

A Theory of Change for promoting coexistence between dingoes and livestock production

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Abstract

Achieving conservation goals, such as coexistence between wildlife and humans, requires an evidence-based understanding of the factors that shape conservation contexts. For addressing conflict between humans and wildlife, this means understanding the barriers and opportunities to changing human behaviors toward wildlife. Here, we develop a Theory of Change (ToC) to promote coexistence between livestock producers and dingoes in Australia. The ToC is based on behavior change principles and interdisciplinary research identifying four key stakeholder groups who may influence dingo management. It employs four overlapping strategies to address these barriers: (a) a media campaign to promote public awareness of dingo management practices, which may result in pressure upon governments to restrict lethal control; (b) promoting more inclusive decision-making processes, specifically including Aboriginal Australians; (c) monitoring and evaluation of the effects of dingo management on livestock and ecosystems to identify opportunities for nonlethal dingo management; (d) campaign to encourage adoption of nonlethal management methods by livestock producers based on an understanding of sociopsychological factors that shape behaviors. The framework is a tool for conservation advocates and policymakers to implement and monitor change that facilitates both wildlife conservation and thriving rural communities.

KEYWORDS

human dimensions of wildlife, human–wildlife conflict, Theory of Change

1 | INTRODUCTION

Management interventions that aim to promote coexistence between wildlife and humans can only be

successful if they incorporate an understanding of the factors that shape human attitudes and behaviors associated with wildlife conflicts. Humans often respond to real or perceived conflict with wildlife by killing the wildlife, seeking to remove the threat. However, evidence of the effectiveness of lethal wildlife control at reducing impacts on human interests is limited and sometimes conflicting (Rodriguez & Sampson, 2019; van Eeden, Eklund et al., 2018). Indeed, lethal control of predators can result in decreases in attacks on livestock, but it can also have

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no impact or even result in increased attacks (Allen, 2013; Wielgus & Peebles, 2014) so livestock producers bear financial and psychological costs of ongoing attacks on their livestock. Furthermore, lethal control to protect livestock is one of the major causes for reductions in large predator populations globally, with consequences for ecosystems more broadly (Ripple et al., 2014). As such, a reduction in lethal control of predators could benefit humans and biodiversity but understanding what shapes human behavior is necessary to implement programs that promote coexistence.

Using the Australian dingo (variously described as *Canis dingo*, *C. lupus dingo*, and *C. familiaris* [Jackson et al., 2017; Smith et al., 2019]) as a case study in livestock-predator conflict, we developed a Theory of Change (ToC) to inform strategies that promote coexistence between humans and problematic wildlife. Use and interpretation of terms such as “human-wildlife conflict” and “human-wildlife coexistence” vary in the conservation literature (Knox, Ruppert, Frank, Sponarski, & Glikman, 2020), so we define “conflict” to mean interactions between humans and wildlife that adversely affect one another, and “coexistence” to imply that solutions are implemented that allow humans and wildlife to live alongside one another by minimizing these impacts in both directions (Conover, 2002; Frank, 2016; Nyhus, 2016). Under these definitions, promoting coexistence includes building tolerance and acceptance of wildlife by humans (Frank, 2016). We therefore focus on reducing lethal dingo control while adequately protecting livestock. The ToC is based on behavior change science and the findings of interdisciplinary research on dingoes to address social norms, and existing power structures and policy conditions that currently promote lethal control. To develop the ToC, we first provide a brief introduction to the dingo, outlining its current management, the conflicts that attend it and then describe four key stakeholder groups important to these and associated pathways to promote reduction in lethal dingo control.

1.1 | The dingo context

Dingoes arrived in Australia at least 3,500 years ago and are now established across much of the mainland (Balme, O'Connor, & Fallon, 2018). They are managed across much of Australia, largely due to the real and perceived threat that they pose to livestock. The cost of managing dingoes has been estimated at up to AUD\$89 million per year (McLeod, 2016). Management of dingoes is mostly through the distribution of poison baits typically laced with sodium monofluoroacetate (or 1080). Evaluation of the effectiveness of these tools at reducing

attacks on livestock is limited. From the studies that have been conducted, some have identified that lethal predator control can reduce livestock losses, others have found that they have no effect on, or even increase livestock losses (Allen, 2015; Allen & Gonzalez, 1998; van Eeden, Eklund, et al., 2018).

At present, governments and industry advocate a “nil tenure” approach to dingo management which promotes landscape-scale poison baiting by all stakeholders across large areas of Australia (Australian Wool Innovation, 2020). This means that lethal dingo control occurs not just on agricultural land, but also on public land including national parks. While some dingo management on public lands occurs to protect threatened native fauna, baiting within 3-km buffer zones of national parks in some states occurs to protect neighboring livestock (WoolProducers Australia, 2014). As part of this strategy, lethal dingo control is encouraged by governments through legislation and financial support (Smith & Appleby, 2015). Dingo control is funded by state governments and local councils in the form of bounty payments (e.g., Southern Downs Regional Council, 2020; Agriculture Victoria, 2020), subsidies and training for poison baiting, and government-implemented aerial baiting (WoolProducers Australia, 2014).

There is also some support for large-scale predator-proof fencing projects called “cluster fencing” (Agricultural and Environment Committee, 2017) whereby several property managers fence their properties together to keep pest animals out of large areas. Whether cluster fencing can be regarded as a nonlethal management tool is questionable because the practice results in killing of dingoes remaining in or entering the area, along with herbivores that compete with livestock for feed (Clark, Clark, & Allen, 2018). Other wildlife can be injured or killed by the fences through entanglement, and fences have ecological consequences in acting as a barrier to wildlife movements (Allen & Hampton, 2020; Smith, King, & Allen, 2020; Somers & Hayward, 2012). We are not aware of any financial support being available to livestock producers who wish to use nonlethal management methods such as livestock guardian animals or improved animal husbandry to protect livestock from dingoes in Australia, although a small proportion of farmers do use these methods voluntarily (Binks, Kancans, & Stenekes, 2015; van Bommel & Johnson, 2012) and not all livestock producers choose to engage in lethal dingo management (Binks et al., 2015; van Eeden, Dickman, Crowther, & Newsome, 2019).

Dingoes are widely considered a major threat to the production of small stock, especially sheep, and lethal control is almost ubiquitous wherever dingoes and sheep

exist together (Allen & Fleming, 2004; Fleming, Corbett, Harden, & Thomson, 2001). Cattle producers, on the other hand, may not be as concerned because dingoes can pose little threat to adult cows, have varied impacts on calves (e.g., Fleming, Allen, Ballard, & Allen, 2012; Wallach, Ramp, & O'Neill, 2017), and may reduce grazing pressure by controlling competing herbivores like kangaroos (Allen, 2015; Caughley, Grigg, Caughley, & Hill, 1980). As such, a “nil tenure” approach may impose a financial, time, and environmental burden on these landholders who are not affected by, or may benefit from, the presence of dingoes (Allen, 2017). Cattle production areas are therefore a good place to start encouraging practices and attitude change that result in coexistence with dingoes.

Several nonlethal management strategies have been proposed that might allow coexistence with livestock. These include livestock guardian animals, switching from sheep to cattle, not grazing sheep near forested areas, moving livestock away from national park boundaries when they are lambing or calving, lower stocking densities, and using negative stimuli such as frightening devices or aversive conditioning (Johnson & Wallach, 2016; Smith & Appleby, 2018). For cattle production, however, simply ceasing lethal control of dingoes and doing nothing else may reduce predation on livestock by maintaining stable social pack structures (Allen, 2013; Wallach et al., 2017). These nonlethal alternatives present an opportunity to change our relationship with the dingo, but changes in policy and behavior are needed to develop this new path.

2 | DEVELOPING A TOC TO PROMOTE COEXISTENCE WITH DINGOES

Theories of Change (ToCs) have been used in a range of contexts for over 30 years, and have been developed more recently as tools for implementing conservation interventions (Baylis et al., 2016; Margoluis et al., 2013). They require first identifying long-term goals and then working backwards from these to identify the conditions that must be in place to achieve these goals (Center for Theory of Change, 2019). This approach can be effectively applied to complex socioecological systems because these systems often incorporate a range of environmental and human factors (Qiu et al., 2018). The pathways proposed to achieve the goals can be set up as testable hypotheses. The conceptual model or framework developed by a ToC allows clear identification of the reasoning behind actions implemented by mapping the chain of results that need to be achieved to meet the desired outcome, and by

identifying the actions needed to achieve these results (Margoluis et al., 2013). One benefit to this approach is that it allows adaptive management through monitoring and evaluation at each stage of intervention, rather than only monitoring whether the ultimate (sometimes intangible) goal has been achieved (Kapos et al., 2008; Margoluis et al., 2013).

We incorporated behavior change theory and research on its application to conservation issues in designing the ToC (McKenzie-Mohr, Lee, Schultz, & Kotler, 2012; Rare & The Behavioural Insights Team, 2019; Reddy et al., 2017). This included identifying barriers and benefits to current and desired behaviors, and developing strategies to target these factors (Table 1, McKenzie-Mohr et al., 2012). The theory of reasoned action proposes that for a person to perform a given behavior, one or more of several conditions must be true (Fishbein & Ajzen, 2010). These include: that there are no environmental constraints to undertaking the behavior and the person has the skills necessary to perform the behavior; the person believes that the advantages of performing the behavior outweigh the disadvantages; they perceive that there is normative (social) pressure to perform the behavior, and that the behavior is consistent with their self-image (Fishbein & Ajzen, 2010). We draw upon these principles in addressing social norms, existing power structures, and policy conditions (e.g., subsidies and legislation) that form the social landscape in the which dingo management is conducted.

For our study, the long-term goal is a shift away from lethal dingo control to support coexistence that benefits both dingoes and livestock producers, particularly cattle producers. As such, we identified the main behavior of interest to be engaging in lethal dingo control (by livestock producers). However, livestock producers' decisions about management are not made in a vacuum, and thus it is important to consider other “pressure points” in the broader context that could influence behaviors and outcomes and how other stakeholders' behaviors affect the behavior of livestock producers (Rare & The Behavioural Insights Team, 2019). As such, in developing a ToC, we also considered existing power structures, opportunities, and behaviors relevant to other stakeholders that may influence decision-making about dingo management. Our ToC aims to promote a more inclusive decision-making process. Our assessment of the relevant contexts and stakeholders is largely informed by the results of the lead author's (LvE) interdisciplinary PhD research on the social, political, and historical factors that shape dingo management (van Eeden et al., 2018; van Eeden, Dickman, Crowther, & Newsome, 2019; van Eeden, Dickman, Newsome, & Crowther, 2019; van Eeden, Newsome, Crowther,

TABLE 1 Overview of the four stakeholder groups included in our Theory of Change

Group	Justification for inclusion	Barriers to change	Opportunities and benefits of change
Australian public	Can be influential in shaping management of wildlife and pests in Australia	<ul style="list-style-type: none"> Limited awareness about dingoes and their management As such, change in management is not a priority for the public 	<ul style="list-style-type: none"> Can be influential in shaping management programs and outcomes for charismatic species Generally hold positive attitudes toward dingoes and negative attitudes toward lethal dingo control
Aboriginal Australian peoples	Typically have limited voice in decisions about dingo management (and that of other wild animals) and may offer an alternative view	<ul style="list-style-type: none"> Existing power structures often mean that Aboriginal Australians have limited voice in landscape scale management decisions outside of Indigenous Protected Areas Other issues (e.g., social, economic) take priority over conservation of specific animals 	<ul style="list-style-type: none"> Some groups have already expressed interest in changing current approaches to dingo management Engaging Aboriginal Australians in decisions about wildlife management could facilitate a stronger voice for them in landscape-scale decisions in general
Policy makers	Policy currently favors lethal control and encourages participation by landholders	<ul style="list-style-type: none"> Path dependency restricts changes to policy and programs Institutional social norms support dingo control Data on the role of dingoes in agricultural and ecological systems is limited and there is no scientific consensus on the costs and benefits of retaining dingoes 	<ul style="list-style-type: none"> Policy makers are accountable to taxpayers Current management is expensive and ongoing
Livestock producers and industry	These are the end-users of control tools so should be targets of behavior change efforts	<ul style="list-style-type: none"> Attitudes toward dingoes and associated behaviors are culturally engrained over 200 years Attacks on livestock can be highly emotive, driving individuals toward reactive, rather than preventative, dingo control In addition to cultural norms, current behaviors are supported by legislation and government funding 	<ul style="list-style-type: none"> Nonlethal methods can be just as effective (and in some cases more effective) for protection of livestock, particularly cattle Some producers (mostly of cattle) see benefit in retaining dingoes due to their role in suppressing competing herbivores Land managers see themselves as stewards of their land and will engage in behaviors that benefit biodiversity

Note: We outline justification for their inclusion along with barriers to change and possible benefits or opportunities associated with change for each of these groups.

Dickman, & Bruskotter, 2019; van Eeden, Newsome, Crowther, Dickman, & Bruskotter, 2020; van Eeden, Slagle, Crowther, Dickman, & Newsome, 2020; van Eeden, Smith, Crowther, Dickman, & Newsome, 2018), along with the expertise of the other three authors (CD, MC, TN) whose combined experience in research on dingo ecology and biology exceeds 49 years.

Based on our assessment of the social and political landscape in which dingo control is conducted, we

identified four key stakeholder groups who influence, or could influence, decisions and management: (a) the Australian public, (b) policy makers, (c) Aboriginal Australian peoples, and (d) livestock producers and industry representatives (Table 1). For the rest of the manuscript, we provide an overview of the relevance of each of these groups, including identifying barriers and benefits (or opportunities) of change relating to dingo control, and develop pathways to addressing each of

these themes. These pathways form the basis of the ToC (Figure 1). Each pathway represents a hypothesis that is yet to be tested.

2.1 | The Australian public

Public perspectives are important because tax-payer funding is used in dingo management and because the public has been a powerful agent in shaping the management of predators overseas (Feldman, 2007; van Eeden, Dickman, Ritchie, & Newsome, 2017), as well as some animals in Australia such as kangaroos and wild horses (McKinnon et al., 2018; Nimmo & Miller, 2007). In a public survey, we found that Australians had limited awareness of dingo management, held negative attitudes toward lethal control of dingoes, and supported retaining dingoes as top predators in Australian ecosystems (van Eeden, Newsome, Crowther, et al., 2019). This included similar (negative) attitudes toward lethal dingo control as those held toward killing kangaroos and horses (van Eeden, Newsome, et al., 2020; van Eeden, Newsome,

Crowther, et al., 2019), so we might expect that public backlash against dingo control would have similar outcomes (i.e., restricting lethal control actions by governments) if public awareness about dingo management improves. Raising public awareness may lead to support for conservationists advocating policy change for dingo management. This has occurred to some extent, with dingoes listed as protected in Victoria under the *Flora and Fauna Guarantee Act 1988* in 2008.

A key barrier to change occurring for dingoes is limited public awareness of current management practices. When describing management of wild canids in Australia, “wild dogs” is an umbrella term that is often used to include dingoes, feral domestic dogs, and dingo-dog hybrids. In a survey of the Australian public, we found that attitudes toward “dingoes” were positive but attitudes toward “wild dogs” were negative, 29% of people were aware that lethal control of dingoes occurs legally in Australia, and only 19% were aware that “wild dog control” includes control of dingoes (van Eeden, Crowther, Dickman, & Newsome, 2020). It has previously been suggested that use of the term “wild dog” to

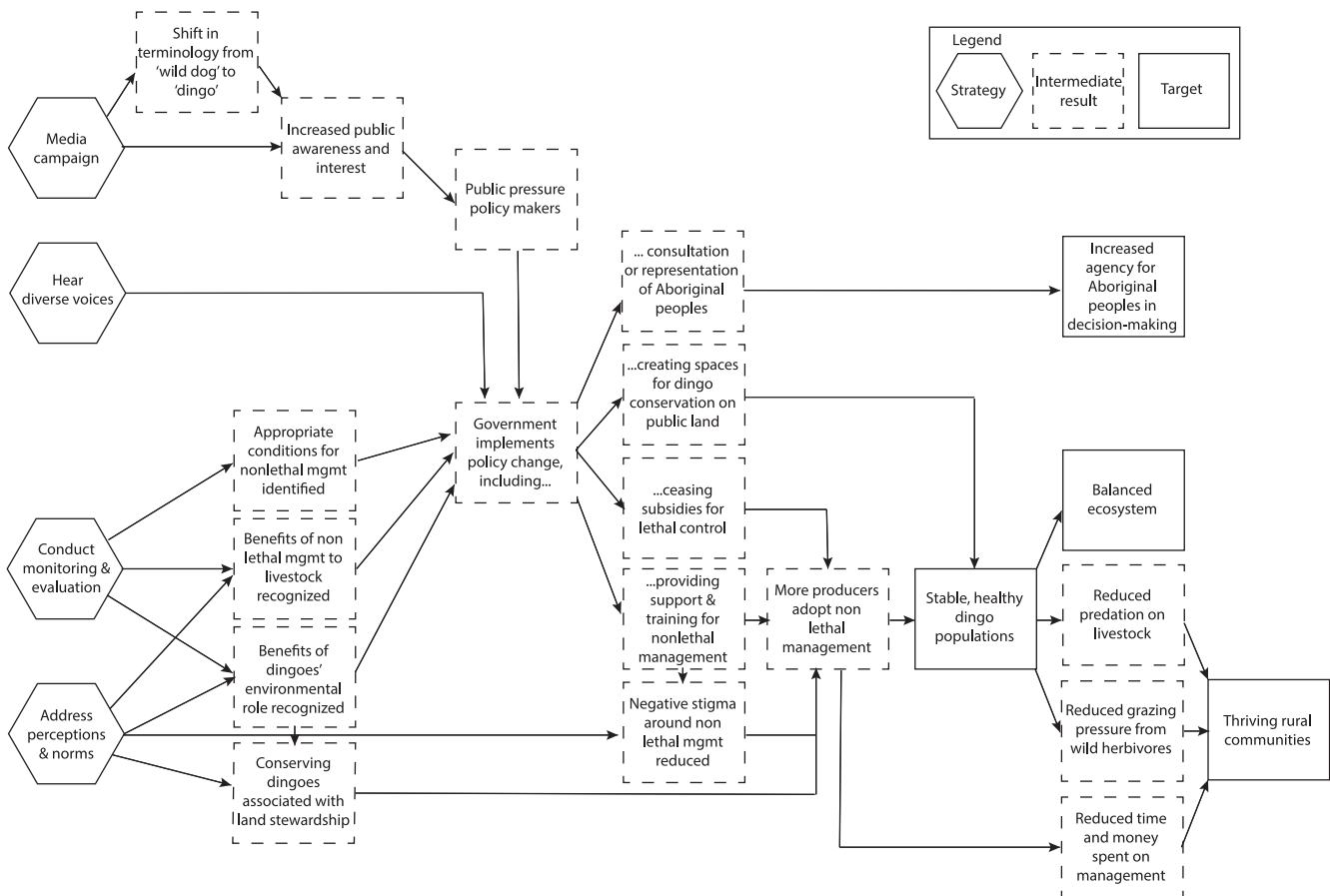


FIGURE 1 Theory of Change for promoting evidence-based management that facilitates healthy dingo populations and thriving rural communities

describe dingoes and their control has intentionally obscured public awareness (Hyttén, 2009; van Eeden, Dickman, Newsome, & Crowther, 2019), and whether the term “dingo” or “wild dog” is used by researchers is typically linked with whether the research is focused on conservation or agricultural contexts, respectively (Kreplins et al., 2018). We consider it likely that narratives surrounding dingoes have hindered public awareness because controlling “wild dogs” appeals to public support for culling of introduced species (Smith, 1999; van Eeden, Newsome, et al., 2020), whereas the term “dingo” affords the animal legitimacy because it is an Aboriginal word and it frames the dingo as an iconic animal which belongs to Australia (Hyttén, 2009; van Eeden, Crowther, et al., 2020).

As such, we propose that an appropriately framed media campaign to raise public awareness about current dingo management practices, including an overview of the terminology used to describe such management, could be an effective first step in driving the public to understand current policy and push for policy change, if desired (Figure 1). This change might result in restriction on use of baiting with poison or creating demand for increased research and support for appropriate nonlethal management methods. Given the controversy and animal welfare concerns around the use of poison baiting, the public and animal welfare groups would likely support a transition away from poison use.

2.2 | Policy makers

There are two important benefits to a reduction in (government-supported) lethal dingo control for government. These relate to accountability to the public (see above) and improved efficiency in government spending. Protecting the livestock industry is a priority for policy makers but the current focus is almost entirely on encouraging, subsidizing, or even mandating lethal control. Here, we outline how shifting away from policy that promotes lethal dingo control and toward adoption of nonlethal livestock protection tools could be implemented to provide benefits to the livestock industry and government based on appropriate research and monitoring.

Ultimately, livestock producers want management that protects their livestock in a cost and time effective manner. Since European arrival in Australia, there has been little standardized monitoring and evaluation of whether the methods employed at controlling dingoes are effective at reducing livestock losses (van Eeden, Crowther, et al., 2018), and thus limited evidence to inform management decisions. However, of the evidence

available, it appears that moving away from lethal control may be beneficial to some producers (van Bommel & Johnson, 2012; Wallach et al., 2017). Appropriate monitoring and research are needed to understand what works in protecting livestock from dingoes in different habitats (van Eeden, Crowther, et al., 2018), what role dingoes play in livestock production systems, and what role dingoes play in suppressing wild herbivores and introduced predators (Figure 1). This means shifting research efforts from focusing on the efficacy of lethal control in terms of its ability to control the target population (e.g., Ballard, Fleming, Meek, & Doak, 2020) to research that quantifies livestock losses in relation to dingo management interventions while simultaneously evaluating the environmental and agricultural costs and benefits of maintaining dingoes in the landscape. The findings of this research should form the foundation for identifying appropriate locations for coexistence with dingoes, combined with tools that predict the likelihood that targeted communities will adopt the desired management behaviors (Kuehne et al., 2017).

Given that not all livestock producers choose to use lethal control, despite cultural and government support to do so, it is important to understand the perceived barriers to adopting nonlethal management. A key factor shaping whether someone will engage in a desired behavior is whether they have the skills to do so (Fishbein & Ajzen, 2010). At present, lethal management methods like poison baiting and payments for bounties are supported by government agencies but, to our knowledge, there is no financial support or training provided for nonlethal methods like livestock guardian animals or improved animal husbandry. Given the potential for nonlethal approaches to benefit livestock production and alleviate public opposition to lethal methods, government and industry stakeholders should be promoting nonlethal methods where they are effective. Research is needed to identify these opportunities.

We propose that appropriate monitoring and evaluation should be incorporated into all government-funded dingo management programs. In addition, conservation advocates should identify means to fund research that finds where coexistence between livestock and dingoes is feasible. The results of this research can then be used to lobby for policy change that provides support for livestock producers who wish to use nonlethal methods and removes support for lethal methods where there is limited evidence of their effectiveness (Figure 1). Such changes could help shift practices on the ground by affecting (a) what management governments implement; (b) what kinds of support livestock producers have access to, that is, shifting from subsidies and training for lethal control to nonlethal management; and (c) social norms around appropriate responses to conflict with dingoes.

2.3 | Aboriginal Australian peoples

The continued, reckless culling of dingoes on Fraser Island, including the “camp dogs” at the K’Gari Camp, represents a continued attack on the rights and customs of the Butchulla people. Dispossess the dingoes and you dispossess us. (Aunty Marie, Butchulla Elder, media release 20th November 2012)

The dingo control practices carried out by settler-descendent Australians are perceived by some to be representative of conflict between Eurocentric and Indigenous land management objectives and ongoing marginalization of Aboriginal Australians (Carter, Wardell-Johnson, & Archer-Lean, 2017; Probyn-Rapsey, 2015; Rose, 2000). Cahir and Clark (2013) write of early European colonizers killing dingoes and camp dogs to drive Aboriginal peoples off their land, recognizing the strong emotional response elicited by the killing, and this practice continued into the 20th century. Like most wildlife in Australia, dingoes have cultural significance to many Aboriginal Australian peoples, which varies throughout the continent (Rose, 2000; Smith & Litchfield, 2009). However, outside of land under Native Title and some protected areas (e.g., Indigenous Protected Areas and areas that are jointly managed), landscape-scale decisions on dingo management are mostly made by representatives from pest control or agricultural interests (e.g., Australian Wool Innovation, 2020). Indeed, the power dynamics shaping decisions around environmental issues in Australia are generally Eurocentric (e.g., Nikolakis, Grafton, & Nygaard, 2015), although Aboriginal peoples are consulted and considered important stakeholders for the management of some pest animals (e.g., camels, Vertebrate Pests Committee, 2010; horses, donkeys, foxes, and cats, Central Land Council, 2020). Some Aboriginal Australian peoples have expressed opposition to lethal dingo control and even proposed reintroducing dingoes to areas from which they have been removed (Carter et al., 2017; Dja Dja Wurrung Clans Aboriginal Corporation, 2017). The quote at the beginning of this section stems from conflict over dingo management in tourist areas on K’gari Fraser Island. In this case, there has been increasing Aboriginal agency in park management decisions through establishment of an Indigenous Advisory Committee, although there is no formal co-management and tension over removal of dingoes remains (Carter et al., 2017). There may be isolated cases where Aboriginal peoples are consulted or even partnered in co-management, but there is still much to be done before Australia can claim processes that embrace full

participation of Aboriginal peoples in dingo management. For example, there is no suggestion that Traditional Owner groups have been consulted in the preparation of the major framework guiding dingo control to protect livestock, the National Wild Dog Action Plan, nor will be as part of its implementation (Australian Wool Innovation, 2020).

Researchers and government agencies are increasingly recognizing that their land management goals (e.g., increased biodiversity, fire hazard reduction) can benefit from traditional knowledge and ways of knowing country (Woodward, Hill, Harkness, & Archer, 2020). Likewise, bridging the perceived divide between Western and traditional knowledges can provide opportunities to afford Aboriginal agency in land management decisions, with cultural and social benefits to Aboriginal people (Adams, 2008).

There can be conflict between Aboriginal constructions of nature and Western ideas about wildlife conservation (Adams, 2008; Rose, 1995) and we acknowledge that Western concepts of dingo conservation and management will not be a priority for all Aboriginal Australian people, nor will all representatives from different Aboriginal nations consider that lethal dingo control should be reduced. It is precisely for these reasons that we think it is important that Aboriginal Australians are given the opportunity to contribute to such discussions. Facilitating this agency allows a more diverse perspective on land management in Australia and challenges the dominant power structure in contemporary management of Australian landscapes (Morris, 1992; Wolfe, 1994). Embedding diverse values, interests, and ways of knowing Country into dingo (and other wild animal) management decision-making platforms would be challenging, hindered by existing institutional cultures, lack of political will, and power imbalances. Nonetheless, promoting increased representation of Aboriginal Australians in decisions about management of dingoes and other wildlife would be a meaningful symbolic step in Australia’s path toward reconciliation.

The inclusion of Aboriginal Australians in resource management decisions on a wide variety of issues is patchy and piecemeal. Dingoes are an iconic example of this. We propose that it is time for a national dialogue, with development of guidelines, on integrating Aboriginal people’s interests in managing natural resources, such as wild animals, that transcend individual landowners. There is a need for a structured process to assure that local Aboriginal people’s concerns are fairly represented at national or state levels (e.g., development of wild dog action plans) and at local levels (e.g., local pest management boards). Because of their prominent place in Aboriginal culture, controversy surrounding their

management, and their impact on agricultural landscapes, dingoes represent a flagship opportunity to get this right.

2.4 | Livestock producers

Social and cultural factors can be important in shaping wildlife management behaviors. In a survey of Australian graziers, for example, we found that perception of the risk that dingoes pose to one's livestock, attitudes toward dingoes, values in relation to wildlife, and social identity were all linked with whether respondents used lethal dingo control (van Eeden, Slagle, et al., 2020). Indeed, the study revealed that whether respondents identified as “pest controllers” or “environmentalists” was the strongest predictor of dingo management behaviors, with pest controllers more likely to use lethal control, and environmentalists less likely to. These social and cultural factors have been shaped over generations of management of dingoes by colonizer-descendent land managers in Australia (van Eeden, Smith, et al., 2018).

In order to influence human behavior, such as that shaping dingo management, it is essential to understand what the target groups consider to be the barriers and benefits of the proposed changes, in contrast with the status quo (McKenzie-Mohr & Smith, 1999). While monitoring and evaluation might reveal that management could be improved, there are social and cultural factors that may override this evidence in shaping the behaviors of both land managers and government stakeholders. Therefore, appropriate approaches are needed to link nonlethal management with supportive social norms (Figure 1).

One barrier to shifting away from lethal control is that such practices are culturally engrained and promoted by some communities. Part of the success of the “nil tenure” approach in encouraging community engagement is that controlling dingoes is promoted as something that should be done to benefit the community: participating in dingo control conforms to social norms, even if individuals do not personally benefit from doing so (Ecker, Aslin, Zobel-Zubrzycka, & Binks, 2015; Howard, Thompson, Frumento, & Alter, 2018). This appeal to social norms presents a barrier to moving away from lethal control as livestock producers may not wish to be alienated by their peers if they choose not to control dingoes (Burdon, 2017; Pollock, 2019). Raising awareness about the successes achieved by producers engaging in nonlethal management may not only directly influence behaviors of other producers who see the advantages of these practices but could also influence social norms.

Some producers may be dissuaded from using nonlethal methods because of pressure from their neighbors, and in the same vein they may be reluctant to share their experiences with their neighbors out of fear of how they may be viewed by their peers. Providing a platform for dingo-friendly farmers to share their experiences may address social stigma and norms about nonlethal dingo management. This approach has commenced, with Facebook groups called “Dingoes Cattle Roos” and “Predator Friendly Network” formed with the aim of providing producers who use nonlethal methods with a platform to share their experiences, while at the same time normalizing nonlethal management among producers.

Path dependence shapes dingo management behaviors not just through individuals' reluctance to change, but also because these social norms surrounding dingo management have been engrained within Australian culture over decades of lethal dingo control. In the case of the dingo, many stakeholders, particularly those who identify as “pest controllers” (van Eeden, Dickman, Crowther, & Newsome, 2019; van Eeden, Slagle, et al., 2020), see managing dingoes as a duty, beneficial to both livestock production and the environment whereas graziers who identify as environmentalists are less likely to engage in lethal control (van Eeden, Slagle, et al., 2020). A campaign to promote coexistence with dingoes should include appropriate messaging that seeks to change attitudes toward dingoes, reframing them as valuable by recognizing benefits they might have in reducing grazing pressure (egoistic values) and suppressing introduced pests (biocentric values), where appropriate (Kusmanoff et al., 2016). Effective messaging strategies can include segmenting the population to develop group-appropriate framing based on social norms (Kidd et al., 2019). For example, appealing to an environmentalist identity may be effective in promoting dingo-friendly farming behavior among those who identify as environmentalists but still use lethal control (van Eeden, Slagle, et al., 2020). If small numbers of influential community members are successful in adopting nonlethal management, they may lead by example, inadvertently encouraging neighboring farmers to adopt the same or similar approaches, a process termed “social diffusion” (McKenzie-Mohr & Smith, 1999; Rogers, 1995). At present, we do not fully understand what “environmentalist” and “pest controller” identities mean in a rural Australian land management context and how the dingo and its management fit with these identities. Thus a targeted campaign would benefit from localized studies of community identities (van Eeden, Slagle, et al., 2020).

While environmentalists might be more easily persuaded to adopt nonlethal management, promoting the potential benefits of dingoes to ecosystems or livestock

production systems is not likely to achieve the desired behavior change for all stakeholders (Kusmanoff et al., 2016). Indeed, some farmers will change their landscape management because of perceived on-farm benefits, such as to the environment or animal husbandry, while others can be influenced to change by external pressure (Bewsell, Monaghan, & Kaine, 2007). In New Zealand, environmental concerns were raised about the impacts of the dairy industry on water quality and so a campaign pushed for dairy farmers to fence cattle out of waterways on their property. Rather than targeting farmers, the campaign targeted policy makers and tried to publicly shame the dairy industry so that big dairy businesses (e.g., Fonterra) would try to improve their image. Policy change and industry pressure resulted in high compliance among farmers (McKenzie-Mohr et al., 2012). For the dingo, lobbying government and industry leaders could be a useful tool for achieving policy and management changes needed to allow coexistence, alongside working with communities to influence behaviors. Consumer disapproval of lethal dingo control might pressure industry leaders to promote change, linking with a media campaign as outlined above.

We propose that, alongside monitoring and evaluation to inform evidence-based management and identification of appropriate opportunities for implementing nonlethal interventions, a campaign should be developed to encourage behavior change by policymakers, industry leaders, and land managers, building on evidence to address perceptions and social norms (Figure 1). The plan should be targeted to suit local contexts by identifying (a) what kind of management is most suited to the environmental, economic, and social conditions; (b) who (individuals, government/industry representatives, or other groups) is likely to be persuaded and who is influential within the community; and (c) how identities and other social factors are linked with management behaviors in those areas so that social identity can be incorporated into an effective strategy. This strategy would need to be driven by advocates with enough legitimacy and resources to challenge the well-resourced campaigns that promote dingo destruction by government agencies and industry groups such as Australian Wool Innovation, Meat and Livestock Australia, and the Centre for Invasive Species Solutions. These might be a combination of well-recognized individuals, advocacy groups and nongovernment organizations such as dingo conservation groups (e.g., Australian Dingo Foundation, Western Australian Dingo Association) or animal welfare groups (e.g., Humane Society International, Voiceless), with support from researchers in dingo conservation and management (including the IUCN Canid Specialist Group “Dingo Working Group”).

3 | CONCLUSION

Understanding human dimensions is critical to shaping the future of wildlife management in Australia. For dingoes, the available evidence suggests that coexistence with some kinds of livestock production is possible and may even benefit producers. What is needed is political will and a culture shift, a difficult task when behaviors have been deeply engrained for over a century. Drawing on the findings of studies of Australian public attitudes and awareness and grazer attitudes and behaviors toward dingoes, we suggest that a combination of appropriate monitoring and evaluation, raising public awareness, more inclusive decision-making groups, and messaging tailored to suit rural social norms and cultures may form important steps to shifting toward evidence-based, nonlethal policy and management (Figure 1).

We recognize limitations to this proposal, including that there may be limited community support or political will to encourage changes via any of these four proposed mechanisms. However, our ToC provides a framework for testing our proposals and revising the pathways as new information becomes available. For example, we do not know how representatives from different Aboriginal nations will perceive the dingo management debate and thus do not know what result increasing Aboriginal agency would have on management. We also do not know what the outcome of increased monitoring and evaluation will be, and whether new data will help solve the debate. Increased transparency may not result in public opposition toward management, and there may be no consumer demand for dingo- (or wildlife-) friendly livestock products. Nonetheless, we consider that our proposal to make decisions about dingo management more transparent, more inclusive, and supported by evidence, will benefit the management system and stakeholders within it regardless of how these changes take place.

Changing management systems that are engrained in culture and behavior is difficult. Making progress in this direction would be important for dingoes and the benefits they bring to ecosystems, but would also show that Australian conservation scientists and advocates can be optimistic about making positive change to other issues by incorporating human dimensions into their research and strategies.

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