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Direct interactions between livestock guarding dogs and wildlife in a transhumance grazing system

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Abstract

Livestock guarding dogs (LGDs) are suggested to help facilitate human–wildlife coexistence because they are considered effective at preventing livestock losses and reducing persecution of predators. However, LGDs have been observed harassing and killing wildlife, yet their interactions with wildlife are seldom purposefully investigated. This study documents LGD–wildlife interactions in the southern Carpathian Mountains, Romania, where on average five to eight LGDs are used as part of a transhumance grazing system to protect sheep from bears and wolves. Thirteen shepherds were interviewed about their LGDs' behaviors and wildlife remains were identified in their LGDs' scats. All shepherds reported that their LGDs chased predators as well as other non-target wildlife. Seven reported wildlife had been injured or killed by their LGDs but these instances were said to be rare. Wildlife were found in 28% of the LGD scats but mostly consisted of insects with only 9% of scats containing vertebrate wildlife remains. The occurrence of LGD–wildlife interactions was not affected by the number of LGDs used together but did align with whether or not shepherds encouraged LGDs to chase non-target wildlife. These findings lend support to existing evidence that LGDs can be used as a conservation tool without substantial negative effects on wildlife when managed appropriately.

KEYWORDS

Canis familiaris, human–wildlife coexistence, human–wildlife conflict, LGD–wildlife interactions, livestock depredation, livestock guardian dog, Romania, scat analysis

1 | INTRODUCTION

Livestock guarding dogs (LGDs) are specialized working dogs whose main role is protecting livestock from wild predators. The use of LGDs originated in Europe and Asia but has since been adopted around the world (Rigg, 2001). Wildlife conservationists have advocated for their use as a tool to facilitate human–wildlife coexistence by improving human tolerance of living alongside wildlife and reducing lethal management of predatory species (González et al., 2012; Infante & Azorin, 2017; Potgieter et al., 2016; Rust et al., 2013; Van Der Weyde et al., 2020). Additionally, LGD use is sometimes targeted towards non-predatory wildlife, such as herbivores, to reduce pathogen transmission and grazing competition between livestock and wildlife (Ugarte et al., 2021; van Bommel & Johnson, 2016; VerCauteren et al., 2012).

Typically, the intended use of LGDs is to disrupt predatory sequences, as predicted by optimal foraging theory, by making resources (e.g., livestock) more difficult to obtain and non-lethally deterring the target species (Bagchi, 2019; Haswell et al., 2019). However, being domestic dogs, LGDs could further impact both target and non-target wildlife through a variety of means including predation, disturbance, competition, pathogen transmission, and hybridization (Doherty et al., 2017; Young et al., 2011). Most accounts of LGDs interacting with wildlife are anecdotal (Smith et al., 2020), but LGDs have been reported to chase and kill wildlife, including apex predators, mesopredators, and a variety of herbivores (Landry et al., 2020; Nayeri et al., 2022; Potgieter et al., 2016; Smith et al., 2020; Whitehouse-Tedd et al., 2020). As such, LGDs could potentially act as surrogate apex predators and exclude co-occurring wildlife from areas through territorial behavior or a landscape of fear effect (Ugarte et al., 2021; van Bommel et al., 2024; van Bommel & Johnson, 2016). However, LGD behaviors and their interactions with wildlife are seldom quantified (Smith et al., 2020).

Several factors could influence LGD behaviors and their interactions with wildlife. First, different breeds of LGDs have different temperaments, with some bred to be more aggressive or dominant for use in areas with higher predator pressure and some seemingly more prone to behavioral problems (Horgan et al., 2021; Ivaşcu & Biro, 2020; VerCauteren et al., 2008). Other factors, including the age and sex of LGDs and whether humans accompany them, can also influence LGD behaviors (Drouilly et al., 2020; Leijenaar et al., 2015; Marker et al., 2021). The frequency of predation events could also depend on the number of LGDs used, as successful hunting of wildlife might be more common when multiple dogs work together in packs (Krauze-Gryz & Gryz, 2014; Silva-Rodríguez & Sieving, 2011). The number of LGDs used to guard livestock herds varies significantly around the world, from typically only one or two LGDs being used in locations such as the United States (e.g., Bromen et al., 2019; VerCauteren et al., 2008) and southern Africa (e.g., Drouilly et al., 2020; Potgieter et al., 2016) to more than 20 used on some French alpine pastures (Landry et al., 2020). Livestock guarding dogs are integral to traditional pastoralism, enabling shepherds to coexist with large carnivores while raising livestock. However, with the increasing use of LGDs and given that such large numbers of LGDs are used in some countries, it is crucial to understand their behavior across diverse management practices and environmental conditions.

Romania is one country where little research has been conducted on the use of LGDs. Although Romania has seen an increase in agricultural abandonment since the collapse of communism in 1989 (Griffiths et al., 2013; Kuemmerle et al., 2009), pendulation, or short-distance transhumance grazing, is still commonly practiced (Huband et al., 2010). Transhumance grazing is a traditional pastoral practice whereby livestock are moved to semi-natural grasslands, typically subalpine and alpine pastures, for the summer months (approximately May–October) (Huband et al., 2010; Săgeată et al., 2023). At the summer pastures, shepherds move their livestock around during the day but usually enclose them overnight in a sheepfold, the location of which is moved every few weeks to prevent the sheep from trampling the land. All sheep flocks are accompanied by shepherds, who usually sleep next to the sheepfold in small shelters, as well as LGDs to help lower the predation of livestock by bears and wolves (Pop et al., 2023). Shepherds typically use mixed-breed LGDs as well as a range of native Romanian LGD breeds, including Carpathian, Mioritic, Bucovina, and Raven Shepherd dogs (Ivaşcu & Biro, 2020). The mixed-breed LGDs are of various origins, with some being mixed non-LGD breeds and some being mixes of both local and imported LGD breeds with non-LGD breeds. On average, shepherds use between five and eight LGDs per livestock herd (Ivaşcu & Biro, 2020), though the number can be higher in some areas; for example, in this study, the maximum number of LGDs used for one flock of 900 sheep was 14.

In Romania, the number of LGDs used per flock is perceived as being high and is a source of contention. In particular, concerns have been raised over LGDs predating wildlife, particularly by game managers who contend that LGDs attack game animals such as deer and wild boar (Ivaşcu & Rakosy, 2017). In 2015, a national hunting law limiting shepherds to using a few LGDs per flock sparked protests, as shepherds argued LGDs are vital for livestock protection, and declining game numbers were due to poor hunting management, not LGDs (Ivaşcu & Rakosy, 2017). The law was repealed the same day. As such, understanding LGD behavior is crucial for mitigating both human–wildlife and human–human conflicts.

In this study, LGD–wildlife interactions were investigated in the Southern Carpathian Mountains, Romania. Consumption of wildlife by LGDs was assessed by identification of wildlife remains in LGD scats collected from summer pastures. At the same sites where scats were collected, shepherds were interviewed about the management and behavior of their LGDs in order to contextualize the scat analysis results. Traditionally, shepherds in Romania remain with, and closely accompany, their LGDs on the pasture, providing an invaluable firsthand perspective on the behavior of these dogs. The study aimed to determine how frequently LGDs consume wildlife in Romania, and whether this behavior is linked to factors including how LGDs are managed by shepherds, and the number and breed of the LGDs at each site. It was hypothesized that there would be more wildlife remains in LGD scats from sites where (1) higher numbers of LGDs were used, (2) shepherds reported that their LGDs chase, kill, or scavenge wildlife, and (3) shepherds self-reported that they actively encouraged these behaviors. This study is one of few purposefully reporting on LGD–wildlife interactions and the first to quantify wildlife in the scats of LGDs from Romania or any similar landscape where transhumance grazing is practiced with the aid of several LGDs.

2 | METHODS

2.1 | Positionality statement

This study was driven by the first author's PhD research on LGDs and involved collaboration between Nottingham Trent University and the international conservation charity Fauna & Flora. Five authors, including the first author, are UK-based researchers with expertise in human–wildlife coexistence, and do not speak Romanian. The first author held temporary residency in Romania during the research. The other three authors are permanent residents of Romania, two of whom are Romanian natives (M.M. and R.P.), and all have been employed by Fauna & Flora for several years. Fauna & Flora have been working in Romania since 1999 helping local organizations and communities to sustainably manage landscapes. As part of Fauna & Flora's "Facilitating Coexistence with Large Carnivores" project, three of the authors (M.M., R.P. and I.T.) were personally involved in distributing Carpathian Shepherd dogs and electric fences to farmers and administering social surveys to local communities. R.P. is also the Vice President of the "Carpatin Club Romania" and helped breed some of the dogs provided to shepherds included in this study.

Through their outreach and activities with Fauna & Flora, M.M. and R.P. have fostered strong relationships with local shepherds and wider communities. As Romanian speakers, M.M. and R.P. asked the questions to the shepherds and then translated a paraphrased version of their responses to B.R.S. who recorded this information in the field. The authors acknowledge that this process could have introduced biases into what information was recorded. Although ethical approval and informed consent was received for all activities, future studies should ensure that permission is also sought to audio record interviews with shepherds to produce verbatim transcripts. The authors also acknowledge that the established relationship between M.M., R.P. and the shepherds, as well as the presence of a non-Romanian speaking female researcher (B.R.S.), could have influenced the information offered by shepherds.

2.2 | Ethics statement

The activities conducted for this study (including both shepherd and animal investigations) were reviewed by the Nottingham Trent University Ethical Review Committee and granted approval under project code ARE192048R(21). Informed, written consent was received from each shepherd or livestock owner for all activities conducted. Participation was entirely voluntary, and no reward or payment was provided for participants. All personal data pertaining to each shepherd and their interview data were stored securely and treated confidentially.

2.3 | Site and LGD selection

This study was part of a wider project examining different aspects of LGD–wildlife interactions. To gain access to LGDs for the project, Fauna & Flora team members invited shepherds they knew through their work with local communities to participate. To ensure an overview of the behavior of local LGD breeds was captured, shepherds were invited who used a mixture of LGD breeds: purebred Carpathian Shepherd dogs only (some of which were donated by Fauna & Flora), mixed-breed guarding dogs only, or both. Only shepherds predominantly grazing sheep (some grazed smaller numbers of goats alongside their sheep) rather than cattle were included to prevent any variance in LGD behaviors arising from guarding cattle (VerCauteren et al., 2012). The number of sites was limited by equipment and time constraints for the wider project, with a total of 15 shepherds invited to take part. For anonymity, data were recorded under a unique identifier for each shepherd comprised of two initials representing the county where they were based (SB, Sibiu; HD, Hunedoara; AB, Alba) followed by a two-digit consecutive number. One of the 15 participants later withdrew from the study due to the shepherd's LGDs being injured by a bear during the study period and another was withdrawn by the researchers as other elements of the wider project could not be conducted at the

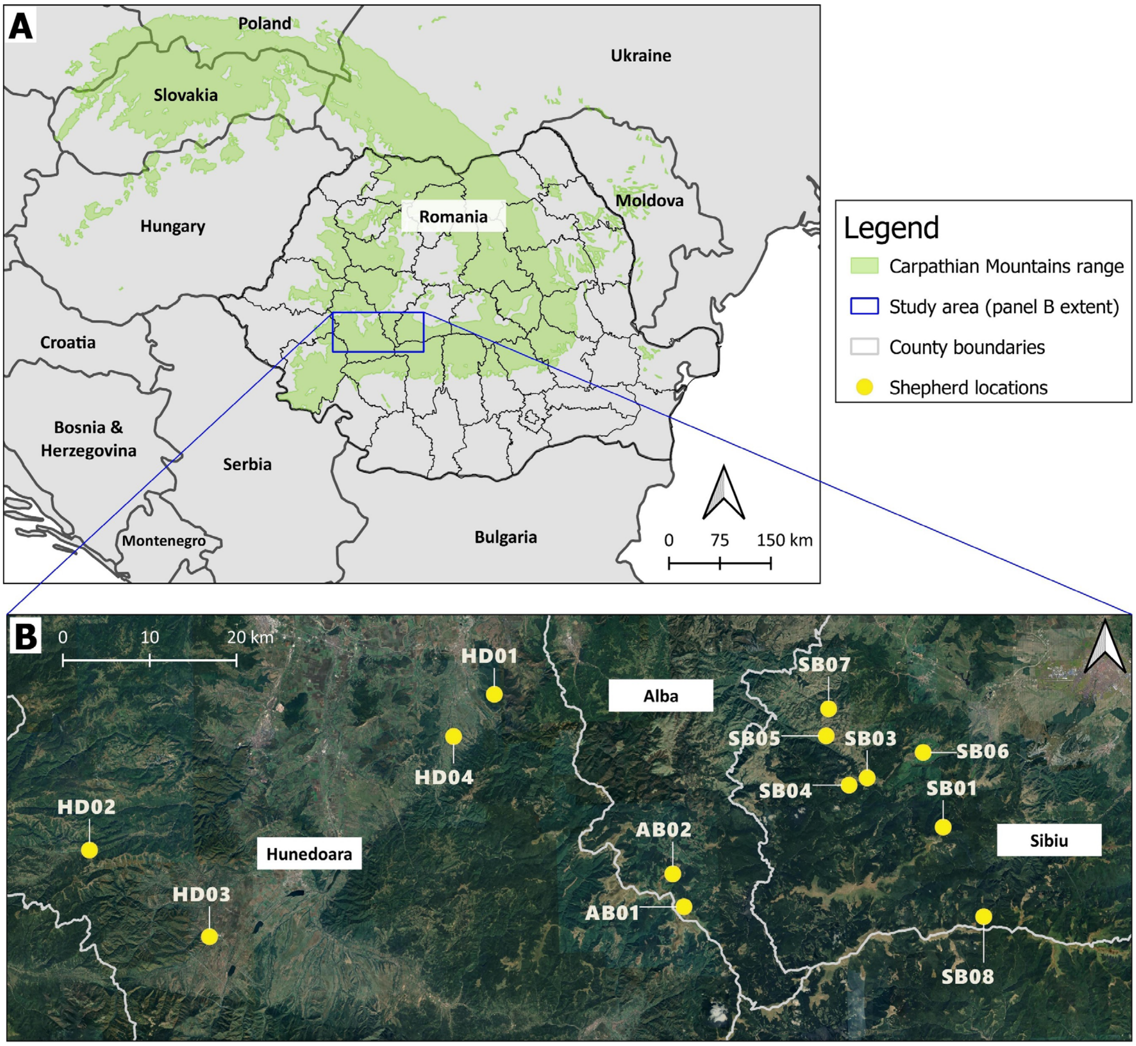

FIGURE 1 (A) General study area in the southern Carpathian Mountains, Romania. (B) Locations of each shepherd's sheepfold at the time of participation in the study (labeled with participant identifier) within each of the three counties: Hunedoara, Alba, and Sibiu. Maps produced in QGIS using Google Satellite imagery for (B).

site due to a lack of GPS signal. At each site, information on livestock husbandry and LGD management was provided by shepherds responsible for each flock and pair/pack of LGDs. Shepherds provided information on the number and type of livestock and how these animals were kept overnight, as well as the number, breeds, ages, and sexes of their dogs. Dietary information was provided in relation to what and when the LGDs were fed, but information was not gathered on the quantities of food provided to LGDs.

2.4 | Study area

Seven of the 13 shepherds were in Sibiu County, four in Hunedoara County, and two in Alba County (Figure 1). The elevations of the sheepfolds ranged from 286 to 1776 m. The sites at lower elevations were those in Hunedoara County, where shepherds either did not take their livestock to higher altitude pastures (HD03) or had already migrated to slightly lower altitude pastures by the time their LGDs were monitored (HD01 and HD04). The average elevation of the sheepfolds in Alba and Sibiu counties was 1396 m (±277 m SD). The number of sheep at each site ranged from 160 to 900 (Table 1). Flocks were typically guarded by one or two shepherds alongside the LGDs.

The climate in the southern Carpathians is temperate with warm summers and cold winters. Vegetation typically consists of three types depending on the elevation. Alpine and subalpine vegetation (mainly sedges and grasses [*Carex* ssp. *Festuca* ssp., *Nardus stricta* and *Agrostis rupestris*]) are found at elevations >1800 m; coniferous forests (Norway spruce [*Picea abies*] and silver fir [*Abies*

TABLE 1 Specific information on the livestock and dogs present at each site, including what and when the livestock guarding dogs (LGDs) were fed (AM—morning, PM—evening).

Site	No. of sheep	No. of herding dogs	No. of LGDs	LGD breeds (no. of each)	LGD age range (years)	Sex ratio of LGDs (male: female)	Neutered ratio of LGDs (neutered: not neutered)	Food type	Feeding time
AB01	700	2	6	Mixed	0.5–13	2:4	0:6	Polenta, whey, dog food, livestock (incl. bones)	AM; PM
AB02	800	1	2	Mixed	3	2:0	0:2	Polenta, meat, dog food	AM; PM
HD01	600	1	7	Carpathian	1–3	4:3	0:7	Polenta, bread, dog food, livestock (incl. bones)	AM; PM
HD02	180	1	7	Carpathian (4) Mixed (3)	1–7	5:2	0:7	Polenta, whey, leftovers	AM; PM
HD03	160	1	5	Carpathian (4) Mixed (1)	1.5–20	3:2	0:5	Dog food, livestock (incl. bones), whey	AM; PM
HD04	400	1	5	Carpathian (2) Mixed (3)	0.5–8	4:1	0:5	Dog food, polenta, livestock (incl. bones)	AM; PM
SB01	900	3	14	Mixed	0.5–10	11:3	3:11	Polenta	AM
SB03	300	1	5	Mixed	1–8	5:0	2:3	Polenta	AM; PM
SB04	180	1	2	Mixed	3	1:1	0:2	Bread, whey	AM
SB05	500	1	6	Mixed	0.5–8	3:3	0:6	Polenta, whey, livestock (incl. bones)	AM
SB06	400	1	5	Mixed	3–13	5:0	4:1	Polenta, whey, dog food	AM; PM
SB07	500	4	8	Carpathian (2) Mixed (6)	1–4	7:1	0:8	Polenta, livestock (incl. bones)	AM
SB08	400	1	10	Mixed	2–10	5:5	0:10	Polenta, whey, dog food, meat from butchers (incl. bones)	AM

alba]) are found between 1200 and 1800 m; and deciduous forests (mainly beech [*Fagus sylvatica*]) are found <1200 m (Rozylowicz et al., 2011). The area is inhabited by an abundance of wildlife, including four of Europe's six large carnivores. The most recent population estimates state there are 6450–7200 brown bears (*Ursus arctos*), 2500–3000 gray wolves (*Canis lupus*), and 2100–2400 Eurasian lynx (*Lynx lynx*) in Romania (Kaczensky et al., 2024). Golden jackals (*Canis aureus*) have recently recolonized parts of Romania and are present in low numbers in the study area (Farkas et al., 2017). Other medium to large terrestrial mammals include red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), chamois (*Rupicapra rupicapra*), red fox (*Vulpes vulpes*), European wildcat (*Felis sylvestris*), European badger (*Meles meles*), pine marten (*Martes martes*), beech marten (*Martes foina*), and European hare (*Lepus europaeus*). Some large birds, such as the ground-dwelling western capercaillie (*Tetrao urogallus*) are also common in the study area.

The combination of abundant large carnivores and livestock leads to frequent human–wildlife interactions such as livestock predation, crop-raiding, and bear attacks on humans (Bombieri et al., 2019; Mertens & Promberger, 2001; Pop et al., 2023). Unlike many other European regions where large carnivores were extirpated,

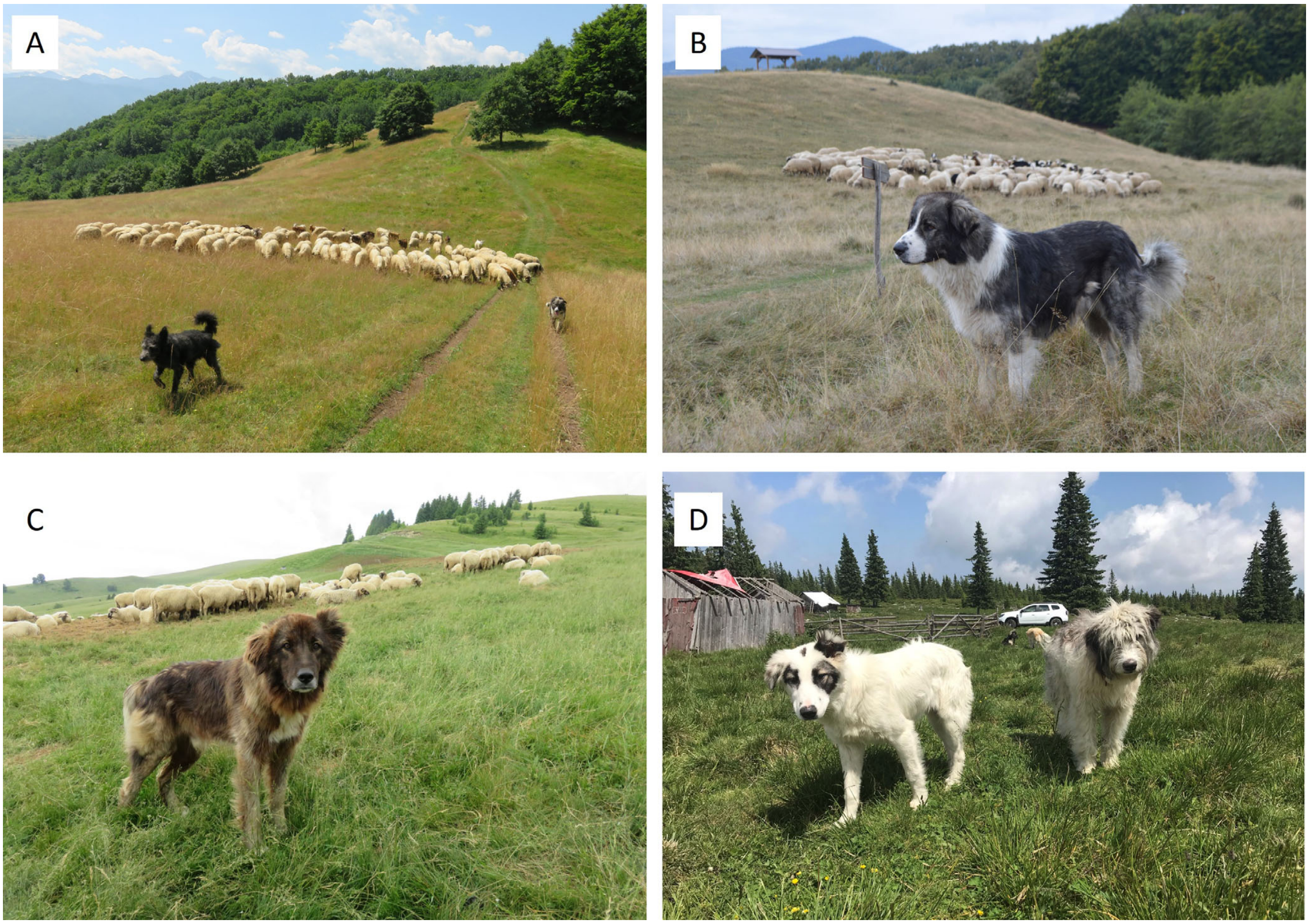

FIGURE 2 Examples of the different dogs in the study: (A) small black herding dogs that all shepherds use to herd livestock, (B) purebred Carpathian Shepherd livestock guarding dog, (C, D) examples of mixed-breed livestock guarding dogs. Photos (A) and (D) by Bethany Smith, (B) and (C) by Mircea Marginean.

Romania has maintained a continual presence of these species (Chapron et al., 2014). This has contributed to people coexisting relatively peacefully with large carnivores in Romania (Dorresteijn et al., 2014). However, there is growing concern that impacts will increase with increasing large carnivore numbers (Dorresteijn et al., 2016; Pop et al., 2023; Salvatori et al., 2020). Calls for managing bear and wolf populations are also growing, partly driven by frustration over strict hunting restrictions imposed when Romania joined the EU in 2007 (Dorresteijn et al., 2016; Popescu et al., 2019).

2.5 | Scat collection

As part of the wider research project, shepherds were visited at their summer sheepfolds between May and October 2021. During these visits, two to four people searched for dog scats opportunistically for a minimum of 30 min. As these visits had to align with other research activities, the sites were searched in different months and on a varying number of days from 1 to 4 days. The search was limited to the open pasture area around the sheepfold, approximately a 250 m buffer, on the assumption that LGD scats would be concentrated there. Searchers did not follow set, systematic transects but walked up and down self-selected tight lines in a grid formation while scanning the ground for scats to thoroughly cover the entire search area and increase the chance of finding scats.

Scats were deemed to be from domestic dogs based on: morphological features—tubular with rounded ends (Laguardia et al., 2015); odor—confusion species such as wolf and fox scats have characteristic odors that aid in their identification (Llaneza et al., 2014; Werhahn et al., 2019); location—next to the sheepfolds where it was assumed wolves would be unable to defecate due to the presence of LGDs; and content—where scats clearly contained polenta or wheat bran remnants, commonly fed to LGDs in Romania (Ivaşcu & Biro, 2020). As well as

LGDs, shepherds in Romania use smaller dogs that are not used to guard livestock but to herd and direct the sheep at the command of the shepherd (Figure 2). Thus, very small dog scats were not collected to ensure scats were from LGDs and not herding dogs. Though it is possible this excluded some scats from younger, smaller LGDs who might behave differently than older LGDs, there was little to no overlap in body size of the smallest LGDs and herding dogs, so it is unlikely that many of the discarded smaller scats were from LGDs. All scats determined to be from LGDs were collected. Scats were placed in plastic bags and stored in a freezer at −18°C until processing.

2.6 | Scat processing

Initially, frozen scats were washed in a washing machine as this has been shown to be a reliable and fast method for separating prey remains from scats (Orr et al., 2003). The first 60 scats were placed into separate sections of nylon stockings and washed at 60°C without detergent. Unfortunately, sharp bone fragments pierced the nylon stockings in the washing machine, resulting in the loss of three samples. To prevent further losses, the rest of the samples ($n = 72$) were washed by hand. Scats were left to thaw for at least 1 h, placed in separate nylon fabric bags, and then washed individually in a sink to remove any fecal matter. Highly calcified scats were either soaked in hot water or gently crushed to finer dust before washing by hand. The washed contents of the scats were then left to air dry.

2.7 | Scat contents identification

Scat contents were sorted into eight categories: polenta/wheat bran (typical dog food in the study region), vegetation, bones, teeth, hairs, insects, other biological material (e.g., feathers, claws, tusks, horns), and non-food items (e.g., plastic, food wrappers). Hairs were grouped by morphological characteristics and then identified to the lowest taxonomic order possible by observing their macroscopic and microscopic characteristics. Hairs were identified microscopically by comparing the medulla and cuticle patterns to reference keys (De Marinis & Asprea, 2006; Normandeau et al., 2018; Teerink, 2003; Tóth, 2017; Vaishnav et al., 2021) and the first author's personal reference collection. Hairs, or cuticle pattern imprints on clear nail varnish, were placed on microscope slides and observed at 10–40× magnification using a compound microscope (GXM-L1500BHTG microscope, GX microscopes, GT Vision Ltd., UK) with a microscopy camera attached (GX Cam HiChrome Met Camera, GT Vision Ltd., UK). Hairs were identified to species where possible but two broader groupings were used for Carnivora and micromammals (small rodents and insectivores approximately <500 g in body weight) to avoid misidentification at the species level. Other recognizable biological contents, such as bones, teeth, claws, hooves, and horns, were identified where possible. Vegetation, feathers, and insects were not identified beyond this broad classification.

The frequency of occurrence (FO)—the percentage of scats containing a particular food item or species—was then calculated. This metric is suited to dietary analysis where items occur relatively infrequently (Klare et al., 2011). The FO was defined as

$$\mathrm{FO} = n/N^{*}100,$$

where n is the number of occurrences of each food item and N is the total number of scats. A relative frequency of occurrence (RO) was also calculated for wildlife, defined as

$$\mathrm{RO} = n/T^{*}100,$$

where T is the total number of occurrences of all wildlife types in the samples (a summation of the individual n values for each wildlife category).

2.8 | Shepherd-reported LGD and wildlife behaviors

During one of the site visits for scat collection, shepherds were interviewed about their livestock and LGD husbandry practices, livestock losses, and interactions between their LGDs and wildlife. These interviews followed a semi-structured format, with a predefined set of questions (Table S1, Supporting Information) asked in the same order, while allowing for follow-up questions to clarify or elaborate on responses (DiCicco-Bloom & Crabtree, 2006). Topics included predator approaches to livestock, reported livestock losses, interactions between LGDs and wildlife, and shepherds' reactions to LGD–wildlife interactions.

All interviews were conducted in Romanian by two members of the Fauna & Flora team (M.M. and R.P.) who paraphrased and translated responses into English for the first author to record in shorthand. The interviews were not audio-recorded so there are no verbatim transcripts available. The initial purpose of these interviews was for the primary researcher to understand the overall context for LGD behaviors at each site. However, it was

TABLE 2 Summary of shepherd-reported LGD–wildlife interactions with target predators (TP) and non-target wildlife (NTW) as well as the self-reported shepherd reactions to these interactions.

	Reported LGD behaviors											
		Injure		Kill								
Site	Chase TP	Wolf	Bear	Wolf	Bear	Chase NTW	Kill/ injure NTW	Kill/injure NTW frequency	Consume NTW	Shepherds encourage chasing of NTW	LGDs ever injured by TP	LGDs ever killed by TP
AB01	✓	✓	✓	✓	–	✓ (vv, le, ce, cc)	✓ (vv)	Sometimes	–	×	–	✓
AB02	✓	–	–	–	–	✓ (vv, le, ce, cc)	×	Never	–	×	✓	✓
HD01	✓	×	×	×	×	✓ (vv, cc, ss)	×	Never	✓ (dead animals, inv)	✓	✓	–
HD02	✓	×	×	×	×	✓ (vv, ss)	✓ (vv, ss)	Sometimes	–	–	–	–
HD03	✓	×	×	×	×	✓ (vv, ss)	✓ (vv)	Sometimes	–	–	–	–
HD04	✓	×	×	×	×	✓ (vv, ce, fs, ss)	✓ (vv, fs)	–	✓ (vv, fs, inv)	✓	–	–
SB01	✓	×	×	×	×	✓ (cc)	×	Never	–	×	✓	✓
SB03	✓	×	×	×	×	✓ (vv, le, cc)	×	Never	–	×	–	–
SB04	✓	×	×	×	×	✓ (vv, le, cc)	✓* (vv)	Sometimes	–	✓	×	×
SB05	✓	×	×	×	×	✓ (vv, cc, ss)	×	Never	–	✓	–	–
SB06	✓	✓	×	✓	×	✓ (le, cc)	×	Never	–	×	–	–
SB07	✓	×	×	×	×	✓ (vv, cc)	×	Never	–	✓	–	–
SB08	✓	✓	✓	×	×	✓ (vv, cc, ss)	✓* (vv, cc, ss)	Sometimes	–	×	✓	×

Note: Non-target species named by shepherds as chased or killed/injured by LGDs are denoted in brackets by the initials of their scientific names: le—European hare (*Lepus europeaus*), vv—red fox (*Vulpes vulpes*), fs—European wildcat (*Felis silvestris*), ss—wild boar (*Sus scrofa*), cc—roe deer (*Capreolus capreolus*), ce—red deer (*Cervus elaphus*). Where shepherds said their LGDs ate insects, this is denoted by "inv" for invertebrates. Unknown information because it was not asked, not mentioned by the shepherd, or the answers were unclear, are denoted by a dash (–). Where LGDs were reported only to injure but not kill NTW, this is denoted with an asterisk (*). The origins of this coded information can be found in Supplementary Information.

later recognized that information from these interviews, while limited, could help contextualize the results of the scat analysis.

The interview notes were organized and then analyzed using thematic content analysis to systematically identify and categorize themes. First, shepherd-reported predator encounters and livestock losses were extracted and summarized (Table S2). Then, LGD–wildlife interactions were analyzed deductively (Bingham, 2023), with information coded into whether LGDs chased, injured, killed, or scavenged wildlife; the frequency of these behaviors; the species involved; and whether LGDs were injured or killed by target predators (Tables S3 and S4a). The occurrence of these interactions was coded as "yes," "no," or "unknown" and grouped into broader categories for target predators and non-target wildlife (Tables 2 and S4b). The frequency of LGD interactions with non-target wildlife was coded as "never," "sometimes" (e.g., described as "rare" or assigned a low quantitative estimate), "frequently" (e.g., described as "common" or "always"), or "unknown" if no information was provided. Because shepherds were not asked for exhaustive species lists, the reported species only reflect those voluntarily mentioned. If a species was reported as injured or killed by LGDs, it was assumed to have been chased as well.

Shepherd reactions to LGDs chasing non-target wildlife were analyzed inductively (Bingham, 2023), as responses to the question "If the dogs chase wildlife [other than target predators], do they undergo any additional training/reprimanding to correct these behaviors?" did not directly address training but rather whether shepherds encouraged or discouraged LGD chasing behavior (Table S4a). Initial coding categorized responses as "encourages LGDs to chase wildlife," "consistently calls LGDs back," or "sometimes calls LGDs back" (Table S4b). The latter two were grouped into a broader "does not encourage" category, based on the inference by the first author that calling LGDs back, even inconsistently, reflects a lack of active encouragement. This inference was supported by reasons provided by shepherds, such as concerns about wildlife mortality or a neutral stance of allowing LGDs to act independently. Coding categories were first established in discussion between two authors, assigned by the first author, and validated by a second author to ensure consistency.

Due to small sample sizes and the lack of interview transcripts, statistical analysis of the interview data in relation to the scat data was not possible. Instead, a qualitative comparative approach was used to assess patterns in the presence of vertebrate wildlife remains in scats relative to three key variables: (1) the number of LGDs at each site, (2) shepherd-reported LGD–wildlife interactions, and (3) shepherd-reported reactions to these interactions. Vertebrate wildlife remains were hypothesized to be present in scats from sites where more than two LGDs were used, where LGDs were reported to kill or scavenge wildlife, or where shepherds reported they encouraged their LGDs to chase non-target wildlife. The observed presence or absence of vertebrate wildlife remains in scats at each site was then classified as either consistent with or deviating from expectations. Agreement or mismatch between the expected and observed results was identified for each variable, with discrepancies explored for potential explanations.

3 | RESULTS

3.1 | LGD management

Eight shepherds used only mixed-breed guarding dogs, one used purebred Carpathian Shepherd dogs alone, and four used a combination of mixed-breed guarding dogs and Carpathian Shepherd dogs (Table 1). The number of LGDs ranged from 2 to 14 (mean: 7 ± 3.5 SD), which equated to a range of 0.25–4 LGDs per 100 sheep (mean: 1.75 ± 1 SD). Information about the LGD breeds, sexes, ages, and whether they were neutered at each site is provided in Table 1. None of the LGDs were enclosed overnight with the sheep or constrained in any way, meaning they were free to roam both during the day and night. Typically, shepherds used one herding dog alongside the LGDs, although the highest number at one location was 4 (Table 1). Provisioning of food varied between shepherds, although most fed their dogs polenta (cornmeal and water) and whey (the protein-rich liquid remains after making cheese) (Table 1). Other foods included commercially prepared dog food, livestock remains, and bread. All dogs were fed at the sheepfold either once in the morning or twice a day in the morning and evening (Table 1).

3.2 | LGD–wildlife interactions inferred from scat contents

In total, 132 scats were collected from 10 of the 13 sites; no scats were found at sites AB02, HD02, and SB03. The three samples lost during the washing process were from sites HD03 ($n = 1$) and SB05 ($n = 2$) leaving 129 scats that were analyzed.

Non-wildlife material found in scats comprised vegetation (frequency of occurrence FO = 97.7%), human-derived foods such as polenta, bran, and corn (FO = 41.9%), and non-food items (FO = 13.9%) (Table S5). Bones were found in 69% of the scats and

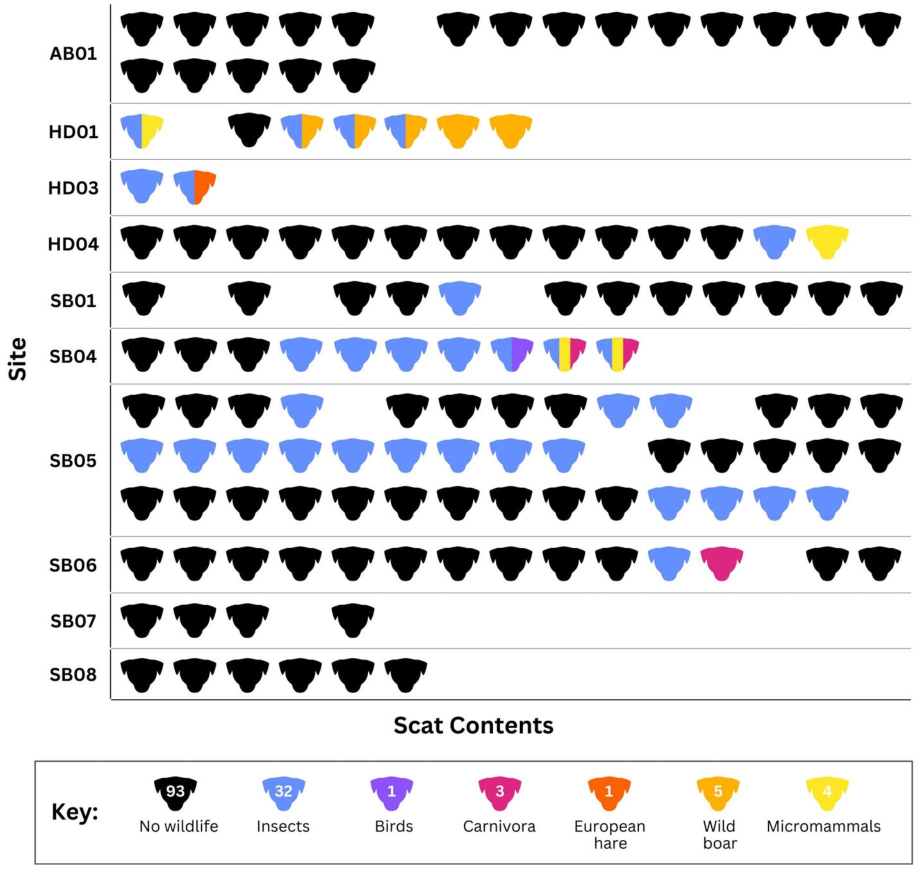

FIGURE 3 Number of scats analyzed from each collection day at each site and the type, if any, of wildlife remains found in each scat. Each dog symbol represents one scat and the color represents the type of wildlife found in that scat. Multicolored symbols represent that more than one wildlife type was found in that scat. The total number of occurrences of each type is given inside each symbol in the key. Reading from left to right and top to bottom, each new day of scat collection is defined by a space between symbols. For example, five scats were collected on the first day of sampling at site AB01, and 14 scats were collected on the second day.

comprised large, unidentifiable fragments. Unless accompanied by other identifiable remains such as wildlife hair or teeth, bone fragments were assumed to be livestock remains provisioned by shepherds. Other biological material (FO = 16.3%) included claws, a feather, eggshell fragments, and fragments of tusks, horns, and hooves. Shepherds were witnessed discarding eggshells on the ground; thus, due to a lack of accompanying feathers or bird bones, the eggshell fragments in the scats were assumed to be human-derived food as opposed to dogs raiding wild bird nests and consuming eggs. Teeth were found in five scats (FO = 3.9%) and identified as belonging to sheep ($n = 3$), wild boar ($n = 1$), and a member of the Carnivora family ($n = 1$). Hairs were found in all scats but one (FO = 99.2%) and identified as wildlife hairs in 11 of the scats.

Overall, there were 46 occurrences of wildlife remains across 27.9% of the scats from seven of the 10 sites (Figure 3). Insects accounted for most of the wildlife remains (FO = 24.8%, RO = 69.6%), with 75% of the scats containing wildlife comprising only insect fragments. Vertebrate wildlife remains were found at only five of the 10 sites where scats were collected. Of the vertebrate remains, mammals were most commonly found (FO = 8.5%, RO = 28.2%) with only one occurrence of bird remains (Figure 3). Two mammalian species could be identified—wild boar (FO = 3.9%, RO = 10.9%) and European hare (*Lepus europeaus*) (FO = 0.8%, RO = 2.2%). Wild boar remains were only found in scats from one site on one sampling day in October, and European hare remains were only found in one scat (Figure 3 and Table S6). Hairs grouped into the Carnivora category (FO = 2.3%, RO = 6.5%) likely belonged to red fox and members of the mustelid family, and those in the micromammal category (FO = 3.1%, RO = 8.7%) likely belonged to voles, mice, and shrews (Figures S1–S4). Micromammals occurred in four scats from three sites, and Carnivora occurred in three scats from two sites (Figure 3 and Table S6). One of the scats containing hairs identified as Carnivora was also the scat containing teeth identified as Carnivora, though a species-level identification was not possible.

3.3 | Shepherd reports of LGD–wildlife interactions

Attacks on livestock by gray wolves or brown bears were reported by all shepherds and occurred as frequently as 2–3 times a week, with losses of up to 15 sheep per season (Table S2). All of the shepherds said they encouraged their LGDs to chase away predators during attacks (Table S3). Four shepherds said they had only ever seen their LGDs barking at and chasing away predators, but the other nine mentioned rare cases of physical contact including fighting. Usually, the predators were reported to run away but some interactions resulted in them being injured or killed by LGDs (Table 2). Five shepherds also mentioned that their LGDs had been injured or killed by bears and wolves (Table 2).

All 13 shepherds reported that their LGDs chased non-target species—animals not responsible for livestock losses (Table 2). This was mostly reported to be in defense of territory as opposed to hunting with several shepherds stating their LGDs would chase any wildlife that entered the pasture (Table S4b). Non-target species reported to be chased by LGDs were roe deer, red fox, wild boar, European hare, red deer, and European wildcat (Table 2). Rarer, though still present, was the occurrence of LGDs injuring and killing non-target wildlife, which was reported by six shepherds (Table 2). Another shepherd said he had not witnessed his LGDs killing wildlife but that they did sometimes scavenge wildlife carcasses. Following informal conversations with shepherds outside of the interview process, the shepherd at AB01 was asked specifically during the interview whether his LGDs interacted with smaller animals. He responded that he had seen the LGDs searching for rodents on the pastures and that they probably ate rats and mice at the lower elevation pastures (Table S4a). Some insect material was noticed in the scats during collection, so the shepherds at HD01 and HD04 were asked about this. They reported that their LGDs ate insects and that it was a good source of protein, although this behavior was said to occur more frequently as puppies, as a form of play than for food.

The reactions of shepherds to their LGDs chasing non-target species were mixed (Table 2). Five shepherds said they encouraged their LGDs to chase non-target wildlife as they did not want other wildlife on the pasture. In particular, the shepherd at site SB07 said this was because other wildlife might bring pathogens and the dogs would only run for 100–200 m without catching any animals. In contrast, three shepherds seemingly discouraged the chasing of non-target wildlife, saying they called the LGDs back either because they liked wildlife or were concerned the LGDs would run too far away. Three of the shepherds were more passive in their reactions, stating they only sometimes called the dogs back when they were chasing wildlife. Two shepherds answered the original question, confirming they used corrective training or reprimands if their LGDs chased wildlife. Although this could be inferred as the shepherds not encouraging their LGDs to chase wildlife, their reactions are categorized as "Unknown" (Table 2) due to a lack of detail in their answers.

3.4 | Comparison of LGD behavior and management to scat contents

There was little evidence in support of the first hypothesis that wildlife would more frequently occur in LGD scats from sites where higher numbers of LGDs were used. Scats containing wildlife remains originated from packs of LGDs comprised of two, five, and seven dogs, and no vertebrate wildlife remains were found in the scats collected at the three sites with the most LGDs—sites SB01, SB08, and SB07 with—14, 10, and 8 LGDs, respectively (Table 3).

Support for the second hypothesis that there would be more wildlife remains in LGD scats from sites where shepherds reported their LGDs to kill or scavenge wildlife was variable. There was concurrence between shepherd-reported behaviors and the scat results at seven sites and a mismatch at three (Table 3). Wildlife remains were found in the scats from three of the four sites where this was expected based on reported LGD behaviors, but there were also vertebrate wildlife remains found in scats from two sites where shepherds reported their LGDs did not scavenge or kill wildlife.

There was some limited support for the third hypothesis as occurrence of wildlife remains in the scats somewhat aligned with self-reported shepherd reactions to their LGDs chasing wildlife (Table 3). For the nine sites where it was possible to make a comparison, vertebrate wildlife remains were found in scats from three of the five sites where shepherds actively encouraged their LGDs to chase wildlife (HD01, HD04, and SB04) and in only one of the four sites (SB06) where shepherds did not actively encourage their LGDs to chase wildlife. However, the authors acknowledge that the shepherd-reported reactions to LGD–wildlife interactions were derived from responses to a question not directly relating to this, so while insightful, they should be interpreted with caution.

No formal comparison was made between LGD provisioned diets and scat contents as there was not enough information about the quality or quantity of food provided to the LGDs. However, it was noted that a

TABLE 3 Expected versus observed vertebrate wildlife remains in scats based on the number of livestock guarding dogs (LGDs) at each site, whether shepherds reported these LGDs to kill or scavenge wildlife, and whether shepherds reported that they encouraged their LGDs to chase wildlife or not.

	Hypothesis 1			Hypothesis 2				Hypothesis 3		
				Reported LGD behaviors						
Site	No. of LGDs	Expected wildlife in scats	Observed wildlife in scats	Kill	Scavenge	Expected wildlife in scats	Observed wildlife in scats	Shepherd reaction to LGDs chasing wildlife	Expected wildlife in scats	Observed wildlife in scats
AB01	6	✔	✖	✔	–	✔	✖	Does not encourage	×	✖
AB02	2	×	NA	×	–	×	NA	Does not encourage*	×	NA
HD01	7	✔	✓	×	✔	✔	✓	Encourages	✔	✓
HD02	7	✔	NA	✔	–	✔	NA	NA	NA	NA
HD03	5	✔	✓	✔	–	✔	✓	NA	NA	✔
HD04	5	✔	✓	✔	✔	✔	✓	Encourages	✔	✓
SB01	14	✔	✖	×	–	×	✖	Does not encourage*	×	✖
SB03	5	✔	NA	×	–	×	NA	Does not encourage	×	NA
SB04	2	×	✓	×	–	×	✓	Encourages	✔	✓
SB05	6	✔	✖	×	–	×	✖	Encourages	✔	✖
SB06	5	✔	✓	×	–	×	✓	Does not encourage	×	✓
SB07	8	✔	✖	×	–	×	✖	Encourages	✔	✖
SB08	10	✔	✖	×	–	×	✖	Does not encourage*	×	✖

Note: Agreement between the expected and observed presence of vertebrate wildlife in scats is shown in orange in the observed column for each hypothesis, disagreement is shown in blue. Gray cells are where a comparison could not be made due to missing data. Where the shepherd reaction is categorized as "Does not encourage*" with the asterisk, these are instances of where shepherds said they sometimes called their LGDs back, but not consistently.

considerable proportion of the wildlife remains in the scats originated from one site where the LGDs were primarily fed bread (SB04). Though it should be noted that wildlife was also found in scats from LGDs that were fed an array of foods including polenta, dog food, and livestock remains.

4 | DISCUSSION

This study is one of very few assessments of LGD–wildlife interactions using both scat analyses and shepherd knowledge, and provides the first assessment of LGD behaviors in Romania where LGDs are used as part of a transhumance grazing system. We found no support for the hypothesis that higher numbers of LGDs led to more wildlife remains in scats. Evidence was mixed for a link with reported LGD–wildlife interactions, but there was stronger anecdotal support for a link between wildlife remains in scats and shepherds encouraging such behaviors. The conservation and management implications of these findings are discussed below with recommendations for future research.

4.1 | Conservation implications

With the exception of LGDs chasing away bears and wolves, as might be expected from their role as livestock guardians, antagonistic interactions between LGDs and wildlife did not appear to be common from this study. Shepherds reported that LGDs killed target and non-target wildlife only on rare occasions. The willingness of some shepherds to openly report instances of LGDs killing or chasing wildlife suggests that the Fauna & Flora programme has successfully established a strong level of trust, thus enhancing the reliability of the shepherd reports on dog behaviors. These reports were

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corroborated by the low frequency of occurrence (FO) of wildlife remains in LGD scats, which were similar to those from another recent study on LGD diets in South Africa (Drouilly et al., 2020). Determining high or low FO of wildlife in LGD scats is somewhat subjective, but the values in this study were lower than in some other studies of free-ranging domestic dogs, which report FO values over 50% for wild mammals (Carrasco-Román et al., 2021; Sogliani et al., 2023). Similarly, the scats containing vertebrate remains could have originated from between five to 12 LGDs (7%–18% of the LGDs in this study), which is lower than a recent study on Romanian feral dogs that found wildlife remains in the stomach contents of 29% of the dogs (Dănilă et al., 2023). The lower frequency of wildlife consumption by LGDs compared to other free-ranging dogs may be attributed to their daily feeding by shepherds, reducing their reliance on wildlife, and to reports from some shepherds in this study that they actively discourage their dogs from chasing or killing wildlife.

The most common mammalian category found in this study was wild boar, occurring in only 4% of the scats, all collected from the same site on the same day. Thus, the wild boar remains likely originated from only one individual wild boar being consumed and could have been scavenged; especially as the wild boar remains were in scats from site HD01 where the shepherd reported that the dogs did not kill wildlife, but consumed wildlife carcasses. Some of the shepherds in this study did report that their LGDs chased wild boars, and one reported their LGDs killed wild boars; a behavior that has also been reported elsewhere in Romania (Figure S5) and in other countries (Caporioni et al., 2005; Nayeri et al., 2022; Rigg, 2004; Sogliani et al., 2023). However, there were also likely to have been wild boar carcasses in the study area due to hunting and recent outbreaks of African swine fever (Boklund et al., 2020; Sauter-Louis et al., 2021). Indeed, any of the wildlife remains found in the scats could have originated from scavenging as one shepherd had witnessed his LGDs eating wildlife carcasses, and previous studies have documented domestic dogs as effective scavengers (Butler & du Toit, 2002; Martinez et al., 2013; Selva et al., 2005). Clearing animal remains from pastures could even be considered an additional function of LGDs, helping to prevent the attraction of predators to the area. There are few studies directly and purposefully reporting on LGD–wildlife interactions; hence, these findings lend support to existing evidence that LGDs can be used as a conservation tool without substantial negative effects on wildlife, namely in the study area and similar contexts.

However, some of the LGD–wildlife interactions found in this study are still of concern. First, insect remains were found in 25% of the scats; a much higher frequency than reported in other studies analyzing dog scats (e.g., Drouilly et al., 2020 [2.3% FO]; Carrasco-Román et al., 2021 [1.5% FO]; Sogliani et al., 2023 [12.8% FO]). It is possible that some coprophagous insects were inside the scats at collection and were not actually consumed by the LGDs. However, although the insect material was not rigorously quantified or identified to any lower taxonomic grouping, much of it appeared to be Orthoptera in origin (Figure S6). The LGDs in this study were observed consuming grass and vegetation, so they could have consumed insects passively rather than actively; but with a quarter of scats containing insects, future studies should investigate the amount of insect biomass consumed on agricultural pastures by LGDs and whether there are any potential ecological knock-on effects or impacts on threatened invertebrate species.

Furthermore, the chasing of wildlife reported by all the shepherds in this study could disrupt normal behaviors and have ecological knock-on effects at different trophic levels (Smith et al., 2020; Suraci et al., 2016). Being chased by LGDs could also compromise the individual welfare of the animals pursued (Allen et al., 2019). It is also possible that scat analysis underestimates how frequently LGDs kill wildlife if carcasses are not consumed. Only one shepherd explicitly said he had witnessed his LGDs consuming the wildlife that the LGDs had killed. This behavior could be typical of domestic dogs as they have an instinctive prey drive to chase animals without necessarily eating them. For example, Martinez et al. (2013) found that over half of the free-ranging dogs in their study did not consume their wildlife kills, and Home et al. (2017) found that only 36% of killed wildlife were then consumed by free-ranging dogs in India. These numbers could be greater for LGDs as they are tasked with the protection of livestock, so killing wildlife in defense of livestock may not be associated with consumption of the carcass, as previously documented for LGDs in Botswana (Potgieter et al., 2013).

While it is not possible to determine whether wildlife in the scats in this study were predated or scavenged, both have important ecological and social impacts. Predation can directly affect prey population numbers, as well as induce morphological, physiological, or behavioral adaptations in prey animals (Say-Sallaz et al., 2019), which can lead to cascading effects in ecosystems (Ripple et al., 2014; Suraci et al., 2016). Predation of wildlife by LGDs could also exacerbate human–human conflicts, as is the case in Romania where tensions arise between game managers and shepherds due to the former claiming that LGDs predate game species (Ivaşcu & Rakosy, 2017). Where dogs act as kleptoparasites feeding on the kills of other predators, or scavenge wildlife carcasses, they compete with other scavengers for food resources and potentially alter scavenger community structures that have important ecological roles (Beasley et al., 2015; Landry et al., 2020). Scavenging of wildlife carcasses by LGDs could also be a public health concern with the increased potential for pathogen transmission between wildlife and dogs, which are then in close proximity to livestock and humans (Costanzi et al., 2021; Davitt et al., 2024). Therefore, given the finding of wildlife in the diets of LGDs, it is important that future studies quantify predation versus scavenging. This could be attempted with extensive observations of LGDs in the field, camera traps positioned at known carcasses near agricultural pastures, or with the attachment of animal-borne video cameras to LGDs.

4.2 | Management implications

There was no apparent difference in the frequency of wildlife remains found in LGD scats between sites with low versus high LGDs per site. This is particularly pertinent in Romania, where shepherds use an average of five to eight LGDs per livestock flock (Ivaşcu & Biro, 2020). It is believed that using more LGDs improves LGD efficacy of protecting livestock from frequent predator attacks, especially when defending against social animals like wolves that are said to employ "decoy tactics" to draw LGDs away from livestock (Table S3) (Ivaşcu & Biro, 2020). Indeed, another study of LGD–wolf interactions in a similar landscape on French alpine pastures recommended that more than six LGDs be used per flock to improve protection against wolf attacks (Landry et al., 2020). Furthermore, bears pose a risk to the life of the shepherds (Bombieri et al., 2019), not just the livestock, so shepherds often say they feel safer in the mountains when accompanied by more LGDs (personal communication) as LGDs are useful at deterring bears from humans even when livestock are not present (Young & Sarmento, 2024). This study helps to establish that higher numbers of LGDs can be used to help shepherds tend their livestock peacefully without necessarily increasing the impacts that these dogs have on co-occurring wildlife. In addition, this finding might help alleviate some human–human conflicts between game managers and shepherds, as game species (roe deer, red deer, and wild boar) were seldom found in scats and their occurrence was not related to the numbers of LGDs being used. However, it should be noted that using high numbers of LGDs can pose other problems and the optimum number of LGDs for effective livestock protection is likely to vary between sites.

The occurrence of wildlife in the scats somewhat aligned with self-reported shepherd behaviors. This finding is similar to the study on LGD diets in South Africa that found that the occurrence of birds, reptiles, and wild mammals in LGD scats tended to be higher when LGDs were accompanied by a human (Drouilly et al., 2020). Thus, it is possible that LGD behaviors towards different species are driven by human attitudes towards wildlife and that more efforts to understand shepherd behaviors and co-develop solutions could help with mitigating LGD behaviors deemed undesirable from a wildlife conservation or welfare perspective. However, the reactions of shepherds to their LGDs chasing non-target wildlife were based on interviews that were not recorded or transcribed. Consequently, these results should be treated with caution and regarded only as a prompt for more rigorous investigation in this area. Training could also be provided to LGDs exhibiting undesirable interactions with wildlife, as this has previously shown some success with correcting LGD behaviors (Whitehouse-Tedd et al., 2020). Furthermore, a considerable proportion of the wildlife remains in the scats originated from one site where the LGDs were primarily fed bread. Dogs provided with nutritionally inadequate food might need to supplement their diet to meet their energetic and nutritional requirements and thus be associated with increased wildlife predation and scavenging (Merz et al., 2022; Sepúlveda et al., 2014; Silva-Rodríguez & Sieving, 2011), but this remains to be rigorously tested. However, if the consumption of wildlife by LGDs is linked to their provisioned diet, then this could be altered to hopefully reduce predation and scavenging.

4.3 | Future research

While the results of this study suggest low levels of wildlife consumption by LGDs, the sample size was limited and constrained to the summer season. The faunal composition is likely to differ around pastures at different elevations; hence, future studies analyzing greater quantities of scats from both the summer and winter pastures could provide a more holistic view of the year-round impacts of LGDs. Connected to this, data on the faunal composition at each site during the summer was not available, and field collection of such data was not possible in this project. However, factors such as the diversity and density of wildlife, alongside the landscape characteristics at each site, inevitably influence the frequency of LGD–wildlife interactions. Other variables, including livestock predation rates, an LGD's prior experiences with predators, and their attentiveness to the flock, may also affect the frequency and outcome of these interactions, as well as shepherds' reactions to them. Assessing these factors was beyond the scope of this study, but all present important avenues for future research.

With regards to the scat analysis, some smaller items such as micromammal hairs might have been missed through using traditional scat analysis methods (Gosselin et al., 2017; Klare et al., 2011). Fecal DNA metabarcoding (high-throughput sequencing to amplify and identify DNA assemblages in scats) could be employed in future studies as this can sometimes provide better estimates of dietary composition (Gosselin et al., 2017; Oja et al., 2017; Shores et al., 2015). Another alternative is stable isotope analysis, which has previously been used to assess domestic dog diets by analyzing the stable carbon and nitrogen composition in whiskers (Canales-Cerro et al., 2022; Wilson-Aggarwal et al., 2021). A key advantage of both stable isotope and fecal DNA analysis is the ability to link specific whiskers or scats to individual LGDs, enabling direct correspondence between diet and specific dogs. This would allow researchers to assess individual variation in dietary habits and better understand potential LGD–wildlife interactions. Integrating individual diets with GPS tracking would further deepen insights into spatial movements and behavioral patterns, thus helping to assess more precisely the extent and causes of LGD impacts on wildlife. Furthermore, employing more rigorous mixed-methods approaches that integrate the lived experiences of shepherds with ecological studies would enhance the collective understanding of working landscapes and support the co-development of effective LGD management and mitigation measures.

AUTHOR CONTRIBUTIONS

Conceptualization: B.R.S., K.W.T., R.W.Y., and A.U. *Methodology*: B.R.S., K.W.T., R.W.Y., A.U., and I.-T. *Investigation*: B.R.S., M.M., A.M., and R.P. *Data curation*: B.R.S. *Project administration*: B.R.S., K.W.T., R.W.Y., A.U., I.T., and M.M. *Supervision*: K.W.T., R.W.Y., A.U., and I.T. *Visualization*: B.R.S. *Writing – original draft*: B.R.S. *Writing – review & editing*: K.W.T., R.W.Y., A.U., I.T., M.M., R.P., and A.M.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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