterrents: Twenty cattle breeders tested acoustic devices which emit pre-recorded sounds, either

Fig. 13. Abruzzese adult protecting a herd (Photo: Arianna Menzano).

at programmed intervals or by photocell activation. Four breeders wanted to use acoustic and visual deterrents concurrently (Fig. 14). So as not to disturb LGDs, we generally recorded the voice of the shepherd. One device per herd was activated at 30-minute intervals from dusk to dawn for a period of 5–7 days (to avoid predators habituating to the sounds). They were positioned close to the herd, which was gathered into a restricted area, in such a way that the emitted sounds could be heard over long distances. Farmers checked their functioning (no maintenance was required). In 14 cases there was no imminent risk of wolf attack and the goal was to evaluate the compatibility of this tool with cattle management. However, in the other six acoustic deterrents were implemented following depredations. No cattle were attacked during the trials and no negative aspects of the devices were reported by shepherds [28].

Fig. 14. Use of fladry and acoustic device to protect a herd (Photo: Massimo Sciandra).

Sources of finance

Slovenia

Compensation: The MESP compensates damage to livestock by large carnivores based on market value. Veterinary costs to treat injured animals are reimbursed. Indirect costs (e.g. lost milk production) or missing animals are not compensated.

Preventive measures: Livestock breeders can obtain subsidies within the EU Rural Development Programme (RDP) for the extra workload to set up, move and maintain enclosures with high electric netting (€119.90/ha), to take care of at least three LGDs (€112.60/ha) and to employ shepherds to protect animals by guiding them into a night enclosure (€107.60/ha). Co-financing (80 %) for the purchase of equipment to instal high electric netting is avail-

Fig. 15. Italian WPIU supporting a farmer in the field (Photo: Arianna Menzano).

able from the MESP to farmers who experience damage by large carnivores. The SFS has been involved in many projects regarding damage prevention measures and since 2011 has donated 80 sets of high electric fences to farmers, mainly for sheep protection.

Piedmont, Italy

Compensation: Piedmont regional programmes 1 and 3 for livestock breeders compensate damage caused by large carnivores. Reimbursement covers 100% of the commercial value of killed or lost animals and indirect costs including veterinary and pharmaceutical expenses for injured animals, removal and disposal of carcasses and lost production.

Preventive measures: The 2014–2020 RDP (Operation 10.1.6 'Defence of livestock from depredation by canids on hill and mountain pastures') provides area-based flat rate payments of €50/ha/year with a 5-year commitment for mobile electric fences, LGDs and constant human presence during grazing. Subsidies cover the workload to set up, move and maintain fences, care of LGDs and constant human presence. Breeders must implement all three measures to access subsidies. Breeders who do not meet the RDP criteria can apply to Piedmont regional programme 2, which also supports the costs of damage prevention measures.

Rapid response teams

Farmers' negative attitudes towards wolf presence are often compounded by two main factors: lack of damage prevention measures and lack of timely, effective assistance from local authorities [30,31]. Experience from other projects such as Progetto Lupo Piemonte[4], LIFE DinAlp

[4] https://www.centrograndicarnivori.it/progetti/progetto-lupo-piemonte

Bear[5] and LIFE SloWolf[6] has shown that the presence of project staff to assist farmers in using prevention systems and taking prompt action in case of attacks is fundamental so that livestock breeders do not feel abandoned. Within the LWA EU project we created a new 'first aid' approach to facilitate direct and immediate contact with breeders who suffer damage or graze livestock in areas of recent wolf recolonisation. Multidisciplinary staff of Wolf Prevention Intervention Units (WPIU) give farmers ad hoc advice and support to improve prevention strategies based on best practice; administrative assistance; information on how to access compensation and subsidies; and mediation through active listening (Fig. 15).

Beginning in 2021, WPIUs have been established in each country of the project (Italy, Slovenia, Austria and France[7]) and there are now a total of around 400 operators in 42 units. During their first year they intervened more than 600 times. They are mostly composed of local public administration staff in order to guarantee their continued operation beyond the end of the project. Those in Italy and Slovenia provide preventive systems such as electric fences, visual and acoustic devices.

Conclusions and recommendations

As both Slovenia and Piedmont face regular and increasing depredation by wolves on cattle, finding long-term solutions is crucial to prevent further damage to livestock and opposition to wolf conservation. Various options are available to protect livestock from large carnivores, but it takes time for farmers to become familiar with the methods, gain trust in their effectiveness and adopt innovative solutions. A key element in this process is to provide technical support so that farmers do not feel alone in dealing with problems related to wolf recovery. Collaboration and exchange of experience between experts and farmers within countries and on an international level are very important in finding good solutions quickly.

Calves are at higher risk of attack by wolves. It is therefore important to encourage farmers to implement a schedule that avoids calving during extensive grazing or adequately protects mothers during calving and in the first few months of calves' lives.

The use of electric fences, both to enclose larger grazing areas and to isolate animals in vulnerable stages, is one of the most common and effective ways of preventing wolf attacks. Correct implementation and adequate maintenance are key to achieving successful results as only fully functional measures can ensure security for livestock. Regular visits by professional advisors such as damage inspectors are therefore crucial to check proper fence installation.

To support the use of livestock guarding dogs (LGDs) to protect cattle, there is a need to raise awareness among breeders of the importance of proper pup selection and socialisation in order to create a strong bond with livestock and to avoid aggression towards people. It is also important to develop specific awareness campaigns for other mountain users with information on how to behave in the presence of LGDs. In addition, clear and solid legal bases, including better legal protection for owners, are needed at the country level to encourage the use of LGDs. In Slovenia, LGDs are now defined as working dogs (like police and military dogs), which is an important step. However, since current legislation requires them to be kept in pastures with electric fencing they cannot be used in free-grazing Alpine pastures.

Acoustic deterrents may be beneficial in protecting livestock for short periods (5–7 days) of heightened risk (e.g. calving away from secure areas) or in emergency situations to prevent further attacks before other measures can be implemented. They are not suitable for routine prevention as predators are likely to habituate to them. As reported in the literature [23–25,32], visual deterrents can provide protection for longer periods (90 days or more), especially in the case of turbo fladry.

If particular problem wolves persist in attacking livestock, causing repeated and ongoing damage, removal of the implicated individuals should be considered to prevent further losses and potential escalation of conflicts.

[5] https://dinalpbear.eu/en/
[6] https://www.volkovi.si/?lang=en
[7] https://lifewolfalps.eu/prevenzione-degli-attacchi-da-lupo-esempi-dai-territori-di-recente-ricolonizzazione/

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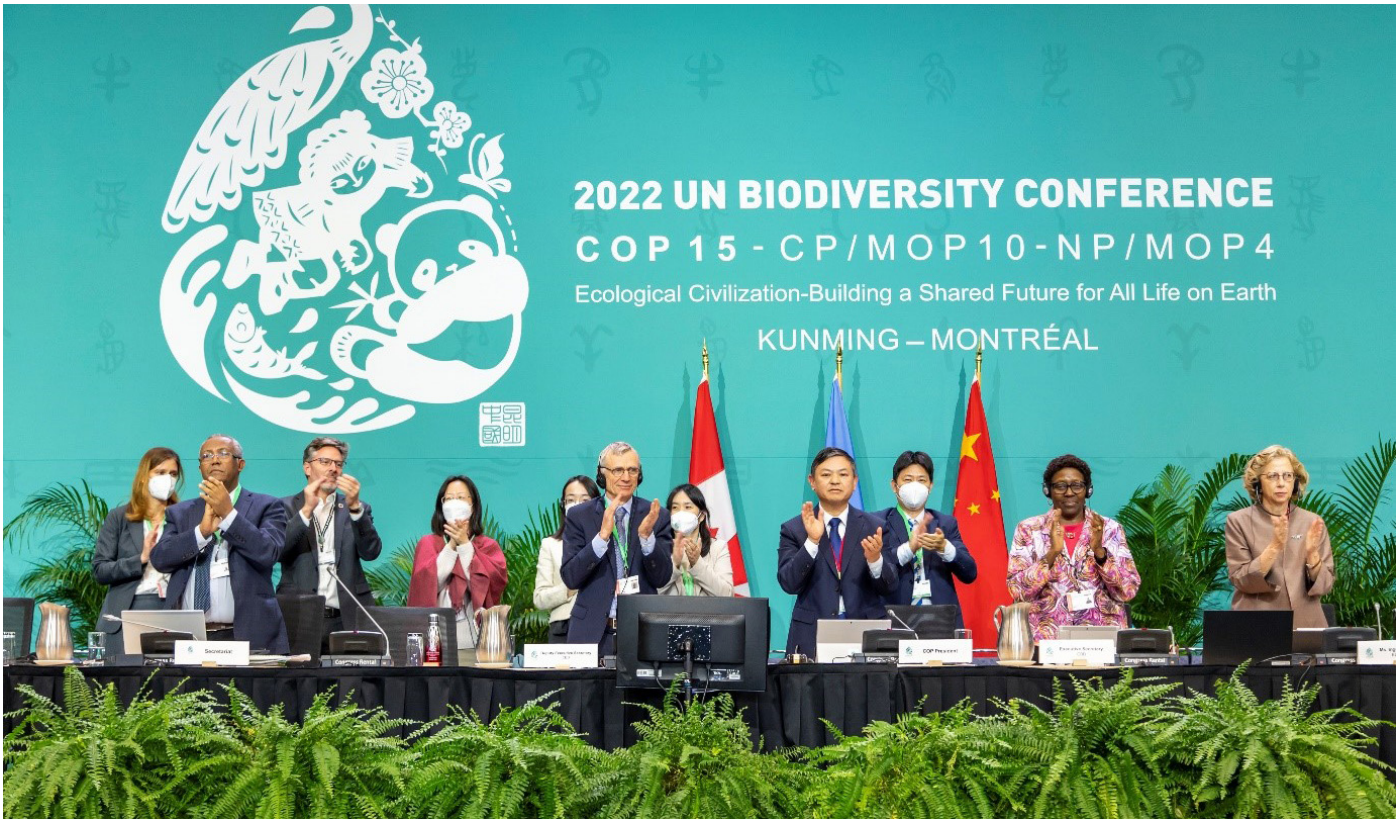
News Roundup

Landmark global agreement

The conclusion of the 15th Conference of Parties to the United Nations Convention on Biological Diversity resulted in the adoption of the Kunming-Montreal Global Biodiversity Framework[1] on 19th December 2022. The Framework consists of global targets to be achieved by 2030 and beyond to safeguard and sustainably use biodiversity. Reducing human–wildlife conflict to facilitate coexistence is included in Target 4:

"Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and **effectively manage human–wildlife interactions to minimize human–wildlife conflict for coexistence.**" *[Editor's note: emphasis added.]*

The IUCN SSC Human–Wildlife Conflict & Coexistence Specialist Group (HWCCSG), which was closely involved in the process, is working to develop indicators to enable monitoring of progress towards achieving the Target. Further information can be found in the HWCCSG Policy and Briefing Documents[2].



Adoption of the Kunming-Montreal Global Biodiversity Framework (Photo: UN Biodiversity https://creativecommons.org/licenses/by/2.0/).

[1] https://www.unep.org/resources/kunming-montreal-global-biodiversity-framework
[2] https://www.hwctf.org/policies

Conference and guidelines on human–wildlife conflict & coexistence

In March–April 2023, the International Conference on Human–Wildlife Conflict & Coexistence[3] was held in Oxford, UK. Organised by the IUCN SSC Human–Wildlife Conflict & Coexistence Specialist Group[4] (HWCCSG), and co-hosted with the GEF-funded and World Bank-led Global Wildlife Program[5], and WildCRU[6] of Oxford University, the conference was attended by more than 500 delegates from 70 countries and six continents. The conference brought together participants from non-profit, government, academic and donor backgrounds from around the world, providing a forum for exchanging knowledge and interdisciplinary discussions. The programme consisted of 48 sessions of scientific presentations, panel debates, keynote speeches and interactive discussions from diverse fields such as ecology, animal behaviour, psychology, policy, conflict analysis, mediation and peacebuilding, resource mobilisation and anthropology. All keynotes, symposia, speed talks and major panel sessions were recorded and compiled in a video library[7] as a resource for all delegates and those unable to attend the conference.

On the first day of the conference, the HWCCSG launched the IUCN SSC Guidelines on Human-Wildlife Conflict & Coexistence[8]. Consisting of 32 short chapters centred around five foundational Principles of understanding and managing human–wildlife conflicts, they aim to provide foundations and principles for good practice, with clear, practical guidance on how best to tackle conflicts and enable coexistence with wildlife. The Guidelines aim to be relevant to any human–wildlife conflict situation, irrespective of species or region, and can be used by any individual, organisation, community or government trying to manage human–wildlife conflict and achieve coexistence. While reading the Guidelines in their entirety is unnecessary, the Principles and the Good Practice Checklist provide an essential general guide, and readers can consult specific chapters depending on their

[3] https://www.hwctf.org/conference
[4] http://www.hwctf.org/
[5] https://www.worldbank.org/en/programs/global-wildlife-program
[6] http://www.wildcru.org/
[7] www.hwctf.org/conference-videos
[8] https://www.hwctf.org/guidelines

interests and needs. During the conference, a panel session was dedicated to introducing the Guidelines with different sections and chapters being discussed, which can be watched online[9]. The HWCCSG explained that the Guidelines are just the first version and invited users to provide feedback and reflections for future improvements.

The HWCCSG plans to hold several online webinars in the near future to maintain the momentum initiated at the conference and discuss the Guidelines further. If you are interested in attending these events, sign up for the HWCCSG mailing list[10] to be notified about them. The HWCCSG also have a quarterly IUCN HWCC Newsletter[11], which provides the latest publications from the HWCC Library and other news.

Alpine shepherd conference

The 4th Swiss shepherding conference, organised by AGRIDEA in Illnau on 21st April, took an international approach by including neighbouring countries of the Alpine area. CIPRA[12] arranged for an international shepherd delegation to attend. Büro Alpe[13] from Austria presented a study on different pasture management techniques and how they influence the daily routines of shepherds. The summer workload of several shepherds was documented and compared between, for example, a free-grazing approach versus fence-assisted herd management. The full study[14] is a worthwhile read. The KORA foundation[15] for carnivore ecology and wildlife management described the current situation of large carnivores in Switzerland. Their presentation also mentioned that if livestock carcasses are not found quickly, scavenging by griffon vultures *(Gyps fulvus)* can make it virtually impossible to prove that predation took place. This is a development to be followed in the coming years.

Shepherd conference in Illnau (Photo: Daniel Mettler).

Moving from east to west, the conference then turned its gaze to France with a presentation from the Agro-Florac institute. The goal of the Past'Oral Transmission project is to use video-based training to help share agro-pastoral knowledge. Further information and videos on different shepherding techniques can be found on the project webpage[16]. Afternoon workshops were characterised by practical input regarding animal health, fencing technology and livestock protection dogs. in a workshop in the afternoon. Further steps towards establishing an international shepherding organisation were defined based on research[17] into the potential opportunities and challenges.

The conference was well attended, with more than 60 shepherds, farmers and agricultural representatives. It ended with an opportunity to chat while tasting delicious local products. The next event is planned in 2025.

New project tackling bold wolves

The European Commission approved funding for a new project within the LIFE programme beginning in 2023. Wild Wolf – Concrete actions for maintaining wolves wild in anthropogenic landscapes of Europe project targets the management of critical situations that arise when wolves fearlessly approach humans. Such events are increasingly reported from several European countries. Most management authorities are not prepared for this, as wolves are traditionally believed to avoid people and feed on wild prey or livestock.

The presence of wolves in highly humanised landscapes has led to them becoming familiar with cars, trac-

[9] https://youtu.be/EIJedb_9Bc0
[10] https://forms.gle/Q5VRwLrt6M8aD4GR8
[11] https://hwctf.us6.list-manage.com/subscribe?u=d85d5cdbe6aac8e8777f7f40a&id=c7fb7d2cb8
[12] https://www.cipra.org/en
[13] https://www.alpe-beratung.at/
[14] https://www.tirol.gv.at/fileadmin/themen/land-forstwirtschaft/agrar/LWSJF/Grosse_Baeutegreifer/Bericht_Neue_Hirtenarbeit_mit_Herdenschutz_2022final.pdf
[15] https://www.kora.ch/en/
[16] https://idele.fr/pastorale/
[17] https://shorturl.at/afwDP

tors, roads and noise. In an opportunistic manner, they may feed on anthropogenic food sources. Such unexpected behaviour catches people by surprise and many respond with inappropriate behaviours that can eventually lead to close approaches and unwelcome feeding habits such as attacking dogs or other domestic animals. To avoid triggering the unwanted process of habituation, a series of measures need to be taken at different levels, from adapting refuse disposal practices, pet management and outdoor activities to raising awareness about the real risks and impact that habituation may have on the ecological role of wolves.

The LIFE Wild Wolf project aims at developing protocols for interventions, procedures to develop a clear chain of command for collecting detailed information and monitoring of each situation as well as reducing the number of negative encounters. The project involves 18 partners from nine European countries and seven wolf populations. It will last five years with a budget of over €7 million. More information is available on the LIFE programme website[18].

Wolf management compared

The fourth thematic conference of the LIFE WolfAlps EU project focused on sharing strategies for coexistence of wolves and human activities. Wolf management in Europe is essentially implemented at national or regional level. Policies in other countries are often misunderstood or poorly known, leading to claims that, "the grass is greener on the other side", in this context meaning that wolves are somehow less controversial or challenging over the border. The conference was an opportunity to learn more from wolf managers and experts from several countries about the challenges, controversies and potential solutions.

A total of nine presentations described the situation of wolves, conflicts and their management in France, Italy, Austria, Slovenia, Germany, Spain and Slovakia. The conference moderators highlighted the diversity of context, governance, perceptions, attitudes and management strategies that exist, the need for a common framework, the need to involve all stakeholders in wolf management and the crucial importance of communication and educational initiatives.

The conference was held on 5–6th December, organised by the French Biodiversity Agency with support from Mercantour National Park. More than 500 people from 16 European countries participated across the two days, either in person or online, representing a diverse audience including livestock breeders, hunters, environmentalists and the general public Video recordings of the presentations can be viewed online[19] and there is a more detailed summary of the event on the LIFE WolfAlps EU website[20].

European policies (still) under scrutiny

In issue 25 of *CDPnews*[21] we reported on a motion adopted by the European Parliament (EP) in November 2022 for a Resolution[22] on the protection of livestock farming and large carnivores in Europe. The European Commission (EC) sent a comprehensive Response[23] to the EP on 7th March acknowledging the challenges presented by the return of the wolf, the existence of social conflicts related to large carnivores and the diversity of views on their management. In its Response, the EC agrees with the need to effectively address the problem of predation on livestock and associated conflicts. It recalls various means already available to EU Member States including funding opportunities for mitigation measures such as damage prevention tools and practices, compensation payments, dialogue and participatory processes with stakeholders as well as possibilities to derogate from the prohibitions of the strict protection regime of the Habitats Directive[24]. The EC also states that during the course of 2023 it will, "carry out an in-depth analysis of all available scientific and technical data, and all other relevant circumstances at hand, in order to assess whether further measures are needed, including for adapting the protection status of species of Community interest based on technical and scientific progress".

[18] https://webgate.ec.europa.eu/life/publicWebsite/project/details/101074417
[19] https://www.youtube.com/@LifewolfalpsEurope
[20] https://www.lifewolfalps.eu/en/lherbe-est-elle-toujours-plus-verte-ailleurs-resume-de-la-4eme-conference-internationale-lwa-eu-2022/
[21] https://www.protectiondestroupeaux.ch/fileadmin/doc/International/CDP_and_General_Infos/CDPNews_25_Automn_2022_WEB.pdf
[22] https://www.europarl.europa.eu/doceo/document/TA-9-2022-0423_EN.html
[23] https://environment.ec.europa.eu/news/follow-european-parliament-non-legislative-resolution-protection-livestock-farming-and-large-2023-06-06_en
[24] https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive_en

Focus

Retrofit electric fencing to protect sheep from wild dogs in Australia

Paul Gibb

Central Tablelands Local Land Services, New South Wales, Australia

Contact: paul.gibb@lls.nsw.gov.au

Wild dogs and sheep farming

It is believed that the dingo was introduced to Australia approximately 3,500 years ago and its origins can be traced back to Asian domesticated dogs [1]. Crossbreeding with modern domestic dogs has occurred throughout the country and the degree of hybridisation relates to length of European settlement and exposure of dingo populations to modern breeds [2].

In New South Wales (NSW), a state on the east coast of mainland Australia (Fig. 1), the term 'wild dog' refers to all free-living dogs: dingoes, feral[1] domestic dogs and their hybrid descendants, all of which are currently considered to be *Canis familiaris*. Wild dogs are predominantly golden or yellow but can be white, black, black and tan, brown, brindle or any combination of these (Fig. 2). Adult wild dogs range from 11 to 25 kg for males and seven to 22 kg for females.

Impacts on the Australian economy from production losses due to predation on livestock, disease transmission in livestock and the national costs associated with control are estimated to range between A$64 million and A$111 million annually [3]. There are also associated impacts on the mental health of livestock producers and the social and economic viability of rural communities [4]. At the time of writing, there was no compensation scheme for livestock killed by wild dogs in Australia.

Wild dogs prey on a wide variety of native fauna including kangaroos and are considered a known or potential risk to at least 14 endangered or vulnerable native mammal, reptile and bird species listed under the Environment Protection and Biodiversity Conservation Act 1999. Predation and attacks on wildlife by wild dogs can have serious impacts on native wildlife species, particularly those such as koalas that are also under threat from other key processes [5].

While each state and territory of Australia has its own specific legislation regarding wild dogs, the general intent is the same, i.e. that the land occupier is responsible for controlling them. In NSW, the Biosecurity Act 2015 places a legislative responsibility on the occupier of all lands in the state to take measures to prevent, minimise or eliminate the risks associated with

[1] The term 'feral' is used to describe animals that have been through the process of domestication but have returned to a wild state.

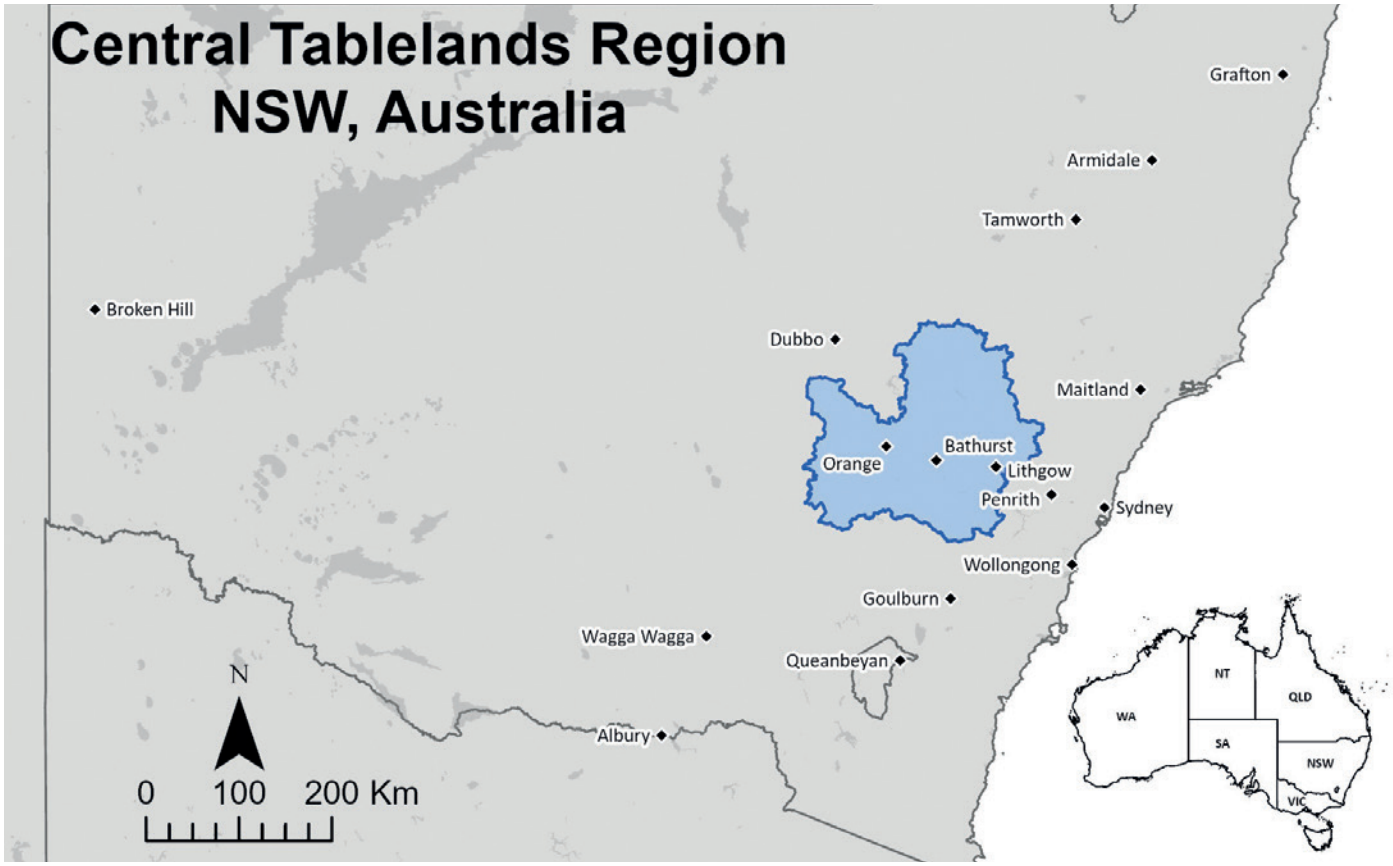


Fig. 1. Location of Central Tablelands, NSW, Australia (Source: Local Land Services).

wild dogs as far as is reasonably practicable. This obliges the occupier of lands, private or public, to take all practical measures, including by lethal means, to minimise the risk of any negative impacts of wild dogs on their land or neighbouring lands.

Poison baiting, leg-hold trapping, opportunistic shooting and exclusion fencing have been used as the primary means of killing or excluding wild dogs in Australia since European settlement[2], with mixed results. The most common form of lethal control for wild dogs is the use of meat baits injected with sodium fluoroacetate, better known as 1080 (pronounced "ten eighty"). This poison is produced as an odourless, tasteless white powder that is diluted with water to concentrations specific for the species being targeted, which include feral pigs, foxes and rabbits. For wild dog control, it is injected into fresh, dried or processed meat baits. The supply and use of 1080 is highly regulated in Australia. It is a restricted chemical product and can only be supplied to persons who are authorised to use it under state or territory laws.

As in other parts of the world, the demographic of rural NSW has been changing for many years, with a drift of people away from agriculture into cities. At the same time, there has been an increase in rural land being subdivided and sold for 'hobby farm' use and recreational purposes.

Fig. 2. A typical wild dog at Box Hill sheep farm, NSW (Photo: M&J Healey).

[2] The use of livestock guardian animals such as donkeys, dogs and alpacas is a much more recent trend as, unlike in Europe and elsewhere, there is no long-term historical connection with them in Australia. The extensive grazing situations that most livestock farms operate in the Central Tablelands of NSW, where livestock are left in paddocks for long periods of time with limited human contact, mean that many farmers have concluded that the work involved in sourcing, training and bonding guardian animals is not a good investment of their time.

Many of these newly created properties are not occupied full-time and they are often owned by people whose values and beliefs are vastly different to those of the remaining large-scale, full-time agricultural producers in the area. Differences of opinion on the role of wild dogs in the environment and the use of poison baits and trapping to control them has caused high levels of frustration within small communities that are impacted by wild dog attacks [6]. The focus of this article is to look at the effectiveness of adding electric fencing to existing fences on farms in the Central Tablelands region of NSW as a non-lethal option to reduce the number of attacks by wild dogs on sheep.

Study area and farm characteristics

The Central Tablelands region covers an area of approximately 31,365 km² in NSW (Fig. 1). It includes the major towns of Bathurst, Blayney, Cowra, Lithgow, Molong, Mudgee, Oberon and Orange. Agriculturally, the region is highly diverse, with evenly spread summer and winter rainfall supporting productive cropping systems. Sheep grazing is the most significant land use (Fig. 3), followed by irrigated farming, broad acre crops and horticultural enterprises including areas of fruit and vegetable growing and viticulture. The region produced 10% of NSW's wool and sheep meat production in 2019–2020 to the value of A$79 million and A$142 million, respectively [7].

The potential of electric fencing to reduce livestock losses to predators was investigated at two sheep farming operations that were heavily impacted by wild dog attacks over a period of several years. Rockleigh farm at Ilford, owned by Colin and Eva Mahy, covers 370 hectares and runs 1,300 Merino ewes (Fig. 4). Box Hill farm at Turondale, owned by Malcolm and Jodie Healey, covers 1,500 hectares and runs 3,000 Merino ewes (Fig. 2). The main source of income at both these farms is wool production, with meat lamb production as a secondary part of the business. The sheep are run on an extensive basis, living in the paddock year-round with lambing at Box Hill taking place in spring while Rockleigh has split lambing, with half the ewes lambing in autumn and the other half in spring. Pastures vary from native grasses to improved pastures such as forage cereals, ryegrass and legumes.

Internal subdivision fences and property boundary fences are usually constructed of steel posts, plain wire and netting with a total height of approximately 1.2 m. While this type of fence keeps sheep where they are meant to be, external pressure from wildlife, normal deterioration over time and weather events such as storms create weak points in the fence that a variety of animals, including wild dogs, use to gain entrance to sheep paddocks. Such fencing, in combination with lethal control measures (including trapping, poisoning, and shooting), was the only means of wild dog control carried out at Box Hill and Rockleigh prior to the retrofitting of electric fencing (see below).

Wild dog attacks increased dramatically on both properties in 2017–2018. At Rockleigh, 31 ewes were killed in 2018. Based on saleyard and individual farmer financial records at the time, the replacement cost for these sheep was A$300 per head totalling A$9,300. This does not include lost wool sales of approximately A$80 per head and lost lamb sales. Lamb marking percentages at Box Hill fell from 95% in 2016 to 32% in 2018.

Fig. 3. Typical Central Tablelands grazing land (Photo: Paul Gibb).

Fig. 4. Merino ewe lambs at Rockleigh farm (Photo: Paul Gibb).

Retrofit electric fence design

In early May 2019, as a result of increasing wild dog attacks in the region, Central Tablelands Local Land Services hosted a group of sheep producers on a tour of properties approximately six hours' drive away to inspect a variety of electric fencing styles being trialled for wild dog control. Based on discussions held with farmers in the trial area and having viewed the types of fencing in use, it was apparent that Gallagher Westonfence electric fencing was proving to be very effective at excluding wild dogs as well as foxes, feral pigs and deer. It consists of a sloping[3] fence attached to an existing fence line and constructed using 81-cm high-density polyethylene posts with five predrilled holes in each post. These are attached to fasten the post to the existing vertical fence. Typically, when a wild dog approaches a fence with the intention of getting to the other side, it will first try to push through the fence at or below snout level or, secondly, try to burrow under the fence. In the case of a Westonfence, it will typically make contact with either one of the two electric wires as it pushes its muzzle into the gaps between wires, resulting in an electric shock.

The effectiveness of this type of fence revolves around the use of high conductivity wire to carry the electricity and high voltage generated by either permanent mains power energisers or solar battery energisers with adequate stored joules of energy capacity (Fig. 7). Typical values for energiser output are 10,000 volts and 100 joules of stored energy. Also essential are proper site prepara-

Fig. 5. Close-up of fence detail at Rockleigh sheep farm (Photo: Paul Gibb).

Fig. 6. Retrofitted electric fencing at Rockleigh sheep farm (Photo: Paul Gibb).

approximately 60 cm above the bottom of the existing fence posts, with the lower end of the dropper sitting on top of the surrounding ground surface approximately 50 cm outside the base of the existing fence (Figs. 5 and 6). The poly droppers are placed approximately six metres apart along the length of the fence, creating a sloping electrified barrier to any approaching animals (Fig. 5).

Westonfences are set up with alternating 'hot' (electrified) and 'cold' (non-electrified) wires. Usually, the bottom wire is non-electrified to reduce instances of electrical shorts from surrounding material such as soil and grass and possible impacts on non-target native animals including reptiles. The wires in the second and fourth holes from the bottom are electrified, the wire in the middle hole is non-electrified and the top, fifth hole is used

Fig. 7. Solar powered energiser in a paddock at Box Hill sheep farm (Photo: Jodie Healey).

[3] There is also a vertical version if a completely new fence is to be constructed.

tion, careful construction – with special attention paid to the earthing system – and, most importantly, ongoing maintenance.

Installation, outcomes, perspective

Due to high levels of interest generated by the educational tour and increasing wild dog attacks on livestock, in late 2019 Central Tablelands Local Land Services established an exclusion fencing grant whereby landholders, through an expression of interest process, were eligible to receive A$1,800 per kilometre towards the cost of erecting an electric exclusion fence. This grant was fully subscribed with funding enabling 144 kilometres of electrified fencing to be constructed by a variety of sheep producers in the NSW Central Tablelands. Technical support was provided by Gallagher during construction and remains available to any landholder requiring it.

The owners of Rockleigh and Box Hill farms erected 10 km and 20 km, respectively, of the sloping-style Weston-fence depicted in this article, attached to a variety of pre-existing fences typical of the area. Fence construction was carried out by the farmers themselves in 2020, including the installation of the recommended energisers and earthing system. Due to the combination of current fence energiser technology and high conductivity fencing wire, only one energiser was required on each farm to power the full length of electric fencing.

In the three years since the fences have been in place there has not been a single wild dog attack on either property even though continuous wild dog presence has been recorded on land surrounding both farms via camera traps along the fence lines and dog tracks found pacing parallel to the electric fences. In contrast, wild dog attacks on sheep have continued on farms with no electric fencing adjacent to both Rockleigh and Box Hill, with reports of wild dog attacks on sheep made to Central Tablelands Local Land Services and associated wild dog control groups indicating that approximately 700 sheep have been killed in the time period since the fences were completed.

Discussions held with participants in this trial have indicated that, at current sheep and wool prices, the average payback period of money invested in electric fencing is approximately 3–4 years, with several farmers having put up additional fencing without any financial subsidy. Aside from financial savings achieved by reducing losses to predation, all participants in the grant scheme have indicated that the reduction in mental health impacts from dealing with wild dog attacks on their sheep was just as valuable to them. Moreover, the exclusion of wild dogs from participating farms has totally removed the need to lay poison baits and set traps on these properties while at the same time helping people remain as sheep producers in their respective local communities.

Nevertheless, the increased adoption of electric fencing for pest animal control has been hampered by the widely held belief that it requires complicated and ongoing maintenance to be effective, for which farmers do not have time. The counter-argument to this position is that all types of fencing require ongoing maintenance to be fit for purpose and that the technology associated with the new generation of fence energisers (i.e. fault indicator displays on energisers, fence status lights located in paddocks, 'back to base' fault alarm systems and text messages sent to the owner's mobile phone to notify of problems) reduce the amount of unnecessary fence inspections compared to non-electric fences.

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Interview

Working together to generate knowledge

Laurent Garde
interviewed by
Daniel Mettler

What led to your commitment to pastoralism?

I did my doctorate in ecology and masters in anthropology, so I have a mixed background in analysing interactions between humans and the ecological context. During my studies, I had the opportunity to spend four months in the Andes in Peru and Bolivia, a world I didn't know at all. I was introduced to local shepherds, who made a big impression on me. That was about 40 years ago, a time when pastoralism in Europe was characterised by an archaism that was disappearing at the end of the 1970s. This chance encounter with the pastoral world of the Andes marked my professional career. The following year, back in France, I had the chance to work on my doctorate with an old shepherd who gave me the key to the topic of pastoralism.

As a city dweller, how did you become involved in agriculture?

Until the 1980s the story was of the intensification of agriculture. We had to increase production with more machinery and complex technologies. In addition, extensive livestock farming came into conflict with forest management, so there were many prohibitions and constraints on grazing. We came out of this period with a new spirit

Laurent Garde, former Deputy Director of CERPAM (Photo: S. Munoz).

in which pastoral practises were revalued together with the new concept of regional parks. This dynamism opened a window of opportunity for traditional pastoralism to

follow new ways to meet society's changing expectations. Scientific institutes emerged at the same time. So, I had the chance to contribute to the study of pastoralism in parallel with all these convergences and new expectations. This new perspective has made it possible to rethink and revalue human activities with biodiversity and natural areas.

The institute where I work, CERPAM (see Box 1), was created at that time as a centre for pastoral studies in the south of France with a regional dimension, on the scale of transhumance movements of herds. It was born as a bridge between the worlds of shepherds and science. All the partners concerned make up the board of directors. I arrived as a researcher. We had no reference for a technical knowledge base for research, so we based our knowledge on pastoral practices and their effect on the environment. Pastoral services emerged following the national pastoral law of 1972, which was visionary and enabled a new territorial organisation of the pastoral world, the basis for a new structure in terms of new collaborations between breeders, territories and scientists.

How is knowledge transferred between scientists and livestock breeders?

There was a need to modify the classic knowledge transfer process between science and the field through the theme of pastoralism. Knowledge grows from the herder and the shepherd. This does not mean sacralising the work of the shepherd, but rather recognising the value of knowledge from daily life, the concrete case and how to do things as well as professional knowledge. Our research is not built on the classical method of experimentation but rather on the compilation of hundreds of cases which we formalise, characterise and synthesise in order to understand and describe underlying principles. The pastoral services and the research institutes carry out this work together: there is co-construction, not scientific elaboration transferring results to technical services. In this process, research is needed to complete and deepen scientific questions, just as research needs the field to formalise knowledge.

Isn't that a bit optimistic, given the variety of practices among breeders?

First of all, I don't make any value judgements about breeders. Through diversity of practices, a network of knowledge is formed among breeders. A system of values is established between herders such as bringing beautiful animals down from mountain pastures, the sustainable management of mountain pastures and the growth of lambs, etc. Herders exchange information and thus create a professional community and practical knowledge. This collective dynamism of the shepherds fascinated me. I would like to illustrate this point with the example of the arrival of livestock guardian dogs in pastoral systems. It upset classical values and forced the herding community to accept a new practice that went against their criteria of values that had formed over decades. So, an old game of flexibility met a game of rigidity through herd protection. This means that farmers who started to protect their herds went outside their community of shared values, both in their own eyes and in the eyes of their colleagues.

How, then, can a new practice such as using livestock guardian dogs emerge?

Trying to identify the know-how surrounding livestock guardian dogs is much more difficult because we are in the experimental phase, which is not the case in the field of pasture management. It is within the world of farmers that new knowledge will be identified. We bring out the knowledge from the field through experience, which is constantly confirmed in everyday life. That's how we enter into a process of building a new sample of knowledge that is the basis for the new practice to develop and become established.

What role has the wolf played in the transformation of the pastoral world?

The wolf has disrupted the pastoral evolution and extensification of livestock farming, which had been in full reinvention since the 1970s. It has upset a real dynamic that consisted in promoting extensive feeding and the development of pastoral management. So, the arrival of the wolf called into question this new appreciation of pastoral practices.

Does this mean that the wolf is a threat to existing good practice?

I don't like the expression 'good practice'. My conception of research and development is to identify practices and understand their meaning. So, it's not 'good practice' but a set of practices that constantly adapt to contexts. I think that the concept of 'good practice' has profoundly degraded the support given to farmers. I know the practices of herd protection, but they are neither 'good' nor 'bad'. It is this game that constantly adapts to the new reality of the return of the wolf, which implies the implementation of new techniques and a diversity of practices. With the concept of 'good practice' there is a risk of monopolising a certain practice that cannot work in a diversity of contexts.

Typical vegetation in the south of France (Photo: Laurent Garde).

How is this set of practices connected with the return of the wolf in France?

You can't deal with the practical and technical consequences without asking the fundamental question of the recolonisation of the territory by wolves. I cannot work on the protection of flocks without questioning the cause and consequences of the return of wolves. What is the overall impact of the wolf on livestock farming? Why and how is the wolf population increasing? Why are investments in damage prevention measures increasing as are losses of livestock during the last 30 years?

What does this mean for your work at CERPAM?

People, including scientists, often believe that we have a problem if we are looking for a solution. No. We are in a crisis that implies a transformation. For us, this means that we document the impact of the wolf on livestock farming as best we can and, at the same time, we accompany farmers to see what adaptations can be put in place in order to be able to manage the transformation that was triggered by the return of the wolf. This is why we start with the concept of 'co-adaptation'.

Can you explain the concept of 'co-adaptation'?

The idea of co-adaptation comes from research. It's a circulation between people with knowledge in the field, development organisations such as CERPAM and university research. So, there is a circular and lasting exchange without a hierarchy. Therefore, both poles, field actors and researchers, are always needed to acquire knowledge in order to co-create new knowledge. We propose abandoning the passive concept of coexistence with wolves in favour of a dynamic concept of co-adaptation. The wolf's intelligence enables it to continually adapt to damage prevention efforts. It is therefore necessary to play on the wolf's capacity to adapt in order to emit new signals that indicate danger if it approaches livestock. There can be no protection of herds against an intelligent predator

such as the wolf unless it perceives a threat. Herd protection should include defensive shooting, provided that wolves are left in peace elsewhere, so that they learn which contexts are dangerous for them.

What role do the state and politics play in this dynamic between researchers and breeders?

The state has played a major role as an arbiter between the new reality in the world of livestock breeding and wolf management. But the state is obliged to implement European policy and I have the impression that, at the moment, the state is trying to manage a situation that is getting out of control on several levels. We started with the idea that the protection of herds would work as a way out of the crisis. But experience has shown the adaptation of wolves to protection measures and limits in the use of livestock guardian dogs.

One man and his dogs: a shepherd with herding dogs (Photo: Laurent Garde).

What is the role of experts concerning prevention measures?

What works well is data collection. In France we have an effective centralised system for understanding situations and their dynamics. It is necessary to affirm that the protection of flocks and herds does not work without knowing the predatory behaviour of wolves. We still know too little. We cannot work on defence strategies if we know nothing about the attackers. That's why we need more interdisciplinary knowledge for a better understanding. But what is happening now, instead of a fruitful collaboration between experts, is a confusion of roles between different disciplines such as biologists and agronomists. I see a great deal of confusion in the knowledge-building process, especially concerning livestock guardian dogs.

Isn't a certain amount of disorder to be expected with the adoption of new practices?

Disagreements are necessary in order to progress, but places for discussion and confrontation are needed and, above all, the scientific process is ultimately about verification in the face of reality. So, we are always obliged to be oriented towards practice. In this process of expertise, there is a gap when we talk about wolf attacks. Biologists tell us that there are individual wolves that attack herds, while farmers tell us that they are obliged to increase the number of dogs in parallel with the number of wolves in packs! Too little is known about the social dynamism of wolf packs and packs of livestock guardian dogs, even though it is becoming clear that there are interactions between these two canids that share the same social signals. And we must not deny that wolves attack domestic prey as well as wild prey in packs!

Flock management in Esparron, Provence (Photo: Laurent Garde).

How can we get out of this situation?

One way would be to rebuild trust between all the actors involved. I am in favour of everyone bringing their particular expertise to the community that deals with the issue. Livestock and pastoralism to agronomists, natural resource management to ecologists and wolf issues to biologists. Interdisciplinarity is not about shared incompetence. First of all, each one cultivates his own garden and from there we share. Feedback from the field, full of in-

formation, must be identified and integrated into this. The creation of a platform for this pooling could be a solution.

If we take the example of the climate crisis, we can see that in the French Alps there were visionaries who anticipated it. Thanks to people from some national parks and pastoral services, a platform was created to encourage exchange and generation of knowledge. This place is called alpages sentinelles and it serves to help us face the crisis together. Initiatives for wolf management in the same style have not been very successful. A lack of neutrality around this issue is the big problem we have encountered.

Why is the conflict around wolves so difficult to manage?

That's a difficult question to answer. The wolf is too 'sacred', too idealised. If we don't leave the prefabricated discourse in the style of, "herd protection works – it's the breeders who don't implement it", there is no good perspective. We have reached the point where a prefabricated truth is more valuable than collecting data and documenting the reality of the world of livestock farmers. It shows that we have reached dogmatism. This is why the current situation is blocked.

The pastoral world is generally too marginal to have enough power in this public discourse. But recognising the values of products and heritage and the services provided to society by extensive livestock farming would be very important for farming families beyond national borders. Feedback from the field is always at the regional level but, in terms of communication, efforts should be made at the European level to better promote the profession and the role of pastoralism. If this is achieved through constant 'co-adaptation', there is a chance that investment in herd protection will bear fruit.

How far should investment in preventive measures go?

On a technical level, the question arises as to how far it makes sense. Fences must be 1.1 m, then 1.3 m, then 1.6 m; two dogs, then five dogs, then ten dogs are needed… If we observe the learning dynamic of wolves and their changing behaviour in the face of protection measures, we must react with other measures such as defensive shooting, which leads to intelligent regulation based solely on the criterion of countering the approaching behaviour of the herds. But for this, it is necessary to document these changes in behaviour in order to gain more knowledge and to be able to intervene at the right moment. The best protection measure, despite all the technical efforts and technological ideas, is still the use of livestock guardian dogs, provided that they are combined with defensive shooting as soon as they are introduced.

What is your wish for the future of the pastoral world?

Give the pastoral actors the capacity of all they have to offer to reach the recognition they deserve and get out of the colonial formulas and prefabricated speeches. I am convinced that the principle of co-adaptation serves in the short term to better protect herds and in the long term we must arrive at a trivialisation of the wolf that moves away from its sacredness towards a more pragmatic, less ideological and more consensual perspective in the sense that the wolf must be negotiated and not held as sacred.

Box 1. CERPAM

The Centre for the Study and Realisation of Alps-Mediterranean Pastoralism, Centre d'Études et de Réalisations Pastorales Alpes-Méditerranée (CERPAM), was created in 1982. It is a specialised service for the six departments of the Provence-Alpes-Côte d'Azur region. In order to improve the management of pastoral environments, CERPAM develops technical references and specific diagnoses and tests innovative pastoral equipment. CERPAM works with pastoral groups and local authorities. It is involved in the design of development projects, equipment and agri-environmental contracts and accompanies their implementation.

Winter grazing in Chaffaud (Photo: Laurent Garde).

Perspective

Recognising the power and limits of different forms of knowledge

John D.C. Linnell

Norwegian Institute for Nature Research and Inland Norway University of Applied Sciences

Contact: John.Linnell@nina.no

It has long been an adage that "knowledge is power" and therefore it is not surprising that there is often a conflict over knowledge, and whose knowledge should be given priority. Fortunately, we live in an era where many forms of science exist to provide robust empirical insights into natural and social processes, rather than forcing us to draw on superstition and mythology. However, there are often debates about the relative value of scientific knowledge versus more localised knowledge [1]. This essay aims to provide some perspectives on this debate and point to possible ways forward to better address this conflict.

There have been tremendous advances in the way that researchers study the complex relationships between large carnivores and humans. Three tools that have emerged during the last years of the 20th century and the first two decades of the 21st century have transformed the ability of researchers to study wildlife. Firstly, digital camera traps can be distributed in the field and left untended for months [2]. They patiently wait on standby and photograph any animal walking past. This allows us to see what would normally remain unseen, confirming the presence of shy, nocturnal and cryptic animals that would never show themselves to a human observer. Secondly, GPS collars allow us to remotely track the movement of individual animals for periods of months or years [3]. The collars collect location data day and night, in all weathers, in all seasons and in all terrain. The data allow us to study their reproduction and their deaths, their habitat choices, and their predatory behaviour, no matter how far they move. GPS-tracking is also used to study the movements and survival of free-ranging livestock. Thirdly, the incredible advances in genetic methods allow us to take a few hairs rubbed against a tree, or a scat dropped on a trail and confirm the species, the sex, and the individual identity of the animal that left these signs behind and even determine its diet [4].

These technological tools allow researchers to learn things that just three decades ago were almost unknowable. We can put numbers onto things that previously could not be quantified with certainty. Perhaps most importantly, these methods allow us to come to know large carnivores as individuals, attributing their movements, behaviours and fates to the identity of specific animals. This allows researchers to associate conflicts with both the overall size of the population of large carnivores and to the actions of individuals or groups, which is crucial information to design appropriate responses and interventions.

But the advances go beyond the realms of technology.

In fact, it would be possible to argue that the most important developments have simply brought us back to where we started: as humans that interact with each other. There has been a tremendous increase in the use of social science methods (such as psychology, sociology, anthropology, ethnography) to study the human perspective of our interactions with wildlife and with other groups in society that hold different views and have different objectives than our own [5]. By investing the time to listen to the diverse stakeholders that influence, or are influenced by, large carnivores, social scientists have been able to identify the diverse ways in which different groups of people experience the impacts associated with large carnivores (or in which they perceive positive values associated with their presence) that could possibly lead to conflicts with other interests or activities. These studies of people have been instrumental in shaping the way policies are developed and how we try to address conflicts [5]. For example, such studies have revealed that the concrete impacts associated with a wolf killing a sheep represent just the tip of the iceberg of the way conflicts are perceived by many rural residents [6]. Gaining insight into the full picture of conflicts requires understanding a far wider range of societal issues related to agricultural and rural policies, the history of specific areas, the power relations between different actors as well as the overall cultural setting.

Combining these modern research approaches from both the social and biological sciences can produce incredibly detailed, objective and accurate data allowing the empirical study of many aspects of the human–wildlife relationship. However, research projects are by definition limited in time and space whereas human–wildlife interactions are open-ended and conflicts relating to large carnivores are experienced across a large proportion of the European landscape in many different social, cultural and ecological circumstances.

Social science methods can also be used to collect insights into the behaviour and ecology of large carnivores. Rural people accumulate many observations of large carnivores (and other wildlife) and of their tracks and signs, as well as experiences of the consequences of their presence. Rural residents, especially those who spend significant time outdoors (e.g. hunters, foresters, livestock herders, outdoor recreationists, amateur naturalists) represent millions of eyes and ears that can potentially contribute with invaluable information about large carnivores on a scale that no researcher or research project could achieve [7]. Furthermore, in many areas that have had a continuous presence of large carnivores for centuries, a body of knowledge about how to adapt to their presence has accumulated over the generations. This local knowledge (also called lay-knowledge, or traditional ecological knowledge) can be collected through interviews and observations with rural people, as well as collected from indirect sources such as historical documents, books, films and social media.

However, there are some clear limitations to local knowledge and some potential pitfalls that must be avoided when using knowledge provided by the public or stakeholders in ecological studies. When conducting social science research, knowledge limitations are not important because the objective is to study the subjective perceptions of the people being interviewed or studied. But when using local knowledge in an ecological or agricultural context there is a need to distinguish between the subjective and the objective.

Firstly, not every member of the public is an experienced animal tracker or observer and many people may not be accurate when reporting observations of carnivores (that typically only appear as fleeting glimpses, often in dense forest) or of their tracks and signs. Such issues can be addressed through training and by requesting photo documentation, for example the Scandinavian Skandobs app for large carnivore monitoring (see below). However, it does require building an understanding that being sceptical and asking for verification is not an insult or a demonstration of distrust. This is simply how science works. Scientists are trained to be sceptical and to critically appraise the reliability of all information and its sources and to provide verifiable documentation where possible. In science, there should be no expert who cannot be questioned by colleagues or the public.

Secondly, it is important to realise that not all rural residents have direct experience with large carnivores (or livestock). Many modern rural lifestyles do not bring people into contact with shy, elusive species of wildlife. This is not to say that their opinions, perceptions and values are any more or less important than anyone else's, but it does limit the extent to which they can contribute objective knowledge or factual data to a research project or monitoring programme. Similarly, it is important to real-

An anaesthetised lynx equipped with a GPS collar in Finnmark, northern Norway, as part of a study investigating predation on semi-domestic reindeer (Photo: John Linnell).

ise that many parts of the world have not had a continuous exposure to large carnivores. This is especially pertinent in many parts of Europe that have recently experienced a dramatic return and expansion of the wolf. In these areas, the traditional knowledge, practices and adaptations of living with large carnivores may well have been lost through lack of continuity in the decades, or centuries, of predator absence.

Thirdly, there are some things that local people simply cannot know without all the technological tools available to professional scientists. For example, if a hunter finds two bear scats in his hunting area, there is no way that he can know if these come from the same bear or from two different bears. Likewise, if two shepherds living 10 km apart experience attacks on livestock by a lynx within a short period of time, they have no way to know if these were made by the same lynx or by two different individuals. An ecotourist can spend a whole day hiking in an area with wolves but not see any sign of them and mistakenly conclude that there are none there. However, using the modern tools of science, DNA analysis, GPS collars, or digital camera traps and statistical modelling, the professional scientist can actually establish if the scats came from one or two bears, or estimate the likelihood of the same lynx moving that distance between the sheep flocks, or determine how many wolves remained hidden from the hiker, maybe seeing him, but not being seen by him [8].

Finally, there is the issue of scale [9]. Most people working or recreating outdoors are limited to relatively small areas such as their hunting ground, their pasture, their farm or their hiking route. These areas are typically measured in hectares or a few square kilometres. While a person can acquire a good understanding of the local carnivore activity within such an area, there is a near universal challenge to communicate the scale at which large carnivores use the landscape. Virtually all individual wolves, lynx and bears that have been studied with modern scientific methods have been found to have home ranges or territories greater than 100 km², with many using areas measured in the thousands of square kilometres. Young animals in the dispersing stage of life can travel tens, hundreds or even thousands of kilometres, often crossing international borders, in very short periods of time [9]. This implies that local people only see a fraction of the area used by individual carnivores, so their experience of carnivore activity within their perceptional area does not embrace that of the carnivore. For example, five

neighbouring grazing areas may all experience the presence of a bear but it does not mean that they each have their own bear! In fact, the same bear is probably roaming through several different grazing areas.

The main message here is that all forms of knowledge gathering are subject to limitations and potential biases. The way forward is to openly recognise these and find ways to address them. It is also possible to find ways to combine different forms of knowledge generation that make the best of each. A good example here lies in the use of citizen science as an approach. Citizen science takes advantage of the fact that interested people are dispersed across the whole landscape and can potentially represent observers of issues on a scale impossible for any research team to operate on. By structuring the way that observations are collected, by introducing some validation procedures and subjecting observations to rigorous interpretation using the tools of modern ecological science, it is possible to collect incredibly rich data at very large scales efficiently and cost-effectively in order to better inform policy development and implementation. The massive growth in the use of mobile phones and associated apps has transformed citizen science in recent years, turning everybody into a potential observer. A second way forward lies through the co-generation of knowledge, where local people and key stakeholders are integrated into research projects, with local voices helping shape the way research is conducted and which questions are prioritised as well as taking part in field activities [7].

Norway provides an illustrative example of many of these issues. Although Norwegian large carnivore management is embroiled in constant controversy, there has been a massive investment in developing cutting-edge research and monitoring programmes which have always tried to build synergies between local- and research-based knowledge systems. For example, the monitoring of lynx depends almost entirely on the public reporting observations of tracks of lynx or other observations such as images from their private camera traps. These observations are submitted via an app (Skandobs[1]) and key observations that represent signs of reproduction are validated and form the basis of annual population estimates. In areas with poor coverage, camera traps are distributed to local experts, often hunters, who deploy them according to a standardised protocol which builds on their local knowledge of sites most likely to be used by lynx. When conducting field research that requires capturing animals to equip them with GPS collars, scientists and wildlife technicians are totally dependent on local experts to help them place traps in the right areas and then to follow the lynx once they have been collared, checking clusters to see what they prey on.

Partnerships with local people have been at the heart of how scientists study lynx for almost three decades and have allowed them to conduct large-scale research and monitoring projects which have transformed the species from a near mythological unknown to one of the best studied large mammals in Europe. This has not removed all conflicts, but it has provided a near common knowledge platform concerning the species and its relationship with people on which actions can be discussed. In effect, it has transformed the debate from conflicts over contested knowledge to conflicts over values (about how this knowledge should be used, or the goals that different people want to reach concerning large carnivores). This represents the core of the conflicts around these species and the ongoing process to identify how the future of coexistence should look.

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Short communication

Wildlife permeability of wolf-deterrent permanent electric fences

Peter Schütte, Timo Nolte, Annette Siegert

NABU Niedersachsen – Herdenschutz Niedersachsen, Winsen/Aller, Germany

Contact: kontakt@herdenschutz-niedersachsen.de

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

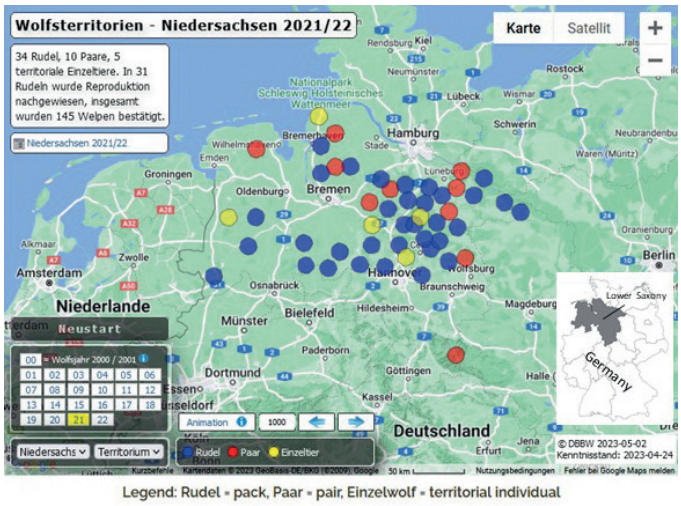

Fig. 3. Occupied wolf territories in Lower Saxony in 2021/22. Circles correspond to the approximate size (diameter 16 km, area 200 km²) of a typical wolf territory (Source: DBBW 2023).

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

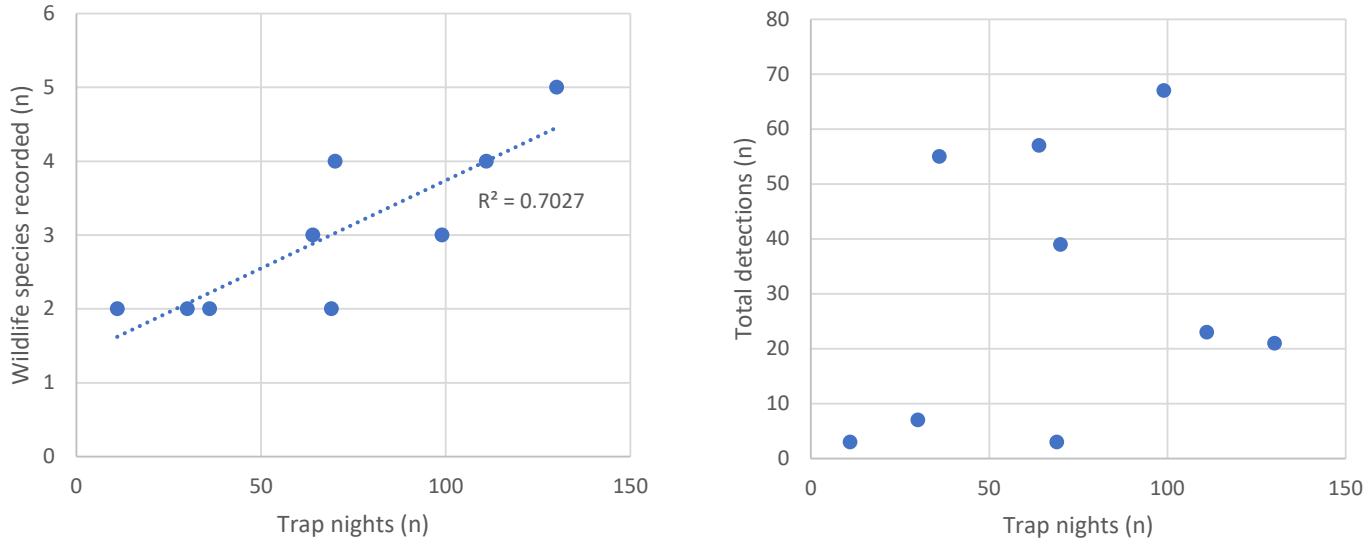

Fig. 7. Relationships between length of observation period and number of wildlife species (left) versus total detections (right) recorded by cameras in nine pastures with wolf-deterrent fences.

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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Pop-up feature

Dialogue platforms on large carnivores

Katrina Marsden[a*], Estelle Bailan[b], Manon Chevalier[c], Rachel Redon[d]

[a] EU Large Carnivore Platform Secretariat, adelphi consult, Berlin, Germany
[b] FEAL facilitation, Valence, France
[c] Vercors Regional Natural Park, Lans-en-Vercors, France
[d] Ceinture Noire, France
* Contact: lcplatform@adelphi.de

The EU Platform on Coexistence between People and Large Carnivores[1] has been gathering information and discussing good practices since 2014. Based on these experiences, an EU-parliament funded pilot project helped establish regional and local stakeholders' platforms[2] in six EU Member States (Italy, Spain, Romania, Germany, France and Sweden).

Within the regional platforms, groups of local stakeholders met to discuss issues linked to the presence of large carnivores and agreed a range of concrete actions, financed by the project. Platform participants defined the topics to be addressed, which included conflicts caused by bears entering villages, wolves depredating livestock and possible protection measures, especially the use of guarding dogs. Livestock breeders were important participants in all the platforms. Interestingly, the actions selected for funding rarely focused directly on large carnivores but often on increasing the economic worth of agricultural products or respect for the work of livestock breeders.

The facilitators and organisers of the platforms have summarised their experience and lessons learned in a toolkit[3] published in January by the EU Platform. There is also an accompanying toolbox[4] with informative examples of platform types as well as templates for stakehold-

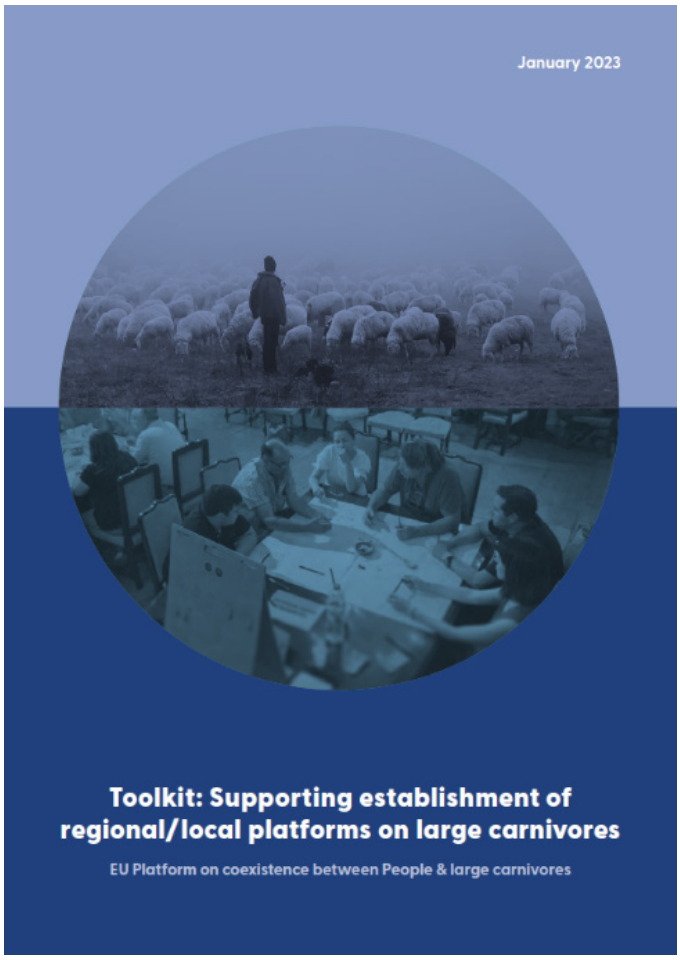
[1] https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive/large-carnivores/eu-large-carnivore-platform_en
[2] https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive/large-carnivores/eu-large-carnivore-platform/eu-regional-large-carnivore-platforms_en#regional-to-local-platforms
[3] https://environment.ec.europa.eu/topics/nature-and-biodiversity/habitats-directive/large-carnivores/eu-large-carnivore-platform/eu-regional-large-carnivore-platforms_en#toolkit
[4] https://circabc.europa.eu/ui/group/0017d03c-7542-40c5-b7a0-2a43b52dc998/library/62474453-8c6f-4a18-a2b2-09b300daba28/details

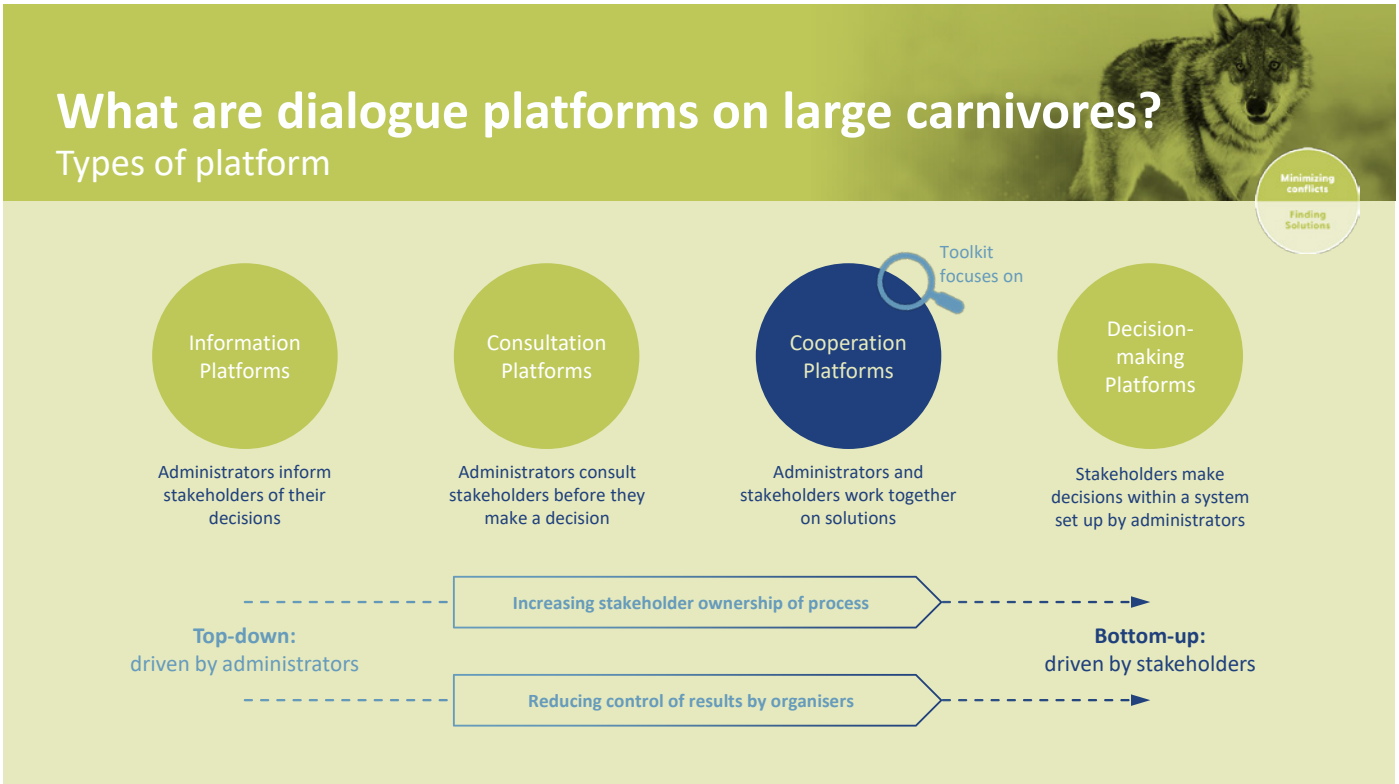
er questionnaires, evaluation and analysis, a budget planner and sample agenda. While addressing the topic of large carnivores, the tools and methods can apply to any other type of multi-stakeholder platform where conflict between interest groups may be an issue. The following example illustrates the progress achieved by the regional large carnivore platform in France.

Creating a common narrative

The wolf returned to Vercors in the French Alps decades ago and many breeders have adapted their practices and implemented protection measures. Conflicts are therefore less about the presence of the wolf itself and more about the reaction of other interest groups such as walkers, trail-runners, cyclists and local people to, especially, the use of livestock guarding dogs (LGDs).

Building on years of effort by Vercors Regional Natural Park authority, a diverse group of stakeholders came together to discuss the park's wolf action plan. The group comprised livestock breeders, shepherds, pastoral associations, nature associations, local elected officials, administrators, sports and tourism representatives. With the help of a trained facilitator, group members worked to-





gether to produce the text of a 'common narrative' on how to share the land, respecting those who work there. A promotional video[5] and leaflets were produced and outreach to the press conducted in order to publicise the narrative while reducing polarised reporting related to wolves. The full text of the narrative is available on the Park website[6] and some sections are quoted below.

Sharing the land

"Vercors has a wide variety of natural environments, plant and animal species and areas developed by man. Many professional and recreational activities are concentrated there: agriculture, forestry, pastoralism, fishing, hunting, outdoor activities practiced independently or with guides, attendants and monitors. This abundance represents one of the major factors of the territory's attractiveness. However, a very particular animal has reappeared within this ecosystem and shaken up the uses of the territory..."

The wolf's return and its consequences

Because the wolf preys on livestock as well as game animals, it has been persecuted by humans since the Middle Ages and a law of 3rd August 1882 formalised its extermination. Packs were hunted down, trapped and poisoned across France, bringing about its total disappearance by the 1930s. The wolf began to return naturally from Italy in the early 1990s. It is now subject to strict protection under the 1979 Bern Convention and the 1992 EU Habitats Directive. According to the French Office for Biodiversity (OFB), the population is still growing in both range and numbers.

Wolves are once again present throughout Vercors Regional National Park and frequently seen. They have regained their place as an integral part of the natural environment. The return of the wolf also has problematic effects, such as attacks on livestock to the detriment of breeders. The presence of packs causes significant damage to this economic activity. Learning to coexist therefore represents a real challenge for the whole of society.

Livestock guarding dogs

Vercors has been a land of pastoralism for more than 1,000 years. This cultural practice forms the basis of the massif's identity and landscapes. Sheep, cattle, goat and horse farms are a major element of the area from economic, social and environmental points of view. After the wolf was eradicated, sheep were left to graze with less intervention by breeders, but since the wolf's return herd management conditions have had to change. The permanent presence of packs and predation makes pastoral activity more complicated and demanding. Protective measures have become necessary again, including the use of LGDs such as patous as this is the most effective tool for preventing attacks.

The name patou (from Old French *pastre* meaning shepherd) refers to a specific breed of dog, the Pyrenean Mountain dog, but this is not the only LGD. Other breeds are also used and are effective at protecting herds: Anatolian shepherd, Maremma, Cão de Gado Transmontano and others. State policy encourages breeders to use them, but raising and caring for them adds to farm workloads. Selected over centuries, these dogs were chosen for their innate ability to attach themselves to a herd and protect it from external threats. They are unlike other dogs, their instinct leads them to protect their flock independently and, for them, any 'stranger' near their 'family' is a source of potential danger. Typically, they begin to voice their disapproval by barking, then they will approach to identify the intruder. Residents, walkers, trail-runners, hikers, mountain bikers, hunters and others who come across them in pastoral areas or near homes must adapt to their behaviour.

[5] https://youtu.be/Eo_1jvMpFTQ
[6] https://parc-du-vercors.fr/loup_territoire

Shepherding in the Vercors region of the French Alps (Photo: PNRV/Brice Palhec).

Sheep flock protected by dogs, fencing and shepherds (Photo: PNRV/Nicolas Antoine).

Respecting shepherds and breeders

Shepherds and breeders face predation throughout the year, day and night. In addition to managing their herd and pastures, they must also observe their LGDs continuously, instilling respect and anticipating their behaviour by knowing their character, maintaining a relationship of trust and adapting the positioning of the herd to best take other land users into account. These new tasks are all the more challenging and difficult to carry out when LGDs are surprised by unexpected leisure practices, exacerbated by the presence of pet dogs.

We expect a lot from LGDs: effective protection from wolves, autonomy, vigilance, calmness within the herd, bonding to livestock, reactivity, balance, liveliness, power, flexibility and sociability towards humans. A remarkable and complicated range of skills for an animal to hold.

Let us not forget that all these concerns are in addition to the shepherd's main activity, which is above all taking care of the flock and grazing. The shepherd's equation therefore becomes difficult to solve: facing wolves while adapting to increasing outdoor activities of tourists and local people, many of whom are unprepared to encounter LGDs.

Learning to share natural spaces

In Vercors, we do not necessarily think about it when we hike with family or friends, but in reality we are almost always also with public or private owners. A lot of hiking trails cross private property and it is thanks to the owners' permission that we take advantage of the beauty of the landscapes in a privileged and protected environment. Vercors is a place that many of us are only passing through. In a context where these natural spaces have never experienced such frequent visitation, hiking and living responsibly means limiting their impacts on the environment as much as possible.

Pastoralism is one of the heritage economic activities that is important to preserve. Everyone must fully understand and respect the uses of these spaces, where leisure activities are combined with economic activities. Thus, going around the herds so as not to disturb them, respecting the shepherd's hut, making sure to close gates and not making fires or leaving litter are fundamental skills to acquire and pass on to younger generations to benefit more sustainably from this exceptional nature. Enjoying the Vercors massif therefore means carrying values within ourselves: respect, politeness, benevolence, interest and attention to local farmers and breeders.

Perspective

Living with wolves: from psychology to management

Julia Bouwer[1*], Johanna Fritz

FVA-Wildlife Institute, Freiburg, Germany.

* Contact: Julia.bo@posteo.de

Introduction

In recent decades the wolf *(Canis lupus)* has been recolonising much of its former range in Europe [1]. In Germany and many other countries, it is strictly protected under national and international law with the goal of achieving species recovery and co-existence with human communities. Problems arise as people and wolves share landscapes [2]. Livestock protection measures are important tools to address such issues [3], but it is only with broad acceptance of these and other management interventions that long-term co-existence is likely to be achieved. To this end, knowledge of the human psyche, as well as of social dynamics, is necessary because humans are integral to the implementation of all these measures.

Here, we elaborate on a summary of the pertinent psychological background which we first prepared for the Forest Research Institute (FVA) in Baden-Württemberg, southern Germany, where wolves have recently settled [4]. The FVA's Lynx & Wolf unit[2] is responsible for monitoring wolves and advising livestock owners on herd protection. The unit places a strong focus on solution-oriented communication as well as transfer of knowledge.

Human dimensions of wildlife

The natural behaviour of wolves is part of the challenge of their co-existence with humans in modern cultural landscapes. When addressing social conflicts between people, however, direct encounters with the animal itself are not the central issue. Much more important is the contact between the people talking about it. The question of how to deal with wolves, and with nature in general, gives rise to differences of opinion between diverse human actors. It is more appropriate to view related disputes as 'human–human conflicts', or 'conservation conflicts', rather than 'human–wildlife conflicts' *per se* [5–7]. To find solutions, it is therefore essential to bring social sciences to the conversation as well as biology and technology.

The field of study that examines social aspects in relation to nature is called 'human dimensions of wildlife' [8]. Management interventions have a greater chance of achieving success if they are guided by an up-to-date understanding of research findings in this field. In the following sections, we begin by describing relevant individual human thought processes and then outline the

[1] Since writing this article Julia Bouwer has left the FVA.
[2] https://www.fva-bw.de/en/top-meta-navigation/departments/fva-wildlife-institute/lynx-and-wolf

development of human attitudes toward wolves as well as what factors influence attitudes and behaviour. Social dynamics resulting from differing attitudes are also addressed. Finally, we provide a comprehensive set of practical recommendations for the development and implementation of management measures.

We are all individuals (in groups)

We must first consider the prerequisite for human action, perception, which is crucial for any further interaction with the environment. Our brains learn early on in life to filter out a multitude of irrelevant stimuli and focus on what we require to understand the situation at hand [9]. The selection of which information our attention is directed to is influenced by current needs (e.g. hunger, fear) but also by our personal, deeply-rooted value orientations, experiences, attitudes and culture [10]. Therefore, we may not be consciously aware of information that does not correspond to our own current needs and experiences. Because we all have different upbringings, each person's world of experience is also different. The question of why someone perceives the wolf as a threat, for example, can only be answered more precisely by looking at the complex background.

Values are the foundation of our understanding of the world. With their help, we can quickly classify things and situations on a moral level: good or bad, precious or worthless, right or wrong, etc. Values are formed early in childhood and are very stable [11,12]. Human value orientations (patterns of basic beliefs) are an important factor influencing attitudes toward large carnivores [13]. In a wildlife context, mainly traditionalist and mutualist value orientations can be distinguished. 'Traditionalists' believe that wildlife should be controlled and utilised for the benefit of humans. 'Mutualists', on the other hand, recognise the needs and rights of wildlife and see humans as protectors of other creatures on an equal basis [14]. This distinction represents a continuum, with many people exhibiting some combination of traditionalism and mutualism. For example, an 'ambivalent wolf opponent' has positive associations towards the wolf that turn into rejection when the wolf is actually present (see below). According to the cognitive hierarchy model (Fig. 1), values, value orientations and attitudes build on each other hierarchically [15]. This can explain the factors on which approval or disapproval of management measures is based.

In psychology, people's attitudes are captured by measuring their reactions to certain objects, which can include wild animals. Attitudes can be expressed both in thoughts (e.g. "Where the wolf hunts, the forest grows") and emotions (such as awe when encountering a wolf or fear of wolves) as well as through certain behaviours (protecting livestock, poaching, protesting, etc.) [16]. A distinction is also made between explicit attitudes, which humans can formulate consciously, and implicit attitudes, which occur as an automatic response to an object. Implicit attitudes are often not consciously perceived but are just as important as explicit attitudes in predicting behaviour [17]. For example, when people are asked directly if they have a particular prejudice, they often answer in the negative even though tests of unconscious (implicit) attitudes determine that they do. A prejudice toward a person or group is an attitude that is generated without thorough examination or consideration of facts and thus often has little basis in reality. As these cognitive processes reduce other people to one specific feature, irritations and con-

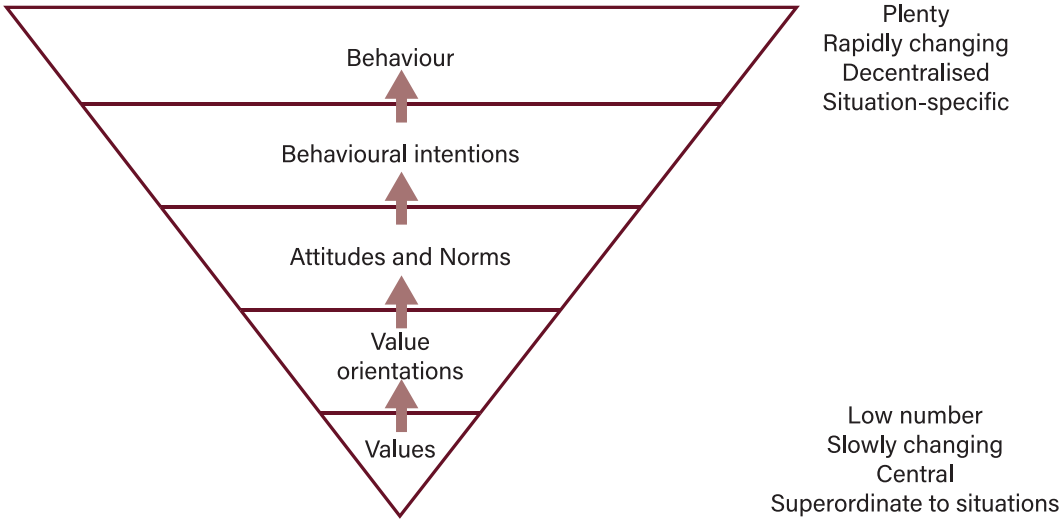


Fig. 1. The cognitive hierarchy model of human behaviour (Source: Vaske & Donnelly [15]).

flicts can arise which have a major impact on group dynamics.

The existence of different life histories, value orientations and attitudes enrich human societies, but also lead to the formation of groups with diverse interests or beliefs. We humans are 'social animals' who look for people similar to us in order to find mutual support and security as a community that gives us a social identity. We strive for our own group to be seen in a positive light and adhere to group norms so that we can remain part of it. Thus, group rules play a large role in an individual's behaviour [18]. Especially when little other information is available about a situation, we strongly rely on the behaviour of other members of our group [19]. Processes of social identification can be found in the field of wildlife management: when people with different attitudes towards an object like a large carnivore come together, a complex dynamic can emerge, especially when this object combines contradictory symbolism [20]. These processes will be discussed in the following section.

Attitudes to wolves and wolf recovery

Building on the general concept of how attitudes are formed, we will now consider how this applies to wolves. Rather than trying to convey a positive image of the wolf as widely as possible, our aim is to examine objectively all factors that are important for a comprehensive understanding of people's varied attitudes.

Symbolism

It is well known that the wolf is surrounded with strong symbolism that has arisen both through its biological characteristics and human socio-cultural development. Different roles and traits are assigned to the wolf through its presence in fairy tales, legends, religion, literature, movies, songs, art and media [21,22]. On the one hand, it is regarded as a divine, wise and mystical being, a mother and provider whose presence is a sign of a healthy forest [23]. The similarity of wolves to humans in terms of their social organisation and hunting behaviour favours identification with them and probably contributed to dog domestication [24]. On the other hand, the wolf is viewed as an ill-omened twilight figure, a symbol of uncontrolled wilderness, danger, aggression and hunger for dominance. This image formed especially in the Middle Ages, when the wolf was used as a bogeyman for difficult times of epidemic and famine [25]. Thus, the wolf combines multifaceted symbolism, positive as well as negative, which various groups still use for their purposes today.

Based on interviews in Switzerland, where the wolf reappeared in the 1990s, Caluori & Hunziker [26] developed a typology in which they classified people according to their subjective interpretations of wolves. They identified three different ideal types, each of which gives the wolf a certain meaning. For the 'modern wolf opponent', the wolf is a symbol of wilderness in a negative sense, loss of control over morality and loss of economic and political security. The 'postmodern wolf advocate' sees the wolf as a symbol of positively valued wilderness, power, strength and resistance to environmental destruction. The 'ambivalent wolf advocate' stylises the wolf as a positively valued but also contradictory symbol, combining both socially conforming social behaviour as a pack animal and the aggressive assertiveness of the individual 'lone wolf'. This positive attitude seems to be unstable, turning into rejection when the wolf is actually present. The authors concluded that the majority of Swiss people could be assigned to this latter type, explaining why opinion polls find high levels of support for wolves but there is nevertheless resistance to their presence. When the wolf is present, the inner conflict of ambivalent wolf advocates becomes more apparent and they tend to orientate themselves more towards traditional values. This trend has also been observed in Germany, where surveys have consistently shown that while attitudes towards wolves are generally positive, the closer wolf recolonisation is to people's place of residence, the more negative their attitudes are [27,28].

Numerous other factors play roles in the formation of attitudes towards the wolf. Some are strongly correlated with each other and they can be grouped in different ways. Here, we distinguish personal characteristics from those related to information and knowledge.

Personal characteristics

Each person has their own particular associations with the wolf. As outlined above, these are formed from their cultural background and life experience. For example, negatively valued symbolism in the story of Little Red Riding Hood contributes to the wolf being perceived as a threat. Sociodemographic factors such as age, gender and education level also influence attitudes: older people and

those with lower levels of education typically view the wolf more critically. Women tend to have more negative attitudes than men, presumably because they are more afraid of wolves [28,29].

Place of residence is another influencing factor: the return of the wolf is more welcomed by people living in urban areas, whereas rural populations are more critical [28]. Residents are more likely to have negative attitudes when wolves are resettling an area that has no recent experience in dealing with them and individual negative events dominate discussions [27]. Awareness of direct impacts, such as predation on livestock, in a person's social surroundings or negative conversations increase personal concern and thus the wolf is perceived as more of a threat [27,28]. However, the longer a person is exposed to the presence of wolves, the more neutral their attitude [27]. Moreover, a recent survey in Germany found that personal, benign encounters with wolves were mostly perceived positively and people expressed a high tolerance of living in close vicinity to wolves [30].

Personal value orientation towards wildlife has a major influence. People with a mutualistic value orientation are more likely to accept wolf conservation efforts as they perceive them as less of a threat to their own control [31]. A more traditionalist orientation favours approval of stricter management measures such as lethal control [13]. Disputes about wolves are thus often representative of conflicts between different values [26].

Emotions influence attitudes as well as the acceptance of management measures to a significant degree [32]. For example, fear is hidden behind many derogatory reactions towards the wolf. A negative emotion such as fear can lead to people being less able to openly search for solutions and instead become fixated on problems [33]. Conversely, when positive emotions such as joy, interest and gratitude are generated, the focus can be directed toward finding creative solutions.

Information and knowledge

In general, it can be stated that higher, fact-based knowledge leads to more positive attitudes. The source from which knowledge is acquired is also important: people are more accepting of information if they trust the source [27]. Science-based information presented in books, films and local wolf information offices contributes to a more positive evaluation of the wolf. In contrast, mainstream information from media such as the press, television, internet and social media may have the opposite effect as they tend to feed fears in order to extent their reach [34].

The choice of words and topics in local media also contributes substantially: coverage that focuses on negative effects of wolf presence decreases acceptance. In this context, selective perception affects information transfer: people who are already critical are more likely to pay attention to critical articles [35]. Digital algorithms reinforce this effect by selectively displaying content with topics that were previously accessed. Furthermore, it has been demonstrated in many psychological, social and political studies that negative framing (the linguistic framework in which a message is embedded) has a greater impact on personal attitudes than positive information [36,37].

From attitude to behaviour

So far, we have looked at factors influencing attitudes, but attitudes only have impacts when put into action. A review of articles published in the journal Human Dimensions of Wildlife found that 62% of studies examined attitudes, values and norms whereas only 18% analysed behavioural factors such as concrete actions [38]. Some research suggests that specific attitudes and social norms influence behaviour more than basic value orientations [39,40]. However, long-term behaviour change can only occur if the associated constructs, such as value orientations or perceived personal concern, are also addressed (see Fig. 1).

Which specific factors contribute to an individual performing behaviour that serves the co-existence of wolves and humans has not yet been conclusively investigated. However, many models exist that deal with the prediction of behaviour in general. According to the well-known theory of planned behaviour, the factors that influence behaviour are subjective norm, attitude toward the behaviour and perceived behavioural control [41,42]. Thus, whether someone performs a certain behaviour is primarily related to what norms prevail in their social environment, what attitude (positive/negative/neutral) they have toward the behaviour and whether the person sees themselves as being able to successfully perform their own behaviour. A more recent study identified psychological drivers of compliance with measures to promote risk-reducing behaviours and thereby mitigate human–bear

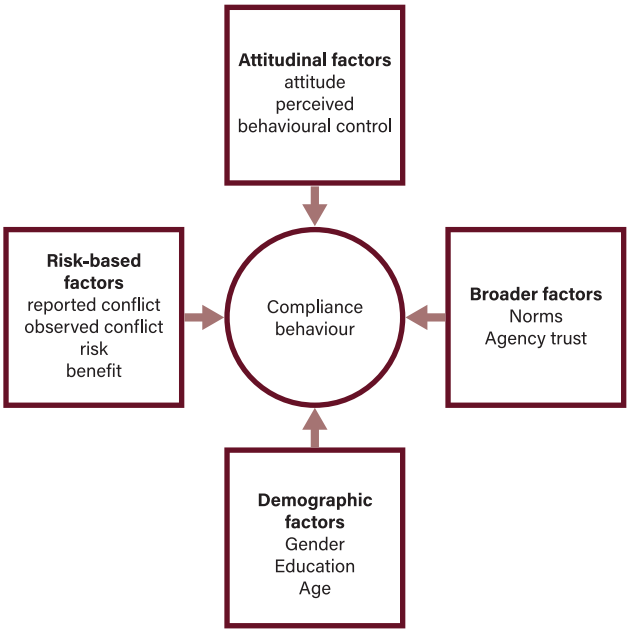


Fig. 2. Factors identified as influencing compliance behaviour (Source: Lischka et al. [43]).

conflict in North America [43]. Some of the drivers are the same as those that influence attitudes, but broader factors such as norms and agency trust are also included (Fig. 2). This model has the potential to be applicable in other wildlife-related contexts.

When people talk about wolves

As we have seen, wolves trigger very diverse associations, feelings and thoughts, so it is not surprising that debates about them are often highly emotional. Facts and myths become blurred, triggering fears and uncertainties [36]. Within these debates, processes can be observed that are typical of many challenges in wildlife conservation today. In addition to problems related to wolves and humans seeking to utilise the same resources (e.g. the threat of damage to livestock), social conflicts arise between groups of people holding different views.

These so-called conservation conflicts, mentioned earlier, are characterised by considerable complexity and dynamics. People feel that their own values are threatened by the attitudes of other groups. To deviate from one's own position is associated with a loss of identity and control, so people become rigid about their own opinions [44]. Due to a lack of willingness to engage in dialogue, disagreements intensify, trust in other groups declines and hardened fronts form that can eventually lead to open confrontation. The wolf itself takes a back seat as interactions between opposing groups become increasingly characterised by anger, at the expense of the relationship with each other [5]. Whereas factual disagreements were the initial cause of conflict, with escalation the focus increasingly shifts to conflict over conflict resolution, to the detriment of a factual resolution process [45]. This dynamic can lead to the conflict becoming more and more complex, extending to other aspects and becoming increasingly distant from the actual trigger (Fig. 3).

For example, rural communities face numerous complex challenges that exist independently of the wolf. The return of the wolf gives citizens in such areas reason to unite in opposition to a wide range of perceived threats to more traditional ways of life [46]. For pro-wolf groups, however, wolf recovery represents restoration of intact nature and a necessary rethinking of a society that has over-exploited wildlife for centuries [26]. This divide, characterised by the use of different symbolism and discussion of deeper values, can be found at regional, transregional, political and economic levels. These complex issues undermine the ability of the various stakeholders to find common ground and build consensus. Trying to solve the problem with technical fixes such as paying compensation for damaged livestock does not do justice to the complex social dynamics and is therefore unlikely to lead to satisfactory co-existence [46].

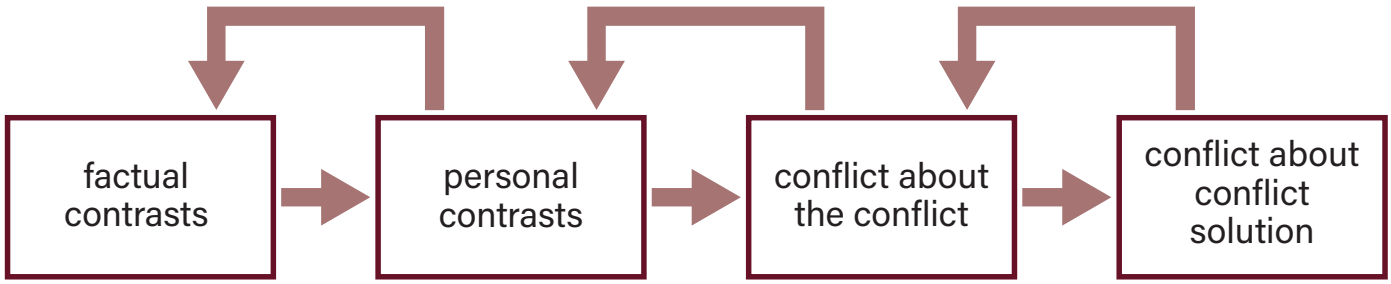


Fig. 3. The escalation of conflict (Source: Glasl [45]).

Mutual trust between partners is one of the most fundamental foundations for dialogue and a key element in addressing conservation conflicts [47]. A trusting relationship is characterised by its positive conditional nature: those involved are mutually dependent on each other and this is generally seen as positive. Trust can arise primarily where people have a similar understanding of a situation. If common understanding is missing, the ability to agree on goals and solve problems is also lacking; consequently, trust is difficult to establish [48]. Cooperative management (co-management), i.e. participatory development of solutions and joint decision-making, can make an important contribution here, especially when there are already controversies about large carnivores in society [49].

Recommendations for management

The following section is a list of recommendations for developing and implementing measures to facilitate co-existence. It is derived from the principles described above as well as other psychological theories and models. The recommendations are categorised into three dimensions (Fig. 4). The first focuses on the individual, who should be supported in his or her reflectivity and competencies. The second dimension is in the social sphere, aiming to build a good basis for trust and cooperation. The third set of recommendations addresses the psychological conditions for successful transfer of knowledge. Livestock protection tools, while essential for co-existence, are not considered here due to their technical nature.

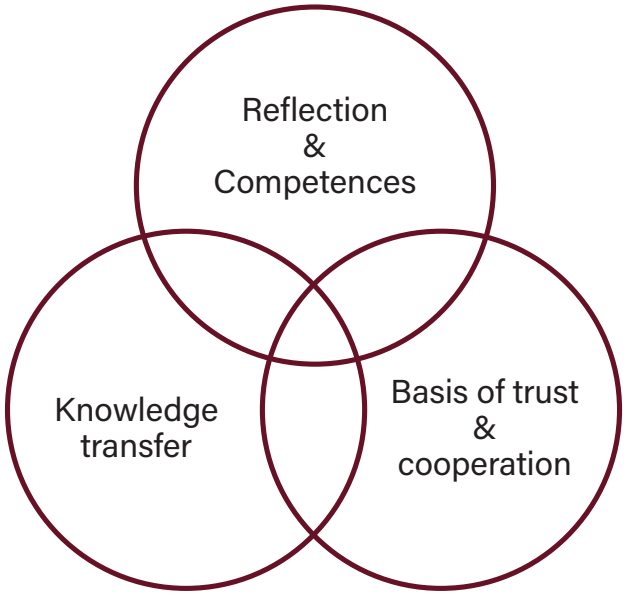


Fig. 4. Categorisation of recommendations for developing management measures.

1(a) Stimulate reflection skills

- Nurture awareness of one's own attitudes and value orientations.
- Teach about the emergence of prejudices, group and conflict dynamics and build understanding of and openness to other perspectives.
- Identify what the respective causes of conflict are, who the actors are, at which stage of escalation they are and what the context is.
- Encourage the recognition of deliberate use of symbolism. Recognise underlying patterns of interpretation in the symbolism of the wolf among individuals, become aware of different symbolism.
- Teach how to separate opinions from facts.
- Promote reflection and regulation of emotions in those involved [50].
- Teach about biases in risk perception since, for example, the likelihood of wolf attacks is often significantly overestimated [51].
- Raise awareness of the situation and needs of the groups involved: the general public should be informed about the material as well as the psychological burden on some groups such as livestock owners. Tell real stories and promote contact.

1(b) Promote competence and control

- Improve media skills: recognising misinformation in social media (e.g. fact checking), stimulate critical analysis of sources and content [52].
- Increase the perceived controllability of the situation: equip target groups with adequate knowledge to create a factual basis for discussion and consideration of realistic options for action.
- Promote communication and conflict resolution skills, especially through understanding: actively listen and summarise what is said. Provide training about communication theories and skills for people involved.

2(a) Create a basis for trust and dialogue

- Create a common understanding among all stakehold-

ers about responsibilities, contents and tasks and about the symbolism of the wolf; develop common goals and ensure long-term commitment.
- Identify similarities in values and interests (e.g. preservation of the cultural landscape, love of nature) and highlight them repeatedly.
- Recognise different attitudes and values, include expertise from local actors, communicate in an appreciative way.
- Acknowledge the emotions of all participants: recognise and verbalise fears and take them seriously as they have a strong influence on problem-solving skills. Respond to emotions with empathy and factual information.
- Maintain neutrality and objectivity:
  - » Decision-makers and those responsible for monitoring or consultation on livestock protection must not allow themselves to be influenced by certain interest groups. Actively live and continuously communicate this.
  - » Legal proceedings against poaching should be done by neutral and independent third parties, not wildlife management staff.
  - » Provide objective, neutral information to inform fact-based discussions with a long-term view.
- Establish and maintain transparency:
  - » Explain decision-making processes in wildlife management.
  - » Make scientific data (e.g. from monitoring) comprehensible and as widely accessible as possible.
  - » Ensure that knowledge is kept up-to-date by publishing new information (e.g. changes in wolf occurrence) rapidly and regularly.
- Remain flexible in the choice of options and the degree of participation (co-management); constantly evaluate and re-evaluate the effectiveness of any measures taken and adapt them if necessary.

2(b) Strengthen cooperation among stakeholders

- Promote co-management/participation: involve all interest groups in decision-making processes. Clearly communicate any limits to participation (e.g. legal frameworks).
- Seek cooperation among the different interest groups: meet individuals from other groups to reduce prejudices. Encourage personal contacts and discussions in a respectful atmosphere.
- Provide exchange platforms:
  - » Establish modern and regular exchange opportunities that can take place in the absence of the media, locally and digitally.
  - » Build on existing municipal and local networks.
- Develop a regional scale. Take regional characteristics into account. Get recognised persons of influence on board, provide multifaceted training and maintain close, personal exchanges. Ensure neutral, professional moderation at local information events.
- Find compromises without questioning the values, identity and action space of the groups.
- Know and use the influence of social norms: establish positive/appreciative solution-oriented group norms together with influential group members and spread these through the group.
- Strengthen cooperation with the media. Maintain personal contacts with media professionals. Use reliable, established contacts. Provide neutral, high-quality, transparent and up-to-date facts. Promote proactive work with the media, communicating the relevance of positive stories and providing examples of best practice. Where appropriate, provide word choice recommendations on technical wildlife topics to help press representatives.

3 Consider psychological conditions of knowledge transfer

- Undertake large-scale knowledge transfer and communication activities as early as possible, preferably before wolves become established in the area.
- Identify the existing knowledge, characteristics and needs of the target groups; process knowledge to fit the respective requirements.
- Ensure that the knowledge to be transferred is at an appropriate level of difficulty that neither over- nor under-challenges the respective target group.
- Promote optimal information processing:
  - » Use matching image and text information, graphics and visualisations [53].
  - » Present knowledge on different channels (visual/auditory = images/videos) and make it visually ap-

pealing. Integrate visual attributes that convey trustworthy action and transparency and create excitement or draw attention.
  - » Present information in a consistent and recognisable format, preferably limiting content to a few essential points.
  - » Include active and interactive elements to stimulate prior knowledge and information processing. In this way, new knowledge can be linked to and integrated with existing knowledge [54].
- Consider the context of the knowledge presented: pay attention to what associations the choice of words evokes. Prioritise neutral, fact-based words. Keep in mind that negative information tends to have a much greater impact.
- Ensure transfer to the real world: the knowledge presented must be applicable and specific. Give plenty of examples.
- Include positive stories (e.g. successful testing of methods) which demonstrate feasible knowledge for action that has a high level of relevance to the target audience. Promote positive symbolism and benefits [55]. The knowledge conveyer should have many things in common with the recipient so that identification takes place.
- Use knowledge sources in a well-targeted manner. Focus on high-quality, science-based information. If social media are used, this should be to disseminate science-based information.

Conclusions

Social sciences have much to contribute to human–wildlife co-existence in general and wolf management in particular. Psychological theory and models have improved our understanding of the multitude of factors that form people's attitudes, drive their behaviour and underpin social conflicts between diverse groups, as well as providing pointers towards how such conflicts may best be addressed.

The recommendations in this article can be applied both for the development of management actions and for improving interactions and dialogue among diverse interest groups and individuals. Actions within the context of livestock protection can use the recommendations to ensure that knowledge reaches the intended target audience and the conditions for consensus-oriented communication are created. Equally, our recommendations are intended to empower wolf managers and conservationists to consider the perspectives of livestock breeders so that acceptable solutions can be found collaboratively.

For individual professionals and practitioners, knowledge of the mechanisms of one's own psyche can contribute to reflection and self-empowerment while coping with the stress of conflictual situations and increasing personal perceptions of control and competence. Additionally, social sciences have a key role to play in ongoing research on conservation conflicts in an effort to unify previous findings in an integrative model that further advances the development of strategies for co-existence.

Acknowledgements

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Research

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

Francisco Álvares[a,b*], Juan Carlos Blanco[a,c], Valeria Salvatori[a,d], Virgínia Pimenta[b,e], Inês Barroso[e], Sílvia Ribeiro[f]

[a] Large Carnivore Initiative for Europe (IUCN/SSC)
[b] CIBIO-InBio/BIOPOLIS, Portugal
[c] CBC, Proyecto Lobo, Spain
[d] Istituto di Ecologia Applicata, Italy
[e] Instituto da Conservação da Natureza e das Florestas, Portugal
[f] Grupo Lobo, Portugal
[*] Contact: falvares@cibio.up.pt

Introduction

Since the last decades of the 20th 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 becoming 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. 1. Iberian wolves have been recovering their range in recent decades (Photo: JC Blanco).

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 km²) 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[1] [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[2] (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/km², 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/km² in 2007 [14,15]. Cattle require less supervision than sheep

[1] Wolf hunting has not been permitted in Portugal since the end of 1988 or in Spain since September 2021.
[2] 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[3]) and other factors including age of calves in mountain pastures. For the latter, calves were classified as either older or younger than three 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 (ρ) 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[4] while in Spain the average was 98 (16–210) head of Casina[5] or various crosses. Most

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).

[3] 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].

[4] 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).

[5] 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-20th 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).

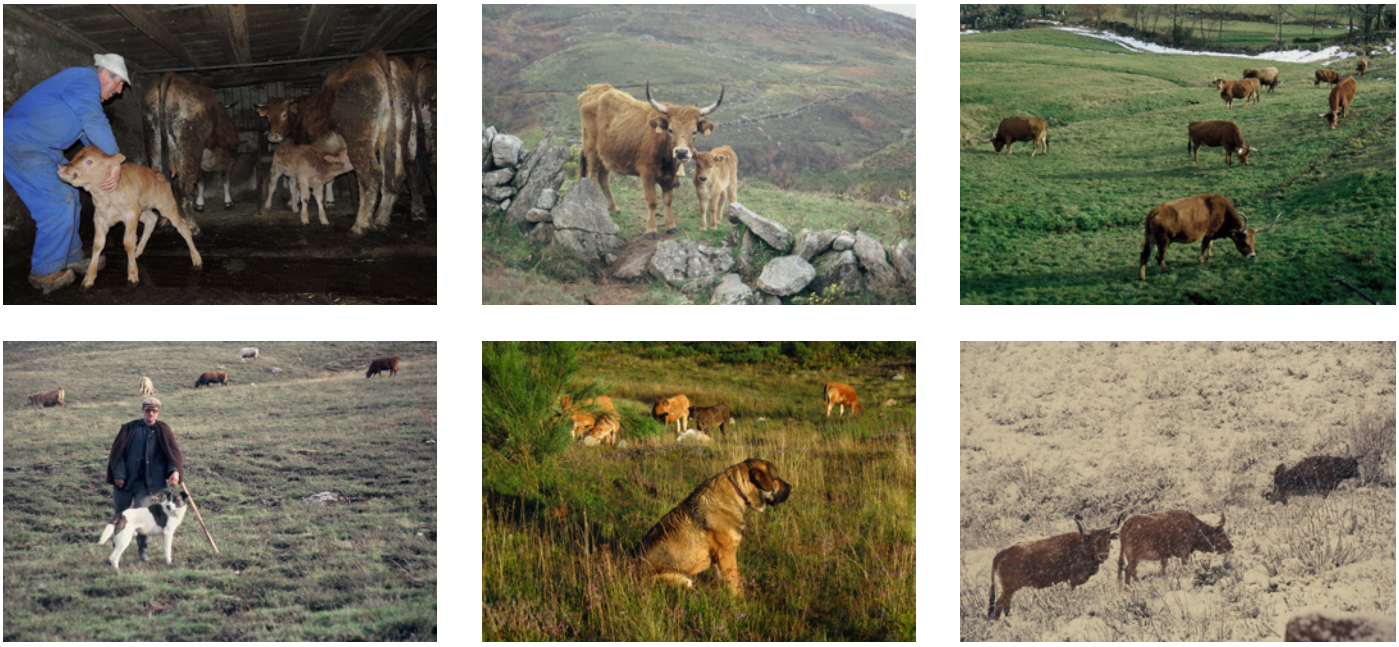

Fig. 9. Current husbandry practices associated with extensive cattle grazing in northern Iberia: (from upper left to lower right) cows with young calves in a barn, Spain; unattended calving in mountain pasture, Portugal; unattended daytime grazing within stone walls, Portugal; extensive grazing with 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 shepherded 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	%
Type of production				
- meat only	31	100	25	83
- milk only	0	0	1	3
- meat and milk	0	0	4	13
Type of grazing				
Confined	0	0	1	3
Attended	1	3	2	7
Free-ranging	30	97	27	90
Seasonality of extensive grazing				
- summer only	0	0	30	100
- year-round	31	100	0	0
Ownership of pastures for extensive grazing				
- communal only	22	71	0	0
- communal and private	9	29	30	100
Damage prevention measures				
- 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	**<0.01**	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	**<0.01**	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	**<0.01**	1,103
	Communal only (22)	9.1		4,176
Overall	All holdings (31)	7.1	-	3,284

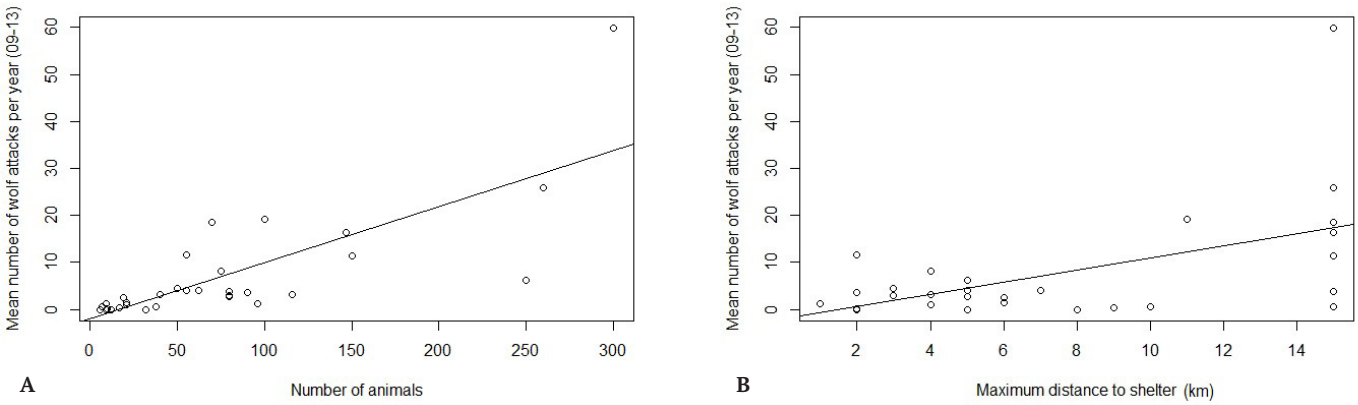

Fig. 12. Relationship between mean annual number of wolf attacks reported in 2009–2013 and (A) number of cattle at holding and (B) maximum distance in kilometres from usual pastures to a barn or fenced pasture for 31 holdings in Peneda-Gerês, Portugal.

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).

haviour 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[6] 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.

[6] 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 implementing 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.

Acknowledgments

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Abstracts of scientific articles

Diverse prevention measures

Effectiveness of interventions for managing human-large carnivore conflicts worldwide: scare them off, don't remove them

Human-wildlife conflicts are associated with a threat to large carnivores, as well as with economic and social costs, thus challenging conservation management around the world. In this study, we explored the effectiveness of common management interventions used worldwide for the purpose of conflict reduction using an evidence-based framework combining expert assessment of intervention effectiveness, impact and uncertainty of assessment. We first conducted a literature review of human-large carnivore conflicts across the world. Based on this review, we identified three main types of management interventions (non-lethal, translocations, and lethal management) and we assessed their effectiveness. Our review indicates that, although the characteristics of conflicts with large carnivores are heavily influenced by the local context and the species, the main issues are depredation on livestock, space-sharing, and attacks on humans. Non-lethal interventions are more likely to reduce conflict, whereas translocations and lethal interventions are mostly ineffective and/or harmful to carnivore populations, without fostering successful long-term coexistence. The literature on conflict management is often imprecise and lacks consistency between studies or situations, which generally makes comparisons difficult. Our protocol allows for the reliable comparison of experiments characterized by heterogeneous standards, response variables, protocols, and quality of evidence. Nevertheless, we encourage the use of systematic protocols with common good standards in order to provide more reliable empirical evidence. This would clarify the relative effectiveness of conflict management strategies and contribute to the global reduction in the occurrence of human-large carnivore conflicts across the world.

Charlotte Lorand et al.
Science of the Total Environment
September 2022
http://dx.doi.org/10.1016/j.scitotenv.2022.156195

Do husbandry practices reduce depredation of free-ranging livestock? A case study with wolves in Greece

Livestock depredation is the primary driver of wolf-human conflict worldwide, threatening wolf conservation and impacting human livelihoods. Most countries implement relevant compensation programs, which are however rarely accompanied by proactive husbandry practices vetted with scientific research. We investigated the influence of husbandry practices on wolf depredation losses for 70 sheep/goat and 68 cattle herds with quantitative modeling of data from semi-structured interviews of livestock farmers along a livestock damage gradient in NW Greece. Sheep/goat herds were better protected than cattle herds in seven preventive measures and annual losses of sheep/goat livestock units were three times lower than losses of cattle livestock units in our study area. Furthermore, according to national compensation data from Greece, costs paid for cattle have doubled in recent years, whereas they have been cut in half for sheep/goats. Our modeling identified three core preventive measures that significantly reduced wolf depredation risk for both herd types, namely increased shepherd surveillance, systematic night confinement, and an adequate number of livestock guardian dogs (optimal ratio was 3 Greek guardian

dogs per 100 sheep/goats and 7 guardian dogs per 100 cattle). Keeping young livestock in enclosures and not abandoning livestock carcasses in pastures were additional effective preventive measures for cattle herds. Our study provides evidence to inform the subsidizing policy put forth in the Common Agricultural Policy of the European Union. It can also serve to inform or revise wildlife-livestock conflict mitigation policy in countries challenged with the competing goals of conserving large carnivores while maintaining traditional grazing regimes.

Maria Petridou et al.
Biological Conservation
July 2023
https://doi.org/10.1016/j.biocon.2023.110097

Factors influencing damage and conflicts

Occurrence and livestock depredation patterns by wolves in highly cultivated landscapes

Attacks by large predators on livestock are an important driver of conflicts. Consequently, knowledge about where predators occur, where livestock depredation takes place and what factors influence it will aid the mitigation of stakeholder conflicts. Following legal protection, wolves *(Canis lupus)* in Central Europe are recently spreading to areas dominated by agriculture, bringing them in closer contact with livestock. Here, we analyzed habitat selection and livestock depredation rates of 43 wolves identified by genotyping on the Jutland peninsula, consisting of mainland Denmark and the northernmost German federal state Schleswig-Holstein. Occupancy by resident wolves correlated positively with forest and other non-forested semi-natural land cover (habitat for natural ungulate prey), whereas occupancy by non-resident wolves correlated with increasing forest cover and sheep density. The latter effect likely reflected increased sampling probability of highly mobile dispersers killing livestock. We recorded 565 livestock depredation events (85 in Denmark and 480 in Schleswig-Holstein), of which 42 % (55 in DK and 185 in SH) could be assigned to 27 individual wolves based on DNA evidence. Livestock (mostly sheep) were killed by wolves in 16 % of the study area. Our results indicate that wolves mostly killed livestock as a context-dependent response, i.e., being dispersers in agricultural areas with low availability of wild ungulate prey and high livestock densities, and not because of behavioral preferences for sheep. Moreover, the livestock depredation was lower in areas with livestock protection measures (implemented in areas with established pairs/packs). We conclude that while wolf attacks on livestock in established wolf territories generally can be reduced through improvement of fences, livestock depredation by non-resident wolves in agricultural areas constitutes a bigger challenge. Albeit technically possible, the economic costs of implementing predator-proof fences and other preventive measures in such pastoral areas infrequently visited by wolves will be considerable. Experiences so far further indicate that lethal removal of identified "problem wolves" may be inefficient in practice.

Martin Mayer et al.
Frontiers in Ecology and Evolution
February 2022
https://doi.org/10.3389/fevo.2022.783027

Wolf depredation hotspots in France: clustering analyses adjusting for livestock availability

Areas exhibiting high levels of predations on livestock generate conflicts between humans and large carnivores. Managers generally seek to identify these hotspots, in order to diagnose the causes that lead to hotspot formations and to provide financial or technical support to the involved livestock owners. When locating depredation hotspots, previous studies have not adjusted for livestock availability, making it difficult for managers to discriminate hotspots resulting from underlying livestock clusters from those due to other factors such as environmental

factors. We studied hotspots of wolf depredation on sheep in France from the beginning of the natural wolf recolonisation in 1994 up to 2018. For each year, we applied the Ripley's K-function and Ripley's Kinhom to determine the general depredation spatial pattern and the Kulldorff statistic to locate depredation hotspots. We showed that omitting livestock availability in these analyses led to flawed inference about the depredation pattern, and resulted in a substantial number of unidentified hotspots, including pastoral surfaces with low sheep availability. Our methodology provides reliable information for managers to understand the depredation pattern over space and time and to allocate resources.

Oksana Grente et al.
Biological Conservation
March 2022
https://doi.org/10.1016/j.biocon.2022.109495

Patterns of livestock loss associated with a recolonizing wolf population in Germany

Predation on livestock presents a daunting challenge for human–carnivore coexistence in agricultural landscapes. In Germany, the recolonization of wolves is ongoing and its consequences are insufficiently understood. Knowledge about which livestock species are susceptible to wolf predation, which farm types are predisposed to attacks by wolves, and when predation on livestock occurs is valuable for mitigating stakeholder conflicts. To this end, we analyzed 14 years of monitoring data and assessed the livestock prey spectrum, identified correlates between predation on livestock, farm type and livestock category, and described temporal patterns of livestock loss caused by a recolonizing wolf population in the state of Brandenburg (Germany). Among a total of 1387 recorded cases, 42 % were unequivocally attributed to wolves (SCALP criteria C1 and C2) and 12 % of cases were not caused by wolves. The number of head of livestock killed during a single wolf attack was mediated by farm type and livestock species; losses per event were greater in full-time farms vs. other farm types and greater in sheep, farmed deer and other livestock species, compared to cattle. While sheep were the most commonly killed livestock species, the increase in wolf territories over the investigation period was associated with a widening of the domestic prey species spectrum. Count regression models provided evidence for the increasing frequency of predation events over the 14-year period, along with an exponential increase in wolf territories. Predation on livestock occurred throughout the year, yet seasonality of events was evident and differed across livestock categories. Predation on sheep peaked in the fall, coinciding with the post-weaning period of wolf offspring. Predation on cattle peaked in the spring, coinciding with the cattle calving period. These results call for renewed investment in the implementation of prevention methods for all susceptible domestic species, particularly during times of elevated predation risk.

Christian Kiffner et al.
Frontiers in Conservation Science
December 2022
https://doi.org/10.3389/fcosc.2022.989368

Planning for wolf-livestock coexistence: landscape context predicts livestock depredation risk in agricultural landscapes

Extensive pastoral livestock systems in Central Europe provide multiple ecosystem services and support biodiversity in agricultural landscapes but their viability is challenged by livestock depredation (LD) associated with the recovery of wolf populations. Variation in the spatial distribution of LD depends on a suite of factors, most of which are unavailable at the appropriate scales. To assess if LD patterns can be predicted sufficiently with land use data alone at the scale of one federal state in Germany, we employed a machine-learning-supported resource selection approach. The model used LD monitoring data, and publicly available land use data to describe the land-

scape configuration at LD and control sites (resolution 4 km * 4 km). We used SHapley Additive exPlanations to assess the importance and effects of landscape configuration and cross-validation to evaluate the model performance. Our model predicted the spatial distribution of LD events with a mean accuracy of 74 %. The most influential land use features included grassland, farmland and forest. The risk of livestock depredation was high if these three landscape features co-occurred with a specific proportion. A high share of grassland, combined with a moderate proportion of forest and farmland, increased LD risk. We then used the model to predict the LD risk in five regions; the resulting risk maps showed high congruence with observed LD events. While of correlative nature and lacking specific information on wolf and livestock distribution and husbandry practices, our pragmatic modelling approach can guide spatial prioritisation of damage prevention or mitigation practices to improve livestock-wolf coexistence in agricultural landscapes.

Hannes J. König et al.
Animal
March 2023
https://doi.org/10.1016/j.animal.2023.100719

The spatial distribution and temporal trends of livestock damages caused by wolves in Europe

Wolf populations are recovering and expanding across Europe, causing conflicts with livestock owners. Here we compiled incident-based livestock damage data across 21 countries for the years 2018, 2019 and 2020, during which 39,262 wolf-caused incidents were reported from 470 administrative regions. We found substantial regional variation in all aspects of the data, including the primary target species, the density of damages, their seasonal distribution, and their temporal trend. More than half of the variation in damage densities across regions was explained by the area of extensively cultivated habitats occupied by wolves, namely natural grasslands and broad-leaved forests. Regional variation in husbandry practices and damage prevention, while difficult to quantify at a continental scale, appear important factors to further modulate these incidents. As illustrated with detailed data from Germany, a relationship between the number of wolf units and damages diminished over time, suggesting some adaptation of livestock owners and local authorities to their presence, for example by increasing prevention efforts. As we argue, temporal trends of damage incidents, which are robust to variation in data collection across regions, are thus informative about the local intensity of the wolf-human conflict. We estimated increasing trends for the majority of regions, reflecting the current expansion of wolves across the continent. Nonetheless, many of these increases were moderate and for more than one third of all regions, trends were negative despite growing wolf populations, thus indicating that wolf-livestock conflicts can be successfully mitigated with proper management.

Liam Singer et al.
Biological Conservation
June 2023
https://doi.org/10.1016/j.biocon.2023.110039

Human dimensions and attitudes

Broadening the toolset for stakeholder engagement to explore consensus over wolf management

Facilitating coexistence between people and large carnivores is critical for large carnivore conservation in human-dominated landscapes, when their presence impacts negatively on human interests. Such situations will often require novel ways of mediating between different values, worldviews and opinions about how carnivores should be managed. We report on such a process in an agricultural area of recent wolf recovery in central Italy where unsolved social tensions over wolf presence have radicalized opinions on either side of the wolf debate, resulting in a stalemate. Where previous mitigation policies based on top-down damage compensation have failed, we tested the potential for applying a participatory approach to engage different stakeholder groups in a dialogue aimed at sharing a deep understanding of the problem and co-creating potential solutions. We based our approach on the theory of meta-consensus, using a decision support tool known as Multi Criteria Decision Analysis (MCDA). Over the course of three months, we carried out five workshops with stakeholder representatives from farming, hunting and environmental associations, and one biologist. Stakeholders shared several objectives and agreed over many management interventions, including the management of free-ranging dogs, the implementation of damage prevention measures, and a damage compensation system suitable for farmers. The process facilitated agreement over actions aimed at improving relations between stakeholders and enhancing the state of knowledge on the issues at stake. Most importantly, we recorded positive social and relationship outcomes from the workshops, and observed a willingness from participants to engage in further discussions over disputed management preferences. Overall, we found MCDA to be a useful tool for laying the groundwork for further participatory and deliberative processes on wolf management. However, challenges ahead included the involvement of a larger number of representatives of different social sectors, and a simplification of the methodology which some participants found too complicated and time consuming.

Agnese Marino et al.
Journal of Environmental Management
October 2021
https://doi.org/10.1016/j.jenvman.2021.113125

Management and policies

Trade-offs in the implementation of good practice in large carnivore conservation and management

Challenges related to increasing large carnivore populations in Europe led to the establishment of the EU Platform on Coexistence between People and Large Carnivores. We present the work undertaken by the Secretariat of the Platform in analyzing case studies in large carnivore conservation and management, which reflected good practice. We focused on 10 case studies ranging from concrete damage prevention methods to broader stakeholder involvement. For these cases, we interviewed stakeholder members with direct involvement. The short listing of case studies was based on the good practice they demonstrated in terms of both conservation and positive outcomes for stakeholder interaction. Our analysis showed that we have much to learn from the unplanned side effects of the actions undertaken, which stakeholders negotiated as part of the process of working together (further referred to as "trade-offs"). We examined how stakeholders dealt with these trade-offs and how they might

lead to adaptations in their future interactions. Stakeholders' responses focused in particular on the following areas: institutional backing of damage prevention and/or compensation; intergroup and in-group relations between stakeholders; instances where costs outweighed benefits; and threats posed by large carnivores. Our findings suggest a need to reconsider what we mean by good practice. In particular, "win-win" solutions may not be realistic, nor even desirable as a management goal. An overconcentration on win-win options may lead to a downplaying of the costs for particular stakeholder groups, which in the end is likely to be counterproductive. Our results indicate that good practice should not be understood as meaning an absence of obstacles but that such obstacles are effectively overcome by stakeholders to achieve desirable outcomes in a specific setting. This conceptualization of good practice has considerable implications for stakeholder engagement in participatory processes and may promote social learning.

Tasos Hovardas & Katrina Marsden
Ecology & Society
December 2022
https://doi.org/10.5751/ES-13434-270415

Predator control

A new era of wolf management demands better data and a more inclusive process

Hunting and trapping of gray wolves *(Canis lupus)* has increased dramatically in the "lower 48" states of the United States. We assess the data used to justify the intense hunting pressure on wolves, and find an absence of accessible biological data. We find there is a clear need for more transparent reporting of livestock losses, wolf kills, and especially the numbers and types of nontarget species captured in traps set for wolves. Also lacking is a full accounting of benefits and costs of hunting wolves, with a noteworthy failure to incorporate the ecosystem functions served by wolves. As apex predators, wolves warrant multi-objective management as opposed to management focused largely on livestock interests and concerns.

Peter Kareiva et al.
Conservation Science and Practice
October 2022
https://doi.org/10.1111/csp2.12821

Videos

Rasco & nous – Un film sur les chiens de protection de troupeaux (Rasco & us: A film about livestock guarding dogs)

Institut de l'Élevage (Idele)
May 2022 (in French)

In France, knowledge and know-how about livestock guarding dogs have yet to spread among livestock breeders. In addition, other users of pastoral areas (hikers, trail runners, mountain bikers, etc.) must learn to conduct their activities taking into account the presence of these dogs. In this film we meet livestock breeders and shepherds from several regions in France. Some, still new to livestock breeding, get help to set up their first guarding dog and others, more experienced, share with us their experience in using livestock guarding dogs.

https://idele.fr/detail-article/rasco-nous-un-film-sur-les-chiens-de-protection-de-troupeaux

Wolf guardians: reducing livestock/wildlife conflict

CGTN Europe
October 2022

This Razor Science Show special looks at how an innovative conservation scheme in Portugal is helping to protect livestock, wolves and farmers' livelihoods. For millennia, livestock guarding dogs worked alongside shepherds to protect herds against wolves and bears. As these predators declined, so did the numbers of guardian dogs, which were replaced with smaller, more affordable dogs. Biologist Silvia Ribeiro of Grupo Lobo runs a government-backed scheme to reinvigorate the guarding dog tradition. The project places pups with farmers and supports their early development and feeding. This has created a sustainable model in which farmers no longer feel a need to persecute wolves due to fears over the safety of their livestock, thus the wolf population can grow along with that of the native guarding dog.

https://www.youtube.com/watch?v=3auwlJdxNc8

Collection of herd protection information

Landcare Germany (DVL e.V.)
April 2023 (in German)

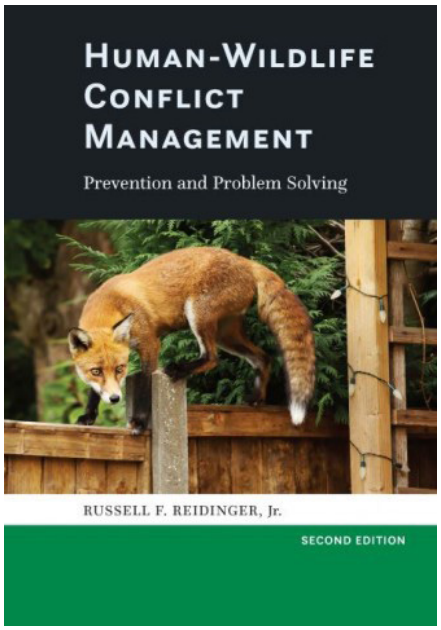
Within their project Livestock protection in grazing animal husbandry (see *CPDnews* issue 25, p. 57), the Landcare Germany association (Deutscher Verband für Landschaftspflege) has produced four films to illustrate selected aspects of herd protection aimed at livestock farmers as well as consultants and breeders. The films, which can be watched on the project website or via Youtube, cover the following topics:

- Effective protection with adequate grounding;
- Types of mobile fences;
- How to master problematic spots in the pasture;
- How to keep fences free from plant growth.

The project is part of the Animal Welfare Model and Demonstration Projects funded by the Federal Ministry of Food and Agriculture, which serves to introduce new findings in farm animal science into agricultural practice. For more information, see:
https://www.herdenschutz.dvl.org

https://www.herdenschutz.dvl.org/dvl-herdenschutzfilme

Books



Title: Human-Wildlife Conflict Management: Prevention and Problem Solving
Author: Russell F. Reidinger, Jr.
Publisher: Johns Hopkins University Press, 2nd edition (2022)
ISBN-10: 1421445255
ISBN-13: 978-1421445250
https://www.press.jhu.edu/books/title/12797/human-wildlife-conflict-management

Publisher's description:

The latest edition of this classic guide details how to understand and resolve a broad array of human-wildlife conflicts.

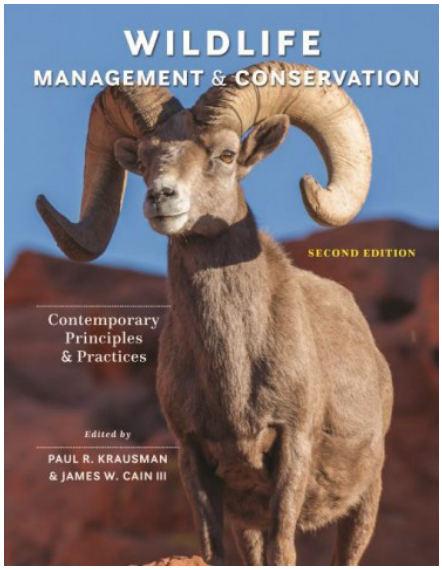
This new edition of Human-Wildlife Conflict Management updates our understanding of the human dimensions, as well as biological and ecological concepts, underlying human-wildlife conflicts. While it provides wildlife professionals and students with the knowledge and adaptive management strategies to resolve such conflicts, it uniquely explores negative interactions with a wide range of wildlife taxa beyond those typically covered in traditional wildlife damage management, including invasive plants, invertebrates, and fish.

Designed to help students and natural resource practitioners gain a deeper understanding of how to successfully avoid and resolve conflict between humans and wildlife, it is informed by author Russell F. Reidinger's decades of teaching students and professionals how to anticipate and manage human-wildlife conflicts, as well as his experience leading a national research program devoted to this work.

The book covers important human-wildlife topics such as:

- individual-, population-, and ecosystem-level effects
- survey techniques
- management methods
- human dimensions
- economic issues
- legal and political aspects
- damage management strategies

Featuring explanations of important terminology and pertinent biological and ecological concepts, Reidinger also shares the latest research, provides a plethora of real-world examples, and includes suggestions for additional resources.



Title: Wildlife Management and Conservation: Contemporary Principles and Practices
Editors: Paul R. Krausman and James W. Cain III
Publisher: Johns Hopkins University Press, 2nd edition (2022)
ISBN-10: 1421443961
ISBN-13: 978-1421443966
https://www.press.jhu.edu/books/title/12570/wildlife-management-and-conservation

Publisher's description:

The definitive textbook for students of wildlife management, now updated to cover the latest techniques, tools, and topics.

Wildlife Management and Conservation presents a clear overview of the management and conservation of animals, their habitats, and how people influence both. The relationship among these three components of wildlife management is explained in chapters written by leading experts and is designed to prepare students for careers in which they will be charged with maintaining healthy animal populations. To be successful wildlife professionals, they will need to find ways to restore depleted populations, reduce overabundant, introduced, or pest species, and manage relationships among various human stakeholders. This book gives them the basic knowledge necessary to accomplish these goals.

This second edition, which is updated throughout, features several new and expanded topics, including communication in the wildlife profession, fire science, Indigenous models of management and conservation, plant–animal interactions, quantitative analysis of wildlife populations, and a detailed glossary. The book also covers:

- Human dimensions of wildlife management
- Animal behaviour
- Predator–prey relationships
- Structured decision making
- Issues of scale in wildlife management
- Wildlife health
- Historical context of wildlife management and conservation
- Hunting and trapping
- Nongame species
- Nutrition ecology
- Water management
- Climate change
- Conservation planning

The most widely used foundational text in the field, this is the perfect resource not only for students but also for early career professionals and those in related fields who need to understand the core tenets and tools of wildlife conservation and management.

Events

Canine Science Forum

11th – 14th July 2023 in Budapest, Hungary

An interdisciplinary conference that brings together scientists with different expertise on canines. Held biannually, it is the main international meeting devoted to the biology, ecology and behaviour of dogs, wolves and related canids. The venue for 2023 is the ELKH Research Centre for Natural Sciences.

For details and updates see: https://csf2023.elte.hu

International Congress for Conservation Biology

23rd – 27th July 2023 in Kigali, Rwanda

A global forum for addressing conservation challenges and for presenting new research in conservation science and practice. Attendees include researchers, students, agency personnel, environmental educators, practitioners and other conservation stakeholders. ICCB 2023 will be held at the Kigali Convention Centre.

For details and updates see: https://conbio.org/mini-sites/iccb-2023/

European Vertebrate Pest Management Conference

28th August – 1st September 2023 in Florence, Italy

EVPMC conferences attract participants from around the world to discuss the latest research, developments, opportunities and achievements in vertebrate pest management. EVPMC 2023 will be held at the Novoli Campus of the University of Florence.

For details and updates see: https://evpmc2023.com/

Wildlife Research and Conservation conference

9th – 11th September 2023 in Berlin, Germany

The WRC2023 conference will have a session on human-wildlife interactions, including conflict prevention, mitigation and monitoring approaches and their performance measurement, socio-cultural aspects of wildlife perceptions and conflicts, and benefits of active project participation of affected stakeholders.

For details and updates see: https://www.izw-berlin.de/en/wildlife-research-and-conservation-sept-2023.html

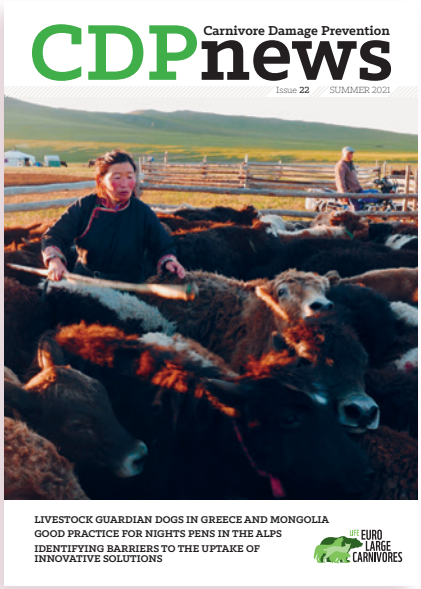
International summit on human–carnivore coexistence

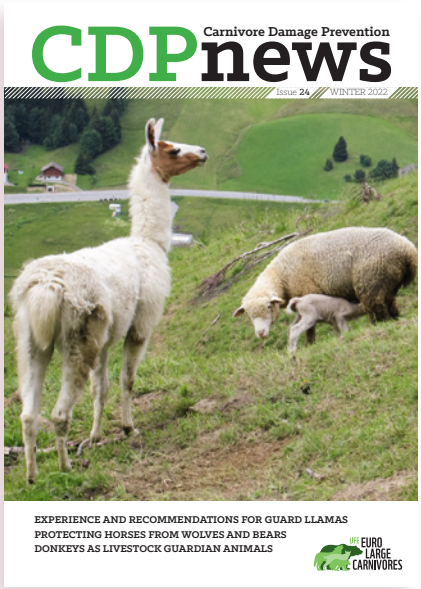
27th – 29th September 2023 in Bucharest, Romania

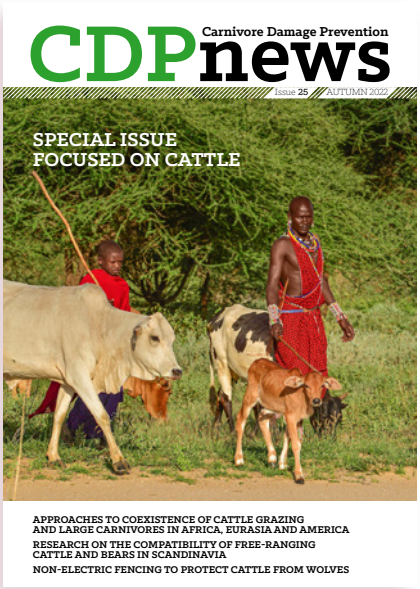
The Romanian Ministry of Environment, Waters and Forests and WWF Romania have announced a 3-day event aimed at, "Achieving coexistence between humans and large carnivores". Its objectives are: to review the state of play with respect to available tools and instruments for the conservation of large carnivores; to review best practices as well as negative examples of their management; and to foster a transdisciplinary approach to managing large carnivore populations in order to achieve tolerable coexistence with people.

An event website was yet to be launched when *CDPnews* went to press.

Previous issues







Next issue

The next issue of *CDPnews* is due out in autumn 2023.

We welcome your feedback and suggestions as well as news, articles and information from around the world.

To contact us, or be added to our mailing list, please write to: info@cdpnews.net

Past issues of *CDPnews* and our Guidelines for Authors can be downloaded from: www.cdpnews.net

CDPnews

Carnivore Damage Prevention