Carnivore Damage Prevention
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LGDs: AN OLD WORLD TOOL
used for conservation in Chilean Patagonia

USE OF LGDs IN ITALY:
from history to modernity

LGDs IN GREECE:
practical conservation measures to minimize human-carnivore conflicts

OFFICIAL SWISS LGDs

THE INNOVATIVE USE OF LGDs
to reduce illegal poisoning

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EDITORIAL

Dear Readers,

Following on from the previous issue of CDPNews, we maintain our focus on livestock guarding dogs (LGDs) with a series of articles illustrating their application in contrasting regions of the world.

While the use of LGDs is becoming consolidated as one of the main carnivore damage prevention tools, their application under different conditions, coupled with the demands of modern farming and society, has led to new challenges which must be addressed. Concerns associated with the use of LGDs encompass economic, social, cultural, ecological, ethological as well as ethical aspects. Growing attention is devoted by managers and researchers to pragmatic approaches to solving problems, assessing and optimizing LGD efficiency in different contexts. There is also a more profound concern that seeks to better understand the fundamentals of LGD behaviour and improve dog selection in order to reduce problems and avoid failure. A wide range of methods and techniques stemming from a multitude of disciplines are available and should be utilised.

The article from Patagonia in this issue shows how LGDs can be successfully introduced into new areas lacking a previous tradition, while a report from the LIFE MEDWOLF project in the Grosetto region of Italy describes their adaptation to changing circumstances. Dissemination and exchange of dogs among owners was common practice when shepherding and livestock production were major activities and is still done where LGDs persist. In areas where their use has become rare, is new or being recovered, establishing and promoting networks between farmers can have wide-ranging positive results, as observed in Greece. A different strategy, currently being implemented in Switzerland, consists of a regulated legal framework, with recognised LGD breeders united in an association. Adult dogs are systematically evaluated before being registered as 'official' LGDs while potential LGD owners are obliged to complete a training course: both steps are prerequisites for receiving government support. The norm in most countries, however, is a lack of regulation regarding the use of LGDs. Adequate legal provisions are needed which support and recognise the important role these dogs play in livestock farming and biodiversity conservation.

The article from Greece also highlights that illegal use of poison is still common in some parts of Europe and can have a major impact on LGDs as well as wildlife, adding to other major causes of mortality such as disease and accidents. Actions are needed to better understand this phenomenon and effectively prevent and control it. LGDs can also be an appropriate tool to reduce motivations behind the illegal use of poison, which affects not only large carnivores but also threatened raptors across Europe.

Providing farmers with adequate information on how to care for and treat their dogs, training on prophylactic measures, and economic support are important steps to keep LGDs healthy. Such measures are often overlooked but can have considerable influence on LGD efficiency, since poor health and disease can severely impact dog performance.

Possible solutions to these and other issues were included in the previous issue of CDPNews in a special feature by a group of experts. Further initiatives are needed to adapt livestock management and direct LGD research to meet new challenges. We hope the collection of articles presented here will help and inspire such efforts.

The Editors

Short Communication

LIVESTOCK GUARDIAN DOGS: AN OLD WORLD TOOL USED FOR CONSERVATION IN CHILEAN PATAGONIA

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1. Introduction

Historically, the conflict between predators and ranchers, both worldwide and in Chilean Patagonia, has been managed through culling predator populations including the use of traps, hunting, and indiscriminate and nonselective poisoning, methods which are often cruel and inefficient. Despite this the conflict has not been resolved, and in many cases has even been aggravated by such practices (Cooley et al., 2009; Stoner et al., 2006). One of the greatest challenges lies in successfully implementing effective measures that mitigate the negative impacts of this conflict. It is imperative to ensure the protection of livestock without compromising the conservation of native biodiversity. Numerous experiments have found that biodiversity influences the primary productivity of ecosystems and other aspects of ecosystem functioning (Tilman et al., 2012). As such, the survival of the flora and fauna contributing to Patagonian biodiversity must be protected. Additionally, it is important to note that the majority of native species, such as culpeo foxes (*Lycalopex culpaeus*) and puma (*Puma concolor*), are under legal protection by the state of Chile.

Recently, the use of non-lethal, predator-friendly methods, such as livestock guardian dogs (LGDs), an ancient tool, have gained increased acceptance in many parts of the world in parallel with the recovery of large and medium-sized carnivores and the establishment of protected areas (Gehring et al., 2010). LGDs originated thousands of years ago in Mediterranean Europe and Asia to help herders protect their sheep and goats from predators such as bears and wolves (Dawydiak and Sims, 2004). These medium- to large-sized dogs live permanently with the flock, which they regard as their companions or family, protecting them against all threats. The guardian dog is largely effective as a deterrent (van Bommel, 2010). The dog will routinely mark its territory with urine and faeces, circle the herd and inspect the limits of its territory in order to alert predators that those areas are visited regularly. This is a very effective and powerful tool for communication between carnivores (Vorwald, 2007).

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Over the years in Patagonia, due to overgrazing, livestock productivity decreased significantly. This, in addition to the existing unfavourable conditions of the sheep market, due in large part to the low international price of wool, caused the owners of the Estancia Valle Chacabuco (80,000 ha) to put their land up for sale in 2004. It was bought by Conservación Patagónica in order to begin the transition of the land from a livestock ranch to a national park. This transition meant developing a plan that considered the gradual reduction and sale of livestock, the removal of hundreds of miles of fencing and the eradication of any practice that caused the death of native predators. Here, we describe a programme for the implementation of LGDs to protect sheep from predators, the results obtained and the promotion of this tool among neighbouring ranchers in Chilean Patagonia during the transition from a livestock ranch toward the future Patagonia National Park as an example of the challenges faced by modern conservation.

2. Study area

Chacabuco Valley, situated in the Aysén region of Chile, is part of the Patagonian steppe biome (Fig. 1). The Valley is surrounded by mountains with southern beech (*Nothofagus*) forest and the ecotone between steppe and forest. For nearly a century, the economy of the Chacabuco Valley region was characterized by extensive Corriedale sheep grazing, for the production of wool and meat (Fig. 2). The farmers of the region primarily make their living through sheep husbandry. The sheep graze on "coiron" (*Festuca pallescens* and *Stipa sp.*) as the primary food source. This also contributes to the natural habitat of healthy populations of guanacos (*Lama guanicoe*), which graze on a variety

Fig. 1. Future Patagonia National Park area in southern Chile.

Fig. 2. Corriedale sheep production at Patagonian steppe.

of plant species, including coiron, neneo (*Mulimum spinosum*) and calafate (*Berberis buxifolia*). The Valley, in the Capitán Prat province of the Aysén region, is a priority conservation site (CONAMA, 2008) because the Patagonian steppe does not have any kind of conservation status and the endemic huemul deer verges on extinction due to habitat loss and competition with livestock. Many other species are also threatened.

Fig. 3. Patagonia Park highlighting Cuadro de las Vacas and Puesto Baño livestock areas.

3. Materials and Methods

3.1. Livestock and damages

It was through the implementation of the above mentioned plan that, between 2004 and 2009, the number of sheep was reduced by 96% from 25,000 to 1,000 and of cattle by 93% from 3,000 to 200. It was decided to maintain a stock of meat animals for internal consumption to feed workers, ranchers and park rangers, as was traditionally done for ranch workers. Two areas of the park, Puesto Baño and Cuadro de las Vacas, maintained a low stocking density, occupying only 1.4% (1,151 ha) of the total area of the park and taking advantage of the natural conditions and existing pastures, corrals and sheds (Fig. 3). In 2010 we began incorporating Texel and Suffolk sheep to improve the quality of meat. The sheep are managed in plots (called "cuadros") of up to several hundred hectares separated by fences and they graze on native grasses as previously mentioned. In each "cuadro" the sheep are separated by category: lambs are placed with their mothers, yearling ewes in another "cuadro" and rams in others. Sheep production is divided into two sectors, each managed by a "gaucho" (the local word for a Patagonian shepherd), who have their own small homes ("puesto") located next to the "cuadros". From here, they manage the flocks checking the sheep with the herding dogs every day. We do not provide extra food for herds since we work at low stocking densities.

We lost between 30 and 50 sheep per month to predation between 2004 and 2009. Despite drastic reductions in sheep numbers (due to stock reduction), yearly fatalities due to predators, such as puma and culpeo fox, remained the same in that period. But with only 1,000 sheep left in 2009, such level of losses would make sheep production economically unviable. It is illegal to hunt the puma or culpeo fox in Chile. Studies conducted in 2008–2015 within Chacabuco Valley, estimated 30-35 pumas residing within the valley. They predate on guanacos (80%), hares and other small mammals (16%) and sheep (4%) (Elbroch and Wittmer, 2012) (Figs. 4, 5).

3.2. Programme and dog acquisition

The challenge became how to maintain livestock without resorting to lethal control of predators. Different alternatives were investigated and evaluated. Among these alternatives was the use of LGDs: a technique that, though used in Europe and Asia for centuries, was not well-known in Patagonia. After con-

Fig. 4. Patagonian puma in the Park

Fig. 5. Culpeo fox in the Park.

sulting the available literature and becoming familiar with the theory of this technique, Conservación Patagónica began searching for suitable dogs.

It was not easy to find LGDs in Chile, as historically they are not very common in the region. Luckily, halfway through 2009, a litter of Great Pyrenees companion dogs was found in the city of Osorno in southern Chile. Two 2.5 month old littermates, a male and a female, were acquired with the goal of immediately starting to bond them with sheep. The female was named Brisa and the male Puelche (named after winds, because of the heavy winds in the sheep-grazing area).

3.3. Puppy management

One key aspect was ensuring that the pups were exposed to ewes, rams and lambs, and their sounds and smells, from as young an age as possible. They were even suckled on sheep, as Darwin observed in South America in the 19th century (Darwin, 1845), although it has been established by modern researchers and practitioners that this is not necessary for successful bonding. Another quite difficult aspect of the programme's initiation was ensuring that the gauchos were able to care of the pups, as the breeding, feeding, and obedience training of guardian dogs is quite different from that of the herding dogs the gauchos were accustomed to. For example, guardian dog pups should eat where the sheep are, ensuring the greatest possible contact between them. Additionally, gauchos must spare no effort in ensuring that pups do not approach their houses. During the first stage of the programme, these recommendations were met with scepticism and resistance from the livestock staff and curiosity from others.

On arrival, the pups were placed in paddocks where they slept in sheds with around 10 lambs (Fig. 6.). In less than a month, Brisa (the female) grasped what her role was and was taken to the grounds where the sheep are kept. It took Puelche (the male) a little longer: after roughly two months he dug a hole under the fence where he was with the lambs and followed in Brisa's footsteps to watch over the sheep. The shepherds brought food every day for the dogs inside the "cuadros". They left the food dish inside the dog houses, to be protected from the rain and the sheep. Then the shepherd checked the flock for dead and sick animals or other problems. Each night the gaucho, riding on horseback and working with the shepherd dogs, herds together the entire flock of sheep in their "cuadro", so they are packed tightly together for the guardian dogs to watch over them during the night (Fig. 7). We worked with the gauchos to correct any bad behaviour, such as pups going back to the "puestos". After the incorporation of the guardian dogs into the herds, we monitored the effect of their presence. A range of indicators were evaluated; from the observed behaviour of the dogs to the losses suffered during key seasonal times, such as the weeks after the lambs were born.

Fig. 6. Pyrenean pups with lambs in paddock.

Fig. 7. Gaucho herding the flock for the guardian dogs.

4. Results and Discussion

4.1. Dog behaviour and distribution in the field

As the days and weeks passed and the gauchos were able to observe the behaviour of the pups around the sheep, they began to trust in the programme and change their attitude. The staff ultimately agreed to take on the challenges of this programme which, though seemingly odd and untraditional, had the potential to work. By the time the pups were six months old (Fig. 8), there was a decrease in monthly sheep losses to predators. At the end of the first year the losses fell by 500 to 144 animals. With this positive feedback, before the first year's end we bought a third pup: a 4-month old male Great Pyrenees named Lolo, from a project run by the University of Chile and the Instituto Pirenaico of Spain, which was promoting the use of the breed in Chile (Lagos Torres, 2012). While Brisa and Puelche initially dedicated themselves to the care and protection of sheep, yearling ewes and lambs, Lolo was, from the onset, incorporated into the care of the rams. The latter are usually managed separately from the sheep and lambs and apparently due to their strong odour they are more attractive to predators and are a favoured prey compared to the other types of sheep.

At the end of 2011, Brisa and Lolo had their first litter of pups (Fig. 9), leaving us with an additional working pup, named Chica. In 2012 another was born, leaving us with a male named Puelche Chico. We divided these five working dogs into two main areas of the Chacabuco Valley. Cuadro de las Vacas (825 ha) has two dogs protecting approximately 500 sheep and 200 cows (Fig 10.) and Puesto Baño (326 ha) has three dogs protecting around 1,500 sheep. Although Cuadro de las Vacas has less total livestock, the flora consists of more shrubs that provide cover for potential predators, requiring more guard dogs to protect the flock. Puesto Baño, on the other hand, is flat grassland without trees obstructing the dogs' line of sight. The two groups of dogs are organized to work together as a family unit.

Fig. 8. Brisa at six months old with the flock in the field.

Fig. 9. Lolo, Brisa and pup at Puesto Baño.

Fig. 10. Puelche Chico in the field with the flock.

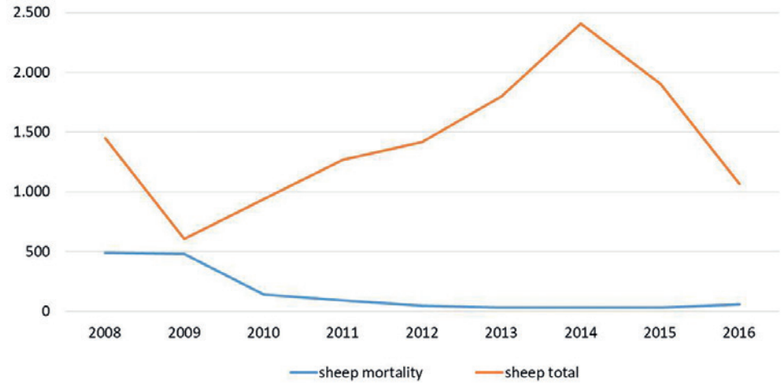

Fig. 11. Sheep mortality and total number of sheep in the Chacabuco Valley from 2008 to 2016, before and after the incorporation of LGDs that started in March 2009. The reduction in sheep numbers from 2014 to 2016 was due to sales.

4.2. Effect of LGDs on sheep survival rates

Mortality caused by predators in the Chacabuco Valley sheep flock has significantly decreased since the incorporation of the Conservación Patagónica guardian dogs from 2009 to date (Fig. 11). Before that no prevention measures were in place which accounted for the very high predation rates. The use of guardian dogs, combined with adequate sanitary management (Fig. 12), vaccination and deworming, has allowed for a significant increase in sheep retention numbers. In addition, studies have shown that dewormed sheep growth is faster and larger than untreated sheep. Thus, the sanitary management improved the health of the flock and reduce the occurrence of diseases (Gallo et al., 1994).

The data show that losses due to predation were reduced significantly over the past five years of the study (2011-2015) with dogs working, averaging 1.3% of total stock per year. This was just over half of the total annual loss including natural death, accidents and illness (Table 1). The guardian dogs have allowed for an increase in the "señalada" (docking, castration, tagging and first counting the lambs from the season) because of a reduction in lamb losses, with a 115% increase in the number of lambs surviving past two months of age. These high numbers are also achieved due to the fact that some of the sheep can birth multiple (two even three) lambs at once.

Fig. 12. Livestock sanitary management at the sheep corrals.

Table 1. Percentages of lambs tagged per year (relative to the number of ewes), total annual losses* and total losses due to predation.

Tagging Year	Sector	Nr. Sheep	Nr. Lambs	% Tagged	Annual Losses	Annual Losses to Predators
2013	Puesto Baño Cuadro de las Vacas	488 203	569 211	117% 104%	48	31
2014	Puesto Baño Cuadro de las Vacas	625 218	689 270	110% 124%	50	30
2015	Puesto Baño Cuadro de las Vacas	513 133	529 158	103% 119%	54	33
Average for the 3 years					2%	1.3%

* Total annual losses include predation, natural death, accidents and illness.

Fig. 13. Wildlife Friendly Enterprise Network certification logo for Patagonia Park.

4.3. Programme impact and perspectives

Thanks to the LGDs, we have managed not only to produce the meat necessary to feed the workers, but also to profit from the sale of sheep and wool. Over the past seven years, the dogs have become ambassadors of Patagonia Park, demonstrating an alternative method of livestock production that exists in harmony with nature and wild predators. The Patagonia Park's LGD programme has become a model, demonstrating that livestock can be grazed sustainably within and in the immediate vicinity of a protected area, cohabitating with natural predators without illegal hunting or poisoning. Additionally, the programme delivers added value to our products through the Wildlife Friendly Enterprise Network (wildlifefriendly.org) international certification and promotes changes in traditional breeding practices, as well as in the management of livestock and native predators (Fig. 13).

From 2011 to February 2017, with two female dogs, we produced four litters and delivered 30 pups to ranchers in order to spread the use of this technique for the care and protection of herds. Today, the dogs can be found working in Chile from Villarrica in the north to Villa O'Higgins in the south, and in Argentina from Río Negro to Calafate, they are found in all places with sheep. We constantly strive to promote responsible management of LGDs. Pups are delivered to ranchers along with a technical manual, which contains advice on the process of bonding the dogs to sheep. In order to obtain the best possible results, Programme professionals advise ranchers to adapt their recommendations depending on the conditions of the ranch where the dogs will work. We delivered most of these pups sterilized (at the owner's request) at 3-6 months of age, as it allowed the dogs to work with fewer distractions. Sterilization also ensures that females do not need to be taken out of the herd and confined in a kennel for three weeks while they are in heat: an absence which predators can exploit (Fig. 14).

Fig. 14. Lolo with pups and sheep.

In parallel to the dissemination of pups, we participated in the development of a documentary film: Livestock Guardian Dogs in Aysén: The Beginning of a History[1]. The story is told through interviews with Aysén ranchers, detailing their experiences with the management of these dogs and the results that they have observed.

[1] https://www.youtube.com/watch?v=NEeXyVDwYKg

5. Conclusions

The LGD programme's achievements in Chilean Patagonia to date have allowed the validation of an old livestock management tool (not well known in Patagonia) for which Patagonia Park has become a local and national reference. The implementation of the livestock guardian dog programme in Chacabuco Valley influenced the National Institute of Agrarian Innovation (INIA) to start breeding Pyrenees pups to sell to local ranchers. We have seen a 90% reduction in losses from predation in the flocks of the Patagonia Park, allowing for a growth in sheep production of up to 125% (115% on average), which has made it possible to meet the annual consumption needs of 500 sheep per year and to sell products such as wool, meat and livestock. The use of LGDs has allowed us to maintain natural predator populations, thereby conserving the local wildlife's ecological equilibrium. These predators consume the weakest, sickest or least adapted individuals, thereby improving the condition of populations of guanaco, huemul, and other wildlife (Elbroch and Wittmer, 2013).

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Research Article

USE OF LIVESTOCK GUARDING DOGS IN ITALY:
FROM HISTORY TO MODERNITY

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1. Introduction

The use of livestock guarding dogs (LGDs) in Italy dates back to Roman times, as recorded by Varro in his "Res Rusticae" in the second century BCE and Columella in his "Res Rustica" in the first century CE. These authors described flocks of sheep associated with large, white dogs that were fearless in the presence of predators and thieves.

LGDs continued to be part of the pastoral system into modern times, particularly in central Italy, where transhumance was common for transferring sheep in the mountains during summer periods. The most commonly used dog breed was a large sized mastiff named in the 1950s "Abruzzo-Maremma Shepherd Dog" by the National Dog Club. The Maremma part of its name was given in consideration of the work done by dog lovers in that area of Tuscany, where they started raising them for other purposes, setting the standards for show dog evaluation of the breed. Transhumance is still practiced in some areas of Italy, but most flocks are now transported by truck. Still, the Maremma is the most commonly used LGD breed when stock is left grazing in pastures or overnight in corrals. In the mountains of central Italy, where the wolf (Canis lupus) was never fully eradicated even when its population reached a minimum in the 1970s

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(Zimen and Boitani, 1975) such customs have never been lost. However, the socio-economic conditions and historical events in other parts of Italy resulted in the disappearance of LGDs.

The wolf population has increased since its protection in 1972, expanding into areas where it had been absent for decades and the tradition of flock protection was lost. The return of the wolf to such areas has been associated with damages to unprotected livestock and the need to implement prevention measures was evident to many livestock owners. In this context, a number of initiatives have taken place in different areas of Italy, contributing to the correct application in modern days of the ancient practice of using LGDs and to evaluation of their effectiveness with the assumption that dog behaviour with the sheep and the owner is an indicator of its ability to provide good services (Breber, 1988). Here we describe activities implemented through three LIFE projects in three areas of Italy, where different aspects of LGD management were tackled.

2. The LIFE COEX Project

The LIFE COEX project (LIFE04NAT/IT/00144) ran from October 2004 to September 2008 and included different areas of intervention in Portugal, Spain, France, Italy and Croatia. The main aim of the project was to implement damage protection measures to mitigate conflicts involving wolves and brown bears (Ursus arctos) in particular sites in the project countries, through specially designed interventions. In Italy, the intervention actions included the implementation of electric fences and livestock guarding dogs in Abruzzo National Park.

2.1. Project area: Abruzzo National Park

The area covered by the Abruzzo National Park (PNALM) is in the central Apennines, and extends for 507 km^2. The area is typically mountainous, with elevations ranging from 400 to 2,285 m. Snow cover generally extends from mid-December to March, but with great annual variability. The park is characterised by the significant presence of large ungulates and the two largest carnivores in Italy: the wolf and brown bear. Although the area has been protected since 1922, human activities are present both in the core protected areas and its buffer. Activities include livestock husbandry, forestry, tourism and some agriculture, mainly in the lowlands. Wildlife protection is a priority for the park, together with the maintenance of traditions and seeking ways for integrating economic opportunities for local communities. There are estimated to be seven wolf packs in the park (LIFE COEX, 2008) and their impact on livestock production activities is managed by the Park Administration through incentives for damage prevention measures and ex-post payment for losses (Latini et al., 2005).

2.2. Methods

LGD pups were acquired with project funds from local livestock owners who used adults for guarding their flocks. LGD recipients were selected according to a set of criteria that included: location in areas where depredations had been recorded previously; presence of other LGDs in the holding; willingness and capacity of the owner to raise the LGD (e.g. extent of time dedicated to farming activity, motivation); and the adequacy of conditions for raising the dog (e.g. risks for the survival of the dog, flock management, sanitary conditions). Once a request was received a first personal interview was made and, if selected, the livestock owner was required to sign an agreement that engaged him in a series of commitments for adequately raising the dog. Food and veterinary care were provided by the project until dogs reached 12 months of age and the new dog owner committed to providing two pups of the first litter (after the dogs had reached maturity) for free to other livestock owners who had contacted the project staff and met the established criteria. A total of eight LGDs were donated in the project area, as many livestock owners already had their own dogs or did not want to undertake the commitment to have a dog to look after. Each LGD delivered was visited on a monthly basis by the project staff and park personnel (a veterinary) in order to check health status and to detect any problems reported by the owner.

The selection of dogs to be evaluated was driven essentially by the willingness of the owner to participate in the study. The behaviour of dogs aged over 24 months was evaluated according to the protocol used by Coppinger and Coppinger (1980). The three parameters considered as proxies for the assessment of LGD behaviour were: trustworthiness, attentiveness and protectiveness. Attentive dogs stay close and follow the flocks' movements, trustworthy dogs do not disrupt the flock or injure livestock, and protective dogs display guarding behaviour in the presence of strangers/predators and interrupt potential attacks. These parameters were assessed through direct observations of the dogs during grazing periods. Each dog was observed for three sessions of four hours each (Mancini, 2006). The observer was always in a non-intrusive position, such as sitting at the edge of the pasture or walking at a distance of at least 100 m from the dog if the flock was moving. For measuring attentiveness, the location of the LGD with respect to the flock or the shepherd was recorded according to Coppinger et al. (1983), using three types of observational measures: i) sidedness (side of the flock relative to the shepherd); ii) orientation (if dogs approached the flock or the shepherd); and iii) proximity (distance of the dogs to the flock and the shepherd as estimated by direct sight. A sidedness score was determined as the percent difference in the number of times the dog stopped on the same or the opposite side of the flock relative to the shepherd. An orientation score was determined as the percent difference in the number of times the dog approached the shepherd or the flock. For further information on the methodology used see Mancini (2006). The average distances of each dog from the shepherd and the flock were also computed. A Spearman correlation test was then used to assess correlation between the different parameters assessed and a Mann-Whitney test was conducted to compare differences between males and females.

For measuring trustworthiness towards the animals in the flock a set of behavioural categories were considered (Cruz, 1999) while observing the dogs, such as: agonistic, neutral contact, investigation, play, and allo-grooming. As for protectiveness, behaviours (e.g. alertness, approaching, barking) displayed in response to unexpected events (e.g. loud noises, non-familiar objects/individuals) were recorded. Behaviour frequencies were registered for each dog.

A total of 15 LGDs were evaluated in the period from mid-August to end of November 2006: two of them adults from the LIFE COEX project and the rest from other livestock owners and aged between 24 and 48 months. There were 11 males and four females from nine farms. The sex ratio depended on the willingness of owners to take part in the project and does not reflect the presence of LGDs in the area. A total of 45 observation sessions were made in the field during the period June–November 2006, usually in the early morning or mid-afternoon.

Finally, a questionnaire was completed by 15 dog owners to assess their personal perceptions regarding the three basic behaviour components for LGDs, as described earlier, and their dogs' overall performance. Each behaviour was explained and the owners rated them according to a four-point scale, ranging from Excellent/Very Satisfied to Bad/Unsatisfied.

2.3. Results

On average, the distance of LGDs from the flock was shorter than from the shepherd (mean LGD-Flock score=2.53±0.37 SD; mean LGD-Shepherd=2.14±0.41 SD; Fig. 1), but never higher than 90 m. Furthermore, a direct correlation between the LGD-sheep distance score and sidedness of the LGD with respect to the shepherd was detected ($r=0.78$, $p<0.001$), indicating that dogs usually approached the flock from the side opposite to the shepherd. Similarly, a significant corre-

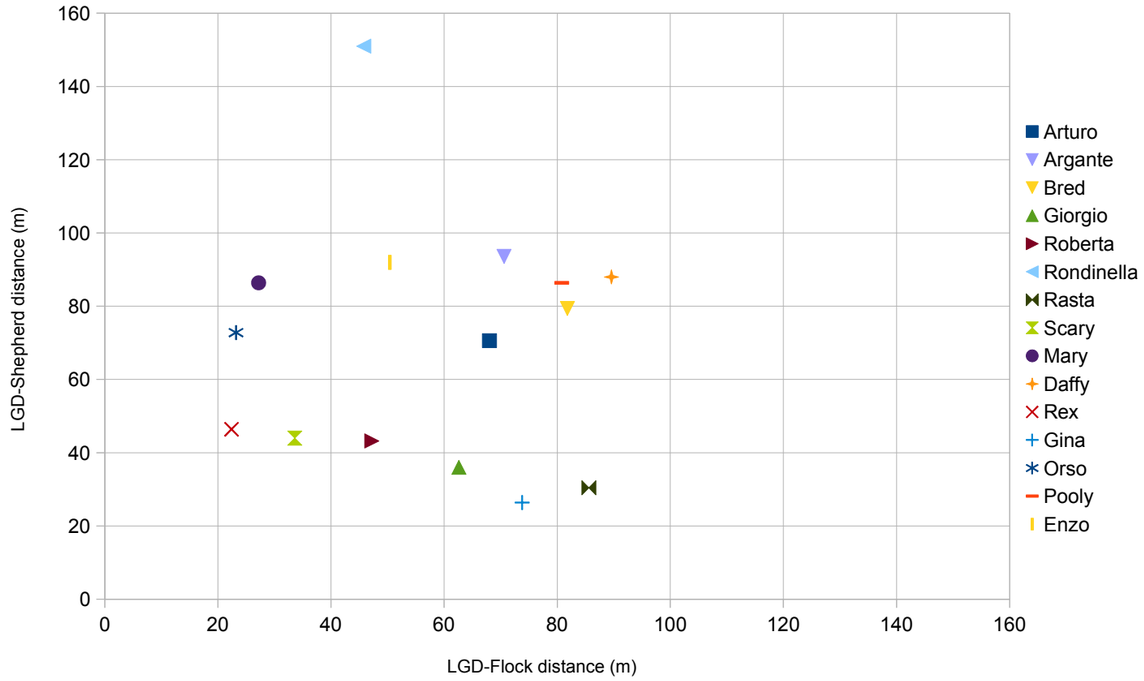

Fig. 1. Distance from the flock and from the shepherd of the 15 LGDs observed in PNALM during the LIFE COEX project.

lation was found between the score of relative distance between LGDs and flocks and the score for orientation ($r=0.56$, $p<0.05$), indicating that approaches of LGDs to flocks were not random. The correlation between the distance of the LGD to the shepherd and the frequency of allo-grooming exhibited towards the sheep was also positive ($r=0.63$, $p<0.05$), suggesting LGDs approaching the flocks were attached to the sheep, following them actively instead of the shepherd. The differences among the two sexes were significant in respect to the distance from the flock: females were on average closer to the flock than males (mean distances: females=4.8m ±0.4, males=14.7m±0.3; $Z=-2.35$, $p<0.05$). This can be explained by the fact that males display a higher frequency of protective behaviours (e.g. approach and alert to the presence of intruders, investigate any strange stimuli around the flock) than females ($Z=-1.98$, $p=0.047$). However, care should be taken when considering these results due to the small sample size and the male-biased sex ratio.

LGD owners were generally satisfied with their dogs. Most dogs (93%) were rated as good-excellent in attentiveness to the flock (only one male was rated as sufficiently attentive) while all were reported as good-excellent for protection of the flock and excellent for trustworthiness. The level of satisfaction with the overall performance of LGDs was good-very good for all owners (Fig. 2). Thirteen LGD owners reported having assisted in cases when dogs chased predators such as wolves or bears trying to attack their flocks. Seven male dogs (67% of all males) were reported to have killed wildlife (hares *Lepus europaeus*, roe deer *Capreolus capreolus*, foxes *Vulpes vulpes*) on many occasions and were observed feeding on them.

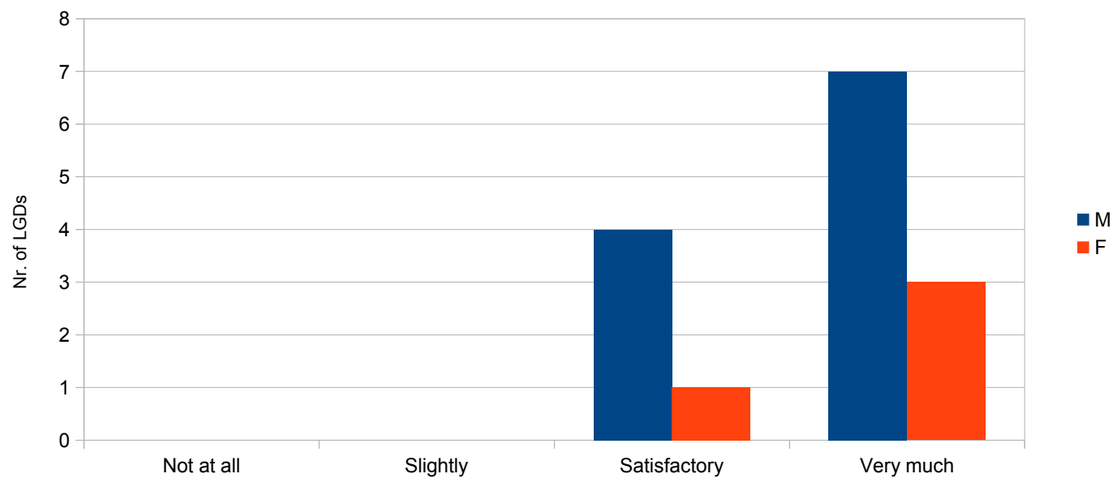

Fig. 2. Degree of satisfaction of 15 LGD owners who completed a questionnaire.

3. The LIFE MEDWOLF Project

The LIFE MEDWOLF project (LIFE11NAT/IT/069), implemented from September 2012 to November 2017, focuses on the conflict between livestock raising activities and wolf presence in areas of Portugal and Italy where the wolf had been absent or at very low densities for decades but has made a comeback in the last two decades, bringing about high levels of depredations to unguarded livestock. The project area in Italy is the Province of Grosseto, where interventions included the allocation of livestock protection infrastructures and livestock guarding dogs, associated with an intensive networking activity among livestock producers from different areas to establish a long-term relationship among users of damage prevention measures. The project is characterised by the cross-sectorial participation of environmental and livestock producer associations as active partners.

3.1. Project area: Province of Grosseto

The Province of Grosseto is part of Tuscany Region, in central Italy, and covers over 4,000 km^2. It is dominated by a Mediterranean-like environment and extends from the Mediterranean coastline to the peak of Mount Amiata (1,738 m). Wild ungulates are present at high densities and livestock production, particularly sheep, is a keystone of the local economy. The province has the lowest density of human presence in Italy and is known for the production of Pecorino Toscano cheese targeted by tourists for its eno-gastronomic productions. There were 1,200 registered sheep farms in 2015 with about 200,000 sheep (BDN, 2015). Claims for damages to livestock production by wolves increased since 1995, when the regional law for damage compensation came into force (Banti et al., 2005). Compensation was paid directly until 2005, when an insurance-based system came into force. The efficacy of the new system in mitigating conflicts was so poor that in 2014 the regional government renewed direct compensation payments (Marino et al., 2016). There were estimated to be at least 12 wolf packs in Grosseto in 2015 (Marco Apollonio, pers. comm.).

3.2. Methods

The project foresaw the allocation of 20 LGDs of the Maremma breed to selected livestock breeders in Grosseto. Recipients were initially selected according to three main criteria: damages previously suffered (in 2011-2013); location of the holding with respect to a risk map elaborated by the project team using data on wolf damage claimed in the years 2011-2013; size of the holding in terms of number of heads (minimum 50 heads). We only focused on sheep producers as the preliminary data gathered on wolf damages indicated the majority of them occurred to sheep. The preliminary list of potential beneficiaries was analysed and direct interviews were made in order to verify that proper conditions were in place for raising dogs, namely confirming the interest and willingness of the potential recipient to devote care and time to the pups, following instructions provided by project staff, and the stock management in the holding.

After the final selection of beneficiaries was made, pups were delivered in the presence of a technical expert from Abruzzo Region, where LGDs are traditionally used. An agreement was signed with the beneficiary, committing them to follow project procedures including a fixed protocol for correcting dog behaviour when necessary and managing dog breeding according to a plan agreed with project staff. The collaboration further assessed the potential to involve the livestock breeder in a network of producers aimed at sharing experience through meetings and communication events.

After the dog was delivered visits were made daily for the first week followed by once a month for behaviour and health condition checks. LGDs aged >24 months were selected for fitting with GPS collars. They were monitored regularly from November 2015 to July 2016 during daily grazing to estimate their positions relative to flocks using Tractive® GPS Pet Tracking collars (Tractive GmbH, Austria), under the assumption that LGDs should stay close to the flock in order to protect it. GPS collars were fitted both to

LGDs and one member of the flock (Fig. 3). The selection of the sheep to be fitted with GPS collar was made with the livestock owner who knew which individuals were more dominant and so would represent the movements of the entire flock. GPS monitoring was performed for 20-day sessions at each farm during which GPS collars recorded positions every 15 minutes during movement and every 60 minutes during rest. Batteries were charged every other day by the livestock owner and data were logged automatically on a daily basis. The period when the flock was closed in the stable was excluded in order to assess only the interactions between dogs and sheep on pastures. Data were analysed considering the intensity of location distribution and the overlap between locations of dogs and sheep represented by the Utilization Distribution Overlap Index (UDOI) (Fieberg and Kochanny, 2005).

3.3. Results

In response to a public call, a total of 201 expression of interest in the damage prevention measures provided by the project were received by project partners. Of these, only a few were interested in receiving LGDs, as farmers had neither knowledge nor experience of having such dogs, which were thus perceived as a bur-

den and essentially a cost they did not want to bear. In order to overcome this initial reluctance, a process of awareness raising and information provision was initiated. Alliances with those few farmers who already had LGDs were established and they were asked to provide information to others during two workshops organised by project staff. These activities allowed the delivery of the first eight LGDs in July 2014. Once these first pups were established in holdings, word of mouth was the most effective means of raising awareness and an additional 12 pups were delivered from December 2014 to May 2015. All pups given in 2014 and 2015 were selected from a working dog breeding cooperative in Abruzzo Region: a farm where working dogs from different farms were bred and selected for sale. There were eight males and 12 females. Until the age of 2.5 months they were raised at eight different sheep farms in Abruzzo Region, who adhered to CIRCA dog breeding cooperative.

All LGDs were vaccinated prior to delivery (repetition was made in due time according to a veterinary protocol) and health checks were made monthly for the first two years of age by a veterinarian contracted by the project. Three LGDs died due to car accidents and health problems (i.e. gastroenteritis). Three had to be transferred to new holdings in the project

Fig. 3. GPS collar fitted LGDs with their flock in Province of Grosseto.

area after the accidental death of the livestock owner (n=2) and due to problems with the original beneficiary (n=1), who was not interested in keeping them according to the project protocol. Fifteen LGDs were fitted the GPS collars (Fig. 4). The distance between dogs and sheep averaged 92±116 m and they tended to use the same areas, with a high degree of overlap of their 95% Utilization Distribution area (UDOI=2.19, Zingaro et al., 2016). The range of distance depends on several variables, particularly the dogs' age and land cover, namely artificial area, forest, heterogeneous area (as described in the CORINE Land Cover). Dog-sheep distance increased in correspondence to wooded areas, while it decreased in the presence of artificial surfaces. Older dogs (over 2 years of age) kept closer to sheep than younger ones (Zingaro et al., 2018).

Dog-sheep distances and UDOI can be a good proxy to a dog's attentiveness to the flock, as defined by Coppinger and Coppinger (1980), with attentive dogs having higher overlap scores and staying closer to the flock. Attentiveness may provide good indications of a dog's efficacy in protecting flocks since, according to Coppinger et al. (1988), it is the most important component for a successful guarding dog, since the mere presence of a dog may disrupt predatory behaviour and thus reduce predation.

With increasing confidence, the number of farmers willing to have LGDs also increased and the experience gained by all of them was made available to others through the network established within the DifesAttiva organisation (see Vielmi and Salvatori, 2017). This resulted in an additional 20 LGDs transferred to 12 new holdings in the period from December 2015 and November 2016 through the newly established networking association DifesAttiva.

4. The LIFE MIRCo-lupo Project

The LIFE MIRCo-lupo project (LIFE13/NAT/IT/000728), implemented from January 2015 until the end of March 2019, aims to reduce the impact of stray and wandering dogs on the Italian wolf population in two Appennino tosco-emiliano and Gran Sasso–Laga National Parks. Free ranging dogs create or perpetrate hybridization problems (Godinho et al., 2011; Pacheco et al., 2017; Verardi et al., 2006) but they can also represent a sanitary issue for wolves living in the same environment (Ciucci, 2013). Dogs and wolves share susceptibility to several infectious diseases (Kreeger, 2003). If dogs are not correctly managed and do not undergo prophylaxis including anti-parasitic treatments and

Fig. 4. GPS collars being fitted to LGD and sheep by the livestock owner.

vaccines they can spread pathologies and negatively influence wolf population fitness (Di Sabatino et al., 2014; Guberti et al., 2004). The project aims to improve the management practices of farm working dogs in the project area and consists of two main actions: i) a preparatory action for monitoring management in terms of the level of supervision and health status of the canine population used as working dogs in farms or LGDs in sheep-goat farms; and ii) a concrete action including health treatments (vaccines and anti-parasitic treatments) and, when missing, compulsory registration of dogs in the official canine registry as extraordinary actions.

4.1. Project area: Tosco Emiliano Apennine National Park

Appennino Tosco-Emiliano National Park (Parco Nazionale dell'Appennino Tosco-Emiliano, PNATE) was established in 2001 by the unification of two regional parks (Parco Regionale del Gigante and Parco Regionale dei Cento Laghi). It covers 262 km^2 and includes parts of four provinces in two different regions: Parma and Reggio-Emilia in Emilia-Romagna and Massa Carrara and Lucca in Tuscany. PNATE and its adjacent territory contribute to the production of several typical products, including Parma ham and Parmigiano Reggiano cheese. A small part of the local economy is still represented by sheep and goat farms. This kind of livestock is mainly bred for milk (to produce pecorino cheese) but also for meat; farmers typically use local breeds (e.g. Massese sheep) which are suitable for both.

In the north-central Apennines the use of LGDs is becoming common since the return of the wolf a couple of decades ago. PNATE, through its Wolf Apennine Center (WAC), has provided assistance to farmers who requested it after having acquired an LGD from other farmers in the area, by either connecting farmers with LGDs or providing technical support for dog behaviour and management. Eight wolf packs are estimated to occupy the entire park territory (LIFE EX-TRA, 2013)[1]. There are 196 registered livestock raisers and many of them use dogs either for guarding or herding livestock. Although it is mandatory by law (L.N. n. 281/1991), LGDs are often not identified with microchips and, consequently, not included in the National Dog Registry database. This poses management problems such as control of the dogs that may roam freely, representing a vector for diseases and/or crossbreeding with wolves (Ciucci, 2012).

4.2. Methods

The selection of dogs to be treated was based on the willingness of farmers to participate and locations of farms. The work focused mainly on rural areas, particularly summer pastures with wolves in and around PNATE. The dogs present in the holdings were screened by project veterinaries for checking their registration in the National Dog Registry (managed by the National Health System), by checking for the presence of a microchip with a microchip reader, and their vaccination history by asking the owner for the vaccination record (Fig. 5). A sample of dogs was also screened for a set of diseases that are known to be potentially transmittable to wildlife, namely canids: Leishmaniasis, Filariasis, Borreliosis, Ehrlichiosis and Herpesvirosis. The first four of these are vector borne diseases linked to temperate climates. Considering climate change, the increased movement of pet or working dogs and the new distribution areas of wolves it is of primary importance to have screening data of all pathologies which have been reported in wild wolves (Kreeger, 2003; Wallach and Boever, 1983). From a preliminary collection of medical data from local veterinarians, we decided not to focus on Parvovirus, Distemper and Toxoplasmosis as these have not been recorded in the study area for the last three decades.

4.3. Results

A total of 234 dogs at 44 farms were inspected in the period from March 2015 to April 2016. Of these, 55% were LGDs and 45% were herding dogs. LGDs were used at 91% of the farms, with the Maremma Sheepdog (87%) being the most common breed, followed by crossbred dogs (11%) and other breeds (2%). The number of LGDs per farm averaged 3.2 and ranged from one to 15, generally positively correlated to the size of the flocks. Only 12.5% of farmers reported correct vaccine prophylaxis at the time of inspection (87.5% of farmers never treated their dogs). As a correct vaccine prophylaxis it was considered a treatment with at least two shots (a first one and a recall booster shot) of a vaccine including protection for: canine distemper virus, adenovirus type 1 (hepatitis) and adenovirus type 2 (respiratory disease), canine parainfluenza virus, canine parvovirus and leptospirosis (with protection for at least *Leptospira interrogans* serogroup *Canicola* and *L. interrogans* serogroup *Icterohaemorrhagiae*). A total of 122 dogs (52%) were vaccinated thanks to the LIFE MIRCo-lupo project (with a four-strain vaccine protecting for *Leptospira interrogans* serogroup *Canicola* serovar *Portland-vere*, *L. interrogans* serogroup *Icterohaemorrhagiae* serovar *Copenhageni, L. interrogans* serogroup *Australis* serovar *Bratislava* and *L. kirscheneri* serogroup *Grippotyphosa* serovar *Dadas*). In addition, 109 dogs were treated for internal parasites with combined medication preventing infestations of nematodes (ascarids, hookworms and whipworms) and cestodes (tapeworms including *Echinococcus* spp.). Ninety-three LGDs (40%) were found to be not correctly registered and so were microchipped and registered in the national database during inspections.

A sub-sample of 50 dogs, 58% of them LGDs, was chosen for the sanitary survey. No dogs tested positive for Filariosis, Ehrlichiosis or Herpesvirosis. Only one dog, a LGD, tested positive for Leishmaniosis at a low antibody titre. Eleven dogs, including six LGDs, showed serological positivity for Borreliosis at different titres. Borreliosis, also known as Lyme disease, is a bacterial disease caused by the spirochete *Borrelia burgdoferi* which may debilitate wolves as well as dogs and represents an emerging primary zoonosis in Italy (Kreeger, 2003; Lindgren and Jaenson, 2006).

Fig. 5. LGD being checked for microchip in Appenino tosco-Emiliano National Park.

5. Discussion

Livestock guarding dogs in Italy are well known in many regions but their use in common practice is limited geographically. The high cultural diversity that characterises Italian regions and the variability in traditions and beliefs are obstacles to the application of certain practices in areas where they were have been abandoned. In such cases the work to be done is similar to that done in countries where the tradition did not exist at all (Coppinger and Coppinger, 2001; Gehring et al., 2010). This is the case in Tuscany, where in the Province of Grosseto only a few livestock owners had LGDs and the LIFE MEDWOLF project had to start with an intensive activity of persuasion and full time assistance to new owners.

[1] The LIFE EX-TRA project - Improving the conditions for large carnivore conservation – a transfer of best practices (www.lifextra.it), aimed to address the conflicts between wolf and bear conservation and human activities. It was implemented in 2009-2013 and involved seven partners from four different countries: Italy, Greece, Romania and Bulgaria.

In other areas, such as the Abruzzo region, the presence of LGDs is considered common practice by all livestock owners, who are used to coexist with wolves and brown bears. In Abruzzo it was easier for LIFE COEX project staff to transfer LGDs and find good quality donors from the area. There, the evaluation of LGDs, even those not provided by project staff and hence raised without supervision, indicated they had the behavioural traits considered desirable for LGDs.

Although the use of LGDs is considered common practice, their sanitary management is not always compliant with current legislation and the threat they pose to wild canids in areas of expansion could be considerable. In such areas, the correct management of working dogs is increasing relevance: not leaving them wandering unguarded and applying sanitary care to minimise the risk of infections from the most common pathologies, including de-worming.

It is clear that although the use of LGDs is spreading and in some cases the Regional Governments are promoting their use (e.g. Regione Piemonte use RDF for covering costs of LGDs), more work needs to be done for their correct management and education. This needs to be adapted to the local cultural settings in different areas in Italy. In some cases the introduction of LGDs might be counterproductive. In the Province of Grosseto, for example, we refused to deliver LGDs to livestock owners that were too close to touristic paths and were not committed enough to work with dogs and correct their behaviour when necessary. Although there is no hard evidence that LGDs pose effective problems to tourists in the area, the perception of local people is negative (as revealed by many local newspaper articles) and intensive communication work should be done before the introduction of LGDs in the area.

It is of paramount importance that LGDs be evaluated for their effectiveness (cf. Eklund et al., 2017). A recent review (Catullo et al., 2016) showed that although LGDs have been distributed through programmes, projects and specific measures of the Rural Development Fund in Italy, only in a very few cases was there a proper evaluation of LGD behaviour with the exception of 4 out of 12 LGDs provided in the Alps in 2004 (Tedesco and Ciucci, 2005) and the 15 LGDs assessed within the LIFE COEX project reported here (Mancini, 2006). LGD effectiveness is more commonly done through interviews with dog owners to assess their satisfaction and perceptions on dog behaviour (e.g. Coppinger et al., 1988; Marker et al., 2005; Rust et. al., 2013). Although this might be a fast and simple method, a good proxy and certainly, an important factor to take into consideration when implementing conflict mitigation measures, owner perception might not reflect the actual behaviour of the dog, and complementary methods should be developed that better quantify the various effects of the interventions. Decrease of damages after the introduction of LGDs to farms is also an indicator of efficacy (Dalmasso et al., 2012; LIFE COEX, 2008), but other factors might affect such results (e.g. changes in wolf presence, wild and domestic prey density and availability, habitat characteristics). We therefore strongly support the implementation of a rigorous method for assessing LGD efficacy and evaluation of its behaviour with a progressive scientifically-based approach.

The selection of farmers to receive LGDs is crucial for the evaluation of the effectiveness of such dogs. Zingaro et al. (2016) reported that the collaboration of the LGD owner was essential for contributing to data collection and for fitting GPS collars to sheep. Tedesco and Ciucci (2005) reported that some LGDs to be evaluated were not approachable even by the sheep owner, while others were used incorrectly, staying all day inside an enclosure.

In the north-central Apennines the use of LGDs is again becoming common following the return of the wolf. The work done recently allowed for the assessment of the sanitary risk posed by dogs in and around the park. Many were not included in the national canine registry database, which poses management problems such as control of the dogs that may roam freely, representing a vector for diseases and/or crossbreeding with wolves (Ciucci, 2012). Even registered farm dogs were seldom correctly vaccinated and treated for parasitic infestations, posing a threat to other canids (dogs and wolves) and in some cases even humans (e.g. for *Echinococcus spp.* and *Borrelia burgdoferi* infestations and for *Leptospira spp.* infections). In canids it is not uncommon that Borreliosis causes no symptoms and the infected animal becomes a carrier. The pathology represents a zoonosis (Krupka et al., 2007; Carstensen et al., 2017; D'Amico et al., 2017): humans, like other hosts, can contract the disease from ticks and, if not diagnosed in time, this can cause severe problems such as myocarditis and arthritis (Stanek et al., 1988). The spread of *Borrelia burgdoferi* in tick populations is high (Strnada et al., 2017) so it is therefore important to educate dog owners to treat them with external anti-parasite products in order to limit the spread of the pathogen in the environment. Even though parasitic prophylaxis treatments were not included in the LIFE MIRCo-lupo actions, inspections combined with serological data allowed the project veterinary technicians to discuss the importance of this kind of treatments with dog owners. In several cases owners were willing to change their approach and were given a prescription in order to use the best antiparasitic protocol.

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Research Article

LIVESTOCK GUARDING DOGS IN GREECE:

PRACTICAL CONSERVATION MEASURES TO MINIMIZE HUMAN-CARNIVORE CONFLICTS

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1. Introduction

The predatory behaviour of the bear (*Ursus arctos*), wolf (*Canis lupus*) and golden jackal (*Canis aureus*) creates conflicts with livestock raisers in Greece. Carnivore-human conflict is one of the most challenging issues for organizations and public authorities involved in wildlife conservation and management. The number and severity of conflicts greatly affect large carnivore (LC) acceptance by local communities and overall conservation efforts (Iliopoulos, 2010).

During the last decade, the recovery of LCs has added to professional challenges faced by farmers in Greece. The Hellenic Farmers Insurance Organization (ELGA) is a public insurance organization supervised by the Ministry of Agriculture, where breeders of cattle, small ruminants, equids, rabbits, game animals and bees are obliged to insure their livestock and pay the yearly value. According to ELGA data for the period 2010-2016, carnivores caused considerable economic losses to livestock. The mean annual wildlife damage compensation paid for livestock losses was 1,053,861 EUR (SD=233,802). In particular, wolves accounted for 14,850 confirmed and compensated cases of livestock damage. ELGA compensated 1,596 cases of brown bear damage to livestock, 295 to beehives and 1,346 to crops. For this period, the total wildlife damage compensation for livestock losses was allocated as follows: 43.1% for sheep, 22.1% for goat, 32.5% for cattle and calves and 2.3% for equids.

The compensation scheme in Greece is uniform for the whole country. Depredation from wild carnivores (wolf and bear) (Fig. 1) and stray dogs (usually living in packs) are among the insured risks according to ELGA's Regulation. The claim procedure is as follows: the farmer contacts ELGA's local office

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and a veterinarian expert inspector performs an in-situ assessment in order to verify that the damage was exclusively caused by species described in ELGA's Regulation as well as to record and estimate the level of damage. The inspector draws up an assessment report, based on which the livestock farmer will be compensated or not for the claimed damage.

Fig. 1. A sheep injured during a wolf attack on the flock. Photo: C.N. Tsokana.

According to ELGA's Regulation, the minimum level of damage eligible for compensation is two sheep/goats or one calf older than 10 days per attack (ELGA, 2011). If damage does not reach this threshold, the claim is discarded and is not recorded in ELGA's database. Such occasional losses, accumulated over a long period, could nevertheless result in a serious loss of animals and income for farmers as well as underestimation of the exact number of attacks on livestock. Additionally, our experience has shown that there are livestock farmers who choose not to report damage by predators or who do not report them systematically or in time. This attitude is attributed to competition among livestock farmers in terms of their professional abilities (herd management and protection, owning efficient LGDs) or to lack of knowledge of their insurance rights and the claim procedure.

Fig. 2. A White Greek Sheepdog protecting the flock and the shepherd (who took the photo from the tree) from a brown bear in the LIFE AMY BEAR/FLORINA Project area, Kleidi village, Florina. Photo: D. Ioannou.

The intensity of damage to livestock, beehives, crops and orchards is positively related to their density, their proximity to important carnivore habitats (e.g. breeding areas) as well as their vulnerability, which is determined by the effectiveness of prevention measures and landscape characteristics. Thus, extensive livestock farming systems are at a higher risk of carnivore depredation compared to less extensive systems, aggravated by the lack of efficient damage prevention measures. For instance, herds that move from lowland winter pastures to higher altitude mountainous areas during the summer sometimes graze without continuous human supervision, especially in the case of cattle. Inadequate preventive methods lead to high depredation by carnivores and the conflict between humans and wildlife is intensified (Blanco et al. 1992; Ciucci and Boitani 1998; Coza et al., 1996; Iliopoulos et al., 2009). As a result, some farmers use illegal practices to reduce losses, such as poisoned baits or poaching of predators. The impact of poisoned baits varies between species: foxes (*Vulpes vulpes*) are strongly targeted to relieve predation on European brown hare (*Lepus europaeus*) and to increase hunting dog performance. In contrast, conflicts with jackals in mainland Greece are less intense and therefore they are not targeted as often.

The most common and traditional husbandry methods adopted by livestock raisers in Greece are night-time enclosures, confinement of young animals, flock surveillance by shepherds and use of livestock guarding dogs (LGDs). The latter is widely used by most agricultural communities, including those in less favoured areas, as an effective mitigation tool (Fig. 2).

According to the Kennel Club of Greece and the Fédération Cynologique Internationale (FCI), there are three indigenous LGD breeds in Greece: the Greek Sheepdog, the White Greek Sheepdog and Molossos of Epirus (Figs. 3-5). The Greek Sheepdog originates from the two major mountain ranges of Rodopi and Pindos and its geographical range covers the major part of the mainland from central Greece to the Vorras mountain. The White Sheepdog is descended from dogs owned by transhumance livestock farmers (Saraktasani) and is distributed in north and central Pindos. The Molossos of Epirus originates from the regions of Ioannina (Metsovo), Arta, Trikala and Grevena and its geographical range covers north and central Pindos. However, all these breeds can also be found in transhumant flocks in the lowlands.

LGDs have been used for centuries as a major aid to livestock guarding in the mountainous regions

Fig. 3. Greek Sheepdogs with flock in the LIFE PINDOS/GREVENA Project area. Photo: A. Giannakopoulos.

Fig. 4. White Greek Sheepdog. Photos: C.N. Tsokana, E. Kourliti.

Fig. 5. Molossos of Epirus. Photos: A. Giannakopoulos.

Fig. 6. A typical summer temporary pen for transhumant flocks in Greece. Photos: A. Giannakopoulos.

Fig. 7. Goat herd in Perivoli village, Grevena, LIFEARCPIN Project area. Photo: G. Kouvatas.

of Greece, under sometimes difficult conditions for both LGDs and livestock; conditions that still persist in modern times (Fig. 6). The special characteristics of the Greek landscape, with extensive livestock grazing performed mostly in remote natural areas (Fig. 7) played an important role in shaping the indigenous breeds' morphology and behaviour. However, crossbreeding with other dogs is a major threat to the long-term survival of Greek LGDs as it results in altered morphological and behavioural traits and gradual loss of valuable abilities and adaptations for efficient herd guarding. Another threat

to the persistence of local traditional breeds is the on-going introduction of foreign LGD breeds that can further reduce the development of efficient guardian dogs.

Here, we present our efforts to develop and support a network for LGD use amongst livestock farmers in the framework of nine carnivore conservation projects during the period 2009–2017: five LIFE Nature projects and four national projects in three national parks. Actions included shepherd selection, dog breed selection, litter and pup selection and pup donation, support of training and health monitoring, as well as establishment and promotion of a network among farmers.

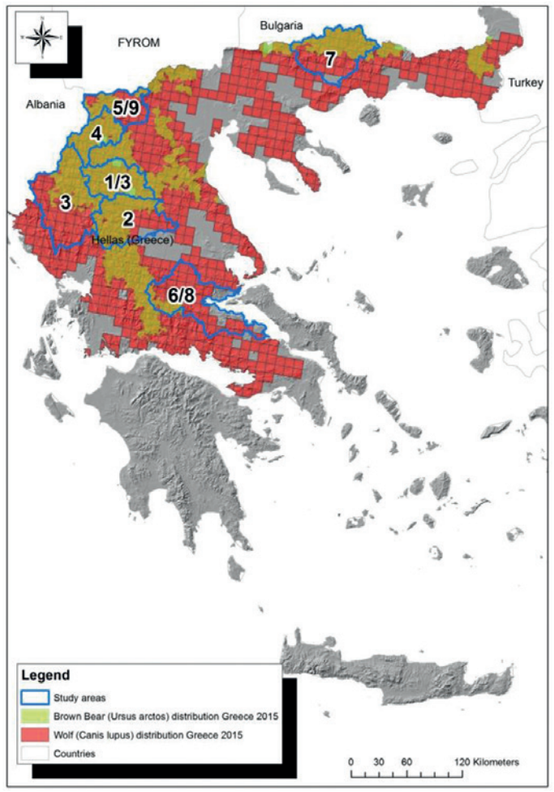

Fig. 8. Wolf and brown bear distributions in Greece (Iliopoulos et al., 2015; Mertzanis et al., 2009; Mertzanis et al., 2015 unpublished data) showing the intervention areas of the nine carnivore conservation projects implemented in 2009-2017: 1) LIFE PINDOS/GREVENA; 2) LIFE EXTRA; 3) LIFE ARCPIN; 4) LIFE ARCTOS/KASTORIA; 5) LIFE AMYBEAR; 6) Preliminary evaluation of wolf-livestock conflicts and mitigation measures in Oiti National Park; 7) Establishing a LGD network amongst farmers in Rodopi National Park; 8) Addressing wolf-livestock conflicts in Oiti National Park; 9) Preliminary investigation to address conflicts with LCs in Prespes National Park.

2. Study areas

Project areas included northern and southern Pindos, Oiti National Park, Grammos Mt., Antichasia Mt. and Rodopi National Park (Fig. 8). These areas comprise mostly broadleaved deciduous woodlands and coniferous forests (Fig. 9) and host bears and wolves, as well as wild prey species, i.e. roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*) and, in some cases, less common ones, i.e. chamois (*Rupicapra rupicapra balcanica*) and red deer (*Cervus elaphus*).

3. Implementing the LGD network

The establishment of LGD networks involved several steps. At the beginning of each project, there was a preparatory phase of one to six months, depending on project area size. In each area, the majority of livestock raisers owning and using LGDs were identified via extensive field surveys conducted by Callisto field personnel. Damage levels were recorded and a database was created. Data on carnivore losses were cross-validated with depredation statistics from ELGA and local veterinary agencies. All potential members were encouraged to participate in the set-up and operation of the network.

Fig. 9. Typical landscape in the LIFE EXTRA Project area. Photo: A. Giannakopoulos.

In each project area, a LGD network core team was formed using specific criteria in order to select amongst candidate farmers. These criteria included quality of LGDs, conflict levels according to average annual losses per farmer as well as willingness to participate and co-operate. A questionnaire was completed during face-to-face interviews to selected farmers to assess LGD quality (in terms of morphology, behaviour and effectiveness), mortality causes, health condition, guardian training methods and prophylactic measures taken by the farmers (Appendix). LGDs were assigned to three classes according to morphological standards: 1)has the morphology of one of the three native breeds; 2) has some of the morphological features; and 3) shows no similarity to any of the three Greek LGD breeds. Information gathered was used to compare the quality and efficiency of LGDs and identify the best dogs, as well as to form a database which is kept and managed by Callisto and the Veterinary Faculty (University of Thessaly). National Park personnel have access to the sections of this database which refer to the region of their authority.

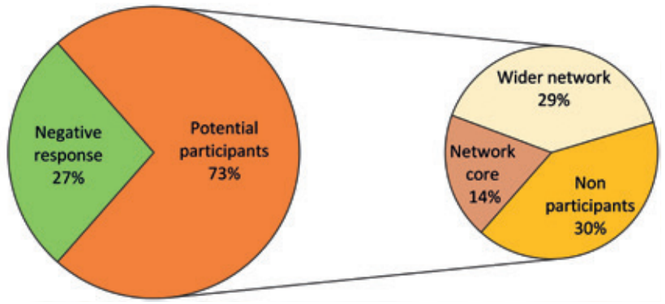

Fig. 10. Livestock raisers' participation in the LGD owners' network.

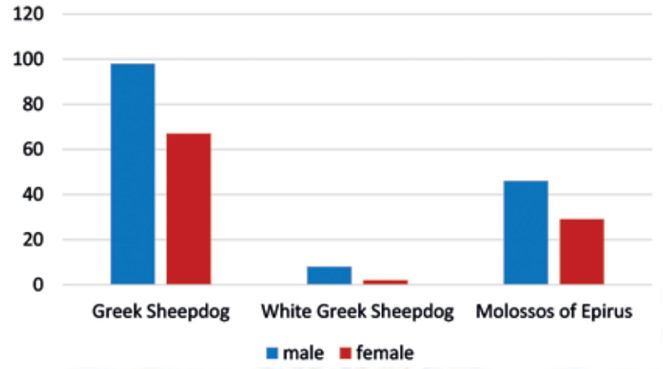

Fig. 11. Number and sex of dogs donated during the nine projects.

There was then an operational phase, lasting from six months to four years or more, as dictated by each project, during which dogs were donated to farmers and monitored in order to: a) fulfil husbandry needs and b) enhance overall quality of LGDs in a particular farm or project area, especially where LCs recovered. Callisto personnel coordinated and facilitated the donation and exchange of LGDs and contacts between farmers and members of existing local networks (i.e. small groups of farmers already exchanging LGDs and local organisations supporting the preservation of indigenous LGD breeds). In most cases, Callisto personnel directly transferred LGD pups, after litter and pup selection, and depending on their availability. Throughout this process an experienced veterinarian supported the farmers by providing veterinary advice and care when necessary during the implementation of the respective project.

4. Results

In total, 571 livestock holdings were visited during implementation of the above-mentioned projects of which 172 (51 with goats, 95 with sheep and 26 with cattle) were found to own good quality LGDs. A dog was considered a "good quality LGD" if it was classified in the upper class according to the set criteria (e.g. morphological, behavioural and LC repellence-efficiency traits; see Appendix: variables 3, 4, 5, 7 and 8). Regarding their potential participation in a LGD owners' network, 73% of farmers responded positively, with 43% of them finally participating in the network, and 14% of them constituting the main core (Fig. 10).

During the operational phase, 250 pups (165 males and 85 females) from two to three months old, and 52 adult dogs (1.5 to 5 years old) of the three national LGD breeds (39 males and 13 females), provided by members of the network (i.e. not from kennels), were donated and/or exchanged amongst livestock raisers (Fig. 11). Pups and adult dogs were selected according to availability and preferentially from LGD progenitors of high quality. Farmers owning good quality LGDs benefitted by exchanging dogs, because this process enhances genetic diversity. This way, the so-called "network core" was formed. The network is still fully operative despite the termination of most of the aforementioned projects and currently consists of 45 farmers.

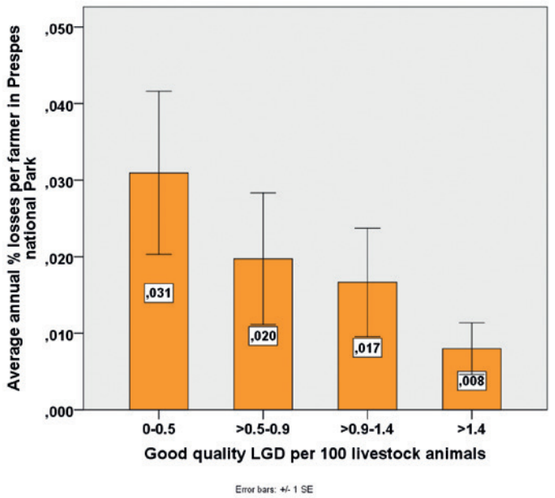

Fig. 12. Relation between number of good quality LGDs and mean percentage of annual livestock losses caused by LCs per farmer in Prespes National Park, Northern Greece (Iliopoulos and Petridou, 2016).

According to data collected during fieldwork and interviews in Prespes National Park, there was a mean of 2.6 LGDs per 100 livestock animals of all species, varying from 3.9 LGDs per 100 cattle to 2.1 LGDs per 100 sheep and goats. Average annual losses per farmer decreased from 3.1% to 0.8% of available stock (a reduction of 75%) when more than 1.4 good quality LGDs per 100 livestock animals were present (Fig. 12). In this area, the vast majority (83%) of livestock raisers preferred local breeds of LGDs; only 10% of them used dogs originating from other regions of the country. In an effort to improve their herd protection, 25% of livestock raisers introduced breeds originating from abroad (i.e. Caucasian Shepherd Dog, Yugoslavian Shepherd Dog-Sharplanina, Anatolian Shepherd Dog-Kangal Dog) assuming that larger bodied sheepdogs would be more suitable to fight off predators, but without considering these breeds' performance in Greek conditions, e.g. high temperatures during the summer.

Overall, 70% of pups and 41% of adult dogs were found to be vaccinated against canine distemper virus, canine adenovirus Type 2, parainfluenza virus, canine parvovirus, *Leptospira canicola* and *L. icterohaemorrhagiae,* and rabies. Deworming (endoparasites and ectoparasites) was applied regularly to 62% of pups and 49% of adult dogs. However, 51% of livestock raisers vaccinated their LGDs only partially(some diseases or some dogs were omitted from vaccination) or not at all, while 53% of adult LGDs were not dewormed regularly for reasons related to financial costs, health issues, ignorance and indifference (Iliopoulos and Petridou, 2016).

The questionnaire survey revealed that a large number of livestock raisers also lost LGDs to poison. Illegal poisoned baits were reportedly used against red foxes, wolves and stray dogs as well as against LGDs due to personal disputes. For instance, in Prespes National Park in 2010-2016 52% of livestock raisers lost LGDs due to poisoned baits and a total of 52 LGDs were poisoned (Iliopoulos and Petridou, 2016). Almost half the livestock raisers (48%) reported conflict between livestock farming and hunting activities as another important motive for killing LGDs. In some cases, LGDs attacked hunting dogs that approached the herd, resulting in conflict with hunters; four out of 36 livestock raisers in Prespes National Park reported that LGDs were shot in 2013-2016 (Iliopoulos and Petridou, 2016).

The mortality rate of donated LGDs aged from 6 to 12 months was 22.4% (in all projects carried out). Of 302 donated LGDs, 235 (78%) survived the first year after donation. In order to increase LGD survival, we intensified veterinary assessment and care of pups, including more consistent vaccination and deworming and rapid tests for the detection of important pathogens in pups (i.e. immunochromatographic tests for the detection of parvovirus and canine distemper virus antigens). In particular, pups older than 45 days were vaccinated (canine distemper virus, canine adenovirus Type 2, parainfluenza virus, canine parvovirus, *Leptospira canicola* and *L. icterohaemorrhagiae*) and the vaccination was repeated twice with a one month interval between vaccinations. Pups older than four months were also vaccinated against rabies and dewormed.

We informed farmers about LGD raising and training methods, health issues and risk of poisoning with the help of leaflets and guidelines, especially published in the framework of the implemented projects. The dissemination of this material was very much appreciated by farmers and should be continued because disease (mainly diarrhoea of nutritional etiology or caused by parvovirus) was the second most frequent known cause of LGD mortality (22%), with poisoning being the first (35%), and wolf/bear attacks being the least frequent cause of mortality (4%) (Figs. 13, 14).

5. Discussion

Livestock losses due to attacks by carnivores (especially wolves) trigger negative attitudes and reactions of farmers and hunters. In some cases, livestock losses caused by dogs (packs of stray dogs, shepherd dogs) might be wrongly attributed to wolves. Such conflicts often lead to illegal practices, such as killing of wild animals using poison baits or other means. The use of poisoned baits has been banned by Greek legislation since 1993 but is still a frequent practice nationwide resulting in the extensive reduction of numbers and distribution of raptors, wild mammals and LGDs, while it also poses a threat to public health.

It has been well documented that good quality LGDs can play a key role in damage prevention systems, as a traditional and effective preventive method reducing livestock mortality caused by carnivores. The results of this study highlight the lack of primary veterinary dog care in livestock farms and the need to inform and educate livestock raisers about its benefits and value in order to sustain efficient LGDs. During the past decade, we have demonstrated the effectiveness of good quality LGDs as a prevention measure in Greece and we have acted as advocates for their use through our efforts to develop and support a nation-wide LGD network. Most importantly, from a management perspective, the creation and maintenance of farmer networks that promote and support the use of good quality LGDs can provide authorities with a valuable tool for dealing with human wildlife conflict, especially in LC recovery areas.

The LGD network facilitates coordination and supports exchange of pups and adult dogs between livestock raisers. Given that owners of good LGDs gain social recognition through this network, it encourages the maintenance of good quality dogs by appropriate breeding practices. Moreover, this encourages other livestock raisers to improve their own dogs, thus reducing damage and conflicts, and consequently improving attitudes towards carnivores and ultimately societal and cultural changes. Lastly, the network also promotes the input of new bloodlines through the exchange of LGDs with suitable body characteristics and guarding behaviour from different parts of Greece.

The initial idea of creating such a network was to use it as an additional tool, secondary to the implementation of Measure 216 ("Subsidies for non-

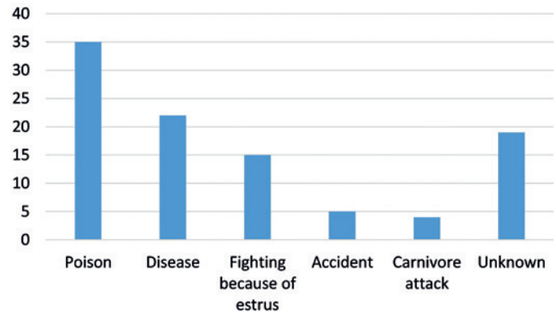

Fig. 13. Mortality causes of LGDs donated during nine projects in 2009–2017.

Fig. 14. Poisoned LGDs and red foxes in LIFE PINDOS/GREVENA Project area. Photo:Y. Iliopoulos.

-productive investments"), Action 1.2 ("Supporting purchase and maintenance of Greek Shepherd Dogs)", which was included in the Rural Development Programme of Greece (RDP) 2007-2013. The implementation of this measure on a nation-wide scale would be the main tool for supporting the rebirth of this traditional prevention method and re-spreading it in the country. However, unfortunately, the aforementioned action was removed from the RDP with a Ministerial Decision in 2010 in order to direct more money to other measures, which were considered more important, such as the conservation of avifauna. Then, the operation of the LGD network and breeding stations (developed in the LIFE PINDOS/GREVENA Project) became the only tool for spreading the use of LGDs in LC habitats. Networking proved to be more financially efficient, flexible and long-lasting than breeding stations as it actively involves many farmers and thus produces a more resilient scheme to provide pups when actually needed.

Appendix

List of information collected by questionnaire survey to evaluate LGDs.

1. Number and breed of adult guarding dogs per herd including sex ratio.

2. Number of juvenile guarding dogs (<1 year old).

3. Overall effectiveness against large carnivores based on farmers' observations of LGD reaction to LCs (i.e. bark, chase, attack, physical contact) and farmers' overall satisfaction expressed for each dog (poor, medium, good, excellent).

4. Degree of integration into the flock during grazing according to the level of flock attentiveness (i.e. seldom, periodically, always follows flock).

5. Intensity of night-time activity in livestock facilities according to farmer observations for each dog (i.e. poorly, periodically or highly attentive/active/aggressive around pens).

6. Age of young dogs' inclusion in the herd.

7. Aggression to humans during grazing (attack on humans or other aggressive behaviour).

8. Aggression to hunting dogs when approaching the herd.

9. Vaccination against canine distemper virus, canine adenovirus Type 2, parainfluenza virus, canine parvovirus, Leptospira canicola and L. icterohaemorrhagiae and rabies.

10. Deworming for endoparasites of the gastrointestinal tract and ectoparasites (ticks and fleas).

11. Training methodology.

12. Number of intentional or accidental poisoning incidents of LGDs in the last few years during the summer or winter grazing period.

13. Reports on motives related to poisoning of LGDs in the area.

14. Incidents of wolf and bear repulsion by LGDs.

15. Willingness of each farmer to participate in the LGD network.

Shepherd in the LIFE PINDOS/GREVENA Project area. Photo: A. Giannakopoulos.

Acknowledgements

We dedicate this work to the memory of our dear friend Constantinos Godes. Special thanks to the Forestry & Veterinary Services of Grevena, Trikala, Fthiotida, Drama, Florina, Larissa and Ioannina as well as the cooperating Management Authorities of Northern Pindos National Park, Oiti National Park, Prespes National Park and Rodopi National Park.

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Perspectives

OFFICIAL SWISS LIVESTOCK GUARDING DOGS

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1. Background

Although it is generally accepted that livestock guarding dogs (LGDs) are an important tool in mitigating conflicts between livestock husbandry and predators (e.g. Rigg, 2001), there are several constraints on their use. This definitely holds true for Switzerland. In this article we give a short review of the Swiss system regarding LGDs, which aims to overcome some of the dog-specific constraints while neither endangering the dogs' capacity to protect livestock nor discouraging livestock farmers from deploying LGDs.

Switzerland is not a typical sheep husbandry country, with sheep currently making up approximately 3% of livestock (approximately 347,000 animals in 2015; FOAG, 2016). However, sheep make up 91% of livestock killed by large predators in Switzerland[1]. Around 55% of sheep are summered on alpine pastures for three to four months where they are especially vulnerable to predation. Despite the apparent need for protection against attacks, shepherds have no knowledge of working with LGDs because large carnivores were completely absent from the country for more than a century due to systematic persecution resulting in the loss of traditional methods of livestock protection (Breitenmoser, 1998).

Legal protection of large carnivores across Europe during the latter half of the 20th century allowed for their gradual return, including to Switzerland. The lynx (*Lynx lynx*) was reintroduced in 1971[2], the wolf (*Canis lupus*) reappeared in 1995, the brown bear (*Ursus arctos*) in 2005 and the golden jackal (*Canis aureus*) in 2011 (FOEN, 2013). Although the wolf was first documented in the mid-1990s, the first pack settled almost 20 years later (2012) in the eastern part of Switzerland. Today around 45 individuals and three packs have been documented.

The growing population of wolves has led to a political debate on how to deal with them. Although large carnivores are protected by national legislation, management procedures follow a pragmatic approach: lynx and wolves can be regulated and individuals shot legally by the cantons[3] if the agricultural damage (i.e. livestock) they cause exceeds a certain threshold (large damage according to legislation). For this evaluation, killed livestock is only counted if effective livestock protection measures were in use prior to the attack. LGDs and/or electric fences are recognised as effective protection measures.

The political situation regarding wolf management in Switzerland renders dealing with LGDs conflictual. On the one hand, LGDs are a tool for farmers to protect their livestock against wolves and, on the other hand, their effectiveness is a factor in the legal regulation of the rising wolf population. At first glance these two aspects seem to be complementary. Considering a third factor, however, namely the strict provisions of Swiss legislation on dogs (see below), this setting turns into a dilemma. Farmers are encouraged to deploy LGDs but at the same time they run the risk of a criminal charge or an injunction by the cantons due to conflicts between LGDs and humans as well as companion dogs and other wildlife (see boxes 1 and 2 for examples).

In 2011 the Federal Office for the Environment (FOEN), the federal administration responsible for the national livestock protection programme[4], ordered an analysis of the legal situation regarding the deployment of LGDs in Switzerland (Bütler, 2011). The recommendations of this study can be summarised as follows: 1) adoption of a legal framework that renders the deployment of LGDs under Swiss provisions legal; 2) establishment of a label for LGDs that conforms to the adopted legal framework; and 3) creation of an association for LGD breeders and owners to help establish and maintain the LGD label. These recommendations are being successfully implemented step by step and dogs in the national livestock protection programme are labelled "official LGDs".

LGDs summering with their herd on a pasture in the Swiss Alps. Photo: AGRIDEA.

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[1] On average 250 sheep have been killed annually by large predators over the past 12 years (FOEN, pers. comm.).

[2] The lynx population in Switzerland is stable and consists of around 195 adult individuals distributed across the Jura Mountains and the Alps.

[3] To date seven lynx (1997 to 2000) and 10 wolves (2000 to 2016) have been legally shot.

[4] The national livestock protection programme is run and financially supported by FOEN. The programme supports the implementation of measures for the protection of livestock, such as LGDs and fences. AGRIDEA agricultural consultancy has been assigned with the coordination of the programme (www.protectiondestroupeaux.ch/en).

Box 1. Conflict management without the "official LGD" label

While moving a flock of sheep that is guarded by two LGDs along a hiking trail in the Alps, a woman accompanied by an off-leash German shepherd dog approaches the flock. The male LGD runs to the companion dog and seizes it by its thigh, resulting in slight bite wounds. The owner of the LGDs is fined 200 EUR due to negligent violation of article 77 of the ordonnance on animal protection (responsibilities of persons keeping or educating dogs). The LGD owner objects and is cleared of all charges by the district court. The department in charge lodges a complaint against the acquittal and the cantonal court pronounces the LGD owner guilty. As a consequence, the convicted LGD owner abandons sheep farming and gives away his LGDs.

Box 2. Conflict management with the "official LGD" label

To avoid incidents – and possible legal consequences – with tourists using a hiking trail to cross an alpine sheep pasture, the shepherd fences his two LGDs separately from the flock of sheep with the intention of releasing the dogs if wolves become noticeable. Because of the presence of two official LGDs, the flock is considered to be protected and therefore killed livestock would be counted in the event of a wolf regulation. The Institute for LGDs (officially mandated with LGD affairs by the federal administration) asks the shepherd several times to deploy the dogs adequately, i.e. not separated from the flock. Because the shepherd refuses to implement the requests, the label "official LGD" is withdrawn. Therefore, the flock is considered unprotected and damages by wolves now cannot be counted towards possible wolf regulation. Although damages continue to be compensated, the LGDs are no longer subsidised. The following year the shepherd allows the Institute for LGDs to test his LGDs in order for him to deploy the dogs adequately. To alleviate the shepherd's dilemma of protecting the flock whilst avoiding potential conflicts with tourism, the responsible authority decides to relocate the hiking trail.

2. Swiss legislation on dogs

Switzerland is a confederation constituted of 26 states called cantons. These are legally autonomous unless a certain legal aspect is considered to be of federal importance and is therefore regulated on the federal level. In this regard, cantonal legislation must always be in accordance with federal legislation, which cannot be contradicted. In Switzerland there is no federal law on dogs and therefore the cantons have the right to determine legal provisions regarding dogs within their cantonal laws. There are, however, federal prerequisites that must be considered by the cantons. The federal ordonnance on animal protection has a provision stating that "a dog owner must ensure that his or her dog does not endanger people and foreign animals". In addition, cantonal legislation requires dog owners to ensure that their dogs are supervised at all times. Due to this combination, the use of LGDs remains difficult and virtually illegal in Switzerland.

Legal clarity is crucial to overcome possible conflicts, which often arise in connection with working LGDs. Conflicts range from intensive barking, intimidating and confronting people on hiking paths to fending off other dogs, foreign sheep or cattle from the herd. Although such aggressive behaviour can be frequently observed, people and companion dogs are rarely attacked[5]. To overcome these constraints, the federal parliament agreed on a motion in 2011, which set up a legal framework for the deployment of LGDs, to monitor the population of LGDs and to subsidise the farmers that employ such dogs. The use of LGDs was thus defined within the federal ordonnance on hunting as follows: "LGDs are deployed in order to independently guard livestock thereby fending off foreign animals." This provision is important as the term "independently" reflects the deployment of LGDs in Switzerland, where they are usually not under direct control. Furthermore, "fending off foreign animals" comes closer to the known behaviour of working LGDs and avoids such discussions as "my poodle is not a wolf, why was it attacked while investigating the sheep?"

[5] There are around seven incidents of LGDs snapping at people per year. Until now none of these incidents has resulted in people being hospitalised.

The concept of a threefold socialisation (livestock, humans and LGD pack) produces emotionally stable dogs that bond with the livestock, fend off predators in cooperation with their pack members, and are sociable towards people. Photo: AGRIDEA.

For LGD deployment to comply with the provisions of the ordonnance on animal protection, it was added that for the evaluation of LGD behaviour in a working context in case of an incident (even with humans), "their working purpose has to be taken into consideration, which is to fend off and expulse foreign animals." This regulation on a national level is only possible if LGDs are defined on a legal basis, meaning they carry a label, otherwise any dog owner could claim his or her dog to be a working LGD. As a result, LGDs (including pups) that are deployed within the framework defined by the federal government will be registered within the database of the national livestock protection programme as "official LGDs". Only such officially registered LGDs are subsidised (approximately 1,100 EUR per dog each year[6]) by the federal administration. The corresponding guidelines of the federal administration on the breeding, education, deployment and keeping of officially registered LGDs will enter into force from 2019 (FOEN, 2017).

3. Organisation of LGD-related affairs

Within the national livestock protection programme the federal administration (FOEN) has charged two organisations to deal with LGDs: the independent Swiss Association for LGDs[7] and the national Institute for LGDs[8]. The Association unites all breeders and is open to owners of officially registered LGDs. Its main objective is the education and breeding of LGDs for agricultural deployment, which has to comply with national legislation. The

[6] There is no concrete restriction on the maximum number of LGDs deployed per herd but a minimum of two dogs is required.
[7] Herdenschutzhunde Schweiz (www.hsh-ch.ch).
[8] Agridea (www.protectiondestroupeaux.ch/herdenschutz-schweiz/fachbereiche).

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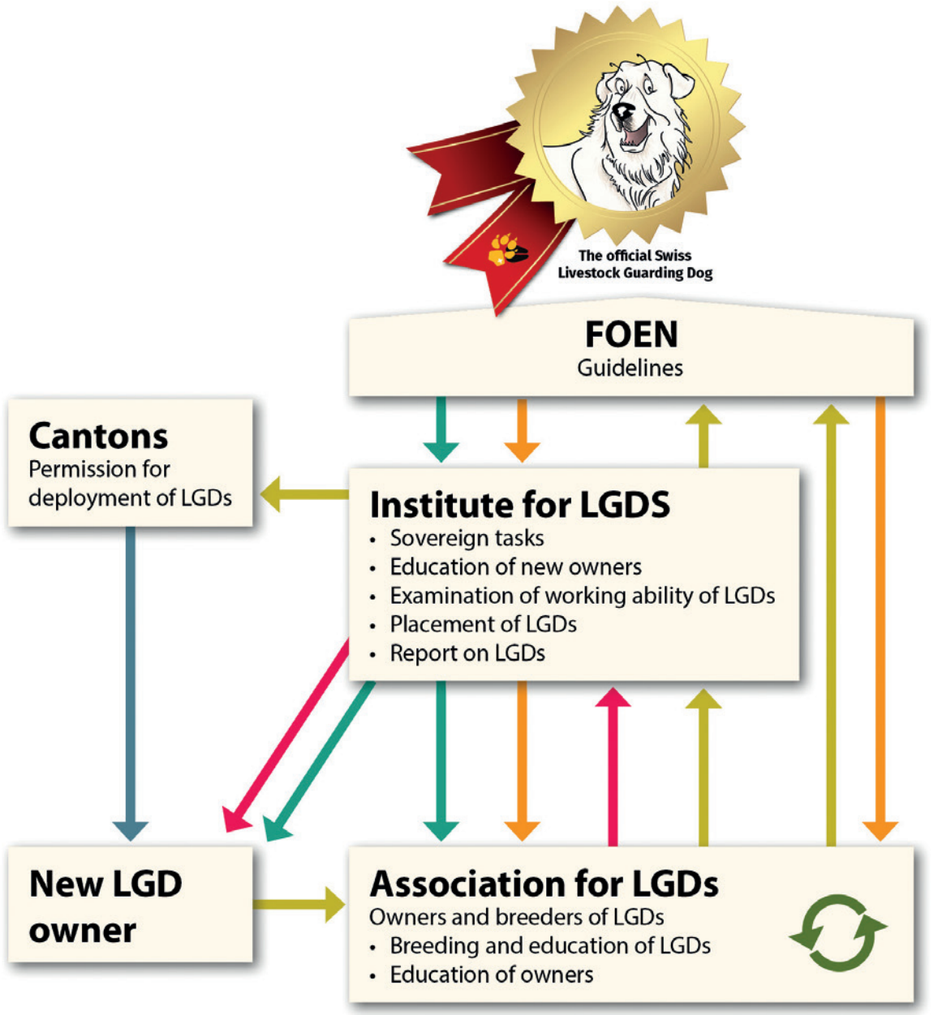

Fig. 1. The official LGD system in Switzerland with its five main elements. Orange arrows: requirements by the official guidelines of the federal administration responsible for the national livestock protection programme (FOEN). Turquoise arrows: financing according to the guidelines. Red arrows: LGD resources (operational LGDs). Yellow arrows: human resources. Blue arrow: commitment of the canton. Green arrows: breeding dogs.

4. Official registration of LGDs within the Swiss system

FOEN officially recognises two breeds of LGDs that are part of the national livestock protection programme: Chien de Montagne des Pyrénées (Patou, MP) and the Maremma Sheepdog (Cane da Pastore Maremmano-Abruzzese, MA). Pups are recognised, registered and subsidised as official LGDs at birth. Each dog has to undergo a test to confirm its official status at the end of its basic educational period (12 to 18 months). The test is set up in order to examine the LGD's working ability with livestock, its good-naturedness outside the herd, i.e. outside its working environment, and its readiness to cooperate with its owner (Fig. 2). Only LGDs that pass this test will be handed over to farmers for deployment.

The same procedure applies and is enforced for imported LGDs. Although such dogs are officially registered within the system on import, their status has to be confirmed within six months for adult dogs and 15 months for pups. In order to maintain an independent and non-biased control of the output of LGDs, the Swiss Institute for LGDs, not the Association for LGDs, is responsible for the organisation and supervision of the test.

Farmers are only subsidised for the deployment of officially registered LGDs within the national livestock protection programme as long as they follow the provisions of the federal government (guidelines on the breeding, education, deployment and keeping of officially registered LGDs; FOEN, 2017). Although farmers are free to deploy other LGDs, such dogs will neither be registered nor subsidised and hence fall under the constrained provisions of the general legislation on dogs.

Fig. 2. Four screenshots from a video of a LGD test using the same dog. **2a**. Undesired behaviour: after 24 hrs with a small flock of five sheep on unfenced and unfamiliar terrain the LGD blocks the arriving person (unknown to the dog) at a distance of approximately 100 m from the flock. A more desirable behaviour would be for the dog to observe the person from a distance and remain with the flock or to calm down quickly. **2b**. Desired behaviour: the same dog and person 30 minutes later in a context without the flock. The person has to release the tied-up dog; the LGD displays friendly behaviour. **2c.** Desired behaviour: at a distance of approximately 100 m from its flock, the LGD displays an explorative behaviour regarding the foreign dog. **2d**. Desired behaviour: three minutes later the foreign dog approaches the flock too closely (30 m) and as a consequence is not only blocked but attacked by the LGD.

5. The selection process of LGDs used for breeding purposes

The breeding of officially registered LGDs is carried out by the breeders of the Association for LGDs. In order to acquire and maintain high quality LGDs, potential breeding dogs are carefully selected. A potential breeding dog must have successfully passed the exam at the end of its education period. Breeding dogs are specially evaluated by undergoing a series of tests in terms of their medical suitability (e.g. degree of hip or elbow dysplasia), functional morphology (e.g. good protective coat, strong and correctly positioned limbs), behaviour (e.g. emotional stability, self-assurance) as well as their working ability (e.g. fending off foreign animals from the herd, Fig. 3).

At the age of two years, when a potential breeding dog has passed all tests, the decision on it entering the official breeding programme is taken. All test results are entered in a database, which functions simultaneously as a stud book. The data are used during annual meetings of breeders of MP and MA where the mating of LGDs is discussed and defined. Owners of breeding dogs are additionally subsidised as long as they are classified as such[9].

To ensure the quality and consistency of LGD education, potential breeders of LGDs have to participate in an education programme run by the Association for LGDs. The programme includes a one-day theoretical course followed by four days of practical work and needs to be completed within one to two years. The theory includes general aspects of the socialisation, education and breeding of LGDs. The

Fig. 3. Screen shots of a LGD test with a remote controlled wild boar dummy (a skin and skull of a freshly killed wild boar mounted on a remote controlled vehicle) approaching a flock of sheep protected by an LGD. **3a**. Undesired behaviour: the dog displays avoidance behaviour and retreats behind its flock. **3b**. Desired behaviour: the dog tries to fend off the wild boar dummy.

[9] For 2017 subsidies range from 65 EUR per month for male dogs to 130 EUR per month for bitches and are paid as long as the dogs are officially recognised as breeding dogs.

practical work consists of modules on the education of LGDs and assessing dog behaviour and performance. On completion the breeder has to successfully pass a practical test. The breeders are tested on their comprehension of the behaviour of dogs as well as dog-human, dog-dog and dog-sheep communication. A further component is the evaluation of results from the test their first educated dog underwent at the age of 12 to 18 months (see above).

The programme enables the breeder to access subsidies for the breeding and education of officially registered LGDs within the national livestock protection programme. LGD breeders are exclusively recruited from farmers keeping livestock such as sheep, goats and cattle, since these are the main livestock species affected by large carnivores. It is vital to highlight once again that the breeding and education is developed and enforced by the concerned agricultural circles themselves and is therefore based on a bottom-up approach. In order to standardise the breeding and education of LGDs the Association of LGDs has developed specific regulations.

6. Procedures for placing LGDs with farmers

According to the federal law on hunting, the cantons are responsible for preventing damages to livestock caused by wildlife. It is therefore the cantonal authorities, normally the agricultural body, who must decide on where dogs are to be deployed to protect livestock. Farmers can only deploy official LGDs and receive subsidies if they possess official approval of the canton for the deployment of such dogs. In order to receive approval, the farmer undergoes a process of consultation and risk analysis that is carried out by the cantonal authorities and supported by advisors of the Institute for LGDs. The aim of this authorisation is for official LGDs to be solely deployed in areas that are acceptable to the canton. Cantonal authorities should be aware that although LGDs are a good tool to mitigate conflicts between wolves and livestock husbandry, they can cause other conflicts, which have to be solved in order for the dogs to maintain their capacities.

No farmer is legally obliged to implement prevention measures hence farmers deploy LGDs on a voluntary basis. This is an important prerequisite to avoid constraints in the motivation to keep such dogs. Consequently, the compensation of damages due to predators is generally not bound to the implementation of livestock protection measures (with a few cantonal exceptions) and damages are usually reimbursed by the cantons and the federal administration. Once the farmer has been approved by the canton to deploy LGDs, he must attend a one-day theoretical course that familiarises him with all the legal aspects of keeping and deploying LGDs. After that, the farmer is ready to buy officially registered LGDs. He is accompanied by an official mentor (a competent farmer and LGD owner educated by the Association for LGDs) while integrating the new LGD into the herd and the farmer's family. Officially registered LGDs are educated and bred by the Association for LGDs and approved and provided by the Swiss Institute for LGDs. Prices are set by the Institute for LGDs and are currently 1,300 EUR per LGD.

7. The concept of educating LGDs

A good LGD requires adequate education; we do not use the term "training" as it generally implies the operant conditioning of dogs. The required characteristics of an LGD, such as fending off foreign animals from the herd, is not achieved by operant conditioning but by providing adequate surroundings during development in order to strengthen its desired behavioural traits. LGDs are not just educated to fulfil their operational purpose but should also be subjected to everyday situations that any dog encounters in order to become emotionally stable and socially compatible.

The widespread methodology for raising LGDs advocated by Coppinger (e.g. Coppinger and Coppinger, 1978; Lorenz and Coppinger, 1986; Wick, 1992) involves depriving LGDs of contact with humans and conspecifics. In contrast, breeders in Switzerland (the Association for LGDs) have, in close collaboration with the federal administration, implemented a concept for the education of LGDs that avoids any deprivation during their development. The concept focuses on a threefold socialisation (livestock, humans, LGD pack) of each LGD and habituating it with its surroundings (see Penner, 2014). The aim is to achieve an emotionally stable dog that bonds with the herd and fends off predators in cooperation with its pack members and simultaneously does not display signs of shyness or fear-aggression towards people and is easy to handle. In our opinion, a good education can only lead to an effective LGD if a certain genetic predisposition is present.

Regular interactions with their owners reinforce the emotional stability and social compatibility of LGDs. Photo: Paul Hugentobler.

When considering deprivation we distinguish three main aspects:

1) Trust deprivation by not forming bonds with the breeder and owner. Such bonding is crucial for all working dogs including LGDs because it opens the possibility of correcting undesired behaviour. Disciplining a dog requires a bond of trust to have an educational value (Berlowitz and Weidt, 2007);

2) Social deprivation by separating pups at a young age and raising them with livestock away from their parents and siblings. It is most important for a growing LGD to have opportunities to acquire the competencies to live in a social unit (pack) that operates between the extreme poles of cooperation and competition;

3) Spatial deprivation by using fences to keep dogs in a restricted area. We consider fences as obstacles rather than as useful means to raise LGDs. Our aim is to deploy stable LGDs that defend their herds in the absence of fences. With this regard two aspects have to be taken into account: firstly, fences generally focus dogs' reactivity to entities (i.e. hikers, other dogs) outside the fence. This well-known "fence effect" holds true for all dogs. Secondly, fences render the breeders' evaluation of LGDs difficult as it is unclear whether they stay with their herd because of their growing competences or simply because they are prevented from leaving due to the fence. As a consequence, all tests of dogs' spatial behaviour in relation to herds (GPS-data) are always conducted in unfenced situations.

8. Conclusions

In Switzerland the label "official LGD" has many advantages compared to an unregulated situation. It does not per se prevent all conflicts but avoids constraints that arise from unadapted legislation. Almost all legal denunciations (e.g. incidents involving LGDs snapping at people or dogs that approach or walk through the herd) could be won in court and convicted LGD owners could be released from their charges. One canton has already changed its law on dogs by claiming that official LGDs on its territory fall exclusively under federal legislation. Private conflicts have turned into public affairs, which seems to be reasonable since coexistence with wolves is also a public affair. Moreover, the label "official LGD" is a prerequisite for the payment of subsidies. If the investment

of public money in LGDs raises their quality in terms of being effective protectors without representing an objective danger to the public, the goal of coexistence with wolves can be achieved.

Due to the concept of educating LGDs, dogs are better socialised and are better habituated to their environment. Therefore, extremely shy LGDs that are difficult to handle, take refuge among the herd and have to be caught or even culled due to a lack of bonding with their owners, are becoming rarer and instead are being replaced with adequately socialised dogs. On the other hand, tests have revealed several problems that need to be addressed:

- Results referring to the performance of LGDs in fending off foreign animals suggest a much higher variability than those referring to the attachment to the livestock herd. This implies that there are more behavioural traits (e.g. ability to intimidate attacking animals) that have to be considered carefully when selecting dogs for breeding;

- The continuous long-term monitoring of dysplasia demonstrates that there is a problem in the Swiss LGD population. MAs seem to be more affected by dysplasia than MPs. Focussing only on the status of dysplasia could lead to excluding LGDs from breeding despite excellent behavioural traits. On the other hand, the dysplasia problem should not be ignored.

The small breeding populations of MAs and MPs (around 30 individuals for each breed) definitely remain the main problem for Switzerland. Being faced with the problem of avoiding any adverse effects of inbreeding that may cause an undesirable allele fixation in a small population, the Swiss LGD population is too small to run a reasonable breeding programme. Opening the current system to additional LGD breeds would have serious implications for the current breeding programme, as the possibility to select among individual dogs is hampered by the diminishment of the breeding output of any of the different breeds. Concentrating efforts on the two LGD breeds already recognised by the national programme will help to reduce this problem to a certain extent. In addition, cross-breeding LGDs would hardly be reasonable, if specific behavioural traits of breeds are not yet approved. Hence, it is of great importance to build a lasting connection with the corresponding LGD populations abroad by securing a network of LGD breeders across the Alpine countries and beyond.

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Short Communication

THE INNOVATIVE USE OF LGDs TO REDUCE ILLEGAL POISONING

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1. Introduction

The Mediterranean region has a long history of poisoning that goes as far back as the 5th century B.C., when the use of toxic plants to control wolves (*Canis lupus*) and other species that could damage game and livestock was described in ancient Greece (Longe, 2005). This practice evolved and spread over time and came to have a high negative impact on human health and biodiversity, becoming one of the most prevalent non-natural causes of death of many endangered species (e.g. Guitart et al., 2010b, Álvares, 2003; Villafuerte et al., 1994). Currently, the use of poison is explicitly forbidden in Europe by the Birds Directive (79/409/EC, Article 8) and the Habitats Directive (92/43/EC, Article 15). Nevertheless, illegal poisoning remains a reality and toxic substances remain available, both legal and illegally (e.g. Martínez-Haro, 2008; Salvatori and Linnell, 2005).

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A single poisoned bait or carcass left in the field can lead to numerous, indiscriminate victims and represents an extremely serious threat to domestic animals, wild species and humans (e.g. Berny et al., 2010; Guitart et al., 2010a; Guitart et al., 2010b). One example regarding large carnivores reports the killing of 29 wolves and one lynx (*Lynx* sp.) in Canada, from a single poisoned deer carcass (Mech, 1970). In Octo-ber 2003, in central Portugal, a single event resulted in the poisoning of 33 griffon vultures (*Gyps fulvus*), three black vultures (*Aegypius monachus*) and three red kites (*Milvus milvus*), of which 24 were found dead and the others received treatment at the Wildlife Re-covery Center (Centro de Recuperação da Animais Selvagens - CRAS) in Castelo Branco, managed by Quercus (Fig. 1).

Furthermore, some compounds can be preserved in the baited carcasses for several months, increasing the risk of killing more animals (e.g. Allen et al.,

Photo: Pedro Martins

Fig. 1. Poisoned wolf and black vulture, in 2004 and 2003 respectively, in Idanha-a-Nova municipality in Portugal.

1996). Secondary poisoning has also been confirmed in many species, from raptors to mammals (e.g. Antoniou et al., 1996; Berny et al., 1997), also with implications for public health, since humans may be at risk of secondary toxicity after consuming poisoned animals. This highlights the need to not only stop the illegal use of poison but also to detect and remove poisoned baits and carcasses that are deployed in the environment to prevent them entering the food chain.

Despite the devastating impact of poison, the lack of reliable data and research makes it very difficult to stop this illegal practice. For example, according to information collected within the Progama Antídoto-Portugal[1], between 2000 and 2010 a total of 288 poisoning cases were registered in Portugal, resulting in the death of 1,367 animals. Still, only 116 of those episodes were reported to the authorities. Furthermore, in many cases the poisoned animals are not detected or sent to rehabilitation centres, and thus do not enter official databases. It is estimated that only 6% of wild animals killed by poison are detected (Cano et al., 2008).

The use of poison in rural regions is usually associated with the economic activities of those areas, namely livestock breeding and hunting (e.g. Álvares, 2003; Villafuerte et al., 1994). However past efforts to address illegal poisoning in Europe have had little or no focus on promoting the engagement of rural groups towards its eradication. The result was weak social knowledge of the impact that this practice has on both biodiversity and public health. In order to tackle illegal poisoning by implementing an innovative strategy based on a participatory approach, a project was developed between 2010 and 2014 focused on gathering a deeper understanding of motivations behind the use of poison and on an active social involvement to fight this illegal practice. The LIFE Project "Innovative actions against illegal poisoning in EU Mediterranean pilot areas" was implemented with the objective of demonstrating and spreading procedures and practices that contribute to halt the loss of biodiversity due to the illegal use of poison in the European Union (EU) and to improve the conservation status of the species most affected. The Project was coordinated by Fundación Gypaetus (Spain) and involved three other environmental NGOs and the Natural History Museum of Crete. It was implemented in eight pilot areas in Portugal, Spain and Greece that represent important Mediterranean habitats, contain affected species and predators, and where conflicting rural uses and reasons which motivate the illegal use of poisoned baits are present (Figs. 1, 2). A set of tools and actions were deployed and monitored, counting on the active and voluntary participation of the target groups, which enhanced their involvement in the deterrence efforts and implementation of awareness raising campaigns, through a shared responsibility in the fight against illegal poison.

2. Study area

In Portugal, one of the study areas where Project actions were coordinated by Quercus included the Tejo International Natural Park, located in Castelo Branco and Idanha-a-Nova municipalities, along the border with Spain (Fig. 2). This is a very important area for bird conservation including several endangered eagles and vultures, according to the Portuguese Red Book of Vertebrates (Cabral et al., 2005), namely: imperial eagle (*Aquila adalberti*), black vulture, red kite, Egyptian vulture (*Neophron pernocterus*), golden eagle (*Aquila chrysaetos*), and Bonelli's eagle (*Aquila fasciata*).

The landscape is characterized by agricultural and pasture lands, in medium to large private proprieties. The average farm size was 15 ha in the northern part of the study area and 50 ha in the south, with the larger farms up to 3,000 ha. There were around 980 livestock farms, with sheep farming representing 80% of livestock production in the area, followed by

[1] Programa Antídoto-Portugal (Antidote Programme) is a platform created in 2004, joining private entities and public authorities in a common effort to fight against the illegal use of poisons and contribute to a better knowledge of the consequences this practice has on wildlife: www.antidoto-portugal.org.

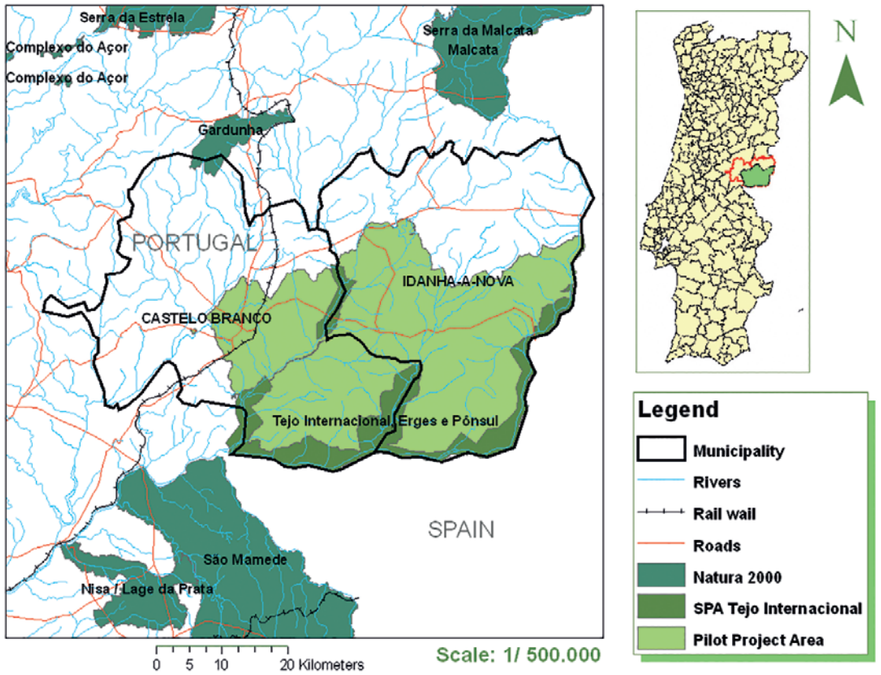

Fig. 2. Locations of the study area, one of the pilot project areas in Portugal, of the Special Protection Area of the Tejo Internacional, and other areas of the Natura 2000 network.

cows (INE, 2011). Livestock is extensively grazed year-round with no damage prevention measures in place. Flocks are not shepherded and the use of livestock guarding dogs (LGDs) is not common, while damage prevention was traditionally based on illegal predator control with the use of poison baits and carcasses. Large predators, like the wolf, are not established in the area, although dispersers may occur. In fact a dispersing wolf was poisoned in 2004 in Idanha-a-Nova (Fig. 1). Feral/stray dogs and smaller predators (e.g. red foxes, *Vulpes vulpes,* and Egyptian mongoose, *Herpestes ichneumon*) are frequent throughout the area and can cause considerable damage to newborn and young livestock. These are not compensated by the authorities, leading farmers to resort to illegal control measures such as snaring and, most often, poisoning.

3. Methods

3.1. Pre-assessment and tool definition

An initial baseline survey of each pilot area enabled us to confirm that the use of poison was commonly associated with areas with small game species (of hunting interest) and extensive livestock breeding areas, which are more vulnerable to predator attacks. The 1,200 inquiries made in the pilot areas also revealed that the illegal use of poison was a socially condemned practice. Nevertheless, it was rarely reported to authorities, even by those that were victims of it. After this initial pre-assessment, the most appropriate tools were identified for each target group: hunters, livestock breeders and municipal authorities. Concerning livestock breeders, a specific list of tools was proposed and applied according to the particular needs of each breeder and the ecological characteristics of each farm (Fig. 3, Table 1).

Fig. 3. Development of innovative capture techniques for feral/stray dogs with large cage-traps to minimize predation and avoid illegal poisoning.

Table 1. Tools proposed in the framework of the livestock breeders' network.

Measures proposed to members of the livestock breeders' network	
Control of feral/stray animals	Technical meetings
	Meetings with livestock breeders and environmental officers to coordinate efforts to control feral/stray animals
	Dissemination of live traps to relevant authorities for capturing feral/stray animals
	Development of innovative capture techniques for feral/stray dogs
Damage prevention measures	Donation of livestock guarding dogs
	Microchiping of livestock guarding dogs
	Implementation of electric fences
	Installation of raven deterrents
Technical advice	Advisory on farm risk assessment, proposal of anti-predation measures and addressing conflicts with the hunting sector
	Mediation to solve conflicts with the hunting sector
	Availability of the European Canine Team in suspected cases of poisoning
	Support in administrative issues
	Free emergency telephone line
Legal consulting	Legal consulting for livestock breeders on poisoning related cases
Awareness raising	Distribution of information materials (e.g. leaflets, flyers) and organizations of workshops, seminars, etc.

Delivering livestock guarding dogs (LGDs) to protect livestock was the most widespread tool in all the pilot areas in the three countries involved, since there was a big interest from livestock breeders.

3.2. Networking

The Project evolved around the concept of fighting the loss of biodiversity caused by illegal poisoning through a social approach, and the work focused on the rural activity sectors commonly linked to this illegal practise, namely livestock breeding and hunting, as well as local administrations (municipalities) who are the public officials closest to the citizens. Specific tools and actions were implemented within three newly-created networks:

i. European network of livestock breeders against illegal poisoning;

ii. European network of municipalities against illegal poisoning;

iii. European network of hunters against illegal poisoning.

These networks gathered a total of 402 stakeholders from the eight pilot areas in Portugal, Spain and Greece, who shared the will to achieve a poison-free environment. Through these networks, locals can participate and incorporate their needs, perceptions and interests in rural space management as well being informed about the costs of biodiversity loss and the benefits of actions against illegal poisoned baits. A total of 58 municipalities and 120 hunting areas from the three countries were involved in the networks. The livestock breeders' network gathered a total of 224 famers, of which 62 were from Portugal. To achieve this, meetings with individual livestock breeders and associations were held, where the Project's goals and the Network's foreseen actions were explained. Adhesion to the network was not always easy to achieve, mainly due to lack of trust in the Project goals and its viability, as well as in the staff, and the lack of interest to commit to the Project, and of having extra work. To overcome these obstacles, we used livestock breeders and association's representatives as crucial interlocutors for the Project to those who were more reluctant.

3.3. Monitoring actions

The use of poison was monitored with field inspections by the European Canine Team (ECT), the monitoring of bioindicator species and constant contact and flow of information with stakeholders and official environmental bodies. The ECT, integrating a dog trainer and six to ten dogs trained to detect poisoned baits and carcasses, conducted 303 field inspections from 2011 to 2014, detecting 126 baits and

Fig. 4. A dog from the canine team finds a poisoned red fox.

Fig. 5. Tagging of a griffon vulture as part of the biomonitoring program.

205 carcasses (Fig. 4). These where collected by the official authorities and samples sent for laboratory analysis to confirm the presence of poison.

A total of 246 scavenger birds and raptors, species that are particularly sensitive to poison due to their feeding behaviour, were tagged with radio and GPS-GSM transmitters (Fig. 5).

4. Results

4.1. Implementing the use of LGDs

Five LGDs (two males and three females), four Transmontano Mastiffs and one Estrela Mountain Dog, were donated in 2013-2014 to 4 livestock breeders in Castelo Branco and Idanha-a-Nova Municipalities

Table 2. Number of damage events to livestock and number of reports of stray dogs on farms of livestock breeders that received LGDs from the Project.

Municipality	Dog Breed	Sex	No. and breed of livestock	Damage to livestock*		Presence of feral/stray dogs	
				Before dog	After dog	Before dog	After dog
Idanha-a-Nova	Estrela Mountain Dog	F	148 Merino da Beira Baixa sheep	37	1	17	2
Idanha-a-Nova	Transmontano Mastiff	M	62 Merino da Beira Baixa sheep	11	0	9	0
Idanha-a-Nova	Transmontano Mastiff	F	21 Angus cows	3	0	4	1
Idanha-a-Nova	Transmontano Mastiff	F	23 Mirandesa cows	5	0	11	4
Castelo Branco	Transmontano Mastiff	M	87 Merino da Beira Baixa sheep	21	2	28	0
			Total	**77**	**3**	**69**	**7**

* Including damage caused by feral dogs, red foxes and Egyptian mongooses.

(Table 2). Two male Transmontano Mastiffs from different litters were donated to the same sheep farmer but placed with different flocks. Dogs were placed in sheep flocks and cattle herds, extensively grazed year-round in medium to large sized farms, averaging 30 ha. In some cases farmers already had a LGD which was not well bonded to the livestock. The beneficiaries signed agreements to join the Project and the livestock breeders' network.

LGD pups were descendants from working stock, placed with new livestock at 2-3 months of age (9 to 11 weeks) and always kept with it to allow the establishment of a strong social bond to foster their success when adults (Fig. 6). Donated pups were microchiped, vaccinated and dewormed.

4.2. Assessing damage and poisoning cases

Results suggest that the presence of LGDs was very effective at reducing depredation, with an observed average reduction in reported damage events of 96.1% when comparing numbers before and immediately after dogs were deployed (Table 2). LGDs had a very rapid effect in reducing damage, since even juvenile dogs reduced, and in some cases eliminated,

Fig. 6. Delivery of an Estrela Mountain Dog pup to a farmer in Idanha-a-Nova and its first contact with the new flock.

damage caused by mesopredators such as Egyptian mongooses and red foxes. They could even prevent attacks by raptors, since during the project seven livestock breeders belonging to the network mentioned damage caused by golden eagles and vultures (griffon and black), mainly to newborn lambs.

The presence of feral/stray dogs (based on livestock breeders' reported sightings) was also reduced at almost 90% of farms after LGDs were placed. The capture of feral/stray dogs at the farms of breeders belonging to the network also contributed to this result[2]. In fact the number of sightings of feral/stray dogs by livestock breeders of the network was reduced from a yearly average of 46.5 before the Project (372 sightings from 2003 to 2010, inclusively) to an average of 1.75 during the project (7 sightings from 2011 to 2014, inclusively).

During the Project, 28 poisoning cases were detected in the study area, but only one was directly motivated by predator control to reduce damage to livestock and thus linked to livestock breeders, and none was registered on farms of livestock breeders belonging to the network. The number of cases significantly decreased as the Project developed, with most of the poisoning cases recorded in the first years, while in 2014, the last year, only one case was detected in the study area.

4.3. Farmers' satisfaction

Farmers were satisfied with their dogs but also with the fact that the Project had contributed to control the problem of poison baits, also used by hunters, which had resulted in the death of many of their farm dogs. Additionally, they stated that, apart from the LGDs donated, the feral/stray animal trapping actions implemented by the Project made a significant contribution to reducing damage to livestock. LGDs played an important role in the direct protection of livestock, but also in detecting and confirming the presence of feral dogs, after which traps were placed on the farm to catch them. This was accomplished by close coordination between the Project staff, network members and authorities, enabling a more efficient control of feral dogs present on member farms, thus helping to solve problems of livestock breeders caused by feral dogs.

The legal and technical support provided to individual farmers and also to farmer associations also extended to bureaucratic issues, namely involving the support provided to enable farmers' access to environment/agriculture subsidies. This helped to build trust which is fundamental to implement such actions and tackle such a secretive practice as illegal poisoning. With this objective, one German Shepherd Dog was also donated for household protection to a shepherd whose guard dog had been poisoned by hunters.

5. Conclusions

The results confirm the success of the strategy implemented that considered a social-based approach and focused on concrete needs and expectations of the stakeholders, effectively reducing the usual motives behind the illegal use of poison, namely by livestock breeders, i.e. illegal predator control aimed at reducing damage to livestock.

The reduction of predation-related problems was achieved via technical advice and through the implementation of damage prevention measures, namely LGDs, which have proven to be very effective against medium-sized predators, but also against feral/stray dogs when two or more LGDs were used, as well as the presence of vultures, and the consequent reduction in the illegal use of poison motivated by damage control. Breeders considered LGDs to be one of the most effective tools to prevent predation and consequently to reduce the use of poison by livestock breeders.

To our knowledge, this is the first time LGDs have been used as a damage prevention tool in the scope of a wider strategy to fight the illegal use of poison, in the scope of conservation efforts directed mostly at endangered raptors and not at large carnivores, as is usually the case worldwide. Nevertheless, the benefits for lager carnivores, namely the lynx or wolf, are evident since they enable the reduction in illegal use of poison, foster a network of livestock breeders involved in the appropriate use of LGDs and promote their use by disseminating puppies descended from working LGD breeding lines. This project has also provided a good opportunity to introduce the use of LGDs in important areas for large carnivores in advance of their expected return.

Also, one of the most innovative actions, a partnership of networks committed to fighting the illegal use of poison, as well as all technical support provided to members, contributed to fostering trust between stakeholders and Project staff which is crucial for success of the actions and the future of the networking process. This was confirmed by the increasing social involvement in the fight against illegal poisoning, with several cases being reported to Project staff within the pilot areas, and with members of the networks presenting themselves as witnesses in legal cases. The networks rely on personal and trust-based relationships and for this reason continuous and close collaboration with the members, and the delivery of solutions to the main problems faced, are essential to reach the proposed goals. Public dissemination of Project results and recognition of the effectiveness of measures encouraged other stakeholders to join the networks.

This LIFE Project provided an extraordinary opportunity to test the effectiveness of a new approach and new tools aimed at the eradication of illegal use of poison, which allow autonomy for the different groups involved in the control of poisoned baits, but the deep social character of this subject made clear that it is vital to continue to build on the work initiated.

[2] These dogs were delivered to the authorities and sent to the local dog shelter, where the veterinarian confirmed if the owners could be identified (e.g. registered microchip), in which case they were contacted to retrieve them and to account for any damage done by the dogs. If the owner was not identified the dogs were kept in the shelter pending adoption.

Acknowledgements

The Project Innovative actions against illegal poisoning in EU Mediterranean pilot areas (LIFE09 NAT/ES/000533), also known as LIFE Innovation Against Poison, was co-funded by the EU under the LIFE Programme.
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ABSTRACTS OF SCIENTIFIC ARTICLES

PREVENTION METHODS

EFFECTS OF SHEPHERDS AND DOGS ON LIVESTOCK DEPREDATION BY LEOPARDS (*Panthera pardus*) IN NORTH-EASTERN IRAN

Igor Khorozyan,
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Amirhossein Khaleghi Hamidi,
Arash Ghoddousi,
Matthias Waltert
PeerJ 5: e3049 / ***2017***

Human-carnivore conflicts over livestock depredation are increasingly common, yet little is understood about the role of husbandry in conflict mitigation. As shepherds and guarding dogs are most commonly used to curb carnivore attacks on grazing livestock, evaluation and improvement of these practices becomes an important task. We addressed this issue by studying individual leopard (Panthera pardus) attacks on sheep and goats in 34 villages near Golestan National Park, Iran. We obtained and analyzed data on 39 attacks, which included a total loss of 31 sheep and 36 goats in 17 villages. We applied non-parametric testing, Poisson Generalized Linear Modelling (GLM) and model selection to assess how numbers of sheep and goats killed per attack are associated with the presence and absence of shepherds and dogs during attacks, depredation in previous years, villages, seasons, ethnic groups, numbers of sheep and goats kept in villages, and distances from villages to the nearest protected areas. We found that 95.5% of losses were inflicted in forests when sheep and goats were accompanied by shepherds (92.5% of losses) and dogs (77.6%). Leopards tended to kill more sheep and goats per attack (surplus killing) when dogs were absent in villages distant from protected areas, but still inflicted most losses when dogs were present, mainly in villages near protected areas. No other variables affected numbers of sheep and goats killed per attack. These results indicate that local husbandry practices are ineffectual and the mere presence of shepherds and guarding dogs is not enough to secure protection. Shepherds witnessed leopard attacks, but could not deter them while dogs did not exhibit guarding behavior and were sometimes killed by leopards. In an attempt to make practical, low-cost and socially acceptable improvements in local husbandry, we suggest that dogs are raised to create a strong social bond with livestock, shepherds use only best available dogs, small flocks are aggregated into larger ones and available shepherds herd these larger flocks together. Use of deterrents and avoidance of areas close to Golestan and in central, core areas of neighboring protected areas is also essential to keep losses down.

LIMITED EVIDENCE ON THE EFFECTIVENESS OF INTERVENTIONS TO REDUCE LIVESTOCK PREDATION BY LARGE CARNIVORES

Ann Eklund,
José Vicente López-Bao,
Mahdieh Tourani,
Guillaume Chapron,
Jens Frank
Scientific Reports 7: 2097 / ***2017***

Successful coexistence between large carnivores and humans is conditional upon effective mitigation of the impact of these species on humans, such as through livestock depredation. It is therefore essential for conservation practitioners, carnivore managing authorities, or livestock owners to know the effectiveness of interventions intended to reduce livestock predation by large carnivores. We reviewed the scientific literature (1990–2016), searching for evidence of the effectiveness of interventions. We found experimental and quasi-experimental studies were rare within the field, and only 21 studies applied a case-control study design (3.7% of reviewed publications). We used a relative risk ratio to evaluate the studied interventions: changing livestock type, keeping livestock in enclosures, guarding or livestock guarding dogs, predator removal, using shock collars on carnivores, sterilizing carnivores, and using visual or auditory deterrents to frighten carnivores. Although there was a general lack of scientific evidence of the effectiveness of any of these interventions, some interventions reduced the risk of depredation whereas other interventions did not result in reduced depredation. We urge managers and stakeholders to move towards an evidence-based large carnivore management practice and researchers to conduct studies of intervention effectiveness with a randomized case-control design combined with systematic reviewing to evaluate the evidence.

PREDATION CONTROL (CHAPTER 9)

Christopher Johnson,
Linda van Bommel
Advances in Sheep Welfare 177–196 9-15 / ***2017***

Sheep are especially vulnerable to predation due to their small size and weak anti-predator responses. Predatory attacks can lead to acute and chronic stress in sheep, with long-lasting impacts on health and welfare. Many different lethal and non-lethal predator control methods can be used to protect sheep from predation. The total impact of a predator control method on sheep welfare is a combination of its effectiveness in preventing predation and the direct impact of the method itself. Considering these aspects, it would seem that the method that does most to enhance sheep welfare is the use of livestock guardian animals, and perhaps sheepherders.

ARE THE LIVESTOCK GUARDING DOGS WHERE THEY ARE SUPPOSED TO BE?

Margherita Zingaro,
Valeria Salvatori,
Luisa Vielmi,
Luigi Boitani
Applied Animal Behaviour Science In press. / ***2018***

In many parts of the world, livestock guarding dogs (LGDs) are considered one of the most powerful prevention tools against carnivore predation on domestic animals, but how they behave when left unsupervised with their flock on pastures is mostly unknown. We monitored 29 LGDs with GPS (Global Positioning System) collars in order to investigate their space use and association with livestock. UDOI (Utilization Distribution Overlap Index) and the VI (Volume of Intersection) Index for 50% and 95% kernel isopleths were calculated to quantify the overlap and the similarity in the use of space for the core area and for the whole movement range of sheep and dogs. Linear mixed models were implemented to evaluate how dog-sheep distance was influenced by environmental (land use, percentage of trees and shrubs in the pasture, size of pasture), dog-related (sex, age), and farming-related variables (number of livestock guarding dogs associated with the flock, herd size). Finally, we tested the usefulness of GPS pet collars in managing LGDs. LGDs spent the majority of their time close to livestock, sharing the same areas but using the space in a different way. Dog-sheep distance was mostly influenced by the environmental variable land use, and the age of the dog. In fact, dogs and sheep tended to separate more in pastures with a high percentage of trees and shrubs, and less in pastures close to inhabited areas. Moreover, older dogs were more associated to the flock compared to younger individuals. GPS pet collars can be an important tool in managing LGDs, as farmers are able to check the position of their dogs and their flock at any time. This can allow producers to improve their management of LGDs, and to limit conflicts with neighbors and accidents. In this study, we demonstrated that the monitored LGDs did not leave the flock unattended when left unsupervised, although further insights into how they behave would support a full evaluation.

IMPACTS OF LARGE CARNIVORES

LARGE CARNIVORE IMPACTS ARE CONTEXT-DEPENDENT

Peter M. Haswell, Josip Kusak, Matt W. Hayward
Food Webs 12, 3-13 / ***2017***

Interactions between large carnivores and other species may be responsible for impacts that are disproportionately large relative to their density. Context-dependent interactions between species are common but often poorly described. Caution must be expressed in seeing apex predators ecological saviours because ecosystem services may not universally apply, particularly if inhibited by anthropogenic activity. This review examines how the impacts of large carnivores are affected by four major contexts (species assemblage, environmental productivity, landscape, predation risk) and the potential for human interference to affect these contexts. Humans are the most dominant landscape and resource user on the planet and our management intervention affects species composition, resource availability, demography, behaviour and interspecific trophic dynamics. Humans can impact large carnivores in much the same way these apex predators impact mesopredators and prey species — through density-mediated (consumptive) and trait/behaviourally-mediated (non-consumptive) pathways. Mesopredator and large herbivore suppression or release, intraguild competition and predation pressure may all be affected by human context. The aim of restoring 'natural' systems is somewhat problematic and not always pragmatic. Interspecific interactions are influenced by context, and humans are often the dominant driver in forming context. If management and conservation goals are to be achieved then it is pivotal to understand how humans influence trophic interactions and how trophic interactions are affected by context. Trade-offs and management interventions can only be implemented successfully if the intricacies of food webs are properly understood.

HUMAN DIMENSIONS

HUMANITY'S DUAL RESPONSE TO DOGS AND WOLVES

Adrian Treves, Cristian Bonacic
Trends in Ecology & Evolution 31, 489-491 / ***2016***

Dogs were first domesticated 31 000–41 000 years ago. Humanity has experienced ecological costs and benefits from interactions with dogs and wolves. We propose that humans inherited a dual response of attraction or aversion that expresses itself independently to domestic and wild canids. The dual response has had far-reaching consequences for the ecology and evolution of all three taxa, including today's global 'ecological paw print' of 1 billion dogs and recent eradications of wolves.

BIG BAD WOLF OR MAN'S BEST FRIEND? UNMASKING A FALSE WOLF AGGRESSION ON HUMANS

R Caniglia, M Galaverni, M Delogu, E Fabbri, C. Musto, E. Randi
Forensic Science International: Genetics, 24, e4-e6 / ***2016***

The return of the wolf in its historical range is raising social conflicts with local communities for the perceived potential threat to people safety. In this study we applied molecular methods to solve an unusual case of wolf attack towards a man in the Northern Italian Apennines. We analysed seven biological samples, collected from the clothes of the injured man, using mtDNA sequences, the Amelogenin gene, 39 unlinked autosomal and four Y-linked microsatellites. Results indicated that the aggression was conducted by a male dog and not by a wolf nor a wolf x dog hybrid. Our findings were later confirmed by the victim, who confessed he had been attacked by the guard dog of a neighbour. The genetic profile of the owned dog perfectly matched with that identified from the samples previously collected. Our results prove once again that the wolf does not currently represent a risk for human safety in developed countries, whereas most animal aggressions are carried out by its domestic relative, the dog.

BOOKS

The Dingo Debate: Origins, Behaviour and Conservation

Edited by Bradley Smith / **2015** / CSIRO Publishing / 330 pp

The Dingo Debate explores the intriguing and relatively unknown story of Australia's most controversial animal - the dingo. Throughout its existence, the dingo has been shaped by its interactions with human societies. With this as a central theme, the book traces the story of the dingo from its beginnings as a semi domesticated wild dog in Southeast Asia to its current status as a wild Australian native animal under threat of extinction. As the book progresses, it describes how the dingo made its way to Australia, their subsequent relationship with Indigenous Australians, their volatile relationship with the media, and their constant battle against the agricultural industry. During these events, the dingo has demonstrated an unparalleled intelligence and adaptable nature seen in few species. The book concludes with a discussion of what the future of the dingo in Australia might look like, what we can learn from our past relationship with dingoes, and how this can help inform us to allow a peaceful co-existence.

The Dingo Debate reveals the real dingo beneath the popular stereotypes, providing an account of the dingo's natural history and behavior based on scientific and scholarly evidence rather than hearsay. Anyone with an interest in the evolution, the mind, and the way that humans and wild animals get on with each other will be interested in this book.

The Domestic Dog: Its Evolution, Behavior and Interactions with People 2nd edition

Edited by James Serpell / **2016** / Cambridge University Press / 424 pp

Why do dogs behave in the ways that they do? Why did our ancestors tame wolves? How have we ended up with so many breeds of dog, and how can we understand their role in contemporary human society? Explore the answers to these questions and many more in this comprehensive study of the domestic dog. Building on the strengths of the first edition, this much-anticipated update incorporates two decades of new evidence and discoveries on dog evolution, behaviour, training, and human interaction. It includes seven entirely new chapters covering topics such as behavioural modification and training, dog population management, the molecular evidence for dog domestication, canine behavioural genetics, cognition, and the impact of free-roaming dogs on wildlife conservation. It is an ideal volume for anyone interested in dogs and their evolution, behaviour and ever-changing roles in society.

Brave and Loyal: An Illustrated Celebration of Livestock Guardian Dogs

By Cat Urbigkit / **2017** / Skyhorse Publishing / 224 pp

Wolf populations in the Rocky Mountains have reached recovery goals due in large part to an environmentally-friendly method of predator control now in use on western ranches: livestock protection dogs. Although these dogs have been used around the world for thousands of years in primitive systems of livestock production, it is only in the past four decades that they have been put to work in America in a systematic manner. Guardian dogs were imported to the United States, and their use has allowed the expansion of predator populations into areas where the animals were previously subject to lethal control. The use of guardian dogs is typical wherever livestock may encounter predators, from foxes and coyotes to wolves and grizzly bears.

In Brave and Loyal, Cat Urbigkit tracks her journeys from a Wyoming sheep ranch to learn about working livestock protection dogs around the globe. Using historic accounts, published research, personal interviews on four continents, and her own experience on western rangelands, she provides the reader with an intimate look into the everyday lives of working livestock protection dogs. Brave and Loyal includes details on raising successful guardians, their behaviour, a discussion of breeds and historic use, an assessment of numbers for various predator challenges, the adoption and spread of programmes to place guardians on American farms and ranches, problems and benefits associated with guardian dogs, predator ploys and matching the dog to the predator challenge. Urbigkit's work provides high quality information on working livestock guardian dogs around the globe, illustrated by more than one hundred beautiful colour photographs.

The Electric Fencing Handbook: How to Choose and Install the Best Fence to Protect Your Crops and Livestock

EBy Ann Larkin Hansen / **2017** / Storey Publishing / 96 pp

Whether you are a gardener, rancher, farmer, homesteader, or beekeeper, you will find all the answers to your fencing questions in this practical guide. Author Ann Larkin Hansen draws on her decades of farming experience to teach you how to select the most appropriate posts and energizer size for your electric fencing needs, then determine the best locations for your gates, the proper number of insulators, and more. Includes step-by-step instructions for building and repairing fences, colour photographs and detailed illustrations, as well as complete information of permanent and temporary electric fencing.

What It's Like to Be a Dog: And Other Adventures in Animal Neuroscience

By Gregory Berns / **2017** / Basic Books / 320 pp

What is it like to be a dog? A bat? Or a dolphin? To find out, neuroscientist Gregory Berns and his team began with a radical step: they taught dogs to go into an MRI scanner--completely awake. They discovered what makes dogs individuals with varying capacities for self-control, different value systems, and a complex understanding of human speech. And dogs were just the beginning. In What It's Like to Be a Dog, Berns explores the fascinating inner lives of wild animals from dolphins and sea lions to the extinct Tasmanian tiger. Much as Silent Spring transformed how we thought about the environment, so What It's Like to Be a Dog will fundamentally reshape how we think about--and treat--animals. Groundbreaking and deeply humane, it is essential reading for animal lovers of all stripes.

*Texts from the books' publishers.

MEETINGS OF INTEREST

7th International Conference on Biodiversity Conservation and Ecosystem Management 2018
Bali, Indonesia
19-20 March 2018
www.clocate.com/conference/7th-International-Conference-on-Biodiversity-Conservation-and-Ecosystem-Management-2018/41698

5th International Human-Bear Conflict Workshop
25-29 March 2018
Gatlinburg, Tennessee, USA
www.humanbearconflict.com

3rd International Conference on Environmental Sustainability, Development, and Protection
Budapest, Hungary
8-10 April 2018
www.clocate.com/conference/3rd-International-Conference-on-Environmental-Sustainability-Development-and-Protection-ICESDP-2018/60133

27th International Conference - Animals in Our Lives:
Multidisciplinary Approaches to the Study of Human–Animal Interactions
2-5 July 2018
Sydney, Australia
www.isaz2018.com

COMING TOPICS

The last issue of the CDPNews produced within the LIFE MedWolf Project will focus mostly on socio-economic aspects of damage prevention. If you are working on a project or study dealing with these or any other aspect of predation by carnivores on livestock and damage prevention measures please contact us to discuss ideas for an article in a future issue. Thank you for your collaboration!

The Editors

To be added to the mailing list or for further information, contacts us at: lifemedwolf@fc.ul.pt

You can download the Carnivore Damage Prevention News on the MedWolf website:

www.medwolf.eu

LINKS

Le Projet CanOvis (The CanOvis Project)
ipra-landry.com/projet-canovis

Perros Protectores de Rebaño: El comienzo de una historia (Livestock Guarding Dogs: The beginning of a story) (Documentary)
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Med Wolf