CDP news

Carnivore Damage Prevention

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LARGE CARNIVORES AND LIVESTOCK IN NORTHEAST TURKEY

PROTECTION OF BEEHIVES AND LIVESTOCK FROM BEARS IN CATALONIA

MULTI-DISCIPLINARY APPROACHES FOR MANAGING SHEEP AND WOLVES IN TUSCANY

LIFE EURO LARGE CARNIVORES

INDEX

Chief Editor
Robin Rigg
Slovak Wildlife Society, Slovakia
info@slovakwildlife.org

Editor and Project Coordinator
Daniel Mettler, AGRIDEA, Switzerland
daniel.mettler@agridea.ch

Associate Editors
Silvia Ribeiro, Grupo Lobo, Portugal
globo@fc.ul.pt

Micha Herdtfelder, Forstliche Versuchsanstalt (FVA), Baden Württemberg
micha.herdtfelder@forst.bwl.de

Valeria Salvatori
Istituto di Ecologia Applicata (IEA), Rome, Italy
valeria.salvatori@gmail.com

Senior Advisor
John Linnell, NINA, Norway
john.linnell@nina.no

Layout and Design
Rita Konrad, AGRIDEA, Switzerland
rita.konrad@agridea.ch

Photo credits
Front cover: **Josip Kusak**
Back cover: **PirosLife Project**

E-mail
info@cdpnews.net

Available at
www.cdpnews.net
www.protectiondestroupeaux.ch

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EDITORIAL

"Variety is the spice of life", as the saying goes, and *CDPnews* is certainly spicy! We cover a broad range of subjects in this issue, from technical interventions in Catalonia to more prosaic practices in Turkey. We examine multi-disciplinary approaches to engaging with stakeholders in Italy and take a playful look at game-based learning as a tool to teach conflict mitigation methods in Africa and beyond.

Protecting the variety of life is the goal of the Convention on Biological Diversity. Its Strategic Plan for 2011–2020 aimed to reduce biodiversity loss worldwide. Lockdowns offer a glimpse of nature bouncing back when human activity is reduced, but the latest UN Global Biodiversity Outlook reported that all 20 'Aichi targets' to safeguard ecosystems and promote sustainability were missed. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services concluded that we are losing species at an alarming rate. WWF's Living Planet Report found that, globally, wildlife populations have shrunk by two-thirds since 1970 due to human population growth and overconsumption.

Is there any cause for optimism amongst this 'doom and gloom'? The challenges are considerable, but conservation is making a difference, saving some species from extinction[1]. A post-2020 biodiversity framework is being prepared with a 2050 vision of "Living in harmony with nature". COVID-19 has raised awareness of the connection between healthy ecosystems and healthy people. Post-pandemic recovery programmes are an opportunity to 'build back better' with green technologies and nature-based solutions. Initiatives like the European Green Deal support transition from 'industrial agriculture' towards more diverse and sustainable 'agroecological systems'. The Earth Optimism movement seeks to motivate people through positive messaging and success stories.

Such innovation requires buy-in from all sectors of society, but what if we don't see things the same way? We have an innate tendency to believe stories that fit our prior convictions[2]. While diversity of views is often a good thing, the virus-like spread of disinformation[3], such as the anti-vaccine movement and climate change denial, has negative impacts on us all. In today's digital age, we are bombarded with information and it is difficult to separate fact from fiction. False news is shared through social media faster and further than the truth[4]; 'bad' news spreads quicker than 'good'[5].

Big predatory animals play key roles in ecosystems. Unfortunately, the journalist's old mantra "If it bleeds, it leads!" applies to them, too. Danger and death make more enticing headlines and clickbait than peaceful coexistence. This gives misleading impressions of the scale, frequency and intractability of conflicts. Ironically, if we try to refute misinformation, we risk spreading it further, particularly online. Our pop-up feature on the LIFE EuroLargeCarnivores project describes recent findings that even scientific publications tend to focus on negative aspects of large carnivores. This has made us think about the name of our newsletter: does 'damage prevention' fall into this trap? Please send your views and comments on this and any other topics covered in *CDPnews* to: info@cdpnews.net

The Editors

[1] https://conbio.onlinelibrary.wiley.com/doi/10.1111/conl.12762
[2] https://www.nature.com/articles/s41593-019-0549-2
[3] https://engineering.stanford.edu/magazine/article/how-fake-news-spreads-real-virus
[4] https://science.sciencemag.org/content/359/6380/1146/tab-pdf
[5] https://www.tandfonline.com/doi/abs/10.1080/21670811.2019.1631706?af=R&journalCode=rdij20

Perspective

LARGE CARNIVORES AND LIVESTOCK IN NORTHEAST TURKEY: A PRAGMATIC COEXISTENCE

Josip Kusak[1], Çağan H. Şekercioğlu[2, 3, 4]

[1] *Veterinary Biology Department, Veterinary Faculty, University of Zagreb, Heinzelova 55, HR-10000 Zagreb, Croatia*
Contact: kusak@vef.hr
[2] *KuzeyDoğa Society, Ortakapi Mah. Sehit Yusuf Cad. 39, 36100 Kars, Turkey*
[3] *Department of Biology, University of Utah, 257 South 1400 East, Salt Lake City, Utah 84112, United States*
[4] *Department of Molecular Biology and Genetics, College of Sciences, Koç University, Istanbul, Turkey*

www.kuzeydoga.net

1. An unexpected land

My name is Josip Kusak and I am a researcher at the University of Zagreb in Croatia. Sometime in spring 2011, I received an interesting email from the president of KuzeyDoğa, a non-governmental organisation for the study and community-based conservation of wildlife and habitats in northeast Turkey (Akküçük and Şekercioğlu, 2016). Professor Çağan H. Şekercioğlu explained that they wanted to expand their focus to include research on large carnivores and asked if I would help with capturing and collaring wolves (*Canis lupus*). He told me there were also brown bears (*Ursus arctos*) and Eurasian lynx (*Lynx lynx*) in the area and yet an online search revealed to me an unfamiliar, mostly open landscape, with only a few small, fragmented forest patches. I was intrigued how large carnivores could live in such an apparently 'unsuitable' place. So, I replied, "Yes, I will come in autumn!"

Turkey is the only country in the world that is almost entirely covered by three global biodiversity hotspots (Caucasus, Iran-Anatolian and Mediterranean), and yet its biodiversity and ecosystems are greatly threatened (Şekercioğlu et. al, 2011 a,b; Tarwar, 2015). Nevertheless in the northeast, where the human population is declining, there is still some potential for the conservation of large mammalian carnivores (Şekercioğlu, 2013a, b).

The Kars-Ardahan mountain plateau is situated at the intersection of the Caucasus and Irano-Anatolian global biodiversity hotspots (Chynoweth et al., 2015; Şekercioğlu, 2012). Its base starts at about 1,900 m and it rises to an elevation of 3,120 m above sea level. Winters are long and cold, with a lot of crystal snow: ideal for winter sports. The name of the main town in the area – Kars, like *'kar'* the Turkish word for snow – seems perfect (Fig. 1). Looking out of the plane window as we descended into Kars airport, I saw a large open valley, with dark, square-shaped patches of arable land on the valley bottom. The surrounding hills were mostly oval, but one had a flat top and steep sides, as if it really belonged in Monument Valley in Utah. A river ran below the ruins of an old fortress on the hill above the town.

It was September, the end of summer, and the hills surrounding the plateau were coloured yellow-brown by the short, dry stems of grass left after the grazing of

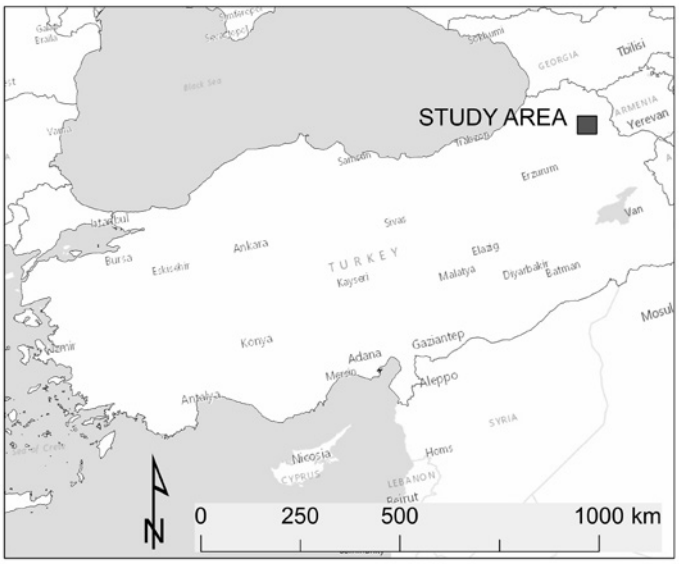

Fig. 1 Location of the study area in north-eastern Turkey, close to the border with Armenia.

many cows and sheep. Only some higher hills were covered with small, dark forest patches. Scattered villages, or rather groups of houses built apparently without much planning and with strange contrasting blue tin roofs, were connected by dirt roads to the two main roads running through the valley (Fig. 2).

Fig. 2 Hamamli, one of many villages on the Kars-Ardahan plateau. Late spring snow is not unusual at altitudes of 2,000–3,000 m. *(Photo: Josip Kusak)*

2. Learning to look down

After a few days in Kars to prepare our equipment, we moved to the smaller town of Sarıkamış ('Yellow reed'), named after the former wetlands on which the town was built. This town is bordered to the northwest and south by stands of Scots pine (*Pinus sylvestris*), whose bark peels off in brown scales, exposing young, yellow bark beneath. There are four patches of

Fig. 3 Emrah Çoban, Josip Kusak and Ayşegül Çoban collecting wolf scat on a dirt road at the edge of Sarıkamış-Allahuekber Mountains National Park in 2011.
(Photo: Çağan H. Şekercioğlu)

such forest covering a total of about 330 km^2. Part of the northern patch is included in Sarıkamış-Allahuekber Mountains National Park, which was established mainly as a memorial park to commemorate the First World War Battle of Sarıkamış.

I got to know the area better after some days of travelling around. During the subsequent decade of working there I have acquired much better insights. My small field crew – biologist Emrah Çoban and his girlfriend (later wife) veterinarian Ayşegül – needed to learn techniques for working with wolves. At first, the main challenge for me was to make them look down. Locating wolves means searching for footprints, scats and scratch marks on the ground (Fig. 3). Being primarily ornithologists, my new colleagues would spot any bird, big or small, on a tree or in the air, but they would step on or drive over wolf scat without seeing it! I would then say, "It's just a bird! Forget birds – keep your eyes on the ground!"

Those days are far behind us now. My Turkish friends have mastered fieldwork techniques for studying large carnivores including capturing, collaring and tracking. Over the years, our work gradually expanded from wolves to lynx and bears (Chynoweth et al., 2015; Şekercioğlu 2013 a, b). During a 10-year period, we captured 29 wolves, 68 bears and 15 lynxes for GPS tracking. Thanks to our long-term, intensive monitoring with camera traps, we registered the first known occurrence of a racoon dog *(Nyctereutes procyonoides)* in Turkey (Naderi et al., 2020).

Sometimes with my colleagues and sometimes alone, I have driven many kilometres of forest roads, visited a multitude of valleys, hills and forest patches (Fig. 4), and enjoyed views of steep canyons with clear, swift-flowing streams. All this was under the 'pretence' of identifying suitable places for traps and remote cameras, searching for signs of wolves, bear dens, day beds, dropped collars, lost signals and dead animals.

We have analysed habitat types, topography, prey base, human presence and activity. We have not yet determined the density of wolves and bears, but my impression is that it is similar to that in good habitats with high abundance of wild ungulates, even though wild boars were the only species of wild ungulate prey available to wolves. From diet analysis, we learned that wolves eat mostly domestic animals during grazing periods (Capitani et al., 2016), but the ratio between predation and scavenging is still unknown. Livestock is kept in stables during the winter when the diet of wolves includes village dogs. The effect of livestock husbandry and seasonal changes on the ecology of wolves in the area have not yet been studied.

Fig. 4 Beside Scots pine, small stands of Eurasian aspen *(Populus tremula)* grow at lower elevations and on south-facing slopes. *(Photo: Josip Kusak)*

3. Two types of bears

Sarıkamış town garbage dump is open, smoky, smelly and generally unpleasant, but is a rather important habitat component for some bears. It is situated one kilometre west of the town, next to the main road and 200 metres from the edge of the forest. In summer, we observed up to 20 bears feeding at the dump (Fig. 5), as well as some wild boars (*Sus scrofa*) and even wolves. Numerous stray dogs live at the

Fig. 5 Ten bears feeding in Sarıkamış garbage dump in 2011. *(Photo: Josip Kusak)*

dump. During the evening, cars full of curious spectators from the town visit the dump to watch bears and other wildlife. It seems that local people do not consider this situation to be a problem. Garbage-feeding bears get accustomed to utilising human food sources ('food-conditioned') and also seem to become rather tolerant of close encounters with people ('human habituated'). Attacks by bears on people are rare in the Sarıkamış area and there is no record of a bear attacking a human at the garbage dump.

We identified two remarkably distinct behavioural strategies of bears. Whereas some individuals regularly fed on garbage and remained sedentary year-round, other bears never visited the dump and instead migrated around 70–90 km in autumn to feed in the nearest oak forest before returning to Sarıkamış to hibernate. This is the first documented seasonal migration of brown bears in the world (Cozzi et al., 2016).

4. The importance of water

In spring and early summer, melting snow from the highest peaks feeds the many streams that cascade through the forests and rejuvenates the grass under the sparse pine canopies. Cattle and sheep are brought to high mountain pastures soon after snowmelt and stay there until the following winter. This dynamic seems to depend on one major factor: water. If there is water from melting snow and spring rains, the grass will be green and there will be drinking water for livestock. But we have already witnessed a lack of water in mid-summer in some years due to insufficient snow accumulation during winter.

It seems that global climatic change, with more extreme weather fluctuations, will not only adversely affect the local skiing business, but is already impacting the entire ecosystem and the people depending on it. Due to uncertainties in the water supply, locals have started building small, illegal dams on more and more streams in the area. Lake Kuyucuk, a Ramsar site in Arpaçay district, completely dried out in late summers of 2014, 2017, 2018, 2019 and 2020 because all the streams feeding it had been dammed illegally to secure water for livestock.

5. Livestock husbandry and protection

Wild ungulate grazers have been almost completely replaced by domestic animals. In a decade of camera trapping, we documented the occurrence of roe deer (*Capreolus capreolus*) on only four occasions! In Kars province alone, about 850,000 heads of livestock are registered: mostly cattle, sheep, some horses, and donkeys. The total number of dogs, including sheep dogs as well as strays in villages, towns, and garbage dumps, may be 30,000 to 40,000. Donkeys and horses are used as work animals. Most of the time they are left unguarded on open pastures close to the villages during the day and in stables at night (Fig. 6). Raising geese is also widespread (Fig. 7), with goose meat being one of the well-known delicacies of the area.

Fig. 7 Geese are the main kind of poultry raised by villagers, with goose meat being one of the well-known delicacies of the area. *(Photo: Josip Kusak)*

Cattle herds and sheep flocks usually consist of several hundred animals (Fig. 9). They are taken to summer villages and camps after the snow melts. There, they graze on mountain slopes as far and as

Fig. 6 Although not common, it is possible to see Turkish 'cowboys' herding free-grazing horses. *(Photo: Josip Kusak)*

Fig. 8 A cattle herd crossing overgrazed pasture while returning to the village for the night. *(Photo: Josip Kusak)*

Fig. 10 Two wolves (one collared for GPS tracking) feeding on a cow carcass which was dumped at the roadside by villagers. *(Photo: Josip Kusak)*

high as they can reach during the day and are always gathered in guarded pens overnight (Fig. 8). Livestock is also allowed to graze in forest patches, including forests inside the Sarıkamış-Allahuekber Mountains National Park (front cover). All snow melts by mid-July and streams at higher elevations dry out. If water has not been secured by owners, livestock must move to lower elevations at this time. Remaining grass is cut for hay. Forest understory vegetation persists only on steep and rocky places, where cattle and sheep cannot reach it.

Domestic animals which die on pastures or in stables are left on pastures or in the forest. Carcasses left on open pastures are usually eaten by scavenging birds, those left in or close to forest are eaten by bears or wolves (Fig. 10), while there are many village dogs

Fig. 9 Sheep flock accompanied by shepherds and a Karaman dog. *(Photo: Josip Kusak)*

Fig. 11 Red foxes are commonly seen on open pastures, but rarely observed or documented by our automatic cameras in forests around Sarıkamış area. (*Photo: Josip Kusak*)

which feed on the carcasses left close to human habitation. This is illustrative of local people's views of and relationship to nature. Wolves and bears have always been present in the area. If they eat a cow which died, then they will not have to attack and kill another one. At the same time, for the owner, the problem of how to dispose of the carcass is solved.

Wild boars are a common occurrence and villagers consider them to be the main problem animal, since they damage fields and crops. It seems that locals use any opportunity to shoot wild boar to reduce the damage they cause. We found that bears also fed in fields, but we did not document any cases of them being shot there. All three large carnivore species are legally protected, but there are no management plans, monitoring programmes or damage compensation schemes. Livestock owners might obtain compensation if it can be proven that their livestock was attacked by a rabid wild animal. Rabies is present in the area, with foxes (*Vulpes vulpes*; Fig. 11) being the main source of infection for domestic animals (WHO, 2018).

Cattle and sheep are generally well-guarded using traditional methods as well as some new ones. Shepherds often carry guns (Fig. 12). Thirty-four percent of our collared wolves died due to human causes within one year of tracking and another 23% had an unknown fate (Kusak et al., 2018). Some GPS-tracked wolves were shot in grazing areas and some on the edge of villages or even within villages during winter.

6. Livestock guarding dogs

Livestock guarding dogs (LGDs) are present on pastures and when livestock is gathered in pens at night. They are used for guarding sheep and cattle which graze near or inside forests (Figs. 13 and 14). Some cattle herds grazing at least a kilometre away

Fig. 12 Armed shepherds guarding sheep in 2013. *(Photo: Josip Kusak)*

Fig. 13 Livestock guarding dogs and shepherds accompanying a cattle herd. (*Photo: Josip Kusak)*

Fig. 14 The Kangal Shepherd Dog is the most common breed of LGD used in the Kars-Ardahan area. *(Photo: Josip Kusak)*

Fig. 15 The Akbash is rarely seen in the Sarıkamış area. *(Photo: Josip Kusak)*

from forest can be seen accompanied by shepherds without LGDs, but sheep flocks are always accompanied by both dogs and shepherds. LGDs accompany livestock day and night together with one or more shepherds who control them. Herding dogs were not used.

The most common type of LGD in the area is a traditional Turkish breed, known locally as the Kangal or KarabaŞ and internationally as the Anatolian Shepherd Dog (Fig. 14). Kangals are large dogs, taller and heavier than the average wolf from the area. Owners usually cut their ears so that wolves cannot bite and tear them. They also equip them with spiked collars (Fig. 16). Other Turkish breeds, such as the Anatolian Mastiff (Fig. 17), which is even larger than the Kangal, Karaman (Fig. 9), Akbash (Fig. 15), Koyun and Kars (Caucasian) Shepherd Dog (Fig. 19), were rarely observed guarding livestock in the Sarıkamış area. Kangal/Karabash and Akbash breeds are generally the most known and common breeds, while the others are in decline in Turkey (Yilmaz et al., 2015).

We have not studied the ratio of number of dogs to livestock and shepherds systematically, but it seems that, on average, for every 100 head of livestock there are three to five LGDs, mostly males, and one shepherd. LGDs move with herds and flocks, check the surrounding area, and frequently scent mark. We documented with camera traps that the same scent-marking sites are used by both LGDs and wolves. It is almost impossible to approach a flock or herd on open pastures or even in the forest. LGDs detect intruders at a far distance by sight or smell, start barking and run towards the intruder. If they threaten a person on foot, shepherds control them by whistling or shouting commands.

Determining the actual extent of losses to predators would be tricky since there is no damage compensation system. In my home country of Croatia,

Fig. 16 Kangal Shepherd Dog with spiked collar and cropped ears, ready to face wolves or bears. *(Photo: Josip Kusak)*

Fig. 17 The Anatolian Mastiff was seldom used as a guarding dog, but more often as a pet. *(Photo: Josip Kusak)*

Fig. 18 Livestock guarding dogs are commonly used to guard cattle, with shepherds always accompanying herds.

(*Photo: Josip Kusak*)

before damage compensation started, livestock owners in traditional wolf range seemed reluctant to admit losses to wolves, perhaps because this would imply that they had not taken good care of their property.

We did not hear about any problems with LGDs or dogs in general. Sarıkamış is full of stray dogs which sleep on the streets and sidewalks and feed on garbage, but nobody seemed to be concerned by this and this is typical in the rest of the country.

Fig. 19 Long-haired Kars (Caucasian) Shepherd Dog and Koyun were sometimes seen guarding sheep flocks.

(*Photo: Josip Kusak*)

7. Times of change

The ecosystem of the Kars-Ardahan mountain plateau is dominated by humans and is far from being an untouched wilderness. The presence of large carnivores does not always indicate a pristine, intact ecosystem (Linnell et al., 2000) and this seems to be the case on the Kars-Ardahan mountain plateau. Agropastoral communities have inhabited the region for millennia and the impact of current and past human activity is ubiquitous across the landscape (Chynoweth et al., 2016). Nevertheless, large carnivores still manage to fit in by finding a balance between the natural and dominant anthropogenic components of their ranges. Local people regard them as just one of many unpleasant parts of nature, like summer storms or long cold winters, which need to be considered and endured. During conversations with villagers, we did not hear many complaints about wolves or bears. Guarding livestock against wolf and bear attacks was considered common sense.

The relationship between humans and large carnivores is dynamic and has been fine-tuned over millennia of coexistence. However, this relationship is now facing new challenges which have emerged on both local and global scales. On the local scale, the challenge is unmanaged garbage, while on the global scale are the unfolding consequences of climate change, such as lack of snow and drinking water.

Turkey is at the intersection of three biodiversity hotspots and at the continental confluence of Europe and Asia (Şekercioğlu et al., 2011a). The biodiversity across taxa in Turkey is extraordinary and deserves proper study and understanding for the purpose of conservation and management. Turkey has a unique opportunity to lead the larger region in biodiversity conservation by establishing a group of experts to design and implement wildlife management plans (Chynoweth et al., 2016). Studies of large carnivores in Sarıkamış are therefore much needed and are ongoing.

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News Roundup

IUCN targets human-wildlife conflict

The International Union for Conservation of Nature (IUCN) is calling for renewed efforts to address human-wildlife conflict in the interests of both people and wildlife. At the World Conservation Congress 2020, the IUCN adopted Motion 117 "Addressing human-wildlife conflict: fostering a safe and beneficial coexistence of people and wildlife"[1]. With 99% of members voting in favour, the Motion urges governments, non-governmental organizations, researchers, practitioners, community leaders, environmental agencies and others to ensure that efforts to manage human-wildlife conflicts are pursued through well-informed, holistic and collaborative processes that take into account underlying social, cultural and economic contexts.

The IUCN has established a Human-Wildlife Conflict Task Force (HWCTF)[2] to foster links between policy, science and communities. This global, interdisciplinary advisory group aims to support professionals by providing guidance and information on best practice to mitigate and prevent human-wildlife conflicts. Two documents produced by the HWCTF were recently endorsed by the IUCN. Its *Briefing Paper* provides an explanation of the different considerations and nuances of the term 'human-wildlife conflict'. In its *Position Statement on the Management of Human-Wildlife Conflict*, the HWCTF summarises the most important aspects of understanding and addressing human-wildlife conflicts. Both documents are available from the HWCTF website[2], where further information, publications and guidance can also be found in the online Human-Wildlife Conflict Resource Library[3]. At the time of writing, the HWCTF was preparing a comprehensive technical policy and advisory document for practitioners working on human-wildlife conflict, which will also be available on the website.

LIFEstockProtect project launched

Described by its authors as the largest and most ambitious livestock protection project in the German-speaking Alpine region, LIFEstockProtect[4] officially launched on 1st September 2020. This 5-year project, with 17 partners and a total budget of around €5 million, seeks to provide farmers in Austria, Bavaria and South Tyrol with know-how, practical assistance and other tools necessary to protect livestock effectively using measures such as electric fencing and livestock guarding dogs.

On 26th January 2021, the LIFEstockProtect project hosted an online conference during which farmers from Italy, Austria and Germany shared their personal experience of livestock protection. More than 500 participants from across Europe joined the event and live-streaming on Facebook reached an additional 5,200 people[5]. A recording of the conference and a detailed presentation of the project's objectives are available on the project's YouTube channel[6].

Conference on coexisting with carnivores

On 18th November 2020, the European Parliament's Biodiversity, Hunting, Countryside Intergroup held an online conference on *Coexisting with Large Carnivores: Next Steps in Conservation and Management*, organised in conjunction with the European Federation for Hunting and Conservation (FACE), hosted by several Members of the European Parliament (MEPs) and moderated by FACE Secretary General David Scallan.

The hosts and speakers recognised that the return of large carnivore populations in Europe is a conservation success, but that it raises multiple challenges. John Linnell of the Norwegian Institute for Nature Research and senior advisor to *CDPnews*, stated that:

[1] https://www.iucncongress2020.org/motion/117
[2] http://www.hwctf.org/resources/tf-publications
[3] http://www.hwctf.org/resources/document-library
[4] https://lifestockprotect.info/
[5] https://wilderness-society.org/livestock-protection-conference-a-great-success/
[6] https://herdenschutz.info/videos

"Coexistence between large carnivores and humans is one challenge. The other is achieving coexistence between different groups of people with different perspectives, interests and values on how we should manage large carnivores […] The solutions to the challenges of coexistence are both technical and political. However, politics can also be a large part of the problem when it instrumentalises conflicts with carnivores for political gains and undermines expertise by creating an alternative universe of fake news and conspiracies. In such situations everybody loses, including carnivores and people, because we ignore the real challenges!"

Moritz Klose of WWF stated that, "When conflict arises, Member States have sufficient flexibility under the Habitats Directive to use derogations on a case-by-case basis. There is no scientific evidence that culling, including a steered hunting regime, is an effective solution to decrease damage to livestock. The focus must instead be on supporting livestock breeders to implement preventive measures such as electric fences and guardian dogs and to provide financial compensation in case of damages".

Nicola Notaro, Head of the European Commission's Nature Unit, underlined that: "Technical and financial support are essential for all those affected by the return of large carnivores to areas in which they had disappeared for a long time. The Commission will continue to make them available through EU funds (Rural Development, LIFE) and through EU as well as regional platforms on large carnivores that allow for information and best practice exchange". MEP Álvaro Amaro stressed the need to involve relevant stakeholders such as hunters, landowners and farmers at all levels in the decision-making process.

The event was attended online by more than 360 participants. A video recording as well as the speakers' presentations are available on the Intergroup website[7].

Wolf hunting in Europe

On 7th September 2020, the General Assembly of the European Federation for Hunting and Conservation (FACE) adopted a position on wolves in Europe. The position acknowledges the ongoing recovery of the wolf as a conservation success but recognises that coexistence with wolves is a challenge in Europe's highly modified and populated landscapes. It advocates for an EU legal framework whereby sustainable hunting can play a key role in the long-term conservation and management of wolves in Europe. The full position statement is available on the FACE website[8].

On 4th February 2021, the autonomous regions of Spain voted by the narrowest of margins to include the wolf in the List of Species of Particular Protection. Listed species cannot be hunted as game but may be culled to prevent damage to livestock. Standpoints were polarised, but most of the regions north of the Duero River, which have around 95% of the country's wolves, were against listing. Some of them wanted to continue hunting in accordance with the EU Habitats Directive and Spain's reservation from strict protection under the Bern Convention. Many of the regions which have few or no wolves voted in favour of listing. At the time of writing, discussions were underway to agree funding mechanisms for farmers, including compensation of damage and more support for prevention measures, as well as for wolf monitoring and research.

DinAlp Bear wins LIFE Award for Nature

During a virtual ceremony held as part of EU Green Week 2020[9], the LIFE Award for Nature was presented to DinAlp Bear, Slovenia. LIFE Awards[10] recognise the most innovative, inspirational and effective LIFE projects in three categories: nature, environment and climate action. LIFE DinAlp Bear[11] monitored and managed brown bear populations in the northern Dinarides and southeastern Alps. Human-bear conflicts decreased thanks to the installation of electric fences and bear-proof compost and garbage bins. Attacks on sheep decreased by 43% overall and the number of bears being hit by traffic dropped by a quarter. A bear-friendly label was developed to award practices that lead to more harmony between bears and humans (see Kavčič and Majić Skrbinšek, 2019 in issue 18 of *CDPnews*). Attitudes towards bears were reported to have improved in the partner countries of Croatia, Italy, Austria, and Slovenia due to an effective communication and information campaign.

[7] https://www.biodiversityhuntingcountryside.eu/

[8] https://www.face.eu/wp-content/uploads/2020/09/EN-FACE-position-on-wolves-in-Europe-1.pdf

[9] https://www.eugreenweek.eu/

[10] https://ec.europa.eu/easme/en/news/eu-reveals-exceptional-nature-environment-and-climate-action-projects

[11] https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4958

Project

IMPROVING PROTECTION OF BEEHIVES AND LIVESTOCK FROM BEARS: PIROSLIFE IN CATALONIA, SPAIN

Nicolás Espinós[1], Àgata Colomer[1], Ivan Afonso[2], Santiago Palazón[3]

[1] *Forestal Catalana S.A., Government of Catalonia, Spain*
Contact: nicolas.espinos_ext@gencat.cat
[2] *Natural environment Head, General Council of Aran, Spain*
[3] *Fauna and Flora Service, Department of Territory and Sustainability, Government of Catalonia, Spain*

www.piroslife.cat

1. Introduction

The Pyrenees mountain range has historically offered suitable habitat for the brown bear (*Ursus arctos*) thanks to its orographic and biogeographic characteristics. However, bears were almost extirpated there at the end of the 1980s, mainly due to human causes, i.e. poisoning, poaching and trapping for bounties (Casanova, 2005). In 1996, a plan was initiated to recover the species in France and the Catalonia region of northeast Spain. Since then, 11 individuals from Slovenia have been released (Quenette et al., 2001; Sentilles et al., 2020). As a result, there is now a population of more than 50 individuals distributed over the vast majority of the Pyrenees.

With the aim of consolidating the bear population in the Catalan Pyrenees, the PirosLife project, a LIFE+ Nature project, was implemented in 2014–2019. Its main goal was to ensure the long-term conservation of bears in the Pyrenees. The project was coordinated by the Department of Territory and Sustainability of the Generalitat de Catalunya and involved partners such as the General Council of Aran, Lleida University, Forestal Catalana and the Fundación Oso Pardo. One of the project actions was to design and implement a series of protection measures to prevent damage by bears to beehives and livestock, as well as to evaluate their effectiveness. This article summarises and discusses the effectiveness of the prevention measures applied during the PirosLife project.

2. Project area

Most of the bear population is located in the central Pyrenees. This area belongs to three different states (France, Spain and Andorra). The Spanish portion is spread across three autonomous communities (Catalonia, Navarra and Aragon) that are responsible for bear conservation and management. The PirosLife project was implemented only in Catalonia, where there are two administrations: the General Council of Aran in the Val d'Aran region and the Generalitat de Catalunya in the rest of the Catalonian Pyrenees.

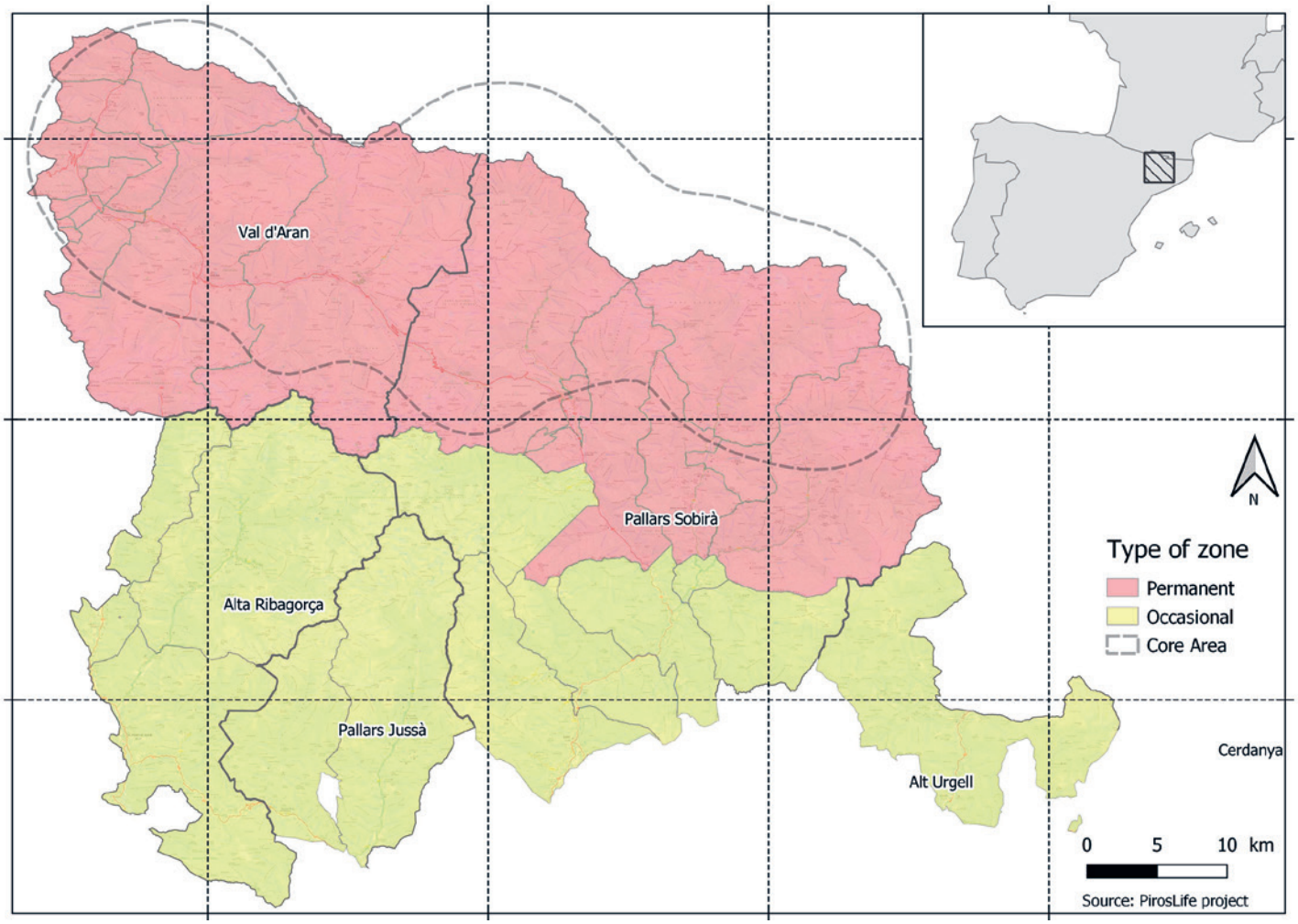

Fig. 1 Location of brown bear permanent presence zone (ZPP), occasional presence zone (ZPO) and Core Area in Catalonia, Spain.

The PirosLife project created two different management areas based on bear occurrence: a zone of permanent presence (ZPP), where prevention measures are implemented at most apiaries and livestock grazing areas, and an occasional presence zone (ZPO) where protection measures are applied only when damage occurs (Fig. 1).

3. Prevention measures: implementation and results

Livestock rearing in the Catalan Pyrenees is mainly dedicated to meat production. It is managed through extensive grazing approximately from April to November and a semi-extensive rearing system during the rest of the year. The main sector is cattle, followed by horses and sheep. The least abundant type of livestock are goats, although recently a few goat farms with semi-extensive rearing systems and dedicated to milk production have arisen. Additionally, at the end of the 20th century, and thanks to the improvement of road networks, transhumant beekeepers began to use the area.

The application of measures to prevent damage by large carnivores is one of the main strategies in any project focused on reintroduction of these species. For this reason, the PirosLife project created a so-called Annual Livestock Plan that includes the bases for the deployment of an integrated system of measures to prevent damage by bears in this economic sector.

3.1 Beekeeping

The presence of sedentary bees in the Pyrenees was not common historically. However, during recent decades, there has been an increasing number of transhumant beekeepers from the south of Catalonia who move from place to place during the summer season in search of high-altitude blossoms.

In the Catalan Pyrenees, until the end of 2017, there was no systematic registration of beehives that were temporarily located in the ZPP. As a result, it was a challenge to trace and check apiaries installed during

the season. Subsequently, the administration made the registration of apiary movements compulsory, thereby motivating and improving communication channels between the administration and beekeepers. In the Val d'Aran, beehives have been registered since 2009.

3.1.2 Implementation of prevention measures

The two administrations in Catalonia have implemented the same protection system: electric fences with three metal wires at heights of 20, 45 and 90 centimetres above the ground, grounding, a battery and 4 Kw solar panel (Fig. 2) (PirosLife Team, 2019). This is similar to fences used elsewhere, but the total height (90cm) is lower and there are fewer wires than fences used, for example, in the Cantabrian Mountains of Spain (Seijas et al., 2016 in *CDPnews* issue 12) and Trentino in Italy (Vittorio et al., 2016 in *CDPnews* issue 12). Maintenance of the fences consists of clearing vegetation around the wires in order to avoid short circuits and checking the continuity and intensity of the power supply. Follow-up maintenance is performed every two weeks during the spring and every 25 to 30 days during the rest of the year.

Protection and maintenance of these electric fences have been slightly different in Val d'Aran than in the rest of the Catalan Pyrenees. In Val d'Aran, apiaries within the ZPP areas were protected with electric fences after damage occurred. Maintenance of these fences was the responsibility of the beekeeper. In the rest of the Catalan Pyrenees, all the apiaries registered or detected within the ZPP areas were protected and the public administration maintained and monitored the fences.

Fig. 2 Electric fence protecting beehives from bears. *(Photos: PirosLife project)*

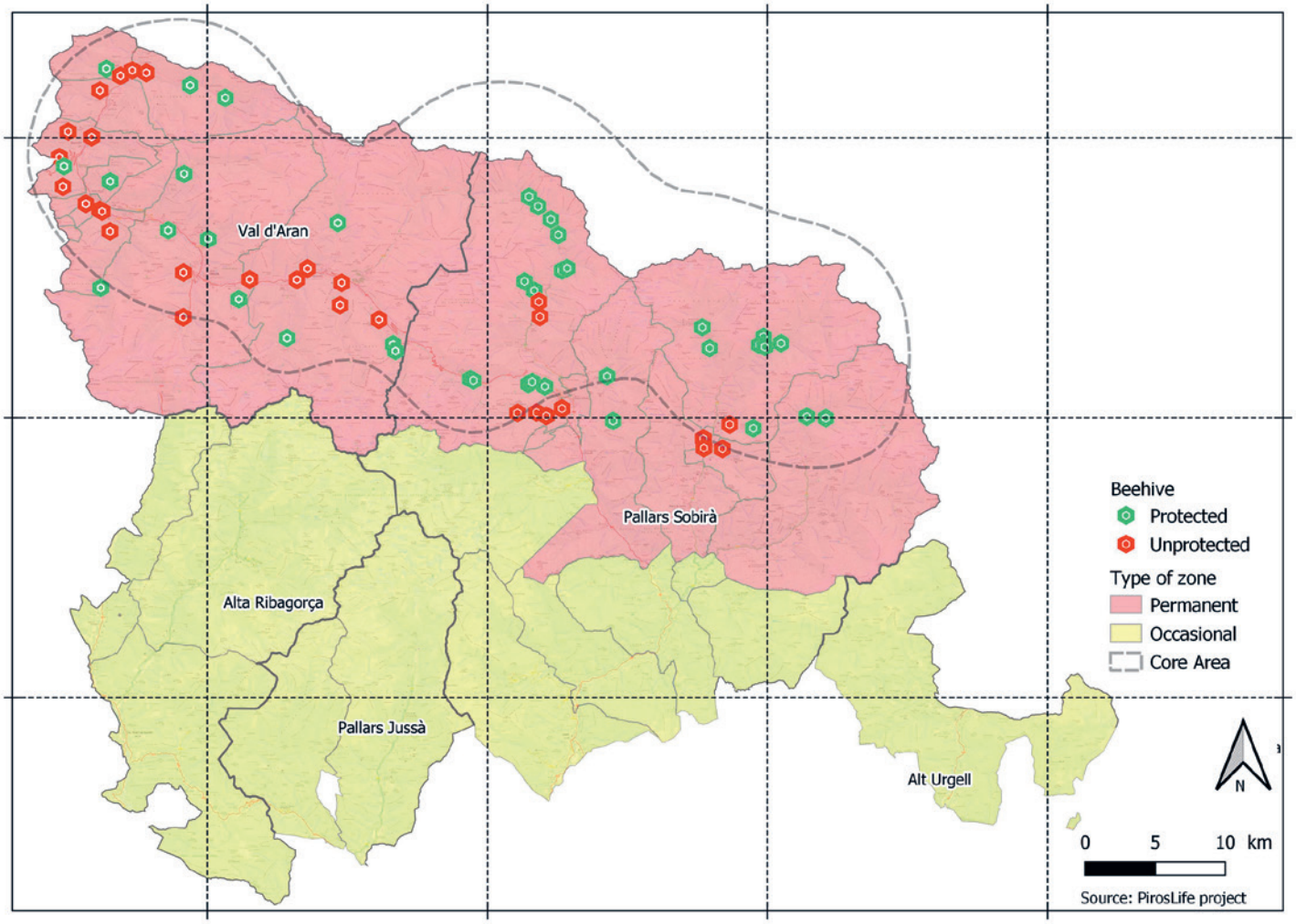

Fig. 3 Protected and unprotected beehives within the zone of permanent presence of bears in 2019.

During the PirosLife project, the proportion of apiaries within the whole project area protected with electric fences peaked in 2019, when 39 of 70 apiaries (56%) located in the ZPP were protected (Fig. 3), including a total of 3,304 hives (63%).

3.1.3 Effectiveness of prevention measures

The outcomes of the applied protection measures differed between areas. Surprisingly, during 2017 and 2018 bears more often damaged protected apiaries than unprotected ones. Most damage to protected beehives occurred in Val d'Aran, due to the presence of individual bears that repeatedly overcame electric fences (Fig. 4). Paradoxically, during 2017 protected beehives suffered 3.75-fold more damage events than unprotected ones (Table 1) and the number of beehives damaged was 10 times higher in protected apiaries. Genetic analysis of biological samples found at damaged beehives revealed that a male bear called Cachou was responsible for these events (see section 3.2.2.2).

In areas without such 'specialised' individuals, properly maintained three-wire electric fences successfully prevented damage by bears. When damage occurred, this was a result of failures in the electrical system due to poor maintenance (vegetation in contact with electric wires or discharged batteries) or defects in fence installation, allowing bears to access beehives easily.

3.1.4 'Specialised' bears

As mentioned above, three-wire electric fences were not enough to stop some individual bears 'specialised' on apiaries. For this reason, electric fences at apiaries that had suffered repeated damage were progressively improved during the PirosLife project. In 2018, double and triple three-wire fences – spaced 50cm apart – were installed, but this change did not increase the protection effectiveness, since 'specialised' bears were still able to pass these fences, either by accumulating soil on the electric wires or digging under them (Fig. 5). Therefore, a new fence design was tested. This consist-

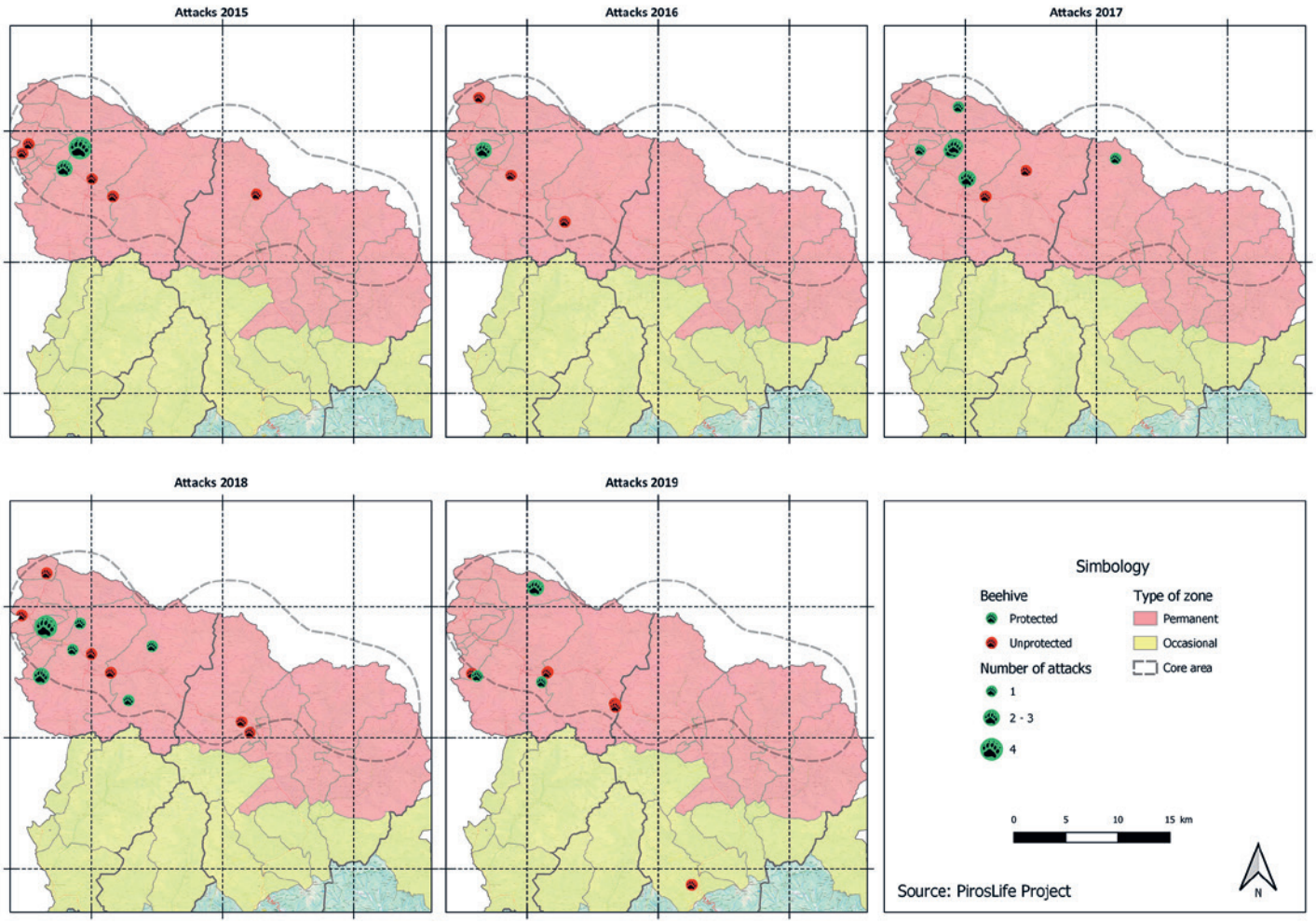

Fig. 4 Incidents of damages by bears to beehives in Catalonia from 2015 to 2019.

Table 1 Number of damage events and hives damaged by bears in protected versus unprotected apiaries in the zone of permanent presence of bears (ZPP) from 2017 to 2019.

Status of apiaries	2017		2018		2019	
	Events	Damage	Events	Damage	Events	Damage
Protected	15	62	10	34	4	14
Unprotected	4	6	6	25	6	28
Total ZPP	**19**	**68**	**16**	**59**	**10**	**42**

Fig. 5 Beehives protected with a double electric fence showing where a bear successfully dug underneath.

ed of wire mesh fencing mounted on wooden poles, with five electrified wires on the outside. In response, 'specialised' bears tried to dig underneath such fences to access beehives (Fig. 6). Therefore, we reinforced these fences with an exterior electric mesh, following which no further damage was recorded.

Two more electric fence designs were developed in 2019 in order to prevent 'specialised' bears from accessing apiaries. The first design, for heavy permanent fencing, was 2.2 m high and built with rigid 15×15 cm iron mesh attached to concrete posts and cemented into the ground, with three electrified wires on the outside. The second design, lighter and mobile, was the same as that tested in 2018 but, to prevent bears digging underneath, 150 cm-wide rigid iron mesh was placed horizontally on the ground, 100 cm outside the fence and 50 on inside (Fig. 7). Since the installation of these reinforced fences, no further events have been detected at apiaries that were previously subject to repeated damage by specialised bears.

3.2 Livestock

3.2.1 Sheep and goats

Sheep and goat farms in the Pyrenees mainly consist of small- and medium-sized farms that use the grass on alpine and subalpine mountains in summer and valleys in winter. The PirosLife project protected approximately 8,000 head of livestock of 40 different owners. In addition, some farmers focused on meat production bring their flocks from other parts of Catalonia to graze on mountain meadows in the ZPP during the summer season, temporarily increasing the number of sheep and goats in the area. During the PirosLife project, four transhumant flocks moved to the project area with a total of 6,000 animals. The owners of these flocks took care of protection measures themselves, using a combination of electric fences, shepherds and livestock guarding dogs (LGDs). The PirosLife project donated equipment (battery, solar panel, mesh) when it was requested by farmers.

Fig. 6 Brown bear digging attempt and detail of fence construction.

Fig. 7 Improved electric fence designs to prevent repeated damage to beehives by 'specialised' bears.

3.2.1.1 Implementation of prevention measures

Shepherds and LGDs almost disappeared in the project area after the eradication of large carnivores. Following the recovery of the bear and the progressive increase of its population, the need to revive these management elements became evident in order to make extensive livestock farming compatible with brown bear conservation. Therefore, the following measures for coexistence were considered:

a. To merge some small flocks into larger flocks, with more than 600 head;
b. To hire herdsmen to watch over flocks during the summer grazing season;
c. To build huts for shepherds to improve their working conditions;
d. To encourage the use of LGDs;
e. To encourage the enclosure of flocks at night in electrified mesh corrals.

The number of protected flocks has varied over the years and according to the needs of the sector. Participation in these groups was a voluntary decision, so that not all livestock farms became beneficiaries. Participating farmers signed a collaboration agreement with the administration, making the following commitments:

- The administration committed itself to pay for shepherds and installing shepherds' huts; to provide and supervise electric fences, batteries and solar panels; to give technical support with LGDs; and to carry out veterinary inspections to check the health status and body condition of livestock.
- The livestock farms had to ensure they had a shepherd working every day, therefore ensuring a replacement during holidays. They were also responsible for verifying the optimal health status and physical condition of animals before including them in the protected flock, to avoid compromising the management of the rest of the group. If optimal health status is not ensured, weaker animals may not be able to follow the rest of the flock, presenting a challenge to protect them within electric fences during the night, increasing the risk of bear attack.

Flocks consisted mainly of sheep for meat. There were not enough goats in the project area to justify the existence of a goat-only flock. In addition, many sheep breeders would not agree to include goats in sheep flocks because of their different behaviour and pasture management. Therefore, goats were not included in combined flocks or even, in most cases, in the project's prevention measures.

Combined flocks were formed for periods of between 3.5 and 5 months from June to October. Each flock included from 600 to 2,000 animals. During the PirosLife project, six to seven flocks were formed each year, each of which had two or three LGDs (Pyrenean Mountain Dog or Spanish Mastiff breeds). In most cases, farmers obtained the LGDs themselves from other farms although, in some cases, the public administration assigned them purebred Pyrenean Mountain Dogs. Additionally, all these flocks were protected with electric fences at night (Fig. 8). The number of protected flocks and farms increased throughout the project. On average, 78% of flocks within the ZPP were protected during the PirosLife project (Fig. 9).

Fig. 8 Sheep flock protected by electric netting and LGDs.

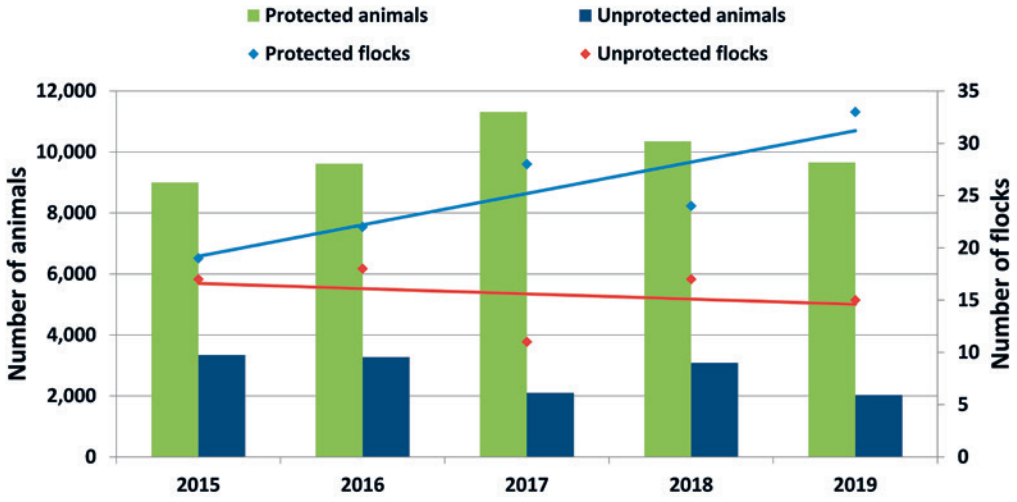

Fig. 9 Numbers of protected and unprotected flocks and animals during the PirosLife project.

3.2.1.2 Effectiveness of prevention measures

Overall, unprotected livestock suffered a higher number of attacks and damage than protected ones, which is evident when we consider the number of animals present in the region in each category (Table 2). On average, 67% of damage was to unprotected livestock and 33% to livestock protected with the measures described above (see section 3.2.1.1). The maximum difference between these two groups was reached in 2018, when 87% of damage was to unprotected livestock. Furthermore, the number of losses per attack was usually lower in protected livestock.

Among the attacks that affected unprotected flocks, three different situations were detected: 74% of attacks affected large farms that grazed extensively during the summer but had not voluntarily adhered to prevention measures and, therefore, did not protect the flocks overnight or use LGDs. Another 16% of attacks occurred on flocks located at the bottom of the valley and outside the summer protection campaign. Finally, 10% of attacks happened on small farms (less than 50 head) that were not included in the prevention system and did not graze on mountain pastures during the summer season.

Among the flocks with preventive measures, 64% of damage occurred while animals were not properly protected. This was mostly due to certain weather conditions (e.g. intense storms or presence of fog) or because some animals were incapable of following the flock due to poor health status or physical condition. The remaining 36% of attacks on protected flocks occurred despite the correct application of protective measures (Fig. 10).

During the PirosLife project, the probability of protected sheep suffering an attack was 0.19% (sd = 0.05), compared to 1.42% (sd=1.04) for unprotected sheep. These figures were obtained by dividing the number of animals killed by bears by the total number of animals included in flocks, considering the number of livestock each year. Unprotected flocks were therefore 7.5-times more likely to suffer an attack than protected ones (Fig. 11).

3.2.1.3. Particular cases

In 2018, an unprotected flock of approximately 2,000 animals that grazed very close to a protected flock suffered several attacks. When this flock moved to another area, the protected flock started suffering bear attacks, probably as a result of the presence of a bear that had become accustomed to attacking the unprotected sheep. In order to improve the protection of the pen, an additional three-wire electrified perimeter fence was installed at a distance of 60 m from the electrified mesh with the aim of preventing the bear from approaching close to the sheep. Based on observations, it seems that this additional fence prevented the sheep from detecting the presence of a bear in close proximity, thereby reducing their stress which had previously resulted in them breaking through the fence. When fences break, protection becomes a challenge, because animals scatter down the mountain. This additional fence also facilitated the work of the LGDs and prevented the animals from passing through the fence if they were frightened.

Some other bear attacks in 2018 happened as a result of a lack of correct implementation of the prevention system. A few participating breeders did not

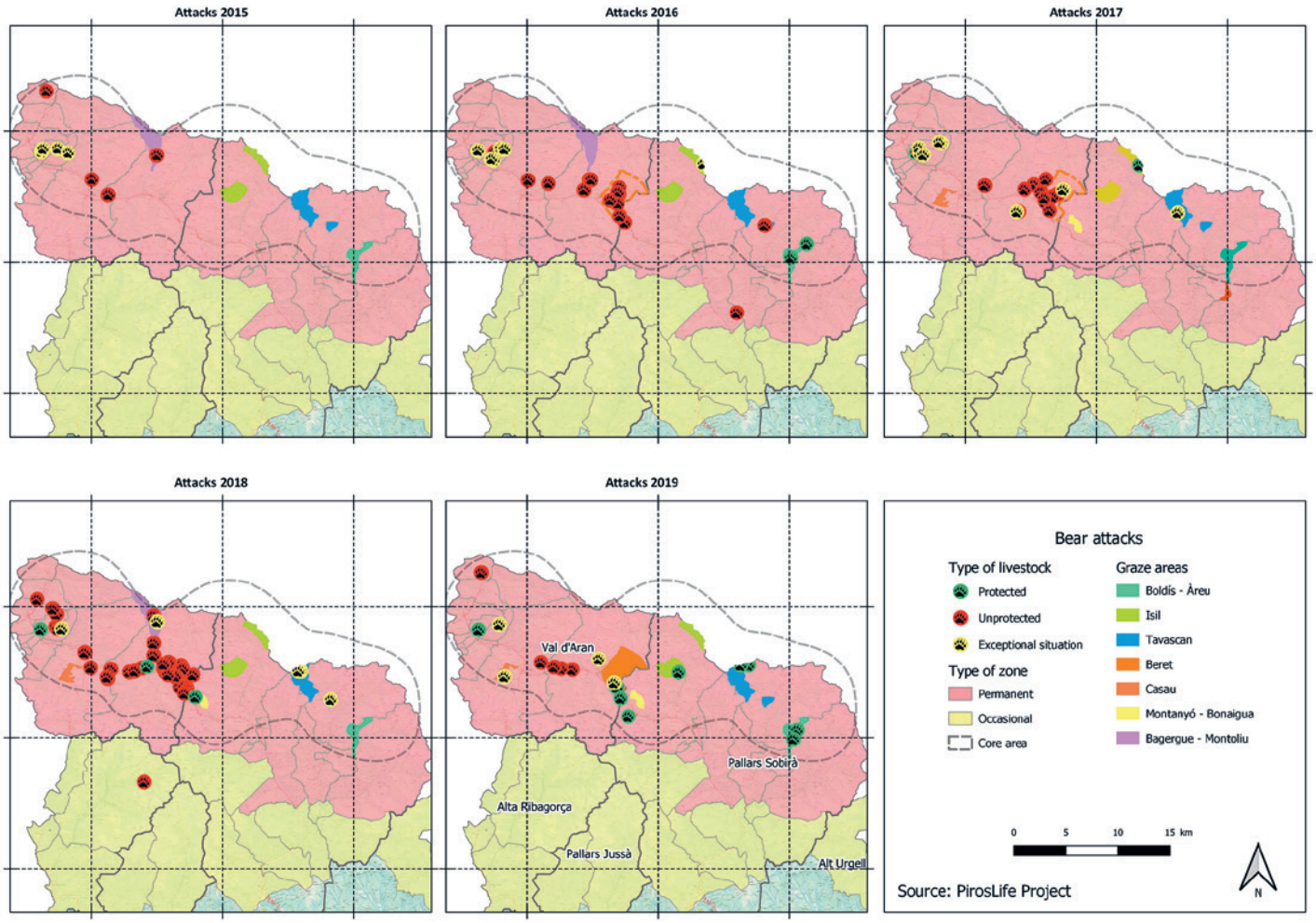

Fig. 10 Distribution of damage to livestock by bears in Catalonia in 2015–2019.

Table 2 Damage by bears to protected and unprotected livestock within the Catalonia zone of permanent presence of bears during the PirosLife project.

Year	Status of flock	No. animals	No. attacks	Attacks/ Animals (%)	No. lost	Losses/ Animals (%)	Lost/ Attack
2015	Protected	8,997	5	0.06	8	0.09	1.60
	Unprotected	3,342	6	0.18	7	0.21	1.17
	Total	**12,339**	**11**	**0.09**	**15**	**0.12**	**1.36**
2016	Protected	9,615	9	0.09	16	0.17	1.78
	Unprotected	3,272	16	0.49	30	0.92	1.88
	Total	**12,887**	**25**	**0.19**	**46**	**0.36**	**1.84**
2017	Protected	11,310	9	0.08	17	0.15	1.89
	Unprotected	2,099	13	0.62	28	1.33	2.15
	Total	**13,409**	**22**	**0.16**	**45**	**0.34**	**2.05**
2018	Protected	10,353	9	0.09	13	0.13	1.44
	Unprotected	3,082	52	1.69	87	2.82	1.67
	Total	**13,435**	**61**	**0.45**	**100**	**0.74**	**1.64**
2019	Protected	9,652	14	0.15	17	0.18	1.21
	Unprotected	2,031	7	0.34	10	0.49	1.43
	Total	**11,683**	**21**	**0.18**	**27**	**0.23**	**1.29**
Average/ Year	Protected	9,985	9	0.09	14	0.14	1.56
	Unprotected	2,765	19	0.68	32	1.17	1.68

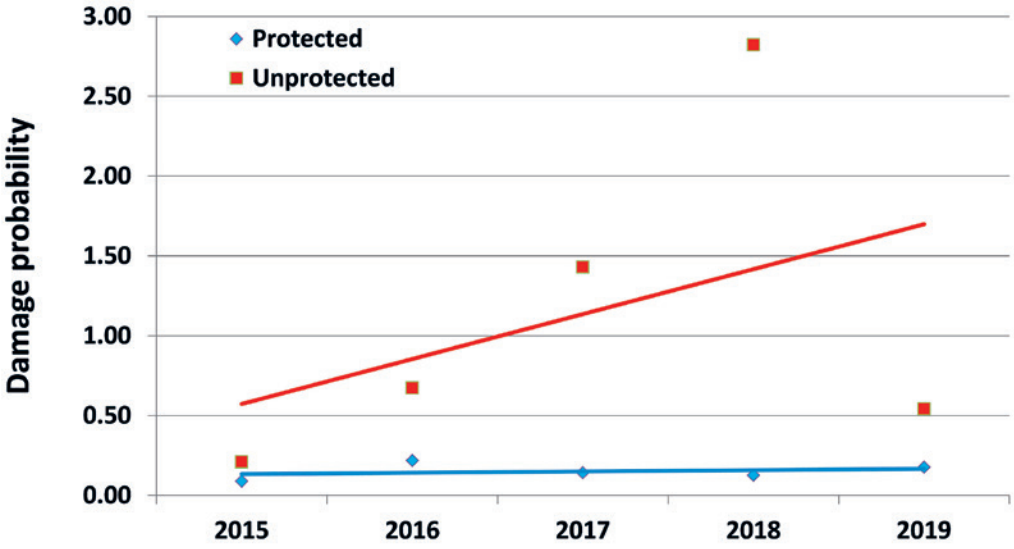

Fig. 11 Probability of suffering damage in protected and unprotected livestock from 2015 to 2019.

apply the measures agreed with the public administration; prevention material and support were therefore removed. There was thus a substantial increase in the number of unprotected flocks in 2018 and, as a consequence, attacks and damage to the resulting unprotected animals also increased. During 2019 the farmers implemented the protection measures correctly and the situation reversed: total damage was reduced from 100 animals killed in 2018 to 27 in 2019.

3.2.2 Cattle and horses

Management of cattle and horses within the project area is characterised by extensive grazing in alpine meadows during the summer season without surveillance or protective measures. Most animals belong to local farmers; transhumant cattle are not very common in the area.

3.2.2.1 Implementation of prevention measures

It is not currently possible to use prevention measures for cattle and horses homologous to those implemented for sheep. One reason is that their cost is not likely to be offset by the benefits of their use. Some pastures are more than three hours away from farms and using electric fences to protect animals overnight would be costly. In addition, farmers are not with their cattle on a daily basis but, more often, only once a week. LGDs have not yet been used in the Pyrenees for large stock, which presents many challenges due to the local context. The free-grazing system makes it harder for dogs to properly bond with cattle which are never in stables, being kept year-round in the mountains or in lower pastures in the valleys, usually confined with a single electric wire. The system also makes it difficult for farmers to regularly monitor dogs' development. Furthermore, the high presence of tourists may easily disturb LGDs and compromise their development and future performance. Therefore, no prevention measures were applied to large stock within the PirosLife project. Instead, a support action to bovine and equine herds was carried out: a person was hired to provide an additional weekly monitoring service in the mountains with the aim of detecting incidents and potential interactions of cattle with bears.

3.2.2.2 'Specialised' bears

Attacks on large livestock were less common than on sheep and goats. When attacks occurred, they were mostly caused by specific bears that had 'specialised' on this kind of livestock. In particular, two male bears named Goiat and Cachou repeatedly caused damage, especially to horses. Goiat was captured in Slovenia and released in Catalonia in 2016, when he was nine years old. He was the main cause of damage to the equine sector in 2017–2018 (Fig. 12), with a total of 11 animals killed in 2018, and an additional case in 2019. Cachou was a local male, captured with a culvert trap and fitted with a GPS collar in May 2019, when he was four years old. He was responsible for seven attacks on mares and foals during summer 2019. Five of these attacks took place within a 15-day period.

All damage caused by these two male bears occurred within ZPP areas, especially that belonging to the Val d'Aran, and affected both young and adult animals, apparently in good health. Within the PirosLife project area, these two bears spent most of their time in Val d'Aran (Goiat in 2017–2018 and Cachou in 2019).

Fig. 12 A mare killed by a brown bear in Catalonia.

Goiat's attacks on horses during 2017 and 2018 caused alarm in the community, leading to the approval of a *Protocol for intervention with bears in the Pyrenees*, prepared by the Pyrenean Brown Bear Working Group (Anon., 2018). This protocol defines the characteristics of a "repeatedly predatory brown bear" as "an animal that repeatedly attacks livestock over an extended period of time (at least two months), with four or more attacks per week on protected sheep or goat flocks, or one or more attacks per week on (unprotected) cattle or horses" (Anon., 2018) and allows the application of aversive conditioning measures and even the removal of such individuals from the natural environment in exceptional cases.

In Val d'Aran, several aversive conditioning techniques were attempted in order to prevent attacks by Goiat and Cachou but in this case proved to be unsuitable. These two bears avoided people and, as a result, aversion techniques were impractical as they could not be performed during an attack. For example, after Goiat had attacked large livestock, acoustic aversive techniques, electric fences or pyrotechnics were applied close to the carcass(es) or large livestock herds, but the next night he attacked horses again. Nevertheless, Goiat's predation on horses decreased and he did not cause any damage to horses in the Pyrenees after July 2019.

Supplementary feeding was conducted in autumn 2019 in an attempt to stop Cachou attacking livestock. Deer carcasses were provided close to horses on which he had previously predated, following which Cachou started predating on wild deer, with only one subsequent attack on horses. Later, Thiram, a fungicide that has been used on wildlife as a chemical repellent (Tobajas et al., 2020), was applied to horse carrion. After his exposure to this chemical, Cachou did not commit additional attacks on livestock. Unfortunately, his death in spring 2020 prevented verification of the long-term effectiveness of these methods.

3.3 Conclusions and recommendations

3.3.1 Beekeeping

Protection of apiaries within the ZPP during the PirosLife project period (2015–2019), as described in section 3.1.2, reduced damage by bears to only one case where the public administration maintained the prevention measures and up to 15 cases where beekeepers were responsible for maintenance, excluding damage related to areas with 'specialised' bears**.** As previously described by other authors (Seijas et al., 2016; Vittorio et al., 2016), the experience of using electric fences to protect beehives during the PirosLife project shows that their effectiveness is dependent not only on proper set-up but also on regular maintenance, such as vegetation clearance around the wires, and a minimum intensity of 4 kilovolts.

In relation to 'specialised' bears that bypass simple electrified fences, the project demonstrated the effectiveness of reinforced barriers: a combination of mesh fencing, electrified wires and anti-digging systems. The additional costs of such measures are amortised within a few years after installation.

3.3.2 Sheep and goats

The probability of bear damage occurring to sheep was 7.5-fold greater for unprotected flocks than for protected ones. The most effective approach is a combination of protection measures: presence of herdsmen, use of LGDs and/or night-time confinement in corrals. Preventive measures have not yet been applied to extensive goat grazing, since this is less common in the project area and husbandry practices hinder the application of such measures. Farmers and shepherds do not support mixing of goats and sheep in a single flock due to their behavioural differences, which

could lead to serious challenges for shepherds to manage the flock and keep track of all individuals while grazing in high mountain pastures.

3.3.3 Cattle and horses

No efficient method of preventing damage to large livestock is widely considered applicable to the region. This affects the level of acceptance of bears by local farmers. Male bears predating on adult mares hampers the establishment of coexistence between the livestock farming sector and the brown bear in the Pyrenees, causing a deep social conflict. To address this, the use of LGDs and technological tools for monitoring are being evaluated, but it is still too early for their implementation.

Aversive measures applied to an adult male bear 'specialised' on horses did not entirely result in the desired outcome, although he progressively changed his behaviour and attacked horses less often. Chemical aversion and supplementary feeding applied to a sub-adult male showed some initial promise, but their long-term effectiveness could not be evaluated. These two bears were not habituated to people and so, when approached by technicians seeking to apply aversive measures, they fled the area. Our experience suggests that classical aversive techniques are not suitable for elusive bears. Nevertheless, further attempts should be made before drawing stronger conclusions regarding their application and effectiveness.

Acknowledgements

Damage prevention methods were developed within the frame of the PirosLife project (LIFE13NAT/ES/001394), co-funded by the EU within the LIFE Programme. Special thanks go to the Forestal Catalana and the Agents Miei Ambient brown bear surveillance team that conducted most of the fieldwork and implemented prevention measures. We also thank the Department of Territory and Sustainability (Government of Catalonia), General Council of Aran, Fundación Oso Pardo and Cos d'Agents Rurals for working together with a common goal: brown bear management and conservation.

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COMMUNICATING ABOUT CARNIVORES: THE GOOD, THE BAD AND THE UGLY

The photo on the left shows the typical appearance of a wolf while that on the right is of the more 'dramatic', eye-catching type of image often favoured by journalists to draw attention to their articles.

Our role in the LIFE EuroLargeCarnivores project (LIFE16 GIE/DE/000661) is mainly about bringing people together from very different backgrounds, such as landowners and conservationists. For this kind of dialogue, face-to-face meetings in neutral locations are usually preferred. However, due to the COVID-19 pandemic and the necessity of 'home office' working, we have had to rethink our communication methods. Our work as project partners and facilitators has changed immensely over the last year as a result.

Current measures to combat the global health crisis have limited the possibilities for direct interactions between people, but digital tools provide new opportunities to connect. Besides a few one-on-one meetings held outdoors, communication has shifted to a great extent online. With the help of video calls and virtual conferences, stakeholders who would not have had the time or budget to travel to distant meetings can now get involved in workshops and even excursions.

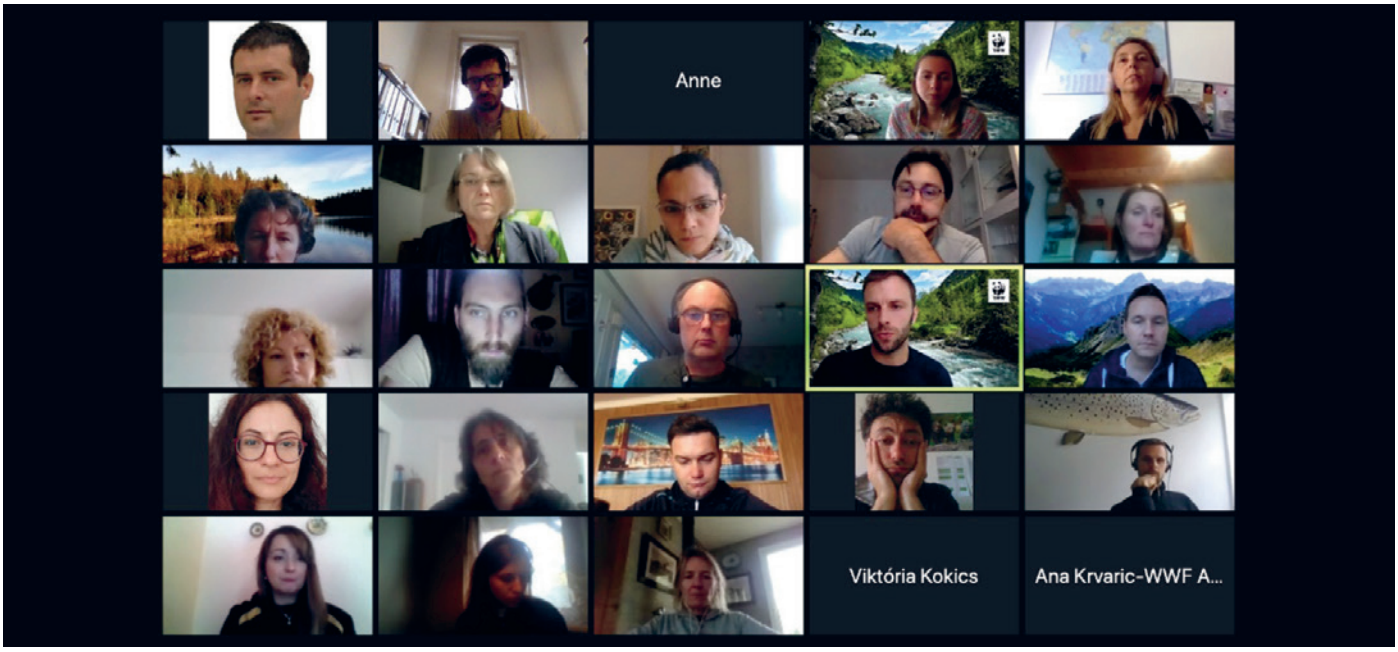
The pandemic has not changed our subject matter: there is still a need to find long-term solutions for coexistence with large carnivores and to mitigate conflicts between different stakeholders. Public discussions on the costs and benefits of large carnivores, particularly the wolf and bear, continue unabated. People often refer to socio-economic aspects to justify a wide range of proposals, from rewilding (i.e. restoring land to its natural, uncultivated state) to establishing wolf-free zones (i.e. removing predators from an area). To improve understanding of what underlies such discussions, we invited a team of independent researchers from the Helmholtz-Centre for Environmental Research and the University of Göttingen in Germany to conduct a comprehensive impact assess-

ment of the presence of large carnivores.

In their article '*Why so negative? Exploring the socio-economic impacts of large carnivores from a European perspective'*, the authors reviewed 77 academic articles on wolves, bears, lynx and wolverines in Europe and North America[1]. They found that the studies tended to be biased towards negative economic effects. Benefits of large carnivore presence to people were often overlooked. These potentially include impacts in the domains of economics (e.g. ecosystem services, commercial ventures), health and well-being (e.g. positive emotions), social and cultural aspects (e.g. cultural heritage, educational and research value). Well-meaning scientists were probably just trying to solve people's problems but, in so doing, they may have been inadvertently reinforcing negative perceptions of carnivores.

Of course, it is not only science that has tended to focus on the negative aspects of large carnivores. Newspapers, television and social media regularly report on, for example, farmers who lost livestock and people who were involved in threatening encounters with wildlife, rather than positive stories such as inspiring sightings of rare species or even just a normal, trouble-free day on a farm. Photo editors often choose dramatic, eye-catching images of aggressive-looking carnivores, giving misleading impressions of how they usually appear (see photos).

There is a clear need for unbiased reporting to inform discussions about large carnivores and for more research on the beneficial aspects of their presence. Whether in digital or analogue form, constructive communication therefore remains the keystone of our efforts to foster better coexistence between people and large carnivores in Europe.



LIFE EuroLargeCarnivores virtual team meeting, October 2020. *(Photo: © LIFE ELC)*

Leonie Weltgen, Raffael Hickisch and Moritz Klose
WWF Germany, Reinhardtstraße 18, 10117 Berlin, Germany
Contact: Leonie.Weltgen@wwf.de
www.eurolargecarnivores.eu

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Research

MULTI-DISCIPLINARY APPROACHES FOR MANAGING SHEEP AND WOLVES IN TUSCANY

Valeria Salvatori [1], Lucia Tudini [2], Simone Ricci [1], Claudio Galli [3], Dario Petrucci [3], Edoardo Passalacqua [4], Aldo Pollini [5], Fabio Rosso [5], Andrea Masini [6], Cristian Serra [6]

[1] *Istituto di Ecologia Applicata (IEA), Via B. Eustachio 10, 00161 Rome, Italy*
Contact: valeria.salvatori@gmail.com
[2] *Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (CREA), Via Po 14, 00198 Roma, Italy*
[3] *Regione Toscana, Via di Novoli 26, 50127 Firenze, Italy*
[4] *Confederazione Generale dell'Agricoltura (Confagricoltura) Grosseto, Via de' Barberi 108, 58100 Grosseto, Italy*
[5] *Confederazione Italiana Agricoltori (CIA) Grosseto, Via Monterosa 130, 58100 Grosseto, Italy*
[6] *COLDIRETTI Grosseto, Via Roccastrada 2, 58100 Grosseto, Italy*

www.medwolf.eu

1. Introduction

Populations of large predatory species such as the wolf (*Canis lupus*), brown bear (*Ursus arctos*) and lynx (*Lynx lynx*) are recovering in Europe (Chapron et al., 2014). Increases in numbers and densities are associated with expansions of their ranges. Their presence has recently been reported in areas where they had been absent for decades (Boitani, 2018), often resulting in predation on livestock if this is not adequately protected (Naughton-Treves et al., 2003). Wolves, in particular, have shown a significant increase in their range in many European countries. In areas of recent wolf recolonisation, where prevention measures are not used, livestock quickly becomes vulnerable prey.

Compensation programmes for economic losses due to depredation are in place in most European countries (Fourli, 1999; Gervasi et al., submitted), but are commonly perceived as insufficient for mitigating the impact of large carnivores on livestock production (Bautista et al., 2019). Compensation schemes are often linked to the use of prevention measures (Fourli, 1999), even though the effectiveness of such tools has not been adequately assessed (Eklund et al., 2017). Moreover, an important social component appears to be systematically underestimated: the willingness of farmers to adopt prevention measures and their associated costs (Widman et al., 2019). In areas where large carnivores have always been present, the use of damage prevention measures to protect livestock is considered part of the farm productivity system. However, in areas of recent recolonisation, farmers may not be prepared to protect their animals and the inclusion of damage prevention measures in the husbandry system may imply modifications that significantly impact productivity (Widman et al., 2019).

In order to provide assistance to farmers and thus increase their tolerance of protected large carnivores in areas of recent recolonisation, the European Commission has funded a number of projects to support

A focus group with livestock breeders in Grosseto Province. *(Photo: LIFE MedWolf)*

the improvement of management practices (Salvatori and Mertens, 2012). Although a range of preventive measures have been used to decrease the impact of depredation, no single method fits all situations and approaches usually have to be adapted to local conditions (Shivik, 2006; Eklund et al., 2017).

In central Italy, wolves have increased in density and expanded their range to the lowlands, being increasingly reported in coastal areas (Galaverni et al., 2016; Lucchesi et al., 2019). The impacts of wolf predation on small-scale, semi-extensive farming systems have been increasing in the last decade and compensation programmes have proven unsatisfactory (Marino et al., 2016).

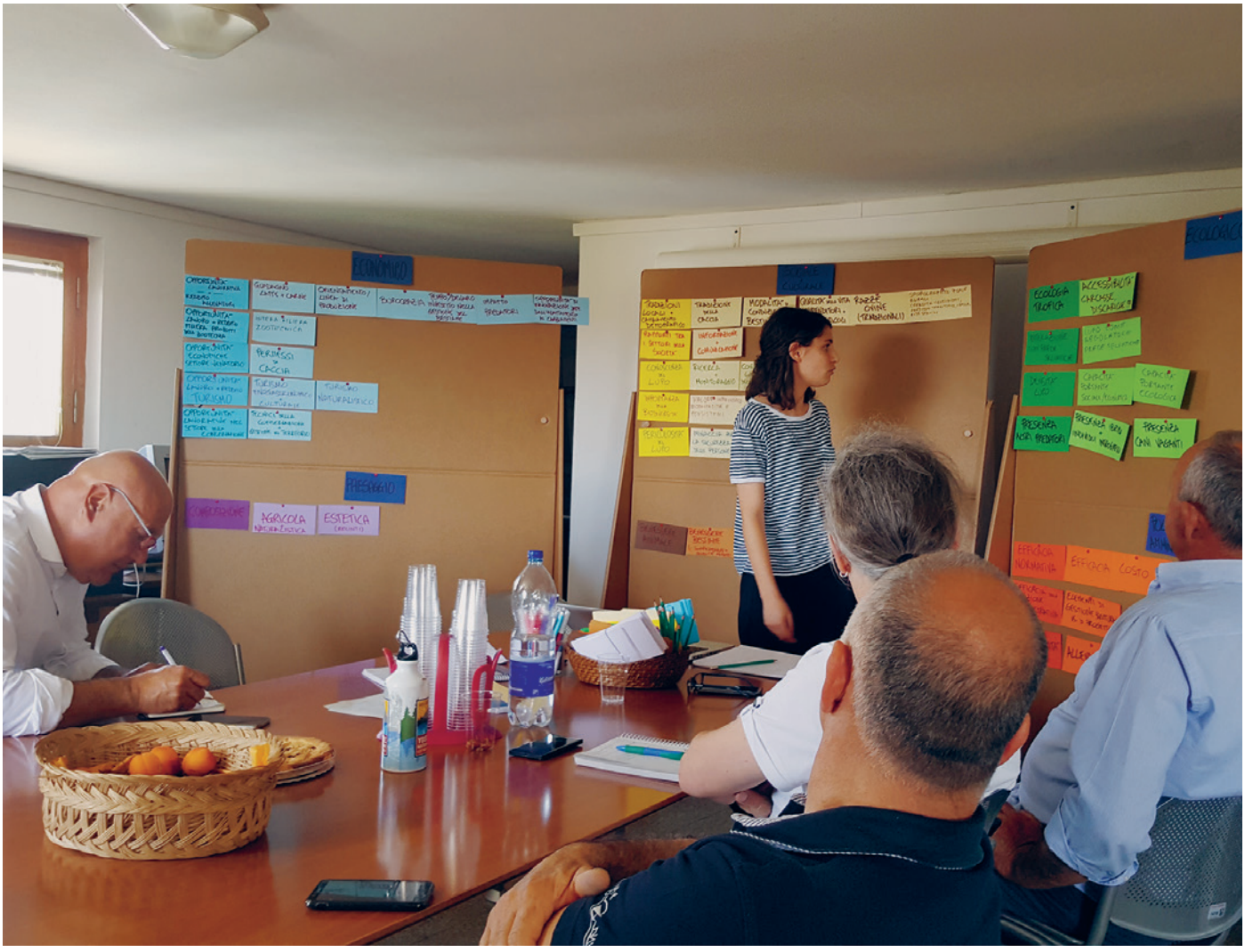
The coexistence of wolves and agricultural activities is a complex and challenging issue, made even more difficult to address as the extensive grazing sheep milk sector already faces serious market difficulties in many European countries. Sheep and goat production plays a marginal role in the agricultural economy of Italy, representing just over 1% of the total value of national agricultural production (ISMEA, 2018). The survival of livestock is, however, crucial for its social and environmental functions in specific areas where other productive activities would not be possible. The sheep milk supply chain at national and local levels is currently facing a market crisis, accentuated over the years by contingent health issues, economic-monetary factors, the decrease in domestic consumption and the collapse in exports for some varieties of cheese (ISMEA, 2020).

Among small-scale producers, the breeding phase is structurally the weakest step in this supply chain, in terms of both contractual relationships with the processing phase and exposure to market fluctuations, as it requires a considerable investment of energy and resources and is vulnerable to environmental and ecological factors, such as the presence of predators and availability of fodder. In Tuscany, there are several complex problems associated with the effects of climate change on the costs and availability of pasture and preserved fodder as well as on production performance, and with the overall market difficulties of products derived from sheep's milk (*pecorino*), culminating in the termination of numerous milk supply contracts by some important processing companies operating in the Region (ISMEA, 2019). It is against this backdrop that in recent decades Tuscan breeders have had to deal with the presence of the wolf and the impact it has on production. Tackling these issues effectively calls for a multi-actor, multi-sector approach developed in a multi-step mode, with each step envisaging consultation and information phases.

With the aim of decreasing the negative impacts of wolves on livestock farming, as part of the LIFE[1] Med-Wolf project (IEA, 2018) we implemented damage prevention measures in an area of central Italy where wolf density had recently increased and assessed: (1) the effectiveness of the implemented measures; and (2) the costs of their implementation at a model small-scale, extensive sheep farm. We anticipated that shared responsibility through participatory processes and active involvement of the affected party would increase the quality of implementation and the information needed to obtain results that could be used for guiding future management policies. We therefore organised a series of events targeting different audiences but made sure that results and planning were always shared with the farmers involved in the project.

2. Background: LIFE MedWolf project

The LIFE MedWolf[1] project, which ran from 2012 to 2017, aimed at mitigating the impact of the wolf on livestock production through the implementation of preventive measures as a tool to increase the tolerance of farmers for this species in two areas with a Mediterranean environment. The wolf is protected in both Italy and Portugal and its populations in these countries are expanding into areas where they have been absent for decades. The two project sites, the province of Grosseto in central Italy and the districts of Guarda and Castelo Branco in north-east Portugal, are dominated by semi-agricultural landscapes, where productive activities represent a significant share of the local economies. The presence of a top predator such as the wolf in these areas is associated with sig-



Application of Multi Criteria Decision Making approach with different stakeholders in Grosseto province. *(Photo: LIFE MedWolf)*

[1] http://www.medwolf.eu/

nificant impacts on farmers because common husbandry practices, such as extensive and semi-extensive grazing in small pastures, leave livestock vulnerable to predation.

The project aimed to share experience and knowledge of damage prevention measures from all over Europe and beyond; establish partnerships with the rural sector; empower selected holdings in management of entrepreneurial activities linked to damage prevention and livestock management; and optimise management efforts through identification of potential areas for expansion. To reach these objectives, several actions were implemented in order to: (1) train the local actors involved; (2) implement damage prevention measures following evidence-based criteria; and (3) assess the effectiveness of the implemented actions.

Each step was developed with an effort to adopt a participatory approach that empowered the different stakeholders, making them aware of their responsibilities. One of the major characteristics of the project in Grosseto was its shared responsibility approach, whereby project partners from environmental associations, agricultural unions and local authorities all received funds for the implementation of some actions and decisions were taken collectively. This was a novel approach, with intra-sectoral collaboration leading to agreement on what activities to implement or how to modify planned interventions.

Social aspects that contribute to conflict ought not to be underestimated and we therefore held many meetings and participatory events that were well-regarded by participants. In this article, we describe the stepwise process used in Grosseto and estimate the costs of adopting damage prevention measures in the province.

3. Study area: Grosseto

The province of Grosseto (mainland 4,479 km^2) is located in the southernmost part of Tuscany, central Italy (Fig. 1). The landscape consists largely of rolling hills at an average altitude of 235m (±225) above sea level. Around 54% of the province is used for agriculture, with mainly broad-leaved forests covering an additional 43%. The average human density is about 50 inhabitants/km^2 (ISTAT, 2013). Livestock production is an important economic activity: in 2013 there were an estimated 3,300 active livestock

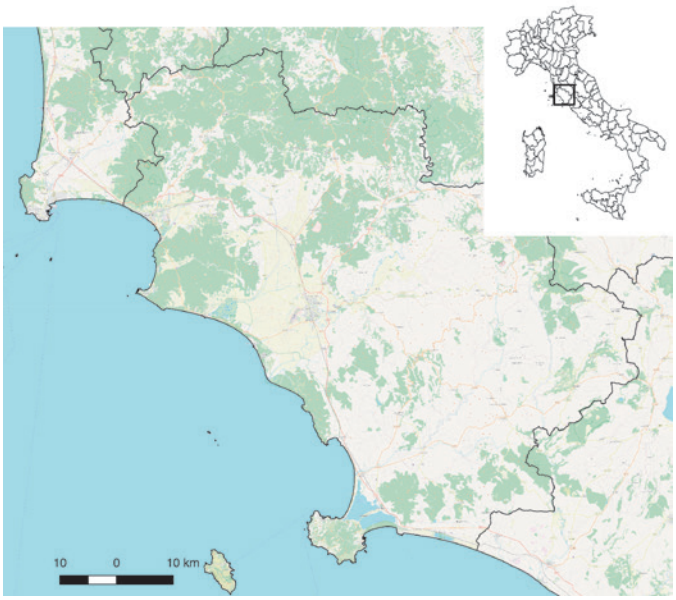


Fig. 1 The province of Grosseto, Italy.

owners (BDN, 2013). Sheep are by far the most numerous species of livestock in the province, with 48.1 head/km^2, followed by cattle (5.9 head/km^2), equines (1.2 head/km^2) and goats (0.54 head/km^2) (BDN, 2013). Reflecting the general trend of decline of the sheep breeding sector, the number of sheep owners has decreased by 3.6% (±1.1) and the number of sheep produced by 2.0% (±2.3) per annum since 2006 (BDN 2013).

Wolves began re-colonising Grosseto in the early 1980s (Boitani and Ciucci, 1993), having been nearly eradicated by the late 1960s (Cagnolaro et al., 1974, A survey in 2013–2014 estimated there to be a minimum of 13 packs in the area, while in 2017 the estimate rose to 22–24 packs (Ricci et al., 2018; Salvatori et al., 2019). They feed on locally abundant roe deer *(Capreolus capreolus)* and wild boar *(Sus scrofa)* as well as livestock, mostly sheep, which represent a secondary item in their diet (Bargagli, 2006).

4. Methods

The LIFE MedWolf project foresaw the implementation of damage prevention measures in Grosseto that had already been adopted in other parts of Italy and elsewhere in Europe (Salvatori and Mertens, 2012). The main tool were mobile electric fences at least 1.2m in height, which have proven effective in significantly reducing damage in different contexts of pasture grazing (Wam et al., 2004). The approach consisted of a series of steps to allow the implementation and evaluation of measures. In order to increase up-

take and empower interested stakeholders, we made the process flexible and included the possibility of modifying technical details (Fig. 2). The methodology for each step is described in detail below.

Step 1 Preliminary assessment

In order to define criteria for selecting beneficiaries of damage prevention measures, we analysed the context with regard to the dynamics (level and location) of wolf attacks on livestock. Data covering the period 2007–2013 were collected from administrative offices involved in damage compensation and assessment, such as the National Health Service Veterinaries, the provincial office for rural development, mayors and a local Consortium (step 1a).

To collect information on the perceptions and interests of farmers, we then organised a series of focus groups (step 1b). We also conducted a total of 150 face-to-face interviews (step 1c) with a random sample of 134 sheep owners with >50 head of sheep selected from a total of 1,094 sheep farms in the province, in proportion to their distribution at the

Fig. 2 Shared responsibility and contributions of different actors in each step of the LIFE MedWolf project implementation process in the province of Grosseto.

municipal scale, and 16 sheep owners who had declared recurrent damages (>6) during the period 2007–2012 (Ricci, 2013).

Step 2 Selection of beneficiaries

To have a longlist of potential beneficiaries to select from, and to make sure we were not imposing any interventions, we opened a call for expressions of interest in receiving damage prevention measures (step 2a). Criteria for selection were based on: location with respect to areas where damage in the previous five years was relatively frequent; number of head; and previous attacks suffered. A total of 201 expressions of interest were received and ranked according to the set criteria (step 2b). Starting with the highest ranking, farmers were visited individually by technicians with long-term experience of setting up damage prevention measures in order to assess their willingness to take part in the project and to decide together what could be the best solution for their husbandry system (step 2c).

Step 3 Assessment of most suitable measures:

As their successful implementation would be highly dependent on the capacity of farmers to include new measures in their current livestock management system, we opted for an approach that would allow them to be tailored to farmers' needs. To this aim, technicians evaluated the feasibility of implementing different measures (step 3a) – mobile electric fences, fixed fences and livestock guarding dogs (LGDs) – and interviewed potential beneficiaries, who were informed of the pros and cons of each measure, as well as providing their input for selecting the most suitable measures for each specific situation (step 3b). In order to include as many farmers as possible, support was limited to €2,500 per farm.

Step 4 Implementation of measures

Once the best suited measures were identified, project partners (farmers' unions) purchased the material needed (step 4a). All selected farmers agreed to contribute to the installation of the selected measures, with economic resources and/or with their own labour, and signed an agreement that implied a commitment to use and maintain in good condition the material received for at least five years after the project's end (step 4b).

Monitoring livestock guarding dog behaviour. *(Photo: L. Vilemi)*

Implementation of LGDs was supported through technical assistance (behavioural, health and sanitary aspects) until dogs reached 18–20 months of age and could be considered self-sufficient and worked independently. Technical assistance was also provided for fence construction and, if necessary, additional interventions were made to rectify unforeseen problems (step 4c). After implementation, farms were visited every six months to monitor correct use of the measures using a structured questionnaire for evaluating elements essential to their proper functionality (step 4d).

Step 5 Evaluation of effectiveness

The effectiveness of damage prevention measures was assessed by project staff using two complementary approaches: a before-after comparison and a treatment-control comparison (see Rigg et al., 2019 in *CDPnews* issue 18). For the former, data were collected through interviews and official statistics of damage suffered at farms that received prevention measures from the project only (step 5a), while the latter was performed through an experimental approach requiring the inclusion of a control sample of farms that did not receive prevention measures, located within 5 km of farms with project measures (step 5b). This buffer was considered to be within the size range of an average wolf pack's territory (Ricci et al., 2018).

A comparison of attacks suffered at 103 control and 50 treatment farms was made for the period from July 2016 to July 2017. Both treatment and control farms were visited after an attack in order to collect data that would allow the characterisation of circumstances in which it occurred. A structured questionnaire was used, with questions aimed at collecting information on the circumstances of attacks and any other attacks that had not been officially reported. We also interviewed farmers in order to assess the degree of satisfaction of those who had received damage prevention measures within the project (n = 62) and who had implemented them through other means (n = 101).

Checking use and status of installed fences. *(Photo: LIFE MedWolf)*

Step 6 Evaluation of costs

Through a shared approach among the various project partners, we identified the main effects of wolf presence[2] on farms (step 6a). In order to obtain information related to the main additional costs and/or losses, a questionnaire was prepared and tested at two farms before administering it to a sample of 20 farmers. This sample was selected taking into consideration a set of variables (location, flock size, membership of union organisation) as well as the willingness of farmers to participate in the survey (step 6b). Finally, a focus group of ten farmers was convened to evaluate the costs associated with the adoption of damage prevention measures at a typical farm in Grosseto (step 6c). Amortisation was calculated using reference values from the National Farming Data Network (FADN) managed by CREA.

Throughout its implementation, a series of meetings was organised to provide farmers with updates on how the project was progressing. In November 2017, a final symposium and a thematic meeting were organised to present the results to those farmers who took part in the project and to the general public in Grosseto and beyond. In April 2019, a thematic workshop on rural development programmes (RDPs) was also held as part of a training action where results of the project were presented.

5. Results

Step 1 Preliminary assessment

Data collected showed that most livestock holdings were managed in an extensive manner, often on rough terrain. Interviews revealed that most livestock owners were engaged in many other activities, as promoted by RDPs. Information gathered showed that dairy production is the main productive line in Grosseto, sheep flocks are split into different productive

[2] The need to identify a shared analysis path stems from the fact that it was decided not to use the data collection methodology of Farm Accountancy Data Network (FADN) because it would have been necessary to have an ex-ante situation (before the introduction of prevention measures) with which to compare the ex-post situation (following the introduction of prevention measures) and we had no funds available for technicians to collect such data at the selected farms.

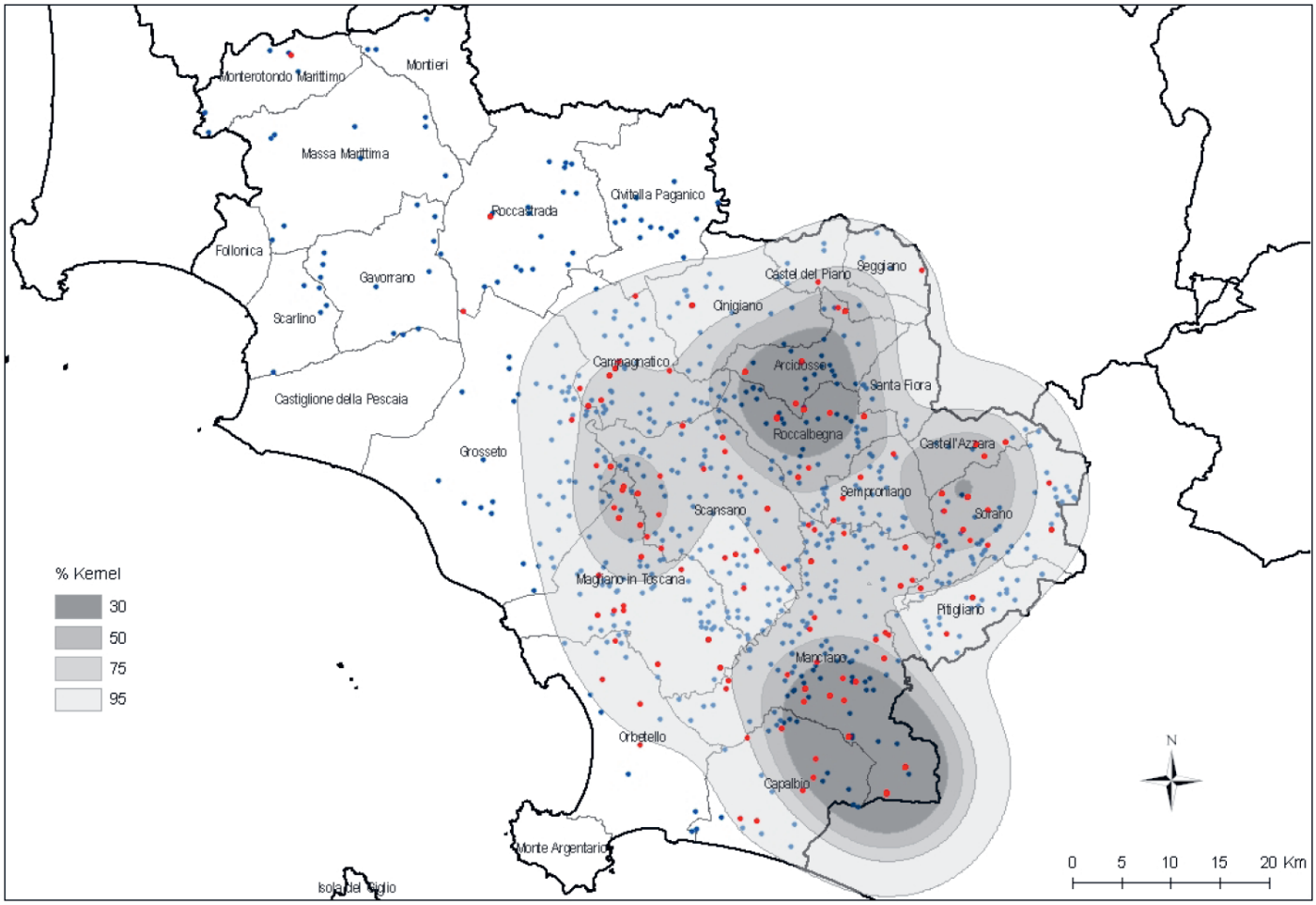


Fig. 3 Spatial distribution of farms that claimed compensation for damage by wolves (red dots) and farms with at least 50 sheep (blue dots) in the province of Grosseto. Grey shading shows the density of damage claims using Kernel Density Estimation.

groups and usually milked at the holding premises twice a day (76% of interviewees).

The landscape and terrain in Grosseto usually allowed grazing areas to be close enough to holdings for flocks to be returned to farms at night. However, most farms did not have appropriate night shelters for their sheep (97% of interviewees reported having 1 m high fences), thus farmers reported high levels of stress and difficulty to rest at night due to the perceived risk of attack (74% reported having suffered attacks at night, often not far from their holdings). Most interviewees (68%) expressed a willingness to receive damage prevention measures.

According to official damage statistics, attacks were mainly concentrated in the east and southeast of the province (Fig. 3). The damage compensation system at the time of our survey (in 2012–2013) was insurance-based, but our results showed that less than 4% of farmers in the province had insurance. This implies that damage often went unreported (Marino et al., 2016).

Step 2 Selection of beneficiaries

A total of 201 expressions of interest were received and a final ranked list was produced according to the set criteria. Visits were made to the 70 highest ranked farms, of whom only six declined the offer to be included in the project after having been fully informed of the conditions and responsibilities.

Step 3 Assessment of most suitable measure

During the preliminary assessment, most farmers had deemed mobile electric fences as unsuitable for their management systems. After consultation with interested farmers, we therefore opted for tools that were easiest to implement and did not require high levels of maintenance, such as fixed metal fences and fixed electric or mixed fences to be used as night shelters. The project also included the implementation of at least 20 LGDs in the area. We thus engaged in a consultation phase with the European Commission and asked permission to modify the planned activities

in their technical implementation and allow for construction of fixed night enclosures, which were more suitable for the project area, rather than mobile electric fences as originally planned.

Step 4 Implementation of measures

The resources available after obtaining permission from the European Commission allowed the project to provide 86 farms with fences, LGDs or both. A total of 79 fences and 54 LGDs were implemented (Table 1).

Table 1 Damage prevention measures implemented at 86 farms in the province of Grosseto through the LIFE MedWolf project.

No. of farms	No. of interventions
Fences	
59	69
LGDs	
19	39
Fences and LGDs	
8	10 fences, 15 LGDs
Total	
86	133 (79 fences + 54 LGDs)

Step 5 Evaluation of effectiveness

The before-after-control-impact (BACI) analysis found a significant decrease in damage suffered by farms (−47% attacks and −50% animals killed) after the adoption of prevention measures. We recorded a total of 139 depredation events between July 2016 and July 2017, 67% of them at control farms versus 33% at treatment farms. The difference between the two groups was greater if the temporal effect is considered: of 32 attacks that occurred at night, 81% occurred at control farms and only 19% at treatment farms (Fig. 4). Moreover, the number of animals killed per attack at night was significantly lower at treatment farms than at control ones (W = 2427, p-value = 0.0398).

Interviews to assess level of satisfaction revealed that fences were judged a valid tool to reduce depredation risk by 81% of respondents (n = 162), while LGDs were evaluated positively by 74% of interviewees. Notwithstanding this high rate of satisfaction, over 60% of interviewees reported that having damage prevention measures was associated with additional work for livestock management.

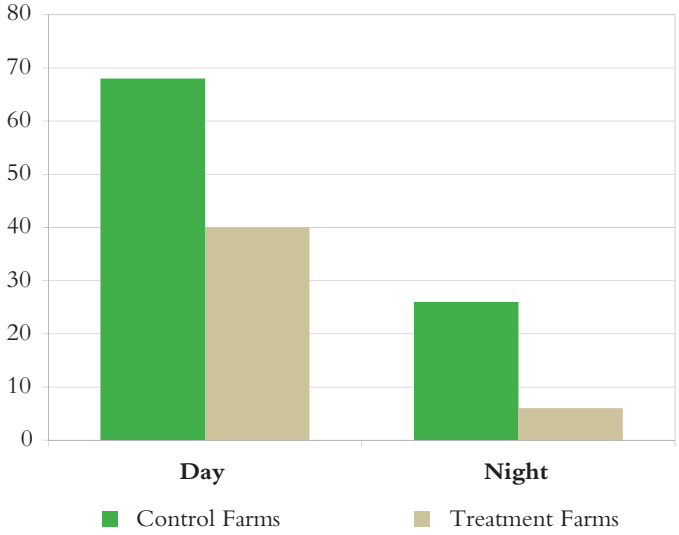


Fig. 4 Number of reported attacks on livestock by wolves at control and treatment farms during the survey period (n=139).

Step 6. Evaluation of costs

Interviews revealed great diversity not only among farms in terms of productive structure and husbandry, but also among farmers regarding their perceptions of wolf presence, of problems related to this, of the difficulties to be faced and of the adoption of different actions and solutions (the typology and use of damage prevention methods), with a variety of changes in management approaches and cost implications.

According to the findings of the focus group, a typical sheep farm in Grosseto was described as having the following general characteristics: family-run, with an average of one or at most two full time equivalent working units; relying primarily on owned land and secondarily rented, but also on other areas for grazing flocks; specialised in sheep breeding (especially dairy), with 300–400 head and selling milk to a processing cooperative; using part of the production for re-use and/or self-consumption; in addition to pastures and fodder, to a lesser extent there are also other productive activities (e.g. cereals, wine, olives), but rarely extra-agricultural activities; it uses the aid of the 1st pillar of the Common Agricultural Policy (CAP) but scarcely activates the investments measures offered by RDPs; for protection from wolves the use of three fences (with a total of 600 linear metres) and 7–8 LGDs (costs for maintenance and recovery) was considered adequate.

Interviews with farmers to assess perception and satisfaction. *(Photo: LIFE MedWolf)*

For a typical farm as described above, the estimate of costs for the adoption and maintenance of damage prevention measures such as fixed metal fences and LGDs ranged from 43 to 54 euros per head per year. It is important to note that 52% of the costs were due to the additional workload, represented mainly by family labour (Fig. 5).

Meetings and workshops were well-attended. Of the 86 farmers who received our damage prevention measures, at least 35 always attended the project meetings. The final international symposium had over 250 registered attendants. More than 25 farmers attended the thematic workshop on RDPs.

6. Discussion

The LIFE MedWolf project represented the first integrated attempt to respond to real problems that sheep farmers have to face as a consequence of wolf presence in a rural area of Tuscany. In order to maximise its effectiveness, we adopted the best available technical tools in conjunction with continuous consultation and participatory approaches. In particular, we focused on:

1. Identifying tailored solutions adapted to the diversity of characteristics and management systems of individual farms, stressing the ad-hoc approach and impossibility to adopt a one-size-fits-all solution imposed top-down;

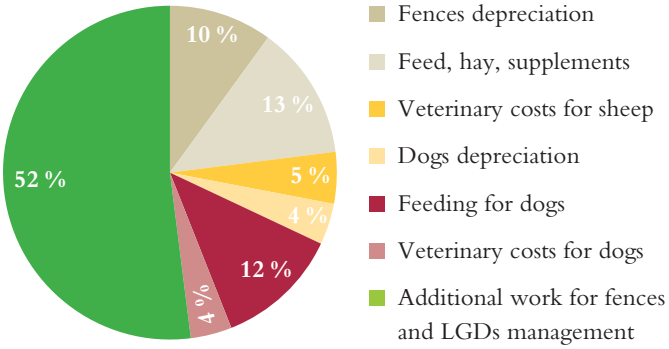


Fig. 5 Cost estimation for adoption and maintenance of damage prevention measures (three fences and 7-8 livestock guarding dogs) at a typical farm in Grosseto.

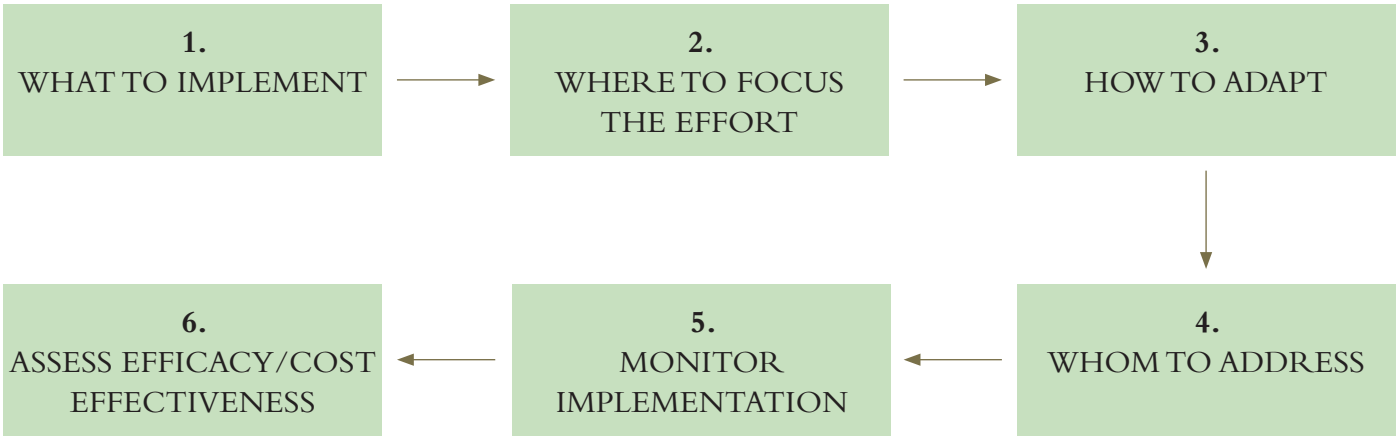


Fig. 6 Workflow adopted in the implementation of the LIFE MedWolf project in Grosseto, Italy.

2. Using a cost analysis methodology to estimate the economic impact of adopting measures to reduce livestock losses to wolf depredation.

For the damage prevention implementation phase, we deemed it fundamental to involve the interested parties at different levels (beneficiaries of damage prevention measures, farmers' unions and public authorities involved in carnivore damage management) from the early stages of project development, and to carefully plan each step of selection, implementation and evaluation as the local social context needed to be taken into account using robust evaluation of results.

Each step allowed identification of the most suitable solutions taking into account both environmental variability and productive characteristics of the farms involved (Fig. 6). This approach allowed a set of tailored solutions to be designed together with each individual farmer in order to meet their specific needs, thus optimising the damage prevention tools used. This process required a high level of flexibility, with the re-design of planned intervention approved by the European Commission and the request of over 50 modifications to the approved budget.

We also needed to hire specialist professionals who could satisfy individual requests in a relatively short time. For the cost estimate process, we started with a brainstorming session and progressed with a series of steps that involved sharing results and collaborative planning. Each step led to the development of reference conditions that were used to identify the most suitable working paths. We adapted the methodology to the situation at hand and modified what was originally planned. In fact, the interviews allowed us to record perceptions, opinions and attitudes that in part could have been predicted but which could have been underestimated or ignored, and revealed strong variation among farms (in structure and breeding typology), farmers (perceptions of the problem, actions taken and solutions adopted) and areas. Therefore, after the interview phase and the analysis of the information collected, we had sufficient information at hand to allow the design of adequate estimation methodology.

The importance of farmers' perceptions of the costs of damage prevention was ignored by many authors for decades but has recently been given more consideration. In southeast Brazil, for example, producers perceived the "unproductive" cost of sheepdogs similarly to the way they viewed taxes and followed a cyclical decision strategy, which basically depended on the purchase price of the sheepdog (Moral et al., 2016). Such an analysis was not originally planned within our project but was done at the direct request of farmers and their representative associations.

The cost composition results from Grosseto should stimulate an assessment of the long-term sustainability of the current productive system. Farms rely on an apparently unlimited workforce, but if the labour of family members were to be paid at market rates this would lead to a collapse of the production system. Furthermore, the damage prevention measures implemented were of a high standard and developed with the technical assistance of project staff, who also provided assistance for solving problems once they arose. Is such an approach sustainable for public administrations which should ensure long-term, large-

scale implementation? What resources can be made available for improvement and modification of husbandry systems necessary to allow the coexistence of protected predators and small-scale livestock breeding?

There are other questions relating to policy: what role do breeders play in providing support, i.e. could a system of amplification of positive experiences be included in the technical assistance that farmers might provide to each other? Is it possible to attach an economic value to a family workforce? Which standards must be used to design the extent of the support to be provided? What resources may be needed from administrations to ensure high quality standards? Would the introduction of standards in RDP funding conditions be feasible? All these questions remain open and should stimulate policy development with a special focus on the assessment of effectiveness with the long-term goal of improving living conditions for all.

Delivery of a new Maremma sheepdog pup by a Difesattiva technician. *(Photo: N. D'Apolito)*

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Project

AN EDUCATIONAL VIDEO GAME TO FOSTER COEXISTENCE: OPERATION FERDINAND

Gabriela Fleury[1], Courtney Hughes[2]

[1] *Rainforest Trust, Warrenton, Virginia, USA*
Contact: fleurygs@gmail.com

[2] *Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada*
Contact: ckhughes@ualberta.ca

www.fleurygs3.wixsite.com/brightfrog

1. Introduction

Across many African countries, human-carnivore conflict often takes the forms of livestock depredation and human safety risk, resulting in famers incurring high livelihood and wellbeing costs (Ripple et al., 2014). In the Serengeti, pastoralists have reported that depredation costs have amounted to up to 19% of their annual cash income (Holmern et al., 2007).

Ideally, conflict mitigation tools should aim to benefit both carnivore conservation objectives and the goals and needs of local farmers who live with wildlife (Loveridge et al., 2017; Sibanda et al., 2020). While many examples of carnivore conservation programmes exist, many use in-person delivery models such as workshops and one-on-one training to engage audiences (Lichtenfeld et al., 2015; Morehouse et al., 2020; Sibanda et al., 2020). However, new ways of engaging people to reduce the risks of living with carnivores are unfolding. This includes the use of game-based learning platforms (Dunn and Vermissimo, 2020).

2. Game-based learning

Conservation education is often used to build awareness and encourage change in wildlife-related attitudes and behaviours (Jacobson et al., 2006). A cornerstone of conservation education programmes is contextually-relevant information presented to learners in an engaging way (Hughes et al., 2013; Jacobson et al., 2006). In engaged forms of instruction, learner involvement in the content is central to the approach (de Jong, 2019). This includes learners performing meaningful activities by modifying or elaborating content (e.g. interpreting, exemplifying, classifying, inferring, differentiating or organising) and reflecting upon it individually or in discussion with others (Prince, 2004). This enables learners to build deeper comprehension and also interest beyond the content to which they are exposed (de Jong, 2019). Elements of engaged learning include focused goals, novelty and variety, and immediate affirmation of learning performance (Dickey, 2005).

Educational video games are one way of promoting engaged learning, as they incorporate a series of learning principles that promote interactive problem-solving as well as a medium to disseminate facts and encourage analysis and reflection through game-play (Dickey, 2005; Egenfeldt-Nielsen, 2006; Gee, 2003). Boyle et al. (2015) conducted a literature review that identified the positive impact of educational video games, with knowledge acquisition as the most frequent outcome. This can bode well for using game-based learning to teach human-wildlife conflict mitigation methods, to promote better understanding of the ecosystem effects of removing carnivores and to encourage pro-conservation behaviours (Bachen et al., 2012; Dunn and Verissimo, 2020). With this in mind, we created an interactive, pictorial, educational video game as a means to prevent conflict between farmers and carnivores in the Niassa National Reserve (NNR) in northern Mozambique.

3. Human-carnivore conflict in Niassa National Preserve

The NNR is one of the largest protected areas in Africa, covering 42,000 km^2 (Fig. 1). NNR is one of only ten strongholds of African lions (*Panthera leo*) in the world and also has more than 350 African wild dogs (*Lycaon pictus*) as well as leopard (*Panthera pardus*) and spotted hyena (*Crocuta crocuta*) populations (NCP, 2016). Importantly, NNR supports more than 4,000 people across 42 villages inside the protected area (Riggio et al. 2012).

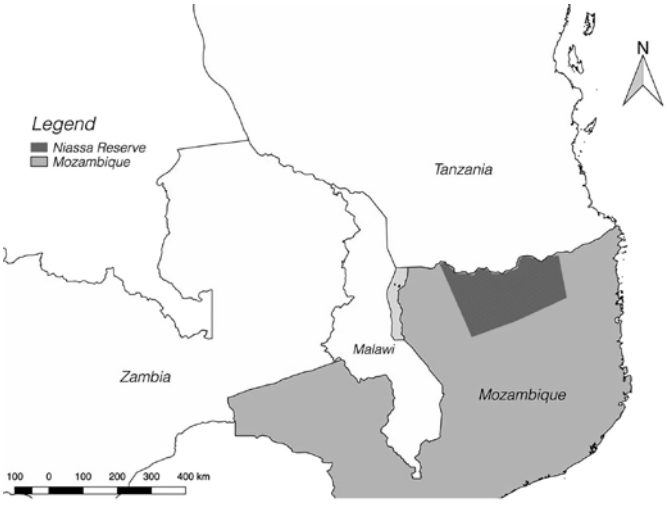

Fig. 1 Niassa National Reserve, Mozambique.

Fig. 2 African lion (*Panthera leo*) in Niassa Reserve killed by carcass poisoning. *(Photo: Niassa Carnivore Project)*

It is widely acknowledged that large carnivores play key roles in regulating ecosystems (Di Minin et al., 2016; Ripple et al., 2014). However, depredation on livestock often brings carnivores into conflict with human interests. This occurs in rural communities worldwide and involves many species (see Bautista et al., 2019; Guerisoli et al., 2020; Miller et al., 2015; Rashid et al., 2020). In Africa, livestock depredation by lions and leopards inflicts high costs on farmers and poses human safety risks (Löe and Röskaft, 2004).

In retaliation for the threat that carnivores pose to their livelihoods, some people resort to illegal measures, such as direct killing or the use of poison (Fig. 2), which is largely indiscriminate and often kills non-target species including scavengers such as the white-backed vulture (*Gyps africanus*) and black-backed jackal (*Canis mesomelas*) (Macdonald et al., 2010). The removal of scavengers can facilitate the spread of disease and negatively affect ecosystem dynamics, species survival and human health (Markandya et al., 2008). Poisoned livestock carcasses also contaminate the surrounding area, including waterholes (Roxburgh and McDougall, 2012). In turn, this may result in debilitating illness or death of livestock, wildlife or even people who drink poisoned water. Addressing farmer perceptions of carnivores and affecting change in livestock husbandry and predator control practices are therefore necessary steps in order to positively affect human well-being, carnivore populations and broader ecosystem health (Lichtenfeld et al., 2015).

Initiatives to address conflict commonly include in–person training on livestock protection measures such as fencing and guarding animals (e.g. Loveridge

et al., 2017; McManus et al., 2015). While these can be effective, they often require in-depth training sessions with farmers where barriers can include language differences and loss of interest or attention. Since 2003, the Niassa Carnivore Project (NCP) has been working collaboratively with government and non-profit organisations to encourage knowledge and behaviour change as a means to address human-carnivore conflict in the area (NCP, 2016). In this article, we summarise a novel approach to addressing human-carnivore conflict using a video-game based platform.

4. Game development and function

Inspired by climate-related games[1], NCP partnered with G. Fleury, a software engineer and graphic designer, to create a free, downloadable Windows and OS X video game suitable for field conditions, utilising simple graphics to communicate key concepts pictorially. The resulting game, *Operation Ferdinand* (*Op Ferdinand*), was intended to be played by children and adults, with more focus on engaging children in interactive learning for existing environmental education programmes, who in turn would pass on learned information to their parents and wider community (NCP, 2016).

Op Ferdinand aims to increase human safety, reduce livestock loss and improve carnivore and environmental conservation. Its use of pictures rather than verbal or written instruction was to mitigate potential challenges for non-English speaking people or those with lower literacy levels, and with foresight for future use elsewhere, given the diversity of languages and literacy levels across African countries. Pictures for game use were created in Photoshop and PowerPoint, and imported into the free Unity game engine, where the game was coded.

The game exposes players to different scenarios whereby they must select appropriate conflict prevention techniques to avoid detrimental or negative consequences (McManus et al., 2015). Key learning outcomes of *Op Ferdinand* include: the principles of building stronger enclosures for small and mixed livestock to prevent losses to carnivores; identification of predator species (from tracks, scat and killing style) in order to improve nonlethal mitigation efforts by facilitating adaptation of livestock protection measures tailored to the carnivore(s) involved; and a short simulation showing the effects of and alternatives to using poison (Fig. 3).

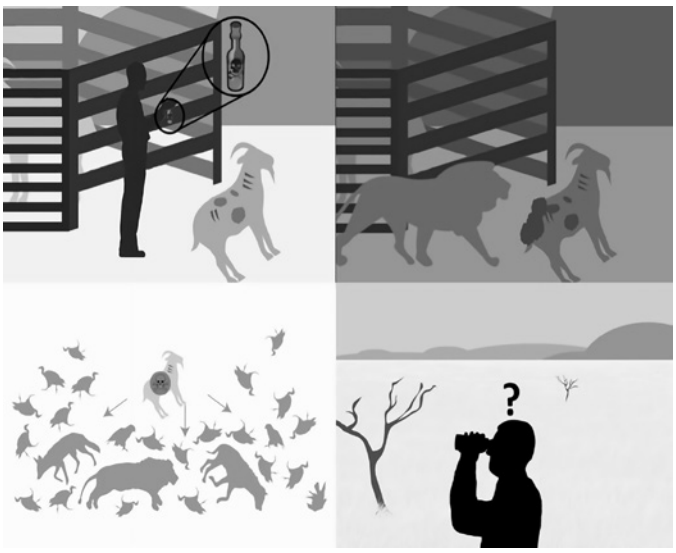

Fig. 3 Graphics illustrating the effects of using poison to address carnivore conflicts.

5. Testing and outcomes

Op Ferdinand was field-tested in June 2017 with 15 local Mozambican children of secondary school age (12–18 years old) from the Mariri village in NCP. The children were allowed to play through the game before providing feedback to facilitators. Responses were positive, with learners describing the game as engaging and easy to understand. Nevertheless, this beta testing phase suggested changes to the game that would improve learner comprehension independent of instructor prompting. This included the addition of a timer to the livestock enclosure section to increase the immediacy of the challenge in selecting prevention techniques; the addition of vulture and lion graphics to show them dying after feeding on a poisoned carcass; and the addition of a human figure collecting water from a poisoned waterhole and subsequently becoming sick. Thanks to these improvements, the game can be played and understood without instructor oversight.

[1] https://www.climateinteractive.org/policy-exercises-and-serious-games/19-climate-games-that-could-change-the-future/

Although *Op Ferdinand* took over a year to complete, it is now a stand-alone program that can be downloaded free of charge[2] and used by multiple groups of learners without additional expenditure. We hope to evaluate its efficacy in three different regions of Africa (Southern, Eastern, Western) with conservation partners that specialise in mitigating human-carnivore conflict.

6. Discussion

Low-complexity video games such as *Op Ferdinand* seem to be well-suited to teaching conservation and conflict mitigation information. Articulating a desired behaviour pictorially can promote better understanding and help learners choose appropriate behavioural outcomes (Cowley et al., 2008). A study focused on environmental education in a primary school classroom demonstrated that perceived ease of use, perceived usefulness, attitudes towards use and intention to use a game reveal a high degree of positive and significant correlations and suggest the possibility for greater learning effectiveness (Cheng et al., 2013). In addition, by working on task-based simulation, educational video games can enable the development of relevant problem-solving skills (Cheng et al., 2013). In our case, this includes prompting players to build effective livestock enclosures to prevent depredation.

Educational video games that use pictures not only make content accessible to non-English language speakers but also mitigate the logistical and financial challenges of tailoring instruction to a host of different language speakers or those with varying abilities (Ke and Abras, 2013; Squire, 2005). The accessibility of *Op Ferdinand* was also enhanced by making it open source. Design costs were minimised largely thanks to the generosity of experts who volunteered long hours of their time to develop the game. The only material costs to NCP were for electricity and use of laptops.

There is considerable potential to implement *Op Ferdinand* with other organisations and communities. The game could be adapted for use outside sub-Saharan Africa and we are currently soliciting such opportunities. For example, typical signs of presence and killing styles of carnivores from other regions could be added to the predator kill identification section. In the meantime, *Op Ferdinand* is available to use as an engaging platform that addresses some of the challenges of coexisting with carnivores within and beyond Africa.

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[2] https://fleurygs3.wixsite.com/brightfrog/projects

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EU Platform on Coexistence between People and Large Carnivores

Meetings

The EU Platform usually organises a range of meetings each year. Due to the challenges of the COVID-19 pandemic, the second regional workshop of 2020 was held on 24th November as a thematic webinar. The event, titled *Stakeholder Involvement in Large Carnivore Monitoring*, was hosted by three Platform members: the European Federation for Hunting and Conservation (FACE), the International Council for Game and Wildlife Conservation (CIC) and IUCN specialist group the Large Carnivore Initiative for Europe (LCIE).

The webinar examined methods of monitoring large carnivores, showed how stakeholders (especially hunters) are involved in surveying populations and explored the potential for expanding their role in data collection. Case studies were presented to identify good practices followed by a discussion on the utility and desirability of involving stakeholders. Two main advantages were highlighted: to increase the reach of surveys and the amount of data collected; and to improve working relations between stakeholders and increase trust in monitoring programmes and their findings. A recording of the webinar and pdfs of the presentations are available on the Platform website[1].

Case studies of coexistence

The EU Platform gathers case studies which document efforts to support coexistence between people and large carnivores in Member States. They illustrate lessons learned which can be applied in other settings if adapted to local conditions. Some examples related to livestock protection measures are highlighted below. More information including contact details can be found on the Platform website[2].

Support for wolf damage prevention measures (Germany)

Lower Saxony in Germany is being repopulated by the wolf. However, the traditional system of extensive sheep grazing that preserves the heathland landscape, as well as horse breeding, are vulnerable to predation. The higher costs of labour associated with the implementation and maintenance of protection measures have been supported financially by the German Federal Environmental Foundation[3] (Deutsche Bundesstiftung Umwelt) and the Lower Saxonian Environmental Foundation[4], with practical actions carried out by the Lower Saxonian Nature and Biodiversity Conservation Union[5] (NABU Niedersachsen) since 2017. Livestock farmers can ask for the support of 'wolf consultants' through the wolf office (Wolfsbüro) within the Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN).

'Wolf consultants' help identify the needs of individual farmers and plan actions which fit their farming practices. Some of the main activities financed include the implementation of livestock protection measures; the training of volunteers to support breeders with livestock protection; the establishment of free, informal and practical support for livestock breeders; and increased transfer of knowledge and experience

[1] https://ec.europa.eu/environment/nature/conservation/species/carnivores/events_sub_thematic_webinar_2020.htm
[2] https://ec.europa.eu/environment/nature/conservation/species/carnivores/case_studies.htm
[3] https://www.dbu.de/2535.html
[4] https://www.bingo-umweltstiftung.de/
[5] https://en.nabu.de/about/index.html

through active partnerships involving authorities, experts, business and research organisations. In autumn 2019, more than 100 on-site consultations were carried out across Lower Saxony. The project also trained over 150 people on livestock protection measures and has organised or been involved in 60 events. As a result, fewer attacks on livestock were recorded in 2019, with the important message to livestock managers that measures to protect their flocks against wolves can be effective.

Improving relations among stakeholders (Switzerland)

Cantonal (regional) Wolf Groups have been established in several Swiss cantons supported by the regional governments since 2006. Their main goals are to encourage discussion and improve relations among stakeholders. The core groups organise meetings of all interest groups, excursions to look at measures on the ground and discussions with livestock owners. The stakeholders involved include cantonal authorities, representatives of farmers' and livestock breeders' associations, the hunting association, game wardens, the NGOs WWF and Pro Natura, AGRIDEA (national coordinator for prevention measures), the Swiss Association for Livestock Guarding Dogs[6] and tourism interests. The membership and priorities of the groups differ between cantons. In the Canton of Bern, for example, the emphasis is on the exchange of information and on solution-solving approaches. Cantonal authorities coordinate two meetings per year and one excursion is organised to visit farmers, to view measures and discuss them with livestock owners.

Conflict has been reduced thanks to increased stakeholder communication and work shared through the Wolf Core Groups, which have increased consensus among members and facilitated a common vision for wolf coexistence efforts. This shows that solutions to individual problems can be found on the local level, even if positions remain opposed on a larger scale.

Livestock guarding dog programme (Portugal)

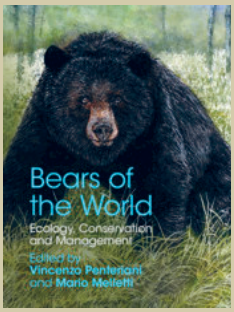
With the decline of wolves in Portugal during the 20th century, the use of LGDs was abandoned, resulting in the loss of experience and knowledge about their use and decreased access to good working dogs. As the wolf population recovers, conflicts arising from wolf damage to livestock may increase. Grupo Lobo's livestock guarding dog (LGD) programme, which was launched in 1996, is working to revive the use of national breeds of LGDs and promote best practices in their use. Livestock farmers are interviewed to gather information on husbandry systems and levels of damage, to verify conditions and ascertain motivation to receive LGDs. An agreement is signed with selected farmers, who are then provided with pups as well as dog food and veterinary care. Technical support concerning dog raising, training, breeding, registering and other legal aspects is also provided. Dogs are regularly monitored until they reach adulthood (at 18–24 months old) and their efficacy is assessed through analysis of their behaviour and levels of damage at the farm. Surveys are made of participating farmers to assess the level of satisfaction with LGDs and perceptions of their effectiveness and to identify advantages and possible problems associated with their use.

By the end of 2019, more than 630 pups had been placed with sheep, goat and cattle herds of nearly 370 participating farmers in northern and central Portugal. Most dogs evaluated, showed desirable behaviour and actively reduced damages. Farmers were satisfied with their dogs, rated them as performing well and perceived them as being responsible for eliminating or reducing damage.

Laure-Lou Tremblay, Katrina Marsden
EU Large Carnivore Platform Secretariat
(adelphi consult and Callisto), adelphi consult
GmbH, Alt-Moabit 91, 10559 Berlin, Germany
Contact: lcplatform@adelphi.de

[6] https://www.cpt-ch.ch/en/

BOOKS



Bears of the world: ecology, conservation and management

Editors: Vincenzo Penteriani,Mario Melletti

Publisher: Cambridge University Press, UK, 2020

Language: English

ISBN: 9781108692571

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People and bears have been sharing landscapes for tens of thousands of years, during which we have competed with each other for food and shelter. In recent times, bears have come under increasing pressure due to human-caused habitat loss, climate change, poaching and illegal trade in body parts, resulting in the decline of many bear populations. On the other hand, in some regions, bears are making a comeback and presenting fresh challenges for coexistence, especially in human-dominated landscapes.

This comprehensive volume, with contributions from 200 specialists, covers all eight extant species on the four continents where bears occur. Although much of the book focuses on biology, taxonomy and genetics, with detailed accounts of each species, practical themes applicable to conservation and management run throughout. In particular, the section on Human–Bear Coexistence has several chapters of relevance to readers of CDPnews:

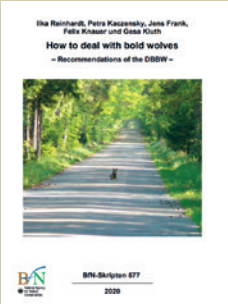
- Human-bear conflicts at the beginning of the twenty-first century: patterns, determinants, and mitigation measures (outlines the main types of human-bear conflicts and their causes as well as summarising evidence for the effectiveness of various conflict mitigation measures);
- Principles of human-bear conflict management in challenging environments (discusses the role of language in framing human-wildlife interactions, summarises the application of conflict studies to wildlife, critiques common approaches to bear management and highlights key factors for successful interventions);
- Patterns of bear attacks on humans, factors triggering risky scenarios, and how to reduce them (presents recommendations tailored to each bear species based on information compiled from scientific literature, databases, theses, online news reports and webpages).

In addition, the section on Conservation and Management has chapters on the management of conflicts involving brown bears and Asiatic black bears in Japan. Several other chapters, such as that on sloth bears in Sri Lanka, also examine aspects of human-bear conflicts and coexistence.

For the most part, the standard of scholarship is admirably high, to the extent that many passages are likely to be of greater interest to researchers and academics than practitioners, managers and the general public. However, a wealth of illustrations, including colour and black-and-white photographs, drawings, maps, charts and diagrams, goes some way towards making the text more accessible to a broader audience.

The work is occasionally let down by less rigorous approaches; for example, an assessment of threats to Eurasian brown bears appears to be based at least in part on unsubstantiated opinions. The book also lacks a concluding chapter to help bring the material together. A major drawback, likely to present an insurmountable obstacle to many would-be readers, is the publisher's exorbitant pricing: 110 GBP for the hardback edition and 116 USD for the eBook.

Nevertheless, for those who can afford it, the 400 pages of this reference work provide an authoritative guide to bears and bear-human interactions worldwide.



How to deal with bold wolves – recommendations of the DBBW

Authors: Ilka Reinhardt, Petra Kaczensky, Jens Frank, Felix Knauer, Gesa Kluth

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For a long time, there were no wolves in Germany. Since 2000, the species has been steadily spreading out from Lusatia and populating more areas. People in areas recently settled by wolves are only gradually learning how to live alongside this animal and are often uncertain how to interpret wolf behaviour. How dangerous are wolves for humans? What constitutes normal behaviour and what is considered unusual or bold behaviour?

This report provides assessments of wolf behaviour as it relates to human safety and recommends managing wolves which display unwanted behaviour. In this report, conspicuous behaviour refers to wolf behaviour towards humans which is considered undesirable, and ranges from unusual to bold.

This report is intended to provide guidance and recommendations to the authorities responsible for wolf management and focusses on wolf-human interactions. It defines terms frequently used in this context, summarises the current state of knowledge relating to the danger posed by wolves and describes the causes for the development of bold behaviour. Recommendations on how to react to reports of bold wolf sightings are also given. Moreover, the report assesses the most common types of wolf behaviour in relation to human safety.

These recommendations are primarily aimed at the competent federal state authorities, to enable them to make an initial assessment of wolf behaviour in terms of human safety and to prepare possible courses of action. However, it is not intended as a general template for action. Every situation in which a wolf is perceived as bold or is behaving conspicuously needs to be assessed on a case-by-case basis.

The aims of these recommendations are:

a) to ensure that people in Germany are not injured or killed by wild wolves;

b) to foster and maintain public trust in wolf management authorities in wolf regions;

c) to ensure that people's fear of wolves does not increase and d) to enable wolves to spread further in Germany without causing serious conflicts between wolves and humans.

ABSTRACTS OF SCIENTIFIC ARTICLES

FACTORS INFLUENCING PREDATION

LANDSCAPE PREDICTORS OF HUMAN–LEOPARD CONFLICTS WITHIN MULTI-USE AREAS OF THE HIMALAYAN REGION

Dipanjan Naha, Suraj Kumar Dash, Abhisek Chettri, Pooja Chaudhary, Gaurav Sonker, Marco Heurich, Gopal Singh Rawat Sambandam Sathyakumar

Scientific Reports:
July 2020

https://doi.org/10.1038/s41598-020-67980-w

Conflict with humans is a significant source of mortality for large carnivores globally. With rapid loss of forest cover and anthropogenic impacts on their habitats, large carnivores are forced to occupy multiuse landscapes outside protected areas. We investigated 857 attacks on livestock in eastern Himalaya and 375 attacks in western Himalaya by leopards between 2015 and 2018. Multivariate analyses were conducted to identify the landscape features which increased the probability of livestock depredation by leopards. The risk of a leopard killing livestock increased within a heterogeneous landscape matrix comprising of both closed and open habitats (very dense forests, moderate dense forests, open forests, scrubland and non-forests). We used the results to map potential human–leopard conflict hotspots across parts of the Indian Himalayan region. Our spatial risk maps indicate pockets in the eastern, central and western part of eastern Himalaya and the central, northern part of western Himalaya as hotspots of human–leopard conflicts. Most of the attacks occurred when livestock were grazing freely within multi-use areas without supervision of a herder. Our results suggest that awareness about high risk areas, supervised grazing, and removing vegetation cover around human settlements should be initiated to reduce predation by leopards.

EFFECTS OF LIVESTOCK LOSS AND EMERGING LIVESTOCK TYPES ON LIVELIHOOD DECISIONS AROUND PROTECTED AREAS: CASE STUDIES FROM CHINA AND INDIA

Binbin V. Li, Kelley Reardon, Nitya Satheesh, Cui Liu, Krithi K. Karanth

Biological Conservation:
August 2020

https://doi.org/10.1016/j.biocon.2020.108645

Increasing livestock grazing in forests has intensified human-wildlife conflicts and caused habitat degradation for threatened species. To balance conservation and local community development, it is crucial to understand if livestock loss in natural habitats plays a role in household livelihood decisions. We used the giant panda habitat in China and the tiger habitat in India as case studies to investigate if livestock loss impacts livestock holding size and if higher loss rate shifts households away from livestock grazing in the future. We applied negative binomial regression and cost-benefit analysis to household level data from 281 Chinese households and 369 Indian households. We found that the livestock loss rate did not impact the number of livestock in China, but it did negatively impact the number of livestock in India. Chinese households were more constrained by labor availability for livestock expansion, while Indian households were limited by financial capacity. However, households tended to ignore the potential livestock loss in future livelihood decisions for both landscapes. Emerging livestock types could change the dynamic and the Indian case indicates a possible win-win solution. New hybrid cattle produced more than seven times the net benefit, but with only 46% potential cost of livestock loss compared to traditional cattle. Therefore, households can simultaneously produce more profits and reduce livestock loss by shifting to hybrid cattle. As higher profit is more important than perceived livestock loss risk in deciding the livelihood practices, better market instruments and assistance should be provided to promote the change.

THE IMPACT OF LEOPARDS *(PANTHERA PARDUS)* ON LIVESTOCK LOSSES AND HUMAN INJURIES IN A HUMAN-USE LANDSCAPE IN MAHARASHTRA, INDIA

Vidya Athreya, Kavita Isvaran, Morten Odden, John D.C. Linnell, Aritra Kshettry, Jagdish Krishnaswamy, Ullas K. Karanth

PeerJ:
March 2020

https://doi.org/10.7717/peerj.8405

There are many ways in which large carnivores and humans interact in shared spaces. In this study we provide insights into human-leopard relationships in an entirely modified, human-dominated landscape inhabited by dense populations of humans (266 per km^2), their livestock (162 per km^2) and relatively high densities of large predators (10 per 100 km^2). No human deaths were recorded, and livestock losses to leopards numbered only 0.45 per km^2 per year (averaged over three years) despite the almost complete dependency of leopards on domestic animals as prey. Predation was not the major cause of livestock mortality as diseases and natural causes caused higher losses (80% of self-reported losses). We also found that ineffective night time livestock protection and the presence of domestic dogs increased the probability of a farmer facing leopard attacks on livestock. Resident farmers faced much lower livestock losses to leopard predation in contrast to the migratory shepherds who reported much higher losses, but rarely availed of the government compensation schemes. We recommend that local wildlife managers continue to shift from reactive measures such as leopard captures after livestock attacks to proactive measures such as focusing on effective livestock protection and informing the affected communities about safety measures to be taken where leopards occur in rural landscapes. The natural causes of livestock deaths due do diseases may be better prevented by involving animal husbandry department for timely vaccinations and treatment.

LIONS *PANTHERA LEO* PREFER KILLING CERTAIN CATTLE *BOS TAURUS* TYPES

F lorian J. Weise, Mathata Tomeletso Andrew, B. Stein, Michael J. Somers, Matt W. Hayward

Animals:
April 2020

https://doi:10.3390/ani10040692

Lion predation on cattle causes severe human–wildlife conflict that results in retaliatory persecution throughout the lion's geographic range. Cattle closely resemble the body size, shape, and herding patterns of preferred lion prey species. We studied cattle depredation patterns in Botswana's Okavango Delta and tested whether lions exhibited specific preferences based on cattle demographic characteristics (sex and age), as well as morphological traits (body mass, horn length, and pelage patterns). We also tested whether human disturbance of kills influenced lion energy intake and whether depredation circumstances influenced loss levels. Lions predominantly killed cattle at night (87.1%) and exhibited no preference for either sex. Overall, bulls and calves were most preferred, whereas heifers were significantly avoided, as were cattle with uniform colour patterns. Cattle with mottled pelage patterns were most preferred, especially among free-roaming herds. Preferences were context-specific, with lions preferring inexperienced calves during enclosure attacks (including multiple cases of surplus killing) and free-roaming bulls and oxen. About 13% of adult cattle had no horns, and these were preferentially targeted by lions, while cattle with short horns were killed in accordance with their availability and long horned cattle were highly avoided. The contemporary morphology of Tswana cattle that resulted from unnatural selective pressures during domestication does not offer effective antipredatory protection. Human disturbance of feeding soon after kills occurred reduced cattle carcass consumption by > 40% (or about 30 kg per carcass per lion). Lions killed significantly more cattle in nonfortified enclosures than in the veldt, although this was influenced by surplus killing. Our results suggest that cattle predation by lions is driven by availability and cavalier husbandry practices, coupled with morphological features associated with facilitating easy husbandry. Cattle no longer exhibit the key features that enabled their ancestors to coexist with large predators and are now reliant upon humans to perform critical antipredator activities. Hence, the responsibility for mitigating human–wildlife conflict involving lions and cattle lies with people in either breeding traits that minimise predation or adequately protecting their cattle.

AGRICULTURAL LANDS OFFER SEASONAL HABITATS TO TIGERS IN A HUMAN-DOMINATED AND FRAGMENTED LANDSCAPE IN INDIA

Rekha Warrier. Barry R. Noon, Larissa Bailey

Ecosphere:
July 2020

https://doi.org/10.1002/ecs2.3080

Conserving wide-ranging large carnivores in human-dominated landscapes is contingent on acknowledging the conservation value of human-modified lands. This is particularly true for tigers *(Panthera tigris)*, now largely dependent on small and fragmented habitats, embedded within densely populated agroecosystems in India. Devising a comprehensive conservation strategy for the species requires an understanding of the temporal patterns of space use by tiger within these human-modified areas. These areas are often characterized by altered prey communities, novel risks resulting from high human densities and seasonally dynamic vegetative cover. Understanding space use within these areas is vital to devising human-tiger conflict prevention measures and for conserving landscape elements critical to maintain functional connectivity between populations. We documented seasonal space-use patterns of tigers in agricultural lands surrounding protected areas in the Central Terai Landscape (CTL) in northern India. We estimated the probability of space use and its drivers by applying dynamic occupancy models that correct for false-positive and false-negative errors to tiger detection\non-detection data within agricultural areas. These data were generated by conducting local interviews, sign surveys, and camera trapping within 94 randomly selected 2.5-km^2 grid cells. We found that agricultural areas were used with high probability in the winter (0.64; standard error [SE] 0.08), a period of high vegetative cover availability. The use of agricultural lands was lower in the summer (0.56; SE 0.09) and was lowest in the monsoon season (0.21; SE 0.07), tracking a decline in vegetative cover and available habitat across the landscape. Availability of vegetative cover and drainage features positively influenced space use, whereas use declined with increasing distance to protected areas and the extent of human settlements. These findings highlight the role of agricultural areas in providing seasonal habitats for tigers and offer a basis for understanding where tigers and humans co-occur in these landscapes. These findings help expand our current understanding of what constitutes large carnivore habitats to include human-dominated agricultural areas. They underscore the need for greater integration of land-sharing and land-sparing initiatives to conserve large carnivores within human-dominated agroecosystems.

WOLF DIET AND PREY SELECTION IN CROATIA

Daria Octenjak, Lana Pađen, Valentina Šilić, Slaven Reljić, Tajana Trbojević Vukičević, Josip Kusak

Mammal Research:
July 2020

https://doi.org/10.1007/s13364-020-00517-8

Tensions between humans and wolves have led to intensive worldwide studies of wolf feeding habits and their relative preference for domestic and wild ungulates. The aim of this study was to provide further insight into the diet composition of wolves in Croatia, based on stomach contents of dead wolves. We examined spatial variation in wolf diet and prey selection relative to availability of wild and domestic animals. Furthermore, we aimed to determine selectivity in feeding habits in relation to wolf gender and age. The study was conducted on the stomach contents of 42 gray wolves (18 females, 24 males). Samples were collected from three regions of Croatia with different ratios of domestic and wild prey availability. The density ratio of domestic to wild ungulates increased gradually from north-west (5.8), through central (11.6) to south-east (134) Croatia. Wolf diet followed this pattern with the ratio of domestic animals increasing from 0.7 to 1.3 and 5.3, respectively. The relative share of wild ungulates in wolf diet was significantly higher in all three regions of wolf range in Croatia, even where livestock availability was high. Female wolves ate birds, rodents, and dogs more than males and in the south, where wild ungulates were scarce. This study showed wolves' selectivity for wild ungulate, rather than for abundant, but well-guarded livestock. The European idea of coexistence of humans and wolves in human-dominated landscape seems possible with some effort and understanding from humans' side.

DIVERSE PREVENTION MEASURES

THE EFFECTIVENESS OF LIVESTOCK PROTECTION MEASURES AGAINST WOLVES *(CANIS LUPUS)* AND IMPLICATIONS FOR THEIR CO-EXISTENCE WITH HUMANS

Antonia Bruns, Matthias Waltert, Igor Khorozyan

Global Ecology and Conservation: March 2020

https://doi.org/10.1016/j.gecco.2019.e00868

Wolves *(Canis lupus)* can kill domestic livestock resulting in intense conflicts with humans. Damage to livestock should be reduced to facilitate human-wolf coexistence and ensure positive outcomes of conservation efforts. Current knowledge on the effectiveness of livestock protection measures from wolves is limited and scattered in the literature. In this study, we compiled a dataset of 30 cases describing the application of 11 measures of protecting cattle and smaller livestock against wolves, estimated their effectiveness as a relative risk of damage, and identified the best measures for damage reduction. We found that: (1) lethal control and translocation were less effective than other measures, (2) deterrents, especially fladry which is a fence with ropes marked by hanging colored flags that sway in the wind and provide a visual warning signal, were more effective than guarding dogs; (3) deterrents, fencing, calving control and herding were very effective, but the last two measures included only one case each; and (4) protection of cattle was more effective than that of small stock (sheep and goats, or sheep only) and mixed cattle and small stock. In all of these cases, the relative risk of damage was reduced by 50–100 %. Considering Germany as an example of a country with a recovering wolf population and escalating human-wolf conflicts, we suggest electric fences and electrified fladry as the most promising measures, which under suitable conditions can be accompanied by well-trained livestock guarding dogs, and the temporary use of deterrents during critical periods such as calving and lambing seasons. Further research in this field is of paramount importance to efficiently mitigate human-wolf conflicts

STUDDED LEATHER COLLARS ARE VERY EFFECTIVE IN PROTECTING CATTLE FROM LEOPARD *(PANTHERA PARDUS)* ATTACKS

Igor Khorozyan, Siavash Ghoddousi, Mobin Soufi, Mahmood Soofi, Matthias Waltert

Ecological Solutions and Evidence: July 2020

https://doi.org/10.1002/2688-8319.12013

1. Human-wildlife conflicts are widespread, particularly with big cats which can kill domestic livestock and create a counteraction between conservation and local livelihoods, especially near protected areas. Minimisation of livestock losses caused by big cats and other predators is essential to mitigate conflicts and promote socially acceptable conservation. As big cats usually kill by throat bites, protective collars represent a potentially effective non-lethal intervention to prevent livestock depredation, yet the application and effectiveness estimation of these tools are very limited.
2. In this study, for the first time we measured the effectiveness of studded leather collars in protecting cattle from leopard *(Panthera pardus)* attacks. We conducted a randomised controlled experiment during 14 months to collar 202 heads and leave uncollared 258 heads grazing in forests and belonging to 27 owners from eight villages near three protected areas in Mazandaran Province, northern Iran.
3. Our results show that none of collared cattle and nine uncollared cattle were lost to leopard depredation, meaning that collars caused a zero relative risk of damage and a perfect 100 % damage reduction. Most losses occurred in summer and autumn due to lush vegetation attracting more cattle, long daytime allowing movements deep into leopard habitats and dense cover favouring leopard hunts from ambush. Losses were recorded in only six owners and four villages, suggesting local rarity and patchy distribution of leopards.
4. We suggest that collars can be successfully applied to cattle freely grazing in habitats of leopards or other felids for a long time and thus remaining persistently exposed to depredation. As grazing cattle are usually not supervised by shepherds or dogs, collars can be the only practical protection tool. Production and sales of collars can become a sustainable small-scale business for farmers to further boost conservation and rural livelihoods.

HUMAN DIMENSIONS

HUMAN DIMENSIONS OF HUMAN-LION CONFLICT: A PRE- AND POST-ASSESSMENT OF A LION CONSERVATION PROGRAMME IN THE OKAVANGO DELTA, BOTSWANA

Eric G LeFlore, Todd K Fuller, Mathata Tomeletso, Tiro C Dimbindo, Andrew B Stein

Environmental Conservation: May 2020

https://doi.org/10.1017/S0376892920000120

Humans are contributing to large carnivore declines around the globe, and conservation interventions should focus on increasing local stakeholder tolerance of carnivores and be informed by both biological and social considerations. In the Okavango Delta (Botswana), we tested new conservation strategies alongside a pre-existing government compensation programme. The new strategies included the construction of predator-proof livestock enclosures, the establishment of an early warning system linked to GPS satellite lion collars, depredation event investigations and educational programmes. We conducted pre- and post-assessments of villagers' livestock management practices, attitudes towards carnivores and conservation, perceptions of human–carnivore coexistence and attitudes towards established conservation programmes. Livestock management levels were low and 50% of farmers lost livestock to carnivores, while 5–10% of owned stock was lost. Respondents had strong negative attitudes towards lions, which kill most depredated livestock. Following new management interventions, tolerance of carnivores significantly increased, although tolerance of lions near villages did not. The number of respondents who believed that coexistence with carnivores was possible significantly increased. Respondents had negative attitudes towards the government-run compensation programme, citing low and late payments, but were supportive of the new management interventions. These efforts show that targeted, intensive management can increase stakeholder tolerance of carnivores.

APPLYING PARTICIPATORY PROCESSES TO ADDRESS CONFLICTS OVER THE CONSERVATION OF LARGE CARNIVORES: UNDERSTANDING CONDITIONS FOR SUCCESSFUL MANAGEMENT

Valeria Salvatori, Estelle Balian, Juan Carlos Blanco, Paolo Ciucci, László Demeter, Tibor Hartel, Katrina Marsden, Stephen Redpath, Yorck von Korff, Juliette Young

Frontiers in Ecology and Evolution: June 2020

https://doi.org/10.3389/fevo.2020.00182

Social conflicts over large carnivores are becoming more frequent following the general recovery of large carnivores in human shaped landscapes in Europe. To manage conflicts over large carnivores a detailed knowledge is necessary on the social, economic, cultural but also interpersonal dimensions of the conflicts. This can be achieved through a participatory engagement of all stakeholders within a procedure tailored to local contexts. We looked at conditions necessary for implementing the above approach in areas of intense large carnivores-human conflict across Europe (bear and wolves), and where traditional management conflict policies do not appear to be successful, as often based on urgent responses to emergency situations. We focussed on four areas in Europe where we interviewed stakeholders to characterize the conflicts and assess the potential for mitigation interventions through participatory processes. We focused on four key aspects related to social conflicts: (a) perception of the current situation and relationship with other stakeholders; (b) availability and accessibility of information and communication; (c) economic, ecological and social impacts; and (d) promotion of coexistence and participatory processes. We show that (lack of) trust between stakeholders and the relevant authorities as well as the lack of genuine communication among stakeholders were the key features that characterized social conflicts related to large carnivores. With specific reference to large carnivores, the lack or inaccessibility of reliable information was reported in all cases by all stakeholders, as well as the need for proactive and inclusive policies developed and implemented by the relevant authorities. A consistent message was that support and engagement from relevant management institutions was pivotal for effective management of conflicts over large carnivores. Our findings highlight the importance for conflict mitigation of a deeper and mutual understanding of issues prior to the implementation of participatory processes.

ONE RULE DOES NOT FIT IT ALL: PATTERNS AND DRIVERS OF STAKEHOLDERS PERSPECTIVES OF THE ENDANGERED IBERIAN WOLF

Rita Tinoco Torresa, Diana Lopes, Carlos Fonseca, Luís Miguel Rosalino

Journal for Nature Conservation: June 2020

https://doi.org/10.1016/j.jnc.2020.125822

Public attitudes are vital for the successful implementation of management strategies and conservation programs. However, contradictory interests among different stakeholders can create important setbacks, creating barriers to achieve conservation goals. The endangered Iberian wolf *(Canis lupus signatus)* occupies now only 20% of its historical distribution area, in Portugal, and its reduction was mostly due to direct human persecution. Here, we assessed locals' attitudes towards the Iberian wolf in northeast Portugal, in a region where humans and wolves coexist for centuries. A total of 323 questionnaires from three different interest groups (general public, livestock owners and hunters) were analysed. We tested the differences in attitude and fear level patterns between the different groups and assessed what socio-demographic factors could be influencing the detected patterns. We found that general attitude towards this carnivore was neutral to positive, probably owing to the low levels of livestock predation and long coexistence with local populations. However, most drivers differed among stakeholders groups. Education, knowledge, and level of fear were strong predictors explaining attitudes towards this endangered species. We stress the importance of assessing attitudes patterns and identifying the socio-psychological factors as necessary tools to facilitate the development of targeted tolerance-promoting strategies. Among other instruments, increasing locals' tolerance toward the Iberian wolf can be achieved by target education interventions, where the stakeholders can actively take part in discussions to accommodate their needs and expectation, rather than be listeners of the implemented programs.

SEEING BENEATH DISPUTES: A TRANSDISCIPLINARY FRAMEWORK FOR DIAGNOSING COMPLEX CONSERVATION CONFLICTS

Hannah L. Harrison, Philip A. Loring

Biological Conservation: August 2020

https://doi.org/10.1016/j.biocon.2020.108670

Conservation conflicts are pressing social and environmental sustainability issues, and the complex underlying causes and escalating factors of such conflicts can often be difficult to understand. Appropriate tools are needed for breaking down complex conservation conflicts into their varied, heterogenous parts so their nature and the complex relationships between them may be better understood and addressed using appropriate interventions. Importantly, these tools must transcend disciplinary silos so as to be applicable across social science disciplines as well as within and outside of the academic context. This article synthesizes a breadth of conservation conflict literature to lay out a transdisciplinary framework for diagnosing complex conservation conflicts composed of six key aspects: complexity, emergence, and stages; conflict status; basis of contention and cognitive framing; state of knowledge; state of values; and interventions. This framework is based in systems thinking and differs from other key conservation conflict frameworks by using conflict emergence as a starting point. To complement this approach, our diagnostic tool encourages users to harness thinking based in storytelling and consider how a conservation conflict represents a larger ongoing narrative with depth, meaning, and containing complex, interrelated storylines. As poorly understood stakeholder disputes can seriously undermine conservation efforts, this framework pushes forward practical understandings of conservation conflict interventions by offering a novel, transdisciplinary diagnostic tool for better understanding their complex, multifaceted variables.

THE IMPACT OF WOLVES ON PSYCHOLOGICAL DISTRESS AMONG FARMERS IN NORWAY

Alexander Zahl-Thanem,
Rob J.F. Burton, Arild Blekesaune,
Marit S. Haugen, Katrina Rønningen

Journal of Rural Studies:
August 2020

https://doi.org/10.1016/
j.jrurstud.2020.05.010

The reappearance of large carnivores in Europe can be viewed as a conservation success, however, the increase in carnivore numbers has also resulted in an increase in livestock predation. While multiple studies have been conducted into farmers' attitudes to large carnivores, the consequence of predation on farmers' mental health and wellbeing is under-researched. Using a mixed-method approach, this study examines the potential regional impact of the presence of wolves on farmers' psychological distress in Norway. Data from the nationally representative Trends in Norwegian Agriculture Survey was analysed using a multiple regression analysis. Psychological distress was measured using a 5 item Hopkins Symptom Checklist. Comparison with register data of livestock losses showed that sheep farmers living in regions where sheep have been killed by wolves within the last 5 years have higher psychological distress scores than (a) sheep farmers elsewhere in Norway, and (b) farmers in the same region without sheep. What makes our study different from others is that the Trends survey was not targeted at the wolf issue directly, meaning that accusations of farmer bias against wolves when responding to surveys cannot explain our results. We support this conclusion by exploring (and, ultimately, dismissing) alternative explanations and through 20 qualitative interviews with sheep farmers in a predation region (regional county of Hedmark) to investigate how carnivore presence is experienced. Stress, anxiety, sleep deprivation, and reduced quality of life were reported as key consequences of the carnivore pressure. The findings suggest that farmers do not need to experience animal deaths and injuries personally to experience the distress of predation. Living nearby and assisting farmer colleagues make this a shared condition.

THE INFLUENCE OF MESSAGE FRAMING ON PUBLIC BELIEFS AND BEHAVIORS RELATED TO SPECIES REINTRODUCTION

Rebecca M. Niemiec, Samantha Sekar,
Mireille Gonzalez, Andrew Mertens

Biological Conservation:
August 2020

https://doi.org/10.1016/j.bio-
con.2020.108522

Little is known about whether messaging strategies drawing from behavioral science theory may effectively change public attitudes, beliefs, and behavior with regard to biodiversity conservation. We conducted a randomized survey experiment with 1415 Colorado residents to examine how messaging approaches influence beliefs, voting intentions, and collective action intentions related to a proposed ballot initiative mandating wolf reintroduction to the state. We tested 6 different messages that drew from behavioral science literature on extreme versus moderate appeals, anthropomorphism, and perceived social norms. We find that overall, message framing has little impact on Coloradans' intentions to vote for or against wolf reintroduction. We find preliminary evidence that extreme arguments that do not address ranchers' concerns may decrease the willingness of individuals with neutral attitudes to share positive information about wolf reintroduction with others. Furthermore, moderate arguments discussing how ranchers' concerns will be addressed reduce intentions to engage in organized opposition to reintroduction (compared to arguments used by those opposed to wolf reintroduction). We find that providing descriptive normative information changes perceptions of norms regarding wolf reintroduction, but such changed perceptions do not lead to changes in behavioral intentions compared to control messages. Our study suggests that to increase the diffusion of positive information about a conservation program and prevent organized opposition, conservation practitioners should avoid extreme arguments that ignore the concerns of the opposition and utilize more moderate arguments that acknowledge and address those concerns.

ADDRESSING INEQUALITY AND INTOLERANCE IN HUMAN–WILDLIFE COEXISTENCE

Neil R. Jordan, Bradley P. Smith, Robert G. Appleby, Lily M. van Eeden, Hugh S. Webster

Conservation Biology:
May 2020

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Millennia of human conflict with wildlife have built a culture of intolerance toward wildlife among some stakeholders. We explored 2 key obstacles to improved human-wildlife coexistence: coexistence inequality (how the costs and benefits of coexisting with wildlife are unequally shared) and intolerance. The costs of coexisting with wildlife are often disproportionately borne by the so-called global south and rural communities, and the benefits often flow to the global north and urban dwellers. Attitudes and behaviors toward wildlife (tolerance versus intolerance) vary with social and cultural norms. We suggest more empathetic advocacy is needed that, for example, promotes conservation while appropriately considering those who bear the costs of conflict with wildlife. To achieve more equitable cost-sharing, we suggest limiting the costs incurred by those most affected or by sharing those costs more widely. For example, we advocate for the development of improved wildlife compensation schemes, increasing the scale of rewilding efforts, and preventing wildlife-derived revenue leaching out of the local communities bearing the costs of coexistence.

CASCADING SOCIAL-ECOLOGICAL COSTS AND BENEFITS TRIGGERED BY A RECOVERING KEYSTONE PREDATOR

Edward J. Gregr, Villy Christensen, Linda Nichol, Rebecca G. Martone, Russell W. Markel, Jane C. Watson, Christopher D. G. Harley, Evgeny A. Pakhomov, Jonathan B. Shurin, Kai M. A. Chan

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Predator recovery often leads to ecosystem change that can trigger conflicts with more recently established human activities. In the eastern North Pacific, recovering sea otters are transforming coastal systems by reducing populations of benthic invertebrates and releasing kelp forests from grazing pressure. These changes threaten established shellfish fisheries and modify a variety of other ecosystem services. The diverse social and economic consequences of this trophic cascade are unknown, particularly across large regions. We developed and applied a trophic model to predict these impacts on four ecosystem services. Results suggest that sea otter presence yields 37% more total ecosystem biomass annually, increasing the value of finfish [+9.4 million Canadian dollars (CA$)], carbon sequestration (+2.2 million CA$), and ecotourism (+42.0 million CA$). To the extent that these benefits are realized, they will exceed the annual loss to invertebrate fisheries (−$7.3 million CA$). Recovery of keystone predators thus not only restores ecosystems but can also affect a range of social, economic, and ecological benefits for associated communities.

HUMAN-WILDLIFE COEXISTENCE IN A CHANGING WORLD

Hannes J. König, Christian Kiffner, Stephanie Kramer-Schadt, Christine Fürst, Oliver Keuling, Adam T. Ford

Conservation Biology:
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Human–wildlife conflict (HWC) is a key topic in conservation and agricultural research. Decision makers need evidence-based information to design sustainable management plans and policy instruments. However, providing objective decision support can be challenging because realities and perceptions of human–wildlife interactions vary widely between and within rural, urban, and peri-urban areas. Land users who incur costs through wildlife argue that wildlife-related losses should be compensated and that prevention should be subsidized. Supporters of human-wildlife coexistence policies, such as urban-dwelling people, may not face threats to their livelihoods from wildlife. Such spatial heterogeneity in the cost and benefits of living with wildlife is germane in most contemporary societies. This Special Section features contributions on wildlife-induced damages that range from human perspectives (land use, psychology, governance, local attitudes and perceptions, costs and benefits, and HWC and coexistence theory) to ecological perspectives (animal behavior). Building on current literature and articles in this section, we developed a conceptual model to help frame HWC and coexistence dimensions. The framework can be used to determine damage prevention implementation levels and approaches to HWC resolution. Our synthesis revealed that inter- and transdisciplinary approaches and multilevel governance approaches can help stakeholders and institutions implement sustainable management strategies that promote human-wildlife coexistence.

MANAGEMENT AND POLICIES

THE ECOLOGY OF HUMAN–CARNIVORE COEXISTENCE

Clayton T. Lamb, Adam T. Ford,
Bruce N. McLellan, Michael F. Proctor,
Garth Mowat, Lana Ciarniello,
Scott E. Nielsen, Stan Boutin

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With a shrinking supply of wilderness and growing recognition that top predators can have a profound influence on ecosystems, the persistence of large carnivores in human-dominated landscapes has emerged as one of the greatest conservation challenges of our time. Carnivores fascinate society, yet these animals pose threats to people living near them, resulting in high rates of carnivore death near human settlements. We used 41 y of demographic data for more than 2,500 brown bears – one of the world's most widely distributed and conflict-prone carnivores – to understand the behavioral and demographic mechanisms promoting carnivore coexistence in human-dominated landscapes. Bear mortality was high and unsustainable near people, but a human-induced shift to nocturnality facilitated lower risks of bear mortality and rates of conflict with people. Despite these behavioral shifts, projected population growth rates for bears in human-dominated areas revealed a source-sink dynamic. Despite some female bears successfully reproducing in the sink areas, bear persistence was reliant on a supply of immigrants from areas with minimal human influence (i.e., wilderness). Such mechanisms of coexistence reveal a striking paradox: Connectivity to wilderness areas supplies bears that likely will die from people, but these bears are essential to avert local extirpation. These insights suggest carnivores contribute to human-carnivore coexistence through behavioral and demographic mechanisms, and that connected wilderness is critical to sustain coexistence landscapes.

CONSERVATION PROFESSIONALS' VIEWS ON GOVERNING FOR COEXISTENCE WITH LARGE CARNIVORES

Michelle L. Lute, Neil H. Carter,
José V. López-Bao, John D.C. Linnell

Biological Conservation:
August 2020

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Decision-making about large carnivores is complex and controversial, and processes vary from deliberation and expert analysis to ballot boxes and courtrooms. Decision-makers range from neighboring landowners to the United Nations. Efficacy, longevity and legitimacy of policies may often depend as much on process as the policy itself. Overcoming controversy requires greater understanding of preferences for decision-makers and processes as well as deeper beliefs about human-carnivore interactions. Although academic debates are rich with recommendations for governance, practitioners' perceptions regarding decision-making processes have been rarely examined. Doing so can facilitate constructive discourses on managing and conserving carnivores across highly-variable social-ecological landscapes. To gain insight into different viewpoints on governance regarding large carnivore conservation, we asked a global community of conservation professionals (n = 505) about their preferences for governance alternatives for carnivore conservation through an online survey. Respondents agreed that government biologists should make decisions while legislators and commissions received low agreement and less consensus. Findings also indicated a general rejection of turning decision processes completely over to the general public, to courts, or to politicians who are perceived as lacking both technical knowledge and local insights. We found evidence for consensus on best management processes using a combination of science, local knowledge and participatory decision-making. According to our sample, sustainable coexistence strategies may require significant shifts in processes that remove mistrusted political influences vis-à-vis ballot boxes, courtrooms, commissions and legislative chambers. Our sample believed governance structures that combine technical expertise with local perspectives in a co-management framework may best withstand tests of time and controversy.

MINIMIZING ANIMAL WELFARE HARMS ASSOCIATED WITH PREDATION MANAGEMENT IN AGRO-ECOSYSTEMS

Benjamin L. Allen, Jordan O. Hampton

Cambridge Philosophical Society: April 2020

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The impacts of wild predators on livestock are a common source of human–wildlife conflict globally, and predators are subject to population control for this reason in many situations. Animal welfare is one of many important considerations affecting decisions about predation management. Recent studies discussing animal welfare in this context have presented arguments emphasizing the importance of avoiding intentional harm to predators, but they have not usually considered harms imposed by predators on livestock and other animals. Efforts to mitigate predation impacts (including 'no control' approaches) cause a variety of harms to predators, livestock and other wildlife. Successfully minimizing the overall frequency and magnitude of harms requires consideration of the direct, indirect, intentional and unintentional harms imposed on all animals inhabiting agricultural landscapes. We review the harms resulting from the management of dingoes and other wild dogs in the extensive beef cattle grazing systems of Australia to illustrate how these negative impacts can be minimized across both wild and domestic species present on a farm or in a free-ranging livestock grazing context. Similar to many other predator–livestock conflicts, wild dogs impose intermittent harms on beef cattle (especially calves) including fatal predation, non-fatal attack (mauling and biting), pathogen transmission, and fear- or stress-related effects. Wild dog control tools and strategies impose harms on dingoes and other wildlife including stress, pain and death as a consequence of both lethal and non-lethal control approaches. To balance these various sources of harm, we argue that the tactical use of lethal predator control approaches can result in harming the least number of individual animals, given certain conditions. This conclusion conflicts with both traditional (e.g. continuous or ongoing lethal control) and contemporary (e.g. predator-friendly or no-control) predation management approaches. The general and transferable issues, approaches and principles we describe have broad applicability to many other human–wildlife conflicts around the world.

LIVESTOCK GUARDING DOGS

INVESTIGATING THE HIDDEN COSTS OF LIVESTOCK GUARDING DOGS: A CASE STUDY IN NAMAQUALAND, SOUTH AFRICA

Marine Drouilly, Caitlin Kelly, Bogdan Cristescu, Kristine J. Teichman, M. Justin O'Riain

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The use of livestock guarding dogs (LGDs) has been widely advocated as a responsible tool for reducing livestock predation and conserving wildlife. However, their hidden ecological costs have rarely been investigated. We analysed scats (n = 183) from six LGDs and visited Global Positioning System (GPS) location clusters (n = 352) from nine GPS-collared LGDs to reconstruct their diet and assess impacts on wildlife and livestock in Namaqualand, South Africa. Wild mammals, including 10 native species, and small-livestock were the main secondary foods (i.e. besides dog food pellets). A total of 90 % of scats and one third of GPS clusters investigated had associated animal remains. When accompanied by a human attendant, fewer LGD scats contained animal matter (39.9%; of which 32.3% wild mammals and 4.6% livestock), in contrast to scats of LGDs on their own (93.2%; 14.4% wild mammals, 75.4% livestock). Similarly, few clusters of accompanied LGDs included animal remains (5.7%; of which 43.8% wild mammals and 31.3% livestock), whereas unaccompanied dogs clustered frequently at carcasses (92.4%; 16% wild mammals, 74% livestock). While sample sizes were relatively small and some dogs might have scavenged, we emphasize the importance of rigorous training and intensive monitoring of LGDs to correct unwanted predation behaviour and to maximize their ecological and protective benefits.

PREDATOR CONTROL

EFFECTIVENESS OF NON-LETHAL PREDATOR DETERRENTS TO REDUCE LIVESTOCK LOSSES TO LEOPARD ATTACKS WITHIN A MULTIPLE-USE LANDSCAPE OF THE HIMALAYAN REGION

Dipanjan Naha, Pooja Chaudhary, Gaurav Sonker, Sambandam Sathyakumar

PeerJ:
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Lethal measures are widely adopted by local communities and governments to manage human-wildlife conflicts. Such measures lead to large scale decline of carnivore populations globally with trophic cascades on ecosystems and questionable impacts on human-wildlife conflicts. Mitigating human-carnivore conflicts through non-lethal measures will protect endangered predators and secure livelihoods. However, information on the effectiveness of such measures are extremely limited and hence cannot be applied in developing scientific evidence. Further to develop human-carnivore coexistence models, it is important for local community members, biologists and wildlife managers to actively participate in conservation programs. We evaluated the response of a non-lethal visual deterrent (i.e. fox lights) to deter leopard attacks on livestock within a multiple-use landscape of western Himalaya through community engagement. We monitored 16 experimental sites and 17 control sites within 27 villages and recorded data on livestock depredation by leopards between April 2018 to April 2019. A multivariate analysis was conducted to determine the influence of landscape predictors and animal husbandry practices on livestock depredation by leopards within the vicinity of human settlements. We found that visual deterrents discouraged common leopards to predate on livestock (cows and goats). We also demonstrated that community based conservation initiatives are successful in mitigating human-carnivore conflicts within large semi-natural landscapes. We suggest developing site specific coexistence strategies and adopting non-lethal measures to safeguard carnivores, livestock and humans within shared landscapes.

Videos

What exactly is a livestock guarding dog?
SEA 74, July 2020 (in French with English subtitles)

Pastoralists of the Alpine Massif and the Regional Natural Park of the Bauges Massif teamed up to produce an animated clip, with the aim of promoting better understanding of the role and behaviour of these dogs.

A science-based solution to the farmer-cheetah conflict in Namibia
Leibniz-Institut für Zoo- und Wildtierforschung, December 2020 (in English)

Scientists of the Leibniz-IZW Cheetah Research Project identify hotspots of cheetah activity as a key to solving the cheetah-farmer conflict in Namibia.

I trained my dog to guard ducks and geese
Gold Shaw Farm, December 2020

A farmer shows how he trained a Maremma sheepdog to protect (and not kill!) ducks, geese and chickens from coyotes *(Canis latrans)*, bobcats *(Lynx rufus)* and other carnivores in Vermont.

UPCOMING EVENTS

XIII European Vertebrate Pest Management Conference
7 – 10th September 2021 in Belgrade, Serbia
EVPMC conferences have been organized since 1997 and attract participants from around the world to discuss the latest research, developments, opportunities and achievements in vertebrate pest management. Due to current concerns about COVID-19, the 13th meeting will be an Online Conference.

For details see: www.13evpmc.com

27th International Conference on Bear Research and Management
In Kalispell, Montana, USA
IBA conferences showcase recent developments in research, management and conservation of all bear species worldwide. The 27th meeting was postponed from September 2020 due to the COVID-19 pandemic. Plans to reschedule the conference were on hold as *CDPnews* went to press.

For details see: https://iba2020mt.com/

International Conference on Human-Wildlife Conflict and Coexistence
In Oxford, UK
This major event, co-hosted by the IUCN's Human-Wildlife Conflict Task Force, the Global Wildlife Program and Oxford University's Wildlife Conservation Research Unit, was due to be held in April 2020 but postponed. When *CDPnews* went to press, the organisers were hoping to be able to run the conference in March 2022.

For details see: https://www.hwcconference.org/

Wolves Across Borders
8 – 12th May 2022 in Stockholm, Sweden
The goal of this International Conference on Wolf Ecology and Management is to facilitate open conversation and knowledge exchange between nations that support wolf populations and the researchers, managers, non-profits and stakeholders that work with wolf ecology, management and conflict resolution.

For details see: https://www.wolvesacrossborders.com/

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NEXT ISSUE

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The next issue of *CDPnews* is due out in spring 2021

CDPnews Carnivore Damage Prevention

LIFE EURO LARGE CARNIVORES