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From Wild to Watchful: Integrating BLM Donkeys (Burros) for Sheep Ranch Protection

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Summary

The historical challenge of protecting sheep from predation has often been addressed through non-lethal measures, notably the employment of Livestock Guardian Animals (LGAs). Among LGAs, donkeys have been underutilized and understudied compared to other protection animals such as dogs. This study evaluated the effectiveness of using feral Bureau of Land Management (BLM) burros (henceforth referred to as donkeys) as LGAs focusing on their acclimation and integration into sheep flocks. Four donkeys were adopted in October 2023 and observed for integration success in spatially separate pastures and their corresponding cohort of ewes (without lambs). The integration timeline varied, with a notable polynomial quadratic relationship between time and distance to the nearest sheep ($P < 0.001$; $R^2 = 0.45$), indicating approximately 5 weeks for full integration across subjects. Individual differences were pronounced; one donkey integrated without intervention, while another required relocation to a simpler environment for successful integration. Sheep did not display high or different levels of vigilance ($\bar{x} = 2.2\% \pm 1.4$ of observations; $P = 0.192$) but donkeys did display high levels of vigilance (ranged from 9.1% to 47.2% [$\bar{x} = 25.7\% \pm 9.3$)] with significant inter-individual variation between donkeys ($P = 0.019$). Challenges in the acclimation and integration of donkeys as LGAs often arose from overly large and complex pasture environments, as well as the presence of distracting equine neighbors. Nevertheless, with meticulous management of pasture size and complexity, we successfully integrated naive BLM donkeys with sheep flocks in a timeframe of less than six weeks. This process underscores the importance of environmental considerations in the effective utilization of donkeys as non-lethal deterrents against predation.

Key Words: *Equus asinus*, Livestock Guardians, Loss, Mortality, Predators, Vigilance

Abbreviations: BLM, Bureau of Land Management; LGA, Livestock Guardian Animal

Introduction

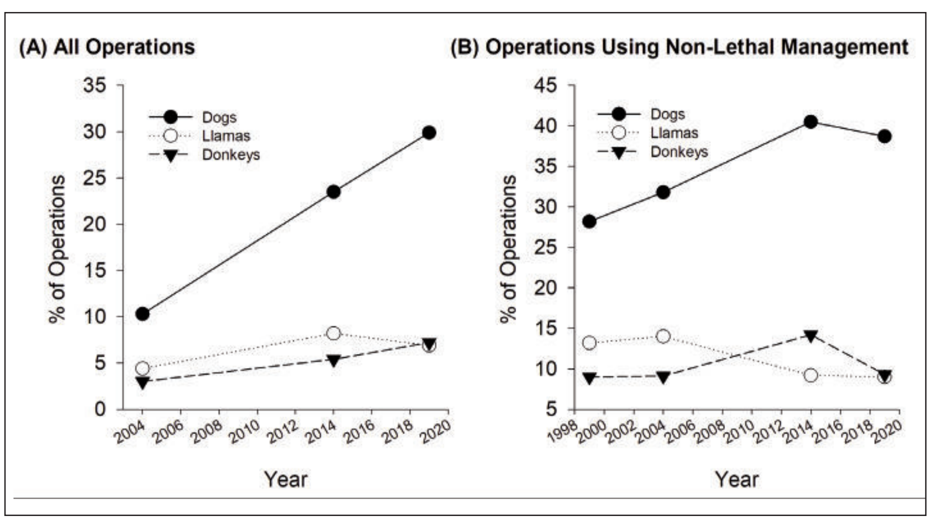
Sheep predation has been a persistent global issue since antiquity, with documented efforts to protect these animals dating back to around 1000 BC, as illustrated by biblical accounts. This problem continues to affect modern sheep production, both intensive and extensive, leading to significant economic impacts (Muhly and Musiani 2009; Mattiello et al. 2012; Scasta et al. 2018). For instance, in 2019, the western United States (AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY), experienced sheep losses valued at approximately $121.6 million with predation accounting for a considerable portion of both adult sheep (32.6%) and lamb mortality (40.1%), predominantly by canids such as coyotes and dogs (APHIS 2020; Western Livestock Journal 2022).

Given the ongoing challenge of predation on sheep and goats, it is crucial to explore various mitigation strategies. These strategies are broadly separated into lethal and non-lethal options. Lethal options include trapping, snaring, and shooting. Non-lethal options include fencing, herding, night-penning, lambing in a shed, repellents and fright tactics, removing carrion, culling older sheep, changing bedding grounds, frequent checks, changing breeding and lambing timing, and Livestock Guardian Animals or LGAs (Shivik 2004; APHIS 2020). The shift towards non-lethal methods has been notable, with their usage increasing significantly among sheep operations from 58% in 2014, to 77.1% in 2019 (APHIS 2020). Among these, LGAs have emerged as a promising solution, with a historical precedent and archaeological evidence supporting their effectiveness, particularly dogs (Smith et al. 2000; Urbigkit and Urbigkit 2010; Scasta et al. 2017). The use of LGAs may also be of increasing interest due to various prohibitions on lethal control including regulatory, legislative, and social including such provisions as the Endangered Species Act.

In the context of non-lethal methods for protecting sheep and goats from predators, LGAs such as dogs, llamas, and donkeys have been employed with varying degrees of adoption (Andelt 2004). Dogs have historically been the most commonly used LGA, with their usage in the United States increasing from 28.2% in 1999 to 38.7% in 2019 (Figure 1). Llamas and donkeys, while less common, have also played significant roles in predator deterrence. The use of llamas fluctuated slightly, peaking at 14.0% in 2004 before dropping to 9.0% in 2019, whereas donkeys saw an increase from 9.0% in 1999 to 14.2% in 2014, stabilizing at 9.3% in 2019, see Figure 1 (Walton and Field 1989; APHIS 2020). Internationally, donkeys have been utilized as LGAs in diverse regions including Australia, Brazil, Canada, Mexico, Namibia (cattle specifically; see Marker et al. 2005), Switzerland, the United States, and Uruguay, demonstrating their global relevance. (Landry et al. 1999; Jenkins and Noad 2003; Bough 2016; Rodrigues et al. 2021). Notably, their successful adoption by Australian ranchers to combat wild dog predation suggests potential lessons for similar challenges in the western US (Bough 2016). While some countries like Germany and Norway have recommended, rather than reported, the explicit use of donkeys as LGAs (Linnell et al. 1996; Reinhardt et al. 2012), historical evidence by Pitt (1988) stated "numerous engravings and pastoral stories, the donkey is found in the middle of the sheep" and contemporary evidence underscores their effectiveness, particularly their innate aversion to canids (Walton and Field 1989; Landry 1999; Smith et al. 2000).

However, there is generally scant information about donkeys as LGAs (Walton and Field 1989; Smith et al. 2000) and according to Bough (2016) "There has been no systematic research into guardian donkeys and how they operate". Very specifically we note there is limited to no empirical information about the acclimation of feral BLM donkeys to sheep as potential LGAs, including the potential factors that could hinder bonding and integration. Despite being rated less effective than dogs and llamas (Andelt 2004), donkeys present unique advantages as LGAs. These advantages include a lower initial purchase price, lesser upkeep compared to dogs, suitability to existing fencing and handling facilities, and similar forage-based dietary composition to the livestock they protect (Walton and Field 1989). Disadvantages include anecdotal reports or difficulty managing obesity and trimming feet. Their ability to coexist with standard farm practices, coupled with a long working life and minimal supervision requirements, positions them as a viable option for predator control (Wilbanks 1995; Smith et al. 2000; Jenkins and Noad 2003). However, the literature reveals a notable gap in systematic research on donkeys' effectiveness and operational dynamics as LGAs, particularly regarding their acclimation and integration with sheep flocks (Walton and Field 1989; Smith et al 2000; Jenkins

Figure 1. Sheep operation use of dogs, llamas, and donkeys as Livestock Guardian Animals (LGAs) for (A) all operations and (B) operations using non-lethal management. Data from the United State Department of Agriculture – Animal and Plant Health Inspection Service (USDA – APHIS) – Sheep Death Loss in the United States 2020.



and Noad 2003; Bough 2016). Wilbanks (1995) stated "Because individual differences in guarding abilities exist among donkeys, management practices may need to be tailored to capitalize on the particular qualities of a donkey".

This study aimed to fill this void by examining the adaptation process of feral Bureau of Land Management (BLM) donkeys to sheep flocks in Wyoming, USA, considering their individual variability and potential in predator deterrence. The study objectives were to explore acclimation and integration processes to better understand how these donkeys can be effectively integrated into livestock protection strategies, acknowledging the nuanced and variable nature of their guardian abilities.

Given the potential advantages in some situations of donkeys over dogs, and the reported adoption of BLM donkeys for use as LGAs, and limited systematic research on the topic, we sought to develop quantitative information about how BLM donkeys acclimate and integrate to sheep flocks in Wyoming, USA. Regarding the concept of acclimation and integration and in the context of this manuscript, we refer to the definitions by the Cambridge dictionary whereas ***acclimation*** is defined as *"the process of changing to suit different conditions of life, weather, etc., or the act of making someone or something do this"* and whereas ***integration*** is defined as *"the action of process of successfully joining or mixing with a different group…"*.

Figure 2. Individual donkeys and identification numbers acquired by the University of Wyoming from the Bureau of Land Management in 2023.

Methods

All animals and property where this project was conducted are owned and operated by the University of Wyoming–Agricultural Experiment Station (AES) at 2,195 m elevation near Laramie, Wyoming at the Laramie Research and Extension Center (LREC). The pastures used in this study included irrigated hay meadows dominated by exotic grasses and native rangeland dominated by native grasses and shrubs. The commercial western white-face sheep used in the demonstration research were mixed age ewes 1 to 6 yrs of age managed in four separate grazing management cohorts. In early October 2023, LREC acquired four female BLM donkeys (originating from California and straight off the range other than general sorting, processing, and transport according to our knowledge of their history), including three yearlings and one aged four years, each assigned a distinct numerical identifier (Refer to Figure 2 for Donkey Identifications: 7100, 7107, 6891, and 7092). These donkeys were individually introduced to separate flocks and pastures, and their interactions were monitored over a 43-day period from October 2, 2023, to November 13, 2023. Observations of ~5 minutes were made daily, either in the morning or mid-afternoon during active grazing periods, to visually estimate the proximity of each donkey to the sheep using a combination of a Bushnell Prime 1300 laser range finder, Vortex 15 × 56 mm Diamondback® HD binoculars, and the Google Earth measure tool. During these observations, the activities of the sheep and donkeys were qualitatively assessed, along with the donkey's relative position to the flock, categorized as 'in', 'near', or 'away' (as described in Figure 3). Subsequent spot checks continued daily until the end of the 2023 calendar year to monitor if the donkeys remained with the flocks or if any issues arose. All animal care and use complied with the guidelines outlined in the "Guide for the Care and Use of Agricultural Animals in Research and Teaching" (McGlone 2010).

To analyze the operational acclimation and integration of the four donkeys to unique flocks and pastures, polynomial regression analysis was employed using a quadratic trendline to model the number of days since donkeys introduction (x) to predict mean distance of all four donkeys to the nearest sheep (y). This analysis was performed with all donkey-flock pairs in a single model using SigmaPlot version 12.3. The variability among these pairings was further explored by detailing pasture and flock sizes, pasture complexity, and any necessary adjustments. Additionally, a daily binary indicator (0 or 1) reflecting each donkey's association with its flock (cate-

Figure 3. Qualitative assessment of burro proximity to the flock relative to general distance, awareness, and behavior used in assessing burro acclimation and fidelity as (A) 'in', (B) 'near', or (C) 'away' from sheep in Laramie, WY, USA.

(A) 'IN': Burro is 'in' the flock actively grazing and behaving similar to the sheep. In this example, the burro is grazing within the flock and often within <10 meters of individual sheep and moves within the flock.

(B) 'NEAR': Burro is 'near' the flock where it is aware of the presence of sheep and generally is moving through the landscape with the flock. In this example, the burro is often within 10 to 30 meters of the sheep and remains within that distance but on the perimeter.

(C) 'AWAY': Burro is 'away' from the flock where it is oblivious to the sheep and is moving through the landscape independent of the flock. In this example, the burro is often >100 meters from the flock and may be paying particular attention to other influences like other equids nearby.

gorized as 'in', 'near', or 'away') was established, and a Wilcoxon signed-rank test was applied for pairwise comparisons among the donkeys based on their proximity to the flock using JASP version 13.1 (Love et al. 2019). The results were then represented as stacked bar charts for each donkey. Finally, behavioral observations of both sheep and donkeys were classified as either 'non-vigilant' (including activities such as grazing, resting, and drinking) or 'vigilant' (including standing, walking, and vocal socialization, such as braying at donkeys in other pastures). The frequency of these behaviors was calculated and subjected to an arcsine transformation to satisfy normality assumptions. One-sample and paired-sample t-tests were then applied to examine the behavioral variations within and between donkeys and flocks, respectively, regarding vigilant and non-vigilant behaviors, using JASP version 13.1 for statistical analysis (Love et al. 2019).

Results and Discussion

Generalizable Integration Dynamics for all Four Donkeys

There was considerable variation among the donkeys regarding their proximity to the nearest sheep (Figure 4A). When assessing the operation-level acclimation and integration based on distance to the nearest sheep, it took approximately five weeks for all four donkeys to fully integrate with the sheep (Figure 4B). The data displayed a significant and correlated (*$P < 0.001$*; R2 = 0.45; Figure 4B) polynomial quadratic response (y = -0.3523x2 + 9.3x + 135.5), showing an initial increase in distance within the first two weeks followed by a rapid decrease between weeks 2 and 5 (Figure 4B). By the end of week 4, the mean distance to the nearest sheep for the operation was consistently less than 50 meters, with the quadratic trendline crossing zero around day 38 (Figure 4B). This aligns with the timeframe reported by Green (1989) of 4-6 weeks for a naive donkey to bond with sheep. Subsequent spot checks until the end of December 2023 confirmed the donkeys' continued affinity to be in or near the sheep, even amidst pasture changes and flock mixings.

Individual Variability and Responses

Immediate Integration: Donkey 7092

This yearling jenny bonded immediately upon introduction to the flock with no intervention, displaying consistent proximity to the sheep throughout the study period (Figure 4A). This donkey exhibited high fidelity to the flock, remaining in or near it during over 90% of observations (Figure 5). Noteworthy to Donkey 7092 was the 17 acre pasture and the flock of 102 mature ewes with a sheep density of 6.0 sheep per acre, which was the highest density of all flock-pasture combinations. There was no other equine sharing the fence line in this pasture but there was one donkey across the road to the north. On average this donkey was 7 m from the nearest sheep and never measured more than 30 m from the nearest sheep (Figure 4A).

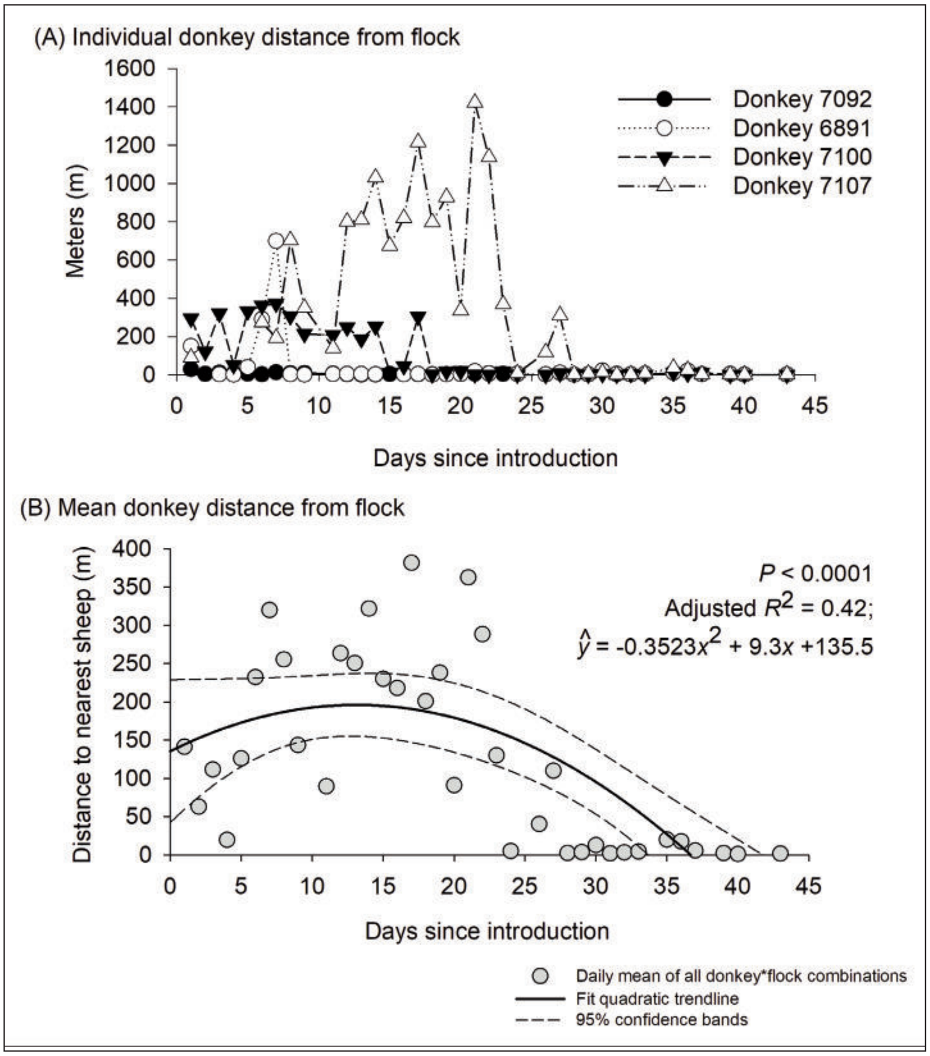
Took Time (Concern with Donkey Across the Road): Donkey 7100

This yearling jenny initially struggled to bond with the flock due to fixation on another donkey (7092 described above) across the road (an issue reported by Green 1989) (Figure 4A). She was placed in a 55 acre pasture with 105 yearling ewes yielding a sheep density of 1.9 sheep per acre which was the second highest density of all flock-pasture combinations. It took approximately two weeks (16 days) for this donkey to integrate fully, with subsequent high fidelity to the flock, albeit with occasional periods away during the initial period of introduction but never more than 20 m away (Figure 4A). Still, on average this donkey was 101 m from the nearest sheep; yet during the early period, one observation was found 372 m 'away' (Figure 4A). During the study period, this donkey was 'away' from the flock 38% of observations and was found 'in' or 'near' the flock 51% and 11% of observations respectively (Figure 5).

Too Many Equine Neighbors (Intervention Needed): Donkey 6891

This yearling jenny was placed in a 102 acre pasture with 114 ewes yielding a sheep density of 1.1 sheep per acre which was the third highest density of all flock-pasture combinations. This pasture created a difficult scenario for this donkey due to the presence of 16 horses in the pasture to the northeast and 15 horses in the pasture to the south. The equine manager recognized the social challenges for this donkey and used a hobbling treatment overnight (1 night) in the pen with sheep, side hobbling, and penning again with the flock prior to turn out and herding together. Within 1 week, the donkey integrated with the sheep and was no longer distracted by

Figure 4. (A) Individual donkey distance from flock and (B) mean of all donkeys (n = 4) distance to flock as an indication of operational mean time to integration across all four donkeys.



the equine neighbors across the fence. On average, this donkey was 39 m from the nearest sheep, but early observations found the donkey 700 m away before interventions (Figure 4A). However, once the donkey bonded after interventions it was never found more than 25 m away from the nearest sheep (Figure 4A). This donkey was recorded 'in' or 'near' the flock for more than 90% of observations and only 9% of observations during the study period found the donkey 'away' from the flock (Figure 5).

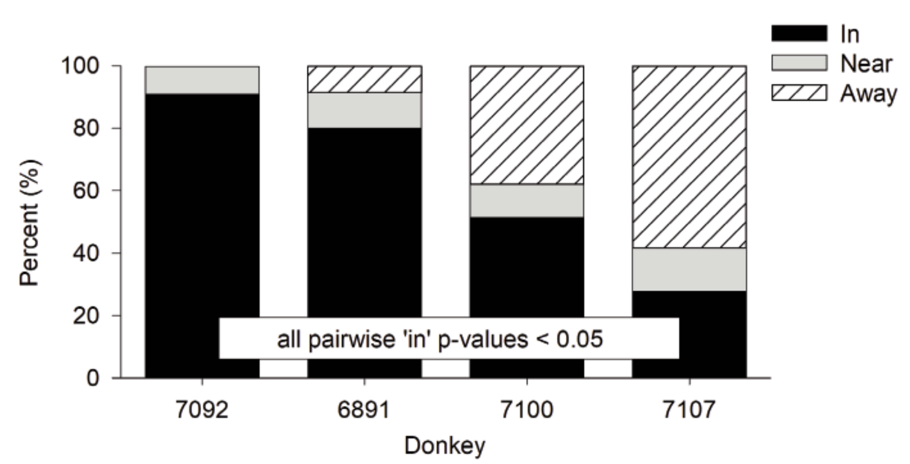
Pasture Too Big and Complex: Donkey 7107

This 4 year old jenny was placed in a 779 acre pasture with 50 mature ewes yielding the lowest sheep density of all flock-pasture combinations at 0.1 sheep per acre. In addition to the vast size of the pasture and the lower density of sheep, complexities within this pasture included: two cross fences (one with an open gate and one with an incomplete section in a marshy area), multiple water points (troughs for livestock water but also access to the Laramie River whereas the other three pastures only had a single water point), presence of 40 cows, 15 horses situated to the east across the road, and occasional visits by an older Great Pyrenees dog. Furthermore, this pasture featured slight undulations and shrubs, which present a more heterogeneously complex environment relative to the topographical cover utilized by predators (Jenkins and Noad 2003). The donkey alternated between spending time near the road, observing the neighboring horses, and mingling with the cattle. As the sheep primarily occupied the distant sections of the pasture, the donkey failed to integrate with them. After 25 days, the managers relocated the donkey to an 18 acre meadow containing 30 ewes and 1 ram, and within 5 days, the donkey formed a bond with the sheep. This smaller pasture had a sheep density of 1.7 sheep per acre, potentially expediting the acclimation and integration process. Despite the presence of the same equine neighbors adjacent to the fence in the new pasture, the donkey appeared to have formed a strong bond with the sheep. On average, this donkey was 383 m from the nearest sheep and during one observation was found >1,422 m 'away' (Figure 4A). During a few attempts to quantify distance from nearest sheep, the donkey was likely even further away because we could not visually locate the sheep due to the pasture size. The observations away from the flock were in the initial extensive and complex pasture as described above and once the donkey bonded with the sheep in the new smaller and simpler pasture, it was never found more than 40 m away and it remained here for the duration of the study (Figure 4A). During the study period, this donkey was 'away' from the flock 58% of observations and was found 'in' or 'near' the flock 28% and 14% of observations respectively (Figure 5).

Sheep and Donkey Activity

Sheep flocks were observed engaging in non-vigilant activities, such as grazing and resting, for the majority of observations (mean = 97.8% ± 1.4), with only a small percentage of observations showing vigilant activities (mean = 2.2% ± 1.4) (Table 1). There were no statistical differences between flocks in their expression of vigilant behaviors ($P = 0.192$) but there were for non-vigilant behaviors ($P < 0.001$) (Table 1). Donkeys exhibited variations in both non-vigilant and vigilant activities, with statistical differences observed between donkeys for both types ($P = 0.002$ and $P = 0.019$, respectively; see Table 1). Non-vigilant activities ranged from 52.8% to 90.9% (mean = 74.3% ± 9.3), while vigilant activities ranged from 9.1% to 47.2% (mean = 25.7% ± 9.3) (Table 1). Comparatively, sheep showed statistically lower vigilance than non-vigilant activity ($P = 0.002$), whereas

Figure 5. Individual donkey proportional qualitative association with flock location ('in', 'near', 'away'; Figure 3).



donkeys did not display significant differences (*P = 0.088*). Sheep did have statistically lower vigilance and higher non-vigilance than donkeys (both *P-values = 0.029*; Table 1). Donkeys showed higher levels of vigilance, particularly in standing vigilance compared to grazing, but anecdotally time spent grazing or drinking increased (or vigilance decreased) after integration was achieved. Additionally, donkeys that took longer to acclimate and integrate exhibited heightened vigilance.

Additional Observations

Our utilization of donkeys as guard animals for sheep aligns with the guidelines provided by Bough (2016), which suggest maintaining a donkey-to-sheep ratio not exceeding 1:200. It is worth noting that while Green (1989) proposes a maximum ratio of 1:200-300, Walton and Field (1989) advocate for a maximum ratio of 1:400, with 1:200 being considered ideal. Furthermore, our findings support the recommendation against using pastures larger than 600 acres, as observed difficulties with donkey 7107 align with this advice (Green 1989; Walton and Field 1989). Throughout the study period, we encountered various observations worth noting. Firstly, a visiting rancher reported witnessing donkeys chasing ravens, an important deterrence given the concern ranchers have expressed about protected predatory birds as discussed by Windh et al. (2019). Additionally, a neighbor reported the presence of a coyote in a pasture containing a donkey, although no depredation incidents occurred. Moreover, there were two instances of sheep depredation observed in flocks lacking integrated donkeys. Anecdotally, during this time period in 2022 approximately 15 depredation incidents were recorded, contrasting with only two incidents in 2023, as previously mentioned (and sheep were similarly managed and distributed across the landscape). Lastly, it is important to consider that while herding dogs were routinely used to gather sheep, some instances were noted where donkeys exhibited defensive behaviors against these herding dogs.

Conclusion

The integration of donkeys can vary depending on the individual donkey, but it is significantly influenced by factors such as pasture size and conditions. A realistic timeline for integration typically falls within the range of 4-6 weeks, as suggested by Green (1989) and Jenkins and Noad (2003). Additionally, the presence of other equids and cattle nearby may initially hinder the acclimation and integration process with sheep, as indicated by Wilbanks (1995). Donkeys' aversion to canids makes them particularly suitable for guarding sheep, especially in environments where the primary predators are smaller canids, such as those found at the LREC farm, as noted by Green (1989) and Bough (2016). In our study, success was more quickly realized as pasture size went down but more importantly as sheep density relative to land area went up. It is crucial for producers to consider the size and complexity of the initial pasture for each donkey's integration. If successful integration is not achieved early on, adjustments should be made by moving the donkey to a smaller, less complex pasture. Additionally, there is a need to further measure the daily activity budgets of acclimated donkeys and utilize

Table 1. Pooled Sheep and Donkey Activity Categories: Non-vigilant and vigilant behaviors analyzed using one-sample t-tests for intra-flock and intra-donkey variation, and paired sample t-tests for sheep vs. donkey comparisons.

Animal Activity Estimate	6891	7092	7100	7107	Mean	One Sample t-test
Sheep - Non-Vigilance (%)	97.1	100.0	100.0	94.1	97.8 ± 1.4	p < 0.001, t = 23.740, df = 3
Sheep - Vigilance (%)	2.9	0.0	0.0	5.9	2.2 ± 1.4	p = 0.192, t = 1.678, df = 3
Donkey - Non-Vigilance (%)	88.6	90.9	64.9	52.8	74.3 ± 9.3	p = 0.002, t = 9.624, df = 3
Donkey - Vigilance (%)	11.4	9.1	35.1	47.2	25.7 ± 9.3	p = 0.019, t = 4.638, df = 3
Paired Samples t-tests						
Test: Sheep Vigilance vs. Non-Vigilance	p = 0.002, t = -11.03, df = 3					
Test: Donkey Vigilance vs. Non-Vigilance	p = 0.088, t = -2.493, df = 3					
Test: Sheep vs. Donkey Vigilance	p = 0.029, t = -3.959, df = 3					
Test: Sheep vs. Donkey Non-Vigilance	p = 0.029, t = 3.959, df = 3					

technology to better quantify their spatial relationships with flocks such as GPS collars on sheep and donkeys. This could potentially involve documenting nighttime protection activity. The current study simulated pastoral conditions at the semi-extensive LREC sheep production site, utilizing dormant hay meadows during a period of the year when predation risks are higher which is similar to many sheep operations in the region. Further investigations in working production systems need to quantify whether donkeys effectively reduce and mitigate predation, especially in relation to different flock sizes, and if once donkeys are successfully acclimated in small pastures does the bond hold in larger pastures. Jenkins and Noad (2003) suggest that donkeys are most effective in flocks with fewer than 50 head yet this statement should perhaps be quantified by the density of the grazing cohort relative to pasture size. However, Bergman et al. (1998) reported that producers in North Dakota used donkeys in flocks with an average of 405 head, while those in Texas had an average of 213 head. Additionally, it is important to assess whether routine production activities such as shearing and resorting of sheep management groups (e.g., breeding groups) impact the acclimatization and integration process of donkeys and should be further evaluated. The use of BLM donkeys as LGAs, which has been reported to range from 62-79% in the US, may provide additional value and utility of these animals in other countries (Bough 2016; Smith et al. 2000). However, some producers may be skeptical about adopting a feral animal that is unproven as opposed to a donkey that has some experience with sheep (Bergman et al. 1998). Finally, future work also needs to address the efficacy against specific predator species including larger carnivores (such as mountain lions, wolves, and bears) which have been noted to prey on donkeys (Wilbanks 1995; Reinhardt et al. 2012).

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