



# Using alpacas as guardian animals in Australia: a survey of sheep producers

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## ABSTRACT

**Context.** This is the first survey, to our knowledge, that examines how sheep producers in Australia use alpacas as guardian animals. **Aims.** To document current management practices surrounding guardian alpacas to protect sheep and gain an understanding about producers' opinions on the effectiveness of their alpacas in increasing lamb survival, and provide recommendations for producers looking to invest in guardian alpacas. **Methods.** An online survey aimed to target sheep producers that use alpacas as guardian animals in Australia. Survey was advertised through social media and mail-out copies were sent to known producers that own guardian alpacas. **Key results.** The majority of respondents (72%,  $n = 65$ ) co-graze 1 alpaca to every 1–50 sheep, with most of respondents (54%,  $n = 44$ ) introducing alpacas to their flock of sheep 10 weeks before lambing. The majority of respondents (82%,  $n = 74$ ) noted that the alpacas bonded with the sheep either straight away or within 1–4 weeks, regardless of the number of alpacas placed with sheep ( $P < 0.001$  for all alpaca to sheep ratios when comparing bonding time of  $<4$  weeks vs  $>4$  weeks). It was common for respondents to own castrated males aged between 2 and 5 years (58%,  $n = 52$ ). Approximately half of the respondents were hobby farmers (48%,  $n = 56$ ). The survey findings suggested that producers believed that alpacas are effective in protecting against foxes, but not as effective against more aggressive predators such as wild dogs. The respondents witnessed alpacas exhibiting a range of guarding behaviours, including staying close to lambs, and chasing, vocalising or killing potential threats. In total, 72% of respondents reported that their lamb survival increased after introducing alpacas and gave the animals an average rating of 7.5 of 10 in relation to their effectiveness. A total of 70 respondents (83%) stated that they would recommend alpacas as guardian animals to other producers and noted that they are highly cost-effective. **Conclusions.** Surveyed producers consistently considered alpacas as an effective form of predator deterrent and associated their use with increasing lamb survival. **Implications.** Lamb mortality remains a major issue in the sheep industry. This survey highlighted one form of predator deterrent that surveyed sheep producers have used in the effort to increase their lamb survival. Additionally, these findings have provided knowledge, such as how these animals are being used by the respondents and information for producers looking to invest in guardian alpacas.

**Keywords:** alpacas, animal welfare, camelids, farmer survey, lamb survival, livestock guardian, predator control, sheep management.

## Introduction

Lamb mortality continues to be a major issue in the sheep industry. In Australia, average lamb losses of 10% for single-born lambs and 30% for twin-born lambs have been reported (Hinch and Brien 2013). It is estimated that predation accounts for 7% of these lamb deaths (Refshauge *et al.* 2015). Lamb losses as a result of predation are both an economic and welfare concern for sheep producers in Australia (Franklin-McEvoy and Jolly 2008; Doughty *et al.* 2017). Therefore, sheep producers are investing in control measures in an effort to reduce predation, including the use of 1080 poison (sodium fluoroacetate used in

baits to control vertebrate species), shooting and exclusion fencing (Greentree *et al.* 2001; Lapidge 2004). Guardian animals such as dogs, donkeys, llamas and alpacas have been used globally as a predatory deterrent (Van Bommel and Johnson 2012; Webber *et al.* 2015; Allen *et al.* 2019; Saitone and Bruno 2020). However, there is limited research on how producers are using alpacas as guardian animals as an effective control measure and how they are being managed with sheep.

Alpacas (*Llama pacos*) are South American camelids that have been traditionally used for their meat, fibre and hide (Jenkins 2003). Alpacas have been identified as potential guardian animals owing to their strong herding and protective instincts, in conjunction with their innate dislike for canids and ability to bond with other livestock (Jenkins 2003). There is some evidence to suggest that alpacas can be used successfully to protect sheep, with studies showing an increase in lamb survival using co-habitation of alpacas with lambing ewes (Mahoney and Charry 2005; Franklin-McEvoy and Jolly 2008). There are a range of behaviours that alpacas have been known to exhibit that could make them suitable guardian animals, including the use of high-pitched vocalisations to deter threats, chasing and stomping at predators and showing a high interest towards lambs they are co-habiting with (AAA 2008; Matthews *et al.* 2020; Miranda-de la Lama and Villarreal 2023). Alpacas have been seen as ideal additions to flocks because they are not susceptible to fly strike, require the same drenching as sheep, have a high feed conversion efficiency, low disease burden because of excretion behaviour and have low environmental damage with a relatively low ground hoof pressure (39 kPA) compared with other livestock such as sheep (82 kPA) (Jenkins 2003; AAA 2008; Franklin-McEvoy and Jolly 2008). However, producers may encounter some management disadvantages such as difficulty of shearing, with the use of restraints being a common practice (Waiblinger *et al.* 2020) and ease of handling during shearing (Windschnurer *et al.* 2021). Habituation for alpacas to handling procedures has also been recommended to reduce stress and avoid having to use invasive methods of restraint during shearing (Waiblinger *et al.* 2020).

Current industry recommendations suggest the number of alpacas per ewe flock (no more than two) and a preference for castrated males (Jenkins 2003; Franklin-McEvoy and Jolly 2008). There are surveys on human and alpaca relationships and alpaca management (Rashid *et al.* 2019; Neubert *et al.* 2021; Windschnurer *et al.* 2021); however, scientific investigations on current management practices of guardian alpacas used by sheep producers in Australia are not available. Therefore, this survey aims to (1) determine how sheep producers in Australia are using guardian alpacas in their flock, and (2) gain an understanding about how the respondents believe their alpacas protect their flock.

## Methods

### Ethics

Approval to conduct this survey was granted by the University of New England (UNE) Human Research Ethics Committee (HE17-213).

### Survey

The data for this study were collected from a 34-question survey on the opinions and use of alpacas as guardian animals. The responses were collected from a web-based surveying tool, Survey Monkey, between January 2018 and August 2020. The survey was advertised on a number of alpaca and sheep breeders' associations' social media pages and potential respondents were identified from breeders who sold alpacas as guardian animals.

The survey consisted of 23 close-ended questions and 11 open-ended questions divided into six sections (Table 1, see Supplementary material). There were some questions where respondents were able to select more than one answer. The respondents did not have to answer all questions if they were unsure of an answer. There was a total of 119 respondents; however, four responses were removed from analyses because one respondent completed the survey twice and three respondents owned goats instead of sheep. All other responses collected from the survey were used in analyses.

### Statistical analyses

Descriptive analyses were used to present data. All questions in the survey were able to be skipped; therefore, the total number of responses to each question varied. The number of respondents that answered each question was used to calculate answer percentages and the number of responses to each answer was noted in the descriptive analyses for clarity as to how many respondents answered each question. Multiple-choice questions were coded (each respondent formed a row and responses formed columns) so as to statistically assess associations among questions. Two-way contingency tables were performed to test associations among different responses and significance was determined by the chi-squared value in a likelihood-ratio test using the statistical software JMP14 (SAS Institute, Cary, NC, USA).

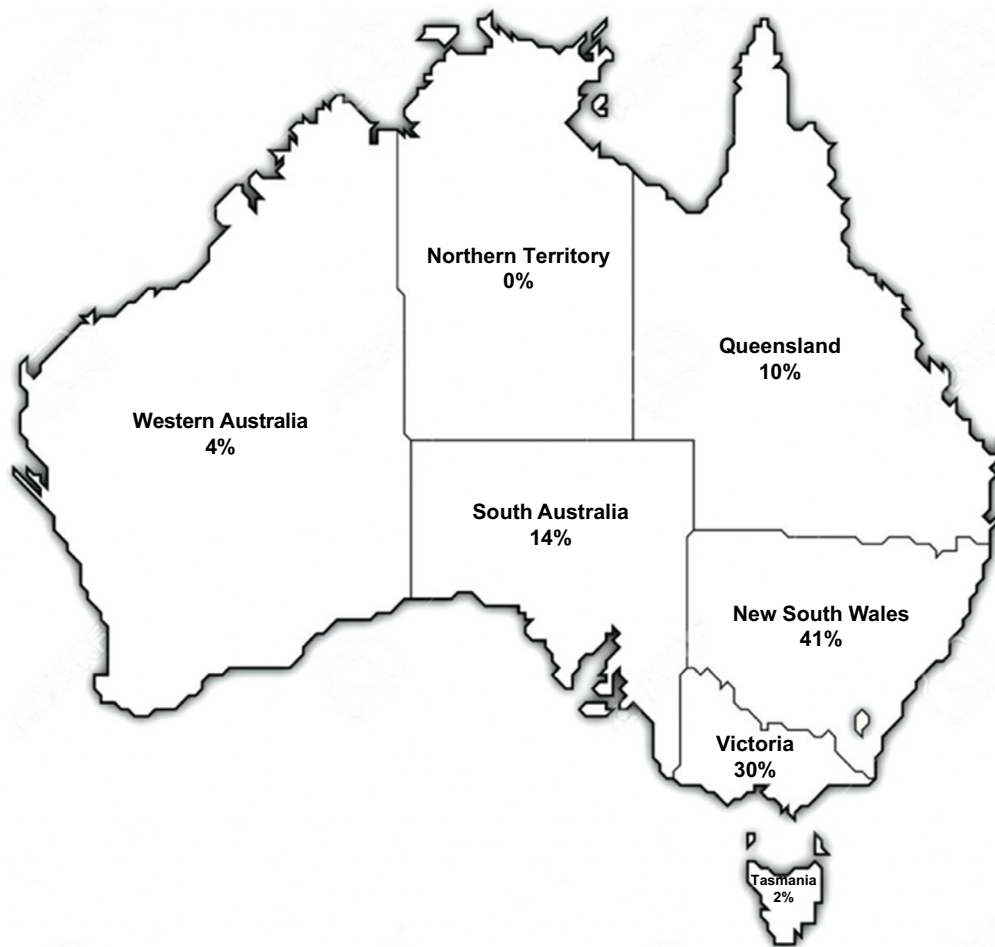
## Results

The majority of respondents resided in New South Wales (41%) and Victoria (30%), (Fig. 1). The respondents reflected the proportion of sheep numbers in each state of Australia (except for Western Australia, which has a higher proportion (21%) of sheep (ABARES 2021)).

The demographics of the respondents was a gender ratio of 67% female and 33% males and the majority (74%) were in the 31–60 age group. The respondents mostly had tertiary

**Table 1.** Summary of survey topics.

Section	Topics
1. Property information	Location (state); zone; type of enterprise; size; vegetation cover; pest issues and management
2. Sheep and alpaca management	Vegetation cover of paddocks during and outside of lambing period; alpaca to sheep ratios during and outside of lambing period
3. Alpaca information	Why the respondents chose alpacas; management issues; number, type, age and sex of alpacas; purchase history
4. Introduction of alpacas to sheep	How and when respondents introduced alpacas; alpaca and sheep bonding time
5. Effectiveness	Observed guarding behaviours; lamb survival; predator observations; cost-effectiveness
6. Producer demographics	Gender; age; level of education; experience

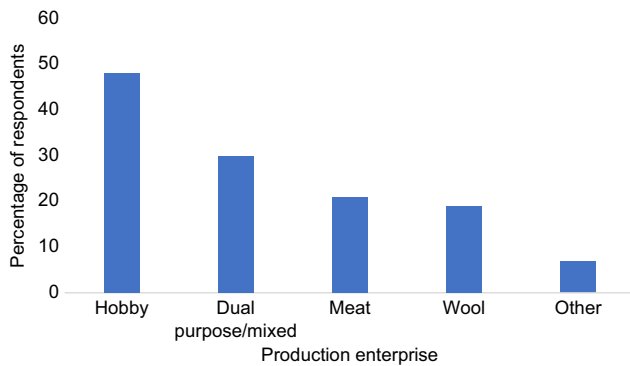
**Fig. 1.** Percentage of respondents located in each state of Australia.

education (75%) and 84% had 5 or more years of experience in the agricultural industry.

### Property information

Property locations were in a mix of the pastoral zone (low-rainfall areas) (27%,  $n = 31$ ), wheat–sheep zone (mid-rainfall areas) (40%,  $n = 45$ ), and high-rainfall zone (33%,  $n = 39$ ). The production enterprise was most commonly described as

‘hobby’ (48%,  $n = 56$ ), followed by ‘dual purpose/mixed’ (30%,  $n = 35$ ) (Fig. 2). The size of the respondent’s property ranged from 1 to 50 ha (61% of respondents,  $n = 69$ ) to over 3000 ha (3% of respondents,  $n = 3$ ). The landscape of respondents’ ( $n = 109$ ) properties ranged from being completely flat (score 0) to being hilly (score 10), with an average of score 4.3. Vegetation cover of respondent’s paddocks ( $n = 111$ ) ranged from 0% (no vegetation cover) to 100% vegetation cover, with an average of 29% cover.



**Fig. 2.** Production enterprise of respondents (%), respondents were able to choose more than one answer.

### Pest management

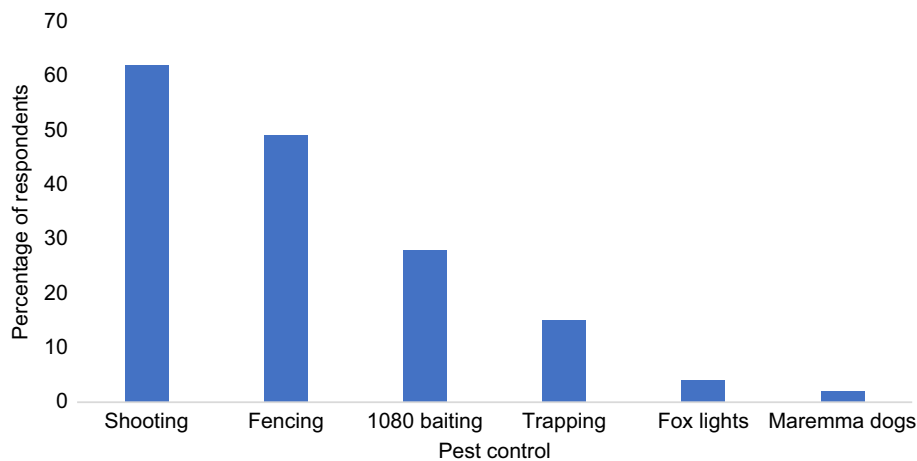
To gain knowledge on the effect of pests in their area, a scale of 1–10 was used to indicate problematic pests ( $n = 113$ ). Foxes were the most problematic for respondents, with an average score of 8, followed by birds of prey, with an average score of 4. Wild dogs, pigs and feral cats were also noted as potential threats to particular respondents, although they were seen as less problematic than foxes and birds of prey. Properties that had low (<50%) vegetation cover appeared to have high fox problems ( $n = 58$ ). The majority of producers in this survey used alpacas because of fox predation, with 65% of respondents stating they had problems with these pests. However, it is difficult to make interpretation of how effective alpacas are on other pest species because it appears that respondents did not use alpacas for other pests such as wild dogs. The majority of respondents ( $n = 111$ ) deployed other means of pest control in conjunction with the use of alpacas to increase lamb survival, such as shooting (62%,  $n = 69$ ) and fencing (49%,  $n = 54$ ). Respondents also noted the use of 1080 baiting, trapping, Maremma dogs as

guardian animals and the use of fox lights to deter attacks on their flocks (Fig. 3).

### Sheep and alpaca management

Vegetation cover of respondent's lambing paddocks ( $n = 94$ ) ranged from 0% cover (no vegetation) to 100% vegetation cover, with an average of 26% cover. The majority of respondents (86%,  $n = 83$ ) co-grazed alpacas with every flock of sheep on their property. Majority of respondents (72%,  $n = 65$ ) co-grazed one alpaca to every 1–50 sheep, with other respondents co-grazing one alpaca to every 51–100 sheep (20%,  $n = 18$ ) and some respondents (8%,  $n = 7$ ) co-grazed one alpaca to over 100 sheep. The majority of respondents (87%,  $n = 82$ ) also co-grazed alpacas with sheep outside of the lambing period, with similar alpaca to sheep ratios.

In total, 75% ( $n = 64$ ) of respondents placed their alpacas with their flocks of sheep immediately, with the remainder of the respondents (26%,  $n = 22$ ) placing their alpacas in adjoining paddocks before introducing them to the flock. Nearly all of the respondents (95%,  $n = 83$ ) introduced their alpacas to their flock of sheep before lambing and only two respondents introduced their alpacas at lambing (2%,  $n = 2$ ) and after lambing (2%,  $n = 2$ ). The majority (54%,  $n = 44$ ) of respondents introduced alpacas to their flock of sheep 10 weeks before lambing, whereas 27% ( $n = 22$ ) of respondents introduced their alpacas 5–10 weeks before lambing and 20% ( $n = 16$ ) introduced alpacas 1–4 weeks before lambing. The responses from this survey suggest that alpacas will bond with the sheep quickly, with most of responses stating that the alpacas bonded with sheep straight away or between 1 and 4 weeks (Table 2). Bonding with the sheep refers to respondents witnessing the alpacas staying in close proximity to the sheep and both animals being relaxed in each other's presence. It was also found



**Fig. 3.** Percentage of respondents (multiple choice,  $n = 112$ ) using other pest-control measures in conjunction with guardian alpacas.

**Table 2.** Duration of time for guardian alpacas to bond with sheep they are protecting (multiple choice,  $n = 90$ ).

Answer	Responses ( $n$ )	Responses (%)
Immediately	34	38
1–4 weeks	40	44
5–10 weeks	7	8
More than 10 weeks	4	4
Unsure	5	6

that more respondents witnessed their alpacas bonding with their sheep in less than 4 weeks than in more than 4 weeks for all alpaca to sheep ratios ( $P < 0.001$  for all sheep to alpaca ratios when examining  $<4$  week vs  $>4$  week bonding time).

The main issue when using guardian alpacas seemed to be in conjunction with using working dogs ( $n = 38$ , 44% of respondents stating this issue). Apart from experiencing issues with using working dogs, it appears that managing guardian alpacas is fairly simple, with 38% ( $n = 33$ ) of respondents experiencing no issues, and a low percentage of respondents reporting issues when shearing the alpacas (29%,  $n = 25$ ), mustering the sheep/lambs and alpacas to different paddocks (27%,  $n = 23$ ) and husbandry practices related to specific health needs of alpacas (5%,  $n = 4$ ).

### Alpaca information

There were many reasons why the respondents had chosen to use alpacas as guardian animals, with most respondents stating that they had heard alpacas work well with sheep as a form of pest control from the media/internet (73%,  $n = 55$ ) and that other producers had advised them to use alpacas (59%,  $n = 44$ ). There were also respondents that had negative experiences with other control measures (15%,  $n = 11$ ). Some had used other guardian animals prior to

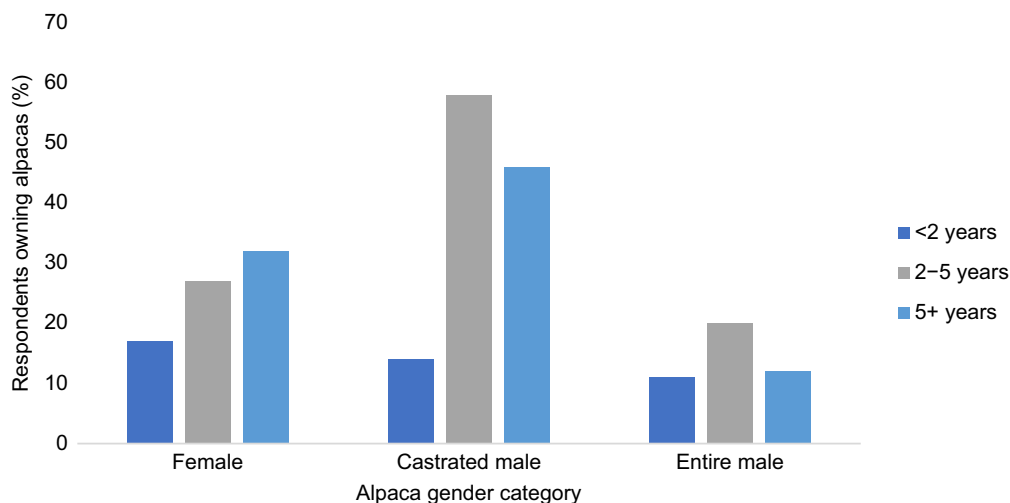
using alpacas (8%,  $n = 6$ ) and some respondents reported that these had not been effective and wanted to try a different guardian species (7%,  $n = 5$ ). Respondents also noted that they chose to use alpacas as guardian animals because they also breed them (12%,  $n = 9$ ) and some used alpacas because they were given to them as a gift (4%,  $n = 3$ ).

The majority of respondents use Huacaya alpacas (78%,  $n = 76$ ), with some using Suri alpacas (22%,  $n = 22$ ). On average, the respondents ( $n = 90$ ) owned six alpacas, with the majority of respondents (58%,  $n = 52$ ) owning castrated males aged between 2 and 5 years. Females of different ages as well as entire males were being used by respondents (Fig. 4). The majority of respondents purchased their animals from alpaca breeders (71%,  $n = 64$ ), regardless of whether they used male or female alpacas.

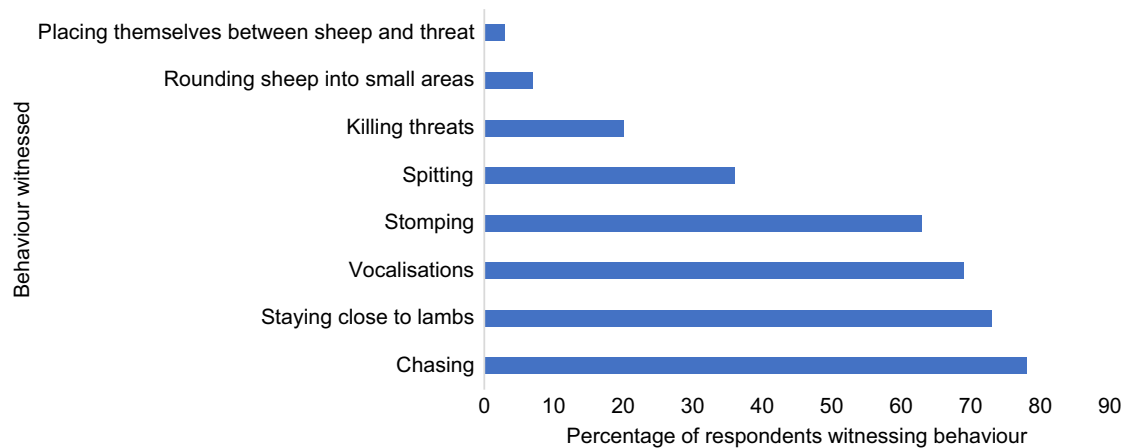
### Guarding effectiveness

Respondents gave an average rating of 7.5 of 10 in relation to how effective they believed alpacas are in protecting stock. Respondents witnessed their alpacas displaying a number of behaviours that would aid in protecting their flock, including chasing threats (78%,  $n = 67$ ), staying close to lambs (73%,  $n = 63$ ), vocalising (69%,  $n = 69$ ) and stomping at threats (63%,  $n = 54$ ) (Fig. 5). Definition of behaviours can be found in Table 3. No significant difference was found when comparing castrated males and females in relation to observed behaviours of spitting, chasing, stomping, killing threats, vocalisation and placing themselves between the sheep and the threat ( $P > 0.05$  for all behaviours). Chasing, staying close to lambs and vocalisations appeared to be the most prominent guarding behaviours exhibited regardless of gender.

In total, 72% of respondents found that lamb survival increased after using alpacas (regardless of the sheep and alpaca ratio), 13% found no change in lamb survival, 15% were unsure and only one respondent found that their lamb



**Fig. 4.** Gender and age of alpacas used by respondents ( $n = 91$ ).



**Fig. 5.** Percentage of respondents witnessing specific Guardian alpaca behaviour (multiple choice,  $n = 87$ ).

**Table 3.** Definition of behaviours witnessed from respondents, exhibited by their alpacas.

Behaviour	Description
Placing themselves between sheep and threat	Using their body to stand or walk between sheep and a potential threat (e.g. fox)
Rounding sheep into small areas	Using their body or vocals to encourage sheep to flock together in close proximity
Killing threats	Intentionally using body part/s to cause death to a threat (e.g. fox)
Spitting	Forcibly ejects saliva from mouth, ears usually pinned back
Stomping	Using either front or hind legs to make quick, aggressive contact with a potential threat
Vocalisation	High-pitched vocal produced by the alpaca in the presence of a predator
Staying close to lambs	Either standing or walking in close proximity (within 3 m) of a lamb
Chasing	Fast movement towards a threat with the intention of encouraging the threat away from the vicinity or to confront threat in an aggressive manner

survival had decreased. The majority of respondents (76%,  $n = 57$ ) had also witnessed fewer predators and/or instances of predation in the vicinity of their property since introducing alpacas to their sheep. It was noted by five respondents in the following additional comments that they believed the alpacas are more effective against foxes than dogs: ‘I feel alpacas are excellent guardians when it comes to foxes. I am not so sure if they would be effective against dogs though as I feel they would be easily overpowered by a pack of dogs’; ‘They will however die protecting a mob if it is a large dog or pack of dogs’; ‘Recommending alpacas ... is dependent on the situation. Foxes yes, birds of prey including ravens/crows yes, wild dogs no.’; ‘Alpacas cannot be used as a sole form of protection against predators, especially dogs’;

‘Alpacas are effective against foxes but don’t seem to be able to guard sheep against wild dogs’.

A total of 70 respondents (83%) stated that they would recommend alpacas as guardian animals to other producers and only 13 respondents (16%) stated that they are undecided and one respondent (1%) stated that they would not recommend alpacas as guardian animals. Respondents rated alpacas on average a 7.7 of 10 in relation to how cost-effective they were compared with other control measures.

## Discussion

The outcomes from this survey consistently showed that the respondents believed their alpacas were successful guardian animals both in increasing lamb survival and witnessing the animals displaying guarding behaviours. The majority of respondents appeared to use industry recommendations in regards to the gender and age of alpacas (castrated males, aged 2–5 years) and found that their alpacas were easy to manage with their sheep flocks. With the majority of respondents recommending alpacas as a cost-effective form of predator deterrent, it is suggested that field trials examining guarding effectiveness be undertaken to validate the respondents’ experiences. Some research in this field has been undertaken and found that alpacas display an increased interest towards lambs compared with sheep (Matthews *et al.* 2023), validating the respondents who witnessed their alpacas displaying interest in lambs by staying in close proximity.

### Effectiveness as guardian animals

The respondents believed that alpacas are effective as guardian animals, which is consistent with past research that has suggested that alpacas are able to successfully guard sheep (Mahoney and Charry 2005). The respondents witnessed the

alpacas exhibiting a range of behaviours, including chasing predators away, the use of vocalisations, rounding sheep into small areas and placing themselves between livestock and threats. These behaviours have been noted in guardian dogs, known as approach–withdrawal behaviours in which the guardian animal exhibits behaviours to deter a threat from attacking, before retreating to its livestock, so as to eliminate the need for an aggressive confrontation between the threat and guardian animal (Lorenz and Coppinger 1986). Alpacas use of loud vocalisations (alarm calls) have been defined as a high-pitched series of sounds described as ‘whinnies’ or ‘whistles’ so as to alert the herd of a perceived danger (Fowler 2008; Miranda-de la Lama and Villarroel 2023). The use of vocalisations could be an important guarding mechanism because it may also alert a producer nearby that there is a threat in one of their paddocks and/or alert the livestock that there is a threat and to act with higher vigilance. The reporting by respondents on alpacas exhibiting more aggressive behaviours towards threats such as stomping at them and also killing threats may be important in how alpacas guard livestock. These behaviours were likely to be exhibited if approach–withdrawal behaviours were not successful and the threat continued an attack on the flock, which has also been witnessed in past research examining guardian alpaca effectiveness (Mahoney and Charry 2005). The majority of respondents had also witnessed alpacas staying close to lambs. This behaviour has been seen in a field experiment examining alpaca behaviour while housed with lambing ewes (Matthews *et al.* 2020), and in an arena test, in which alpacas showed a greater preference towards lambs than other novel stimuli (Matthews *et al.* 2023). This is seen as an advantageous behaviour for a guardian alpaca to exhibit, staying close to an animal with a higher vulnerability to threats. The behaviours the respondents witnessed supports alpacas having a high potential as a guardian species.

It is not surprising that respondents reported alpacas to be highly cost-effective, particularly given the current high price of lambs (estimated 766 cents/kg, equating to an estimated AUD\$168 for a Merino lamb) (ABARES 2021). Prices of alpacas vary, whereas wethers cost approximately AUD\$450 (Lawrie 2019). Therefore, alpacas would quickly cover their purchase costs and make their producers a substantial profit if their behaviour resulted in an increase in lamb survival.

## Pest management

This survey showed that alpacas were viewed by respondents as effective in protecting against foxes. It could be theorised that alpacas are effective in protecting against small predators such as foxes that rely on ambush attacks, and the use of vocalisations and chasing may be enough to deter these predators from attacking compared with larger predators such as wild dogs that act with more aggressive attacks and may also hunt in packs (Fleming *et al.* 2001). Wild dogs cost producers millions of dollars in livestock loss each year and

are a concern for land managers across Australia (Fleming *et al.* 2014). However, wild dogs were not a major concern for the respondents of our survey. This could be because producers who do have a high concern in relation to wild dogs are not using guardian alpacas as a form of predator deterrent, but are more likely to be using methods such as dog-proof fencing (Allen and Sparkes 2001). Producers with a wild dog problem who are looking at investing in a guardian animal may be more inclined to invest in guardian dogs, for which there is scientific evidence that supports their effectiveness in protecting against wild dogs (van Bommel 2010). Although the results from this survey support the notion that alpacas are effective as guardian animals, the respondents still deployed other means of pest control such as shooting, fencing and 1080 poisoning. This suggests that although alpacas can be effective in reducing lamb losses, producers are relying on an integrated control approach to protect their flocks. Furthermore, inferences by respondents on the effectiveness of alpacas as guardian animals need to be made with caution, given that almost all respondents employed additional control measures and the effectiveness of alpacas may have resulted from the integration of these strategies.

## Alpaca and sheep management

The only management issue respondents noted when using guardian alpacas, is using working dogs in conjunction with the alpacas. This would be expected as alpacas appear to have an innate dislike of canids (Jenkins 2003). This enhances their abilities because a guardian animal, as they do not need to be trained to act with vigilance and aggression towards canid threats in their environment. Although this is an advantageous trait for a guardian animal to exhibit, producers need to be aware that they may need to adjust certain management practices, such as mustering animals to different paddocks, if they rely heavily on their working dogs. Although the respondents noted they have come across issues when using working dogs, this does not seem to be of great concern.

It is not surprising that the respondents did not find any major issues in relation to alpaca management because, along with sharing similar management to sheep (AAA 2008), they exhibit a low frequency of aggressive behaviours towards caretakers (Windschnurer *et al.* 2021). Difficulty shearing alpacas is a known issue, which has been rectified using a chute or restrained in a stretched position with ropes at the front and hind legs either on the ground or on a shearing table (Waiblinger *et al.* 2020).

The majority of respondents co-grazed alpacas with their sheep outside of lambing period. As alpacas share similar management to that of sheep, they can be managed with sheep at a low cost, without additional management practices. This is an advantage to using alpacas compared with using other guardian animals such as dogs that require extensive

time and commitment in relation to training and management (Van Bommel and Johnson 2023).

The majority of respondents used the ratio of one alpaca to every 1–50 sheep or one alpaca to every 51–100 sheep and own multiple alpacas. This is consistent with best-practice protocols suggested by (Jenkins 2003). Although Jenkins (2003) suggested one alpaca to every 100 sheep, there has been some evidence to suggest that alpacas can be successful in guarding larger flocks of 1500 (Mahoney and Charry 2005). The majority of the respondents from our survey were hobby farmers, which is why we may not have received a large number of responses with larger flocks of sheep. Further research examining lamb-survival percentages of different-sized flocks guarded by alpacas is needed to provide best-practice protocols for producers in relation to alpaca: sheep ratios. Producers should be mindful that it has been suggested that having more than two alpacas in one flock or having multiple alpacas in adjoining paddocks could encourage the alpacas to socialise with each other and not protect the sheep flock (Jenkins 2003; Mahoney and Charry 2004).

The results from our survey suggest that producers can successfully place guardian alpacas in with a flock of sheep straight away, without the need to place them in adjoining paddocks and the alpacas will bond with the sheep quickly. It is not surprising that the alpacas appeared to be able to bond successfully with sheep because alpacas are herd animals and rely on social behaviours to facilitate integration of a herd, improve protection against predators and aid in the group care of offspring (Bonacic 2011; Miranda-de la Lama and Villarroel 2023). Because South American camelids social group is an integral part of this species survival and group viability (Aba *et al.* 2010), their necessity to be a part of a flock could facilitate the success of alpacas bonding to sheep. The ability of alpacas to bond with sheep quickly is an advantageous quality for a guardian animal to possess, because there is no need for the producer to invest extra time in relation to bonding the alpacas with the sheep. From this survey it appears to be important for producers to ensure that they place their alpacas with their flocks of sheep before lambing. This would ensure that the alpacas have successfully bonded with the sheep before they start lambing. This is consistent with Jenkins (2003), who suggested that alpacas should be placed within the flock they are protecting 4–6 weeks before lambing.

### Alpaca information

The majority of the respondents owned Huacayas, compared with the Suri, which is not surprising because Huacayas are thought to make up more than 90% of the world's population of alpacas (Atav and Türkmen 2015). The main difference between the two breeds is their type of fibre, with Suri fibre being more lustrous, fine and longer, with a dreadlock appearance, than is the Huacaya fibre, which is thicker and crimped (Atav and Türkmen 2015). There is no evidence to

suggest that one breed is more effective as a guardian animal. However, it could be theorised that the long fibre of the Suri (Lupton and McColl 2011), if not maintained, could obscure the alpaca's eyesight and inhibit the efficiency of detecting predators. Further research would be needed to examine whether there is a difference in guarding ability between the two breeds.

The majority of respondents owned castrated males aged between 2 and 5 years of age, which is consistent with best-practice protocol suggested by Jenkins (2003). It is thought that protective instincts of alpacas do not fully develop until they are approximately 18 months of age (Jenkins 2003). Therefore, deploying alpacas as guards between the age of 2 and 5 years should be appropriate. The majority of respondents purchased their animals from alpaca breeders. This could be why a high proportion of producers were using castrated males, because alpaca breeders would be expected to have an excess of males available, while keeping females in their breeding herds. The opportunity for alpaca breeders to sell their unwanted males as guardian animals is advantageous for the alpaca industry because it gives purpose for the male alpacas and therefore results in less wastage for the breeders. Although the majority of respondents used male alpacas, our results showed that females are still being used successfully. Females' ability as guardian animals was supported by Lawrie (2019) who suggested that females are more aggressive than males and by Matthews *et al.* (2020, 2023) who have found that females are just as attentive towards lambs as are males. Female alpacas also have a strong maternal instinct, which could translate to desirable guarding traits. Therefore, even though males are more easily available for purchase from breeders, further research is needed on the effectiveness of gender on guarding ability.

### Conclusions

This study has identified that sheep producers in Australia are using alpacas as guardian animals in an effort to protect lambs during lambing time from predators, such as foxes, which will assist in increasing lamb survival. Respondents considered that the alpacas were successful as a guardian animal, but given they employed other strategies concurrently and this is based on observation data, we cannot conclude whether alpacas are successful in changing lamb survival. The majority of respondents used castrated males and used an alpaca to sheep ratio of 1:1–1:50; however, more research in relation to the effect of gender and also alpaca to sheep ratios would be beneficial to ensure that producers have the knowledge to be able to use these animals efficiently and as effectively as possible. It is evident that alpacas exhibited a range of behaviours so as to deter an attack on their flock, including chasing predators away, the use of vocalisations, rounding sheep into small areas and placing themselves between



livestock and threats. With lamb survival being a critical issue in the sheep industry and the consistency of respondents acknowledging alpacas as successful sheep guards, additional research in controlled studies is advised.

## Supplementary material

Supplementary material is available [online](#).

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