Carnivore Damage Prevention
CDP news

Issue 16 AUTUMN 2017

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used for conservation in Chilean Patagonia

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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

Coppinger R, Coppinger L, Langeloh G, Gettler L, Lorenz J (1988) A decade of use of livestock guarding dogs. Proc. Thirteen. Vertebr. Pest Conf., pp. 209–214.
Coppinger R, Lorenz J, Glendinnig J, Pinardi P (1983) Attentiveness of guarding dogs for reducing predation on domestic sheep. Journal of Range Management 36, 275-279.
D'Amico G, Dumitrache MO, Matei IA, Ionică AM, Gherman CM, Sándor AD, Modrý D, Mihalca AD (2017) Ixodid ticks parasitizing wild carnivores in Romania. Experimental and Applied Acarology 71, 139-149.
Dalmasso S, Vesco U, Orlando L, Tropini A, Passalacqua C (2012) An integrated program to prevent, mitigate and compensate wolf (*Canis lupus*) damage in Piedmont region (northern Italy). Hystrix, the Italian Journal of Mammalogy 23, 54-61.
Di Sabatino D, Lorusso A, Di Francesco CE, Gentile L, Di Pirro V, Bellacicco AL, Giovannini A, Di Francesco G, Marruchella G, Marsilio F, Savini G (2014) Arctic lineage-canine distemper virus as a cause of death in Apennine wolves (*Canis lupus*) in Italy. PLoS ONE 9(1): e82356.
Eklund A, Lopez-Bao J-V, Tourani M, Chapron G, Frank J (2017) Limited evidence on the effectiveness of interventions to reduce livestock predation by large carnivores. Scientific Reports 7, 2097.
Fieberg J, Kochanny CO (2005) Quantifying home-range overlap: the importance of the utilization distribution. Journal of Wildlife Management 69, 1346. doi: 10.2193/0022-541X(2005)69.
Gehring TM, Vercauteren KC, Landry J-M (2010) Livestock protection dogs in the 21st century: Is an ancient tool relevant to modern conservation challenges? BioScience 60, 299.
Guberti V, Bolognini M, Lanfranchi P, Battelli G (2004) *Echinococcus granulosus* in the wolf in Italy. Parassitologia 46, 425-427.
Kreeger TJ (2003) The internal wolf: physiology, pathology, and pharmacology. In: Mech LD, Boitani L, editors. Wolves: behavior, ecology, and conservation. The University of Chicago Press, Chicago, pp. 191-217.
Krupka I, Pantchev N, Lorentzen L, Weise M, Straubinger RK (2007) Ticktransmitted, bacterial infections in dogs: Seroprevalence of *Anaplasma phagocytophilum, Borrelia burgdorferi* sensu lato and *Ehrlichia canis* in Germany. Prakt Tierarzt. 88, 776–788.
Latini R, Sulli C, Gentile L, Di Benedetto A (2005) Conflitto tra grandi carnivori e attività antropiche nel Parco Nazionale d'Abruzzo, Lazio e Molise: Entità, esperienze e prospettive di gestione. In: Ciucci P, Teofili C, Boitani L, editors. Grandi carnivori e zootecnia tra conflitto e coesistenza. Biol. Cons. Fauna 115, 151–159.
LIFE COEX (2008) Action D2. Installation and monitoring of electric fences as a damage prevention measure. Annex 11 to the Final Technical Report. Istituto di Ecologia Applicata, Italy, 29 p.
LIFE EX-TRA (2013) Final Report. Annex VI Report of action C.3. Parco dell'Appennino Tosco Emiliano, Italy, 63 p.
Lindgren E, Jaenson TGT (2006) Lyme borreliosis in Europe: influences of climate and climate change, epidemiology, ecology and adaptation measures. WHO Regional Office for Europe, Copenhagen, Denmark, 34 p.
Mancini R (2006) Osservazione sul comportamento del pastore Maremmano-Abruzzese: studio degli indicatori dell'efficienza nella difesa del gregge. Tesi di laurea specialistica in Conservazione e Gestione del Patrimonio Naturale, Facoltà di Scienze MM. FF. NN., Università di Bologna. Bologna, Italy, 91 p.
Marino A, Braschi C, Ricci S, Salvatori V, Ciucci P (2016) Ex-post and insurance-based compensation fails to increase tolerance for wolves in semi-agricultural landscapes in Italy. Eur. J. Wildl. Res. 62, 227-240.
Marker LL, Dickman AJ, Macdonald DW (2005) Perceived effectiveness of livestock-guarding dogs placed on Namibian farms. Rangel. Ecol. Manag. 58, 329–336.
Rust NA, Whitehouse-Tedd KM, MacMillan DC (2013) Perceived efficacy of livestock-guarding dogs in South Africa: Implications for cheetah conservation. Wildlife Society Bulletin 37, 690-697.
Stanek G, Pletschette M, Flamm H, Hirschl AM, Aberer E, Kristoferitsch W, Schmutzhard E (1988) European Lyme Borreliosis. Annals of the New York Academy of Sciences 539, 274-82.
Strnada M, Hönig V, Růžek D, Grubhoffer L, Rego RO (2017) Europe-wide meta-analysis of *Borrelia burgdorferi* sensu lato prevalence in questing *Ixodes ricinus* ticks. Applied and Environmental Microbiology AEM-00609.
Tedesco E, Ciucci P (2005) Monitoring the efficiency of livestock guarding dogs: a preliminary application with dogs assigned to shepherds in the Alps. In: Ciucci P, Teofili C, Boitani L, editors. Grandi carnivori e zootecnia tra conflitto e coesistenza. Biol. Cons. Fauna 115, 181-190.
Vielmi L, Salvatori V (2017) DifesAttiva: a farmer's association to foster networking and support for damage prevention. Carnivore Damage Prevention News 15, 1-8.
Wallach JD, Boever WJ (1983) Diseases of exotic animals. Medical and surgical management. W.B. Saunders Co., Philadelphia, 426 p.
Zimen E, Boitani L (1975) Number and distribution of wolves in Italy. Zeitschrift fur Saugetierekunde 40, 102–112.
Zingaro M, Vielmi L, Salvatori V, Boitani L (2016) Using GPS collars to evaluate the association between livestock guarding dogs and flock: preliminary results. Hystrix, the Italian Journal of Mammalogy 27, 158.
Zingaro M, Vielmi L, Salvatori V, Boitani L (2018) Are livestock guarding dogs where they are supposed to be? Applied Animal Behaviour Science. In press.

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.

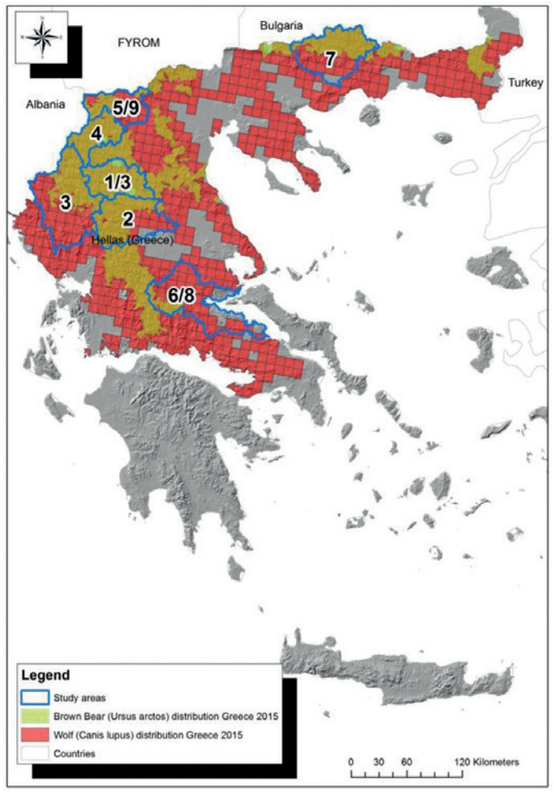

Fig. 8. Wolf and brown bear distributions in Greece (Iliopoulos et al., 2015; Mertzanis et al., 2009; Mertzanis et al., 2015 unpublished data) showing the intervention areas of the nine carnivore conservation projects implemented in 2009-2017: 1) LIFE PINDOS/GREVENA; 2) LIFE EXTRA; 3) LIFE ARCPIN; 4) 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.

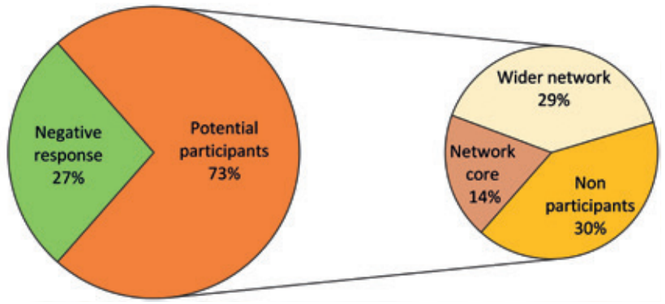

Fig. 10. Livestock raisers' participation in the LGD owners' network.

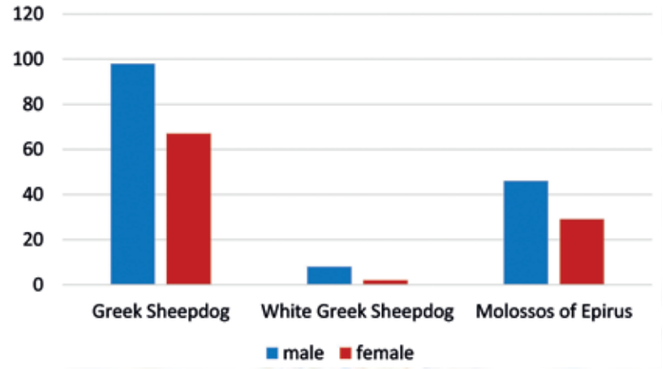

Fig. 11. Number and sex of dogs donated during the nine projects.

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.

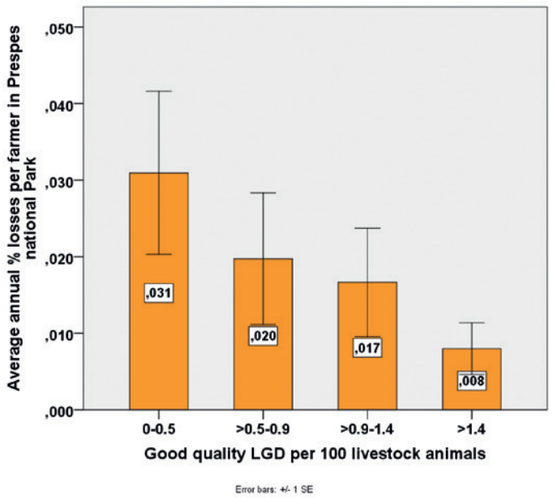

Fig. 12. Relation between number of good quality LGDs and mean percentage of annual livestock losses caused by LCs per farmer in Prespes National Park, Northern Greece (Iliopoulos and Petridou, 2016).

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-

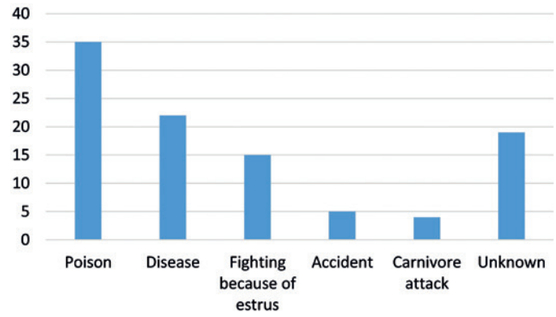

Fig. 13. Mortality causes of LGDs donated during nine projects in 2009–2017.

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.

This study was financed and enabled by five LIFE and four national projects: 1) LIFE PINDOS/GREVENA - Demonstration of Conservation Actions for Ursus arctos and habitat type 9530 in Northern Pindos NP, Grevena Prefecture, Greece (LIFE07NAT/GR/0002912); 2) LIFE EXTRA - Improving the Conditions for Large Carnivore Conservation: A Transfer of Best Practices (LIFE07NAT/IT/000502); 3) LIFE ARCPIN - Conservation actions for improving conditions of human-bear coexistence in Northern Pindos (LIFE12NAT/GR/000784); 4) LIFE ARCTOS/KASTORIA - Improving conditions of bear-human coexistence in Kastoria Prefecture, Greece - Transfer of best practices (LIFE09NAT/GR/000333); 5) LIFE AMYBEAR - Improving Human-Bear Coexistence Conditions in Municipality of Amyntaio (LIFE15NAT/GR/001108); 6) Preliminary evaluation of wolf-livestock conflicts and mitigation measures in Oiti National Park (2012); 7) Establishing a LGD network amongst farmers in Rodopi National Park, (2013); 8) Addressing wolf-livestock conflicts in Oiti National Park, Operational Programme "Environment" (2015); 9) Preliminary investigation to address conflicts with large carnivores in Prespes National Park (2017).

Special thanks to Callisto personnel: Katia Dimitrakopoulou, Yorgos Theodoridis, Effie Gelastopoulou and Loukia Argiriadou. Many thanks to our livestock farmer friends: Yiannis Kolitsas, Yorgos Sioutas, Yorgos Koubatas, Nikos Tsarapatsanis, Vaggelis Karatziolis, Apostolos Karatzios, Yorgos Palios, Kostas Tsafkopoulos, Elias Tapis, Nikos Sourlis, Yorgos Moustakas & Aleka Moustaka, Yorgos Vasiliou, Panos Tolis, Lakis Dematis & Kostas Dematis, Babis Politis, Thanasis Mpletsas, Apostolos Mpampanikas & Aimilios Mpampanikas, Elias Karagiannis, Nikos Papigkiotis, Nikos Tolis, Yorgos Zigos, Aggelos Kassos, Christos Ntontis, Yorgos Mitrakis, and many others that helped and supported the LGD network.

We are thankful to the editors of the CDPNews for their valuable comments and editing that greatly improved the manuscript.

References

Blanco JC, Reig S, Cuesta L (1992) Distribution, status and conservation problems of the wolf *Canis lupus* in Spain. Biological Conservation 60, 73-80.

Ciucci P, Boitani L (1998) Wolf and dog depredation on livestock in central Italy. Wildl. Soc. Bull. 26, 504-514.

Cozza K, Fico R, Battistini M-L, Rogers E (1996) The damage-conservation interface illustrated by predation on domestic livestock in central Italy. Biol. Conserv. 78, 329-336.

ELGA (2011) Animal insurance regulation. Hellenic Farmers Insurance Organization. FEK 1669/B/27-7-2011, Athens 1–12. [In Greek]

Iliopoulos Y, Sgardelis S, Koutis V, Savvaris D (2009) Wolf depredation on livestock in central Greece. Acta Theriol. 54, 11-22.

Iliopoulos Y (2010) Wolf (*Canis lupus*) packs territory selection in Central Greece: habitat selection, daily movements and effect on livestock. PhD Thesis, Aristotle University of Thessaloniki, Thessaloniki, 439 p.

Iliopoulos Y, Astaras C, Petridou M, Sideri E (2015) Total deliverables for wolf monitoring. In: Papamichail C, Arapis T, Petkidis K, editors. Monitoring and assessment of the conservation status of species of mammals of Community interest in Greece. YPEKA, Athens, pp. 17-21.

Iliopoulos Y, Petridou M (2016) Preliminary investigation to address conflicts with large carnivores in Prespes National Park. Final Report. Management Body of Prespes National Park, 122 p.

Mertzanis Y, Giannakopoulos A, Pilides C (2009) Status of the brown bear *Ursus arctos* (Linnaeus, 1758) in Greece. In: Legakis A, Maragou P, editors. Red Data Book of Threatened Vertebrates of Greece. Hellenic Zoological Society, Greece, pp. 385-387.

Mertzanis Y, Iliopoulos Y, Giannakopoulos A, Tragos A, Aravides H, Tsaknakis Y, Lazarou Y, Psaroudas S, Koutis V (2015) GIS data for brown bear *Ursus arctos* distribution in Municipality level for the implementation of Measure 216 ("Subsidies for non-productive investments"), Action 1.1 ("Purchase and installation of electric fences)", which was included in the Rural Development Programme of Greece (RDP).