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Are the livestock guarding dogs where they are supposed to be?

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ABSTRACT

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.

1. Introduction

Wolf (*Canis lupus*) populations are continuing to expand their range toward more inhabited areas across European countries following legal protection, improvement of habitat quality and exodus from rural areas (Chapron et al., 2014). Therefore, farmers have an increasing need to protect their livestock from predation.

From the late 1970s, nonlethal methods such as livestock guarding dogs (LGDs) have gained popularity among farmers and conservationists, as demonstrated by the large number of conservation projects that include their use (Rigg, 2001; Otstavel et al., 2009; Salvatori, 2014). In many parts of Europe, Asia and North America, LGDs are considered one of the most powerful prevention tools against carnivore depredation on domestic animals (Andelt, 2004; Shivik, 2006; Gehring et al., 2010; Lescureux and Linnell, 2014).

LGDs have been the subject of numerous reviews and evaluations of their use and efficacy, but few of them rigorously assessed the factors influencing effectiveness (Gehring et al., 2010). LGDs were judged effective using mainly questionnaires on farmer's perception (Marker et al., 2005), censuses of livestock losses (Andelt, 1992) and focal animal behavior sampling (Coppinger et al., 1983). Nevertheless, these studies could be biased by confounding factors that cannot be controlled by researchers, such as density of predators, experience of shepherds or LGD individuality (Gehring et al., 2010). As Landry et al. (2014) pointed out, the efficiency of LGDs should be evaluated observing the interactions between dogs and wild predators when attacks occur. However, these episodes are difficult to observe as they are unpredictable and occur mostly during the night or on heavily vegetated terrain (Landry et al., 2014). For this reason, typically indirect methods and proxies are used.

Spatial proximity between sheep and guarding dog is an essential precondition for preventing livestock depredation by predators (Gehring et al., 2011; VerCauteren et al., 2012). It is determinant also for a dog's attentiveness, one of the traits that a good guardian should show (Coppinger and Coppinger, 1980). Attentiveness implies a social bond between sheep and dog, which results in the dog constantly

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Table 1
Information on LGDs and farms involved in the study. From November 2015 to July 2016 we monitored 29 LGDs (16 males and 13 females), mostly Maremmas, at 11 farms. Each farm generally owned more than one flock and guarded by at least two LGDs (except Farm B-first sampling session). Herds were composed of "Sarda" breed dairy sheep, except in Farm B and F where herds were also composed of "Amiatina" breed meat sheep.

Dog ID	Sex	Dog Breed	Age	N LGD/ flock	Flock size	Flock ID	Sampling period	Farm	
1	M	Maremma	1.5	2	200	1	Nov-15	A	
2	F	Maremma	1	2	200	1	Nov-15	A	
3	M[a]	Maremma	10m	1	50	2	Nov-15	B	
4	M	Maremma	1	5	120	3	Nov-15	C	
5	F	Maremma	1	5	120	3	Nov-15	C	
6	M	Maremma	4	5	120	3	Nov-15	C	
7	F	Mixed	3	2	120 – 70	4 and 5	Dec-15	D	
8	M	Maremma	1.5	2	70	4	Dec-15	D	
9	M	Maremma	1.5	2	120	5	Dec-15	D	
10	F	Pyrenees	3	2	150	6	Dec-15	E	
11	M	Pyrenees	8	2	150	6	Dec-15	E	
12	F	Maremma	2.5	2	70	7	Dec-15	F	
13	M	Maremma	2.5	2	70	7	Dec-15	F	
14	F	Maremma	1.5	2	180	8	Dec-15	G	
15	F	Maremma	1.5	2	180	8	Dec-15	G	
16	M	Maremma	7m	2	160	9	May-16	H	
17	M	Maremma	7m	2	160	9	May-16	H	
18	M	Maremma	1	2	300	10	May-16	I	
19	F[a]	Maremma	1	2	300	10	May-16	I	
20	F	Caucasian	1	3	450	11	May-16	E	
21	M	Caucasian	1	3	450	11	May-16	E	
22	M	Mixed	2.5	2	150	12	May-16	J	
23	F[a]	Mixed	2.5	2	150	12	May-16	J	
24	F	Pyrenees	9	5	350	13	Jul-16	E	
25	F	Caucasian	1	5	350	13	Jul-16	E	
26	M	Maremma	7m	2	150	14	Jul-16	K	
27	F	Maremma	7m	2	150	14	Jul-16	K	
28	M	Maremma	7m	3	260	15	Jul-16	A	
29	M	Maremma	1.2	2	170	15	Jul-16	B	
			2	3	191				Mean
			2	1	105				SD

[a] Neutered/spayed dogs.

maintaining contact with the flock (Coppinger et al., 1983; Coppinger and Coppinger, 2005).

As Lorenz (1989) stated, "if the dog isn't with the sheep it isn't where it's supposed to be". However, in a livestock farming system that uses fenced pastures to graze the animals, some roaming is expected as the dogs create territorial boundaries, which they maintain to help them to protect their livestock (van Bommel and Johnson, 2014). On the other hand, territorial behavior might be less important for dogs raised in a more nomadic livestock farming system where an increased closeness to the flock is expected.

A dog is an effective tool if it is not a cause of concern for the farmer and society. Indeed, some dogs do not stay with sheep and may harass people (Andelt, 2004). When a LGD roams far and wide, it is not protecting livestock and is more likely to create problems. In human-dominated landscapes, where road and human densities are high, a roaming dog can cause accidents (Gehring et al., 2010). In natural areas, roaming LGDs can chase wildlife for territoriality, for playing or as prey if they are not properly maintained (Marker et al., 2005; Potgieter et al., 2013). Moreover, wide-ranging dogs could increase the possibility of infecting wildlife with diseases (Lescureux and Linnell, 2014) and hybridizing with wolves (Kopaliani et al., 2014).

Thus, understanding the spatial behavior of these dogs in relation to the livestock to be protected is pivotal from both ecological and management points of view, especially now that the shepherding system has changed in many areas around the world. While the traditional use of LGDs was in association with a guardian or shepherd, in modern days it is becoming more difficult to have a full time shepherd, particularly where farmers strive to obtain a higher income turning to diversification. In such conditions, how dogs use the space and interact when left alone with the flock on pastures is mostly unknown.

Using GPS pet collars, we monitored LGDs on working farms in order to investigate their space use and their proximity to the flock, which, if integrated with other information, can be used as a proxy for the evaluation of appropriate dog behavior. We quantified the overlap between the movement ranges of dogs and sheep, and we evaluated how dog-sheep distance was influenced by environmental, dog-related and farming-related variables. In addition, we trialed the usefulness of GPS pet collars for LGDs and sheep husbandry.

2. Methods

2.1. Study sites

The study was performed on 11 sheep farms situated in seven municipalities of Grosseto province (Tuscany Region, Italy). We sponsored this research across 20 farms with LGDs, which were previously involved in conservation initiatives in Grosseto province. We offered them the opportunity to test GPS pet collars in dogs and sheep husbandry. The farmers could verify the location of their dogs and sheep on their electronic devices in real time (PC, smartphone, tablet), and they were alerted if an unwanted behavior occurred (e.g., roaming or staying at home). All farmers who volunteered for the study were included.

Seven farms were located in areas containing large portions of forest and four farms were located in a more open agricultural landscape. Apart from Mt. Amiata (1738 m asl) and the mountainous group of Colline Metallifere (1060 m asl) in the northern part, the Province is hilly country. Waterways are abundant.

Wolves (*Canis lupus*) and free ranging dogs (*Canis familiaris*) are the major threats to livestock in the area. Between January 2014 and mid-September 2016, 48% (N = 407) of depredation claims in Grosseto province came from the municipalities in which the study was conducted (National Health Authority database).

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